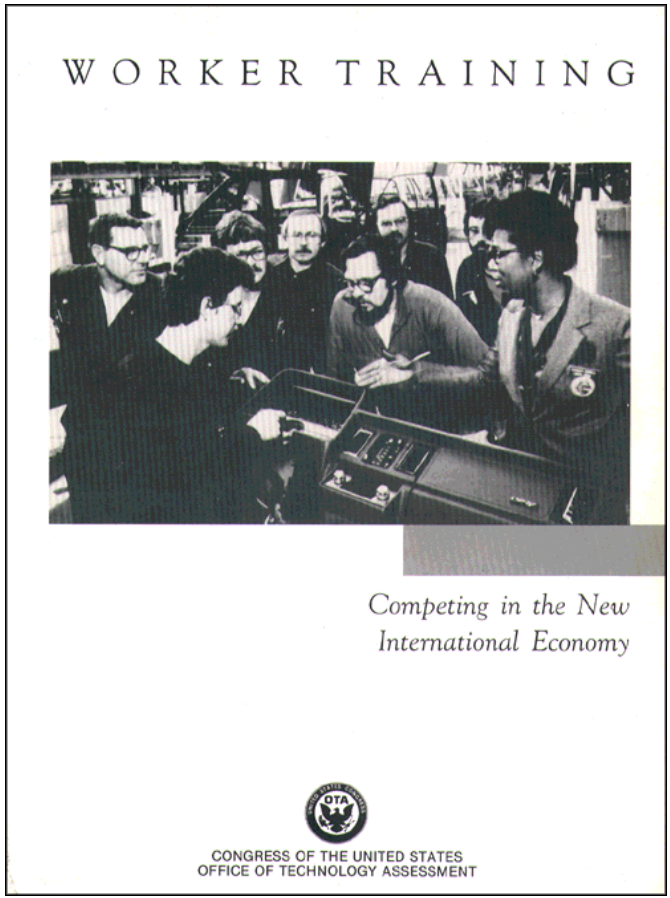
Worker Training: Competing in the New International Economy

September 1990

OTA-ITE-457
NTIS order #PB91-106716
GPO stock #052-003-01214-6



Recommended Citation:

U.S. Congress, Office of Technology Assessment, *Worker Training: Competing in the New International Economy, OTA-ITE-457* (Washington, DC: U.S. Government Printing Office, September 1990).

For sale by the Superintendent of Documents
U.S. Government Printing Office, Washington, DC 20402-9325
(order form can be found in the back of this report)

Foreword

Effective use of technology depends as much on people as on the technology itself. This has never been more true than it is today. The once great technological advantage of American firms has narrowed in many industries. Increasingly, the competitive edge will go to the company or country with flexible, well trained workers who can adjust quickly to rapidly changing demands and who have the skills to fully exploit new technology. Such workers are key to the creation of more productive, effective enterprises-the kind likely to contribute to raising living standards.

The stakes are high-for America's position in the global economy, for national living standards, and for the individual worker. Many of our competitors have well educated, highly skilled workforces, who are paid less than our own, and receive more training. Clearly, we can't compete with these countries on the basis of wages without sacrificing living standards. If we are to avoid falling behind, far more American companies (and other institutions, public and private) will need to develop and tap their employees' skills at all levels. The few leading edge American companies that have done this find that they must make major commitments to training, both in resources and attention to quality, and that the training must reach all levels of the workforce-not just managers, professionals, and technicians. Often, these companies have discovered that they need to upgrade the basic skills of their workers before the workers can benefit from training.

For such reasons, employee training, once a minor concern in American industry and largely ignored in public policy, must move toward center stage. This report, requested by the Senate Labor and Human Resources Committee, the House Education and Labor Committee, and the Senate Finance Committee, focuses on the training given to employed workers both from the standpoint of the competitiveness of U.S. industry and from the standpoint of the individual worker who may need training to advance. Most workers who get training get it from their employer, and much of the report looks at the employer provided training system. The message of this report is that the debate about national training policies needs to be broadened to encompass not only training programs for the economically disadvantaged, the displaced worker, or people with special needs, but also those who stand on the front line of American productivity-employed workers at all levels.

John H. Gibbons
Director

Advisory Panel—Workplace Training: Competing in the New International Economy

Donald N. Frey, *Chairman*
Department of Industrial Engineering and Management Sciences
Northwestern University

Paul E. Barton
Director
Policy Information Center
Educational Testing Service

John H. Bishop
School of Industrial and Labor Relations
Cornell University

Waker H. Bruning
Consultant
Process Management Institute

Anthony P. Carnevale
Chief Economist and Vice President,
National Affairs
American Society for Training and Development

Peter S. DiCicco
President District 2
International Union of Electronics, Electrical
Technical, Salaried and Machine Workers

Patricia M. Flynn
Institute for Research and Faculty Development
Bentley College

Badi G. Foster
President
Aetna Institute for Corporate Education

Paul Funk
Major General
Us. Army

Robert W. Glover
Center for the Study of Human Resources
The University of Texas at Austin

Annie L. Hill
President Local 7904
Communication Workers of America

Malcolm S. Knowles
Professor Emeritus
North Carolina State University

Harry M. Lasker
Vice President
Applied Learning

Ira C. Magaziner
President
SJS, **Inc.**

Larry W. McMahan
Vice President for Human Resources Development
Federal Express

James R. Morns
Executive Director
State Board for Technical and Comprehensive
Education, South Carolina

William Pechstedt
President
Sanford-Lussier, Inc.

Ernest J. Savoie
Director
Employee Development Office
Ford Motor Company

Gail Spangenberg
Vice President
Business Council for Effective Literacy

A. William Wiggenhorn
Corporate Vice President for Education
and Training
Motorola, Inc.

Joan L. Wills
Vice President
National Center on Education and the Economy

NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

OTA Project Staff—Workplace Training: Competing in the New International Economy

Lionel S. Johns, *Assistant Director, OTA*
Energy, Materials, and International Security Division

Audrey Buyrn, *Manager Industry, Technology, and Employment Program*

W. Wendell Fletcher, *Project Director*

John A. Alic, *Senior Associate*

Margaret L. Hilton, *Senior Analyst*

Gretchen Kolsrud, *Senior Associate*

A. Jenifer Robison, *Senior Analyst*

Stephen E. Baldwin[1] Joan G. Erhardt Michael J. Feuer

Gale R. Morse[2] Willie Pearson, Jr.[3]

Administrative Staff

Carol A. Guntow, Office *Administrator*

Christopher N. Clary, *Office Administrate@*

Diane D. White, *Administrative Secretary*

Publishing Staff

Katie Boss, *Publishing Officer*

Cheryl Davis Dorinda Edmondson Steve Kettler

Chip Moore Christine Onrubia Susan Zimmerman

Contractors

Columbia University
Paul V. Delker
Ronald Dore and David Cairncross
Ralph E. Grubb
Larry D. Hirschorn
Thomas J. Hoffman
Industrial Technology Institute
Greg Kearsley
John F. Krafcik
Joe W. Lee and Youngho Lee
Robert R. Miller
Northern Illinois University
Lynn M. Powers
Frances R. Rothstein
Technology Management Group

[1]Detailee, National Commission fOr Employment Policy.
[2]0TA fellow.
[3]OTA fellow.
[4]Until June 1990.

Contents

Chapter 1

Summary

CONTENTS

Boxes

Figures

Tables

Chapter 1
Summary

The quality of the U.S. workforce matters now more than ever. Well-trained, motivated workers who can produce high-quality goods and services at low cost help enhance industrial productivity and competitiveness and keep American living standards high. In today's international economy, workers must be prepared to change the way they do their jobs in order to capture the benefits from rapidly evolving technology. Training goes hand-in-hand with productivity, quality, flexibility, and automation in the best performing firms.

Good training pays off—for the individual worker whose skills are upgraded, for the company seeking a competitive edge, and for the Nation in overall productivity and competitiveness. Conversely, inadequate training costs firms and workers—in downtime, defective parts or equipment, wasted material, health and safety risks, late deliveries, and poor customer service. Poor training also can delay the implementation of new technology or work reorganization.

When measured by international standards, most American workers are *not well* trained. Many in smaller firms receive no formal training. Larger firms provide more formal training, but most of it is for professionals, technicians, managers, and executives. Our major foreign competitors place much greater emphasis on developing workforce skills at *all* levels. Experienced production workers at Japanese auto assembly plants, for example, get three times as much training each year as their American counterparts.

American manufacturing and service workers have the skills for yesterday's routine jobs. But, these workers will need new skills to function well in the more demanding work environments that increasingly characterize competitive industries able to provide high-wage jobs. Skills and responsibilities are broadening. Competitive manufacturing and service firms will increasingly rely on employees with good higher order skills-reasoning and problem-solving. Work reorganization forces employees to take more responsibility, cooperate more closely with one another, understand their roles in the production system and in the organization, and act on that knowledge. These changes require good worker training.

The need for better training is clear in both manufacturing and service industries. American manufacturers have repeatedly lost out to foreign competitors who are able to make more reliable products with better features at lower cost. In many of the service industries, it is domestic competition, shifts in consumer demand, and deregulation that have forced companies to reassess their management and training policies. Like manufacturers, service firms compete on the basis of price (e.g., for insurance), quality (e.g., rapid but accurate response to customer inquiries), and flexibility (e.g., new banking products). Many services now depend on redesigned production systems built around dispersed computing power and on employees with the social skills to interact with customers. They need workers who are motivated, managed, and trained in new ways.

Simply providing more training will not promote industrial competitiveness, however. If work is not organized to tap employees' skills, the firm's investment will be wasted. In addition, training must be focused on workplace problems and delivered effectively. Techniques such as relating training more closely to business goals, following instructional development principles, and effectively using training technology can improve the quality of training and increase its chances of transferring back to the job. Yet, systematic efforts to apply these techniques are still rare outside of sophisticated firms with large training budgets. Most training programs lag far behind the state-of-the-art.

Demographic change is shaping training needs. Over the rest of the century, the labor force will expand more slowly than at any time since the 1930s. In 2000, the average worker will be nearly 40 years old, compared with 36 today. Keeping this slowly aging workforce up-to-date and flexible will require ongoing training. Many new entrants will come from minority groups that historically have received less education. New entrants in general need better basic skills, including reading, writing, arithmetic, and oral communication, as will many Americans already in the labor force. In part because

American workers are so mobile, especially when they are young, most companies offer training only sporadically, such as when introducing new equipment. Moreover, few American workers voluntarily upgrade their skills for job advancement.

Our major trade competitors provide more and better worker training. Their governments offer both financial and technical support to firms and workers for training. Our competitors also provide better basic education. On average, young Americans have lower academic competencies than young people in several other industrialized countries. Moreover, in other industrialized nations, training and learning on the job are seen as a continuing need. More than ever before, the international economy pits the U.S. workforce against those in other countries. The worse the United States fares in this competition, the more American industrial competitiveness and living standards will slide. American companies can move some of their operations abroad; few American workers have that choice.

Over the long term, improving the educational system and developing more effective ways to help young people make the transition from school to work will be crucial to the Nation's continued economic success. Yet, people already at work will comprise a majority of the workforce over most of the next two decades. In the near term, their training will have the greatest influence on national competitiveness. While the need to improve the schools has been the focal point for much debate, policymakers have only recently begun to turn their attention to the continuing training and education needs of employed workers.

The U.S. Government now does little to influence corporate training. With a few exceptions (e.g., small grants to demonstrate ways to improve the basic skills of workers), federally sponsored training programs focus on the unemployed or economically disadvantaged. State governments provide only very modest direct support to corporate training in economic development programs, plus indirect support through community colleges.

New institutional structures will be needed to make affordable training available to employees of small businesses and other firms with limited resources. A variety of approaches, including industry training consortia, involvement of employer organizations in training, State assistance programs, and joint labor-management programs promise to enhance the scope and quality of training. Such efforts currently are very limited, however.

For a slowly increasing number of businesses, training *is* becoming an integral part of competitive strategy-key to continued growth. When improving their production systems, however, most American firms focus on investments in hardware-equipment and physical plant—rather than on the people who will make the hardware perform. When managers treat their workforces as adjuncts to technology instead of as capital assets, they fail to capitalize on employee skills and to reap the rewards that can come from blue-collar innovation.

This assessment, requested by the Senate Labor and Human Resources Committee, the House Committee on Education and Labor, and the Senate Finance Committee, examines employee training issues from the standpoint of maintaining a competitive workforce. The assessment analyzes the forces that are shaping training today, and describes the extent of current U.S. employer-provided training compared with that of our major competitors. The assessment also examines trends in instructional technology and their use in training programs. Finally, it presents options Congress may wish to consider to encourage employer-provided training, improve the quality and effectiveness of training, link training and technology assistance, and provide retraining to individuals for career advancement.

THE CHANGING AMERICAN WORKPLACE

American firms are competing with foreign rivals that are much more competent today than just a few years ago. The competitive pressure will only grow stronger over the coming decades as more companies in more parts of the world master the skills needed to export or to compete with imports in their domestic markets.

Cost, quality, and flexibility determine competitive outcomes. Success in producing high-quality goods at low cost comes from highly developed production systems that effectively couple product and process design, work organization, and shop-floor management.

Many U.S. firms lag behind their competitors in introducing flexible automated production systems that can offer the variety that consumers expect and the just-in-time deliveries that corporate customers

demand. American firms also lag in the reorganization of work—and the worker training-needed to improve quality and flexibility. These problems show in the marketplace (e.g., when America's drivers purchase imported cars or when foreign banks underwrite bonds for American corporations).[1]

The higher the competitive standing of U.S. industries in the international economy, the higher will be average U.S. living standards. To pay wages commensurate with American living standards, U.S. firms must equal or surpass their foreign counterparts in productivity or quality. And, the competitiveness of small firms and the services matters even if their products do not trade internationally. Many of these businesses supply other firms that do export or compete with imports. Suppliers' costs, quality, and productivity directly affect those of their corporate customers. As most new jobs in the United States over the next several decades will be in the services, the strength of service industries will be critical to living standards. Small firms of all types also will create proportionately more jobs than their total share of employment.

Faced with ever more intense competition, U.S. firms are searching for strategies that offer sustainable long-term advantages. While the mass production era has not ended, the rules for success have changed (see table 1-1).[2] The changes summarized in table 1-1 and in the discussion below are in their early stages. A few American firms have already reorganized along these lines. Many others are taking tentative steps, experimenting with new approaches. Smaller U.S. companies, in particular, have been slow to grasp the new forces at work and their implications for training.

Some American companies that have radically altered how they do work have emulated Japanese production systems, which depend heavily on motivated and capable employees to prevent or catch product defects. Japanese firms also seek stable, long-term relationships with smaller groups of frost-tier suppliers that are expected to be sensitive to customers' day-to-day needs. To be responsive to shifting market demands and provide more customization for individual clients, Japanese companies also design products for ease and speed of manufacturing. Finally, they emphasize employee involvement and job rotation backed up with substantial—and ongoing-training. American companies that have adapted this model have found that their workers can achieve levels of productivity and quality equal to the best in the world.

U.S. multinational firms must achieve productivity levels equal or superior to their competitors abroad; everything else the same, such firms will locate plants in countries where costs are lowest and productivity and quality highest. Multinationals are seeking to combine operations in the major industrial nations into a globally integrated whole while geographically dispersing design, development, production, distribution, and marketing (see chs. 3 and 4). American workers might be expected to help schedule production to coordinate with foreign deliveries, or they may need to cooperate with their counterparts in factories overseas to solve quality problems. Globalization also can bring new workplace technology (e.g., computer networks for worldwide inventory control), rapid changes in the goods a factory produces, and frequent minor changes to accommodate national markets (e.g., labeling in local languages).

At the same time, the United States has special significance for foreign multinationals. As the largest market in the world, the United States is a magnet for goods and investment from abroad. Any foreign firm that aspires to global success must be competitive here. This means jobs and opportunities for American workers. It also means that foreign-owned plants in the United States will continue to be sources of new ideas in production management. Foreign-owned consumer electronics firms introduced new concepts during the 1970s and 1980s; more recently U.S. auto assembly plants operated by Honda, Toyota, and other have been trendsetters in productivity and training.

---

[1]OTA's ongoing assessment of Technology, Innovation, and U.S. Trade involves three reports on competitiveness in manufacturing. The first in the series analyzes the role of manufacturing in the U.S. trade deficit; see *Paying the Bill: Manufacturing and America's Trade Deficit* (OTA-ITE-390). For policies to restore the technological leadership in manufacturing, see *Making Things Better: Competing in Manufacturing* (OTA-ITE-443). *The third* report, due in spring 1991, will examine the trade and industrial policies of Japan, other East Asian countries, and the European Community and their possible relevance to U.S. competitiveness. An earlier OTA report dealt with service industries; see *International Competition in Services* (OTA-ITE-329).

[2]A more comprehensive version of table 1-1 maybe found in ch. 4 as table 4-3.

Table I-I-Changing Organizational Patterns in U.S. Industry

Old model Mass production, 1950s and 1960s	New model Flexible decentralization, 1980s and beyond
Overall strategy	
• Low cost through vertical integration, mass production, scale economies, long production runs. • Centralized corporate planning; rigid managerial hierarchies.	• Low cost with no sacrifice of quality, coupled with substantial flexibility, through partial vertical disintegration, greater reliance on purchased components and services. • Decentralization of decisionmaking; flatter hierarchies.
Production	
• Fixed or hard automation. • Cost control focuses on direct labor. • Outside purchases based on arm's-length, price-based competition; many suppliers. • Off-line or end-of-line quality control. • Fragmentation of individual tasks, each specified in detail; many job classifications. • Shopfloor authority vested in first-line supervisors; sharp separation between labor and management.	• Flexible automation. • With direct costs low, reductions of indirect cost become critical. . Outside purchasing based on price, quality, delivery, technology; fewer suppliers. . Real-time, on-line quality control. . Selective use of work groups; multi-skilling, job rotation; few job classifications. • Delegation, within limits, of shopfloor responsibility and authority to individual and groups; blurring of boundaries between labor and management encouraged.
Hiring and human relations practices	
• Workforce mostly full-time, semi-skilled. • Minimal qualifications acceptable. • Layoffs and turnover a primary source of flexibility; workers, in the extreme, viewed as a variable cost.	• Smaller core of full-time employees, supplemented with contingent (part-time, temporary, and contract) workers, who can be easily brought in or let go, as a major source of flexibility. • Careful screening of prospective employees for basic and social skills, and trainability. • Core workforce viewed as an investment; management attention to quality-of-working life as a means of reducng turnover.
Job ladders	
• Internal labor market; advancement through the ranks via seniority and informal on-the-job training.	• Limited internal labor market; entry or advancement may depend on credentials earned outside the workplace.
Training	
• Minimal for production workers, except for informal on-the-job training. • Specialized training (including apprenticeships) for grey-collar craft and technical workers.	• Short training sessions as needed for core workforce, sometimes motivational, sometimes intended to improve quality control practices or smooth the way for new technology. • Broader skills sought for both blue-and grey-collar workers.

SOURCE: Office of Technology Assessment, 1990.

The new flexible decentralization model in table 1-1 has two central themes: 1) reorganizing production so that lot sizes can be smaller and production runs shorter with little sacrifice in efficiency, and 2) transferring decisionmaking authority downward and outward to semiautonomous divisions and/or the shopfloor. Both these trends are reinforced by U.S. industry's growing reliance on outside sources of labor (contract employees), expertise (engineering services), and tangible inputs to production (purchased components and sub-assemblies).

Those American firms that have redesigned their production operations most effectively have done so systemwide. The needed perspective encompasses not only selection of machines and factory layout, but design of products for efficiency in manufacturing, appropriate allocation of tasks among people and machines, and careful coordination of production flow. These firms are decentralizing, flattening their management hierarchies, and purchasing more on the outside, all in the interests of cutting costs, improving quality, and responding more quickly to market demands. To be effective, these changes require substantial training for employees at all levels.

THE NEED FOR TRAINING

Many American workers are ill-equipped for the sweeping changes industry must make to be competitive. Their jobs may not have required strong basic skills, teamwork, or higher order skills such as problem-solving. In the future, many more jobs will require these skills. But the need for training and retraining is not just a matter of meeting the needs of growing sectors, growing occupations, or companies hard-pressed by inter-

Photo credit: UAW-Ford National Education, Development and Training Center

Growing computer use means more workers need to develop their computer skills. This training facility is jointly sponsored by a cooperative union-management program.

national competition—it is critical throughout industry if the United States wants a high-wage, high-skill economy.

Training for the Workplace of the Future

Nearly half of business investments for capital equipment now go for computers and related technologies. Personal computers and other inexpensive terminals collect data on the factory floor, track inventories, and help schedule production. Statistical process control reduces variance in production by tracking process parameters (e.g., temperature, pressure) over time and examining the trends in those parameters to determine the limits beyond which product quality begins to deteriorate. Computer-aided design systems automate drafting and graphics and maintain databases of drawings and specifications. While computer-integrated manufacturing remains a dream more than a reality, companies are slowly but surely learning to capitalize on flexible automation. Service firms rely more and more on decentralized computer systems for data processing, for tracking inventory and sales, and for delivering their products.

To be used effectively, these technologies will require workers to learn new, very different skills. While some jobs become less demanding with automation, many others become more complex because of the mix of tasks assigned to workers and the speed of production (see box l-A). Emphasis on quality and prevention of mistakes requires employees to have a broader understanding of the production process. With statistical process control, for example, machine operators may also have to enter data and construct and interpret control charts. These tasks may require basic arithmetic skills as well as an understanding of how one step in the production process relates to others.

Companies with flexible design, development, and production systems rely on workers to anticipate possible problems, eliminate bottlenecks, avoid production shutdowns, and ensure quality. Increasingly these systems include continuous improvement *(kaizen)* programs that focus on cutting costs, improving quality, and reducing waste and scrap. Workers participate in group problem-solving meetings and employee involvement programs. They need strong social and communications skills to fit into a group, contribute effectively, and convey information about group actions or suggestions.

Many American firms have found training employees for new technology more difficult than anticipated. Many workers need to upgrade their basic skills before they can handle other training. Narrowly focused training, common in the past, is likely to be ineffective in achieving corporate goals for implementing new technology when the context is the total production system. Moreover, problem-solving and teamwork are new objectives for non-managerial training in the United States, and the most effective approaches have yet to be defined clearly.

New forms of work organization push responsibility and authority downward in the corporate hierarchy, from line managers and staff engineers toward the shopfloor. Information systems bring business data previously restricted to managers—incoming orders, unique customer requirements, production schedules, cost and sales projection directly to the factory floor. Shopfloor groups often must know how to interpret such information and apply it to their work. This change, more than any other, promises to fundamentally alter traditional workplace hierarchies and to create a new set of training requirements.

Job classifications are broadened, with tasks such as inspection and quality control, routine maintenance, and equipment calibration transferred to semiskilled workers. In the auto industry, for example, traditional U.S. assembly plants have 80 to 95 job categories, compared with 2 to 4 in the U.S.

Box l-A—Job Opportunities and Skills: Growing Mismatch

Will automation and other technological changes downskill the workforce-making jobs simpler, less demanding, hence less deserving of wage premiums? Or will a higher skill workforce be imperative for using technology in ways that will enhance competitiveness, hence raising wages and living standards? Does the machine-particularly the computer-automated machine in the factory or in the office-replace human skills, or extend and supplement them?

Such questions have been debated for years. The only unambiguous answer is "yes and no." The scale and complexity of the Nation's economy, along with poor measures of skill, make other conclusions hard to defend. And yet, what might seem an academic question has implications for training policy and for the careers of workers. This box summarizes findings from later chapters (especially chs. 3,4, and 6) concerning upskilling/downskilling questions, and the probable mismatch between the better job opportunities generated by the U.S. economy and the skills of much of the labor force.

Neither Upskilling Nor Downskilling, But Both

Technological innovations may raise skills needed for some jobs while stripping skill away from others. In the early years of numerically controlled (NC) machining, generating and debugging programs was quite difficult, and typically assigned to engineers or other specialists (see app. 4-A, ch. 4) Machining jobs were deskilled, in some cases to little more than machine monitoring. Today, preparing NC programs is easier, more like working with word processing equipment. Those machinists who now prepare their own programs (a few always have) find their jobs upskilled. The new skills are mental (planning a sequence of cuts and programming it) rather than manual (set-up, gaging, tool sharpening). But eventually, most of the simpler NC programs will themselves be prepared automatically. People will handle only the exceptions—make decisions that cannot be left to an automated system—resulting in another round of deskilling. As this example suggests, the overall dynamics of cycles of downskilling, upskilling, and reskilling are not easily predicted from short-term trends.

What about the aggregate picture? To get a handle on future skill and occupational needs, it is useful to think of the economy as consisting of just two groups: traditional and knowledge-intensive sectors (see app. 3-A in ch. 3). While the two groups now employ roughly the same number of people, the knowledge-intensive sectors (including high-technology manufacturing, health services, and business services) are growing more rapidly and will create more new jobs than the traditional sectors (e.g., retail trade, personal services, traditional manufacturing).

Of course, some jobs in the traditional sectors require a great deal of know-how (e.g., the skilled trades) and many jobs in the knowledge-based sectors require little knowledge or skill (hospital orderly). Moreover, jobs and skills in both sectors are affected by restructuring and automation (e.g., the computerized systems used for ordering, inventory control, and on the sales floor in retailing). But the traditional sectors create low-skilled and low-paying jobs in larger proportion. More of the jobs in the knowledge-intensive sectors are technical, administrative, or otherwise specialized; they are likely to require education/training credentials for entry. In health care, for example, job and skill categories continue to expand, in part due to new technologies. Some familiar jobs have changed dramatically-technicians in pathology laboratories now work with automated equipment alongside their microscopes, for instance-while diagnostic techniques like magnetic resonance imaging require new sets of skills for both maintenance and use.

Mobility and Demographics

The simplified two-sector picture of the economy-one sector in which skill requirements change relatively slowly (in both directions), the other characterized by more rapid flux-can now be contrasted with the labor market (also divided into two parts), As described in chapter 3, the lower tier of the labor market consists of poorly paid occupations (e.g., clerk, custodian, waitress) that have not generally required much education. The upper tier includes managerial, administrative, technical, and professional or paraprofessional occupations (many though not all quite well paid, but most requiring education/training credentials). The traditional sectors generate low-tier jobs in large numbers, along with some upper tier jobs. The knowledge-intensive sectors generate jobs in both tiers.

Atone time, people of ability and ambition could, with on-the-job experience, climb beyond the lower tier with relative ease. Today, specialized education or training may be required simply to enter a track promising upward mobility. Many employers even screen applicants for jobs usually regarded as unskilled for credentials that suggest trainability. Relatively speaking, there will be fewer opportunities for people without credentials to prove themselves in the workplace and then to advance.

These shifts mirror a population in which more and more Americans take some college courses. While the relation between years of schooling and job performance is loose, people who lack basic skills and/or the credentials to find a job that promises upward mobility will be left behind. In the years ahead, more young workers seeking entry-level jobs will be blacks and Hispanics who on average have received less education than whites. Some will be immigrants, with poor language skills. During the boom years of mass manufacturing, lack of schooling or poor basic skills were no handicap to getting a job in a textile mill or an auto plant. Today, they are. Automation and foreign competition have cut into blue-collar manufacturing jobs, and technological change has raised the skill requirements for many of those remaining. Many jobs in the services require employees at home in dealing with the public. Without substantial changes in the performance of the U.S. education and training system, the mismatch between jobs and job opportunities and the skills and abilities of the workforce will grow. There will be too many people who can qualify only for the least demanding of jobs, too many people who will not be able to move upward. There will be too few people with the skills needed to drive innovation and economic growth.
SOURCE: Office **of Technology** Assessment 1990.

plants operated by Japanese automakers (at a minimum, production and maintenance workers). When group members rotate among jobs, multiskill training becomes important. Job rotation not only adds flexibility (workers can help and cover for one another), it brings variety to the workplace and helps morale.

These changes also require new forms of management and professional training. First-line supervisors will spend more time on planning and coordination than direct oversight of production. They must be retrained to oversee work groups, which calls for skills in facilitating change and resolving conflicts. Supervisors and managers also need training in how to make the most effective use of retrained workers—how to follow up on worker training to ensure it transfers to the job, and how to help workers assume more responsibility. Product engineers and manufacturing specialists may be expected to join continuous improvement meetings and to act on suggestions from production employees. These employees will require not only teamwork training, but will have to accept new workplace roles. Training managers may also meet with corporate strategic planning groups-a situation unheard of a few years ago and one to which executives may have trouble adjusting.

Reorganizing along these patterns generally calls for good basic skills, a wider range of task-specific technical skills, and organizational training. The latter sets each individual's job in its overall context and demonstrates its importance for achieving the company's goals. Such training is difficult to deliver effectively.

Globalization also means new responsibilities. Flexible organizations that must respond quickly to local market conditions cannot wait for decisions from the home office. Local managers must be trained and informed to make decisions themselves. Companies also may need to train their employees in other cultures and languages, both to better understand their competitors and to operate in foreign markets.

These changing skill needs pose special difficulties for smaller fins. American companies are seeking stable, long-term relationships with relatively small groups of frost-tier suppliers. Xerox, for example, now purchases from 500 rather than 5,000 suppliers. Today, suppliers may be expected to provide just-in-time deliveries and guarantee quality control (e.g., with their own statistical process control and continuous improvement programs). They may be asked to install computer-aided design equipment compatible with the manufacturers' to facilitate shared engineering databases and rapid exchange of technical information. Suppliers that hope to be part of such a strategic partnership must hire more engineers and technicians and provide additional training for their workers. A few suppliers get technical and training assistance from corporate customers, but most must fend for themselves.

Training is not an end in itself, but a means to implement workplace change. With more training, workers find further learning easier and are better able to adapt to new technologies, processes, and organizational structures. Managers who recognize this and embrace the concept of continuous training have taken a major step toward continued competitive success.

Basic Skills in the Workplace

Any nation expecting to attract or retain new model industries of the sort discussed above must offer a flexible and trainable workforce. Many American workers—20 percent or more in some firms-are deficient in basic skills (reading, writing, arithmetic, and communication). The problem is seldom illiteracy, but that workers need to upgrade their basic skills to cope with changing job requirements. Workers need good basic skills to interpret and apply information in the workplace and to participate in both formal and informal training. Many firms have faced delays in implementing new technology or work practices (including training) until they upgraded their employees' basic skills. Workers without sound basics will find it increasingly difficult to advance beyond entry-level positions or to change jobs. (Ch. 6 discusses basic skills issues in detail.)

A 1986 survey of adults aged 21 to 25 found that 20 percent have not achieved 8th grade reading levels, and 38 percent cannot read at the 11th grade level. Many job-related reading materials (e.g., manuals) require 10th to 12th grade reading skills. Although some can be rewritten at lower proficiency levels, technical or complex information is difficult to convey at such levels.

An unacceptably high number of young adults-half or more—are not good at quantitative problem-solving of any complexity. While only 7 percent in the 1986 survey were unable to perform simple arithmetic operations (e.g., adding two entries on a bank deposit slip), around 35 percent were unable to reach the correct answer when the addition was part of a problem in which judgment had to be exercised to determine which numbers were relevant. Even among those with 2 or 4 years of college, 39 percent were unable to figure the cost of a specified meal from the prices on a menu, and determine the tip and correct change from a restaurant check.

The basic skills needed to perform job-related tasks can be quite demanding-more so than those needed in school. Workers often have to apply what they have read immediately or risk production problems or downtime. They also need to be able to ask questions and monitor their own comprehension when reading on the job, in part because they need to recognize and seek clarification of incorrect, misleading, or extraneous information. Thus, the concept of basic skills is enlarging to encompass problem-solving, the ability to adapt existing knowledge to new situations, and effectiveness in group interactions-skills traditionally associated with management. While some workers with limited education are excellent at these higher order skills, strong basics always help.

The costs of basic skills deficiencies are quite high for American companies. Although accurate estimates do not exist, the direct costs in lower productivity may include ruined parts and equipment, wasted material, and health and safety risks. Administrative costs for screening and hiring new employees also can be significant.

Companies would prefer not to have to upgrade employees' basic skills. The presence of a well-educated labor force is often a factor in firms' location decisions, whether domestic or overseas. Firms also can use technology to replace or deskill jobs to compensate for workers' inadequate basic skills. Many workers with poor basics learn to cope, often developing practical solutions to problems that would stump them if presented outside the job context (e.g., on a written test). Not all of these options are available to every company, however, and they do not necessarily further overall competitiveness.

Only a few U.S. companies now offer in-house basic skills training. Many large or medium-size companies test job applicants for basics and most do not hire those who fail. Other companies offer remedial programs in skills basic to specific jobs (e.g., blueprint reading, accounting principles). Still others may encourage workers to enroll in free courses offered by public agencies, but active support (e.g., giving employees paid release time) is rare. The total funding that employers, government agencies, unions, and workers dedicate specifically to improving employees' basic skills has never been accurately estimated. However, it probably does not exceed $1 billion per year. This compares with estimated total annual industry expenditures for formal training of $30 billion or more.

For many years, States have offered basic adult education, partly supported by Federal programs. Some States support workplace basic skills improvement activities with other kinds of customized industrial training programs (see discussion of the State role in providing training, below).

Recently, several workplace-oriented basic skills programs based on partnerships among government, employers, and/or unions have emerged. These include workplace literacy demonstration projects funded by the U.S. Departments of Education and Labor. Major expansion for workplace programs has been proposed in the 101st Congress as part of comprehensive adult literacy legislation (see discussion of policy options, below).

Workplace programs need to take into account the various levels of proficiency among workers. People with the most severe problems—who read or write at the 6th grade level or below—need extensive individualized help. Workers who need to upgrade basic skills benefit from programs that use work-related materials. The more successful workplace-oriented programs encourage transfer of learning back to the job by developing and using materials and tasks that relate to the learner's job (e.g., teaching arithmetic via blueprint reading). Such customized workplace programs are still rare, however.

Basic skills programs often can be enhanced through well-designed courses delivered via computers or other forms of instructional technology (see chs. 6 and 7). High-quality technology-based training takes less time to deliver than traditional classroom instruction, with equivalent or better learning gains and transfer to the job. Moreover, many workers like computer-based or interactive video instruction. Relatively little courseware now available is targeted toward adult learners, however, or toward workplace-oriented skills.

There is a clear need for more research, evaluation, and dissemination of findings on the most effective ways to upgrade basic skills. Not only would this aid firms in establishing their own programs, it would help policymakers determine how much public workplace-oriented efforts should depart from the traditional model of adult basic education.

Working definitions of the basic skills needed in a competitive economy will continue to broaden. Training employees in competencies such as cooperation and teamwork-skills rarely stressed explicitly in the educational system-can be expected to be a more frequent requirement in many fins.

Labor Mobility and Changing Demographics

The U.S. labor force has changed dramatically over the past decade. The baby boom entrance bulge is past, and overall labor force growth has slowed. The civilian labor force grew by nearly 3 million people each year during the late 1970s, but only by about 2 million annually during the late 1980s. Labor force participation has reached a new peak, with 67 percent of all Americans aged 16 and over working or actively seeking jobs; previously, labor force participation had remained stable for years at 58-60 percent. The increase is due primarily to the entry of women into the workforce; nearly twice as many women were working in 1989 as in 1969. The fraction of the workforce with part-time jobs increased from about 15 percent in the rnid-1960s to more than 20 percent in the mid- 1980s.

The overwhelming majority of people who will work in American industry at the beginning of the next century are working now.[3] In the next few years, the labor force will have fewer new entrants, and many entrants will be minorities or immigrants—groups that have been underserved by the educational system. Overall, the labor force will continue to be overwhelmingly white. Through the end of the century, women will account for nearly two-thirds of employment growth. There will be fewer younger workers (aged 16 to 24), although by the mid- 1990s this age group will begin to grow as the baby boomers' children begin entering the labor force (see table 1-2).

While labor force growth has slowed, labor mobility still is high. Americans change employers and occupations more frequently than workers in other advanced industrial economies. People move from job to job; entrepreneurs start new companies, with varying success; existing companies grow, promote people, transfer them. American companies must more or less continuously integrate new employees into their organizations. At least 15 percent of the labor force may need some new training each year simply because of mobility. They will not necessarily get it—mobility makes employers reluctant to train their employees. Many

[3]The Bureau of Labor Statistics estimates that workers from the 1988 labor force will Comprise 70 percent of the year 2000 workforce. The estimate depends in part on retirement decisions of workers and other variables. Judging from the age distribution of workers in table 1-2, the estimate could be low.

Table 1-2—The Changing Labor Force: 1976-2000

	Labor force share (percent of total)		
	1976	1988	2000'
Blacks	9.9%	10.9%	11.7%
Hispanics	4.4	7.4	10.1
Asians and other minorities	1.9	3.0	4.0
Young workers, al laged 16 to 24	24.3	18.5	15.9
Aged 25 to 54	60.8	69.0	71.8
Older workers			
All aged 45 to 54	17.7	15.7	21.8
All aged 55 and over	14.9	12.4	12.3
Women (all)	40.5	45.0	47.3
Total number of workers (million)	96.2	121.7	141.1

[a]Bureau of Labor Statistics moderate growth scenario.

SOURCE: HowardN. Fullerton, Jr., "New Labor Force Projections, Spanning 1988 to 2000," *Monthly Labor Review,* November 1989,table 1, p. 4.

firms try to get by with little or no training for new hires. Many firms also are reluctant to train older workers (age 45 and up). As baby boomers enter middle age, the United States also will need to find ways to keep a slowly aging workforce up-to-date and flexible.

Small enterprises have accounted for about 35 percent of total U.S. employment in recent years. But hundreds of thousands of these small firms appear, grow, and die each year, contributing to U.S. labor mobility. Over the next two decades, small firms will create more jobs than their share of employment might suggest. They face special problems in training. Many lack experience in training and often the resources to develop expertise or to pay for outside training. Further, these companies typically experience higher than average rates of turnover, and therefore are reluctant to invest in their employees. Small firms rarely have enough people who need training at any one time to justify a focused training effort. Public policies have provided little help in solving small firms' training problems.

Retraining for older workers will become more important as the workforce ages. Average retirement ages have been declining in most industrial nations; companies continue to encourage early exits and tailor most training for workers farther from retirement. Programs initiated under the Older Americans Act and Job Training Partnership Act have successfully placed older workers in jobs, but these programs offer no incentives to firms to train their older employees. The aging of the U.S. workforce will force both corporate officials and government policymakers to pay more attention to training for older workers and to capitalizing on their skills and experience.

Immigrants accounted for 22 percent of labor force growth between 1980 and 1987—more than twice their contribution during the 1970s when the labor force as a whole grew very rapidly. Immigrants are projected to account for an even higher portion of labor force growth over the next decade. While many are highly skilled professionals, such as engineers and doctors, roughly 33 percent have only an elementary school education and 13 percent have not progressed beyond the 4th grade. As many as 17 percent speak no English at all. Without basic skills upgrading, these people will be stuck in low-paying, unskilled jobs.

Younger American workers switch jobs more frequently than older workers. Because younger people are so mobile, larger firms tend to hire only those with 3 to 4 years stable work experience for career path jobs and most employers are reluctant to provide young workers with much training. Good training early can help motivate younger workers to continue learning-on the job and off—throughout their careers.

Nationwide, about 85 percent of workers are high school graduates, but the rate is lower among minority groups (see table 1-3) and as low as 50 percent in some geographic areas. Even among those who graduate from high school, however, the bottom third academically are poorly prepared for work. Groups with the most formal schooling have the lowest incidence of unemployment. Educational level also is seen as an important indicator of receptiveness to learning when workplace technologies are changing rapidly; better educated

Table 1-3-Educational Credentials of Employed Workers[a]

	Not a high school graduate	High school only[b]	One or more years of college
Whites[c]	15.8%	39.8%	44.4%
Blacks	22.7	42.4	34.8
Hispanics	39.0	33.5	27.4

[a]Employed during March 1988.
[b]Includes those with less than 1 year of college.
[c]Non-Hispanic whites only.

SOURCE: George Silvestri and John Lukasiewicz, "Projections of Occupational Employment, 1988-2000," Monthly *Labor Review*, November 1989, table 10, p. 83.

workers are viewed as more likely to know how to learn. Moreover, while U.S. workers' average number of years of schooling has risen, actual academic competencies of high school graduates have increased only marginally. Students in competitor nations score higher on academic skills tests than American students.

The United States also does not seem to be doing as much as our competitors to prepare non-college bound youth for the workworld. Graduates of secondary vocational education programs in this country often find their skills ill-suited to the workplace because the rapid pace of technological and organizational change in modern firms has outpaced curricula.

The best vocational education programs ***can*** produce graduates well-prepared for the modern workplace. These programs emphasize both practical and theoretical skills in a setting where students work together. They also typically involve access to--or a blend of—vocational and academic courses. Students can be taught basic skills such as arithmetic quite effectively within the context of vocational courses such as drafting. Employer involvement adds relevance to today's workplace (e.g., through assistance in curriculum development), as do real-world work experiences such as cooperative education or internships. Congress is considering legislation to encourage more vocational programs to adopt best practice approaches (see discussion of policy option 6 below and in ch. 2, and ch. 8).

Growth in jobs will be highest in the South and the West. Particularly in these regions, the mismatch between the capabilities of job seekers and the needs of the local economy will continue (see box l-A). The only way to cure this mismatch is through better education and training, particularly for minorities, women, older workers, and people from rural areas and inner cities.

Training and Human Resource Practices

Current human resource practices in most American firms place a low value on training. Many firms try to hire people with the skills they need rather than develop current employees' skills. Large firms do extensive screening, including tests and interviews, to measure prospective employees' skills. Firms that have reorganized to emphasize multiskilled work groups also test for higher order skills and performance in a group setting. People who do not pass are not hired. Larger firms often can pay above average wages to get the skills they need. When implementing new technology or processes, they can afford to-and sometimes do-hire new employees with the needed skills. Current employees with outdated skills or who have trouble adapting to new conditions may not be retrained or retained.

Small firms' access to new hires with good skills is much more limited. These companies usually pay less and cannot screen prospective employees extensively. When introducing new technology, smaller firms typically add new tasks onto existing jobs, with training provided informally or by the equipment vendor. These approaches seldom prove adequate, making it more difficult to capitalize on the investments.

When times are bad, companies often slash their training budgets. Few firms evaluate the costs and benefits of their training programs, either in terms of job performance or business outcome. Thus they have trouble justifying continuing their training programs during bad times. Moreover, most American firms of all sizes respond to economic downturns by laying off employees.

Some U.S. firms do retrain and redeploy their workers when they reorganize rather than laying off one group and hiring another. This strategy can be cost-effective. Reorganization and restructuring for increased competitiveness require employees who understand corporate goals and believe themselves important to achieving those goals. But employees will not feel coremitted to corporate goals if they believe their employer will respond to the next generation of automation or to economic downturns with immediate layoffs. Moreover, retraining and redeploying employees (e.g., assigning

Photo credit: UAW-Ford National Education, Development and Training Center

Reorganizing work to encourage employee involvement can improve morale and productivity.

them routine maintenance tasks) during slow times can be more cost-effective than laying them off and then rehiring them at the end of the slack period, particularly if many move on to other jobs.

A few companies have even begun to use downturns to provide concentrated training on company time. These firms believe that the upgraded worker skills will improve productivity and competitiveness when demand picks up again.

Relying more heavily on contingent workers (including contract labor and services) makes it easier to retain a core workforce if sales slump, but managers must balance this against the difficulty of integrating contingent workers into the organization when markets are booming again. Growing use of contingent workers poses special challenges, as these workers may not receive the training and benefits given to core workers.

It is difficult for firms to justify changing their human resource practices without understanding the relative costs and benefits. For training, in particular, such benefit/cost evaluations are necessary not only to provide a basis for corporate decisions about the level of investment in training, but to target the investments at specific business needs, to weigh alternate delivery systems for cost-effectiveness, and to improve the quality of training.

If new practices in workplace organization and training are to become a permanent part of the American industrial landscape, it will be because of top management understanding and commitment, backed up with funding. A 7-year business expansion has made it relatively easy for American industry to invest in training and experiment with innovations in production. The test will come in the inevitable downturn. Executives need to grasp what training can and cannot accomplish, and how reorganization and restructuring backed up with training can help their firms compete. Without direction from the top, inertia will prevail.

TRAINING APPROACHES: THE UNITED STATES AND OUR FOREIGN COMPETITORS

Corporate training in the United States is delivered unevenly across firms and among workers. On-the-job training-the kind most U.S. workers receive—usually is informal and unstructured, consisting of experienced workers showing newer employees how to carry out tasks. The U.S. Government has little influence on training of employed workers; Federal programs focus on the unemployed and economically disadvantaged. State support for industrial training is limited, though growing. Other nations, including West Germany and Japan, have more effective public and private training systems than the United States (see table 1-4). These competitor countries provide more training, take a much more systematic approach to training, provide government support for it, and train their workers to higher average standards. Box 1-B compares U.S. and Japanese training programs in automobile plants as an example.

In the sections below, American training practices and programs—by firms, for workers, and by the States—are first discussed. This is followed by analysis of foreign training practices, especially in Japan and West Germany.

Corporate Training in the United States

Reliable estimates of the extent and cost of U.S. worker training do not exist. The few company surveys that have been conducted have had very low response rates. Only a few large firms keep track of training expenditures and they account for training costs in very different ways. Estimates based on worker surveys depend on employees' recall of

Box l-B—Training in U.S. and Japanese Automobile Assembly Plants

Creative engineering abroad has meant heavy pressure on American firms to follow suit (e.g., automobiles with multivalve engines, electronically controlled transmissions, and antilock brakes). Not only must companies bring these technologies to market quickly, they must do so with minimum risk of recalls or product liability suits. This places a greater burden on workers to maintain quality. Training is a critical factor in achieving this goal.

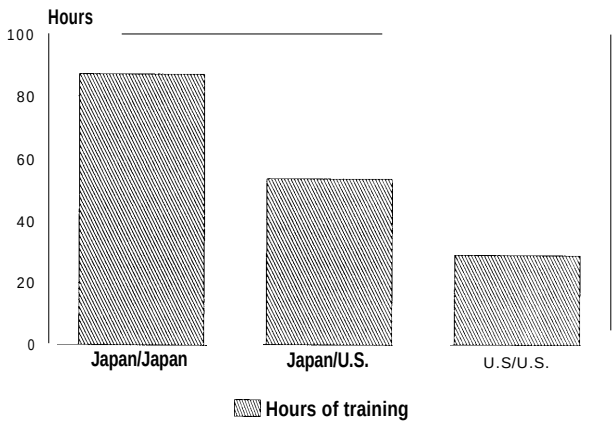
Figure 1-1 compares annual hours of training per employee for Japanese auto assembly plants in Japan (J-J), Japanese-owned plants in the United States (J-U.S.), and U.S.-owned plants in the United States (U. S.-U.S.). As shown in the figure, autoworkers in J-J plants get more than three times as much training each year as workers in U. S.-U.S. plants. The differences are even more striking for newly hired workers (figure 1-2). New employees in J-J plants get more than 300 hours of training in their first 6 months compared with fewer than 50 hours for U. S.-U.S. plants.

In pre-employment screening, Japanese automakers value willingness and ability to learn more highly than previous experience or specific skills. Their training programs emphasize individual and group responsibility along with job skills. U.S. automakers look more for experience and their training tends to stop with narrow technical skills for craft workers and brief on-the-job sessions for unskilled workers.

Japanese automakers combine just-in-time production with continuous improvement and quality circle programs. Their work organization is built around semi-autonomous groups with substantial training and careful attention to shopfloor management. Work groups serve as vehicles for communication between factory floor and engineering to help achieve design-for-manufacturability. In contrast, workers in U.S. plants have narrowly defined responsibilities. Organizational barriers still impede information exchange among product design, manufacturing engineering, and the shopfloor. Not surprisingly, Japanese auto manufacturers achieve higher productivity and quality levels than their U.S. counterparts.

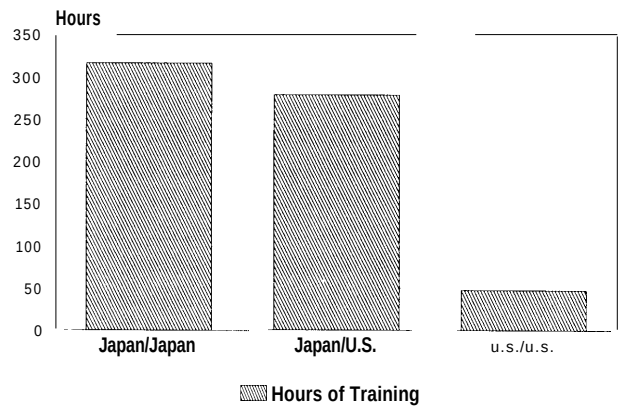
SOURCE: John F. Krafcik, "Training and the Auto Industry: International Comparisons," report prepared for the Office of Technology Assessment under contract N3-1910, February 1990.

Figure l-l—Annual Hours of Training Per Employee, Automobile Assembly Workers



SOURCE: John F. Krafcik, *Training and the Automobile Industry: International Comparisons,* contractor report prepared for the Office of Technology Assessment under contract N3-1910, February 1990, pp. 8-9.

Figure 1-2—Hours of Training, Newly Hired Automobile Assembly Workers



SOURCE: John F. Krafcik, *Training and the Automobile Industry: International Comparisons,* contractor report prepared for the Office of Technology Assessment under contract N3-1910, February 1990, pp. 8-9.

training events, which may be unreliable. Employers more often train workers informally on the job than in formal settings, and it may be difficult to differentiate between training time and work time. Therefore estimates of total employer investment in training vary greatly (see ch. 5).

The few data available suggest that U.S. employers' investments in formal training are between $30 billion and $44 billion annually. This range is equivalent to 1.2 to 1.8 percent of total private sector worker compensation ($2.4 trillion in 1988), 0.61 to 0.9 percent of 1988 gross national

Table 1-4-Worker Training Compared

	United States	Germany	Japan	Korea
School-to-work transition	Left mostly to chance; some employers have ties with local schools	Apprenticeship for most non-college-bound youth	Personal relationships between employers and local schools	Employers recruit from vocational and academic high schools
Vocational education				
Extent	Available in most urban areas	Universally available	Limited; mostly assumed by employers	Universally available
Quality	Wide range: poor to excellent	Uniformly good	Fair to good	Vocational high schools uniformly good
Employer-provided training				
Extent	Largely limited to managers and technicians	Widespread at entry level and to qualify for promotion	Widespread	Limited; employers rely on public vocational institutes
Quality	Wide range; some excellent, but more often weak or unstructured	Very good	Very good	Generally poor
Public policies	Federal role very limited; State aid to employers growing	Govern apprenticeship; encourage continuing training	Subsidies encourage training by small firms	Directive-some employers resist policies

SOURCE: Office of Technology Assessment, 1990.

product, and 10 to 14 percent of the national investment in primary, secondary, and higher education in 1987. Some companies spend much more on training, such as IBM and Xerox (4 percent or more of payroll), and Motorola (2.5 percent of payroll). Informal training may cost firms as much or more than formal, but the costs (e.g., lost production during training) and the benefits (improved quality or productivity) are difficult to tie directly to training and impossible to quantify.

Only about 35 percent of workers recalled taking skill improvement training in their current job, according to a U.S. Department of Labor study.[4] Professionals (e.g., lawyers, teachers, engineers) are the most likely to get continuing training for their jobs (see figure 1-3). Technicians are next most likely to get upgrade training, followed by executives and managers. Shopfloor and other blue-collar workers are less likely to receive such training in the United States.

U.S. employers are reluctant to provide training for several reasons. Many fear that employees will leave for better jobs and the firm will lose its training investment. Others lack expertise in training or have had unhappy experiences with poorly conceived training programs. Senior managers may not plan well enough for training when introducing new technology or process changes. Production managers are often reluctant to disrupt operations by releasing employees for training.

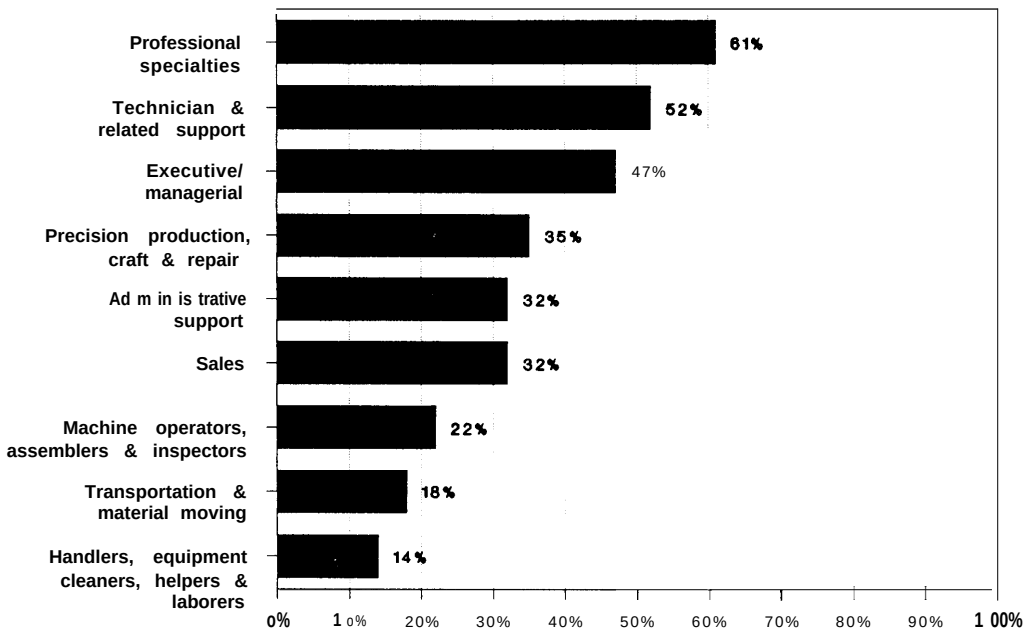
Larger firms are more likely to provide formal training than smaller ones. Large firms typically have lower labor turnover and more money for training. Moreover, they find that training tends to be associated with lower labor turnover.

Some large firms with organized training programs provide new hires with formal training-a preliminary to on-the-job training. Formal training may cover technical skills (both task-specific and generic) and workplace hazards. Some firms orient new employees on company policies, customers and product lines, and the fro's plans for the future. The purposes are to encourage employees to take responsibility and link workplace tasks to the company's overall goals, and to build loyalty to the organization.

Small firms are more likely to employ workers who have less education, or who are older or young. Jobs in small firms often involve a variety of quite different tasks. Lacking training budgets, small firms usually try to develop employee skills through unstructured informal training, which varies widely in quality. Those smaller firms that do invest in both

[4]The study was based on information obtained from special questions in the 1983 Current Population Survey; it has not been repeated since thin. See Max L. Carey, *How Workers Get Their Training,* Bulletin 2226, U.S. Department of Labor, Bureau of Labor Statistics, March 1985.

Figure 1-3—Upgrade Training by Occupation
(percent of workers reporting upgrade training in their current job)[a]



[a]Note: On average, 35 percent of all workers reported skill improvement training for their current job.

SOURCE: Max Carey and Alan Eck, *How Workers Get Their Training* (Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1985), pp. 18-19.

formal and informal training usually have a strong management commitment to training.

In addition to in-house training, U.S. workers get training from many sources, including equipment vendors, private training consultants, community colleges and other educational institutions, union programs, and technology-based courseware (e.g., computer-based training). U.S. fins' purchases of training from outside resources are estimated to total about $9 billion per year.

Only the vendor may have the expertise to train workers to use and maintain new equipment. Equipment vendors are not in the training business, however. They typically design courses to highlight a product's features rather than to prepare trainees for possible problems. Downtime due to employees' lack of skills can offset the gains in productivity that would otherwise result. from new equipment. Vendor training also tends to reach only a few workers, and not always those who will actually operate the new equipment.

Regardless of the source, training often does not transfer to work. Training is more effective when it is quickly reinforced on the job. Successful learning often occurs in practical and collaborative job settings, such as apprenticeship, where the concepts learned are applied to daily tasks. Training also is more effective when developed as part of an overall strategy linked to corporate goals.

Training technology can deliver quality on-demand instruction. Simulators, for example, can train workers to fix a wide range of malfunctions safely and without equipment downtime. Embedded training is valuable for malfunctions that occur infrequently and in situations where it is either impossible or not cost-effective to train everyone in all operational characteristics.[5]

[5]Embedded training is instruction tbat is an integral component of a product or system. An example would be a machine display panel with a diagram that shows the location of a malfunction and a list of the steps needed to fix it.

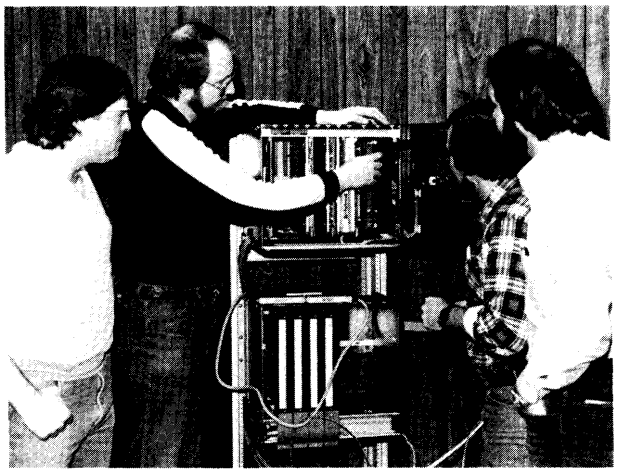


Photo credit: American Association of Community and Junior Colleges

Instructor explaining programmable controller to Alcoa employees.

Training quality also is directly affected by the expertise of training professionals and courseware developers. Many entrepreneurs are attracted to this low-overhead business with potentially high earnings. Some are highly knowledgeable training professionals that produce quality products; some hype ''new age' training methods whose effectiveness is unproven; a few are con artists.

Training and Workers' Careers

Training is important not only to companies, but also to individuals (see ch. 8). More than half (55 percent) of workers in the Labor Department study cited above said that they needed some specific training to obtain their current job. Most got the training at a school or informally on the job. Not surprisingly, nearly all professionals needed qualifying training, as did 85 percent of technicians, and most managers. Nearly two-thirds of those in the craft and skilled trades also needed training to qualify for their current job. The proportions vary not only by occupation, but also age, race and educational background. Minorities receive a disproportionately small share of training. Employers are hesitant to train young workers (aged 16 to 25) because of their mobility; older workers also get less training than their share of the workforce might suggest. Those with the most education to begin with get or take the most training.

Increased competitive pressures and the resulting restructuring of the national economy have made jobs and income less secure. Moreover, in many industry sectors, career ladders within companies have become fewer. Many manufacturing firms, for example, have cut back on the number of first-line supervisors-jobs often filled in the past by promotion of production workers.

People who do not have the appropriate blend of educational credentials, training, and experience will find it increasingly hard to win promotions and pay increases. The skills and abilities needed to gain entry onto an upward track tend to be broad and general, associated more with formal education than on-the-job training and experience. It will be more difficult than in the past for people without educational credentials to demonstrate through on-the-job performance that they deserve a chance to move upwards. The U.S. training system will have to begin delivering both task-specific skills ***and*** the broader problem-solving and social skills traditionally associated with managerial work if the system is to serve both workers and industry effectively.

The training workers get in firm- or equipment-specific skills may not transfer to other jobs. Employer-supported programs leading to formal credentials (e.g., apprenticeship, associate degree programs) are more transferable than other types of training. But, transferable training is hard to get.

At the post-secondary level, community colleges and other institutions offer widespread opportunities for vocational training. As these institutions work more closely with employers on customized training, their vocational curricula may become better matched with local labor market needs. At the same time, post-secondary vocational education should provide students with broad transferable skills.

Adult education is one of the strengths of the U.S. system, although under 15 percent of all adults participate in any year. About two-thirds of participating adults take courses for job-related reasons, with employers paying for nearly half of these courses. Other countries also stress adult education. One-fourth of adult Canadian workers participate in adult education. Japan has an effective adult education system, with many companies encouraging or requiring employees to attend night classes or take correspondence courses. The Japanese Government offers subsidies to employers who offer financial incentives to workers taking such courses.

The United States has long ranked near the bottom among industrialized nations in the number of workers who have completed apprenticeships. The total number of apprentices has remained about the same (300,000) over the last decade while the workforce has grown by 20 percent. Only 0.16 percent of the U.S. civilian workforce currently participates. By contrast, a majority of the West German labor force has completed an apprenticeship. U.S. apprenticeship is highly concentrated in a few occupations; over half of those in registered programs work in the unionized construction industry.[6]

Apprenticeship training is high in quality as measured both by workers' wages and productivity, and there is new interest in revitalizing the U.S. apprenticeship system. The apprenticeship model, combining classroom instruction with hands-on practice and skill-building, is a very effective approach to technical training. Because it relies heavily on informal but structured on-the-job training, which is the predominant training method in smaller companies, apprenticeship is particularly well-suited to these fins.

The major barrier to the creation of nonunion apprenticeship programs is financing. U.S. apprentices typically take evening classes two or three times per week, as well as receiving on-the-job-training, over a 3- or 4-year period. The formal instruction alone averages $2,500 per apprentice annually in some crafts. A single firm may be unwilling or unable to support such extensive and expensive training. Industry associations could overcome this barrier by soliciting voluntary contributions from member firms to support apprenticeships.

The U.S. Department of Labor (DOL) is examining ways both to strengthen traditional apprenticeships and to introduce the concept in industries that have not been active participants in the past. DOL calls the latter effort structured workplace learning. It includes various combinations of classroom and on-the-job training leading to a portable credential. DOL launched several pilot projects to demonstrate the concept in banking, health care, and small business in 1989. If successful, these demonstrations could encourage more employers in more industries to try similar programs in the future. However, DOL lacks the resources to strengthen traditional apprenticeships. More funding is needed at the Federal and State levels to improve outreach programs.

Photo credit: National Training Fund, Sheet Metal and Air Conditioning Industry

Apprentice practices welding while others observe.

Providing transferable skills also is a thrust of many joint union-management training activities. Although unions represent a small and declining share of the labor force (from a peak of 35 percent of nonagricultural workers in 1954 to 16.4 percent in 1989), they are still important in workplace training and in retraining displaced workers. Successful joint union-management training initiatives exist in both the automobile and telecommunications industries. In 1989 alone, five of these programs had a total of about $324 million available to support training activities. Enrollments ranged from 16 percent to over 50 percent of the 709,000 eligible workers. Most instruction is offered outside of regular working hours at the plant site. It typically focuses on topics such as basic skills, health and safety, computer literacy, and career and financial planning. Some training, however, is keyed directly to the workplace (e.g., offering basic arithmetic instruction off-hours to help workers taking statistical process control training on company time).

As with corporate training generally, joint union-management programs are of mixed quality and have not been evaluated rigorously. Efforts have

[6]Under the registration system operated by the Federal Bureau of Apprenticeship and Training and by State Apprenticeship Councils, apprenticeship programs may be sponsored by either a single employer or a group of employers, either unilaterally or jointly with a union.

begun to educate local training committees about techniques for design, delivery, and evaluation, and to encourage outside course evaluations. Joint training and teamwork programs have shown measurable benefits, nonetheless, including lower production costs, increased uptime, and expanded output without investments in more modern equipment.

Older workers have even less access to on-the-job training and outside courses and programs than younger workers. Training declines with age within the older worker population, in part because employers believe they will not recoup their training investment before a worker retires. Many managers and executives also rate older workers low on flexibility and adaptability. Yet older workers also are perceived as having a strong work ethic and good work habits; they also change jobs less often than young workers.

The increasing proportion of older workers in the labor force makes it important both to prepare this population for technological change and to understand how advancing age affects job performance and learn how to compensate for any negative effects. Despite gradual physiological changes (e.g., reduced sensation and perception, motor control, and memory), age-related declines in performing traditional tasks in most occupations seem to be slight. Efforts to compensate can focus either on the worker or on the job. Older workers' health-and job performance-can be improved through company-based health promotion and awareness programs. Training can compensate for some age-related deficits. Jobs also can be modified to facilitate retention of older workers.

Most older workers, however, are more in need of training to upgrade skills that have been outpaced by technological change. Federal support for older worker training programs is limited and companies have shown little interest in developing training tailored to older workers' needs. Training methods that minimize stress (e.g., self-paced learning) and reduce the need for memory (e.g., embedded training) are especially beneficial for older workers. Educating managers about age-related issues also can be effective in changing their perspectives on training older workers. The great variability among workers in the same age range means that policy with respect to the older worker should be flexible and individualized rather than uniform.

The Growing State Role

In the United States, most direct government assistance to firms to train their workers comes from the States. In fiscal year 1989, 44 States operated over 51 customized training programs (those tailored to needs of specific industries or companies) costing approximately $375 million (see ch. 5). Additional State expenditures on worker training are embedded in industrial recruitment programs and in support for vocational-technical institutes and community colleges. The States report increasing demand for upgrade training of employed workers; almost one-third spent more than 35 percent of funds on training workers at existing firms.

State customized training programs have an uneven record in meeting employers' needs for worker training. The States expect such programs to serve mixed, often conflicting goals-attracting new industries, aiding in expansion of existing fins, enhancing workers' careers, and providing broader societal benefits. Customized training for existing employers must compete for scarce State resources with efforts aimed at these diverse goals. Programs focused on a single goal-such as assisting employers with specific training needs or enhancing the performance of existing firms—are most successful.

State funds can help companies overcome many barriers to providing their own training, including limited access to training experts, poor understanding of how training can improve business performance, concerns about losing trained workers to other fins, and bad experience with prior training efforts.

About 10 States also currently spend a combined total of between $25 million and $40 million a year on industrial extension services, which provide technical assistance to small manufacturers. Current State technology transfer programs are limited in scope and poorly linked with State training assistance. Most will refer clients to training agencies, but of five that OTA surveyed, only one provides integrated training and technical assistance and helps businesses obtain funds from State training programs.

One of the largest *regional* efforts to assist small business is the Southern Technology Council's Consortium for Manufacturing Competitiveness. Formed in 1988 with some Federal support, the

Consortium has 14 members—all State-supported schools that offer technical associate degrees-who extend services to employers and help leverage private funding. A key purpose is to transfer new manufacturing technology. Member institutions also provide training support, such as mobile training vans and skills assessments.

While States are becoming more involved in both training and technology assistance to small firms, funding is still very limited. Both types of programs are inadequate to meet growing employer demand for services. The average State training program helps just 64 companies and fewer than 4,000 workers annually (see table 1-5). Most of the assistance goes to firms with more than 200 employees.

Training Among Our Competitors

One of the reasons companies in the Federal Republic of Germany (FRG) and Japan are able to compete so effectively with U.S. firms is that their workers are well-trained (see ch. 3). Thus, companies in those countries are well equipped to take advantage of flexible production systems turning out high-quality products at low cost. Moreover, training is explicitly supported by their governments' policies.

In the FRG, for example, about two-thirds of the employed workforce has completed an apprenticeship program. These programs-as good as any in the world—are financed jointly by public and private investments. The government works with trade associations and unions to define uniform national curricula and examinations for apprentices in over 400 occupations. Policies and traditions also give status and respect to blue- and grey-collar workers.

West Germany's Federal and Lander (State) governments offer substantial incentives to firms to provide training to their workers. The Lander typically provide the formal schooling portion of apprenticeship at no cost to the employer. Both Federal and Lander governments also defray some on-the-job training costs. The Federal Government picks up half the costs of special training centers set up by trade associations to serve the apprenticeship and continuing training needs of small business.

The FRG's education and training system contributes in a major way to both high labor productivity and product quality. A comparison of skills training and cost, productivity, and competitiveness in West German and British firms in several industries clearly showed that, when factors such as production machinery are held constant, the West German workers have higher productivity, are more adept with computerized equipment, and can adapt better to short production runs of specialized goods because they get more and better training than their British counterparts.

The Japanese excel at integrating on-the-job training with day-to-day operations. Managers and supervisors deliver most training on the shop-floor with little loss of working time, and provide continuing followup and evaluation. Managers who serve as instructors can stay in closer touch with factory operations and also can keep workers abreast of company plans; it also gives managers frost-hand experience with the usefulness of training. Long-term employment relations (common in many Japanese companies) allow firms to train core workers with little fear of losing them. Training is more than a means for advancement; corporate and cultural pressures encourage continuous learning with workers often participating on their own time.

Table 1-5—State-Financed Customized Training Programs[a] (most recent fiscal year)

	Median	Low	High
Number of contracts with firms			500
Average contract amount per program	$43,313	$6,500	$1,046,000
Range of total program expenditures among States	$2,400,000	$111,700	$106,000,000
Number of employees trained	3,940		55,243
Expenditure per enrollee	$460	$75	$3,461

[a]Based on 51 programs in 44 States.

SOURCE: Peter A. Creticos, Steve Duscha, and Robert G. Sheets, *State Financed, Customized Training Programs: A Comparative State Survey,* report prepared for the Office of Technology Assessment under contract L3-3081O, 1990, tables 4,6.

Japanese Government assistance is less pervasive than West German assistance; companies and individuals absorb most of the training costs. The Ministry of Labor (MOL) provides some subsidies for companies and industry groups with an approved skill development plan. Small firms qualify for larger subsidies (e.g., half the cost of hiring teachers and purchasing in-house training materials, versus one-third for bigger companies). Japan's prefectures spend about two-thirds as much on training as the MOL, supporting vocational colleges, skill development and training centers, and testing and certification programs. Special subsidies go to companies that train employees aged 45 and older. Quasi-public industry groups, such as the Japan Industrial Training Association, the Japan Management Association, and the Japanese Efficiency Association also provide training.

South Korea and other developing Asian nations are making worker training a central element in economic development policies. Training in South Korea draws heavily on the German example; indeed the FRG helped South Korea establish one of its first vocational training institutes. The South Korean Government offers construction financing, low-cost land, subsidies for instructors' salaries, and free training equipment for trade associations. Skills tests and preferential hiring for certified workers help to counter biases against vocational education.

Levies are used by several nations-West Germany, France, South Korea, and Japan among them-to support training. In some countries, firms only pay the levy if they fail to spend an equal amount on training their employees. In other cases, the levy finances training programs conducted for various purposes by public agencies.

TRAINING TECHNOLOGY

Large companies such as IBM, Ford Motor Co., and Motorola expect that by the late 1990s over half of their corporate training and education will be delivered outside the traditional classroom using some form of instructional technology. Flexibility and savings in time and money are the major reasons technology-based training is catching on. Such training might be delivered at a worker's desk or on the shopfloor, at a training center, or in an electronic classroom. It may be undertaken individually, or in small or large groups. The courseware may cover all aspects of a job or task, or it may review only those steps a worker needs to perform a particular task. It might involve basic, technical, or interpersonal skills (e.g., sales, job orientation).

Well-designed technology-based training can provide greater mastery of the material in less time and with higher employee satisfaction than the average classroom lecture. These benefits, combined with delivery and content flexibility, add up to savings in travel expenses and employee time off for training. IBM was able to avoid $150 million in training costs by streamlining its education programs, including expansion of its technology-based learning systems. NCR Corp. expects to save over $70 million annually in this way.

Today, most companies use some form of 'technology' for delivering training or reminding workers how to perform tasks. Such technology spans the low- to high-tech spectrum, from traditional lecture/lab instruction and job aids such as templates, to elaborate simulators and advanced electronic classrooms with interactive teleconferencing. Even informal on-the-job training typically involves hands-on practice with equipment or models of it. Table 1-6 presents some examples of the work-related applications of training technologies.

Classroom instruction, however, is still the most common formal training method in the United States. Even training professionals learning about new training technologies are most likely to do so in a traditional classroom setting. Yet, in terms of labor costs (and often travel), classroom instruction generally is the most expensive form of training to deliver.

Several considerations promise to spur continued growth in the use of technology-based training. The hardware and software have matured and their costs have become affordable to most large and medium-sized firms. A wide selection of courseware is available commercially and is increasingly interactive. Personal computers are becoming more portable, more powerful, and less expensive. Their pervasive presence in the workplace will make it difficult and expensive *not* to use them as training tools. Advances in computer literacy among today's students also will tend to encourage the future expansion of technology-based training. Finally, the limitations of most classroom training in terms of retention and transfer to job performance will lead managers to be more open to technology-based

Table 1-6—Work Related Applications for Training Technology

Setting/representative examples	Characteristics
Worksite applications:	
Shop or office floor refresher training	
• emulator for computer numerically controlled machine tools allowing training on different brands of programmable controllers	• immediacy, proximity to worksite helps transfer information to job tasks • more uniform, predictably reliable guidance than informal consultation with coworkers or supervisors
. interactive videodisc showing correct methods for tracking status of overnight shipping packages	. many training programs can be used at worksite computer terminals not acquired for training, thus keeping costs down
Performance support/enhanced job aids	• worker often must initiate use on own
• work station video displaying procedures for parts assembly	
. display identifying correction steps for copy machine paper jam	
• expert system job aid for identifying automobile malfunctions	
. interactive video showing correct safety procedures for forklift operation	
Corporate learning center or classroom support:	
. Basic skills upgrading using computer-based or interactive video courseware to supplement instructor capabilities	. instructional technology can supplement instructor's subject matter expertise or sometimes stand-alone
• Sales training pratiice sessions using interactive videodisc and video display of trainee responses, with feedback from sales instructor	flexible scheduling is possible for practice or stand-alone applications . well-conceived programs reduce training time away from job
. Use of simulators to train recovery boiler maintenance personnel and operators to adjust operating conditions to avoid downtime or emergencies	• telecommunications allows corporatewide or outside interaction with authoritative experts without need for trainees to travel to a central site
. Knowledge updating of engineers through distance learning courses, with audio hook up	• reliable information can be packaged and distributed throughout the corporation
• Managerial training using electronic classrooms and corporate satellite television networks for teleconferencing	. off-the-shelf programs may not meet specific corporate needs, while customized products are too expensive for most training applications . dedicating equipment specifically for training is expensive
Home study applications for computers, television, video:	
. Continuing professional education	. allows self-paced learning at individual's discretion
. Basic skills, GED preparation	• convenient
. Distance learning courses for degree programs	• uses widely available consumer electronics
• Occupational correspondence courses leading to a recognized certificate	• Progress highly dependent on individual motivation . individuals need sound advice on product quality

SOURCE: Office of Technology Assessment, 1990.

approaches—particularly those that bring training to the work station.

Yet, there continue to be barriers to the use of training technology. Most corporate trainers have too little experience with it to use it confidently or to design courses around it. Early experience with clumsy or unreliable technologies has soured many firms on this approach. The cost of technology-based training can be high, often too high for smaller fins. Even for large fins, customized courses can be expensive. Creating good instructional material-especially interactive courseware (see box l-C)-can require substantial development time and a team of experts, including instructional designers, subject matter experts, computer programmers, and sometimes video, audio, or other technicians.

Several trends promise to reduce the cost of technology-based training. Tools such as authoring systems and other instructional design programs, CD-ROM resource discs, advanced database formats, and expert systems can both speed up the process and reduce the needed programming expertise. Current authoring systems allow instructors with no programming background to create computer-based courseware. The more sophisticated systems also automate many of the tasks previously performed by technicians, such as integrating graphic

Box l-C—Measuring Interactivity

Interactivity refers to the give-and-take that occurs between the learner and the training program (usually videodisc or computer-based). Conceptual models are used to classify the types of things an interactive course lets the learner do. In these models, "level" means the courses' instructional sophistication. Often, however, sales literature uses 'level' to describe the kind of hardware needed to run a program rather than how much interactivity it delivers.

Under one such conceptual model of sophistication, five levels or generations of interactivity are defined according to three groups of instructional design factors: presentation, practice, and adaptation. The groups are subdivided further into specific factors such as use of illustrative examples, relevance to job tasks, frequency and effectiveness of practice and feedback, and ability to adapt to individual learning rates. The levels are:

1. First-generation courseware is the least interactive. It may lack graphics and usually provides few examples. Feedback typically indicates only whether answers are right or wrong, and opportunities for practice are rare. The program cannot adapt to the trainee's learning pace or branch to different topics. An example would be a computer-based tutorial that plunges into its first point without an overview, proceeds with dozens of text screens without a break or branch, does not summarize them, asks a few multiple-choice or fill-in-the-blank questions at the end, and includes no opportunities for practice.
2. Second-generation courseware provides more relevance to job tasks, but is still limited in content and design. Examples and opportunities for practice are more frequent, but graphics are still scarce. Feedback is as limited as in first-generation. Learners gain some control over the selection of topics, but neither the learner nor the system can modify exercises or tests. An example would be a computer-based or videodisc tutorial that allows learners to select one of several lessons or to leave a lesson at any time, but does not allow review of individual points without starting over. Practice might consist of around five questions at the end of each lesson.
3. Third-generation courseware is much more relevant to job tasks, provides unit overviews and summaries, has effective visuals, and offers both positive and negative examples. Learners receive clear definitions and procedures. The course provides frequent and relevant practice, and adapts to users' learning rates. Typically a third-generation program includes pretests and mastery tests, and allows learners to select among individual topics and from lessons within those topics. Each lesson ends with an exercise that simulates the skill being taught.
4. Fourth-generation courseware has all the benefits of third-generation plus it integrates full-scale simulation into the instruction. That is, the design allows trainees to practice job tasks in a simulated environment without risking mistakes that might cause havoc in the real world. Examples include a course on a particular piece of software that allows the learner to practice using the software without the potential for damaging actual data, or a maintenance training program that allows the learner to simulate repairs before actually using the machinery.
5. Fifth-generation also simulates actual job conditions, but adds artificial intelligence to observe, guide, and coach individual learners and mod@ the instruction accordingly. It critiques learners' reasoning and adapts to their cognitive style. Learners usually are offered more than one simulation. Fifth-generation courseware is in its infancy; at present, courses have been developed for medical and military applications.

SOURCE: "The Other Generation Gap," ***Training: The Magazine of Human Resource Development,*** **October 1989, vol. 26, No. 10, p. 17.**

overlays, audio, and video. Advanced systems under development will automate more of the front-end design and analysis tasks. Expert systems will augment designers' experience. When these tools are available, the time and skill required for instructional design should decrease further.

Other trends include equipment and courseware leasing and similar concepts that reduce the front-end costs for training that is delivered infrequently. Some professional associations are promoting the concept of ''shareware' for training materials. Learning centers offer services such as satellite links, and computer and videodisc training stations with accompanying courseware.

As with its classroom counterpart, the quality of technology-based training always will be a concern. The potential cost savings will not materialize if the training fails to impart appropriate skills, includes irrelevant information, or fails to accommodate varying trainee backgrounds and learning styles. Adherence to instructional design and development principles can help make a training program relevant, complete, and suitable.

Although most training developers now follow proven instructional development principles, there is much to learn about designing effective training materials. One problem is the lack of evaluative data. Few companies have the time or resources to

Box l-D—Future Prospects for Training Technology

New developments promise to stimulate broader use of training technology and enhance its capabilities. Over the next few years, as more people become accustomed to computers in work, education, and entertainment, their use as instructional tools will grow naturally. Computer-based training could become more responsive to individual needs with the use of intelligent tutors and expert systems. Advances in optical storage will greatly extend the possibilities for multimedia instruction. Expanded storage and advanced data management systems will make huge databases of instructional or background information easier to learn and use. More companies will develop electronic classrooms to facilitate the use of training technology. Embedded training and other sophisticated job aids will bring electronic instruction to the workstation.

In the near term, these changes will mean learning on demand-usually at the normal workstation but increasingly in the field or at home. The learner will be more likely to control the training, and multimedia training will be responsive to individual trainees' learning style and pace. In the long term, these developments also could profoundly change the way many people work (e.g., by eliminating the need for a fixed irregular worksite in service industries)as well as the way they learn. Training would become even more integral and no longer would be considered an activity separate from work.

In the long-term (5-20 years), broadband digital telephone networks will allow information of any type-text, graphics, audio, video-to be transmitted to any location at an affordable cost. Advanced embedded training systems will be designed that take advantage of workers' intuitive skills while helping them develop a deeper understanding of the processes they work with. Researchers also are working on systems that will allow people to feel immersed in 3-dimensional computer-generated worlds and to manipulate elements of that world by moving their bodies in a natural manner. This would provide an entirely new environment for simulations and for manipulating remote environments.

For these developments to be widely used in the long term, training professionals (instructors and managers) will need to become more sophisticated about instructional technology. Senior management and human resource development departments must place a high emphasis on training technology. Corporations and the Federal Government will have to increase R&D funding for instructional technology. Research also is needed on adult learning and instructional design, and on how instructional technology relates to issues such as retraining, basic skills, team training, participative management, and multiculturalism.

SOURCE: Office of Technology Assessment, 1990.

evaluate technology-based training's effectiveness compared with traditional methods.

A more fundamental problem is the limited application to training of basic knowledge about how adults learn. Despite the enormous sums spent on education and training and despite the shortcomings evident in both systems, learning research has never been well-supported outside the military.

If designed carefully, technology-based training has the capacity to provide environments that accommodate the wide diversity among adults and their learning styles, and that promote learning and work simultaneously. Much technology-based training can be delivered at the work station in collaborative settings that facilitate learning. Good interactive computer or video courseware provides relevance, participation, practice, and feedback. Advanced videodisc courses combine audio, video, text, and graphic material. Future technological developments will greatly enhance capabilities and reduce costs further (see box l-D).

FEDERAL POLICY OPTIONS

As challenges to American competitiveness grow, debate has intensified on the best approaches to improve worker training and on the appropriate level of Federal involvement. The need for improvement spans the public education system, integration of young people into the workforce, and upgrading employed workers' skills. But, because the great majority of the workforce of 2000 is employed now, upgrading employed workers' skills will have the greatest competitive impact in the near and medium term.

Currently, the Federal Government plays little direct role in assisting firms or their employees with training. The Department of Labor provides limited support for apprenticeships. Some Federal vocational and adult education funds support up-

grading of employees' skills. Most Federal training programs, however, focus on displaced workers, the economically disadvantaged, or people with special needs.[7]

Corporations, adult education programs, and workers themselves will play critical roles in upgrading employees' skills. Indeed, worker training will remain largely a private sector responsibility. Yet proposals for greater Federal involvement are increasing. They have come from various national commissions, the executive branch, and Congress. They range from providing better information about training, to support for industrial training consortia, to skills certification programs, to tax credits for training expenses, to payroll levies. In 1989, the Labor Department announced a 7-point 'agenda for action" to improve workforce quality. Several bills under consideration in the 101st Congress touch on aspects of employee training, such as industrial training consortia and workplace literacy. The Nation's Governors also are debating how to address workforce skills in their ongoing efforts on national education goals as a followup to their 1989 ' 'education summit" with President Bush.

The pros and cons of these proposals need careful assessment—in terms of the need for an expanded Federal role and its costs and benefits. If American firms and workers saw a need and were taking action to upgrade skill levels there would be little rationale for government involvement in employee training. However, despite some notable exceptions, the prevailing view among workers and employers is that little training is needed to develop the skills required to perform most jobs. The view is that, when new skills *are* called for (e.g., to operate new equipment), firms usually provide it.

Such a view fails to take into account the growing realization that American companies will have to make fundamental changes in work organization to become more competitive in international markets and maintain a high-wage economy. These changes require a workforce comfortable with working in groups, and with both good basic and technical skills as well as higher order skills such as problem-solving. Some pioneering companies (e.g., Aetna, Motorola, Digital Equipment Corp., Hewlett-Packard) that are making these changes place major emphasis on training and development of their employees.

Yet, the good results that can be achieved by such firms (see ch. 4) are not likely to be replicated on a widespread basis unless some training gaps are closed. To review some of these: the proportion of American workers in apprenticeship, long lower than nearly all other advanced industrial nations, fell by nearly one-half in the 1970s and 1980s with no equivalent system of vocational education springing up to take its place (see ch. 8). While a serious basic skills problem exists in the workplace, few employers evidence much interest in acting on their own to remedy the problem at the scale needed (see ch. 6). Often, firms that stand to gain the most from training-related productivity and quality improvements are in a poor position to train their workers (see ch. 3). Moreover, the quality of training is spotty, and firms often do not make good use of training (see chs. 5 and 7).

There also are steep barriers to corporate investment in training. High U.S. labor mobility, for example, makes employers see such investments as risky. Firms also lack information about how to go about providing good training. In small firms, these problems are compounded by lack of human and capital resources to support training.

Many other advanced industrial economies have put in place government policies that, in effect, protect a firm's training investments by assuring that other firms make similar investments. Similar policies have not been adopted here. Nor, by and large, does the recognition yet exist here that there is a broader public good in having a well-trained workforce that extends beyond the benefits to any firm or worker.

Some studies show that, compared with their untrained counterparts, workers with training can expect higher wages, less likelihood of unemployment and shorter duration of joblessness if they do become unemployed. While other factors affect these outcomes, training can be expected to contribute to broad societal benefits stemming from a highly productive workforce. To the extent that such

[7]Programs for retraining and reemploying displaced workers were addressed in previous OTA reports. See *Technology and Structural Unemployment: Reemploying Displaced Adults* (OTA-ITE-250), *Plant Closings: Advance Notice and Rapid Responses* (OTA-ITE-321), and *Trade Adjustment Assistance: New Ideas for an Old Program* (OTA-ITE-346). Better coordination of these programs, and their integration with any new training initiatives, is needed.

a workforce might command better wages, and their employers' realize higher profits, government tax revenues would increase to defray part of the public's investment in training. There also are likely to be reductions in public costs associated with unemployment.

U.S. society has a categorical interest in seeing to it that a high skill industrial system, one able to justify high wage jobs and rising living standards, is developed and maintained. This is a fundamental justification for public investments in training.

As it considers possible policy directions, Congress might wish to evaluate the degree to which proposed actions support not only industry training but also contribute to broader societal goals. For example, actions to improve the overall skills in the workforce would help not only firms but also workers adjust to the demands of new technology and changing competitive circumstances in the coming years. For workers without much formal education, workplace training can be a major source of learning and the last chance for upward mobility.

The American system of federalism offers numerous alternatives for allocating responsibilities among levels of government and the private sector. State governments, for example, are better positioned to provide direct services to fins. The States already provide modest assistance in customized worker training, as well as technology and industrial extension services and support to community colleges. In the long-term, States may beef up these programs as well as expand assistance into other areas; for now, their scope is small, and both scope and quality vary greatly from State to State.

There are aspects of training support that need to be carried out at the national level, either to achieve equity or uniformity, or to promote national goals. The Federal Government, for example, is in the best position to gather and analyze data about national trends in training. There also is a clear Federal role in research, evaluation, and dissemination of best training practices, especially since the military and some other Federal agencies maintain their own training programs and are major supporters of training research. State programs generally are motivated by competition for economic development; Federal assistance and policies could help dilute the rivalry. As mentioned, other countries' national policies help protect firms' training investments by ensuring that other firms are making similar investments. Only the Federal Government could take meaningful action to accomplish such a broad objective. A well-trained and educated workforce contributes to a broader public good—a higher standard of living and a healthy national economy with a satisfactory balance of trade-that transcends the interests of any State or industry.

Within this context, OTA examined 16 policy options that address four broad issue areas:

A. reducing barriers to company training,
B. upgrading individual workers' skills,
C. providing training and technology assistance, and
D. enhancing the quality and effectiveness of training.

Table 1-7 lists these 16 options and indicates the approximate level of Federal involvement and expenditure, as well as the policy goals they would promote. The options are discussed briefly below; additional detail may be found in chapter 2.[8]

Some options would extend existing but very limited Federal support for worker training; others would significantly expand the Federal role. None are mutually exclusive, although some combinations would require free-tuning. Indeed, packages of options could be devised that represent differing degrees of Federal involvement. An incremental package that builds on current Federal assistance for training research and demonstrations, program evaluation, and best practice dissemination, for example, represents a modestly supportive but indirect Federal role. A broader version of such a role would add programs such as workplace basic skills demonstration projects and permanent tax incentives for employer-paid tuition. A still broader approach might add new initiatives such as support for industry training consortia, funding for State clear-

[8]Even if fully implemented, these options comprise only a portion of a national strategy for human resource development. Other segments related to displaced workers have been addressed in previous OTA reports cited in footnote 5. Several OTA reports also address issues associated with education. See *Power On! New Tools for Teaching and Learning (OTA-SET-379), Linking for Learning: A New Course for Education* (OTA-SET-340), *High School Vocational Education: Measures of Program Performance* (OTA background paper), *and Elementary and Secondary Education for Science and Engineering (OTA-TM-SET-41).* For a discussion of human resources in manufacturing, see *Making Things Better: Competing in Manufacturing* (OTA-ITE-443), ch.4; for services, see *International Competition in Services* (OTA-ITE-329), *chs. 7* and 8.

Table 1-7—Summary of Federal Policy Options

	Degree of increase in level of Federal involvement[b]	Change in level of Federal expenditure or revenue loss[c]	Policy goals promoted[a]						
			Encourage all private training	Help small firms	Promote high skill work organization	Improve knowledge of best practices	Help upgrade basic skills	Encourage State programs	Improve training data
Issue Area A: Reducing Barriers to Company Training:									
1. Help firms set up training consortia	M	S-M	X	X	X	X	X	?	?
2. Expand technical assistance to trade associations and others	M	S-M	X	X	X	X	X	?	?
3. Establish limited tax credit for corporate training	M	L	X	X	X	?	X	?	X
4. Phase-in payroll-based national training levy	A	S	X	X	X	?	X	X	X
Issue Area B: Individual Workers and Retraining:									
5. Expand apprenticeship concepts	M	M	X	X	X	X	?	X	?
6. Fully fund Federal vocational programs	M	M	X	X	X	X	X	X	?
7. Fund workplace basic skills programs	M	M-L	X	X	X	X	X	X	?
8. Provide favorable tax treatment for continuing training	S	M-L	X	X	?	?	?	?	?*
9. Evaluate ways to help workers finance continuing education[d]	S	S	X	X	?	?	?	?	?
Issue Area C: Training and Technology Assistance:									
10. Coordinate technology and training assistance	S	S-M	X	X	X	X	?	X	?
11. Help States include training in industrial extension services	S	M-L	X	X	X	X	?	X	?
12. Support creation of an employer institute for workplace-based learning	M	M	X	X	X	X	X	?	?
Issue Area D: Improving the Effectiveness and Quality of Worker Training:									
13. Encourage adoption of best practice approaches and technologies	S	S	?	?	X	X	?	X	?
14. Fund the Federal Training Technology Transfer Program	S	S	X	X	X	X	X	X	?
15. Fund more civilian learning and training technology research	M	M	?	X	X	X	X	?	?
16. Improve the data about work-based training	S	S	?	?	?	?	?	?	X

[a]X = would clearly further goal; ? = little or unclear effect.
[b]S = small; M = moderate; A = aggressive.
[c]S = small ($10 million or less); M = moderate ($10 to $100 million); L= large ($100 million plus); a range indicates that it depends on how the option is implemented.
[d]Note that this option refers only to evaluation; actual implementation would be more aggressive and costly.

SOURCE: Office of Technology Assessment, 1990.

inghouse services, or legislative mandates for technical assistance.

Incremental approaches would have low initial implementation costs; many of their features are in place or being considered by Congress. However, if funding stayed at the initial level only, they would do little to change companies' fundamental training practices. The States would play the primary government role, with implementation priorities likely to vary greatly, and corporate training would continue to be delivered unevenly. For long-term effectiveness, even an incremental strategy would need to lead to sustained Federal support for meaningful impact. Thus, as shown in table 1-7, many options that might initially involve relatively small Federal expenditures (under $10 million) might need to expand in time to over $100 million annually to have much impact.

To overcome the barriers that inhibit American companies from providing widespread training, Congress would have to choose more far--reaching initiatives. The largest single potential impact on corporate training with little or no direct effect on Federal revenues would come from a payroll-based levy.[9] A levy would fundamentally change training practices among *all* employers (including government and small business). But many firms would see it as an unwarranted intrusion. Business cooperation might be more forthcoming if a new institution-outside existing government agencies—were chartered to work with industry and labor on issues related to new technology, work organization, and training. Other options, including direct assistance or tax incentives for workers and firms to undertake specified forms of training, would have less pervasive impacts than a levy. Moreover, if not formulated carefully, tax options could have great potential for abuse (e.g., writing off executive seminars at a resort as training). Nonetheless, all these measures would give national attention to worker training for competitiveness in the new international economy.

Issue Area A: Reducing Barriers to Company Training

Barriers to company training arise from limited funds to support training, inadequate understanding of training needs, lack of knowledge about good training practices, and reluctance to train young and older workers. There are several approaches Congress might consider to alleviate structural barriers to company training. One possibility would be to encourage firms to participate in training consortia (Option 1). A bill introduced in the 101st Congress (S.2114) would establish a Labor Department training program to provide start-up grants to firms interested in establishing consortia. A program of this sort, if initially funded at a level of a few million dollars per year, could be a low-cost means for the Federal Government to encourage joint ventures that would help share the risks of training, increase the resources available to small firms, and allow more cost-effective development of training materials. The Federal Government might also earmark some funds to consortia that emphasize transferable skills (e.g., basic skills, apprenticeship or other certification).

A related possibility would be to expand technical assistance to trade associations and other industry groups and to joint labor-management organizations to aid in developing training programs for their members (Option 2).

Congress might also give the Department of Labor (which now funds such services on a more or less ad hoc basis) an explicit mandate to provide technical assistance for work-based learning and charter an office to provide support services on a continuing basis. With more funds, the office could work to increase industry involvement in developing training materials.

The Federal Government also could use tax inducements to make training investments more attractive. A limited tax credit for certain kinds of training+. g., basic skills training or classroom training associated with apprenticeships-might encourage more firms to engage in these forms of training (Option 3). Unless carefully defined and monitored, however, a tax credit could involve sizable revenue losses to the U.S. Treasury without a corresponding increase in the desired training activities. Congress might first instruct the Treasury Department, in cooperation with the Department of Labor, to study the optimal design of such a credit. To better predict the behavior of firms, a field test

[9] In the short term, there could be some reduction in Federal revenues from corporations if firms use otherwise taxable income to cover a training levy. Over the longer term, Federal revenues might increase if productivity improvements accruing from a better trained workforce led to greater profitability.

could be conducted in which companies would be reimbursed for eligible training costs at a level equivalent to a tax credit. If the study showed that a credit would increase and improve worker training, Congress could then decide whether the benefits outweighed the expected revenue losses.

A national training payroll levy, perhaps more than any other action, could guarantee increases in training—and could do so with no direct loss in Federal revenues (Option 4). Companies would choose between either spending a specified percentage of their payroll (say, 1 percent initially) on particular types of training, or contributing that percentage to a national fund for training initiatives. Several other countries (including France, West Germany, Ireland, and South Korea) use payroll-based levies of various types to encourage employers to train workers. In the United States, four States now raise training funds through a small payroll-based levy.

As an alternative to immediate implementation, Congress might phase in a training levy. The initial stage could be devoted to developing industry-sector information about training costs and aiding firms in identifying their training needs. During the initial period—perhaps 3 years-firms could either report their annual training expenditures or pay the 1 percent payroll levy. As reporting firms would not pay the levy even if they spent nothing on training, the main burden of the requirement would be the paperwork involved in calculating training costs. The reporting requirement would alert firms to the need to develop a training strategy. At the end of the 3-year period, Congress would then have information on training norms within industry sectors that would be helpful in fine-tuning the levy before full-scale implementation.

Issue Area B: Individual Workers and Retraining

Although the United States has an extensive adult education system, the employer is still the primary source and incentive for education and training for many employees. Most large and medium-sized firms provide broad training for professionals, technicians, and managers. But few firms train production workers (except for specific needs), younger entry-level workers (those most likely to move to another job), and older workers (the fastest growing segment of the U.S. workforce). Minorities also get less training. Despite growing corporate concern about basic skills, few employers have remedial programs or offer support (e.g., paid leave) to workers who participate in public programs. Federal policies that would encourage greater investment in transferable skills training would be beneficial to employees and employers alike.

Apprenticeship has long been one of the best examples of a training program that develops the technical skills firms need while at the same time providing workers with a credential that leads to a better paycheck. Yet, the American apprenticeship system is stagnating. The Department of Labor has been looking at ways to revitalize traditional apprenticeship and also at ways to apply apprenticeship concepts—including portable credentials-to industries with little history of apprenticeship (e.g., service industries). Yet funds (in real terms) and staff for the Bureau of Apprenticeship and Training have fallen. More funding will be needed if the Bureau is to do much to revitalize traditional apprenticeships. The Department of Labor also might work with industry to develop national standards for certification of skills for trainees in industries that do not have apprenticeship traditions (Option 5).

Congress also could expand assistance available to firms for certain activities+. g., basic skills training and vocational skills upgrading-that make it easier for employees to participate in training (Option 6). The major Federal vocational education law is undergoing reauthorization in the 101st Congress. In the summer of 1990, a conference committee reported a vocational education measure that reconciled differences between bills passed by the House and the Senate. If enacted, the measure would charnel more support for integrating secondary school vocational and academic curricula. It also would authorize some support for upgrading of skills of employed workers (including apprenticeships). Because of the measure's breadth, it is unclear whether funds will be adequate to support all these activities.

Congress is also considering a major new literacy initiative, which, if passed, would greatly expand the available Federal assistance for workplace basic skills (Option 7). A Senate-passed bill (S.1310) would increase funding for basic skills training under the Federal Adult Education Act and would authorize $50 million for the Education Department's workplace literacy demonstration grant pro-

gram (current funding is ***$20*** million). A House-passed measure, Title V of H.R. 5115, also would increase Adult Education Act funding, and would establish a new ''national workforce literacy strategies program.' The bill would authorize up to $40 million per year in grants to improve current workforce skills on a regional, statewide, or industry-wide basis. Both bills would also expand literacy activities in other areas (e.g., research) as well. Whatever approach is taken, Congress may wish to ensure that the special needs of workers in small business are also addressed, and that research on, and evaluation and dissemination of, the most effective approaches are required.

Another existing law—a provision in the tax code that exempts workers from paying taxes on educational assistance from their employers—will expire in 1990 unless renewed by Congress. Continuing the exemption (Option 8) would cost the Treasury an estimated $255 million in fiscal year 1991, with the amount possibly rising after that, but would mean that few workers would halt their own retraining efforts for tax reasons.

While employer assistance programs only reach a small portion of workers, and many workers cannot afford to finance their own continuing education, the Federal Government administers a number of student aid programs that workers might use to finance continuing education. For the most part, however, these programs are more oriented toward full-time students, than employed adults. Special incentives have been suggested to extend these programs to workers' continuing education needs, such as proposals to loan workers education funds that would be paid back through an income tax surcharge. Other alternatives would guarantee all Americans some level of financing for post-secondary education at some time during their lives. Because they could be expensive and because they have significant potential for abuse, such proposals would need careful evaluation before decisions were made (Option 9).

Issue Area C: Training and Technology Assistance

Training can make or break the effectiveness of new technologies and work practices. While knowledge about the most effective training approaches is increasing, the process of diffusion can be quite slow—few firms share successful techniques with potential competitors. Expansion of government efforts to disseminate information and provide technical assistance could help speed diffusion.

Several Federal agencies—including the Departments of Commerce, Labor, and Education—now have demonstration projects and other small programs that provide training or technology assistance to firms (either directly or through the States). If Congress expanded these efforts, it might designate a lead agency (e.g., the Department of Commerce) to work out coordination among these programs so as to provide greater benefits to firms (Option 10).

In addition, the Federal Government could help State governments expand their training assistance to firms (Option 11). States have long used training subsidies to entice firms to relocate. Now, as part of their efforts to retain firms and reduce unemployment, many States have modest training programs to help existing firms upgrade their workforces. A handful of States give workforce skills development a prominent place in their growth strategies. While such State activities are promising, there has been little in-plant evaluation of their training programs. At a modest cost, the Federal Government could provide funds for such evaluations and dissemination of the results to other States and the private sector.

Some States also help firms with production technology and management. Such State industrial extension programs could help firms identify their training needs as well, but, aside from referrals, few now do. Moreover, as discussed in the recent OTA report, ***Making Things Better,*** total State funding for such programs in 1988 was only $58 million. A small Federal grant program was authorized under the 1988 Trade Act, but funds were not appropriated until fiscal year 1990, and then only to the tune of $1.3 million. If Congress decides to appreciably increase this funding, it might encourage States to experiment with different ways to combine or more closely coordinate their training and technology services. Funds to finance such experimentation could be made available to the National Institute of Standards and Technology (NIST) in the Commerce Department (Option 11). NIST also might provide expanded training to workers and managers at its national manufacturing technology transfer centers. Such activities could help achieve better coordination in the delivery of both technology and training services to fins.

The human resource development issues related to the organization of work and workplace learning currently receive scattered and sporadic attention. No single institution at present addresses workplace learning issues over the range from research and development to and best practice dissemination issues. A new organization, with an explicit charter to address such concerns, might bring new visibility to the need for employers to adopt more effective human resource development practices (Option 12). A National Institute on Workplace Learning, to be effective, would need to have extensive employer involvement. In fact, to have the greatest impact on industry, such an organization might well need to be outside the traditional agency structure of the Federal Government. Startup Federal funding would be needed. In time, employers might fund such an institute on their own if the benefits were clear.

Issue Area D: Improving the Effectiveness and Quality of Worker Training

Increased Federal support for work and learning research and for development and dissemination of new training technologies could bring, in time, substantial benefits to the entire training system, both public and private, at comparatively modest cost. The quality of training varies greatly. Some U.S. firms are world leaders in training. However, most firms (and many training institutions) know little about the best practices for training or about the latest training techniques and technologies. Moreover, research on how adults learn-research that could, over the long term, lead to improvement in the efficiency and quality of training-often fails to be integrated into training practices. One possibility (Option 13) would be for Congress to direct Federal agencies with education and training programs (e.g., Defense, Education, Labor, Commerce, Health and Human Services) to develop and disseminate information about best practice approaches and technologies. Congress could, for example, support efforts by NIST to gain industry acceptance of operating standards for training technologies and related software. Such standards, if adopted, would facilitate use of training products. It also might support Federal agency efforts, now informal, to disseminate information on training technology.

The Federal Government, historically, has played a major role in developing new instructional technologies and approaches for the Defense Department and other Federal agencies (see box l-E). Increased efforts to disseminate federally developed

Box l-E—The Military and Training

The military **is the** largest single institution in the United States that recruits and trains young people (see report appendix). The military model for skills training is similar to apprenticeship, except that the "related instruction" which takes place simultaneously with on-the-job training in traditional apprenticeship is front-loaded in the military. That is, recruits receive intensive classroom instruction after basic training, followed by on-the-job training coupled with written and practical skills tests.

There are several basic differences between military and conventional private-sector training. Private firms expect young workers to move on within a year or two, while the military recruits for 3- to 4-year tours of duty. A small percentage stay in the military for a 20- to 30-year career. Further, the military model is "up or out"; if recruits do not pass training and move up, they typically are discharged. Military training also is based more on job analysis and job-specific performance standards than most private-sector training. Military training is constantly evaluated, with feedback from the users of the training-the trainees' commanders. Also, instructors are rotated, conducting training for 3 or 4 years at a time and then returning to the field. Thus they maintain and upgrade their duty *skills.*

Instructional technology is more prevalent in military training than in the civilian sector. The military has a high interest in training technology for several reasons. It has an extremely high turnover rate but a large population worldwide. Instructional technology provides both the portability and consistency to meet the needs of this type of population. The military also frequently introduces new equipment that has increasingly sophisticated and complex capabilities. In addition, it can afford the startup costs associated with hardware and software development.

Although the bulk of training is still lecture/lab with practice on real or simulated equipment, the military is rapidly adopting more sophisticated training technology. Current changes in training systems requirements and technologies include trends toward simulators, networking for team training, and embedded training systems.

SOURCE: Office of Technology Assessment 1990.

or sponsored training materials and expertise to the civilian education and training communities have been underway for several years, with limited success. In the 1988 Trade Act, Congress directed the Department of Education to establish a training technology transfer office, but did not appropriate funds. The Administration also has been slow in setting up the office. Thus, implementation cannot be expected to begin in earnest until fiscal year 1991 at the earliest. Initial funding of this office-at least at the $3 million level originally called for in the Trade Act-could help launch this program effectively (Option 14).

Even if such efforts are stepped up in the years to come, the need for more evaluation of workplace training and the educational system would remain. Promising techniques need evaluation so that best practices can be disseminated with some confidence to potential users. Various proposals have been made to set up a national institute for learning technology and research, either through an existing Federal entity or outside of the normal Federal structure (Option 15). The Education Department also could expand its support for education research and development centers to include more emphasis on workplace and adult learning issues. The National Science Foundation could support research on human resource development, work organization, and issues associated with training technology adoption. While Federal funding for such activities would need to be sustained over a period of years, the potential benefits could be substantial. The Federal support could lead to more effective training practices in the longer term. Given the fact that the workforce is aging, remarkably little research has been conducted on the most appropriate training practices to meet older workers' learning needs. Earmarked support for such research may be needed if it is to be sustained.

Finally, information about the extent and effectiveness of workplace training is very poor. If Congress would like more knowledge about worker training trends, it could direct the Census Bureau, the Labor Department, and the Education Department to develop and periodically update information on workplace training (Option 16). Data collection could be done through separate directives to these agencies or as part of an overall review of Federal statistical priorities. The impacts of worker organization and worker training on productivity, efficiency, and competitiveness are pervasive. Sound policies in the future will depend on knowledge of effective practices and their extent.

Chapter 2

Policy Issues and Options

CONTENTS

Boxes

Tables

Chapter 2
Policy Issues and Options

INTRODUCTION AND CONTEXT

There is a broad consensus that the American training system needs strengthening; the questions are how to achieve it and who is to do it. American society needs to do abetter job of integrating young people into the work world, providing them with initial training, and helping workers upgrade their job skills during their working lives. In many other countries workforce skill levels equal or exceed our own, or are advancing rapidly, often with government stimulus. If the pool of skills in the American workforce becomes obsolete relative to the highly trained workforces of the Pacific Rim nations and Western Europe, further erosion in the U.S. competitive position—with adverse implications for living standards-could occur.

The corporate training system, the adult education system, and the individual workers themselves will play the critical roles in upgrading workforce skills. At present, the Federal role in encouraging these players to interact is very limited. However, proposals have been made in Congress or elsewhere to broaden Federal support, ranging from provision of more information to support for industrial training consortia to tax credits to a national training levy. Also, some executive branch agencies, such as the U.S. Department of Labor, are looking at ways to encourage work-based learning. The States are also examining their role: the Nation's governors are debating how to improve workforce skills in their effort to flesh out national education goals emerging from the 1989 Education Summit with President Bush. (See box 2-A for discussion of recent recommendations of national commissions on workplace training; recent executive branch actions are summarized in box 2-B.)

With some notable exceptions (see box 2-A), the proposed actions do not represent an overall national strategy toward human resource development for the workforce. A comprehensive strategy would need to encompass many elements, ranging from education of children, drop out prevention, and training programs for the unemployed and the economically disadvantaged, to training of scientists and engineers.

The focus here is on just one element—Federal policy and the continuing training of employed workers. Before examining the need for such policies, and the arguments for and against an expanded Federal role, a review of some of OTA's major findings is in order:

- While strengthening public education is critical for developing future workforce skills, the most immediate opportunity for skill development—the one that would have greatest impact in the near and medium term-lies in improving the skills of those already working. Indeed, 7 out of 10 workers in the year 2000 will be people already in the workforce in 1988; the typical worker will also be older than is the case today.[1] The flexibility of' this workforce, especially how well workers at all levels—horn the shopfloor to the executive suite-respond to challenges will be a critical factor for national competitiveness over the next decade.
- Aside from managers, professionals and technicians, few American workers get much training on their job, or act on their own to upgrade skills. By contrast, our most formidable economic competitors, including Japan and West Germany, do far more to assure the continuing development of workforce skills at all levels than does the United States. Most West German workers go through formal apprenticeships; much additional training is needed for workers to move up to supervisory positions. In Japan, high quality secondary schools, well structured but informal training on the job, and worker interest combine to produce highly skilled, flexible workers. Production workers in Japan's auto assembly plants get three times more training-formal and informal-than their American counterparts.
- Labor mobility in the United States is high. Companies cannot expect to fully capture all benefits from training investments, particularly broad training that gives workers transferable skills. Recognizing this, many other advanced

[1] Howard N. Fullerton, Jr., "New Labor Force Projections, Spanning 1988 to 2000," *Monthly Labor Review, November* 1989, p. 10.

Box 2-A—What National Commissions Recommend on Workforce Training

Several recent commissions and national studies have concluded that systemwide improvements are needed in education and training if the United States is to be able to compete effectively in a world economy in which the best prospects for a rising standard of living lie in the skills of the workforce. Two which advocated a stronger government role:[1]

- ***The Secretary of Labor's Commission on Workforce Quality and Labor Market Efficiency (1989):***[2] ***This*** panel of business, labor, and education representatives expressed alarm about possible economic decline unless more is done to educate and train the American workforce. Its recommendations for public and private actions encompassed both the school system and the workplace. While noting its concern about the budget deficit, the Commission said that there was "likely to be a clear and pressing need for a sustained increase in Federal expenditure on human resource programs. " It called for sustained human resource investments to, among other things, improve student achievement, encourage lifetime education and training, and make better use of workers' skills.

  Among its suggestions for Federal action in the training area: give employers a limited tax credit for training, offer more technical assistance and clarify antitrust provisions for multiemployer training programs, and continue the favorable tax treatment workers get for employer provided education assistance. It urged Federal and State Governments to ensure that all adults have lifetime access to basic skills education. It called for more Federal efforts to disseminate information about best-practice worker participation approaches, and called for improvements in labor market data. Finally, the Commission urged formation of a Presidential committee to coordinate human resource policy.

- ***The Commission on the Skills of the American Workforce (1990):***[3] This panel, also comprised of business, labor and education representatives, concluded that American living standards will rise only if far more American companies reorganize work along a high performance, high skill model. To develop the needed skills, the Commission proposed restructuring the American education and training system at all levels. Many of the group's recommendations focused on noncollege bound youth and workers. It recommended that young people under the age of 18 should not be allowed to work unless they could meet (or were taking steps to meet) a new educational performance standard, and urged major levels of support for dropout recovery programs. It called for a program of financial support to allow all students and workers to enroll in programs giving technical education certificates or associate's degrees.

  A national board, comprised of industry, labor, and education representatives, would appoint industry and trade based committees to develop specific standards for certification. The Commission also proposed that the States and the Federal Government see to it that all Americans could receive 4 years of financing for postsecondary education at some time during their lives.

  As for employers, it called on the Federal Government to require all firms to spend at least 1 percent of payroll on education and training, with the amount increasing over time. Firms that did not spend the required amount on their own workers would pay this amount to a Skills Development Fund to train temporary, part time, dislocated, or disadvantaged workers. The Commission also proposed increased technical assistance to help firms reorganize work in ways that would take advantage of highly skilled workers.

---

[1] See also the President's Commission on Industrial Competitiveness (1985). This group, headed by industrialist John Young, recommended strengthening the capabilities of vocational schools and community colleges to provide customized training to employers, especially small business, and also called for evaluation of tax proposals to achieve a balanced tax treatment of employer investments in physical and human capital.

Another group, MIT's Commission on Industrial Productivity, in its 1989 report Made *in America,* stopped short of policy recommendations. However, it noted the adverse impacts from what it called a "legacy of long neglect in training" and a widespread reluctance by U.S. firms to invest more in training and in reorganizing work to promote continuous learning.

[2] Commission on Workforce Quality and Labor Market Efficiency, *Investing in People: A Strategy to Address America's Workforce Quality* (Washington, DC: U.S. Department of Labor, 1989). The Commission appointed by Ann McLaughlin, a Secretary of Labor under former President Reagan, made its report to President Bush's Secretary of Labor, Elizabeth Dole, on Labor Day, 1989.

[3] The Commission on the Skills of the American Workforce, *America's Choice: High Skills or Low Wages!* (Rochester, NY: National Center on Education and the Economy, June 1990).

Box 2-B—Executive Branch Initiatives on Workforce Quality

During the last 5 years, the executive branch—and especially the Department of Labor-has been actively studying new avenues for improving workforce quality. The Commission on Workforce Quality and Labor Market Efficiency, set up by former Labor Secretary Ann McLaughlin late in the Reagan Administration, proposed a strategy, and some 44 recommendations for private and public actions, to address what it called "America's workforce crisis' before it disbanded in the fall of 1989[1] (see box 2-A for details). Also in late 1989, Elizabeth Dole, President Bush's Secretary of Labor, announced her own seven-point "agenda for action" to improve workforce quality. In contrast to the actions urged by Commission, few items on the agenda would require legislative action or much new Federal spending.

Items from the agenda directly pertinent to industry training include:

- The Secretary's Commission on Achieving Necessary Skills (SCANS): SCANS is to recommend national guidelines to help schools better define educational competencies needed to meet workplace skill needs. The Commission will work to identify needed skills, acceptable levels of proficiency, and effective ways to measure these skills. Former Secretary of Labor William Brock chairs the Commission, which is expected to issue its final report in May, 1991.
- A National Advisory Board on Workplace Training: The board would focus on ways to expand apprenticeship to new industries and occupations (such as service industry jobs). It will work with industry to develop standards to accredit work-based training programs and to provide workers with recognized credentials. The board had yet to be appointed when this report went to press.
- A Workforce Quality Clearinghouse: The clearinghouse would work to promote best practices by employers in meeting employee needs, such as flexible benefits, training, and innovative labor-management relations. Initial operations were expected to begin in the Fall of 1990.
- Research and demonstration projects to test incentives for employer- and employee-financed training and partnerships with industry groups.

Secretary Dole's agenda also calls for research and development on School-to-Work Transitions, including awards recognizing exemplary practices, and more volunteer efforts. A national conference on the subject was held in May 1990. In addition, the Secretary has acted administratively to establish an Office of Work-Based Learning, which includes the Bureau of Apprenticeship and Training and also has responsibilities for displaced workers and trade adjustment assistance.

The 1989 Education Summit with President Bush and the Nation's Governors also has focused some concern on workforce skills. One of the six national education goals adopted by the governors after the Summit concerns adult literacy and lifelong learning. The goal states that, by 2000, every adult American should be literate and possess the necessary skills and knowledge to compete in a global economy and exercise good citizenship. Among the stated objectives: to involve "every American business in strengthening connections between education and work" and in giving "all workers the opportunity to acquire the knowledge and skills, from basic to technical, to adapt to emerging technologies, work methods and markets through public and private educational, vocational, technical, workplace or other programs."

In July 1990, the National Governors' Association proposed alternative strategies for States to consider in implementing the education goals.[2] Progress toward these goals will depend on continued commitment at all levels within the society.

[1]The Commission actually reported t. President Bush's Secretary of Labor, Elizabeth Dole. It's report, *Investing in People: Strategies to Address Americans Workforce Crisis*, (Washington, DC: U.S. Government Printing Office, 1989) was issued on Labor Day, 1989.

[2]Report of the Task Force on Education, *Education America: State Strategies for Achieving the National Education Goals* (Washington, DC: National Governors' Association, 1990).

industrial economies have put in place government policies that, in effect, protect a fro's training investments by assuring that other firms make similar investments. Similar policies have not been adopted here. Nor, by and large, does the recognition yet exist here that there is a broader public good in having a well-trained workforce that extends beyond the benefits to any firm or worker.

Should the Federal Role Be Expanded?

The Federal Government now requires employee training in some areas where the public interest is clear-such as workplace safety, health, and hazard-

ous material handling.[2] However, it does little to assist firms and their employees with skills or job performance training. Does the national interest in maintaining economic competitiveness and living standards justify Federal incentives for employee training? And, if a Federal role is appropriate, what should be its scope?

It is clear that the private sector must be the primary actor in employee training. **Proposals that** will receive serious consideration by policymakers are likely to aim at expanding the Federal role through activities that augment or enhance, not substitute for, private efforts. With the list of proposals growing, the pros and cons of an expanded Federal role need careful assessment.

Is There Need?

There would be little need for government involvement if employers provided an optimal level of training or if workers undertook such training on their own. A common view in American management—and among many workers—has been that little training is required to develop the skills needed to perform most jobs. When training is needed to develop specific skills (e.g., to operate new equipment), firms will provide it. The practice of reducing jobs to their simplest tasks has been widely used by American management, in part because training needs were minimized.

While this practice still prevails, its suitability as a contemporary model for work organization is increasingly challenged. Indeed, as chapter 4 of this report discusses, a growing number of American firms are beginning to reorganize work in ways that more fully develop and exploit the skills of their workers. These companies usually find that considerable training is necessary for success. Most fins, however, continue to rely on the traditional model of work organization.

Thus, there is growing concern, reflected in the commissions cited in box 2-A, that American society is doing too little to develop the skills needed to support a globally competitive set of industies and an improved standard of living. Training is too often given low priority or is used ineffectively by management. According to this view, U.S. society has a vested interest in a high skill industrial system, one that is likely to produce high wage jobs and raise living standards, and this is a persuasive rationale for government assistance in training.

Indeed, training can benefit firms, workers, and society as a whole. For workers, training is associated with higher wages, less liklihood of unemployment, and shorter duration of joblessness if they do become unemployed. While other factors also affect outcomes, training can be expected to contribute to broad societal benefits stemming from a highly productive workforce. To the extent that such a workforce might command better wages, and their employers' realize higher profits, government tax revenues would increase to defray part of the public's investment in training. There also are likely to be reductions in public costs associated with unemployment.

Won't Firms Train on Their Own?

A few American firms are world leaders in training; by all accounts, however, most firms do little training. More might begin to act on their own to provide training as the benefits of well designed programs become clear. This seems unlikely, however, unless some structural impediments that now make many firms reluctant to train are overcome.

Companies cannot expect to fully capture all of the benefits of their training investments, particularly training that develops general skills. High labor turnover in the U.S. economy makes many employers, especially small employers, view training that gives workers transferable skills as a risky investment. Even though the training might enhance the skills of their workforce, these employers fear that their workers will take other jobs before the firm recoups its training investment.

There can be a broader public good arising from training that the individual firms or workers are not in a position to achieve through their own actions. Several other countries recognize this through national policies that help protect a fro's training investment by assuring that other firms also make similar investments. Similar approaches could be taken here.

---

[2] For example, nursing homes that receive Medicare and Medicaid funding must meet minimum Federal standards for nursing aid training. Many States are now developing literacy tests for truck drivers to meet federally established standards for truck drivers. Implementation of the Occupational Safety and Health Act now requires companies withover 10 employees to label hazardous substances, warn workers of their dangers, and provide special training in their safe handling.

Government assistance will not do much unless there is strong management commitment (which could require a change in management attitudes) and employee motivation (which might follow a change in management attitude) to more fully use worker skills. Without this, training might do little to improve a fro's performance. It could be a goal of government to provide the information and incentives that could contribute to this change in behavior and attitudes.

Are There Training Gaps?

Several highly publicized reports have suggested a growing mismatch between worker skills and workplace demands. Many low skill jobs will continue to be created that require little training. However, unless the overall pattern is toward high skill jobs that can command high wages, the United States risks becoming a low skill, low wage country. The conclusion is almost inescapable that U.S. industry will not be able to widely replicate the good results realized by the best-practice firms unless some major gaps in the worker training system are addressed.

As discussed in chapter 6 of this report, the best estimate is that one-fifth of young adults aged 21 to 25 read only as well as an average eighth grader, and the incidence of poor basic skills could be higher for the workforce as a whole. Few employers on their own can be expected to offer basic education to their employees. The United States ranks near the bottom among industrialized countries in apprenticeships. Small firms and firms facing financial difficulty—the firms that might benefit most from the improved productivity and quality that can come from relatively low-cost investments in training-are often in the poorest position to train their workers. Moreover, the quality of training is often poor, and firms often do not make good use of training. In the face of such findings, business-as-usual will leave many U.S. workers unprepared to participate in the kind of high skill economy that is most likely to lead to an improved standard of living.

Government Action: State, Federal, or Both?

What level of government would be best suited to assist in addressing these gaps? The American system of federalism offers many different alternatives for structuring partnerships between the Federal Government and States. Ideally, policy initiatives could be crafted to exploit the special strengths of each level of government.

Clearly, the States are better positioned than the Federal Government to provide direct services to fins. Most States now offer modest assistance to industry for training, and several are now active providers of workplace literacy assistance. Because several States also offer industrial extension services, they have the potential to provide firms with coordinated technology, training, and management assistance at the same time. Many States also support community colleges, which provide firms with training services. States also play a pivotal role in public education. Some also are experimenting with new ways to finance training assistance, such as payroll levies and tax credits:

While the level of State activity is increasing, progress could be slow and spotty without national leadership and support. State spending for industry training and technology services is modest—probably less than $1 billion. The State activities are driven by economic development objectives, and the States are in competition on this. National policies could help create a more favorable environment for continuing education and training throughout the country.

There are other activities that would be difficult to carry out without Federal leadership. Clearly, the Federal Government is better suited than the States to collect and analyze data about national trends in training. A Federal role to support research, evaluation, and dissemination of the best training practices is another area where national scope is important, especially since the military and some other Federal agencies are major supporters of training research.

Competition for Federal Dollars

An expanded Federal role could heighten competition for Federal funds, a matter of no small concern in a day of budget deficits and limited funds for existing Federal training programs for the disadvantaged. Employer spending on formal training-a low-end estimate would be $30 billion per year-is one-third more than the total budget of the U.S. Department of Education and about 10 times the amount the Federal Government spends for services to economically disadvantaged people and displaced workers under the Job Training Partnership Act.

Clearly, Federal support, or any governmental support, for that matter, would need to be carefully targeted. Otherwise, government dollars might simply substitute for private training dollars, hence doing little to expand industry training. Government efforts might aim at improving the effectiveness of training. Another possibility would be to target assistance on either employees that seldom receive much training or on transferable training.

Government involvement would not necessarily require major increases in Federal spending, however. Most options discussed in this chapter would have a small (under $10 million per year) or moderate (under $100 million per year) initial cost. Many of these options would need to be sustained for a period of years to have much impact, and some of them might well need to be expanded in time beyond the $100 million level to fully succeed. But the option that would stimulate the most training, a training levy, would do so with only modest fiscal impact on the Federal Government.[3] It would force many firms who do not now conduct training to spend on training, but it would also ease 'free rider' problems for other firms that do spend money on training. There would be a danger of training for training's sake-with resources not always used in the most efficient and productive fashion.

Other government roles, such as support for research, have the potential to improve training throughout society-including the training Federal agencies give to their own employees and the training offered through such Federal programs as the Job Training Partnership Act. The efficiency gains might in time pay for the research many times over. Finally, an initiative aimed at equipping workers with transferable skills would help workers get new jobs in the event of displacement.

Do We Know Enough To Take Action Now?

To those demanding a high degree of certainty, the absence of good data may seem a reason to delay a major Federal initiative in this area (e.g., a national training levy). Better information clearly would be desirable. But there also are risks in delaying action for the protracted period (certainly several years) needed to develop good data about training. The findings of numerous national studies in recent years clearly indicate that more needs to be done-and soon—to enhance workforce skills. If a major initiative is to be launched, it will need to occur very soon to have much impact in this century.

As it considers possible policy directions, Congress might wish to evaluate the degree to which proposed actions support not only industry training but also contribute to broader societal goals. For example, actions to improve the overall skills in the workforce would help not only firms but also workers adjust to the demands of new technology and changing competitive circumstances in the coming years. For workers without much formal education, workplace training can be a major source of learning and the last chance for upwind mobility. Workers with abroad base of skills are likely to have less difficulty in finding new jobs if they are displaced, reducing unemployment costs to society.

Defining the Scope of Federal Responses

OTA has identified, and analyzed below, 16 policy options that, taken in sum, would broaden and deepen employer and employee commitments to training. (Table 2-1 lists these options, grouped under four broad issue areas, and directs the reader to more detailed policy tables and discussion in the text.) Some options would provide a stronger institutional base of support within the Federal Government for industry-based training, building on existing programs. Others, if adopted, would go well beyond the current Federal role. These options are not mutually exclusive, although some would need to be modified if other approaches were also taken,

These options could be put together in various combinations, reflecting different degrees of government involvement. One approach would be for government to play a supportive, but largely indirect, role in encouraging training by fins, individual workers, and States. This incremental approach would build on current Federal activities (sponsorship of research and demonstration projects, help to States for evaluating training programs, development of data, dissemination of information about best practices) that could provide a better information base for training. Some existing programs (e.g., workplace literacy demonstration projects, favorable tax treatment of employer provided education

[3] A *training* levy would not entail direct Federal expenditures. There could be some near term revenue loss to the Government if firms used funds from otherwise taxable profits for training. On the other hand, if the training led to more productive enterprises, the long-term effect for Federal revenues would be positive.

Table 2-I--Summary Guide to Policy Issues and Options

Issue areas and options	Table no.
Issue area A—Reducing barriers to firm-based training	
Options:	
1. Help firms setup training consortia.	Table 2-2
2. Expand technical assistance to trade associations, others	Table 2-2
3. Consider limited tax credit for private-sector training	Table 2-2
4. Phase-in payroll based "national training levy"	Table 2-2
Issue area B-Retraining individual workers for career advancement	
Options:	
5. Expand apprenticeship concepts	Table 2-3
6. Adequately fund Federal support for vocational programs	Table 2-3
7. Fund workplace basic skills program.	Table 2-3
8. Provide favorable tax treatment for continuing education	Table 2-3
9. Evaluate ways to help finance workers' continuing education	Table 2-3
Issue area C-Linking training and technology assistance	
Options:	
10. Coordinate technology and training assistance	Table 2-4
11. Help States expand industrial services, combined with training	Table 2-4
12. Support creation of an employer institute for work-based learning	Table 2-4
Issue area D--improving the quality and effectiveness of training	
Options:	
13. Encourage adoption of best practice approaches and technologies.	Table 2-5
14. Fund the Federal training technology transfer program ... ,	Table 2-5
15. Fund more civilian-sector learning research/technologies	Table 2-5
16. improve the information base on work-based training	Table 2-5

SOURCE: Office of Technology Assessment, 1990.

assistance, assistance to State technology programs, and transfer of federally developed training technology) might be continued or expanded. Some new initiatives (e.g., planning support for industry training consortia, earmarking funds for learning research, and funding of State clearinghouse services) would be launched, but at a modest level of funding.

The incremental approach has attractions; in its early stages, it would not cost the Federal Government much to implement, because it would take time to build the capacities to use resources wisely. Moreover, many of its features are partly in place or under consideration in Congress or the executive branch. It relies on persuasion and avoids controversial measures likely to be resisted by business. But it also has limitations. Even if effectively implemented, the specific measures that in sum constitute this approach would likely have a modest impact on skills upgrading. Since Federal policy would have little direct impact on the training behavior of employers, progress would depend on employer initiatives and actions at the State level. Some States would do a lot; others little.

If widespread action is desired, Congress could consider more far-reaching approaches to encourage skills development and technology upgrading by firms. These actions would not preempt the measures identified in the incremental approach, but would provide, in addition, broad incentives or requirements for employee training. First, Congress could attempt to raise employer investment in training, through options ranging from extensive funding for technical assistance to tax credits to a training levy. The most far-reaching approach-one that would affect all firms-would be a national training levy; with a levy, employers would either commit a small percent of their payroll to training or pay the same amount to a national or State training fund. Other possibilities, such as a limited tax credit or direct assistance for training, could be used to assist firms that have limited resources for training, but these would cost the Federal Government quite a bit. Enhanced support could be made available to help individual employees undertake training on their own.

The more aggressive strategy outlined above, with its national training levy, would result in a fundamental change in the training behavior of all employers (including small business and government). It would elevate training and skill development in the national consciousness. On the other hand, it could quickly devolve into training-for-training's sake. If phased in too fast, and without

some control over the quality of training, its potential to upgrade workforce skills would be reduced. Moreover, most employers would need time to evaluate their training needs and to put management structures in place to take full advantage of the new skills possessed by their workers. The training might have greater effect if it were combined with technology assistance to help firms adopt new technologies and more effective ways to implement these technologies. State industrial extension services or Federal technology assistance might help.

Many fins-even those that spend enough on training to be unaffected by a training levy—would see the levy as intrusive and would be concerned about bureaucracy, red tape, and possible government involvement in the content of training. Business might be more willing to be involved if a new institution, located outside any existing government agency, were chartered to work with industry groups on employee training, work organization, and new technology adoption issues. Ideally, such an institution would be set up by the employers themselves; it might be funded through the national levy, were this adopted.

Even if fully implemented, the options and approaches discussed in this chapter would comprise only one leg of a national strategy for human resource development. As a new area of involvement for the Federal Government, the relationship of work based training policies to other kinds of government training programs—assistance to displaced workers, older workers with outdated skills, the economically disadvantaged, at risk youth, and those on welfare-would need to be defined and clarified,[4] Although not within the scope of the policy options discussed here, better coordination and integration of these programs, especially at the implementation level, is emerging as a major concern. Indeed, Congress, in its consideration of bills to reauthorize the Job Training Partnership Act and the Carl D. Perkins Vocational Education Act, is evaluating alternatives, such as a human resource council, to better coordinate Federal training, education and social service assistance now distributed to a wide variety of State and local bodies. Others have proposed merging of existing education and training programs where possible, or creation of new entities, such as Employment and Training Boards, to serve local labor markets. Whatever mechanism is selected, close interaction with employers will be needed.

ISSUE AREA A: REDUCING BARRIERS TO FIRM-BASED TRAINING (Table 2-2)

Employers, of course, benefit from having well-trained workers. But many firms shy away from paying for broad-based training. There are several reasons.

Compared to workforces in many other countries, U.S. workers tend to change jobs more often—especially in the early years of their careers. Many employers, especially small ones, fear losing their investment if they provide general training to an employee who then takes a job at another firm (maybe even a competitor). Of course, firms often do find ways to share training costs with employees. Moreover, some evidence suggests that employees who receive the most training tend to have longer tenure with their employers than those who get less.

Another uncertainty for employers is whether the training support system available in the community will meet their needs. Relatively few companies can afford to develop and implement their own internal training systems. The majority are therefore dependent on outside providers—vendors, consultants, community colleges, private training schools-of highly variable quality.

A third reason is employer uncertainty about whether their workers' performance will actually improve after formal training. Some firms have found that 20-30 percent of their nonsupervisory workers must take remedial courses before taking classroom training and, although classroom training can be effective, transferring the training back to the job can be difficult. Faced with such circumstances, employers may pursue management strategies that minimize the need for training.

[4]For discussion of displaced worker issues, see the following Office of Technology Assessment reports: Technology *and Structural Unemployment: Reemploying DisplacedAdults* OTA-ITE-250 (Springfield, VA: National Technical Information Service, February 1986); *Plant Closings: Advance Notice and Rapid Response* OTA-ITE-321 (Springfield, VA: National Technical Information Service, September 1988); *Trade Adjustment Assistance: New Ideas for an Old Program* OTA-ITE-346 (Washington, DC: U.S. Government Printing Office, June 1987).

Assuming that Congress wishes to encourage employers to invest more in training, there are many options it could consider. Four approaches are discussed below:

1. helping firms setup training consortia
2. helping trade associations and industry groups build training capabilities
3. offering tax credits for certain training expenditures; and
4. implementing a payroll based levy for training.

Option 1: Help Firms Set Up Training Consortia (Table 2-2)

Training consortia or cooperative training ventures involving several employers can help employers reduce costs and ease their concerns about the perceived risks of training. Small companies in a consortium can share costs of instruction and training facilities. Consortia could be used by large firms and their supplier networks to develop shared training approaches and common workplace practices (e.g., for quality control). Consortia also might be used to upgrade the training skills of first-line supervisors and others who are expected to give informal training but have little training background. Community colleges and other training organizations could play constructive roles in consortia. While a few examples of training consortia exist (see ch. 5), organizing new consortia can be difficult; moreover, some firms worry (though perhaps needlessly) that joining a consortium could make them vulnerable to antitrust actions. To help companies set up training consortia, Congress could authorize start-up assistance and clarify the relationship of training consortia to antitrust laws.

No Federal agency has a continuing program to help firms setup multifirm training consortia.[5] A bill to setup such a program in the U.S. Department of Labor is before the 101st Congress (S. 2114 as introduced).[6] The bill would (among other things) authorize grants to help companies in the same industry or using similar technologies to plan and organize training consortia. The training would aim to help technicians, nonsupervisory workers, first-line supervisors, and other workers function more effectively with new technologies, management practices, and new forms of work organization in both manufacturing and service industries. The bill would authorize the program for 10 years, with $5 million for the first fiscal year, and such sums as necessary thereafter.

Some employers shy away from involvement in multiemployer training activities out of fear that their participation might be interpreted as violating Federal antitrust laws.[7] This concern may not be warranted, given the fact that some firms now participate in multifirm apprenticeship programs. However, the perception of legal problems can be as great a barrier as actual legal barriers.

To reduce business uncertainty, Congress could clarify how antitrust law would be applied when firms form training consortia. In some special cases, Congress has adjusted antitrust law to minimize interference with other public policy objectives. In the 1984 National Cooperative Research and Development Act, Congress clarified that precommmercial research and development collaborations are to be judged "on the basis of. . . reasonableness, taking into account all relevant factors affecting competition,' and also limited damages for registered projects to actual injury.[8]

In helping firms initiate consortia, the Federal Government also could support efforts to provide consortia with information and technical advice on best practices. Multifirm consortia can be used to develop and deliver several important types of training. For example, they might make it more cost effective for firms to provide the classroom training associated with apprenticeships. With encouragement, multiemployer groups might develop and administer industry-specific programs to address basic skills problems encountered by member firms,

---

[5]The Department of Labor on occasion bas provided demonstration grants to industry and educational consortia to develop training materials.

[6]Section 404 of S.2114, the proposed Excellence in Mathematics, Science, and Engineering Education Act, as introduced.

[7]Commission on Workforce Quality and Labor Market Efficiency, *Investing* in *People: A* Strategy To *Address America's Workforce Crisis; A Report to the Secretary of Labor and the Amen"can People (Washington DC:* U.S. Department of Labor, September 1989), p. 19.

[8]Public Law 98-462, 15 U.S.C. 4301 -4305." Even without the clarifying legislation, this "rule of reason" would usually apply. However, the 1984 law did substantially reduce business uncertainty and the need for extensive legal analysis. The 1984 Act and possible further antitrust clarifications and amendments to facilitate interfirm cooperation are discussed in U.S. Congress Office of Technology Assessment *Making Things Better: Competing in Manufacturing,* OTA-ITE-443 (Washington, DC: U.S. Government Printing Office, 1989) pp. 219-231, pp. 66-69.

S. 2114, as introduced in the 101st Congress, proposes that publicly disclosed training consortia covered under the bill would be judged by a similar rule of reason.

Table 2-2—issue Area A: Reducing Barriers to Firm-Based Training

Option 1! Help firms set up training consortia: . This could include start-up grants and technical assistance to firms, trade associations or industry groups, and training institutions (e.g., community colleges) to organize multifirm training consortia. To give the program visibility and staying power, Congress could give the administering office a statutory basis, and funding authorization, and clarify employer concerns about antitrust violations. Beyond this, Congress could, as a further inducement to companies to engage in cooperative training efforts, set aside some funds from Federal adult education and vocational programs specifically for consortia activities. Consortia could involve: 1) new groups specifically set up to provide training, and 2) existing industry and trade organizations, given added training functions.	Advantages: . The consortium approach might induce more firms to share training or risks they might not singly assume. If coordinated with other Federal education and training programs, the consortium approach could expand access of small businesses and their employees to basic education, job skills upgrading and transfer of the latest training technology and techniques. The consortium approach also might help more firms send personnel (such as supervisors and others responsible for informal training) for train-the-trainer instruction.	Disadvantages: • While used in some industries like construction, there could be structural reasons why the training consortia or cooperative training concept has not caught on with American firms. Firms could be concerned about loss of proprietary information and also about raiding of trained employees by firms outside the group. Also, small firms often do not join trade or industry groups.
Option 2: Expand technical assistance to trade associations, others: . In conjunction or separately from Option 1, give a statutory charter and technical assistance funds to the U.S. Department of Labor (DOL) to: 1) help trade associations and other industry groups identify industry-specific training needs, and to, 2) help them build training capacities and institutional structures. DOL now funds about $3 million of work-based learning demonstration projects a year. To launch a meaningful program of technical assistance, initial funding at three times this level might be needed. Some of the funds could be made available to State industrial training assistance programs.	Advantages: . The approach might encourage more industry-sector responses to skill development, building on private sector initiative and depending on the private sector for implementation. If evaluation and dissemination were built into the program, other industries might become more involved, with little need for further government assistance. • By setting up a statutory office and program authorization at the Federal level, Congress would place Federal support for research, demonstration, and technical assistance for industry-based training activities on a firmer foothold, less subject to year-to-year flux in allocating Departmental research funds.	Disadvantages: • Startup funds alone might not be enough. It could be difficult for industry organizations to develop and sustain required levels of support once government funds ended. Federal technical assistance, even if provided for several years, will not necessarily be sustained by employers or trade associations on their own. . Many trade associations and industry organizations lack close linkages to small employers and have limited capacities to deal with training issues. Those industry organizations most likely to seek Federal help might have planned training actions in any case; hence, the Federal funds might simply substitute for industry funds.
Option 3: Consider a limited tax credit for private-sector training: • The initial steps might include: 1) directing the Treasury Department (in coordination with the Department of Labor and the Department of Commerce) to evaluate alternatives for targeting the tax credit; and 2) directing Treasury (again in cooperation with Labor) to conduct afield trial on the fiscal impacts of a limited tax credit by, for example, reimbursing participating firms with an amount equivalent to what they might receive for training if the limited credit were in effect. The fieldtest could be restricted to small and medium-size firms and also limited to particular kinds of training expenses (such as basic skills training). Legal considerations would prevent offering an actual tax credit to selected firms during the trial period; hence, appropriated funds would be needed.	Advantages: . The fieldtest would give a sounder basis for subsequent decision about whether to proceed with a tax credit. As for the advantages of an actual tax credit, firms would have the choice of using or not using this incentive-and it would thus be more accepted by employers. If carefully targeted to certain kinds of activities like basic skills education, a tax credit approach might affect the behavior of firms at the margin.	Disadvantages: . Tax credits are difficult to target and limit. Tax credits would not do much to encourage firms to undertake training they were not predisposed to take. Hence, the approach might not be effective for such training as basic skills. At the same time, tax credits can be inefficient when firms actually do make use of them, since it is difficult to determine whether the credit simply substitutes for training the firm would undertake in any case. Tax credits would not help not-for-profit employers and their employees. Finally, tax credits run counter to recent efforts to hold tax expenditures under control.

Option 4: Phase In a payroll-based national training levy:

- **Employers would be obliged to spend a small percentage of their payroll (say 1 percent) on broad, transferable training *or* pay an equivalent amount into a government training fund. (The government fund could support such activities as workplace literacy, training of contingent workers or other underserved workers, technical assistance, or services to displaced workers.) During the first phase, employers would not have to pay the levy if they reported their training expenditures to the government (even if they spent nothing on training.) implementation would be phased in over several years to allow firms to develop training expertise and select the best service providers. The levy could be made to apply to employers in all sectors, including nonprofit organizations and governments.**

Advantages:

- **This approach would assure a certain minimum of worker training by all firms and employing organizations, including nonprofit organizations and government. it thus has the potential to raise worker skill levels throughout the employed workforce. Because the cost would be borne by the employers, direct competition for public funds—such as training of unemployed people--wouid be minimized. Depending on how it were implemented, this approach could also give firms considerable flexibility about how to fulfill their training obligation.**

  Even if full implementation of the levy never occurred, the approach proposed (with an initial period of tax forgiveness if the firm reported training expenditures to the government) would for the first time create benchmark data on firm-based training expenditures that would provide policymakers with a sounder basis for subsequent decisionmaking. The first phase data alone might affect the training behavior of firms, since they would be able to compare their expenditures with overall trends in their sector.

Disadvantages:

- **The more targeted the training requirements (e.g., basic skills training, apprenticeship training) the more monitoring and paperwork would be needed. Yet, without targeting, firms might not use the training to meet publicly important objectives.**
- **There is a danger that this approach could lead to training for training's sake, especially in the early days of full implementation. Many providers could be expected to jump into the training market, with the probability that much poor quality training would be offered.**
- **Some employers, especially employers having financial difficulties, might not be able to meet the levy requirements.**
- **The first phase of the program, in which firms would have the option of paying the tax or reporting their training expenditures, could create burdensome paperwork or undue expenses for some firms.**
- **The levy could result in undue emphasis on formal training in classrooms, to the exclusion of improving on the job training.**

SOURCE: Office of Technology Assessment, 1990.

using curricula and instructional materials directly relevant to the students' jobs. All of these activities could be aided by technical assistance.

Consortia, in themselves, will not overcome employer concerns about losing training investment when workers leave before a certain payback period. Consortia members could have cost recovery agreements when trainees move from one member firm to another. However, outside firms may be "free riders, able to hire away well trained workers from consortia members without incurring training costs.[9] But the employer's investment would be smaller, due to economies of scale, so concerns about loss would be smaller.

Generally, such concerns might be eased if individual firms and their employees were to establish "training compacts" to upgrade training of underserved employees and new entrants. Apprenticeship might offer a model. Some apprentices in unionized industries enter into compacts when they receive training financed by joint union-management trust funds. Apprentices who leave the unionized industry during or shortly after finishing the training may have to reimburse the trust fired for part of the assistance. Congress might instruct the Department of Labor to explore and report on alternative approaches for risk-sharing by employers, workers, and government that could lead more firms to experiment with training contracts of one sort or another.

Option 2: Provide Technical Assistance to Trade Associations and Other Industry Groups (Table 2-2)

Whether or not Option 1 is adopted, Congress might give the U.S. Department of Labor (DOL) a statutory charter and more funds to help fins, trade associations, and other industry organizations build up their training capacities. DOL recently set up a new Office of Work-Based Learning (OWBL), which is beginning to move in this direction.

[9]Laurie J. Bassi, *Multi-Employer Training Consortia: An Idea Whose Time Has Come"* **(Washington, DC: National Federation of Independent Business Foundation, April 1990) pp. 4-5.**

However, OWBL has other major program responsibilities (including trade adjustment assistance and retraining of displaced workers). A statutory charter for OWBL, or creation of a similar office to support training consortia and training by other industry groups, would signal congressional commitment to technical assistance.

OWBL now funds a few national demonstration projects (3 million dollars' worth in 1989) on an ad hoc basis to show new uses for apprenticeship concepts. (See Option 5 for apprenticeship discussion). Even the most successful demonstrations, however, would reach only a tiny fraction of U.S. employers. With a statutory charter, a separate authorization, and enough funds, DOL could launch a sustained effort to help trade associations, other groups of firms, or labor/management cooperative groups involve their members with training.

U.S. trade associations, for the most part, are less involved with training than their European counterparts. Without encouragement, they are not likely to become involved on their own; with encouragement, such as technical support, some might act. DOL might help them identify industry-wide training needs and, when the needs are known, assist in developing training materials and best-practice approaches that member firms might use. The Canadian Federal Government has had some success with this approach. In one case, it convinced large Canadian electrical firms and their unions to join a government-sponsored study on the industry's training needs. After the study was done, the companies and the unions set up a joint training committee which agreed to adopt a joint training fund, with some cost-sharing by the Federal and provincial governments.

DOL would need much more than $3 million—the current funding for demonstration projects-to launch a significant technical assistance program. In fact, without initial funding of $10 million per year, there would belittle point in characterizing the effort as anything other than a demonstration program. An expanded DOL technical assistance program would complement Option 1 (help to industry for training consortia). Of course, it might be possible that the States or a nongovernmental organization will become more integrally involved in providing technical assistance. For example, if a nonprofit institute to work with employers and employer organizations on workplace learning were established, the institute could perform part of DOL's technical assistance mandate. (See Option 12 in table 2-4.) If the States greatly expanded their technical assistance capabilities, the Federal role might evolve into a grant assistance program (with higher funding levels) or, if State efforts were sufficient, be reevaluated.

Option 3: Field-Test Limited Tax Credits for Private-Sector Training (Table 2-2)

There have been several recent proposals to give firms a limited tax credit for employee training.[10] For tax purposes, firms now treat much of their training costs as expenses that can be deducted in 1 year rather than amortized over several years as is the case for capital equipment.[11] Proponents believe a tax credit would leverage more employer training investments at less cost to the government than

[10] Three examples: 1) H.R. 1219, the proposed National Training Incentive Act of 1985, as proposed but never acted on in the 98th Congress, called for a 25-percent tax credit for eligible training expenditures (e.g., apprenticeships, cooperative education programs) that exceeded a company's average spending on these activities over the previous 5 years; 2) The Commission on Workforce Quality and Labor Market Efficiency, in proposing a training tax credit to Secretary of Labor Dole, also called for a long base period for calculating the credit; the Commission proposed to limit the credit to (a) compensation of full time corporate trainers, (b) purchase or development of instructional materials and equipment, and (c) payments to third-party training institutions. (One member of the commission dissented on the tax credit.); 3) A recent joint report issued by the National Center for Education and the Economy and the American Society for Training and Development called for tax-based investment incentives to partially subsidize development and delivery of training, and discussed some issues involved in designing a tax credit. See Anthony P. Carnevale and Janet W. Johnston, *Training America: Strategies for the Nation,* (Alexandria, VA: American Society for Training and Development 1989), pp. 53-58.

[11] John M. Quigley and Eugene Smolensky, "The Tax Treatment of Training and Educational Expenses," *Investing in People: A Strategy To Address America's Workforce Crisis,* background papers, vol. 1, p. 838.

would be the case for directly appropriated funds.[12] The tax credit also could make training more visible to high level corporate officials. Tax credits also tend to be viewed favorably by potential beneficiaries.

At the same time, tax credits are hard to target effectively and can bean inefficient way to stimulate investments. If a training tax credit were authorized, it would be difficult to devise safeguards to keep firms from taking a credit for training they would undertake in any case. Also, the tax credit would have to be carefully designed to exclude some kinds of training expenses (e.g., renting a conference center at a vacation resort, transportation to such facilities). For reasons such as these, as well as the unpredictable effect of tax credits on the Treasury, many consider tax credits to be bad public policy.

Of course, the credit could be narrowed to a few eligible activities (e.g., basic skills instruction or formal classroom training in programs that give successful trainees a recognized certificate of successful completion) .13 The credit also might be restricted to training of certain categories of employees (e.g., nonsupervisory workers). If narrowly drawn, the credit might help firms build their internal training capabilities. One possibility would be to allow smaller firms (those with under 250 employees) to get a partial credit for training materials and equipment, or for sending supervisors and other personnel to courses on training.

There is a danger that a tax credit would need to be so narrowly cast that it would not serve as much stimulus. Building in safeguards would increase paperwork, which in turn would reduce the likelihood of company participation in the program. Very few companies centralize record keeping of their training expenses; to make sure that the credit supported additional training, data collection would be needed to establish a baseline. While some activities (e.g., corporate payments to outside training institutions) would be quite easy to document, internal training activities, if covered by the credit, would be very hard to document.

Given the implementation questions involved in administering a tax credit, Congress might take some preliminary steps (as discussed under Option 3 in table 2-2) before deciding to authorize a full-fledged training tax credit. For example, Congress might instruct the Department of Treasury, in coordination with the Departments of Labor and Commerce, to prepare a detailed analysis of how a tax credit might be targeted to meet identified training needs.

As part of the evaluation process, Congress could also authorize Treasury, in conjunction with Labor, to experiment with a field test of training incentives that would be equivalent (in essence) to a tax credit. One possibility would be to offer the training incentive to a set of randomly selected firms for, perhaps, a 2-year period. Firms that elected to participate in the field trial, as a condition for assistance, would need to be willing to work with Treasury or Labor personnel on appropriate accounting measures.

Option 4: Phase in a Payroll-Based National Training Levy (Table 2-2)

Among options considered here, a payroll based training levy would be the most far-reaching approach the Federal Government or the States could take to stimulate employer investments in training. It also would be the most controversial with employers. Many variants of a payroll-based levy exist in other nations. The one discussed here would

---

[12] *Training America: Strategies for the Nan-on,* for example, speculates that a 20-percent tax credit for new training expenses could leverage a 20-percent increase incorporate training activities. This would mean that the spending off- on formal training could increase to $36 billion-from $30 billion (the authors' estimate of what firms now spend on formal training). Revenue losses to the government, they estimated, would be $600 million. Of course, there is no way to predict in advance just how much of a stimulus the tax credit would be. The stimulus anticipated by *Training America* would appear to be at the extreme upper end of likely outcomes. An analysis of the early years of the U.S. research and development (R&D) tax credit (viewed by some as a model for a training credit) found thafirms spent on average only 1.2 percent more onR&D because of the credit than they might have withoutit; losses to the Treasury were probably greater than the gain inR&D attributed specifically to the credit. See EdwinMansfield, "Public Policy toward Industrial Innovation: An International Study of Direct Tax Incentives for Research and Development, '' in Kim B.Clark, Robert H. Hayes and Christopher Lorenz, eds., *The Uneasy Alliance: Managing the Productivity-Technology Dilemma* (Boston, MA: Harvard Business School Press, 1985), pp. 385-386.

[13] Some contend that a Federal basic skills tax credit is a red herring that would prompt little employer action and might divert policymakers from dealing with thereal barriers to employer involvement. While a tax credit alone would not solve theproblem, the only way to find out how employers would react would be totry out the concept. If carefully crafted, a temporary credit would cost little if it failed. (For an analysis of possible limitations of the tax credit for basic skills, see Forrest PChisman and Wendy L. Campbell, ''Narrowing the Job-Skills Gap: A Focus on Workplace Literacy," Forrest P. Chisman and Associates, *Leadership for Literacy: The Agenda for the 1990s* (San Francisco, CA: Jossey-Bass, 1990), pp. 165-167.)

give employers a choice between spending a certain amount on training (say 1 percent of payroll) or paying the same amount into a special training fund administered by a public agency[14] (see box 2-A). The levy could apply to all employers, including government agencies.

This option is not so much a tax as an "obligation" that employers provide their workers with training or pay the levy. Within broad guidelines, employers would have the flexibility to use the training for purposes that fit into their strategic needs. Only if a firm elected not to spend the money on eligible training would the levy be imposed. (Another variant would be a levy-grant system, now used in some States, in which all employers pay a payroll tax for training that is then redistributed for specific training projects. See box 2-C for discussion.)

Many training intensive countries, including France, Sweden, Ireland, South Korea, Singapore, and the Netherlands, use variants of a levy system to insure that more firms engage in training or to insure that workers do receive needed trainings (see ch. 3 for a discussion of the French and Korean programs). France requires employers to spend an amount equivalent to 1.2 percent of payroll on training or pay the same amount to a training fund. A separate 0.5 percent payroll levy is earmarked exclusively for apprenticeship training. In place since 1971, this use-it or lose-it approach has been quite successful in generating more firm based training-small and medium-size firms have doubled their training over the period[16]—in part because firms have a great deal of discretion about whom and how to train. But questions of need and suitability of the training remain.

There is little doubt that the levies have stimulated additional training in these countries. If applied in this country, the levy could be used to place a floor under employer-based training activities, with minimal direct outlays of public funds. This would have the advantage of minimizing competition for limited public funds available for training of economically disadvantaged people, displaced workers and others. The levy might have some short term impacts on Federal revenues, as some firms would use otherwise taxable profits to meet the 1 percent requirement. Firms with better trained employees might be more productive and efficient and generate more taxable income, thus offsetting any fiscal impact.

What training activities would the levy cover and how might it be implemented? One possibility would be to target the levy for training activities that develop broad-based skills of employees or that develop the firm's internal training capabilities to develop such skills. Examples: basic skills training, apprenticeship or other training that would give employees recognized credentials, and costs for developing relevant training materials or paying trainers to conduct these programs. Administratively, it would be easiest if the States oversaw the levy as they already collect a payroll tax through the Unemployment Insurance system.

While promising in theory, a levy has disadvantages as well. It would add to the amount currently subject to payroll tax collection under various Federal laws—an amount some view as already burdensome. Some economists might argue that the workers, not employers, would ultimately bear most of the cost. If so, workers in firms that elected to pay the levy would be in the position of paying for the training of others, without getting training themselves.

Some training produced by the levy-at least in its early years—would probably be poor in quality, with little direct connection to the real needs of the firm or the workers. In France, some managers still complain that the government is forcing companies to conduct training for training's sake. Also, while the system clearly has generated a great deal of fro-based training, it has not necessarily been directed to those workers with the greatest need.

[14] This approach was recently advocated by the Commission on the Skills of the American Workforce, a private group Setup by the National Center for Education and the Economy, in its report, *America's Choice: High Skills or Low Wages/* (Rochester, NY: National Center on Education and the Economy, 1990).

[15] Other countries, including West Germany and Japan, use payroll taxes to finance a range of employment and training programs; some of these funds are used to train employed workers. Ibid., Supporting Information IV.

[16] cited in S. Barnow, Amy B. Chasanov, and Abhay Pande, *Financial Incentives for Employer-Provided Worker Training: A Review of the Relevant Experience in the U.S. and Abroad,* report prepared for the U.S. Department of Labor Employment and Training Administration, Apr. 2,1990, p. 35.

Box 2-C—State Training Levies

At least four States (California, Delaware, Rhode Island, and Alaska) now collect a small payroll-based training tax from employers.[1] These States use what has been called a levy-grant system to fund training.[2] Most of the tax is used to train unemployed workers, but some of the tax can be used to support firm-based training if it would serve certain objectives (e.g., reduce the likelihood of a plant closing or layoff). In contrast to the French approach, the firm does not receive credit for the training expenses it incurs; instead, the employer pays the money into a government fund that is redistributed in grant form. Only a few firms—those who apply for and receive a grant-directly benefit from the tax.

These States collect the training levy when firms pay their Unemployment Insurance (UI) payroll tax. However, the training taxis not part of UI. The four States first imposed the training tax at a time when they could lower the unemployment insurance tax rate firms' pay. Since the employers' payroll tax rate was no higher than the year before, political opposition was lessened.

The State levies are not large; they amount to just 0.1 percent of that portion of payroll that is subject to UI taxes. The largest amount raised is in California, which has about $100 million available in its training fund.[3] (By contrast, the training tax component for payroll levies in France, the Denmark, Sweden, Ireland, Singapore, South Korea, Japan, and West Germany range from about 1 percent of payroll to about 2.5 percent.)[4]

Other States could impose such training levies—provided they are kept separate from the Unemployment Insurance trust fund. However, training levies are only likely in States that have a surplus in the trust fund. States in deficit—those with the greatest recent demand from claimants—would not have the option of offsetting scheduled tax reductions as the base for the levy. Thus, any payroll-based approach would constitute an increase over current tax rates for nonsurplus States.

Of course, States have other options-such as the levy approach used in France-that they could pursue and some States already fund programs out of general revenues. The levy might only be collected if companies failed to spend the required amount on eligible training activities for their employees. Funds collected from the levy could be made available as grants to companies or organizations involved in training of employees, or pooled to defray publicly supported training of (among other possibilities) displaced workers, contingent workers, older workers, or employed workers in industries or occupations vulnerable to displacement.

---

[1]See Peter A. Creticos, Steve Duscha, and Robert G. Sheets, "State Financed Customized Training Programs: A Comparative State Survey," report prepared for the Office of Technology Assessment under contract No. L3-381O. In addition, New Jersey uses penalties and fines collected from its Unemployment Insurance system to finance training. Five States ulottery funds tofinance industry training. The remaining States with customized training programs finance the programs through general revenues.

[2]Robert J. Gitter, "A Review of Financial and Non-Financial Incentives for Apprenticeship *programs,"* contractor report prepared for the U.S. Department of Labor Bureau of Apprenticeship and Training, September 1988, p. 25.

[3]This includes some *carryover.*

[4]See chapter 4 and the Commission on the Skills of the American Workforce, *America's Choice: High Skills or Low Wages!* (Rochester, NY: National Center on Education and the Economy, 1990).

As mentioned, a levy could be crafted to meet objectives such as improving the basic skills of employees or providing lower level workers with access to training. In this event, some strings would have to be attached, with an accompanying need for some paperwork and administrative oversight to assure compliance. The French simply ignore this issue by leaving it to the firm to decide the kind of training to provide-a circumstance that would not necessarily direct training to the desired areas. In countries that have targeted the levy (e.g., Ireland and South Korea), firms encounter more reporting requirements.

Still, the levy approach merits greater consideration in the United States than it has received heretofore. As in the case of a tax credit, there are enough uncertainties about a national training levy that a good deal of spadework would need to precede full-scale implementation. For example, without sound information on firms' training expenditures, there is little basis for determiningg whether the overall objective of the levy should be to assure that firms spend, say, 1.0 percent or 1.5 percent of payroll on training. Nor is there a basis for estimating differentials in training by industry sector.

Rather than simply study the issue, however, Congress might consider proceeding with a national levy in a two-stage process. During the first phase, lasting perhaps 3 years, firms would have the choice of either paying the levy or reporting their training expenditures. Firms that did report their expenditures would owe nothing, even if they spent nothing on training. By the end of the first phase, policymakers would have detailed information on which to base a decision about whether to proceed with the levy. Of course, it might be possible to obtain the needed data through a special survey of firms, without imposing the levy. However, the very existence of the levy during the first phase would prompt large numbers of firms to begin keeping closer track of their training activities. Moreover, during the trial period, industry-sector training information could be made public, so that firms would have a basis for comparing their training activities with their competitors'.

ISSUE AREA B: RETRAINING INDIVIDUAL WORKERS FOR CAREER ADVANCEMENT (Table 2-3)

In contrast to the education system, where social equity and fairness issues are of much concern to policymakers, equity concerns get much less consideration in the debate about human capital development and the workplace. Training can make a major contribution to career advancement for individual workers. (See ch. 8.) Several measures suggest that training is associated with long term positive effects for the subsequent income of trainees.[17] One study comparing trained and untrained workers with 12 years of experience found that the trained workers had wages averaging 9.5 percent more than their untrained counterparts at any point during the ten years following training. (Trained workers with more experience also fared better, although not so dramatically.) While company training, especially, had a major impact, with increased earnings observable for over 13 years, vocational training at a school also had a positive effect. Moreover, the benefits of training extended across a broad spectrum of the workforce. Managers experienced the greatest increase in earnings following training, while semiskilled workers had the longest duration of benefits. Training is also associated with a lower likelihood of unemployment. Moreover, trained workers who do experience unemployment are more likely to return to work more quickly than their untrained counterparts. These findings suggest that public support for training will be partly repaid by higher levels of taxable income, and less need for services to the unemployed.

Yet, many workers get little training from their employers, at least in broad, transferable form that can help them make worklife transitions when needed. Part-time or temporary workers who do not work for temporary service firms often get little training except on their own. Nonsupervisory workers also get little training, as do both older workers and very young workers. Minorities and people with less education also get less training. At least in the past, women also received less training than men.

While the United States has a large adult education system, many barriers, including financial constraints, scheduling problems, insecurity, and poor basic skills, impede participation. In this section, several options to encourage more employers and employees to address the training needs of individuals are discussed, including: 1) expanding apprenticeship, 2) funding of postsecondary vocational education, 3) supporting workplace basic skills programs, 4) extending favorable tax treatment for employee education, and 5) evaluating support for continuing education.

Option 5: Expand Traditional Apprenticeship (Table 2-3)

Apprenticeship, which combines supervised training on the job with some classroom instruction, can be a very effective way to produce highly skilled workers who have a sound grasp of the theory and practice of their trade. In contrast to the school-to-work transition apprenticeship systems that prevail in European countries like West Germany, apprentices in the United States are typically workers in their 20s and older who have been out of school for some time.

[17] See Lee A. Lillard and *Hong* W. Tan, *Private Sector Training: Who Gets It and What Are Its Effects,* report prepared fOr the U.S. Department of Labor (Santa Monica, CA: The Rand Corporation, 1986). Of course, many other factors are relevant. Employers can be expected to invest more heavily in the workers they believe to be most capable and most likely to benefit from training. It is also possible that workers who seek training on their own may be more motivated, more capable, or more ambitious than workers who do not seek training.

Table 2-3-Issue Area B: Retraining Individual Workers for Career Advancement

Option 5: Support efforts to expand apprenticeship concepts: • **As a starting point, more funding could be given to the U.S. Department of Labor's Bureau of Apprenticeship and Training to promote expansion of traditional apprenticeships. (BAT's staff and budget have declined in recent years). BAT also could be directed to begin collecting information and statistics on the continuing training of journeymen. Some funds could also support Department of Labor efforts to work with industry and unions to develop national standards for certification of skills among trainees in industries that do not now have strong traditions of apprenticeship.**	**Advantages:** • **The portion of the U.S. workforce that has gone through apprenticeships is small. A revamped Federal effort, if successful, might raise the status of traditional apprenticeships.** • **Structured approaches for work-based training might well be appropriate for industries that seldom have been involved in traditional apprenticeship programs. If certification standards were developed, benefits for both workers and firms would likely accrue; workers would receive credit for the training they completed -- a factor that could help them make job transitions; certification could make it easier for employers to select qualified personnel.**	**Disadvantages:** . **Prior efforts to expand apprenticeship-type approaches in this country produced little effect. Further efforts might simply deflect attention from other constructive efforts to develop workforce skills.**
Option 6: Adequately fund Federal support for vocational programs: . **The Carl D. Perkins Vocational Education Act (or the reauthorized version of the vocational education law) has several provisions related to adult education and retraining, including employee training.**	**Advantages:** • **Bills proposed in the House and Senate to reauthorize the Perkins Act would authorize some support for employed worker retraining, including apprenticeships. These activities could be beneficial for both firms and workers.**	**Disadvantages:** • **Even if fully funded, the amounts made available would not have much impact on employer based training, and could deflect limited funds available for improving secondary vocational education.**
Option 7: Fund workplace basic skills programs: . **One possibility: recast Federal support for workplace literacy training from a demonstration grant approach (as now authorized under the Adult Education Act) to on-going programmatic assistance. As part of that effort, earmark some funds for: 1) cooperative basic skills development efforts by small businesses and other consortia; 2) industry specific projects aimed at developing and administering basic skills projects to meet specific needs within industries; 3) research, evaluation, and dissemination on the most effective approaches (including technology based approaches) to industry.**	**Advantages:** . **Workbased projects have the potential to expand provision of services to the fraction of the employed workforce with basic skills deficiencies.** • **Earmarking funds to small business and consortia could assure that the benefits of this program do not accrue disproportionately to large firms and their workers.** . **Earmarking funds for industry specific materials and approaches also appears desirable, since research suggests that basic skills developed in occupationally specific contexts are more likely to be transferred back to the job.**	**Disadvantages:** • **Workplace based approaches have not been extensively evaluated; this is needed so that the most promising approaches can be disseminated to others. It maybe premature to proceed with an on-going program of support for workplace literacy until evaluations of initial demonstration grants have been completed.** . **Turning what is now a demonstration grant into a continuing program of regular assistance could result in competition for limited Federal funds for basic skills programs between employers and individuals seeking adult basic education courses on their own.**
Option 8: Extend favorable tax treatment for employee involvement in continuing education: . **Make Section 127 of the Internal Revenue Code permanent, so that workers receiving employer provided educational assistance will not need to declare this assistance as income in filing their Federal income taxes.** . **Allow workers to fully deduct job-related education expenses, and allow them to take the deduction on the short form.**	**Advantages:** . **Section 127 is one of the few Federal incentives for continuing education of workers. Making the exclusion permanent would assure that workers would not discontinue training programs they enter on their own simply because they might have to pay taxes on the assistance they receive from their employers.** • **Section 127 has expired several times before Congress has renewed it—and made its coverage retroactive. By making the exclusion permanent, Congress could end confusion among employers about reporting requirements and underscore its commitment to continuing education.** • **Workers can not now deduct job-related education expenses that they pay for themselves unless these expenses (and other miscellaneous expenses) amount to 2 percent of their adjusted gross income.**	**Disadvantages:** . **Section 127 may cost the Federal Government $255 million or more per year in foregone tax revenues. If the purpose of Section 127 is to help low-wage workers with continuing education, there may be more appropriate and direct ways to accomplish this.**

(continued on next page)

Table 2-3-issue Area B: Retraining Individual Workers for Career Advancement-Continued

Option 9: Evaluate ways to help workers finance continuing education: • Among the possibilities that could be covered by the evaluation: human resource investment funds for workers, surcharges on individual income taxes to repay education loans, and approaches for guaranteeing a specified amount of postsecondary education to all Americans.	**Advantages:** • Thorough evaluation would be needed to determine which would be most likely to be cost effective and successful.	**Disadvantages:** . More study is not likely to resolve the fundamental issues, which concern education philosophy.

SOURCE: Office of Technology Assessment, 1990.

Apprenticeship in the United States is not in very good shape, and apprentices represent a declining proportion of the workforce. During the 1980s, the proportion of enrolled apprentices fell by one half, from about 0.3 percent to about 0.15 percent, as manufacturing companies discontinued long standing apprenticeship programs in the midst of layoffs and downsizings. Many companies that discontinued their apprenticeship programs in the recession years of the early 1980s have yet to begin them anew.[18]

Despite its problems, apprenticeship has served industry and a small segment of the workforce well for over 50 years; it continues to be one of the most important means available to supply the United States with highly skilled craft, trade and repair workers. Efforts to rebuild apprenticeship-with nonunion as well as union employers—will be needed. The Federal Government might help by doing more to promote apprenticeship and by offering technical assistance through DOL's Bureau of Apprenticeship and Training. DOL also is evaluating ways to expand apprenticeship concepts to nontraditional industries, which could require funding for demonstration projects and certification efforts[19] (see box 2-D and ch. 8 on old and new approaches to apprenticeship).

While apprenticeship has many strong points, expanding or even maintaining the current level of apprenticeship could be difficult unless existing problems are solved. Some problems relate to image; many nonunion employers see the formal apprenticeship system as dominated by unions, and are reluctant to become involved, even though there are many successful apprenticeship programs in nonunion fins. Federal and State roles in registering new programs and supporting existing ones are not clearly defined, and there is little oversight of program quality. Most apprenticeship programs have rigid time requirements; trainees must complete all hours of training even if their performance shows they are fully competent. Some formal requirements—such as a requirement for 144 hours of classroom training per year-appear inflexible and unnecessarily prescriptive.

It is difficult to see how the Bureau of Apprenticeship and Training (BAT) could do much to expand apprenticeship into new areas (as proposed in the Department of Labor's Apprenticeship 2000 activity), let alone promote traditional apprenticeship, without more funding. BAT's staff has been cut in half since fiscal year 1978—from 495 full time positions to 245 today—while its budget has stayed about the same ($14 million). (In constant 1982 dollars, it's budget has declined by 60 percent.) President Bush's fiscal 1991 budget proposal (noting budgetary constraints and high priority staffing needs) also calls for further (albeit modest) reduction

[18]The United States has long ranked near the bottom among Western industrialized nations in civilian workforce apprenticeship programs. In 1977, before the decline in the 1980s, the United States ranked 14th among 16 industrialized countries in the proportion of its workforce enrolled in apprenticeships according to the Bureau of Apprenticeship and Training.

[19]U.S. Department of Labor, *Work-Based Learning: Training America's Workers* (Washington, DC: U.S. Government Printing Office, 1989) p. 17.

Box 2-D—Apprenticeship: Old and New Models

In late 1987, the U.S. Department of Labor announced its "Apprenticeship 2000" initiative to find ways to apply apprenticeship concepts in raising skill levels of American workers. Broadly speaking, the initiative has two components: strengthening traditional apprenticeship, which is concentrated in construction and manufacturing, and extending apprenticeship-like concepts to other industries and to nonunion firms. To achieve the second component, DOL's newly established Office of Work-Based Learning has given demonstration grants to organizations like the AFL-CIO, the 70,001 Employment and Training Institute, and the National Alliance of Business.

It remains to be seen whether the projects will have a lasting impact on trade associations, unions, or industry groups. However, earlier efforts by DOL to expand apprenticeship to "nontraditional' industies had mixed results. DOL's "New Initiatives in Apprenticeship" program, launched in 1973 and expanded in 1977, was not so much a demonstration as a continuing program, lasting several years. DOL contracted with 18 unions and trade associations to develop new apprenticeship programs. Of these, nine programs, aimed at fire fighters, emergency medical technicians, police officers, electrical workers, machinists, auto sales representatives, auto mechanics, vending machine repair technicians, and cooks, were evaluated in 1979 and 1980.[1]

The evaluation concluded that promoting apprenticeship through existing industry organizations was a "valuable and workable concept," but that it had "inherent limitations. "[2] In general, the union programs had positive outcomes, while those operated by national industry associations did not. The problems with those run by industry associations, such as the National Auto Dealers Association and the National Automatic Merchandising Association arose from a lack of cohesive structures within the associations themselves. For example, staff levels were inadequate to reach the many small shops belonging to the Automotive Service Council.[3]

While some industry associations have long and extensive involvement in training, most do not. Hence, building up the capacity of the staff of these organizations will be critical if industry groups are to deal with training issues at a broader and deeper level. There are special problems in reaching small businesses. Small employers are less likely to belong to national associations than larger firms and are less likely to be aware of the training resources these associations might make available.

[1]Kirschner Associates, *Inc., Evaluation of the National Industry Apprenticeship Promotion Program,* prepared for Employment and Training Administration, under Contract Number 23-11-78-04 (Washington, DC: National Technical Information Service, 1980), p. ix.

[2]1bid., p. xii, xiii.

[3]Ibid., p. 59.

(with staff positions reduced to 239 full time employees). If Congress wishes BAT to expand its efforts, BAT will need more funds to increase staff, to provide technical assistance, and to develop and register new programs. Congress also might direct BAT to work with employers, employees and State agencies to revamp quality standards for apprenticeship programs, a move that could enhance the portability of the apprenticeship credential. If BAT's technical assistance capabilities are to be strengthened, the agency will also need an adequate travel budget, and money to train and develop current and new staff. (As noted in Option 6, proposed amendments to Federal vocational education programs would authorize some funds to be used for apprenticeship.)

Option 6: Adequately Fund Federal Support for Vocational Education Programs (Table 2-3)

The Federal Government has supported vocational education since 1917. Over the years, Congress has periodically revised and expanded vocational education programs-although Federal vocational funds account for less than 10 percent of total expenditures. In 1984, Congress passed the Carl D. Perkins Vocational Education Act, a law that, among other things, placed somewhat more emphasis on vocational opportunities for adults. On average, the States used roughly 40 percent of the Federal funds they received under the Perkins Act to support vocational programs at post-secondary educational institutions.

A need to reauthorize the Perkins Act has provided the 101st Congress with the opportunity to consider some new priorities for Federal support for vocational education. The House and Senate passed quite different vocational education bills (H.R. 7 and S. 1109). As this report went to press, a House-Senate conference committee had just reported a vocational education bill, the proposed Carl D. Perkins Vocational and Applied Technology Education Act Amendments of 1990, to resolve the differences.[20] The conference committee's version of H.R. 7 would authorize a $1.6 billion package of support for vocational education in fiscal year 1991 (and such sums as needed for subsequent fiscal years through 1995). Nearly 80 percent of the authorized funding for fiscal year 1991 would be for basic State grants. These basic grants would be used to, among other things:

- support better integration of vocational and academic curricula in vocational education to give students both academic and occupational competencies;
- promote partnership efforts among industry, labor, community based organizations, and education groups;
- support so called tech-prep partnerships covering the 2 years before high school graduation and 2-year postsecondary or apprenticeship programs;
- support leadership and instructional programs in technology education.

The bill also authorizes several special grants to States of relevance to school-to-Me transition programs, apprenticeships and employer involvement in vocational education. (See ch. 8 for discussion of these issues.) The tech-prep education special program would be authorized at the $125 million level for fiscal year 1991. Another special program (authorized at $10 million for fiscal year 1991) would provide cost-sharing support for business-labor-education partnerships in training. Among other things, these partnerships could be used to provide apprenticeships and internships in industry, to encourage business and labor representatives to be involved in the classroom, and to provide training and counseling that would help workers retain or upgrade their jobs. (The Federal cost-share would be somewhat higher when small business were involved.)

Several national or federally administered programs would be authorized by the bill. Among others, these programs would support:

- development of national standards for competencies in industries and trades. The Secretary of Education, in consultation with the Secretary of Labor, would be authorized to make grants to trade associations and labor organizations to organize business-labor-education technical committees, which in turn would propose the standards.
- development of interactive teaching materials that could be delivered through telecommunications. (Projects serving workers in need of improving basic or vocational skills to retain employment would be among those given priority).
- model programs for regional training in the skilled trades, including prejob and apprenticeship training and career counseling and upgrade training in specialized crafts.
- cooperative demonstration programs, including cooperative efforts between the private sector and vocational education agencies to address school-to-work transitions.

Assuming that the conference version of the bill is ultimately enacted, the issue of funding for vocational education will continue. A high level of overall funding may well be needed if the new special and national programs discussed above are to be fully implemented. In this regard, it is worth noting that Congress authorized (but never funded) a special State program for adult training and retraining when it originally enacted the Perkins Act in 1984. This unfunded special program was not proposed for reauthorization in the 1990 bill.

Option 7: Fund Workplace Basic Skills Programs (Table 2-3)

As discussed more fully in chapter 6, the basic skills problem in the United States affects many employed workers. Inadequate basic skills are no longer seen as the problem of the individual worker alone; many companies have discovered that one-fifth or more of their workforces need basic skills upgrading before participating in technical training. Demographic change in the workforce-in particular the smaller number of new workers who will

[20] The Senate passed the conference committee version of H.R. 7 on August 2, 1990.

enter the workforce in the next few years-will also make it harder for employers to be selective, assuming that relatively low levels of unemployment continue.

While the long-term solution to the basic skills problem lies in better preparation of primary and secondary school students, major efforts will be needed to upgrade the basic skills of adult workers for the foreseeable future. Even if new high school graduates in the next few years have far stronger basic skills-an outcome that, despite years of curriculum reform, has been slow in coming-the workforce over the next two decades will still have many employed workers with basic skills problems that need to be remedied. Many Federal literacy programs do not focus on the employed, although, by some estimates, half of the adults with limited basic skills are working.[21]

Workplace basic skills remediation is not likely to happen without more government support. Despite expressions of concern, few employers see development of the basic skills of their employees" as a primary training responsibility-nor should they necessarily see it so. While firms often encourage workers to improve their basic skills or get a high school equivalency diploma, it is doubtful that even 10 percent of large firms make a significant effort to upgrade the reading, writing, arithmetic, and oral communication skills of their employees. (See table 6-2 inch. 6.) Smaller firms are far less likely to have such programs.

Support for workplace efforts has been ad hoc until recently. As part of the 1988 amendments to the Adult Education Act,[22] Congress authorized a workplace basic skills demonstration program. The demonstrations aim to foster partnerships that include educational institutions and business or labor.[23] Interest in this program has been keen. For example, in fiscal year 1988 when $9.5 million were available for award, the U.S. Department of Education received over 350 applications requesting nearly $100 million for workplace-based literacy programs. Just 37 projects in 26 States were selected.[24]

Bills pending in the 101st Congress when this report went to press would, in essence, elevate Federal support for workplace literacy beyond the demonstration phase. A Senate-passed bill, S.131O, the proposed National Literacy Act of 1990, would, among many other things, authorize $50 million in fiscal year 1991 (and such amounts as necessary in fiscal 1992 and 1993) for business, industry, labor, and education partnerships for workplace literacy. The workplace literacy program would continue to be administered by the Department of Education, in consultation with the Department of Labor and the Small Business Administration. (Priority would be given to partnerships that include small businesses.)

On the House side, an adult literacy initiative is contained in Title V of H.R. 5115, an omnibus education act passed by the House in July 1990. Title V of H.R. 5115 would, among many other things, make up to $40 million in grants available annually through fiscal year 1995 for large-scale, strategic approaches for improving the basic skills of the current workforce. One purpose would be to develop and evaluate approaches to improve workplace basic skills that would encourage business investment and be cost-effective for individual employers to use. The emphasis would be on regional, State and industrywide cooperative ventures.

H.R.5115 would also authorize appropriations of up to $15 million annually through fiscal year 1995 for a National Institute for Literacy. The Institute would conduct basic and applied research on literacy. It would assist in developing, implementing and evaluating adult literacy policy. It would also provide technical, policy and training assistance to government agencies to help improve the effectiveness of literacy programs. The bill also has provisions for coordination of Federal and State literacy efforts.

Both the Senate and House bills would increase funding for other Adult Education Act activities.

---

[21] As is discussed in Forrest p. Chisman, "The Federal Role in Developing an Effective Adult Literacy System," *Leadership for Literacy,* Op. cit., footnote 13, p. 244. The explanation appears to be that Congress, in the last few years, has given literacy mandates to several social service programs serving specific groups of people (e.g., welfare recipients, immigrants) that are not generally available to employecworkers. Most Federal assistance for employed workers is through the Adult Education Act, the oldest and, until recently, the largest Federal program for adult literacy.

[22] Public law 1oo-297.

[23] "The Workplace Literacy Program," U.S. Department of Education, mimeo, no date.

[24] Congress appropriated $11.9 million for a second round of demonstration projects in fiscal year 1989. Due to delays in approval of other regulations related to the Adult EducationAct, implementation ofthis program was delayed. Grants were not awarded until May 1990.

Whether or not a new bill is enacted, continuing oversight and monitoring of the existing workplace literacy demonstration projects would be useful. It is not clear at this point that these projects will provide the kind of experience base needed to enlist significant employer involvement in upgrading the basic skills of their workers. After the first demonstration grants have been evaluated, Congress may want to review progress to determine whether fine tuning is needed to address the needs of employed workers and their fins.

It is important to recognize that basic skills upgrading programs in the workplace need to be customized to meet the needs of both business and workers:

- In many workplaces, the problem is not an illiterate workforce, but rather an essentially literate workforce that needs upgrading. Often, the need for upgrading may not be apparent to anyone, including the worker, until a workplace change (such as adoption of a new technology or management approach) requires formal training for which the worker does not have the requisite basic skills to complete. In such instances, the traditional adult basic education approach could be quite inappropriate.
- The most effective workplace-based approaches often involve materials and tasks that have direct relevance to the workers' current jobs. This relevancy helps initiate learning and makes it more likely that learning will transfer back to the job. Also, workers and employers often perceive benefits stemming from the program.

It will be particularly important to see that the needs of small business and its employees are met. Very few of the initial workplace demonstration grants focused specifically on small business. This is unfortunate, since small firms face special difficulties in supporting basic skills education. Unlike training intensive large fins, which may assign staff to seek out government assistance for training, managers at small firms seldom have the time or resources to seek out such programs. Yet, employees of small firms, on average, have less education than their counterparts at larger fins. Setting aside some funds for small business projects may be essential if appropriate ways to involve small firms are to be developed. Beyond this, it will require outreach services and technical assistance to get small firms to participate.

Option 8: Provide Favorable Tax Treatment for Continuing Education

How the Internal Revenue Code treats education expenses can affect workers who take courses on their own time to improve their jobs skills or to learn new ones. One issue concerns how the tax code treats tuition assistance employers provide. A second issue is how the tax code treats money the employee spends on job-related education.

(a) *Employer-Assisted Education:* Many employers provide tuition assistance or other educational benefits to their workers. About 300,000 workers, or 2 percent of all post-secondary students taking classes in fall 1986, received some financial assistance from their employer.[25] Under a provision in the Internal Revenue Code, workers do not have to treat this assistance as taxable income when it is provided under an employer's educational assistance program that meets Federal requirements. This exemption covers most courses, even those not directly related to a worker's current job. It is due to expire at the end of September, 1990. Unless extended by Congress, assistance received thereafter could be subject to Federal income taxes, unless related to the employee's current job.

The exemption was frost authorized in Section 127 of the Revenue Act of 1978.[26] Since then, Section 127 lapsed several times before Congress acted to temporarily extend the exemption, usually with retroactive coverage. The current law places a capon the amount of tax-free tuition assistance and excludes graduate level courses from the tax exemption.[27] Participation in tuition assistance plans offered in some joint labor management training assistance programs fell off when companies began to withhold income tax on the value of tuition benefits after Section 127 lapsed temporarily. (See figure 8-2 inch. 8.)

[25] Steven R. Aleman, Library of Congress, Congressional Research Service, "Employer Education Assistance: A Profile of Recipients, Their Educational Pursuits, and Employers" (January 1989), p. 7.

[26] Public law 95-600.

[27] The authorization last expired at the end of 1988. This most recent extension was provided under the Omnibus Budget Reconciliation Act of 1989, which made the provision retroactive to cover the tuition assistance employees received after Dec. 31, 1988.

With the exemption again slated to expire, Congress might consider making Section 127 permanent. In weighing such a decision, Congress may wish to consider several factors, including the original objectives of the law, its cost, and its benefits. The legislative history suggests that Congress had several objectives for frost enacting Section 127—to simplify the tax code and remove burdensome paperwork, to make treatment of taxpayers more equa1[28], and to enhance upward mobility by encouraging employers to provide transferable training. The first goal has been achieved; Internal Revenue Service personnel, employees, and employers no longer have the cumbersome administrative burden of determining whether the assistance is job-related.

There are mixed views about the second goal—the extent to which Section 127 benefits less educated or lower income workers.[29] One recent study contended that Section 127 has done relatively little to help those with the least previous education; however, this study compared the income of Section 127 beneficiaries with the income of other students, including full-time students who are not employed.[30] A more recent study comparing the incomes of those benefiting from Section 127 with those of other full-time workers concluded 'benefits do not accrue disproportionately to higher paid employees."[31]

While the costs of Section 127 to the Federal treasury are not known precisely, Congress' Joint Tax Committee estimates that, if Section 127 were made permanent, Federal revenue losses would be $255 million in fiscal year 1991 and $331 million in fiscal year 1992, with the amount increasing to $372 million in fiscal year 1995. By making Section 127 permanent, Congress would forego this amount to make continuing education more attractive to workers at all income levels. Although they may benefit less, some less-educated and lower level workers do benefit from the tax exemption. If Section 127 were repealed, some less-educated workers who took training to prepare for new jobs or occupations might face tax payments for employer-provided educational assistance.[32]

If Congress made Section 127 permanent in its current form, workers at all levels, including those with higher incomes, could be assured that they would not be taxed on these educational benefits. If Congress is more concerned with increasing access to education for those with the least skills and incomes, it could target Section 127. For example, the tax exemption could be made available only to workers earning $25,000 annually or less.

(b) *Individual Investments in Training:* Section 127 is not the only, tax incentive for worker training that has been affected by recent changes in tax law. Many workers enroll in training at public and private schools and colleges at their own expense for courses directly related to their current jobs. They have long been able to deduct these expenses as a cost of employment when calculating their income tax. However, under the 1986 Tax Reform Act, these expenses are considered deductible only to the extent that they and all other miscellaneous deductions exceed 2 percent of the individual's adjusted gross income.[33] To encourage workers to invest in their own training, Congress might place the job related education deduction among the items that are fully deductible and allow them to record the deduction on the short form. Otherwise, the benefits of the change would accrue exclusively to tax payers who can itemize deductions on schedule A.

Option 9: Evaluate Ways to Help Finance Workers' Continuing Education (Table 2-3)

Only part of the education needs of workers are likely to be met by employers. Structural changes in the economy, the likelihood that most workers can expect to develop new job skills during their work lives, the aging of the workforce, and the growth of the contingent workforce all suggest the kinds of employment security concerns that might attract individual workers to seek education and retraining. Often, these workers may not be able to get

[28]Prior to enactment, only job-related educational assistance was tax-exempt. IRS examiners decided on a case-by-case basis which expenses qualified as job-related.

[29]United States Code Annotated, vol. 6, Legislative History, "Revenue Act of 1978, Senate Report," p. 6864.

[30]Aleman, op. cit., footnote 25, p. 14.

[31]Coopers & Lybrand, *Section 127 Employee Educational* Assistance: Who *Benefits? At What Cost?* (Washington, DC: Coopers& Lybrand,1989).

[32]Ibid.

[33]Richard H. Mansfield III, "Training and the Law," Robert L. Craig, cd., *Training and Development Handbook,* 3rd Ed. (New York, NY: McGraw Hill, 1987), p. 101.

education assistance from their employers. Moreover, workers may not be willing to make education investments on their own if they are concerned about possible loss of employment.

The Federal Government might evaluate alternative incentives for post-secondary education and training, expanding on the existing system of education loans and grants. With some modification, a payroll-based levy (see discussion of Option 4) could be made to serve the continuing education needs of employees as well as the needs of employers. The payroll tax could be levied on employers, employees, or both to create a human resource investment account that workers could tap when needed during their work lives.[34] Another option would be for funds to be loaned to workers, subject to repayment through a surcharge on their income tax while they work.[35] Various forms of individual training accounts or funds also have been proposed. Yet another approach would be to guarantee financing of a specified amount of post secondary education and training for all Americans at some point during their lives.

ISSUE AREA C: LINKING TRAINING AND TECHNOLOGY ASSISTANCE (Table 2-4)

As discussed in chapter 4, training can make an important contribution to efforts by firms to implement new technologies and work practices aimed at improving quality and productivity. Yet, many companies-by no means all of them small-have difficulty in adopting and using technology effectively. Some managers underestimate the training that may be needed when introducing new technology. Others may avoid new technology because of uncertainty about whether their workforces have the skills to use it.[36] Many firms are unaware of the training practices used by leading edge companies.

Effective use of new technology often requires firms to change their management practices and human resource policies. Yet few small firms have the resources to identify the needed changes or to implement them-a circumstance that may partly explain the relatively slow pace of diffusion of new technology among small firms.

Small and medium-sized businesses typically have been slow to adopt new technology-with such exceptions as small firms in high technology areas or supplier firms facing customer pressures to revamp their operations. This may change as more companies that were once shielded from international competition are thrust into it.

There is a large gap between the best practices for training and the training that usually takes place in industry. Much existing training fails to be effectively transferred back to the job. Often, training decisions are made in a haphazard way, so that the purposes of the training are neither well defined, nor closely related to changes in technologies or management practices. Many firms depend almost entirely on equipment vendors for training when new technologies are installed.

While knowledge about effective training is increasing, the process of diffusion can be quite slow. Few firms share successful techniques with potential competitors. Expansion of government efforts to disseminate information and provide technical assistance could help speed the diffusion process. The discussion that follows looks at options Congress might consider to better coordinate Federal technology and training activities and to support State government efforts to provide training and technology services to business.

Option 10: Coordinate Technology and Training Assistance (Table 2-4)

Several Federal agencies, including the Commerce, Labor, and Education Departments, administer programs, mostly small, that provide technology or training assistance to firms-either directly or through the States. Other agencies, e.g., the Small Business Administration (SBA), also administer assistance to fins. Most of the existing training and technology services are funded at a low level or are demonstration projects. If these programs are expanded along the lines discussed in this report, the

[34] For discussion, see *Training America: Strategies for the Nation,* op. cit., footnote 10, p. 60.

[35] Commission on the Skills of America's Workforce, op. cit., footnote 14, Supporting information V.

[36] For example, one survey of small West Virginia firms found inability of workers to make good use of new technologies to be one of the top barriers to adoption of computer numerically controlled machinery. See Phil Shapira and Melissa Geiger, "Survey of Technology Use in West Virginia Manufacturing—Preliminary Report" (Morgantown, WV: Regional Research Institute, 1990) pp. 3-4.

agencies will need to coordinate services to a greater degree than currently.

The recent report by the Commission on the Skills of the American Workforce called for all Federal assistance to employers to be coordinated through a Commerce Department clearinghouse.[37] At least in theory, such an approach might permit better integration of Federal assistance with the needs of firms and their workers.

Option 11: Help States Expand, Combine Industrial Services With Training (Table 2-4)

Several States now offer technology services to fins, as well as separate training services, either through State agencies or through other providers (such as community colleges). There is good potential for better coordination of these services at the State level. Although the current level of State activity is modest, expansion could occur in the future, especially with Federal incentives.

It would be logical for State industrial services to help firms identify their training needs during their consultations about manufacturing technology. In reality, most extension services do little more than make referrals to local training providers.[38] There are exceptions. The Michigan Modernization Service (MMS), set up in 1985 to help firms adopt programmable automation, is the most salient example. MMS field representatives (engineers with manufacturing experience) help firms develop a technology deployment strategy. Usually, the engineer is accompanied by a training specialist, who will evaluate the clients' training needs, prepare a training plan, and help the customer apply for training assistance through the Governor's Office for Job Training. This special grant program supports training of current employees for company modernization.[39] Firms receiving grants may use the funds for in-house training or outside training from community colleges, equipment vendors, or consultants.

As pointed out in the recent OTA report, *Making Things Better: Competing in Manufacturing*[40], *the* United States, in contrast to Japan and West Germany, does not provide extensive institutional support for technology diffusion to small enterprises. State technology transfer and technology/management assistance programs for all business amounted to about $58 million in 1988, with the Federal Government contributing a small amount through its own programs. It would cost between $120 million and $480 million to provide a modest level of extension services to 24,000 small firms per year-or about 7 percent of the Nation's small manufacturers. I-f the Federal Government picked up 30 percent of the costs (as it does in agricultural extension), the cost to the U.S. Treasury would be $36 million to $144 rnillion.[41]

More than likely, an increase of this magnitude would need to be phased in over a few years to give State and Federal officials time to expand programs incrementally. Congress, in the 1988 trade act, authorized a small amount of assistance ($2 million annually) for State industrial extension programs; funding in fiscal year 1990 amounted to $1.3 million, but the Bush Administration sought no funding for this program in fiscal year 1991.

If Congress were to expand this program along the lines discussed above and in *Making Things Better,* it could call on States to better integrate training assistance with their technology extension services. It could also direct the Commerce Department to move aggressively in implementing the State technology extension clearinghouse called for in the trade act. This function also might be performed by one of the organizations representing the States. The move would also facilitate coordination with State industrial training activities.

State industrial training programs, like industrial services, reach only a tiny portion of firms and workers. OTA's survey of State programs found that the median program reached only 64 employers—

[37]Commission on the Skills of the American Workforce, *America's Choice: High Skills or Low Wages! op.* cit., footnote 14.

[38]In a recent survey, more than half of the State industrial extension services said they often or frequently referred clients to training sources. However, only 24 percent helped firms identify training needs, and less than one-fifth actually provided the training. See Phil Shapira, *Towards Industrial Extension: Modernizing American Manufacturing,* January 1990.

[39]Jack Russell, "Manufacturing Base Modernization: A Michigan Strategy," Ann Arbor, MI, Industrial Technology Institute, November 1988.

[40]U.S. Congress Office of Technology Assessment, *Making Things Better: Competing in Manufacturing,* OTA-ITE-443 (Washington, *DC:* U.S. Government Printing Office, February 1990). The report discusses these State technology assistance programs, along with policy issues and options associated with expanding their coverage, in detail.

[41]Ibid., p. 27.

Table 2-4-issue Area C: Linking Training and Technology Assistance to Firms

Option 10: Coordinate Federal technology and training assistance to firms: • Several Federal agencies now have programs (mostly small) that assist industry, either directly or through the States, in such areas as manufacturing technology transfer, training technology transfer, workplace literacy, and small business development. If Congress expands these programs, better coordination, with the possibility of one-stop shopping for firms or industry groups seeking assistance, could facilitate integrated provision of services. One possibility: give the Commerce Department, now involved with technology transfer, lead agency responsibility for coordinating with other agencies (especially Labor, Education and the Small Business Administration).	Advantages: • *Better* coordination of services would make it more likely that firms would get assistance in the most useful manner.	Disadvantages: • Coordination efforts are often exercizes in paper shuffling, with few real results.
Option 11: Help States expand industrial services, combined with training: • Substantially expand the Commerce Department's now tiny State industrial services program, administered by the National institute of Standards and Technology (NIST). The purpose would be to help States expand their technology services to firms (now less than $50 million per year) with added support for assessment, consultation, and referrals on training. This Option would not be meaningful unless current funding (just $1.3 million) were expanded many fold over the next few years. • Direct Commerce to work with Labor and the Department of Education to help States expand and better integrate training, education, and industrial extension services available to small firms. The NIST industrial extension program might also be a vehicle for training technology transfer through close coordination with another Commerce Department agency, the National Technical Information Service, and the Department of Education's newly established Office of Training Technology Transfer. • Fundevaluation research on the effectiveness of State training assistance to private industry, and establish a single clearinghouse to disseminate best practice information to industry and State governments. One of the national organizations representing the States might be willing to undertake the clearinghouse function. The effort would complement other state clearinghouse activities on industrial extension and basic skills. A modest level of funding, less than $1 million per year, would be needed.	Advantages: • Small-firms frequently need impartial advice about the most suitable technology and training choices. Very few small businesses are currently served by state training or technology extension services, let alone combined services. A more supportive Federal role could help more States offer one stop consulting services to small business. This type of assistance could increase the quality and productivity of small and medium size supplier firms, helping them compete against firms in other countries. • Few firms now undertake evaluations of training activities; this option would provide a low-cost way to conduct evaluations and disseminate information on what works best in firm-related training. It would also help policymakers at the State and Federal levels assess relative success and failure of different kinds of public support for private-sector training.	Disadvantages: • Federal support, unless well balanced, might further exacerbate competition among individual States for new business, to the detriment of other States. If the individual State programs are biased in favor of attracting new businesses into the State, existing businesses within the state could be adversely affected. Federal funds could substitute for State and private funds. • There are now a plethora of clearinghouses on an assortment of human resource topics. Adding one more could simply add to the confusion. Coordination efforts are often haphazard.

Option 12: Support creation of an employer institute for work-based learning:	**Advantacges:**	**Disadvantages:**
• **To encourage employer involvement, the Federal Government could cost-share start-up costs for a nonprofit institute with employers. The institute could be structured to include: 1) employer involvement in direction of the institute (with the Federal Government serving as a member by virtue of its status as an employer); 2) institutional location outside any Federal agency; 3) sufficient start-up funding guarantees for several years of operation. Once underway, the institute might perform some technical services otherwise provided by government. Initially, the Federal cost-share might be $10 million out of general revenues, with private employers providing a similar amount. The employer-contribution also could come from a national training levy (see Option 4 in Table 2-2).**	• **By and large, trade and industry associations and other employer-institutions in the United States have not been heavily involved in developing training for firms. This proposal would attempt to draw employer-institutions (including small business groups) more directly into the effort to improve training. The organizations could work with specific industry sectors to build their training opacities. The institute would be outside the government, with extensive private sector involvement in setting research priorities and activities-an arrangement likely to be favored by employers. The fact that government could join the institute as an employer would facilitate close interactions and more rapid spread of best practice approaches between the public and private sector.**	• **Employers could set up such an organization 'on their own if they wished; the Federal funds going to start up the institution, therefore, might have little impact. If the start-up phase were successful, on the other hand, pressures to continue Federal funding would mount.** • **The public interest in supporting such an institute rests in activities that would benefit a broad spectrum of the workforce, while employers might see the institutes mission as narrower.**

SOURCE: Office of Technology Assessment, 1990.

and just under 4,000 employees—per year. The Federal Government could help States develop and diffuse information about what works and what doesn't work in these programs. This could pay off not only through more effective use of State funds, but also improved employer understanding about the relative effectiveness of different training approaches, and the impact of training on corporate performance.

Very few firms evaluate training. Those that do are reluctant to share the results. State-supported training projects can be useful sources of information about effectiveness. They, too, however, have received little evaluation, and States have few channels for communicating results. The National Governor's Association, with funding from the Federal National Commission for Employment Policy, has undertaken some research on the feasibility of evaluating State training assistance at specific firms.

However, there is no existing program of ongoing evaluation, research, and information dissemination on best training practices to States and firms. The Federal Government could help States perform this clearinghouse function. Not much money would be required. If a total of up to $1,000,000 were available, much useful information for firms and States to consider in designing and implementing training programs would be produced. The clearinghouse could be run by the National Governor's Association or another organization representing State governments. Or, it might be part of the mission of an employer institute on work-based learning. (See Option 12.)

Option 12: Support Creation of an Employer Institute for Work-Based Learning (Table 2-4)

Although technical assistance and other government supporting roles can help, employers will continue to have the primary responsibility for workplace training. It seems logical, therefore, that an institute representing employers could be very important in encouraging more firms to develop new approaches to work-based training. Yet, few industry associations or other employer-based institutions in this country consider training a top priority. A recent report by the American Society for Training and Development found that only 6 percent of American trade and professional associations offered training programs; 3 percent provided training as part of a certificaation program.[42] With some exceptions like apprenticeship, there are also few national-level committees or other employer-based institutions focused on training in specific industry sectors or more broadly.

Nor are there many equivalents in the private sector (or in the civilian agencies of government) to the human resource research institutes that advise the U.S. military with its training requirements (e.g.,

42 Anthony p. Carnevale, Leila J. Gainer, Janice Villet, and Shari L. Holland, *Training Partnerships: Linking Employers and Providers* (Alexandria, VA: American Society for Training and Development, 1990), p. 25.

the Human Resources Research Organization, the Institute for Defense Analyses). A few universities and organizations now have small programs that explore work and learning relationships-largely funded by the Federal Government. However, these programs tend to be small in scale, with limited funds, or too narrowly focused in mission to address the full spectrum of workforce related learning needs now emerging. Many of these centers exist on short-term Federal grants.

A more visible institution to focus the attention of employers on human resource issues associated with the rapidly changing American workplace could be helpful. Such an institution, to accomplish its purposes, would need to encompass more than employee training and development; it would need to address work organization questions, incentive systems, and management approaches, as well as the ways in which employers address technology needs. To succeed, such an institution would need extensive employer involvement.

Ideally, employers would act on their own to set up and fired such an institution. The fact that they have not done so suggests that public funds could be needed not only for start-up but to share in the costs of sustaining the organization in its frost few years. However, employers and labor representatives would need to play major roles in the direction of the organization, and a substantial amount of the funding would need to come from employers. (With public funds, there would need to be public accountability to assure that the institute benefited a broad spectrum of the workforce. Once the institution became self sufficient, the Federal Government's role in direction could be as an employer.) With strong sectoral involvement, the institute might be able to address industry specific needs, e.g., building and strengthening the training capacities of trade associations and other employer groups.

If given sufficient resources-say $10 million or $15 million per year-the institute could begin to develop the linkages among employers, the educational system, and the training community needed to improve workforce effectiveness. The organization could support research, development and diffusion of best practices. It could encourage private research through cost-shared projects with private fins. The institute could also encourage more use of learning-technology innovations, such as distance learning and computer-based training, in small business, at homes, and in other places convenient for adults. The institute could also work to enhance the development of the training profession through support of graduate programs.

If Congress were to adopt a national training levy, some money from the levy might be used to fund the institute. How much impact the institute would have in the long term would depend on how useful its work was to industry.

ISSUE AREA D: IMPROVING THE QUALITY AND EFFECTIVENESS OF TRAINING (Table 2-5)

The high cost of training and its uncertain quality may keep many companies from expanding training beyond the minimum. Poor timing of training, lack of reinforcement at the work site, and other factors often prevent effective transfer of knowledge to the job. Moreover, there are a limited number of people who are conversant with the best ways to integrate training techniques with the subject matter to be taught.

Training can be improved when systematic approaches are used. This way, companies can select the most appropriate and cost-effective training techniques from the many choices available. These choices range from traditional pencil-and-paper approaches to use of instructional technologies e.g., computer-based training, interactive videodisk, and satellite delivery with one- or two-way video and audio links.

New instructional technologies also have the potential to expand access to company-provided training. As discussed in chapter 7, the growing presence of personal computers in the workplace make them well suited for use in training. In time, they can help bridge the gap between formal and informal training by bringing sophisticated performance support systems to the workstation. Many large corporations already run satellite and other communication networks that could be used more extensively for training. Small firms, too, can benefit from the use of new instructional technologies. The costs of satellite receiving dishes are coming down to the point where smaller businesses can afford them. It is possible that, working through consortia or trade associations, small businesses could pool the costs of developing courses to be delivered by computer or by satellite.

The Federal Government has long played a major role in supporting training research and instructional technologies, primarily through the military. An expanded Federal role, with more emphasis on the civilian sector, could benefit not only private-sector employers but also government agencies in training their personnel. It also could benefit job training programs aimed at the unemployed and the disadvantaged.

Option 13: Encourage Adoption of Best Practice Training Techniques and Technologies (Table 2-5)

Best-practice instructional approaches and technologies are relevant to most of the options discussed in this chapter—whether for workplace basic skills, industry training consortia, or industrial extension. Whether or not Congress adopts these options, it could direct relevant Federal agencies and departments-whether Education, Labor, or Commerce-to develop and disseminate information about best practice approaches and technologies. Thus, for example, the Department of Labor, in offering planning and technical assistance to multifirm training consortia of the sort discussed in Option 1, might direct the consortia to information about best-practice approaches, as might the Department of Education, in offering workplace literacy grants discussed in Option 7. Projects using best-practice approaches and technologies might be given funding priority.

There are some specific activities now underway or proposed that could contribute to better dissemination of information. As is discussed in chapter 6, a National Basic Skills Consortium has been proposed to help States and local service providers share information about the best techniques, including technology-based techniques, for basic skills instruction. Officials at several Federal agencies, meanwhile, have set up a roundtable which meets periodically to share information on training technology. Both activities are now undertaken informally, with no funding sources. With modest funding, the two activities could be placed on a freer foundation. If the two shared resources, initial year funding of $350,000 to $500,000 would be sufficient for them to build a small staff and undertake outreach activities. In time, the State consortium could be supported by membership fees.

The Federal Government could also continue to play a supporting role in gaining industry acceptance of standards for training technologies and related software. Federal agencies have a major stake in standard setting efforts because they are major purchasers of training products. Some technology-based training products acquired by Federal agencies have been incompatible with other systems, thus limiting their use. Support for standard setting activities by the Commerce Department's National Institute of Standards and Technology and various industry groups could end up benefiting trainers in Federal agencies as well as the private sector.

Option 14: Fund the Training Technology Transfer Program (Table 2-5)

As mentioned, many companies do not apply systematic approaches to their training functions. Yet, these approaches are well known-the outgrowth of earlier research and development on training, much of it sponsored by the Federal Government, in particular, the military. (See ch. 7 and report appendix.)

The Department of Defense (DoD)-the largest single trainer in the United States-has made major contributions to the development of effective training techniques and technologies. A conspicuous example was the U.S. Air Force's role in the development of instructional systems design (ISD) in the 1950s and 1960s. Originally conceived as a component of ''programmed instruction," ISD has proven useful in the development of all types of training, whether delivered by hardware or more traditional methods.[43] Instructional systems design approaches have slowly diffused to the private sector and are widely used in training intensive companies.

DoD funding for research and development of educational technology averaged $42 million per year in the 1970's and $56 million per year in the 1980s, far more than the National Science Foundation and the Department of Education, which together averaged $4 million annually in the 1970s and $7 million per year in the 1980s.[44] Military agencies supported development of computer-assisted in-

[43] Charles Blaschke et al., "Support for Educational Technology R&D: The Federal Role,' contractor report prepared for the Office of Technology Assessment, Sept. 30, 1987, p. ix. (Report prepared for Power On: New *Tools for Teaching and Learning, OTA-SET-379,* September 1988.)

[44] Ibid., p. vi.

Table 2-5-issue Area D: Improving the Quality and Effectiveness of Training

Option 13: Encourage adoption of best-practice approaches and technologies: . For example, Congress could direct the Departments of Labor and Education to give funding priority to projects that use best-practice approaches, and to support dissemination of research findings, including research directed at evacuating the effectiveness of work-based programs, and instructional technology use where cost-effective and appropriate.	Advantages: . Identification and dissemination of best-practice approaches would help improve the quality of training. Research could bring long term improvements in quality and effectiveness of education and training practices in both the public and private sector.	Disadvantages: • Requirements for best-practice application could become micromanagement if rigid criteria were applied. Rapid expansion of research could result in funding of duplicative or poorly thought out projects.
Option 14: Fund the Federal training technology transfer program: . The 1988 Trade Act assigned the U.S. Department of Education responsibility for a governmentwide training technology transfer program, but no funds have been appropriated for this purpose to date. Congress could provide initial funding (beginning at $3 million per year) to get the transfer office started. Subsequent funding levels would need to be evaluated when realistic estimates have been made about the potential for training technology transfer.	Advantages: . Initial funding would help to determine how much relevance training technologies developed to meet the mission needs of Federal agencies (such as the U.S. military) have for private sector trainers and the education system. If funded, the program could in time transfer promising training approaches and technologies to the private sector.	Disadvantages: . The transfer activity could divert some resources and staff from primary agency missions. The inventory would be of little use unless the quality and utility of the materials were assessed.
Option 15: Fund more civilian sector learning research/technologies: . One possibility: earmark at least 1 percent of Federal education and training program funds for R&D activities (in addition to continuing to fund existing research programs). Another possibility: establish a special institute for learning technology and research. A third possibility: direct the Department of Education's Office of Educational Research and Improvement to give more priority to work-based learning in its funding of research centers, A final possibility: give the National Science Foundation a mandate to conduct research on connections between new technology adoption, work organization, and training.	Advantages: . Even highly effective transfer of military research and instructional technologies would only meet a small part of civilian sector needs. These alternatives would complement the training technology transfer efforts by creating a research and technology base for civilian needs.	Disadvantages: . While earmarking funds at the 1 percent level would have little impact on program functions, it might contribute to more frequent use of this tool, and overly prescriptive micromanagement in the long term.
Option 16: Improve information on work-based learning: • Provide funds to the Bureau of Labor Statistics and the Census Bureau to periodically update surveys of workers about the training they receive in relationship to employment; • provide funds to the Department of Education and the Census for updating the survey of adult education (last completed in 1984) on a 3-year schedule; • Provide funds for continued longitudinal studies of worker careers and education; • Provide funds to the Census Bureau to undertake special surveys and studies of technology adoption by firms and associated human resource development practices, such as training; • Require an overall review of Federal statistical priorities, including whether the Federal statistical agencies need to give greater priority to workplace, education and training statistics.	Advantages: • Much of the current data on workplace training is dated, incomplete, or based on proxy data. The steps listed, if undertaken, could begin to remedy this situation.	Disadvantages: . There probably never will be fully satisfactory information on these topics; a data collection effort, if it resulted in postponement of needed actions, could be counterproductive.

SOURCE: Office of Technology Assessment, 1990,

struction, research on human cognition, and the development of simulations for skills training.[45]

With DoD still the largest sponsor of learning research and educational technology development, there is continued interest in transferring promising DoD sponsored approaches to the private sector and to educational institutions. Several other Federal agencies, including the Department of Energy and the Office of Personnel Management, also develop training technologies that might be relevant to users outside government as well as to other Federal agencies.

As part of the Omnibus Trade and Competitiveness Act of 1988, Congress called for the creation of a formal mechanism for transfer of training technology from Federal agencies to the private sector and educational institutions.* The law gives the Education Department major responsibility for coordinating the development of a government-wide mechanism for training technology transfer, including the Departments of Defense and Energy.

To date, progress in implementing the Trade Act initiative has been slight. No funds have been allocated to the Education Department for fulfilling this purpose. As this report went to press, the Department had yet to act on the law's requirement for an Office of Training Technology Transfer (OTTT), although a plan for organizing OTTT was under consideration. Another Education Department office, the Office of Educational Research and Improvement (OERI) has taken up some of the slack. It is, for example, preparing a report for Congress (due in August 1990) on conversion of education and training software. It has also been working informally with other agencies to setup training technology information transfer processes.

However, OERI cannot assume the full responsibilities given to OTTT and its Director (still to be appointed) under the Trade Act. In theory, the law gives the Director powers intended to spur commercialization of federally sponsored training technology. Specifically, the Director could sell or lease public domain copyrights and patents for Federal training software to commercial users and could waive the purchase price or lease fees when the commercial user agrees to pay to make the software usable by nonprofit education or training groups. The law's requirements for developing a clearinghouse on federally developed education and training software will require funding to fulfill as will efforts to convert training technology to non-Federal use.

While OTTT has the formal governmentwide responsibility, other agencies also play a role. For several years, the Commerce Department's National Technical Information Service has disseminated information about Federal training technology to interested parties. All of NTIS training technology transfer activities, however, are undertaken on a cost recovery or reimbursable basis with clients. NTIS does not have funds to maintain or update products. Nor does NTIS have the power to assign copyright. Other agencies, including the Department of Labor's Center for Advanced Learning Systems and the Smithsonian Institution, collect, disseminate, or have demonstration facilities for training technologies.

Obviously, it takes money to conduct a detailed inventory of federally developed training products or to set up a training product evaluation process or to fulfill the other requirements of the Act. A 1987 study estimated that it would cost about $1,500,000 to undertake a comprehensive inventory of federally developed training products; far more money would likely be required if the quality of the materials were assessed. If Congress wishes these activities to proceed, initial funding at the beginning level authorized in the Trade Act ($3 million per year) would no doubt allow staffing of the office, completion of an inventory, and further work on the feasibility of transferring training products on a regular basis.

Whether or not funds are appropriated for a training technology transfer office, private sector trainers might benefit if individual Federal agencies did abetter job of keeping track of their own training materials. Most Federal agencies, including some that are extensively involved in training, do not have policies for agency-wide inventorying of their training packages.[47] This inefficiency can lead to dupli-

[45]U.S. Congress, Office of Technology Assessment, *Power On: New Tools for Teaching and Learning*, OTA-SET-379 (Washington, DC: U.S. Government Printing Office, 1988), p. 152.

[46]The Training Technology Transfer Act of 1988 was one chapter in Public Law 100-418.

[47]An exception is the Department of Energy, which has developed an on-line database covering 3,000 training packages. Recently, the Department of Defense has taken some steps to collect more complete information about its taining products.

cation of effort, since some training programs are generic in nature and could be applied in many settings. If more agencies developed inventories of their training packages, and made this information publicly available, private-sector access could be increased. This information would be particularly useful if evaluation information were included.

Federal agencies occasionally cooperate to transfer training technologies on an ad hoc basis. One of the more ambitious of these efforts (involving the Departments of Defense, Labor and Education) aims to adapt the Job Skills Education Program (JSEP), a computer-based remedial education program developed by the Army for about$11 million in the early 1980s, to civilian use. This conversion process, formally underway since 1987, has been protracted and expensive, entailing $600,000 in Federal funds to date, and legal issues associated with transfer of JSEP to commercial use are still in negotiation between the Army and JSEP's developer. Although this effort may in the end pay off the process is by no means predictable.

Even if transfer activities are stepped up, only a small part of the Nation's need for better training materials can be met by converting materials developed for one purpose and mission to another purpose. In each case, developers and users need to evaluate whether it would be better to take existing training programs and convert them to other uses or to develop new materials.

Option 15: Fund More Civilian-Sector Learning Research/Technologies (Table 2-5)

While military training approaches and technologies may continue to provide models for the private sector, there could be significant risks in over reliance on military funds to support the Nation's learning research and instructional technology needs:

. Some of the military's research and development (R&D) is too specialized to have much immediate relevance to private sector training. Also, even general purpose instructional programs developed for use in the military often have to be modified before they can be widely used in civilian settings. As the JSEP example above suggests, the expense involved can make the routine transfer of military training technologies to the private sector difficult, expensive, and time consuming.
- Military resources are more limited now than in the past. During the 1980s, both the Army and Navy reduced expenditures for learning and training research, while Air Force expenditures increased only slightly .48 The Defense Advanced Research Projects Agency, which played a unique role in support of research in cognitive and computer science, has redirected its R&D to more strictly military applications.[49] These trends may reduce the opportunities for continued transfer of state-of-the-art training techniques to the private sector even though a formal process for technology transfer is in place.

Thus, broader support for adult learning and other training research and for civilian development of learning technologies would be useful. Various possibilities are listed under Option 15 in table 2-5. (See also the discussion of adult literacy under Option 7, and an employer institute for work-based learning under Option 12.) These include:

- establishing a national learning and technology institute (an approach proposed in S. 2114 introduced in the 101st Congress);
- earmarking a portion of Federal agency education and training budgets to research and development. Earmarking 1 percent of program budgets would result in a substantial supplemental increase in research now conducted primarily through separately funded research programs. Of course, funding levels in the existing research programs would need to be maintained for this to do much good.
- directing the Education Department, through the Office of Educational Research and Improvement, to give more attention to workplace and adult learning issues in its research agenda. (Two of OERI's 18 educational research and development centers focus primarily on workforce issues.) This should not come at the expense of other education research, which has generally been funded at a low level.
- giving the National Science Foundation (NSF) a role in research on work organization and training. For example, if Congress were to upgrade the status of manufacturing sciences at

[48]Blaschke et *al.*, op. cit., footnote 43, p. 59.

[49]*Power On*, op. cit., footnote 45, p. 157.

NSF from the Divisional to the Directorate level, it could specify that part of the mission would include research on shopfloor training and work organization.[50]

A special need, given the aging of the workforce, is for more research on the older worker. If Congress were to earmark research funds for adult learning, research on the older worker could be one important component. Alternatively, Congress could increase funding (now minimal) for older worker research in the budgets of the Department of Labor or the Health and Human Services Department's Administration on Aging.[51]

Option 16: Improve the Information Base on Work-Based Training (Table 2-5)

As is discussed in chapter 5, data on private sector training (including the amount of money firms spend on training and the nature and quality of training) is limited. Most national estimates about training in firms is based on proxy data—some 10 or more years old-or very limited empirical information that has been extended to the economy as a whole. While there are many uncertainties, information deficiencies are not so great as to preclude rational debate about policy now. Whether or not Congress expands the Federal role, better information would help inform future choices made by decisionmakers in the public and private sectors.

The need for better information is clear. Therefore, Congress might choose to direct Federal statistical agencies—such as the Bureau of Labor Statistics, the National Center for Education Statistics, and the Bureau of the Census—to prepare and regularly update surveys of industry training or adult education and earmark funds specifically for this purpose. Since many firms do not track their training expenses carefully, there would more than likely need to be an initial effort to develop an appropriate survey instrument. (This need would exist even if firms reported training data to the government as part of a national training levy, discussed in Option 4.)

There also is a growing need for regular collection of data about adoption of new technology by firms and about changes related to work organization and human resource practices. The Census Bureau, which undertook an initial survey of manufacturing technology in 1988, would be a logical organization to develop this information. A relatively modest amount of money—say $750,000 per year-would give the Census Bureau the resources needed to undertake periodic surveys on new technology adoption by firms and special studies on training, work organization, and other human resource practices in fins.

From time to time, the government also collects information from individuals about their training. However, this information quickly becomes dated. The Survey of Adult Education, issued by the Education Department's National Center for Education Statistics, contains information about the portion of adults who received company-provided education. The last survey, however, was conducted in 1984. Similarly, the last detailed survey of how workers get their training, conducted by the Bureau of Labor Statistics in conjunction with the Census Bureau, was undertaken in 1983.[52]

The shortcomings in the available data about industry training are just one of many areas that complicate public and private sector decisionmaking on human resource policies. Several recent studies have pointed out the attrition in Federal statistical series during the 1980s. Without increases in funding, it will be extremely difficult for the Federal statistical agencies to develop new information series without cutting into existing programs. As an example, the Bureau of Labor Statistics, which has suffered significant budget cuts since the late 1970s, has eliminated many of its data collection programs and now devotes much effort to maintaining the integrity of existing data series.[53] Similarly,

[50]For further discussion, see U.S. Congress, Office of Technology Assessment, "U.S. Manufacturing: Problems and Opportunities in Defense and Commercial Industries," staff paper, May 1990.

[51]For a more detailed discussion of the range of issues and options for older worker research, see Frances R. Rothstein and Donna J. Ratte, Training *and Older Workers: Implications for U.S. Competitiveness, report* prepared for the Office of Technology Assessment under contract N3-1630, March 1990.

[52]Results were reported in Max Carey and Alan Eck, *How Workers Get Their Training,* U.S. Department of Labor Bureau of Labor Statistics Bulletin 2226, 1985. Earlier BLS surveys were conducted in 1977 for metalworkers and in 1964 on occupation training.

[53]As discussed by the Commission on Workforce Quality and Labor Market Efficiency. The Commission noted that BLS curtailed 19 data series in 1982 alone. See *Investing in People: A Strategy To Address America's Workforce Crisis*, op. cit., footnote 7.

the Education Department's National Center for Education Statistics has had a hard time maintaining some of its data series, including longitudinal studies.

The need to periodically reexamine workforce statistics-to establish new priorities where needed—would remain even if the Federal statistical agencies had not lost ground. While the Bureau of Labor Statistics and the Census Bureau do reexamine their priorities, the last major external review of workforce statistics-conducted by a congressionally mandated commission with members appointed jointly by Congress and the President-was completed over a decade ago.[54]

In another report, OTA examined Federal statistical series and possible measures for improving data on a governmentwide basis, and found a pressing need for an organization to reexamine Federal statistical priorities.[55] While the Office of Management and Budget has formal responsibility for statistical policy, its implementation effort has been flawed. Not much effort is made at present to evaluate whether current statistical efforts really meet contemporary needs. If Congress elects to redirect Federal statistical policy, it might emphasize the need for Federal agencies to expand their perspective to encompass previously underreported areas, like work-based training. Congress also might wish to direct the Administration to appoint an external review group on workforce statistics as part of its efforts to review Federal statistical policy.

The options discussed in this chapter are only a small fraction of the possible actions available if Congress wishes to provide broader support for work-based training. The issue of work-based training itself is only one part of the broader spectrum of human resource development issues now facing the Nation. Nonetheless, the issue is an important one-one that cannot be safely ignored.

[54]For a review of changes in data needs since this group—the National Commission on Employment and Unemployment Statistics—completed its work, see Sar A. Levitan and Frank Gallo, *Workforce Statistics: Do We Know What We Think We Know-and What Should We Know?*, U.S. Congress Joint Economic Committee, Dec. *26, 1989.* Levitan chaired the Commission.

[55]U.S. Congress, Office of Technology Assessment, *Statistical Needs for A Changing Us. Economy*, background paper, OTA-BP-E-58 (Washington, DC: U.S. Government Printing Office, September 1989).

Chapter 3

Human Resources for Competitiveness

CONTENTS

Boxes

Figure

Tables

Chapter 3
Human Resources for Competitiveness

SUMMARY

Principal findings of this chapter include the following:

1. Quite independently of skills required for dealing with new technology, turnover and new business formation create a continuous need for training—a need some American companies meet much better than others. Some of this training entails little more than introducing new employees to the workplace. Some seeks to build commitment to corporate goals. Other training programs include extensive instruction in task-specific technical skills-e. g., operating a nuclear powerplant.
2. Small firms-those with 100 employees or less-create many of the new job opportunities in the U.S. economy. Such firms face special training problems. Many lack experience with training, and the resources to afford it. Typically experiencing higher than average rates of turnover, small companies are reluctant to invest in their employees. Policies that support the training needs of smaller firms have a special claim, particularly because these establishments provide so many entry-level jobs for younger workers.
3. Four classes of workers likewise have a special claim on training: young, entry-level employees; older Americans; displaced workers; and minorities.
   - Because younger workers change jobs so frequently, many employers give them only the minimum training necessary. Given the importance of early training<. g., in forming attitudes toward work and motivating continuing learning-there is a clear public interest, independent of the interests of employers, in supporting training for younger workers.
   - With the labor force steadily aging, there is an equally clear public interest in training for older Americans. In the past, companies have been reluctant to invest in training for older blue- and grey-collar employees. With fewer entry-level workers, this will have to change.
   - Displaced workers typically find themselves unemployed through circumstances outside their control, while training opportunities of any kind drop sharply during recessions (because employers seek to cut costs). This conjunction of layoffs and declines in training points to a need for public policies that pay consistent attention to the training needs of displaced workers and that kick in added support during business downturns.
   - In the past, access to the best training (e.g., apprenticeships) was largely limited to white males. With new workforce entrants more likely to be minorities and immigrants—many of whom have relatively poor basic skills (e.g., reading, arithmetic)-new training practices and programs suited to their needs will be required. Training is particularly important because, more so than in the past, the right certificates, diplomas, and degrees will be needed to start on an upward career track.
4. The outcomes of international competition—particularly the success that countries like West Germany have had with relatively formalized systems—suggest that the United States will need a much stronger commitment to training in the future. Indeed, the U.S. training system seems remarkably underdeveloped compared with our leading competitors. Most American companies look frost at the costs of training, and at the time workers spend away from the job. To them, shorter training programs are better training programs. In both Germany and Japan, in contrast, training is viewed as an investment. The German and Japanese systems are very different, but both are more extensive and more effective than that of the United States.

For many decades, the United States drew strength from a remarkable pool of skills, one fed by immigration and by long standing commitment to universal education. Immigration still contributes, particularly in engineering and science, but today other countries can boast of superior primary and secondary education. And if the U.S. economy is the most dynamic the world has ever seen, the Nation's

training system is not. Companies have been reluctant to invest in training. Other institutions have failed to keep up with emerging needs. As a result, the United States is operating with a glaring weakness in international economic competition. That half of the labor force that is below average in education, training, and skills is poorly prepared compared to their counterparts in a number of the Nation's principal economic competitors.

Nearly half of all Americans now take some college courses. The education and training system serves these people relatively well, especially those who complete college and goon to white-collar jobs in the professions or in management. The system does a poor job of meeting the needs of people who do not pursue higher education, who may not even graduate from high school. Countries as different as Germany, Japan, and South Korea work much harder to educate and train, not only the upper half of their labor forces, but the lower half.

For the United States, the message conveyed by a multitude of surveys-of educational credentials (high school graduation rates, table 1-3 in ch. 1), achievement (basic skills, ch. 6), workplace capabilities (ch. 4)----is simple and direct: the training system and the schools—more properly, society as a whole-do a poor job of serving the economically disadvantaged, particularly blacks and other minorities. In the years ahead, the drive to raise productivity and improve the competitiveness of U.S. industry could help transform the ongoing debate over social equity into one over economic growth. For the first time since World War II, the needs of the workplace and those of the disadvantaged could merge. This will not happen by itself. It will take commitment to better preparation for work—by individuals, by schools, by employers, by government.

Lack of skills not only hurts the people in the bottom half as individuals, it hurts the economy. These people will lose the most if U.S. industries continue to decline competitively: they will be laid off first, or find the pressure of international competition forcing their earnings downward. Many have already found ladders of upward mobility pulled down, as the invisible logic of computer-based systems makes abstract thinking more important than manual skills, and companies rely on educational credentials to find trainable workers.

In the end, the Nation's economy must support everyone at some level. This simple fact creates the fundamental justification for public investments in training. The lagging quality of the U.S. labor force slows economic growth and drags down the standard of living for everyone-not just those who suffer as individuals from poor education and training. By the same token, abetter qualified labor force will benefit society as a whole.

THE SKILL POOL

Companies hire from local, regional, and national labor markets, and draw on internal labor markets when they promote current employees or move them laterally into new jobs. A company's choices reflect the pool of people and skills available to it externally and internally, relative to its needs. Those needs depend on its place in the economy. Service industries employ a mix of people differing from that in manufacturing; the knowledge-based services (including education, finance, and business services) draw on quite different sets of skills than the traditional or tertiary services (e.g., retailing, transportation).[1] As summarized in app. 3A, at the end of this chapter, U.S. employment has been growing rapidly in knowledge-based services (and in a few knowledge-intensive manufacturing sectors). But because high-technology industries remain small compared to the overall economy, job creation concentrates in sectors such as retailing and occupations such as clerk and custodian.

The skills available in the labor market drive economic growth and competitiveness. The United States has always revered its inventors and entrepreneurs, Edison and Carnegie in the past, Steven Jobs and Mrs. Fields today. Nor is it only the storybook figures that matter. Nearly any enterprise will need a substantial range of skills to survive and prosper: ''unskilled' blue-collar workers; middle-level grey - collar employees (e.g., technicians); white-collar salespeople and bookkeepers; supervisors, administrators, and managers.

[1]U.S. Congress, Office of Technology Assessment, *International Competition in Services*, OTA-ITE-328 (Washington, DC: U.S. Government Printing Office, July 1987), ch. 7 and 8. See especially pp. 228-230 for the distinctions between knowledge-based and tertiary services, as well as traditional and knowledge-intensive manufacturing. Also see table 3A-2, in the appendix to this chapter.

People's skills expand and develop over time, as they attend school, enter the labor market, gain experience, move from company to company. Some of the practical skills essential in the workplace come largely from everyday experience. People learn one set of problem-solving, social, and communications skills in school, quite a different set at home, on the playground, learning to cook and to ride a bicycle. Both sets are important.

Simple tests exist for measuring simple skills: manual dexterity; visual acuity. Basic skills can be surprisingly difficult to measure. Such skills remain important, but competitive manufacturing and service firms in a high-wage economy also require higher order skills-judgment, reasoning, interpersonal communication. These are still more difficult to measure, to teach or train for.[2]

Table 3-1 classifies skills from lower order (manual) to higher (cognitive, social), and from the academic skills associated with schooling to the practical skills learned in daily life (of which school is part). The three broad classes in the left hand column build on one another in the sense that people normally employ mental/cognitive skills in the course of activities that also call for manual skill. And by definition, social and communications skills have mental/cognitive dimensions. Because higher order skills are harder to measure with tests, employers today rely more heavily than they once did on interviews, even when hiring unskilled or semiskilled workers. As the examples in the table suggest, many everyday or practical skills can be just as important in the workplace as academic skills learned in school or technical skills learned in specialized training programs.

As more American companies in both manufacturing and the services adopt production systems that call for people to work in groups, social skills and communication become more important. (Ch. 4 explores patterns of work organization in some detail, while box 7-F inch. 7 discusses technologies for automated training in interpersonal skills.) Work groups, moreover, are typically expected to help solve problems involving not only routine but unexpected events (e.g., equipment breakdowns).

Because measures of skill, and testing procedures for skills, remain primitive, employers frequently use educational credentials as surrogates (even though education often fails to predict on-the-job performance). This trend has begun to widen the split in the U.S. labor market between a lower tier of poorly paid unskilled and semiskilled jobs, many in the services, and an upper tier, or superstructure, of well-paid jobs, many of them professional and managerial.[3] To the extent that employers rely on educational credentials as a screening device, passage from the lower tier to the upper grows more difficult. Although the upper tier is growing rapidly, many people lacking a saleable combination of educational credentials, motivation, and training and experience (a moving target as the economy changes) will never get a chance to compete for these jobs, or to show their ability to take on more challenging work. Fewer ladders will extend from the lower tier to the upper—a trend already quite evident in sectors ranging from textiles to retailing. Compared with earlier decades, the middle levels will be sparser. Reorganized manufacturing firms, for example, frequently cut back or eliminate jobs for first-line supervisors (ch. 4)-jobs once filled largely by promoting production workers. As illustrated by examples from the textile industry, later in this chapter, grey-collar technical jobs increasingly require education or training credentials secured outside the workplace; on-the-job experience might suffice for learning to repair wholly mechanical machines, but not those that incorporate digital electronics.

---

[2]Higher order skills are poorly understood, and so tooteaching/training/learning. See, for example, *Thinking andLearning Skills, Volume 1: Relating Instruction to Research,* Judith W. Segal, Susan F. Chipman, and Robert Glaser, eds. (Hillsdale, NJ: Erlbaum, 1985), especially Peter G. Poison and Robin Jeffries, "Instruction in General Problem-Solving Skills: An Analysis of Four Approaches," ch. 12, pp. 417-455; *Practical Intelligence: Nature and Origins of Competence in the Everyday World,* Robert J. Steinberg and Richard K. Wagner, eds. (Cambridge, UK: Cambridge University Press, 1986); and Richard E. Nisbett, Geoffrey T. Fong, Darrin R. Lehman, and Patricia W. Cheng, "TeachingReasoning," Science, Oct. 30, 1987, pp. 625-631.

[3]For a more extensive discussion, see *International Competition in Services,* op. cit., footnote 1, chapter 7. As *a* simple example of the shifts taking place, note that early generations of computer systems deskilled many jobs in services like banking and insurance. Companies replaced clerical workers and bookkeepers with data-entry clerks (fewer relative to the volume of work) plus a small coterie of supervisors, and the systems specialists who oversaw the mainframe computers of that era. With later generations of decentralized computer systems, much of the routine data entry work also disappeared. The remaining jobs tend to require at least some problem-solving skill. Nonetheless, these remaining jobs have carefully delimitedboundaries, offer limited opportunities for upward mobility, and can be nearly as routinely repetitive as yesterday's keypunching.

Table 3-l—Skill Dimensions and Examples

Skill type	Academic	Technical	Everyday/practical
Manual	Penmanship	Welding; short-order cooking	Painting walls; changing a flat tire
Mental/cognitive	Writing an essay	Inspecting welds; institutional menu planning	Furnishing a room; driving in traffic
Social/behavioral	Teaching composition	Designing playground equipment; serving meals in a restaurant	Giving a dinner party; managing a car pool

SOURCE: Office of Technology Assessment, 1990.

These shifts, already underway if slowly paced, could have profound implications, not only for the competitive ability of U.S. industry, but for social stability. More than likely, the mismatch between job opportunities and labor force abilities will continue to widen. Through lack of training and channels for upward mobility, industry may be cutting itself off from needed skills. Even when unemployment stood at 9 or 10 percent, in the early 1980s, a million or more jobs remained unfilled because employers could not find people with the right skills. Meeting the needs of both individuals and industry will require better training in task-specific skills, as well as problem-solving capabilities and social skills. Basic skills and education must provide the foundation.

Labor Market Dynamics

The Demand for Training

Churning in the economy far exceeds net job creation as a driving force for training. The number of newly hired people entering a given industry (or occupation) in a single year can easily exceed the net total of jobs created in that industry over a full decade. This is true even for rapidly growing industries and occupations. Labor mobility makes employers reluctant to provide training.

Of the nearly 20 million Americans that take a new job each year (in a civilian labor force approaching 125 million), no more than one-quarter can claim previous experience in the same occupation (these tending to be managers, professionals, or technical/craft workers).[4] Some 15 percent of the labor force may need training each year simply because of mobility and churning. Many, unfortunately, do not get it.

In good times and bad, mobility in the U.S. economy remains high. When unemployment rates fall, people move voluntarily-often to take jobs at higher wages. When unemployment rises, people hold onto their jobs but may lose them involuntarily to layoffs. Young people switch jobs much more frequently than older workers. Nearly 80 percent of teenagers have been in their current job for less than a year, compared with just under 10 percent for those aged 60-64. Workers under 30 account for about a third of total employment, but 56 percent of those on the job for less than a year. Lateral moves by older workers, particularly men with blue-collar manufacturing experience, are likely to be a consequence of layoffs rather than choice.

A good deal of the total need for training, then, as opposed to ongoing workplace learning, arises simply from churning. People move from job to job; entrepreneurs start new companies; existing companies grow, promote people, move them horizontally. These events occur with much greater frequency in the United States than in Western Europe or Japan. American companies must integrate new employees, many of them young workers with relatively little experience, into their organizations on an ongoing basis.

Even firms with shrinking employment levels-because they have lost business, because they have sold off divisions, or because of productivity improvements—may have to bring in new people to stay ahead of attrition. Companies laying workers off may need to reassign and retrain those remaining. Births and deaths of firms also add to labor market turbulence. New small firms face special training needs: most of them lack experience in providing training and the resources to pay for it.

[4]James P. Markey and William Parks II, "Occupational Change: Pursuing a Different Kind of Work," *Monthly Labor Review,* September 1989, pp. 3-12, which analyzes data collected in the January 1987 Current Population Survey-source of the most recent information on U.S. labor mobility.

Job Creation and Small Firms

Net growth in employment equals the sum of jobs created by new firms, plus expansion by existing firms, minus the jobs that disappear when establishments close their doors or lay off workers. In recent years, small enterprises-those with less than 100 employees—have accounted for a near-constant 35-36 percent of total U.S. employment.[5] Births and deaths of these firms number in the hundreds of thousands each year.

Over the 1976-86 period—the latest for which such data are available-the United States generated slightly more than 22 million new jobs. This total was the result of 45 million new jobs created by startups, and 14 million jobs generated through expansions, offset by 29 million jobs lost through establishment ''deaths' and 8 million lost to contractions. Table 3-2 shows that, over this entire 10-year period, firms with fewer than 100 employees and those with more than 500 employees generated roughly equal numbers of jobs. However, during the recessionary period of 1980-82, very small firms—those with fewer than 20 employees-created almost all the net new jobs. Big firms tend to cut back on training during recessions, and small firms do little formal training under any circumstances, so that training opportunities drop sharply when business slumps.

New small firms tend to grow by fits and starts, often responding differently to changing economic conditions than their larger, better established counterparts. In a young computer software or biotechnology company, a rapid growth spurt may be followed by employment decline, as the firm struggles to develop its products, begin production, enter the marketplace, and finally expand (at which point it may begin generating many new jobs). Other enterprises remain small by choice: many are started by people who prefer to be their own boss, but have no particular desire (or ability) to turn a small business into a large one. Neighborhood retailers and franchise outlets typify these enterprises, a much larger group than entrepreneurial startups; when they disappear, it is more likely because of poor management (or retirement, a lost lease, or some such reason) than that they have over-reached.

Table 3-2—Employment Growth by Size of Firm

Period	Employment growth (millions)	Percentage share by size of firm (number of employees) 1-19	20-99	100-499	500+
1976-86	22.3	26.2%	17.470	13.6%	42.8%
1980-82	1.5	97.8	-5.9	3.5	4.5

SOURCE: *Handbook of Small/Business Data* (Washington, DC: U.S. Small Business Administration, 1988), table 8-13, p. 259.

High rates of births and deaths among small firms contribute to a rate of labor market mobility in the United States exceeding that in economies with a less pronounced entrepreneurial dynamic. This form of churning creates background noise that can make it difficult for both companies and workers to detect labor market signals. Businesses may downplay the need for training if contractions and closures elsewhere continually replenish their labor supply, while workers lacking stable occupational prospects may be reluctant to invest in training on their own.

In part simply because of their high labor turnover, small companies invest less in training than large firms. Many workers leave small firms because they can earn more by moving to a bigger enterprise.[6] But smaller establishments provide a major port of entry to the labor force for young people (men especially-women are more likely to take jobs with large enterprises), who get general training as well as job experience, then 'cash in' by moving to another employer. This puts a double burden on small companies, in addition to their typical lack of resources and training experience. First, small enterprises rarely have enough workers in need of training at any one time to justify an organized effort. Second, those workers who do get training will, everything else the same, be more likely to leave a job with a small firm. As a result, small firms

[5] *Handbook of Small Business Data* (Washington, DC: U.S. Small Business Administration, 1988), table 6-6, p. 143. The job creation data in the next paragraph come from table 6-12, p. 257. The Small Business Administration maintains the only U.S. database linking job creation with fro-level business activities.

[6] David Drury, William Dickens, and Christopher Martin, "Labor Turnover and Worker Mobility in Small and Large Firms: Evidence from the SIPP,' report prepared for U.S. Small Business Administration by Berkeley Planning Associates, Berkeley, CA, December 1988. Data from the Survey of Income and Program Participation (SIPP) show that turnover rates for 1984-85 were higher in companies with fewer than 100 employees, after adjustments for differences in industry occupation, wages, and hours worked, and that employees who leave a small firm for a larger one earn higher wages on the average.

provide less formal training than larger companies.[7] It seems fair to conclude that it is often not in their interests to do more.

Workforce Demographic[8]

Demographic changes will compound the growing needs for training created by international competition and new technology. At a time when labor force projections show growth rates of about 1 percent annually, the economy is expected to continue growing at two or three times that rate. Labor shortages may arise in some regions and some sectors. Average ages will increase, with the graying of the labor force combining with an increasing fraction of minorities to create a new set of training needs.

Shifts in Composition

Over time, as the labor force expands, its composition shifts (see app. 3-A, table 3A-l). Young people leave school and seek jobs, immigrants enter the labor market, older workers retire. With the baby boom bulge past, overall labor force growth has slowed. During the late 1970s, the civilian labor force grew by almost 3 million people each year; by the late 1980s, the increase had fallen to 2 million per year.[9]

In other ways as well, the U.S. labor market has changed quite dramatically over the past decade. Unemployment has been cut almost in half, to 5-plus percent compared with nearly 10 percent in 1982 and 1983. At the same time, labor force participation has reached a new high. Until the middle 1970s, participation had remained relatively stable at 58-60 percent. Today, two-thirds of Americans aged 16 and over hold a job or are actively seeking work. The big change: more women in the workplace. Nearly twice as many women held jobs in 1989 as in 1969 (53 million compared with 29 million).[10]

During the 1990s, women will account for nearly two-thirds of U.S. employment growth. Younger women now join the workforce at rates approaching those for their male counterparts.[11] Historically, black women have been more likely to work than white women, except in the youngest age groups. This difference in participation rates will probably shrink somewhat, as more white women work. Although more women have been finding jobs in traditionally male occupations-e. g., the professions—women's wages relative to those of men have improved only slightly over the last two decades. Still, with the rise in employment opportunities for women, the past becomes a poor guide to the future. For example, considerable uncertainty attaches to future labor force participation rates of older female workers, which BLS predicts will rise for those aged 50 to 64, but decline for those over 65.

Many women work part-time or take temporary positions, sometimes (like men) because this is the only work they can find.[12] From the middle 1960s to

---

[7]Sheldon Haber, Joseph Cordes, and James Barth, "Employment and Training Opportunities in Small and Large Firms," report prepared for the U.S. Small Business Administration by Sirnon & CO., Potomac, MD, June 1988. This report also draws on SIPP data, which show, for 1984, that only 5.4 percent of workers in companies with fewer than 100 employees had ever participated in a formal training program with that employer. The percentage of workers reporting such training was twice as high (10.4 percent) for those with jobs in firms having more than 100 employees. About 15 percent of each group had received training outside of their present firm, suggesting that workers with previous training are hired in roughly equal proportions by small and large firms, but that those in largefirms are twice as likely to receive job-specific, in-house training.

[8]Much of the analysis in this section is based on Willie Pearson, Jr., "Demography of the Workforce," Working Paper #1, Office of Technology Assessment, Mar. 22, 1989. Unless otherwise noted, data and projections come from the moderate growth scenario of the Bureau of Labor Statistics (BLS), as summarized in the November 1989 *Monthly Labor Review. This scenario assumes* a 2.3 percent (real) annual increase in gross national product, 1.2 percent annual increase in the labor force, and 5.5 percent unemployment.

Following BLS practice, all Hispanics are treated as a single group in the discussion and tables in this chapter. Nearly 95 percent of people of Hispanic origin are classed as white, but in the text and tables that follow,"white" refers to non-Hispanic whites only.

[9]*Employment and Earnings*, vol. 37, January 1990, table 1, p. 160.

[10]*Employment and Earnings, vol.* 37, January 1990, table 2, p. 161.

Although BLS expects participation rates to edge upwards towards the 70 percent mark, a relatively low level of population growth means that labor force growth could be no more than one percent annually during the early 1990s. And depending in part on future rates of immigration, the labor force growth rate could drop to zero by 2020. See U.S. Congress, Office of Technology Assessment, *Technology and the American Economic Transition: Choices for the Future,* OTA-TET-283 (Washington, DC: U.S. Government Printing Office, May 1988), pp. 474-475.

[11]Between 1975 and 1986, labor force participation rates for mothers of children less than a year old doubled, from 26 percent to 50 percent; more than half of all married women with children aged one and up now work, most of them full time. Today, mothers with children under age six represent the fastest growing segment of the labor force. See "Needed: Human Capital,"*Business Week,* Special Report, Sept. 19, 1988, pp. 100-141; William B. Johnston and Arnold W. Packer,*Workforce 2000: Work and Workers for the 21st Century* (Indianapolis, IN: Hudson Institute, 1987), p. 95. Fifty-two percent of mothers hold full-time jobs, but only 13 percent want to.

[12]On temporary and part-time employment, see *International Competition in Services,* op. cit., footnote 1, pp. 243-250.

the middle 1980s, the fraction of the workforce with part-time jobs increased from about 15 percent to more than 20 percent. The increase in contingent employment—part-time, temporary, and contract work, plus self-employment-reflects, on the one hand, the choices of people seeking time to be with their families and the freedom to pick and chose what they wish to do. But it also reflects the drive for flexibility in business and industry. As noted in the next chapter, by moving from a large core workforce to a smaller group of more-or-less permanent employees, coupled with temporary and contract workers brought in as needed, businesses can adjust more easily to shifting competitive circumstances. They can also save on their wage bills: part-time and temporary employees rarely receive the fringe benefits that go to permanent staff.

The people who will hold jobs in the first decade of the next century have already been born; most of them are working now. Many of the new workers will be black, Hispanic, or members of some other minority group. Nonetheless, three-quarters of the U.S. labor force will be (non-Hispanic) white. Because of the size of the workforce, it takes many years for its composition to change much. Even so, as table 1-2 in chapter 1 showed, by 2000, women will make up nearly half the labor force, and minorities one-quarter. There will be far fewer young people, and swelling numbers of middle-aged and older workers.

By the end of the century, those in the baby boom generation will be entering their 40s and 50s. As this group passes into and through their middle years, the median age of the workforce will move upward from 36 currently to 39-plus by 2000.[13] Those aged 45-64 will reach a peak expected to be about 28 percent of the workforce in 2010, after the last of the baby boomers pass into this age range.[14] As these people move on into the over-65 category, it will expand rapidly-horn 13 percent of the population in 2010 (only slightly above the current level), to more than 20 percent in 2030.

While labor force participation rates have been declining for men over 50, the training system will plainly have to adapt to a steadily aging population during the frost several decades of the next century. Employers have traditionally been reluctant to invest in training for older workers. On the other hand, older workers tend to be much less mobile, which should help dampen employers' fears of training people only to see them move on to other jobs.

Minorities

New labor force entrants will come increasingly from minority groups simply because of population trends: blacks, Hispanics, and recent immigrants represent growing fractions of the overall U.S. population. Other factors are secondary, although not insignificant. For instance, falling labor force participation rates among black men mean that black women and Hispanic men could outnumber them in the workforce by the end of the century.[15] Already, labor shortages in some suburbs stand alongside high levels of central-city unemployment, predominately among minorities.

Minorities (like women) will be most heavily concentrated among younger workers in entry-level jobs—in principle, prime candidates for training. In 1988, blacks and Hispanics made up 23.6 percent of the labor force aged 16-24, a share expected to approach 30 percent by 2000.

With exceptions including a number of Asian groups, minorities enter the labor force with less schooling than average, and often with educational attainments below average for their grade level. Many more students drop out of high school in cities and States with heavy concentrations of minorities: nationwide, about 85 percent of young people

[13] The median age was even higher in the early 1960s, peaking at 40,5 years-a consequence of low birth rates during the depression of the 1930s. Howard N. Fullerton, Jr., "New Labor Force Projections, Spanning 1988 to 2000," *Monthly Labor Review*, November 1989, table 6, p. 10.

[14] *Projections of the Population of th, United States, by Age, Sex, and R... 1988 to 2080*, *current* Population Reports, Series P-25, No. 1018 (Washington, DC: Department of Commerce, Bureau of the Census, 1989), table 4, Middle Series.

[15] Projections for Hispanics are sensitive to assumptions concerning future levels of immigration, both legal and illegal. Immigrants as a whole represent an extraordinarily diverse group, one that includes scientists and engineers born in India and China, and physicians and nurses from the Phillipines, as well as both skilled and unskilled workers from Latin America. (Rates of business ownership are much higher for Asians than for other minority groups-55 per 1,000 in the population, versus 13 per 1,000 for blacks and 17 per 1000 for Hispanics. Wendy Manning and William O'Hare, "The Best Metros for Asian-American Businesses,' *American Demographics*, August 1988, pp. 35-37, 59.)

On immigrants in the U.S. labor force more generally, *see International Competition in Services*, op. cit., footnote 1, pp. 250-252. Also *The Effects of Immigration On the U.S. Economy and Labor Market*, Immigration Policy and Research Report 1 (Washington, DC: Department of Labor, Bureau of International Labor Affairs, 1989).

graduate from high school, but the rate in Louisiana is barely 50 percent.[16] A growing mismatch between the skills of this part of the labor force and the jobs available in the U.S. economy will place far greater demands on the training system (and the schools). A glance at the unemployment rates in figure 3-1 suggests the difficulties faced in assimilating younger blacks, in particular, into the workforce. This is the stiffest test the Nation's education and training system will face in the years ahead-a test that it shows little sign of being prepared to meet.

Employers rely heavily on educational background in deciding who to hire, particularly when it comes to young people with little or no job history. On average, more years of schooling mean higher earnings. People with more education are more likely to participate in the labor force, less likely to experience bouts of unemployment.[17] It is no surprise, then, that blacks and Hispanics earn less than other workers, and find jobs that tend to be concentrated in occupations expected to grow at below-average rates (App. 3A) or to decline. Demographic patterns are largely fixed. If they will not change, the education and training system will have to.

What kinds of occupations have minority workers traditionally found? Blacks comprise 10 percent of the workforce. Table 3-3 lists the occupations in which blacks held 15 percent or more of all jobs in 1988. They tend to be low in pay and in skill requirements. Employment in the health services will expand rapidly in the years ahead, but as noted in app. 3A (table 3A-4) the fastest growing occupations will require credentials. Meanwhile, opportunities for operators, fabricators, and laborers will remain static, and household workers will decline in number.

Demographic shifts are reinforcing the trend toward a two-tier structure in the U.S. labor market. With minorities comprising a growing fraction of

Figure 3-l—Unemployment Rates, 1988[a]

[a] Adding discouraged workers who have given up seeking jobs would raise these percentages somewhat; the U.S. Government defines the unemployed as including those seeking work and unable to find it, but not people who have stopped looking for jobs. The latter are also excluded from labor force totals. In 1988,94.5 percent of white men aged 25-54 were counted as laborforce participants, compared with 88.7 percent of black men in the same age group.

SOURCE: Ronald E. Kutscher, "Projections Summary and Emerging Issues," *Monthly Labor Review,* November 1989, table 5, p. 72.

Table 3-3—Occupations With Heavy Minority Representation[a]

	Percentage of jobs held by	
	Blacks	Hispanics
Health services	28%	6%
Custodial	23	15
Household workers	23	17
Mail clerks and messengers	22	9
Operators, fabricators, and laborers	15	11

Occupations in which blacks held 15 percent or more of all jobs in 1988. Blacks made up 10 percent of the workforce in 1988, Hispanics 7 percent.

SOURCE: George Silvestri and John Lukasiewicz, "Projections of Occupational Employment, 1988-2000," *Month/y Labor Review, No*vember 1989, table 11, p. 84.

[16] Robert B. Reich, *Education and the* N@ Economy (Washington, DC: National Education Association 1988), p.19. Americans living in the South, regardless of race oretbnic background, report less education than those living in other parts of the country; more than 35 percent of all adult Southerner lack a high school diploma. *Employment and Training Reporter,* Dec. 7, 1988, pp. 344-345. Black Southerners get less education than white Southerners, and rural residents less than city dwellers.

For the country as a whole, 57 percent ofblacks and about half ofHispanics (but only one-quarter of whites) live in central cities with generally poor schools and poor job prospects. Four in ten blacks reside in one of 11 cities, of which only two, greater Los Angeles and Atlanta, have experienced relatively high rates of economic growth in recent years. *Workforce 2000:Work and Workers for the 21st Century,* op. cit., footnote 11, p. 91.

[17] In 1988, 88 percent of all college graduates aged 25-64 were in the labor force, but only 61 percent of people aged 25-64 who had not completed high school. The jobless rate for college graduates aged 25-64 was only 1.7 percent, compared with 9.4 percent for high school dropouts. Yet 3.3 percent of black college graduates were unemployed, more than twice the level for whites. "EducationalLevel of U.S. Labor Force Continues to Rise," News, Department of Labor, Bureau of Labor Statistics, Aug. 29, 1988.

new entrants to the labor force, and with labor shortages in fast-growing occupations and regions, some companies in some parts of the country will be forced to reexamine their hiring and training practices, finding an accommodation between two very different extremes:

- bidding up the wages of well-educated younger workers, most of whom will be white, and/or providing more training and retraining for older workers; or
- adopting more aggressive training programs for **assimilating young minority** workers into their organizations.

Companies, of course, may not pose the question this way, and most will chose some combination of these two alternatives.[18] Furthermore, the context for their decisions is broader. It includes such alternatives as automation to reduce labor requirements (in service industries as well as manufacturing), moving to parts of the country where labor is less expensive and/or better educated, and moving to foreign countries in search of cheap labor. Visible success over the next few years in the education and training of young minority workers could substantially influence future decisions by companies—decisions that are likely to have impacts on American society going far beyond employment and competitiveness.

TRAINING AND COMPETITIVENESS

The international competitiveness of U.S. goods and services depends on the value for money offered by American firms compared with foreign products—as judged in the marketplace. Customers vote with their dollars and deutsche marks. When Americans buy cars produced by Honda or Hyundai, their purchases register in the ledger of competitiveness. Much the same is true when Citibank underwrites a bond issue for a West German corporation.

Products that do not trade internationally also count in the ledger of competitiveness, although not so directly. First, American companies that export, or that compete with imports, buy goods and services from other domestic fins. The prices charged and quality provided affect competitive outcomes downstream. For example, about 15,000 American firms sell parts and components to motor vehicle manufacturers. Thousands of other companies sell to this group of direct suppliers. A few of the suppliers are relatively large; they may produce and sell tires or electronic components or structural plastics overseas as well as at home. But most are smaller firms that make sheet-metal stampings, fabricate equipment and tooling to order, or provide contract services ranging from engineering to plant security.

There is a second reason why the productivity and efficiency of smaller firms matters, along with services that do not trade internationally. The more productive each U.S. industry is, the higher will be average U.S. living standards. All else the same, more productive industries can pay higher wages, produce goods and services at lower costs, and sell them at lower prices. Greater efficiency in fast-food restaurants means American consumers get more for their money.

Competing in the New International Economy

If national welfare depends on productivity, efficiency, and competitiveness aggregated throughout the economy, these depend, among other things, on the education and training of the workforce.[19] Better educated workers have learned to learn: that is a major reason why employers rely on educational credentials for screening. Even if the subject matter is irrelevant to the task at hand, more years of schooling generally translate into more trainable- and retrainable-employees.

Education seems especially important (e.g., as an indicator of receptiveness to training) when workplace technologies are changing rapidly .20 When

[18]For the results of a survey conducted during early 1990 on employer expectations of skill needs and availability, see "Workforce 2000—Competing in a Seller's Market: Is Corporate American Prepared? A Survey Report on Corporate Responses to Demographic and Labor Force Trends," Towers Perrin and Hudson Institute, July 1990. The survey suggests that few companies have, ayet, begun to implement human resources strategies keyed to changing labor market demographics.

[19]Edward Denison, in his seminal study *Why Growth* Rates *Differ* (Washington, DC: Brookings, 1967), found that relative levels of education accounted for a significant share of differences in productivity growth rates amongnations.

[20]Ann p. Bartel and Frank R. Lichtenberg, "The Comparative Advantage of Educated Workers in Implementing New Technology," *Review of Economics and Statistics,* Vol. LXIX, February 1989, pp. 1-11; Hong W. Tan, "Private Sector Training in the United States: Who Gets It and Why," National Assessment of Vocational Education discussion paper, February 1989.

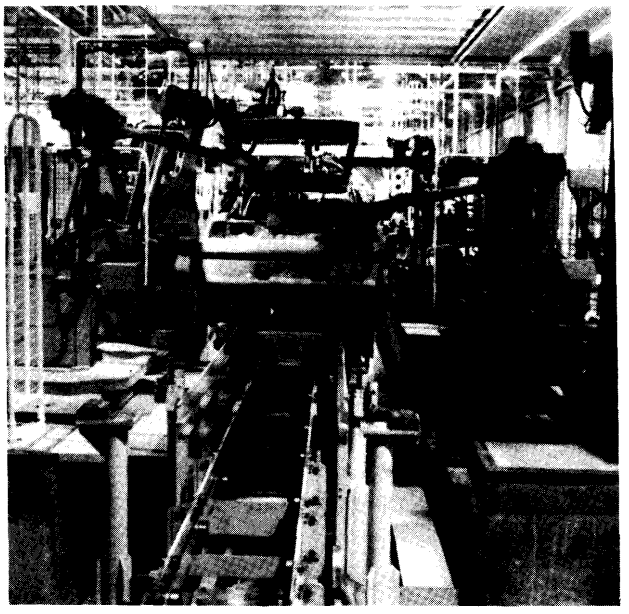


Photo credit: Diamond-Star Motors Corp.

Robots on automobile assembly line install tail lamps.

the technology is fluid, as it is today in computer-intensive industries, company-provided training takes on greater significance because needed skills are less likely to be taught in the schools (see ch. 5).

Larger, more competitive firms can often pay above-average wages to attract the talent they seek. Even so, the pressures of international competition have forced many such U.S. firms to reexamine their hiring practices and redesign their workplaces. New hiring criteria go hand in hand with production systems intended not only to reduce costs, but to improve product quality and organizational flexibility. Chapter 4 discusses the new practices, which have begun to ripple through the economy as they diffuse from innovating companies.

In the years ahead, employee skills will be particularly important for building organizations with the ability to respond quickly to new market opportunities. Restructuring and work reorganization place new demands on employees. Two decades ago, lack of literacy was no great handicap in a textile mill; in many mills today, operators of high-speed looms must be able to read and write (box 3-A). In this industry, as in others, lower costs and greater flexibility come both from technology and from a workforce that is asked to know more and do more.

Reorganizing Production: Costs, Quality, Flexibility

In industry after industry over the last two decades, familiar U.S. brand names have lost market share to aggressive competitors from abroad. Even in industries like textiles, market segments that once seemed safe attracted new competitors. The reasons are many. American firms had become rather relaxed, not only about manufacturing quality, but about the quality of their product designs. Managements underinvested in plant and equipment, sometimes failed even to maintain existing facilities.

In the future, American firms will have to do better on three dimensions of manufacturing: costs, quality, and flexibility. Costs are central: everything else the same, American products cost too much to design, develop, and build. But everything else has not been the same. American goods have also fallen behind in quality-first in quality of manufacture (conformance to design spectifications), more recently in quality of design (functional attributes and performance). Finally, many U.S. firms lag behind their competitors in introducing more flexible production systems permitting smaller lots to be produced without cost penalties.

costs

Xerox's experience is typical of many American companies that have found themselves falling behind their rivals. In the late 1970s, Xerox was in danger of being pushed out of all except the top end of the copier market. In extensive comparisons of its copiers with those produced by Minolta, Sharp, and others, Xerox found its manufacturing costs to be as much as 50 percent higher, and its defect rates 10 to 30 times greater.[21] Given this, even a near-generic brand name could do the company little good.

Xerox concluded that about half its cost disadvantages lay in product design and half in the production process. While the company has now managed to cut costs very substantially, it cannot relax: to keep up with the competition, the firm expects to reduce costs a further 50 percent by the mid- 1990s. Training

[21] H. Barry Bebb, "Quality Design Engineering: The Missing Link in U.S. Competitiveness," paper presented at the NSF Engineering Design Research Conference, University of Massachusetts, Amherst, June 11-14, 1989. Also see "Pushing To Improve Quality," *Reseurch-Technology Management*, May-June 1990, pp. 19-22.

has played a substantial role in bringing costs down-e.g., through reducing defects, scrap, and rework.

Quality

American companies in industries ranging from autos to semiconductors have fallen behind in quality. Chasing moving targets, some have closed the gap part way, but few have managed to pull even. Manufacturers have always known that they give quality short shrift at their peril. Still, over the past two decades, customers have become more demanding..[22] At the same time, Japanese firms have made quality a major corporate objective and marketing tool.

Xerox has given each of its production employees 28 hours or more of quality-related training-a total of 4 million man-hours. Three-quarters of the fro's workforce participates in quality circle activities. At the same time, by working more closely with fewer suppliers, Xerox has cut defect rates for purchased parts and components from 10,000 ppm (parts per million) to less than 300. The company's target for 1992-93 is 30 ppm. As the size of these reductions suggests, the competitive game has truly changed.

Flexibility

Companies in many industries, finally, have begun pursuing strategies emphasizing frequent product redesigns. Traditionally, low costs were the result of standardization and long production runs: cotton sheets, in white only; Model T Fords in black. Henry Ford had to go along when dealers and customers clamored for color, but he did so reluctantly, and Alfred Sloan's product differentiation strategy enabled General Motors to overtake Ford. The approach of the American automakers then changed relatively little until the Japanese onslaught of the 1970s. Since the 1930s, models and indeed entire car lines had been distinguished from one another largely through cosmetic changes—trim, styling, sometimes engines. Pontiacs commanded higher prices than Chevrolets even though production costs were nearly the same. Today, automobile manufacturers differentiate their products through both style and function. Automakers have introduced new nameplates, developed vans and light trucks that can substitute for the family car. Consumers can choose from hundreds of models, rather than dozens.

With more consumer goods becoming fashion items-e.g., athletic shoes marketed like women's clothes-manufacturers in many industries must be able to react quickly, earn profits on smaller volumes. These trends place a premium on short design and development cycles and rapid change-overs on the factory floor. Organizations must be able to respond quickly to both success and failure, ramping up production when demand warrants, replacing products that fail to sell. So far, Japanese manufacturers have proven most adept. It currently takes Xerox 24-36 months to develop anew copier, compared with 12-18 months for the firm's rivals in Japan.

FOREIGN TRAINING SYSTEMS: HOW DOES THE UNITED STATES COMPARE?

In many other nations, including the Federal Republic of Germany (FRG) and Japan, public and private training systems function more effectively than in the United States. There is no question that these two countries, and several others, train their workers to higher average standards. Table 3-4 (an expanded version of table 1-5 in ch. 1) briefly compares U.S. and foreign education and training systems. (Because of the lack of reliable figures for the United States, OTA has not attempted to estimate training expenditures in other countries.)

The Competition: Training Systems Abroad

Germany and Japan pursue markedly different approaches to training. The contrast between the United States and Germany is particularly striking. The FRG not only has the best apprenticeship system of any major economy, jointly financed by public and private sectors, but policies and traditions that give status and respect to blue- and grey-collar work. In Germany, the prestige associated with a college education works against broad vocational

[22] When asked for the "main forces acting on a global consumer products company like yours," the Chairman of L'Oreal, makers of perfumes and cosmetics, replied "One of the most striking things is the increasing desire of customers in all parts of the world for quality products—and their ability to perceive quality differences. Even in product categories like cosmetics, which everyone used to think of as driven by the whims of fashion, consumers are now carefully buying those products that are, objectively, technologically superior." Gerard J. Thulliez, "The View from France: French CEOS Look Ahead," *McKinsey Quarterly*, Autumn 1989, pp. 2-45 (quote on p. 40).

Box 3-A—Training in the Textile Industry[1]

Since the mid-1970s, U.S. textile firms have sought to meet international competition through automation, work reorganization, and greater product variety. Two decades ago, mills were organized for long runs of a few standard products. The workforce was largely unskilled or semiskilled. Recent work reorganizations, along with computer-based automation, have placed greater demands on employee skills. Some jobs now require operators to read manuals and enter or record information on electronic control panels.[2] Machine repair has become much more demanding.

Textile firms have had limited success in recruiting better educated workers. Forced to improve the skills of current employees, they have begun to implement training programs in basic skills and in grey-collar technical work.

Forces for Change

Since the mid-1970s, three sudden shocks have hit the U.S. textile industry. First, styles began to change at an accelerating pace. Many American textile suppliers had specialized in a limited range of standardized goods. Now apparel manufacturers (and retailers and consumers) demand variety even in denim; cotton "white goods" come in hundreds of styles rather than dozens. Survival has meant adaptation. Second, import competition has grown steadily more intense, not only from low-wage Asian economies (China, Korea, Hong Kong), but from mills based in Europe and Japan that concentrate on high-quality, high-fashion fabrics. Third, after several decades of relatively stable production technology, a wave of innovation hit. Water-jet and air-jet looms operate many times faster than traditional shuttle looms. Microprocessor-based controls enhance consistency and quality. Inexpensive computer systems track product flow.

Automation and Organizational Change

In earlier years, U.S. textile firms had sought to keep their costs competitive by moving to the Southeast, where organized labor was weak and wage rates low. Investments in the new generation of automated equipment helped the industry increase its productivity by 5 percent annually between 1975 and 1987, a much higher rate than for U.S. manufacturing as a whole. But imports also grew, and employment fell.

Some American firms, unable to compete either with cheap fabrics coming in from Asia or with high-fashion textiles entering from other advanced economies, began to search out market segments where their capital-intensive, vertically integrated plants would create advantages. They found them particularly in fabrics for home furnishings and in industrial textiles-categories that, together, accounted for 52 percent of U.S. textile production in 1980,60 percent in 1985, and 63 percent in 1988. Within their chosen niches, firms began offering greater variety. One spinning mill went from three active styles to 35 in 2 years; another now offers 300 furniture fabrics rather than 100. These strategies depend on fine-tuning the flow of production: computers have literally revolutionized production planning and control in the mills, where they are now used for tracking in-plant inventories as well as handling ordering and invoices. Some firms have also reorganized by replacing traditional functional departments, one for each step in the production process, with product-oriented departments that carry out a lengthy sequence of operations for a given product class.

Work and Skills

Textile jobs were much the same in 1975 as in 1955. The work was repetitive, and, despite high levels of mechanization, largely manual. With the technological flux of the 1980s, jobs for operators, for maintenance and repair workers (''fixers' '), and for supervisors have all changed. For instance, threads break far less often in spinning and weaving, so that operators now spend less time tying them back together-a task requiring dexterity and experience. Operators spend much more of their time monitoring automated equipment. Errors in such tasks as recording information and entering new instructions can have serious consequences; to minimize machine stoppages, operators must understand something of the production process and their place in it. Some companies

---

[1] Based on "Training and Competitiveness in U.S. Manufacturing and Services: Training Needs and Practices of Lead Firms in Textiles, Banking, Retailing, and Business Services," report prepared for OTA under contract No. L3-3560 by Lauren Benton, Thomas Bailey, Thierry Noyelle, and Thomas M. Stanback, Jr., Columbia University, February 1990, pp. 60-89. The productivity levels and market share figures in this box come from unpublished data of the American Textile Manufacturers Institute.

[2] For a complementary discussion focusing on apparel, especially in Europe, see Jonathan Zeitlin and Peter Totterdill, "Markets, Technology and Local Intervention: The Case of Clothing," *Reversing IndustrialDecline? Industrial Structure and Policy in Britain and Her Competitors*, Paul Hirst and Jonathan Zeitlin, eds. (Oxford, UK: Berg, 1989), pp. 155-190. In some apparel plants, each worker now has a keypad at his or her workstation for recording production flow information. Among other things, these systems automatically calculate each workers' pay on a piecework basis. Clive Cookson, "A Good Fit on the Factory Floor," *Financial Times*, June 6, 1990, p. 13.

are training operators to diagnose machine problems (e.g., stoppages) and enter a corresponding code from a multipage manual. They must use good sense in deciding when to call in a supervisor or fixer. They must also have the basic skills needed for looking up the codes and punching them in; if the plant is to run smoothly, operators must not only be able to diagnose equipment problems, but read and write-skills rarely needed in the old days. In some cases, even loom cleaners, who are among the lowest paid of mill workers, must be able to follow written instructions and punch numbers into a key pad.

In maintenance and repair, the balance has tipped still farther from manual toward mental skills. At one time, tinkering outside the workplace coupled with informal on-the-job training could suffice to earn a promotion from operator to fixer; lack of basic skills was no bar. Fixers could see how older machines worked; today, with invisible electronic logic replacing electro-mechanical controls, they need conceptual understanding. Textile firms are seeking graduates of 2-year associate degree programs, and increasing the formal training they give their technicians. Promotions of operators to the next level without formal training, once common, have become rare.

Upward Mobility

In earlier years, unskilled workers could enter the mills in service jobs (cleaning) or as laborers (unloading bales) and move upward through progressively more demanding positions. People with aptitude and interest could look forward to becoming operators, then fixers, perhaps eventually a supervisor. Most training was informal. Companies saw no need for a high school diploma. On-the-job experience would serve, whatever a person's formal education, given the unchanging nature of the work. These traditional job ladders have broken down. Most textile firms still post openings internally, and try to recruit from within, but they have had trouble finding enough qualified people internally to fill the growing need for fixers and technicians who can cope with the latest equipment.

Education and Training

The industry has trouble finding skilled workers in part because it is concentrated in the smaller cities and towns of the Southeast. Wages have always been low, and textile firms buffeted by cheap imports argue that they have little scope for raising them. The industry also seems trapped by its past practices of hiring unskilled, poorly educated workers. It now needs better educated employees, but can offer neither the image nor the wages nor the opportunities that would attract them.

Vocational schools and community colleges have been little help, in part because textile firms rarely tried to work with them in the past. Few community colleges have kept abreast of the industry's technical needs; students attend these schools in part to escape the mills. Of 75,000 students in 1985-86 taking technical courses in North Carolina community colleges, 5,000 were studying for occupations in demand in the textile industry, while 35,000 were preparing for office jobs in service industries.

Unable to hire from existing labor pools, textile firms have responded in three ways: 1) by seeking to improve basic skills in local labor pools, through participation in literacy programs and strengthened relationships with secondary schools; 2) through technical training, both internally and in conjunction with community colleges; and 3) by contracting for training provided by equipment manufacturers. Companies with workplace literacy programs have aggressively pursued funds from Federal and State programs. In South Carolina, for instance, the Governor's Initiative for Workforce Excellence has established literacy programs at several textile firms, including Milliken. The literacy initiative is playing a key role at Milliken's Kingstree, SC plant, which has installed 400 new weaving machines and begun reducing the number of job classifications from 38 to four. Employees must know three of the four new jobs to be promoted; an off-hours basic skills program helps them prepare.[3]

While community colleges rarely took the initiative in developing technical courses suited to the needs of the industry, they have been more responsive to firms asking for specialized programs; these help the schools attract students and justify State funding. Companies have also sent employees to training programs, typically several weeks long, offered by equipment manufacturers. Some firms have then used these courses as models for in-house training on other types of machinery.

New skill requirements caught most U.S. textile firms off guard. As companies discovered they could not recruit the workers they needed, they began turning to training. If these efforts-which remain in early stages-do not succeed, American textile firms stand to lose still more ground to imports.

---

[3] "Basic Skills Education in Business and Industry: Factors fOr Success Or Failure, " report prepared for OTA under contract No. L3-1765 by Paul V. Delker, January 1990, p. 41. On Milliken's overall labor force strategy, which includes reorganization around work groups, reductions in supervisory ranks, and tighter links with fewer suppliers, see "Pushing To Improve Quality, " *Research-Technology Management,* May-June 1990, pp. 19-22.

Table 3-4—Worker Training Compared

	United States	Germany	Japan	Korea	Canada
Primary and secondary schooling	Local control contributes to wide range in course offerings and quality	Excellent for those in academic high school; generally good for others	High quality; uniform curriculum; emphasis on rote learning	Strong core curriculum and basic skills emphasis evident in international test scores	Wide range in quality
School-to-work transition	Left mostly to chance; some employers have ties with *local* schools	Apprenticeship for most non-college-bound youth	Personal relationships between employers and local schools	Employers recruit from vocational and academic high schools	Left mostly to chance; apprenticeships available for some young people
Vocational education					
Extent	Available inmost urban areas	Near-universal availability	Limited; mostly assumed by employers	Widely available	Available in most urban areas
Quality	Wide range: poor to excellent	Uniformly good	Fair to good	Vocational high schools uniformly good	Wide range: poor to excellent
Adult education					
Extent	Moderate; community colleges offer widespread opportunities	Limited but growing	Widespread; self-study common	Limited	Widespread
Relationship to work	Relatively common	Nearly universal	Common	Common	Common
Employer-provided training					
Extent	Emphasis on managers and technicians	Widespread at entry level (apprenticeship) and to qualify for promotion	Widespread at all levels	Limited; employers rely on public vocational institutes	Limited[a]
Quality	Sometimes excellent, but more often weak or unstructured; many firms do not train	Very good	Very good	Generally poor	Not evaluated
Public policies	Federal role limited; State aid to employers growing	Governs apprenticeship; supports further training	Subsidies encourage training by small firms	Directive--some employers resist government policies	Limited, but growing; aid to trade association and union training efforts

[a]One estimate is that Canadian firms spend less than half as much per employee on formal training as do U.S. firms—*Success in the Works* (Ottawa, Ontario: Employment and Immigration Canada, April, 1989), p. 2.

SOURCE: Office of Technology Assessment, 1990.

training, but not nearly so strongly as in the United States.

In Japan, rigorous academic preparation coupled with extensive company training yields a highly qualified workforce. Firms and individuals absorb most of the costs of training. Stable, long-term employment relations, particularly in large corporations, mean that Japanese companies can invest in their workers with little fear of losing them. For employees, training is more than a means for advancement: in Japan, a host of subtle and not-so-subtle pressures encourage continuous, life-long learning.

Japanese and German managers embrace broad, ongoing training as a way to enhance productivity, quality, and competitiveness. Although the two countries rely on very different training systems, the net effect is much the same. Most workers have broad skills: they can do more than one job, and participate effectively in the ongoing search for better production methods. Because many U.S. employers fear they might lose skilled workers to another employer, or have to pay higher wages, company training is spotty (see ch. 5). In smaller firms, many employees receive no formal instruction; larger firms slant their training towards supervisors and managers. U.S. apprenticeship programs have been in decline (ch. 8), while other forms of vocational education and training have not picked up the slack. Although Japan's vocational education system is weak, pervasive employer-provided training makes up for this.

Germany: Apprenticeship as a Foundation

The strength of the German training system lies in its integration of training with education, in contrast to Japan, where schools and employers function independently to create a high-quality labor force. The vast majority of the German work force boasts formal training; 60 percent have completed an apprenticeship.[23] Today, these long-established programs have been reinforced with incentives for post-apprenticeship training.

The FRG Government works with trade associations and unions to define uniform national curricula and examinations for apprentices in over 400 occupations. Most apprenticeships last three years, combining on-the-job training (for a small wage) with at least 1 day per week of classroom instruction. Certification requires passage of written tests and demonstration of practical skills. Trade associations have always played a central role: beginning as a compulsory system of artisan guilds in the Middle Ages, Germany's apprenticeship system evolved into one jointly regulated by employers and government, ''with the changeable consent of the unions."[24]

All apprentices must attend Lander-supported vocational schools 1 day per week. The structure of the rest of the week depends on the firm. In large companies, apprentices spend much of their time in training centers, often licensed and partially funded by *Lander* governments; these supplement vocational school curricula.[25] Apprentices in smaller companies spend more time on the factory floor, often interspersed with periods of a few days to several weeks at area training centers supported roughly half and half by local chambers of commerce and the Federal Ministry of Education and Science.

Training beyond the apprenticeship has traditionally taken the form of night classes delivered by local trade associations; governmental bodies often pay the bills. Employees who pursue such opportunities, and pass the required tests, can win certification as a master craftworker. Among other things, this qualifies him or her for promotion to foreman. Workers normally attend these courses on their own time (in the United States, first-line supervisors often get their training on company time). In addition, many certified apprentices go back to school, graduating from vocational institutes or even

---

[23] *Berufsbildungsbericht* 1988 (Bonn: Federal Ministry of Education and Science). P. 64.

[24] Arndt Serge and Malcolm Warner, *Comparative Factory Organisation* (Brookfield, VT: Gower, 1986), P. 192.
Although apprenticeships have existed in Germanyforhundreds of years, they were not formalized and regulated until 1969. Two forces lay behind legislation passed at that time: 1) shortages of apprentices (young people had turned away from vocational training); and 2) labor union concern that apprentices were being exploited (working for low wages while learning relatively little). The 1969 law led to nationwide standards for each apprenticeable occupation specifying both the content of training, and testing following completion of the three-year program. The Federal Vocational Training Institute develops curricula in consolation with unions and trade associations.

[25] Anthony P. Carnevale arid Janet W. Johnston, *Training America: Strategies for the Nation* (Alexandria, VA: *American* Society for Training and Development and National Center on Education and the Economy, 1989), p. 27.
Germany's *Länder* correspond to our States.

Box 3-B—Impacts of the German Training System on Productivity and Competitiveness: Two Examples

Comparisons With British Industry[1]

A series of studies carried out by British investigators offers perhaps the most careful and comprehensive examination of the effects of training and skills on the performance of manufacturing firms ever undertaken. These studies demonstrate in striking fashion the impacts of the German training system on costs, productivity levels, and quality. Intended to help diagnose the competitive problems of British industry, the comparisons covered a set of quite different sectors: metalworking (45 companies producing small parts such as screws, springs, and drill bits); fitted kitchen furnishings (23 companies making such products as countertops and cabinets); and women's clothing (22 matched plants). The results demonstrate that German firms perform better than their British counterparts because of their better trained workers.

The average labor productivity in German metalworking firms was more than 60 percent greater than in the British sample. About half the shopfloor workers in the German metalworking companies had earned apprenticeship or similar qualifications, compared with one-quarter in Britain. German furniture-making firms were 50-60 percent more productive, and turned out higher quality goods. In every German furniture company sampled, 90 percent or more of the shopfloor workers had, as their minimum qualification, certification following 3 years of training; in none of the British firms did more than 10 percent of the employees have any formal qualification. Higher skill levels in the German apparel industry helped firms move into short runs of specialized, highquality clothing for export, while British firms continued to mass produce lower priced, standard goods for the domestic market. In the apparel sample, 80 percent of German maintenance workers had completed an apprenticeship program, while not a single British worker had earned any form of certification. Machinery breakdowns were far less frequent in the German plants.

Plant visits and surveys revealed no possible source for the differences except training. The British firms, for example, typically had comparable manufacturing equipment—indeed, had sometimes made heavier capital investments. But British workers and supervisors were unable to use their equipment as effectively.

Training in a German Machine Tool Firm[2]

When faced with stronger Japanese competition in the late 1970s, Scharmann, a machine tool manufacturer located near Dusseldorf, made worker training a central element in reshaping its corporate strategy. The firm decided to specialize in automated equipment for producing relatively large parts, rather than the standard tools emphasized by Japanese competitors. Scharmann won a major order from Caterpillar's Belgian factory in 1980, helping the company move in this new direction.

Scharmann was able to build on its own earlier experience. Like many machine tool builders, the company designs and fabricates much of its own production equipment. During the 1970s, the company had automated internally while trying to save on payroll costs by hiring unskilled workers (including several who had completed apprenticeships in unrelated fields like baking). When this effort failed, Scharmann decided to strengthen its apprenticeship program.

In the new program, a 16-year-old apprentice could expect to spend a day-and-a-half each week in one of Scharmann's own classrooms, another day at a nearby vocational school studying the principles of machine tools, plus 2 days at work in the company training center. After completion of the program, Scharmann sends selected workers to a technical college for 2 years of further study in industrial electronics. The company's unskilled work force has dropped from about 230 to fewer than 40 (of 800 total). Scharmann has been able to draw on its employee's

---

[1]This section summarizes the following articles, each from the noted issue of *National Institute Economic Review:* A. Daly, D.M.W.N. Hitchens and K. Wagner, "Productivity, Machinery and Skills in a Sample of British and German Manufacturing Plants," February 1985, pp. 48-61; Hilary Steedman and Karin Wagner, "A Second Look at Productivity, Machinery and Skills in Britain and Germany," November 1987, pp. 84-95; Hilary Steedman and Karin Wagner, "Productivity, Machinery and Skills: Clothing Manufacture in Britain and Germany," May, 1989, pp. 41-57. Also see the broader comparisons between British and German education/training practices likewise appearing in *National Institute Economic Review:* S J. Prais and Karin Wagner, "Some Practical Aspects of Human Capital Investment: Training Standards in Britain and Germany," August 1983, pp. 46-65; S.J. Prais and Karin Wagner, "Schooling Standards in England and Germany: Some Summary Comparisons Bearing on Economic Performance, ' May 1985, pp. 53-76; S.J. Prais, "Educating for Productivity: Comparisons of Japanese and English Schooling and Vocational Preparation" February 1987, pp. 40-56; and S.J. Prais and Karin Wagner, "Productivity and Management: The Training of Foremen in Britain and Germany," February 1988, pp. 34-47.

[2]Ira Magaziner and Mark Patinkin, *The Silent War (New* York: Random House, 1989), pp. 120-136.

new skills to make the steady, incremental improvements in work methods and production practices necessary to achieve its cost and quality targets.[3]

[3]Comparisons of British and German machine tool producers matched by size have shown that a broadly-skilled work force, capable of both programming and maintaining automated equipment, helps German firms compete more effectively *Comparative Factory Organization*, op. cit., footnote 24, p. 164.

universities. Among those who completed apprenticeships during the 1960's, nearly 20 percent have now either been certified as master craftworkers (9 percent) or graduated from a vocational institute or university (10 percent).

As international competition and the need for top-quality products has grown, more West German employers are offering on-the-job training, as well as paying for outside courses that may not be tied directly to certification as a master craftworker. Government support for such training has grown. At the same time, more German workers are enrolling in classes on their own time, sometimes at their own expense, sometimes with government assistance. For example, between 1980 and 1985,23 percent of employed adults took at least one job-related course (other than courses to become a master craftworker), an increase over the 1974-79 period, when 20 percent did so.

German employers view completion of an apprenticeship as evidence of motivation and willingness to learn. Nearly half (43 percent during the 1980s) of certified craftsworkers find themselves in occupations other than those for which they apprenticed, but they are nevertheless much less likely to experience unemployment than unskilled workers.[26] Although a substantial fraction of apprentices leave the firm in which they train, nearly 80 percent of all firms with at least 20 employees participate in apprenticeship programs.[27] Growing numbers Of German workers have also been participating in less traditional forms of continuing education and training-e.g., short courses in data processing, or sales and management.

Box 3-B summarizes an extensive series of comparisons between training and measures of costs, productivity, and competitiveness in German and British industry, as well as outlining changes in employment and training practices in a medium-sized German machine tool firm. The German-British comparisons demonstrate in convincing detail the shopfloor benefits that German manufacturing firms get from better trained workers.

Japan: Training Integrated With Work[28]

Employer-provided training in Japan contrasts sharply with that in the United States: large Japanese fins, and many smaller ones as well, pursue training with unmatched zeal. Managers and supervisors deliver much of the training-an approach that has paid substantial dividends by integrating ongoing learning into corporate cultures.

Japanese firms provide extensive training for both new recruits and seasoned hands. After hiring in, blue-collar workers in larger firms typically begin with a week or so in an off-the-job motivational program. These programs are intended to impart not only the essentials of their employer's history, organizational structure, and product lines, but its culture and "philosophy' '-based, in many cases, on the thoughts of the original founder. Employees then rotate through several jobs, a few days at a time, so they can develop a broad view of the company's business. During this period, they get systematic on-the-job instruction, commonly making use of training manuals prepared by supervisors or by a work group (e.g., as part of quality circle activities). After a few weeks, each recruit is assigned to a group, beginning with simpler tasks under the supervision of an experienced employee.

Production workers as well as managers are taught to embrace the concept of continuous improvement *(kaizen)* and hence continuous learning as a foundation for economic success. Quasi-public

[26]*Berufsbildungsbericht 1988*, op. cit., footnote *3, p. 65.

[27]*Zur Finanzierung der Berufsausbildung* (Bonn: Kuratorium der deutschen Wirtschaft fuer Berufsbildung, 1985), p. 4. This was the percentage in 1983.

[28]This section is based on "Employee Training in Japan," report prepared for OTA under contract No. L3-4335 by David Cairncross and Ronald Dore, March 1990.

industry bodies, such as the Japan Management Association and the Japanese Efficiency Association, have provided training to blue-collar workers since the 1950s; in recent years, they have offered courses for managers as well. With the recent rapid expansion of foreign direct investment by Japanese firms, many companies (40 percent according to one survey) now provide language training, not only to managers and sales staff, but to technicians and other skilled workers. Increasingly, such employees may not only be asked to respond to technical inquiries from overseas but be sent abroad temporarily (e.g., to aid in new plant startups, or train foreign workers).

The distinctive Japanese approach to training is relatively recent. Following a period of conflict after the Second World War, industry and labor reached an accommodation. The mostly male core employees of large firms, especially skilled workers and supervisors, won the benefits of 'lifetime' employment (and systematic training) in return for an end to labor strife. Although lifetime employment is by no means universal for Japanese workers, the precedents and practices set by the largest firms strongly influence employment and training practices throughout the economy.

American experts helped establish the Japan Productivity Center and the Japan Industrial Training Association to meet growing training needs, especially in smaller firms. The initial focus on training supervisors as instructors helped shape the practice of integrated on-the-job training that has proven so successful. As with Japan's adoption of quality control practices pioneered in the United States, these postwar training efforts frost borrowed U.S. practices, then refined and extended them.

Smaller Japanese firms sometimes benefit from assistance that large corporations provide to associations of frost-tier suppliers.[29] For example, each of the three largest construction companies in Osaka has helped its leading subcontractors establish a local training center. Government grants also channel financing to these training centers. Finally, small firms in Japan often pool training resources through producers' cooperatives.

Training in Japan tends to be structured in terms of content, although delivered by managers and supervisors rather than specialists-both on the shopfloor and during the day or two per year that employees typically spend in a classroom setting. Their role as trainer helps managers stay in touch with the shopfloor and keep workers informed of company plans. It is no surprise that Japanese managers have more confidence in the usefulness of training than their U.S. counterparts. Moreover, the benefit/cost ratio is higher in Japan because so much training takes place on the job with little loss of working time. Employees quickly grasp the connections between new skills and their everyday work. And, as noted in chapter 1 (see box l-B), many Japanese workers get more hours of training than their American counterparts. Not only is training in Japan more effective, there is more of it.

Vocational Credentials and Status

Other countries also work harder than the United States to maintain the quality of vocational education programs, seeking to keep them attuned to the needs of the labor market and to overcome widespread biases in favor of academic education. For example, Germany, South Korea, and to a lesser extent Japan, use skill certification as an incentive and symbol of achievement. The governments of Japan and Korea also support young people who participate in skills competitions (box 3-C).

Unrealistic attitudes and overemphasis on college help explain the disappointing record of high school vocational education programs in the United States (see ch. 8). Although post-secondary vocational education has a somewhat better track record, many graduates of such programs find their newly acquired skills ill-suited to the job market. Germany, in contrast, has been quite successful in creating and maintaining respect for blue- and grey-collar work: the concept of vocation is deeply ingrained, the link between formal qualifications and occupational status far stronger than in most countries. After 10 years of schooling, as required by law, about 90 percent of West Germans continue in some sort of formal education/training program-either an apprenticeship (three-quarters of the 90 percent who continue), an academic high school in preparation for university (20 percent), or a vocational high

[29] One-quarter of small- and medium-sized manufacturing firms responding to a 1984 survey reported that an affiliated parent firm had helped them with training. "New Technology Acquisition in Small Japanese Enterprises: Government Assistance and Private Initiative," report prepared for OTA under contract No. J3-4950 by D.H. Whittaker, May 1989, p. 23.

Box 3-C—National and International Skills Competitions

In 1950, Spain initiated the International Vocational Training Competition (called the International Youth Skill Olympics, or IYSO, in the United States). Entrants, who must be under age 23, compete biannually in areas ranging from welding to graphic design. In 1989, more than 400 people from 21 countries participated.

From 1975, when a U.S. team first entered, until 1983, the Americans finished last. Teams from South Korea, Japan, and Taiwan earned the highest scores, while European countries with apprenticeship systems also did well. By 1985, a U.S. team reached the middle rank.[1]

IYSO results mirror government policies for the support of vocational education and training. Japan, Korea, and Taiwan, among others, support national and international skills competitions to help encourage young people to enter skilled trades. In each of these countries, a government training agency sponsors the IYSO team; American entrants have been sponsored by the Vocational Industrial Clubs of America, a private nonprofit group. In other countries, government training agencies coach the contestants, sometimes provide living allowances, and may provide cash prizes to winners at local, national, and international levels. Korea, for example, uses money from a payroll levy both to support public vocational institutes (as discussed later in the chapter) and to provide substantial cash awards to winners of national and international skill Olympics.[2]

---

[1]The American team finished 11th among 18 competing nations in 1985, 13th out of 19 three years later, and 13th of 21 in 1989. "International Youth Skill Olympics Fact Sheet," Vocational Industrial Clubs of America, January 1990.

[2]Winners at the national level get about $9,200, and are automatically certified as "Class II" craftsmen. Those who win in the IYSO contest get a sum twice as large, plus exemption from military duty, special housing privileges, and scholarships. The Korean Government also gives winners seed money for starting their own businesses, Although these rewards may not have changed the views of Korean parents and students, who place high values on a college education, they have undoubtedly spurred on the teams that have won seveIYSO competitions. See "Training of Private Sector Employees in South Korea," report prepared for OTA under contract No. L3-4180 by Joe W. Lee and Youngho Lee, March 1990, p. 90. (Most of the information on Korea elsewhere in the chapter comes from this report.)

school (the remaining 5 percent). Skill certification helps encourage young people to prepare for occupations ranging from bartender to machinist to office assistant.

In Japan, many more young people—some 95 percent—go onto an academic high school than in Germany. Of the 90 percent that graduate, two-thirds attend an academic or vocational post-secondary institution; the others enter the labor market immediately. Vocational credentials get less emphasis than in Germany, although Japan's Ministry of Labor (MOL) established a national testing system in 1959, declaring its intent to "raise the social status of blue-collar workers by giving public recognition to the skill level which they have achieved. "[30] The MOL administers examinations covering 130 occupational skills, with industry bearing most of the testing costs. In addition, the Ministry of International Trade and Industry oversees a special set of tests for skills needed in the electronics industry. Many firms have also created internal certification procedures as incentives for their employees. Japan's testing and certification standards tend to be much more specialized than those in Germany, and ongoing informal evaluations by supervisors carry more weight within a company than formal qualifications.

Other Examples: South Korea and Sweden

Like a number of developing Asian nations, Korea has made education and training a central element in economic planning. Over the past 20 years, 3-year vocational high schools and l-year training institutes, established under government auspices, have helped train some 2.4 million workers, half of Korea's current workforce (about 60 percent of whom are high school graduates).

Korean training practices draw on the German example. As in Germany, the Korean Government has sought to counter bias against occupational rather than academic skills through testing and certification programs, and by requiring government bodies at both local and national levels to preferentially hire workers with such credentials. Even more than in the FRG, training in Korea has been driven by government policies. Companies have often been reluctant partners, although it seems plain that the remarkable performance of the Korean economy—where labor productivity has grown at an average

[30]Cited in "Employee Training in Japan," op. cit., footnote 28, p. 28.

Photo *credit: National Training Fund, Sheet Metal and Air Conditioning Industry*

Student practicing flame cutting.

rate of 10-12 percent annually and exports at 25-30 percent-owes much to education and training.

In Sweden, as in most countries with well-developed training systems, high-quality general education provides the foundation. Vocational preparation in Sweden bears the stamp of the country's strong trade unions, closely allied with the Social Democratic party. Swedish unions have traditionally opposed apprenticeships in private companies, fearing that employers will stress narrow job- and firm-specific skills. Instead, Sweden relies heavily on school-based vocational education through "integrated upper secondary schools' that provide both liberal arts and vocational courses.The government has recently added a third year to the vocational track, during which students spend at least half their time in on-the-job training.[31] About 55 percent of Swedish young people graduate from high school with a vocational specialty, after which they can expect extensive on-the-job training and easy access to adult education.

Educational Preparation

It is no news that education in the United States compares poorly with a number of our economic rivals-a sad irony given the historic U.S. commitment to free and universal schooling. Although the schooling system helped support industrialization during an earlier era, the United States has fallen behind during the last several decades. The most dramatic evidence comes from international comparisons on standardized tests (table 3-5). Not only did American 13-year-olds rank near the bottom in the latest such comparison, but if Japanese and Taiwanese students had been included, U.S. performance would no doubt have looked even worse. Other tests have shown similar results, with widening gaps between the performance of U.S. and foreign students as grade levels increase.[32]

Today, the best American high schools continue to graduate students well-prepared for elite colleges and professional careers. Many others offer a decent education to students with the initiative to take advantage of it. But the quality of instruction varies greatly across the Nation, and American schools, generally speaking, do a poor job of serving average and below-average students. This hurts not only the people who find themselves entering adulthood lacking basic skills and the willingness to work and to learn but the competitive ability of U.S. industry. Japan offers a sharp contrast, with a tightly controlled nationwide curriculum completed by most young people. While the regimented Japanese educational system has its own dark side, the bottom half of Japan's labor force maybe the best qualified in the world.

Compensating in part for weaknesses in primary and secondary schooling, and in employer-provided training, the United States can claim a well-developed system of adult education. Enrollments have grown from 8 percent of all adult Americans as

[31] The schools, not the companies, control the content of this on-the-job training. "Working Classes," *The Economist, Nov. 12, 1988,* p. 18.

[32] Students in other countries might get higher average scores in thehighergrades if poorer students are selected out for early exits into the labor market. However, Americans test poorly even in the primary grades. For instance, gaps in performance between American, Japanese, and Taiwanese children in reading and mathematics have been found to grow between the first and fifth grades. Harold W. Stevenson et al., "Mathematics Achievement of Chinese, Japanese, and American Children,' *Science,* Feb. 14, 1986, pp. 693-699. In mathematics and science tests conducted by the International Association for the Evaluation of Educational Achievement(IAEEA) between 1983 and 1986, the relative rank of U.S. students fell, from low at ages 10 and 14, to almost always the lowest at age 17. Kenneth Redd and Wayne Riddle, "ComparativeEducation: Statistics on Education in the United States and Selected Foreign Nations," Congressional Research Service, November 1988, pp. 54,57,59. In thIAEEA tests, Japanese students were at or near the top in both age groupings.

Table 3-5-Rank Ordering in Mathematics and Science Tests at Age 13[a]

Mathematics	Science
South Korea (568)	South Korea (550)
Spain (51 2)	United Kingdom (520)
United Kingdom (510)	Spain (504)
Ireland (504)	United States (479)
United States (474)	Ireland (469)

[a]By average score (in parentheses) on the International Assessment of Mathematics and Science, administered during 1988 by the Educational Testing Service to random samples of about 1,000 students in each country (from both public and private schools). In addition to the countries listed, the tests were given in four Canadian provinces; because no aggregate results for Canada are available, that country has been omitted from the table.

SOURCE: A.E. Lapointe, N.A. Mead, and G.W. Phillips, *A World of Differences: An International Assessment of Mathematics and Science* (Princeton, NJ: Educational Testing Service, 1989).

long ago as 1957, to 14 percent in 1984.[33] Still, some nations show up better. Canada, for example, estimates that a quarter of employed people overage 17 participated in adult education during 1983 (the latest available year); nearly half of those surveyed were enrolled in job-related courses, with nearly half of those courses provided by employers.[34]

Germany has an extensive system of adult education, offering advanced technical courses at convenient times and often at no out-of-pocket cost to the worker. And given the near-reverential view so many Japanese have of education, it is no surprise to find widespread and effective adult education in that country. Many Japanese companies encourage or require employees to take courses in off hours, while the government pays firms that help their employees with the costs. Nihon Denso, like many other larger companies, also pays its employees a small stipend (about two-thirds of the minimum wage) for the time they spend on home study or in off-site classes. Correspondence schools cover subjects from steelmaking to bookkeeping. Given that self-study is widely valued throughout their society, many Japanese need little encouragement from employers.

Government Policies

Policy choices underlie many of the contrasts summarized in table 3-4 and discussed above. In the United States, the Federal Government rarely seeks to influence company training or to support training directly. In Germany, however, a partnership of employer associations, labor unions, and Federal, *Lander,* and local governments designs, delivers, and pays for apprenticeship, and increasingly, further training. Area training centers, funded equally by the Federal Government and local chambers of commerce, provide short courses for certified craftworkers as well as apprentices. They house training advisors who work directly with companies to design and deliver both apprenticeship and upgrade training programs. In addition, some firms and workers receive direct subsidies for training from a Federal payroll tax levy. The FRG also encourages firms to provide advanced programs through direct subsidies, technical assistance, and regulations.

In recent years, Japanese policies have shifted from their earlier focus on pre-employment training to emphasize upgrading the skills of employed workers. For example, many of the Skill Training Centers that once trained young people as craft workers now function as schools offering short courses for employees of nearby firms. Government bodies at both national and prefectural (local) levels channel payments to individuals, companies, and industry groups (such as the associations of first-tier suppliers mentioned earlier). To be eligible for MOL funds, companies must first submit an Enterprise Skill Development Plan. Smaller firms qualify for larger subsidies-e.g., half the cost of hiring teachers and purchasing in-house training materials, versus one-third for bigger companies. In total, Japan's prefectures spend about two-thirds as much on training as the MOL, supporting vocational colleges, skill development and training centers, and testing and certification programs.

Other governments have also looked to industry and trade associations for delivery of training, especially to smaller fins. Canada and Australia provide technical assistance for identifying training needs and designing training programs for groups set up jointly by unions and trade associations. Korea offers a package of incentives-including construction financing, low-cost land, subsidies for instructors' salaries, and free training equipment-to or-

[33]Susan T. Hill, *Trends* in Adult *Education 1969-1984* (Washington, DC: Department of Education, Center for Education Statistics, 1987), pp. 6-7. These are the most recent data available, gathered as part of the May 1984 Current Population Survey. The 1957 data from Ivan Charner and Bryna Shore Fraser, "Access and Barriers to Adult Education and Training," report prepared for OTA undercontract, 1986, p. 46.

[34]M.S. Devereaux, *One i. Every Five: A Survey of Adult* Education in *Canada*, (Ottawa: Statistics Carom and the Department Of the Secretary Of State, 1984), table 7, p. 18. (Somewhat lower participation by men tban women evidently accounts for the title of this publication.)

ganizations such as the Korea Machinery Industry Association.

Payroll-Based Levies

West Germany and a number of other countries tax payrolls to help pay for training. The FRG's 4-percent payroll tax-half charged to the company, half to the employee-goes to the Federal Employment Institute. Most of the Institute's budget provides income support for unemployed workers, but about 15 percent is spent on three types of training: 1) post-apprenticeship programs; 2) training in new technologies; and 3) retraining of unemployed workers. Most payments go to workers individually.

On launching its program of support for further training in 1969, the West German Government expected that most funds from the levy would be used to help firms retrain employed workers to use new technology and meet growing international competition. However, as long-term unemployment has grown and persisted, a growing fraction of the money has been targeted to displaced workers—during 1988 and 1989, over half (55 percent) of the participants were unemployed. Many of the employed participants are studying for certification as master craftworkers, while others are enrolled in on-the-job training. In addition to the payroll levy, the German Government supports the area training centers discussed above. Another source of government assistance is the *Lander,* which provide tuition aid to some workers for outside courses. Some *Lander* now require firms to give employees 1 or 2 weeks per year of paid ''training leave' to attend outside seminars.

In France, Korea, and several other countries, payroll taxes are used to encourage company training: if a fro's training expenditures equal or exceed the levy, no payment is required, French companies employing 10 or more workers must devote 1.2 percent of their payroll costs to employee training.[35] (Another 0.5 percent is collected for apprenticeship training.) Firms can meet this ''obligation to spend' by providing training themselves, by contracting with outside providers, or by joining in a multifirm training fund. Government has little control over what is taught or who is selected for training; some French companies take these programs much more seriously than others.

Korea requires all firms with over 300 employees to either spend a certain percentage of payroll (varying with industry sector and firm size) for training or pay a tax. Most of the tax money goes to support the extensive system of public vocational training institutes that provide a year of pre-employment training for young people. In part because of stringent requirements on the type and amount of training necessary to avoid the levy, and in part because it was originally quite low, most Korean companies simply paid the tax, whether or not they provided any training. In the 1980s, with Korea's first wave of industrialization completed and the economy beginning to shift from labor-intensive industries such as textiles towards those requiring higher skills, the government passed new legislation. Current law makes it easier for companies to satisfy the government's requirements, while raising the levy substantially. As a result, many more Korean fins, including smaller enterprises, have established in-house training programs complying with government standards. Funds raised through the levy help pay for cooperative training programs involving companies and the public training institutes. In these programs, entering 15-year-olds get 3 years of training and must then spend 4 years working for the participating firm-a "dual system' modeled on German apprenticeships.

Older Workers

Among the major industrial nations, only the United States and Japan have implemented employment and training policies specifically for older workers.[36] Evaluations of U.S. programs funded under the Older Americans Act and the Job Training Partnership Act indicate that they have been suc-

---

[35] Olivier Bertrand, "Employment and Education Statistics in the Service Sector in France," report prepared for the Organisation for Economic Cooperation and Development July 1988.

Companies can include the wages of those in training as part of the required expenditures, which were set at 1.1 percent of payrolls until 1987. Any company spending less than the current 1.2 percent requirement is supposed to pay the difference to the treasury, but most firms report spending more. Indeed, the government's figures show that payroll percentages devoted ttraining have increased steadily since since the law was passed in 1971, and now exceed 2.5 percent of payrolls. (For 1987, 2.5 percent of French payrolls would be equivalent to about $4.3 billion.)

[36] Canada's government does fund *a* National Labor Market Innovations Program that supports pilot programs fOr training and employing older workers. Mary Trueman, "Training of Older Workers in Canada,' ILO discussion paper, International Labour Office, Geneva, May 1989.

cessful in placing older workers in jobs.[37] Nonetheless, most American firms have been reluctant to train older workers, nor do Federal programs encourage them to. The aging of the U.S. labor force will no doubt force both corporate officials and government policymakers to pay more attention to these issues over the next decade or two (see ch. 8).

In Japan, the government has urged firms to continue training their older employees, providing special subsidies for companies that train workers aged 45 and up.[38] These and other measures are intended to encourage large Japanese companies to offer training as part of life-long career development plans, rather than "farming out" middle-aged workers at lower pay to subsidiaries.

Lessons From Abroad

In Germany, widespread participation by companies, government bodies, and labor unions has kept the training system responsive to shifting demands for skills. Both business and labor have a stake in the system; both understand the need to adapt to ongoing changes in technology and international competition.

Japan's experience shows that comprehensive training need not carry a high price tag. If American firms embedded training in day-to-day operations like Japanese firms, using frost-line supervisors as instructors, some would find they spent less on training than they do now (once they had trained their supervisors). But such an approach, by itself, would not be enough. As many Japanese firms have discovered, automation means that on-the-job training must be supplemented with classroom instruction to develop the broader and deeper skills needed by those who work with the new equipment. Despite such limitations, the Japanese approach suggests that many American firms could benefit from structured, on-the-job training as part of the daily routine for supervisors and shopfloor workers.

In addition, the payroll levies adopted by a number of countries show that such policies can spur increases in employer-provided training. But these levies also have limitations. Korean companies viewed the original requirements as onerous; few complied, preferring simply to pay the tax. In France, on the other hand, government allows companies a great deal of latitude, with the result that some "training" consists of junkets for top management.

CONCLUDING REMARKS

High levels of mobility in the U.S. labor market, driven by both supply (people seeking new or better jobs) and demand (new companies, established enterprises seeking new workers), create continuing needs for training. At a minimum, newly hired employees need an introduction to the workplace what the job requires, how the company views task assignments and responsibilities. Over and above these routine activities, new workplace technologies and new organizational practices entail training or retraining. Finally, American companies increasingly find they must provide some basic skills training, in addition to instruction in particular tasks. In their efforts to cut costs, improve quality, and enhance flexibility, companies are also relying on training to help motivate employees.

Most of the new jobs created in the U.S. economy over the next several decades will be in the services; relatively few service products trade internationally. Small firms will create more jobs than large fins; few small companies face direct international competition, regardless of whether their products are goods or services. Even so, the link between skills and competitiveness is a vital one. Each and every industry counts, regardless of whether firms in that industry are exposed to international competition. The need for training and retraining is pervasive; it is not just a matter of meeting the needs of growing sectors, growing occupations, or sectors beset by international competition.

Under intense pressure, often from imports, to improve quality while at the same time lowering costs, many American companies are reevaluating the ways in which work gets done, making sweeping changes in workplace organization. Together with shifts in consumer preferences and in markets for producer goods and services, the pressures have already led to substantial restructuring in U.S. industry. Like labor market churning, these changes

[37]Harold L. Sheppard and Sara E. Rix, "Training of Older Workers in the United States," ILO discussion paper No. 31, International Labour Office, Geneva, 1989.

[38]Masako M. @&o, Training *of Older Workers in Japan* (Geneva: International Labour office, 1989).

—the subject of the next chapter—add to the demand for training.

Better training cannot but help in rebuilding U.S. competitiveness. Indeed, it is one of the essential steps. Training has proven central in aggressive corporate strategies stressing quality, flexibility, and customer service, as well as cost and price. Dispersed computing power for automating the back offices of banks places new demands on workers, just like computers for managing the flow of production in a textile mill. Management style is at least as important as worker training itself in responding to these demands: when a firm reorganizes production, it will probably need to retrain supervisors along with shopfloor workers. In larger U.S. corporations, particularly multinationals, high-level executives increasingly see continuous training as a necessary investment for competitive survival-on a par with investments in plant and equipment.

Even so, it remains true that German and Japanese firms are more likely to view training as an investment, U.S. firms to see it as a cost. And more than ever before, the international economy pits American workers against those in other countries. If the U.S. labor force fares poorly in this head-to-head competition, American living standards will suffer. Unemployment levels may rise, particularly among the disadvantaged. American companies can move operations abroad. Few American workers have such alternatives.

APPENDIX 3-A—THE CHANGING STRUCTURE OF U.S. EMPLOYMENT

The U.S. economy will continue to create large numbers of low-skilled jobs in the future, but the most rapid rates of growth will be in occupations calling for higher skill levels. This expected pattern of occupational expansion does not match up neatly with projected labor force growth.

During the 1990s, nearly 3 in every 10 new workers will be a member of a racial/ethnic minority (table 3A-l). One in four of all new workers may well be an immigrant. Both these groups, which of course overlap, have historically fared relatively poorly in the competition for high-paying, high-skilled jobs.

According to BLS projections, nearly all the net new jobs created over the rest of the century will be in service industries, which will soon account for nearly 80 percent of nonfarm employment (table 3A-2). Of these new jobs, somewhat more than half will be in the knowledge-based services, where health care will account for the greatest number. Most of the rest will be in the tertiary (or traditional) services, with retailing making a major contribution.

Table 3A-l—Projected Labor Force Shifts, 1988-2000a

	Number in the labor force (millions)		
	1988	2000	Change, 1988-2000b
All workers	121.7	141.1	19.5
Aged 16-24	22.5	22.5	—
Aged 25-54	84.0	101.3	17.2
Aged 55 and over	15.1	17.4	2.3
Women, all	54.7	66.8	12.1
Blacks, all	13.2	16.5	3.1
Hispanics, all	9.0	14.3	5.3
Asians and other minorities, all	3.7	5.7	1.9

[a]BLS moderate growth scenario.
[b]May not equal difference of first two columns because of rounding.

SOURCE: Howard N. Fullerton, Jr., "New Labor Force Projections, Spanning 1988 to 2000," *Monthly Labor Review,* November 1989, table 1, p. 4, and table 7, p. 11.

Jobs created in both the knowledge-based and tertiary services will range broadly in skill requirements and pay scales. Health service occupations include housekeepers as well as nurses and physicians; likewise, financial service occupations range from clerks and tellers to loan officers and investment bankers. In the tertiary services, too, the range in occupational skills is broad. But here a much greater fraction of new jobs will be low-skilled and low-paying, the chief exceptions being managers and technical specialists (e.g., computer system analysts working for retail chains). Thus it is the ***distribution*** of occupational skills that distinguishes knowledge-based from tertiary (or traditional) services: the knowledge-based sector creates high-skilled jobs in substantially higher proportions. This sector includes law and accounting firms, hospitals, and private schools; the tertiary services include barber shops, funeral parlors, and movie theaters.

Table 3A-3 summarizes the job creation picture by occupation rather than sector. This table, listing the 10 occupations with the greatest expected increase in jobs, again highlights the extent to which the U.S. economy will continue creating low-skilled positions in stores, offices, and hospitals. Of the occupational categories in which large numbers of new job opportunities will exist, only two-nurses and managers—normally require post-high school credentials for entry. The other eight range in skill requirements from the personal and technical skills

Table 3A-2—Employment Growth by Sector, 1988-2000"

	Net job creation (thousands)
Total	**18,100**
Sector 1, Agriculture and Mining	**-280**
Sector II, Traditional Industries	**370**
Construction	760
Manufacturing, except knowledge-intensive (below)	-390
Sector III, Knowledge-Intensive Manufacturing [b]	**70**
Sector IV, Knowledge-based Services	**9,620**
Health	3,080
Business services	2,740
Education	1,200
Professional services (legal, engineering, accounting, etc.)	810
Financial services (banking, credit, securities)	650
Government not included elsewhere	620
Insurance	300
Real Estate	130
Communications media	90
Sector V, Tertiary Services	**8,250**
Retail trade	3,770
Personal services	1,870
Wholesale trade	910
Transportation and public utilities	660
Lodging	410
Other tertiary services[c]	640

NOTE: Subtotals may not add because of rounding.

[a]For this table, the BLS moderate growth projections have been recast into five broad sectors following the rationale discussed in *International Competition in Services,* OTA-ITE-328 (Washington, DC: U.S. Government Printing Office, July 1987), pp. 228-230.
[b]Includes electrical, electronic, and communication equipment (except for household appliances and electric lighting), instruments and related equipment, office and computing machines, printing and publishing equipment.
[c]Includes postal workers.
SOURCE: Projections summarized in Valerie A. Personick, "Industry Output and Employment: A Slower Trend for the Nineties," *Month/y Labor Review,* November 1989, table 6, pp. 34-38.

Table 3A-3—Occupations With Greatest Number of New Jobs, 1988-2000[a]

	Net increase in jobs (thousands)	(percent growth)
Retail salespersons	730	19%
Registered nurses	610	39
Custodial workers	560	19
Waiters and waitresses	550	31
Managers	480	16
Office clerks	460	18
Secretaries [b]	380	13
Nursing aides and attendants	380	32
Truck drivers	370	15
Receptionists and information clerks	330	40

[a]BLS moderate growth scenario.
[b]Excludes legal and medical secretaries.

SOURCE: George Silvestri and John Lukasiewicz, "Projections of Occupational Employment, 1988-2000," *Monthly Labor Review, November 1989, table 6, p. 60.*

Table 3A-4—Fastest Growing Occupations, 1988-2000"

	Net increase in jobs (thousands)	(percent growth)
Paralegals	62	7570
Medical assistants	104	70
Home health aides	160	68
Radiological technologists and technicians	87	66
Data processing equipment repairers	44	61
Medical records technicians	28	60
Medical secretaries	120	58
Physical therapists	39	57
Surgical technologists	20	56
Operations research analysts	30	55

[a]BLS moderate growth scenario.

SOURCE: George Silvestri and John Lukasiewicz, "Projections of Occupational Employment, 1988-2000," *Month/y Labor Review, November 1989, table 6, p. 60.*

expected of secretaries and other office workers, to the minimal (but perhaps rising) levels needed for custodial work.

A rather different picture emerges from a listing of the 10 occupations expected to grow most rapidly (table 3A-4). The totals are smaller than those in table 3A-3, despite much higher rates of expansion. Every one of the occupations listed in table 3A-4, 7 of 10 of which are health-related, will require credentials of some sort for entry, generally from a formal education or training program. Moreover, training will be more demanding in terms of task-specific technical skills than for most of the occupations listed in table 3A-3. Rapidly growing occupations like those listed in table 3A-4 are the ones most likely to see labor shortages. These are the kinds of jobs for which people who lack basic skills will be unable to qualify (they will not even qualify to enter training programs). The mismatch between jobs and skills will be most acute in such occupations, and in the economic sectors that depend on them.

Chapter 4

Technological and Organizational Change: Implications for Training

CONTENTS

Boxes

Figures

Tables

Chapter 4
Technological and Organizational Change: Implications for Training

SUMMARY

When surveyed in mid-1990, half of a group of 401 U.S. firms reported that poor worker skills and motivation hurt their ability to deliver high-quality goods and services.[1] To improve employee morale and create positive attitudes toward quality and customer service, companies are reorganizing their workplaces—for instance, by introducing multi-skilled work groups with self-management responsibility. This trend, together with a second—the spread of decentralized computing-is reshaping the American workplace. To function effectively in the new environment, employees need adequate basic skills, competence in interpersonal relations and communication, and a relatively broad range of task-specific skills.

Computers and related information processing technologies accounted for nearly half of U.S. spending on capital equipment in 1989.[2] As PCs, terminals, and keypads appear on more and more desks and work stations, employees must be able to read from them, enter data, interpret prompts, help screens, and job aids. In automobile plants and textile mills, banks and department stores, more employees will be expected to make decisions and take action on their own initiative.

Some of these people will need relatively advanced technical skills-for weighing alternative production schedules, debugging programs for numerically controlled machine tools, or distinguishing between faulty instrument readings and a production process that has gone out of control. Others will have to take greater responsibility for their work: for inspection and quality control; for routine maintenance, simple troubleshooting, and ad hoc problem solving; for dealing with other departments, and perhaps with customers.

These skills can be hard to transmit, harder to evaluate. It becomes more difficult to trace success or failure on the shop floor or in the back office of a bank to particular individuals. But these are the skills that U.S. industry will need in order to be competitive. Not all employees must have them, but the direction of change seems clear: mental skills increasingly stand alongside manual skills, sometimes replace them; more jobs will require good social skills, not only because of the greater importance of working in groups, but because of the growth of service jobs that place employees in contact with customers.

Although changing workplace practices have been heavily publicized, some firms continue to pay more attention to investments in capital equipment than to investments in human capital and organizational restructuring. Nothing illustrates this better than the failure of General Motors (GM) to benefit more substantially from its investments in plant and equipment during the 1980s (table 4-l). While many other factors influenced the productivity figures shown in the table, ranging from labor relations to product mix and designs suited for efficient manufacturing, the simple fact is that GM was unable to utilize its plant and equipment as effectively as its competitors, for reasons that more than likely lie in organization and management of production.

[1] "Higher Wages Not Major Factor Holding Back U.S. Competitiveness, Business Survey Finds," *International Trade Reporter,* July 11, 1990, p. 1077. Seventy percent of these companies, surveyed by the Gallup organization, had more than 500 employees.
In another survey, managers rated employee training and motivation as the most important factor for improving the competitiveness of U.S. manufacturing. At the same time, their responses to other questions revealed that many, particularly in small and medium-sized firms, had no more than a hazy idea of how to go about improving either training or motivation. This survey, conducted by Ernst & Young, is summarized in Lawrence T. Michaels, "Priorities for Obtaining Competitive Advantage through Manufacturing," paper presented at Autofact '89 Conference& Exposition Detroit, MI, Oct. 30-Nov. 2, 1989.

[2] *Dun & Bradstreet Comments on the Economy,* April/May 1990, p. 2.

Table 4-I —Investment by U.S. Automobile Producers and Productivity Improvement, 1979-89

	General Motors	Ford	Chrysler
Investment in plant and equipment (billions of dollars)	$72.6'	$41.2	$22.5
Investment per vehicle produced	$920"	$680	$1,090
Change in labor productivity:			
Engines	-13%	43%	9%
Stamping	14	45	30
Vehicle assembly	5	31	19

a,979-1988.
SOURCES: Investment-annual reports. Productivity-Bruce Beier and Mary Gearhart, "Productivity Vs. Profit Sharing," *Automotive Industries,* April 1990, pp. 53-56, based on *The Harbour Report: A Decade Later.*

In fact, few of the trends outlined in this chapter have as yet penetrated very deeply into U.S. industry.[3] Some American firms have moved decisively to implement new forms of work organization. Others are experimenting with statistical process control (SPC) or just-in-time (JIT) production without understanding that these are techniques for aiding in reorganization as much as ends in themselves.

Some of the new practices had earlier been exported from the United States to Japan (SPC is perhaps the best known example). In emulating these and other features of Japanese production systems, American firms are not only chasing moving targets with no assurance of catching up, they are, in some cases, adopting features selectively—and hoping that a system with only some of the parts in place will function acceptably.

The striking contrasts between U.S. and Japanese production systems lie, not in the equipment on the factory floor, but in how companies manage and train their people, allocate tasks to individuals, to work groups, and to automated machinery. Most Japanese managers realize that training must be an integral part of strategies for automation. Most American managers do not. When managers treat their workforce as an adjunct to "technology," as many still do, they fail to capitalize on employee skills, to reap the rewards that can come from blue-collar innovation (alongside the white-collar innovation that comes from technical and professional workers).

How far will the new practices outlined in this chapter eventually spread? The limits will be tested when restructuring bumps up against adversarial traditions of labor-management relations. In Japan, labor is weak, the workforce docile; management techniques that would be viewed as coercive in the United States have been common. On the other hand, the no-layoff policies of Japan's large corporations provide a level of employment security seldom approached here. Will American firms emulate this aspect of the Japanese system? Successful reorganization and restructuring depends on workers who view themselves as part of a more-or-less professional undertaking, one tied at providing value to the firm's customers. Such beliefs will not last long if companies respond to the next recession with immediate layoffs. It is one thing to treat and train ordinary workers as professionals, or at least try to convince employees that the company views them this way. It is another thing to pay them when there is no work to do.

PRESSURES FOR CHANGE

The skills and training required of shopfloor employees have changed a good deal over the past two decades.[4] Technological change-notably the computer in the workplace-is part of the reason. But it is new technology as reflected in the redesign and reorganization of work, more than simply new

[3]Thirteen percent of American firms responding t. a survey in early 1990 were using some form of self-managed work group, with another 4percent reporting plans to move in this direction. "Workforce 2000—Competing in a Seller's Market: Is Corporate American Prepared? A Survey Report on Corporate Responses to Demographic and Labor Force Trends," Towers Perrin and Hudson Institute, July 1990, p. 27. This survey covered 645 companies, in both manufacturing and the services Because most of the responding companies were relatively large, and large companies have been in the lead in adopting work groups, these percentages probably should be regarded as upper bounds.

[4]This chapter draws heavily on "Corporate Strategy and Industrial T raining," report prepared for OTA under contract No. L3-5240 by Robert R. Miller, Feb. 28, 1990. Interviews and plant visits for that report, and by OTA staff, underlie much of the discussion that follows.

machines or processes, that creates new needs for training. (In this chapter, work organization refers to the design and management of the production process, with the more inclusive term restructuring reserved for the enterprise and its strategy as a whole.)

In earlier years, most training had a simple function: to teach unskilled or semiskilled workers how to perform specific tasks and operate particular pieces of equipment. Today, companies put more emphasis on flexibility and adaptability; they seek workers who can master a variety of tasks. In many redesigned production systems, people work in groups; collectively, the group takes over some of the responsibilities earlier vested in first-line supervisors (foremen), and some of the tasks once the province of grey-collar technicians and maintenance workers. By replacing some of their skilled workers, companies not only save money, but gain flexibility: group members can rotate from one job to another, help each other out, fill in for absentees. Workers must have the social and communications skills to fit into the group and contribute. For such reasons, firms seeking to implement new competitive strategies based on new forms of work organization typically find they must modify their approach to hiring as well as to training.

Computers and computer-based equipment also require new and different skills-whether they are part of highly automated systems, or when simply used as adjuncts to traditional plants and processes.[5] Nonetheless, it is the changing context for work that puts the greatest demands on trainers and on managers and supervisors. Work reorganization forces lower level employees to take more responsibility, sometimes including self-supervision and group supervision, cooperate more closely with one another, understand their place in the production system and in the organization. This can be unsettling for some people, including first-line supervisors—who may in fact find their jobs vanishing. Responsibilities broaden. So do skills. People are less likely to be pinned down by **a narrow** job classification.[6] Reorganization calls for somewhat more technical training, but most of all for new forms of behavior. Much of the training is indirect, embodied, for instance, in courses in SPC or JIT. In manufacturing, the forces driving these changes stem largely from international competition. In the services, they stem primarily from domestic competition.

As they pay more attention to training, managers find themselves paying more attention to the costs of training. When most worker-level training was one-on-one in the factory or the office, the costs were buried, while the only measure of effectiveness was whether new employees learned to perform their assigned tasks. Today, more companies view training as a cost center, work harder to contain costs and measure effectiveness.[7]

Globalization

With imports and exports growing faster than the economy itself, more American goods and services face foreign competition each year. Globalization, a trend that goes well beyond simply investing in foreign subsidiaries for production and distribution, accelerated markedly during the 1980s. The objective: to combine and integrate operations in the major industrial nations. Often, this involves decentralization, with such functions as design, development, manufacturing, distribution, and marketing located in different parts of the world. Instead of first developing products for home markets, and then, if these prove successful, moving abroad, companies now design products for world markets, modifying them only slightly for different countries. New products may be simultaneously introduced in Japan, Europe, the United States, and elsewhere.

To compete in this environment, American firms must control costs and raise quality (ch. 3). They must also build more flexible organizations, able to provide the variety that consumers now expect and the just-in-time deliveries demanded by corporate

---

[5]When Martin Marietta adopted MRP 2 (Material ReviewPlanning (sic)), a computerized method for production planning and control, the company spent five times as much on trainingas on the hardware and software required. William B.Scott, "Aerospace/DefenseF irms See Preliminary Results From Application of TQM Concepts," *Aviation Week & Space Technology,* January 8, 1990, pp. 61-63.

[6]Automobile plants operated by the major U.S. producers have traditionally had large numbers of job classifications—80-95—with strict rules governing who could do what. Some "transplants' '—U.S. factories operated by Japanese automakers-have only two classifications, for production workers and maintenance staff; none has more than four. *Foreign Investment.' Growing Japanese Presence in the U.S. Auto Industry, GAO/NSLAD-88-111* (Washington DC: U.S. General Accounting Office, March 1988), p. 52.

[7]In 1985, IBM conducted a corporate-wide study of training expenses, findingthey totaled $900 million exclusive of lost work time—50 percent more than expected. Over the next 2 years, the company cut $150 million from its education/training budget. Ralph E. Grubb, Academy for Educational Development personal communication% May 11, 1990.

customers. Multinationals are both expanding and decentralizing, while seeking alliances with customers, with putative rivals, and with suppliers. Firms are simultaneously integrating globally and disintegrating by farming out more production, contracting for services once provided internally, and pursuing joint ventures and other intercorporate linkages (e.g., cooperative R&D and technology development). Truly international corporations have begun to emerge-IBM and Citibank, Sony and Honda. Although the notion of a rootless multinational remains an exaggeration, borders have less significance for many companies today than in the 1970s. Globalization means that American plants will have to achieve overall productivity levels superior to those abroad, else lose work to overseas locations with lower costs, superior quality, or quicker and more responsive customer service.[8]

The Japanese Approach to Production

Japanese companies have been highly visible in the United States, first as exporters, and more recently through direct investments in onshore plants. Both American and European managers have been forced to rethink their global strategies, especially in production. Japan's prowess in manufacturing has particular significance for training. Success in producing high-quality goods at low cost—computer chips or supertankers-stems from highly developed production systems that effectively couple product and process design, work organization, and shopfloor management. The better workers know their jobs and understand their role in the system, the better the system will function.

In automobile assembly, the best Japanese production systems have been termed "lean" because they attempt to minimize buffers of work-in-process (WIP) inventory that might obscure production problems and slow their resolution.[9] These systems depend heavily on employees trained to avoid rather than detect and correct product defects.

Even more than in the textile examples in chapter 3 (box 3-A), mistakes by shopfloor workers in an automobile plant can be disruptive and costly. With little backup, one mistake can shut down an entire line, idling dozens of workers. Japanese firms not only accept the risks of such systems, they exploit them to cut labor and inventory costs to a minimum, keep the system under control, and keep the pressure on the workforce.

Lean systems require skilled, flexible, and motivated workers to anticipate possible problems, eliminate bottlenecks and production shutdowns, ensure quality. Training plays an intrinsic role in terms of motivation as well as for transmitting concrete skills. These systems also depend on products designed for ease and speed in manufacturing, and on a management style stressing employee involvement and job rotation. Work groups, *kaizen* (continuous improvement) programs, and quality circles are common. Among other functions, these help create communications channels between the factory floor and engineering to achieve true design-for-manufacturability.

In contrast, the "robust" systems common in U.S.-owned auto plants rely on large inventory buffers as safeguards against unforeseen events (e.g., machinery breakdowns, late delivery of parts). In robust systems, workers typically have relatively tightly defined task responsibilities, few engineers spend time on the factory floor, and organizational barriers impede the flow of ideas between product design and manufacturing engineering, as well as between the shop floor and engineering.

Lean systems attempt to avoid problems, robust systems to guard against their consequences. On the evidence of plant performance, lean systems perform better, exhibiting higher levels of both productivity and product quality than the robust systems

[8]With the spread of automation, direct labor cost has become less important in decisions on location. At Tandy Corp.'s Fort Worth, TX, plant, direct labor accounts for less than 2 percent of the cost of each PC produced. "North American Profiles,' *Datamation*, June 15, 1990, p. 67. In automobile production, direct labor now comes to about 10 percent of total costs, indirect labor (including management) adding another 15 percent. Bruce Beier and Mary Gearhart, "Productivity Vs. Profit Sharing," *Automotive Industries*, April 1990, pp. 53-56. But if the relatively high wage levels of U.S. production workers serve as less of a handicap, competition to control indirect costs will be no less fierce.

[9]John F. Krafcik, "Triumph of the Lean Production System," *Sloan Management Review*, Fall 1988, pp. 41-52. Also see Haruo Shimada, "Japanese Management of Auto Production in the United States: An Overview of 'Humanware Technology'," *Japanese Investment in the United States: Should We Be Concerned?* Kozo Yamamura (cd.) (Seattle, WA: Society for Japanese Studies, 1989), pp. 183-205.

Photo credit: Diamond-Star Motors Corp.

Automated welding of automobile bodies.

favored by American firms.[10] Indeed, productivity, quality, automation, and training are found together in the best-performing auto plants—in U.S. transplants as well as in Japan. Honda, Nissan, and Toyota give their American workers substantially more training than do American automobile manufacturers (box l-B, ch. 1), and achieve higher productivity levels. The transplants, moreover, seem to be operating at quality levels slightly better than sister plants in Japan.

In effect, the production systems developed by Japanese automakers combine work organization built around semi-autonomous groups with substantial training and careful attention to shopfloor management to achieve outstanding quality and productivity. Nonetheless, while making some changes in work organization in some plants (GM calls its version of JIT synchronous production), the American automakers continue to operate traditional, robust assembly plants, and, as figures 1-1 and 1-2 showed (ch. 1), provide relatively little training. Even so, some American firms have begun imitating some aspects of Japanese production systems. GM, for instance, invested in its joint venture with Toyota, NUMMI (New United Motors Manufacturing Inc., Fremont, California) with the explicit intent of learning from its partner's approach to shopfloor organization and management.

In the automobile industry, and in many others, American firms have also emulated Japanese practices by reducing the ranks of their suppliers, and seeking closer working relationships with the most capable of them (see box 4-A). Stable, long-term links with a relatively small group of frost-tier suppliers help keep the overall chain of production flexible, responsive, and well controlled, much as JIT production helps isolate defects and other systemic problems within a given plant. Xerox now buys from fewer than 500 suppliers, compared with 5000 a decade ago. As major American corporations continue to emulate Japanese production strategies, their suppliers will have to revamp their own production systems—and in many cases retrain their employees-or lose business to more nimble rivals, some of them foreign-owned.

WORKPLACE ORGANIZATION AND MANAGEMENT

Old and New Approaches

The design of most U.S. production systems continues to reflect the scientific management paradigm descending from Frederick Taylor, whose book on the subject appeared in 1911.[11] Particularly in labor-intensive mass production of consumer goods (automobiles, apparel, appliances), unskilled workers have been assigned to a particular work station—tied to a machine, or to one position on an assembly line. Their job: to repeatedly carry out a single task or a short sequence of simple tasks. Specialists designed the work. Foremen oversaw it. Large inventories between stations and lines provided "robust' protection against disruptions that might stop the flow of production. Inspectors

10 "Training and the Auto Industry: International Comparisons," report prepared for OTA under contract No. N3-191O by John F. Krafcik, Competitive Manufacturing Research, February 1990. This report summarizes results of surveys conducted by MIT's International Motor Vehicle Program, most of them in 1988, covering 45 automobile assembly plants. The 45 plants included 12 in the United States operated by U.S. automakers, 8 in Japan operated by Japanese firms, and 3 transplants operated by Japanese automakers in the United States. (Most of the 22 others were in Europe.) Also see John F. Krafcik and John Paul MacDuffie, "Explaining High Performance Manufacturing: The International Automotive Assembly Plant Study," International Motor Vehicle Policy Forum, Massachusetts Institute of Technology, May 1989; and John Krafcik and John Paul MacDuffie, "Effect of Design Manufacturability on Productivity and Quality: An Update of the IMVP Assembly Plant Study," International Motor Vehicle Policy Forum, Massachusetts Institute of Technology, January 1990. Comparisons of design-for-manufacturability in the latter study found Japanese automakers ranking high, with two of the three major U.S. producers in the bottom half of all firms surveyed.

11 Frederick W. Taylor, *The Principles of Scientific Management (New* York: Harper & Brothers, 1911).

Box 4-A-OEM-Supplier Relationships

OEMs, or original equipment manufacturers, buy raw materials, parts, components, and subassemblies from other firms. Automakers, for instance, purchase steel, glass, plastic resins, and paint. They also buy carpeting and trim materials, catalytic converters and air bag systems, microprocessors and fuel-injection nozzles. Seeking to match Japanese standards of cost and quality, American OEMs are trying to integrate suppliers more fully into their own operations.

The process begins with technical requirements and specifications developed by the OEM's engineering department. "Buyers" then solicit bids and select suppliers. Until a few years ago, the buyer's job was well-structured, much of the work relatively routine-a matter of soliciting bids, managing the selection process, processing contracts, orders, and invoices. While the purchasing department had to know which firms promised to be reliable, monitor those chosen, and help solve delivery and quality problems as they arose, bids were evaluated primarily on costs. (Excess capacity during the 1980s made it particularly easy for automakers to play vendors off against one another.)

Today, the selection process is changing. Price remains important, but competitive bidding has been de-emphasized. In evaluating prospective suppliers, OEMs examine their history of providing consistently high-quality products, and often their internal engineering capabilities. Candidates may be asked to conduct self-assessments and provide detailed information on cost structures, quality control procedures, factory equipment, and workforce capabilities. The OEM may inspect each candidate's plant.[2]

If they pass the initial screening, suppliers become candidates for long-term contracts, perhaps on a sole-source basis; in the automotive industry, such arrangements might extend over a 5-year model run or longer. Suppliers can expect a steady flow of orders so long as their shipments meet the OEM's quality and JIT delivery targets (suppliers may be expected to provide just-in-time deliveries in small lots several times per day). The OEM may consult them at an early stage in the design of new products, ask the supplier's own engineers to take over or share in development work, and stand ready to make modifications during production. Parker-Hannifin, for example, a major producer of hose assemblies for automotive air conditioners, now designs many of these assemblies; in earlier years, OEMs provided Parker-Hannifin with detailed drawings and specifications. Major U.S. automakers have asked suppliers to install computer-aided design equipment compatible with their own to speed exchanges of technical information.

For the OEM, dealing with a smaller group of more broadly capable vendors promises reductions in the upfront cost and time of product development; the OEM shifts some of the risks of development to suppliers (the product may not sell, and the supplier may lose its investment in design, in worker training, even in new production equipment). More important, OEMs hope that common interests will motivate their suppliers to work harder to meet cost, quality, and delivery goals. In return, the suppliers get implicit or explicit guarantees of future sales, with monitoring by the OEM replacing repeated bidding. Pressure to reduce costs has been replaced by pressure to provide JIT delivery and ensure quality *(so the* OEM does not have to inspect 100 percent of incoming goods). Although OEMs now find themselves helping suppliers with technical problems, few offer direct assistance in training beyond providing materials (e.g., manuals, videotapes).[3]

---

[1]Original equipment manufacturers, or OEMs, sell end products—e.g., cars, computers, airplanes. Caterpillar, for instance, offers a broad range of construction equipment as an OEM. It purchases many parts from its own suppliers, and also sells diesel engines as a supplier to builders of heavy trucks.

The discussion in this box is based on "Corporate Strategy and Industrial Training," report prepared for OTA under contract No. L3-5240 by Robert R. Miller, Feb. 28, 1990, pp. 12-14; and "Supplier Relationships and Training, report prepared for OTA under contract No. L3-2850 by Louis G. Tornatzky, Rocco DePietro, and James Jacobs, The Industrial Technology Institute, Ann Arbor, MI, Dec. 15, 1989. Also see *Foreign Investment: Growing Japanese Presence in the U.S. Auto Industry*, GAO/NSIAD-88-111 (Washington, DC: U.S. General Accounting Office, March 1988); and David N. Burt, "Managing Suppliers Up to Speed," *Harvard Business Review*, July-August 1989, pp. 127-135.

[2]Japanese-owned subsidies in the United States put particular stress on quality. In a recent survey, 62 percent of transplant respondents (engineers and managers in Japanese-owned automobile plants, more than half of them Americans) ranked quality as the most important factor in purchased components, while 83 percent viewed a comprehensive SPC program as the most important criterion for chosing suppliers. Daniel J. Holt, "Selling to the Transplants," *Automotive Engineering*, April 1990, p. 8.

[3]In 1985, Ford spun off an in-house training and technical assistance group to form the not-for-profit American Supplier Institute, which now sells services to all comers. The Institute specializes in quality control practices, and has become perhaps the best-known U.S. apostle of Taguchi methods-a set of techniques that stress life cycle quality, reliability, and customer satisfaction. For a nontechnical introduction see Genichi Taguchi and Don Clausing, "Robust Quality," *Harvard Business Review*, January-February 1990, pp. 65-75.

Many smaller suppliers have had trouble meeting the new requirements. Surveys reveal sharply differing perceptions among OEMs and suppliers concerning the need for such manufacturing practices as JIT, SPC, and ***kaizen*** (continuous improvement), with suppliers uninformed or negative compared with OEMs.[4] Such findings suggest that, on the whole, movement towards more streamlined supplier networks will be relatively slow in the United States. They also suggest that many small and medium-sized manufacturing firms, at sea amidst the confusing choices posed by an array of new technologies, shopfloor practices, and customers seeking more responsive service, will have trouble surviving. These companies will have to reorganize their own production operations or look for less demanding customers. Over the next decade or two, thousands of such firms will probably be bought out or merged. Others will simply shut their doors.

[4]A recent Delphi survey conducted by Andersen Consulting with 288 respondents from vehicle manufactures and 431 from suppliers, found wide agreement (90 percent) on the importance of structured programs for continuous improvement such as *kaizen*. But few respondents from the supplier group placed much weight on JIT, *kanban*, and similar production practices—even though these are necessary tools, goals, and yardsticks for measuring progress in any continuous improvement effort. In another indication of the relatively slow pace of change in the motor vehicle and parts industry, Andersen's Delphi panels have seen JIT as a constant 2-3 years in the future ever since the early 1980s. Peter C. Van Hull, "Results of 1989 Survey of Automobile Trends: Putting the Pieces Together," paper presented at Autofact '89 Conference & Exposition Detroit, Oct. 30-Nov. 2, 1989, summarizing Andersen's proprietary report.

checked quality at various points. Supervisors called in technicians or maintenance workers to handle problems as they arose.

In these traditional production systems, unskilled workers might need some minimum level of manual dexterity, but the work was more likely to be boringly repetitive than technically demanding. Grey-collar employees—toolmakers, electricians, machine repairers-analyzed problems, exercised judgment, made decisions. So did supervisors and manufacturing engineers. But not ordinary workers. Particularly in unionized plants, the tasks each employee could do were tightly circumscribed by a plethora of work rules.

The era of mass production is not over, but work reorganization together with flexible automation (discussed in app. 4-A, at the end of the chapter) has made shorter production runs economical, and encouraged product differentiation. In assembly, where the inroads of automation have been slow, more companies have turned to work groups to improve quality and flexibility, while reducing the number of first-line supervisors to cut costs. Typically, supervisors have been assigned managerial and liaison tasks earlier exercised at higher levels (e.g., interdepartmental coordination).

Table 4-2 summarizes the primary features found, singly and in various combinations, in redesigned production systems, taking the view that it is the organization of production, not the computer methods summarized in appendix 4-A, that distinguishes the best performing companies. As noted in the table, when work groups replace individual work stations, employees typically need broader skills. Sometimes, shopfloor-workers may even be asked to deal directly with customers (perhaps their counterparts in other fins). Supervision in the traditional sense often recedes, with hourly paid group leaders given responsibility for internal coordination and conflict resolution, as well as liaison with other departments.

Rarely will the production system in any one company include all the characteristics listed in table 4-2. Partial, halting, and piecemeal implementation has been the rule. But many American companies are experimenting with at least some of these steps. This generally calls for three types of training:

1. *Basic skills.* With more employees required to read information from computer terminals and enter data correctly, companies that reorganize as outlined above typically screen employees for competency in reading, writing, and simple arithmetic, followed by refresher courses or intensive instruction for those who need it.
2. *Task-specific technical skills.* Companies seeking a multiskilled workforce must necessarily provide more training in the operation of particular pieces of equipment.
3. ***Organizational training.*** Intended to set each individual's job in overall context, demonstrate its importance for achieving the firm's goals (i.e., cost, quality, customer service), and motivate workers, this kind of training is by far the most difficult to deliver effectively. Companies frequently rely on indirect methods--e. g., training in SPC—to prepare workers to take more responsibility.

Table 4-2—New Job and Organizational Design Practices in **U.S.** Industry

1. Seeking flexibility, firms *define jobs more broadly,* with multiskilled groups often taking over responsibility for a number of tasks. Sometimes broader skills and responsibilities follow more or less directly because computer automation permits each person to do more.
2. Training exposes employees to corporate goals and enhances *motivation, sense of belonging, and commitment. These* objectives often merge into the development of the *contextual/ /knowledge* employees need in order to understand how their work affects the rest of the firm and its customers.
3. Employees at lower levels maybe granted *a say in decisions on procedures,* and perhaps equipment, as well as day-to-day operations. Often, participation takes the form of consultation between employee representatives and the company's technical and managerial staff.
4. Managers may give groups of *workers* some or all of the authority formerly vested in first-line supervisors, including responsibility for quality and for coordination with other departments.
5. In selecting new employees, companies may weigh *motivational and attitudinal/ factors,* as well as social and communications skills, more heavily than experience. Some American firms have adopted multiple levels of screening, with aptitude and perhaps psychological tests followed by interviews with both supervisors and prospective co-workers.
6. *Pay sea/es* may reflect an employee's skills (pay for skills) and/or performance (payment for results).
7. In decentralizing, some companies have replaced functional with *product-centered organizations,* intended to channel work smoothly and directly from input to output of the system, creating a faster, more flexible (through-not necessarily less costly) production process.

SOURCES: Technology *and Structural* Unemployment: *Reernp/eying* Displaced *Adults,* OTA-ITE-250 (Alexandria, VA: National Technical Information Service, February 1986), pp. 356-357: *International Competition in Services.* OTA-ITE-328 [Washington. DC: U.S. Government Printing Office, July 1987), pp. 278-284. "

Much organizational and motivational training aims to modify attitudes concerning employee responsibility, encourage awareness of the link between workplace tasks and the company's overall success or failure, and build loyalty to the organization. The intent is to persuade people that their jobs are vital for the continuing prosperity of the firm, and that management values their contributions, small or large. Although some of this training smacks of paternalism-and some **companies admit** this-it should not be viewed solely in that light.

Box 4-B gives examples of two American manufacturers, pressed in different ways by international competition, that have taken some of the steps outlined above. To the extent that cost-benefit tradeoffs can be evaluated, more firms are making careful efforts at measuring them; they are finding that training helps workers learn on the job, that careful attention to integrating new employees into the organization can reduce the time required for them to become fully productive.

New Responsibilities

With work groups taking on self-management responsibility, companies have eliminated foremen, or placed them over several groups (totaling perhaps 80 or 100 employees, rather than a dozen or so). As the number of job classifications declines, production workers also take over some of the responsibilities of technicians and craft workers (e.g., inspection, simple maintenance). Finally, those few plants that have undergone more-or-less complete transitions to work groups have had to change their ''management' information systems in rather fundamental ways. Some have begun transmitting customer orders (and sales projections) directly to the factory floor.

Production Workers

In the United States, management has traditionally given orders and labor has followed them. As once-sharp lines blur, companies call on a loosely

Photo credit: UAW-Chrysler National Training Center

A joint union-management team develops training plans.

Box 4-B—Work Reorganization and Training in U.S. Industry: Two Examples[1]

Motorola: Microprocessor Production

Managers at Motorola pride themselves on their success in taking on Japanese competition, both at home and abroad. A 1988 recipient of the Malcolm Baldridge Quality Award, Motorola was quicker than most U.S. electronics firms to recognize that manufacturing would be critical during future rounds of international competition. The company's managers realized that training had to be part of their plans for improvement in manufacturing, as illustrated by the reorganization of the firm's Austin, Texas, microprocessor plant.

The Austin factory is currently in the midst of a two-stage program to cut costs and improve quality and customer responsiveness. The first stage, largely completed during 1989, entailed a complete redesign of facilities and operations, but little in the way of new capital outlays. During the second stage, Motorola will invest in a new generation of flexible manufacturing equipment. The company believes it makes no sense to automate until the production process is already functioning well. (This is also one of the hallmarks of Japanese manufacturing practice.)

Although cost reduction was a major goal, this could not be achieved simply by cutting direct labor, which accounted for no more than 5 or 6 percent of manufacturing costs. Motorola sought improved quality (fewer bad parts, greater customer satisfaction), shorter delivery times, and greater flexibility-as well as better employee morale-by organizing production around work cells and work groups. Each cell, manned by 6 to perhaps 20 employees, performs a particular set of tasks. Since the plant operates around the clock, the equipment within a cell might be shared by as many as four work groups. The product mix varies, so that different shifts may be making different chips. In the words of one manager: ''The strategy was to make the product mix problem more manageable . . . to inculcate a strong sense of ownership and accountability in which participative management principles could be applied."

There are no foremen in the Austin plant. Instead, group leaders, who are hourly employees, have taken over the supervisory tasks; planning the flow of production based on incoming orders is one of their primary responsibilities. Each group is accountable for its own output quality, for productivity improvements, and for meeting in-plant delivery schedules (e.g., to the next cell). Technicians and engineers have been assigned to work with most of the groups. Group members must be comfortable with SPC, with a constantly changing mix of products, and with frequent product/process changes. Sometimes they must placate angry customers. Computer systems bring business data directly to the factory floor.

When a skills assessment showed that nearly one-third of the existing Austin workforce was weak in reading, writing, and arithmetic—which had not been apparent in the old work environment-Motorola instituted a 300-hour internal basic skills course. Like their counterparts in other firms, Motorola managers would prefer not to spend time and money making up for what they see as deficiencies in the public education system. But, short of culling employees on the basis of present skills-which no company really wants to do-there was little choice but to proceed with remedial education.

With the first phase of reorganization largely complete, a plant that had been approaching capacity at some 1.5 million microprocessors monthly now produces more than 4 million. Direct labor has been reduced by half, and on-time delivery performance greatly improved. Quality has increased steadily toward the firm's ''six sigma" goal of near-zero defects. Additional training will be required during the second phase, when sophisticated new equipment is installed.

Caterpillar: Heavy Industry in Trouble

In many countries, Caterpillar's familiar yellow earthmoving and construction equipment has traditionally held more than half the market, but in the early 1980s the firm's position came under severe attack. First, Japan's Komatsu expanded its product range far beyond the lower end of the market and into Caterpillar (CAT) territory. Komatsu moved aggressively into Far Eastern countries, and began lining up dealers in the United States. Next, the exchange rate moved against CAT. With the dollar gaining some 40 or 50 percent against major currencies, and much of its production in U.S. plants, CAT found itself in a severe cost-price squeeze. Finally, U.S. contractors, loyal Caterpillar customers, were steadily losing their dominance of international construction markets.

(continued on next page)

[1] ''Corporate Strategy and Industrial Training,'' report prepared for OTA under contract No. l-3-5240 by Robert R. Miller, Feb. 28, 1990. Also Robert L. Rose," Caterpillar Sees Gains In Efficiency Imperiled by Strength of Dollar,'*Wall Street Journal,* Apr. 6, 1990, pp. Al, All; Nick Garnett, "Caterpillar Gets Dug in to $2bn Factory Modernization,'' *Financial Times,* June 6, 1990, p. 14.

Box 4-B—Work Reorganization and Training in U.S. Industry: Two Examples-Continued

Over 3 years in the mid-1980s, CAT lost more than $1 billion. With the return of the dollar to lower levels, the company's income statement improved. Nonetheless, the huge losses were traumatic. CAT has substantially altered its business practices, seeking to reduce exchange rate risks by moving production overseas and purchasing more components abroad. In departing from its past practice of making most of its own parts and components, CAT has sought to shift risks to suppliers. Today, the company continues to operate 17 plants in the United States, but it produces components internally only when it has a substantial cost advantage or wishes to preserve core technological capabilities. Worldwide, Caterpillar now has only 60,000 employees (two-thirds in the United States), compared with 100,000 at the beginning of the 1980s.

To bring down overall production costs, CAT is investing more than $2 billion in its own manufacturing operations. Much remains to be done, but the company has moved toward a JIT system, and reorganized plants around machining and assembly cells fitted with state-of-the-art flexible production equipment. Inventories have been reduced substantially. Although 60 job classifications remain, the number had earlier been more than four times greater. Work groups have been given responsibility for quality, productivity improvements, and meeting JIT delivery schedules. As an example of the results, transmission assembly at CAT's Peoria, Illinois, plant now takes a few days rather than 3 months.

Given a lengthy history of labor discord, the long-term success of the new practices remains to be seen. Less supervision, flatter organizational structures, and ever-sticter demands for higher quality and lower costs require new skills throughout the workforce. CAT's training has traditionally targeted skilled workers and supervisory personnel, but this has begun to change: the company has introduced new programs to help unskilled and semiskilled workers cope with the group-oriented approach to production, which has far less formal structure than found in the company's old plants.

CAT has also begun helping its U.S. suppliers with training, providing them at cost with courses in SPC, blueprint reading, and geometric dimensioning and tolerancing. The company would like to avoid in-coming quality inspections, relying instead on annual certification of vendors, but many suppliers have been unable to meet the new quality targets.

Recently, CAT has become concerned that it may not be able to find enough machinists and other skilled workers in the years ahead. while the firm has revived its apprenticeship program, halted in 1980s as losses mounted, qualified candidates have been scarce.

related group of ''soft' technologies-continuous improvement *(kaizen)* and employee involvement programs, SPC and JIT-to help employees feel comfortable in their new roles. SPC and JIT, for example, frequently function on two levels: as well-defined technical methods, and also as tools for impressing on workers their roles and responsibilities in the redesigned production system. For engineers and managers, SPC functions as a rigorous, quantitative method for monitoring and controlling production. Shopfloor workers may be asked to help-by recording SPC data, trying to analyze it, applying the results where possible-but the primary purpose is motivational, aimed at self-discipline.[12] SPC thus becomes a tool for workers to understand what they are doing and find ways of doing it better. Indeed, SPC in an American firm may not differ much from *kaizen in* a Japanese firm. Box 4-C discusses in more detail these methods for helping organize and manage complex production systems.

The organizational technologies outlined in box 4-C serve as preliminaries to automation, helping companies avoid mechanizing wasteful or ineffi-

[12] This is true not only in the United States, but in Japan, where:

> Groups begin by learning a number of statistical procedures which the foreman has been taught in special courses-tree diagrams, Pareto curves, how to use, if not actually how to do regressions. This is partly for real; these are indeed the techniques which-depending on the nature of the work-place—may be used to identify problems for the group to tackle. Partly, also, they are symbolic-ways of absorbing and expressing a scientific attitude to work; an initiation into a confraternity, a little like the Boy Scout learning his knots.

"Employee Training in Japan,'' report prepared for OTA under contract No. L3-4335 by David Cairncross and Ronald Dore, March 1990, p. 15,

For an extensive comparative study of quality circles and their diffusion, see Robert E. Cole, *Strategies for Learning: Small-Group Activities in American, Japanese, and Swedish Industry* (Berkeley, CA: University of California Press, 1989). On current quality control procedures in U.S. industry, particularly for semiconductors and optical fibers, see "U.S. Investment Strategies for Quality Assurance," Planning Report 90-1, Quick, Finan & Associates for the National Institute of Standards and Technology, April 1990.

cient processes. Once a firm understands its processes and the needs that a reorganized production system must satisfy, it is in a far better position to specify new equipment (recall the Motorola example, box 4-B). In this light, computer-integrated manufacturing (CIM) is evolutionary, not revolutionary.

These stages of refinement and streamlining need not require extensive training in task-specific skills. They do require attention to problem-solving, singly or in groups, and to skill breadth. With JIT or JIT-like systems, there is no time to wait for a supervisor to assess a problem (defective parts, a machine breakdown) and a specialist to fix it. Workers should be in a position to diagnose and solve most such problems themselves. Maintenance training, for example, then serves multiple ends, helping employees understand how equipment operates, and thus how it may fail, as well as enabling the company to reduce its maintenance staff.

How much training is needed when work is reorganized? What makes for good training in support of continuous improvement or employee involvement? These questions have no general answers. But it does seem clear that techniques like those summarized in box 4-C are more likely to prove effective when part of a company-wide reorganization, one that the workforce will accept and believe in. Typically, this means linking reorganization in convincing fashion to the company's competitiveness-hence job security for shopfloor workers. If employees sense a quick-fix effort, or think they will be blamed for future problems, reorganization more than likely will fail.

Supervisors

The supervisor's role in a reorganized factory differs fundamentally from that of the line foreman. There is less need for such traditional supervisory tasks as motivating and disciplining workers, or monitoring performance. When supervisors oversee a number of work groups, becoming coordinators and facilitators, it is more as if the supervisor works *for the* group rather than ***over*** it. For example, the supervisor may become the liaison with the personnel department. Ideally, persuasion replaces authority, with teaching and training added to the supervisor's role. Supervisors also need better diagnostic skills, and, if they work with engineers, some familiarity with technical issues.

Some companies have found that fewer than half their supervisors can adjust, even after training in human relations, participatory management, and organizational technologies like SPC or JIT. Supervisors who cannot make the transition have sometimes found themselves out of work. Other companies have tried to train redundant supervisors for technical support jobs, where interpersonal skills are less important. But these jobs have grown considerably more demanding with the spread of computer-based equipment, and few supervisors, especially those promoted from the factory floor, have an ideal background for filling them. Indeed, the simpler support jobs, like quality control, tend to disappear with reorganization, while others may now call for a college degree (using sophisticated computer models for planning and scheduling-e. g., computer-aided process planning, or CAPP—see app. 4-A).

Engineers

Reorganization, finally, alters the relationship between shopfloor workers and engineering staff. Both product engineers and manufacturing specialists may be expected to act on suggestions and ideas from production workers, join in quality circle and *kaizen* meetings, and otherwise treat shopfloor employees more or less as equals. Many companies have found this to be a painful experience for their engineers, who tend to view themselves as fountains of expertise and the workforce as receptacles.

In the scientific management ideal, there was one best or optimum way to organize production, that way known to the initiates. To the extent that this view still shapes the attitudes of American engineers, they will continue to have trouble working effectively with shopfloor employees. When it comes to process design, engineers often concentrate on the hardware-machinery and equipment—treating the workers as adjuncts, there to do whatever is too complex or expensive to automate. In the extreme, engineers may view automation as a way to get people out of the system because they are sloppy, unpredictable, inefficient-the source of errors. A recent survey finds manufacturing engineers poorly prepared for CIM because interested only in the technology, not in how people can use it.[13]

[13]Detlef K. Koska, "Technology's Impact on the Manufacturing Engineer in the Year 2000, " paper presented at Autofact '89 Conference & Exposition, Detroit, MI, Oct. 30-Nov. 2, 1989. The survey was conducted by the A.T. Kearney consulting firm.

Box 4-C-Organizational Technologies

Statistical Process Control

The goal of SPC is to reduce variance in the production process, resulting in more consistent output with fewer and less serious defects, minimum scrap and rework.[1] American firms developed the fundamentals of SPC during the 1920s and 1930s, but the methods have been much more visible since their reimport from Japan, beginning in the 1970s.

By measuring process parameters (e.g., the moisture content of cookies as they enter a baking oven), and examining trends over time, SPC defines the limits past which product attributes begin to deteriorate (e.g., the cookies leave the oven too hard or too soft). Once these limits have been determined, the process can be monitored to keep the critical parameters in the proper range. Seemingly simple, SPC can become quite complicated when dozens of variables are involved, or the process goes out of control and the causes cannot be located.

Many if not most such problems are matters for the engineering staff. Companies train shopfloor workers in SPC methods in large part to impress on them the need for continuous and disciplined attention to their work. Rarely do they expect employees to actually learn anything about statistics beyond a few simple terms like averages and ranges. The intent is to socialize them, integrate them into the production system, and create a self-managing work environment. Still, basic skills are necessary if workers are to enter data and read the control charts that tell them whether or not they are doing a good job.

The example of Plumley Companies, an auto parts supplier in Tennessee, illustrates the impacts of SPC and the training required. During the early 1980s, Plumley was shipping parts with defect rates of 1 in 300; the company had lost its oldest and one of its best customers-Buick. When Plumley tried to implement SPC in conjunction with the installation of new manufacturing equipment, it discovered that nearly half of its 500-person workforce had not completed high school; many employees, including supervisors, were unable to read. The company embarked on an employee education program. With its investments in new equipment, plus SPC, Plumley was eventually able to reduce its reject rate to 1 in 10,000. The firm has won back business from Buick, and gained such demanding new customers as Nissan.

In another example, at a cookie factory, introduction of SPC proved troublesome, but not because of basic skills problems.[2] Managers neither explained the goals of the program adequately, nor provided appropriate training. Bakers, mixers, dough rollers, and machine captains focused on maintaining particular target values for moisture content, line speed, and temperature in each of eight oven zones, without regard for the process as a whole. This missed the point: actions at each stage affected those downstream; turning out cookies with the desired weight, shape, color, and consistency required attention to ranges and trends, rather than specific values. Most parameters must in fact be slightly "off-target:" "tithe dough is too moist, oven temperatures must be a little higher, and perhaps the line speed a bit slower, else the cookies will be too soft. It was only when management attempted to improve the situation through a course in problem solving skills that they realized workers not only misunderstood the purpose of SPC, but resented the way it had been implemented (some, for instance, felt they were simply being asked to do needless paperwork).

Just-In-Time

The central idea behind JIT production (sometimes known, especially in Toyota's version, as ***kanban) is*** simple: materials, components, and subassemblies should be delivered (to the factory, assembly line, workstation) only as needed. Because JIT minimizes work-in-process inventory and buffers of parts between production stages, it is an essential element in the lean production systems for automobile assembly described earlier in the chapter.

JIT saves money directly through lower inventory levels and reductions in factory floor area (since less storage space is needed). With on-line inspection, bad parts and other production problems surface immediately, rather than days or weeks after the fact. While any disruption serious enough to interrupt the flow of parts can shut down production, this seeming disadvantage lies, in fact, at the heart of the JIT approach: the goal is ***to prevent*** disruptions; this is achieved by making them intolerable. As with SPC, the objective is to keep the process always under control and running smoothly. The costs of disruptions become so high in a JIT system that all workers understand the need to avoid them.

---

[1] In a typical example, a manufacturer of nylon stockings reduced defects by more than 80 percent over 7 months through SPC, with no increase in production cost. W. Edwards Deming, *Out of the Crisis* (Cambridge, MA: MIT Press, 1986), pp. 380-387.

[2] "Training Factory Workers: Three Case Studies," report prepared for for OTAunder contract No. N3-2670by Larry Hirshhorn, Wharton Center for Applied Research, October 1989.

Because a full-blown JIT system marks such a big change in the production process, introduction typically calls for considerable training. For example, workers may need multiple skills so they they can help one another out when necessary. JIT also requires more sophistication on the part of purchasing departments, which, as noted in box 4-A, must select suppliers on the basis of reliable delivery and consistent quality so that inspections of incoming parts can be minimized (and because a batch of bad parts can shut down the plant).

Rather than simply a matter of minimizing inventories, JIT methods actually comprise a broad set of guidelines for designing and coordinating factory production. Understood in this fashion, JIT becomes another way of continually examining each and every piece of the manufacturing process, in all possible lights, looking for potential problems and potential sources of improvement. Toyota's ***kanban*** system, for instance, evolved through a quarter of a century of experience-based learning. When the automaker decided to automate this informal system (named ***kanban*** after the tags used for scheduling), Toyota engineers realized they would first have to spend 2 or 3 years figuring out the logic embodied in the actions of the people running around the plant with their ***kanban*** tags.

Continuous Improvement

Kaizen, or continuous improvement programs, even more than SPC or JIT, should be seen as "philosophy"-a way of keeping workers focused on the need for cost reduction, quality improvement, reduction of waste and scrap. Group problem-solving sessions (e.g., quality circles) and employee suggestion programs have been among the most popular methods for fine-tuning production operations. Workers may meet with supervisors, production planners, or members of the engineering staff to seek and solve problems and make suggestions for improvement (better hand tools, reductions in set-up time).

At the NUMMI plant, for example, small groups of production workers meet periodically to seek ways of modifying assembly tasks or eliminating wasted motion. Improvements may be as simple as rearranging a work station to allow easier access to parts, or as complex as persuading engineers to alter component designs for ease of production. Work groups at NUMMI also help plan training, which has ranged from task-specific skills to human relations and problem-solving. Experience at many companies shows that ***kaizen-like*** programs prove most successful when they include training in both technical skills and group dynamics.

RESTRUCTURING FOR COMPETITIVENESS

This section examines restructuring more broadly, including human resource practices in service industries. While the sources of competitive pressure differ, competition in the services centers on costs and prices, quality and flexibility, just as in manufacturing. Retail banks, for example, advertise low-cost checking accounts, organize production to minimize bookkeeping errors, and invest in automatic tellers to provide round-the-clock service (and cut labor costs). Banks now ask ''customer service representatives to engage in active selling, using computer simulations to demonstrate the virtues of, say, an individual retirement account.[14] As this example suggests, service fins, like manufacturing companies, have begun to manage, train, and motivate their employees in ways that would have been quite foreign 15 or 20 years ago.

From Work Redesign to Organizational Restructuring

At Motorola (box 4-B), managers believe that the days of long production runs of standardized microprocessor chips are pretty much over. They see more customization, requiring a production system that can respond to constantly shifting market demands without cost or quality penalties. In this light, the reorganization of Motorola's Austin plant simply marks the first step in adjusting to the competitive realities of the 1990s. Subsequent steps maybe more difficult. The first phase was limited to the factory floor. Later phases will extend beyond the factory, affecting engineering, marketing, and finance. Bureaucratic obstacles seem inevitable. In this, the future for Motorola resembles that for most of American industry.

New organizational forms emerge gradually, taking on different shapes in different industries and different parts of the world. While the picture

[14] U.S. Congress, Office of Technology Assessment, *International* Competition *in Services*, OTA-ITE-328 (Washington, DC: U.S. Government Printing Office, July 1987), pp. 288-291.

remains cloudy, at the most general level the overall shift can be described as one from ''Fordist" mass production to more flexible organizational structures.[15] There is no need to accept the theorizing that goes with so many of the discussions of both Fordism and flexible specialization to sketch out the implications for training.

Table 4-3 (a slightly abbreviated version of which appeared in ch. 1 as table l-l) traces the shift by contrasting two ideal types: an older model characteristic of U.S. mass production industries in the 1950s and 1960s, and anew model that encompasses many of the changes described in this chapter. Old and new approaches to training appear at the bottom of the table. The new model has been termed flexible decentralization to underline two primary points: 1) investments in flexible automation make shorter production runs possible with little sacrifice in efficiency; and 2) decisionmaking authority is being transferred downward and outward, to semiautonomous divisions and to the factory floor.

Labor-Management Relations

Organized labor has been ambivalent or opposed to several of the changes summarized in table 4-3 (e.g., reductions in job classifications, outsourcing). In some cases, their suspicions have good cause: not a few companies have implemented aspects of the new model, or closed old plants and built new ones in States where organized labor is weak, as part of antiunion strategies. Given continued opposition not only from some union members, but from managers who would prefer not to yield authority to line workers, attempts to reorganize existing plants along the lines outlined in table 4-3, particularly plants with strong unions and a history of labor-management discord, have sometimes proved impossible.

Although many companies seek to avoid unions when restructuring-a number of Japanese transplants have located in rural areas where labor unions have little support-in other cases competitive pressures have spurred cooperation between unions and management. Organized labor has been generally supportive of one of the key elements in table 4-3—transfer of authority downward to the shop floor. At NUMMI, for example, management agreed to hire a majority of workers from among the laid-off employees of GM's old Fremont plant-known for troubled labor relations—while the United Auto Workers (UAW) agreed to accept flexible work rules and only four job classifications. About 240 hourly workers spent 3 weeks at Toyota's facilities in Japan for classroom and on-the-job training prior to plant start-up. These workers then became trainers for the rest of the 2,000-person workforce. NUMMI has maintained high quality standards, while productivity exceeds the GM average by 40 percent.

At GM's own factories, joint labor-management training and quality programs have also had positive impacts. In the company's Hamtramck plant, all assembly is performed by work groups, a Joint Activities Committee meets weekly to evaluate quality and productivity, and employees regularly attend the UAW-GM off-site Paid Educational Leave program.[16] In other examples, a group organized through the UAW-GM Human Resources Center found ways to cut costs of body sealer at the Lansing (Michigan) Body Plant from $8 to $3 per car, while joint committees at stamping plants have managed to dramatically reduce die change times. As discussed in chapter 8, the UAW has negotiated joint training funds with the three major U.S.-owned automakers. These funds are used to promote teamwork as well as provide technical training.

Genuine Change or Cosmetic?

Companies that take a piecemeal approach to reorganization risk failure, particularly those that pick and choose Japanese production practices according to whether managers feel comfortable with them. It is entirely possible that the new

[15] Michael J. Piore and Charles F. Sabel, The Second *Industrial Divide (New* York: Basic Books, 1984); Charles F. Sabel, "Flexible Specialization and the Re-emergence of Regional Economies, ' *Reversing Industrial Decline? Industrial Structure and Policy in Britain and Her Competitors,* Paul Hirst and Jonathan Zeitlin (eds.) (Oxford, UK: Berg, 1989), pp. 17-70; Richard Florida and Martin Kenney, "High Technology Restructuring in the USA and Japan," *Environment and Planning A,* vol. 22 (February 1990), pp. 233-252; Paul Milgrom and Jobn Roberts, "The Economics of Modern Manufacturing: Technology, Strategy, and Organization,'' *American Economic Review,* vol. 80 (June 1990), pp. 511-528. Also see *International Competition in Services,* op. cit., footnote 14, pp. 253-287.

[16] Joseph M. Callahan, ''Solidarity in Poletown!'' *Automotive Industries,* June 1989, p. 71. Also see ''UAW-GM Joint Activities at the Plant Level,'' Work in America Institute, Inc., Apr. 19, 1989.

Unions in chemicals, steel, and the airlines, among others, have agreed to flexible job assignments, including material handling, repair, and housekeeping tasks. Harry C. Katz and Jeffrey H. Keefe, ''Industrial Restructuring and Human Resource Preparedness in Unionized Settings," Peter B. Doeringer et al., (eds.), *Turbulence in the American Workplace (New* York, NY: Oxford University Press, forthcoming).

Table 4-3—Changing Organizational Patterns in U.S. Industry

Old model Mass production, 1950s and 1960s	New model Flexible decentralization, 1980s and beyond
Overall strategy	
• Low cost through vertical integration, mass production, scale economies, long production runs. . Centralized corporate planning; rigid managerial hierarchies. • International sales primarily through exporting and direct investment.	. Low cost with no sacrifice of quality, coupled with substantial flexibility, through partial vertical disintegration, greater reliance on purchased components and services. . Decentralization of decisionmaking; flatter hierarchies. . Multi-mode international operations, including minority joint ventures and nonequity strategic alliances.
Product design and development	
. Internal and hierarchical; in the extreme, a linear pipeline from central corporate research laboratory to development to manufacturing engineering. . Breakthrough innovation the ideal goal.	. Decentralized, with carefully managed division of responsibility among R&D and engineering groups; simultaneous product and process development where possible; greater reliance on suppliers and contract engineering firms. • Incremental innovation and continuous improvement valued.
Production	
. Fixed or hard automation. . Cost control focuses on direct labor. • Outside purchases based on arm's-length, price-based competition; many suppliers. . Off-line or end-of-line quality control. . Fragmentation of individual tasks, each specified in detail; many job classifications. • Shopfloor authority vested in first-line supervisors; sharp separation between labor and management.	• Flexible automation. • With direct costs low, reductions of indirect cost become critical. . Outside purchasing based on price, quality, delivery, technology; fewer suppliers. • Real-time, on-line quality control. • Selective use of work groups; multiskilling, job rotation; few job classifications. • Delegation, within limits, of shopfloor responsibility and authority to individuals and groups; blurring of boundaries between labor and management encouraged.
Hiring and human relations practices	
• Workforce mostly full-time, semi-skilled. • Minimal qualifications acceptable. • Layoffs and turnover a primary source of flexibility; workers, in the extreme, viewed as a variable cost.	• Smaller core of full-time employees, supplemented with contingent (part-time, temporary, and contract) workers, who can be easily brought in or let go, as a major source of flexibility. • Careful screening of prospective employees for basic and social skills, and trainability. • Core workforce viewed as an investment; management attention to quality-of-working life as a means of reducing turnover.
Job ladders	
. Internal labor market; advancement through the ranks via seniority and informal on-the-job training.	• Limited internal labor market; entry or advancement may depend on credentials earned outside the workplace.
Governing metaphors	
• Supervisors as policemen, organization as army.	• Supervisors as coaches or trainers, organization as athletic team. (The Japanese metaphor: organization as family.)
Training	
. Minimal for production workers, except for informal on-the-job training. • Specialized training (including apprenticeships) for grey-collar craft and technical workers.	• Short training sessions as needed for core workforce, sometimes motivational, sometimes intended to improve quality control practices or smooth the way for new technology. • Broader skills sought for both blue- and grey-collar workers.

SOURCE: Office of Technology Assessment, 1990.

approaches work because the elements are mutually interdependent. With only some of them in place, the system may perform poorly. Or improvement may be temporary, with the organization later sliding back into its old ways—particularly if higher management does not buy into the entire agenda, but treats it as another way of manipulating employees.

A 7-year business expansion has made it relatively easy for American industry to invest in training and experiment with innovations like those outlined in tables 4-2 and 4-3. The test will come in the inevitable downturn. Some companies in some industries (including, for example, IBM, Hewlett-Packard, Motorola, Pacific Telesis, and a number of large banks) have had long-standing policies of adjusting employment levels through attrition, retraining and redeploying their existing workforce when product or process technologies change, rather than laying off one group while hiring another with needed skills.[17] Facing potential layoffs in its electric motor and transformer plant in Fort Wayne, Indiana, General Electric moved some of its growing production of aircraft engine controls to Fort Wayne, finding it less expensive to retrain hundreds of employees with 20-plus years of seniority than to lay them off and train new people.[18]

Still, overcapacity or recession will from time to time force large cutbacks in the output of some U.S. industries. How will employers respond? A few companies have begun to experiment with concentrated training on company time during periods of slack demand, hoping to upgrade worker skills for the long-term good of the organization. Such policies remain the exception, with many more American firms still subscribing to start-stop practices in training. One point seems plain: firms that seek to adopt Japanese production methods in a full-blown way will not be able to close entire plants for weeks or months.

Sectoral Comparisons

Table 4-3, while cast in terms of manufacturing, could just as easily incorporate terms appropriate for service fins. Table 4-4 givess summary descriptions of the changes underway in four U.S. sectors—two in services (banking and retailing), and two in manufacturing (textiles and automobiles). These help fill in the general picture of restructuring, while illustrating differences among industries. Textile manufacturers, for example, appear the least sophisticated by far in their approach to training.

In both banking and retailing, the forces driving change have been domestic more than international: deregulation in the case of financial services; greater consumer buying power, shifting tastes, and migration to the suburbs in the case of retailing. Financial service firms and retailers have adopted aggressive training and human resource strategies, although, as the table indicates, necessarily quite different from those of manufacturing firms.

Automobile manufacturers pay wages well above the average, and offer attractive fringe benefits (about the same in union and nonunion plants); they have had little trouble finding people with adequate basic skills who can be trained to work effectively in their production systems.[19] In contrast, most low-level jobs in banking and retailing pay far less, yet employers want personable, competent workers-able to deal with the public and convey the desired image.

Not only can few service firms pick and choose their workers, many must live with annual turnover rates of 50 percent or more. As a result, training

[17] "Layoffs Called Wrong Approach to Saving Money During Hard Times," *Daily Labor Report,* Sept. 22, 1986. On the other hand, companies including R.J. Reynolds, Eastman Kodak, Bank of America, and Chase Manhattan have abandoned earlier no-layoff policies. John Hoerr and Wendy Zellner, "A Japanese Import That's Not Selling," *Business Week,* Feb. 26, 1990, p. 86. Even IBM has used early retirement incentives to cut its labor force in recent years.

[18] Jerome M. Rosow and Robert Zager, *Training: The Competitive Edge (San* Francisco, CA: Jossey-Bass, 1988), pp. 209-212.

One analysis, based on data from several companies, found retraining 100 redundant employees and keeping them on the payroll (doing maintenance and security work) for 6 months to be less expensive than laying them off and then rehiring them when demand picked up. Roxane Dean and Daniel W. Prior, "Your Company Could Benefit from a No-Layoff Policy," *Training and Development Journal,* August 1986, p. 40. Part of the reason was the expectation that some of the laid-off workers would find new jobs, so that the company would have to fully train 25 new people as replacements. Other factors rnaking the layoff alternative more expensive included greater Unemployment Insurance charges, separation payments, administrative costs of both hiring and firing, and lost production due to lower morale among those employees who were retained.

[19] In the late 1980s, Diamond-Star Motors, the Mitsubishi-Chrysler joint venture in Bloomington-Normal, IL, hired a workforce averaging nearly 14 years of schooling; more than 50,000 people applied for fewer than 3,000 jobs. Mazda's Flat Rock, MI, plant, which employs 3,100 people, received nearly 100,OOO applications. Richard Child Hill, Michael Indergaard, and Kuniko Fujita, "Flat Rock, Home of Mazda: The Social Impact of a Japanese Company on an American Community," *The Auto Industry Ahead: Who's Driving?,* Peter J. Arnesen (cd) (Ann Arbor, MI: University of Michigan, Center for Japanese Studies, 1989), pp. 69-131. The Mazda plant began production in late 1987; Diamond-Star's first cars left the factory in 1988.

Table 4-4-Restructuring in Four U.S. Industries

Textiles	Automobiles [a]	Banking	Retailing
Response by U.S. firms to competitive pressures, domestic as well as international			
• Product variety within narrower market segments • New investment in automated production equipment	• Renewed emphasis on larger family cars; introduction of small trucks, vans, and utility vehicles . Strategic alliances with Japanese and Korean automakers for small car design and production . Investments in automated production equipment; closing of high-cost plants	. Aggressive movement into offshore markets, and in some oases into foreign commercial banking . New financial instruments for both retail and corporate customers . Heavy use of information technologies, often proprietary (e.g., cash management services)	. Diversification, expansion into specialized stores and market niches (fast foods, luxury goods), and new regional and local markets; smaller stores . Heavy use of information technologies
Restructuring and reorganization			
• Tighter links with suppliers and customers . "Quick response" production systems, with more attention to fashion trends	. New plants somewhat smaller • Closer working relationships with smaller groups of suppliers . Limited vertical disintegration, with selected engineering tasks farmed out to suppliers	. Functional organizations with front and back office collapsed . Greater stress on safes, marketing, customer service	• Decentralization of decisionmaking to store managers . Integrated, computer-based inventory, ordering, and point-of-safe systems
Labor market supply conditions (Many of the shortages noted reflect prevailing wage levels)			
• Shortages of workers with adequate basic skills, high school education . Shortages of skilled technical workers and entry-level supervisors	. Continuing reductions in both white-collar and blue-collar workforces . Shortages emerging in some skilled trades due to cutbacks in apprentice training during the recession years of the early 1980s	. Shortages of workers with adequate basic and social skills for customer service jobs in retail branches	. Shortages of workers with adequate basic and social skills, especiafly in some urban areas, for jobs requiring customer contact . No consistent source for managerial tracks
Recruiting and human resource strategies			
. At lower levels, take all comers • Efforts beginning to work with community colleges	• High prevailing wage levels help automakers recruit young workers with high school and beyond	• Hire more female, temporary, and part-time workers • External hiring for management ranks (e.g., directly from college), rather than promotion from within • Eliminate low-skilled jobs through automation, self-service	. Seek new sources of temporary and part-time workers-e.g., women, students and retirees • Internal promotion to management levels, but increasing insistence on college as a prerequisite • Elimination of low-skilled jobs through automation, self-service (e.g., in gasoline stations)
Skill changes and job design			
. More operator responsibility for quality, monitoring of equipment performance, and routine maintenance; basic skills needed . Repair work more complex	. Selective use of multiskilled work groups . Operator responsibility for quality, some routine maintenance, simple troubleshooting	. Lower level employees assigned broader range of tasks (e.g., selling) • Computer literacy may be needed	. Safes clerks responsible for credit card verification, data entry . Some computer literacy may be desirable
Training strategies			
• Basic skills programs . Technical training through community colleges and equipment vendors	. More cross-training; emphasis on quality control practices (e.g., SPC) • Training programs used to build employee allegiance to corporate goals • Basic skills and adult education courses through joint union-management training programs	. Basic skills for entry-level workers • Training in proprietary information systems • Intensive training for managerial candidates	. Brief but intensive training for entry-level workers . Extensive training for managers as they progress upward

[a]Vehicle manufacturers, including Japanese-owned transplants, but not suppliers.

SOURCE: Based in part on "Training and Competitiveness in U.S. Manufacturing and Services: Training Needs and Practices of Lead Firms in Textiles, Banking, Retailing, and Business Services," report prepared for OTA under contract No L3-3560 by Lauren Benton, Thomas Bailey, Thierry Noyelle, and Thomas M. Stanback, Jr., Columbia University, February 1990, Table 01.

programs are brief but intensive, stressing basic skills, firm-specific workplace technologies (e.g., point-of-sale terminals), and customer relations. Although both banks and retail outlets have traditionally employed many women, longer business hours (themselves in part a consequence of the greater number of working women) have led to an even greater focus on women as part-time workers. Firms in these sectors, finally, as in a number of other services, place demands on supervisors and managers quite different from those in manufacturing organizations. As noted in the table, large banks and retailers have developed formal procedures for selecting managerial candidates, and training them at successive levels of the management track.

Changing Practices in Employment and Training

Supply and Demand

Generally companies retrain existing employees when they redesign their production processes. Moreover, in high-turnover industries, like many of the services, half the workforce is new each year, so that training must be built into ongoing operations. As illustrated by the examples in box 4-B and elsewhere in the chapter, training an existing workforce is not so easy as it might seem. Many companies have found that existing skill levels have simply not been good enough. Even so, few executives in major corporations see poor basic skills as a barrier that cannot be overcome. What frustrates industry is the double burden of providing remedial education to improve the skills of high school graduates who cannot read or do simple arithmetic (and who may show no interest in learning), before being able to train in job-specific technical skills. To avoid this, companies in a position to be selective build more filters into the screening process before they hire.

No longer is a high school diploma accepted as a meaningful credential. Some personnel departments have also adopted tests intended to measure how well people perform in a small group setting, while applicants may have to be approved by the production group they will join. As such trends imply, in the longer term, hiring and training practices, particularly in manufacturing, will probably change quite substantially. Wage levels may have to rise, if manufacturing firms-many of which pay much less than in such traditionally unionized sectors as autos or steel—are to attract workers with the needed capabilities. Many young people who once might have taken jobs in manufacturing now go on to a junior or community college; fewer seem interested in pursuing a factory-bound career. It has become difficult for many U.S. firms to find, not only production workers with adequate skills, but technicians and engineers willing to work on the shop floor. Still, managers of large companies generally see the most serious problems, not in their own organizations, but in their suppliers-particularly small firms that not only pay low wages but do little or no training.

Contingent Workers

As noted in tables 4-3 and 4-4, American companies have begun relying more heavily on contingent workers—those without formal or long-lasting ties to an employer. During the 1980s, temporary and part-time employment grew at roughly twice the rate of permanent, full-time employment, and now accounts for about one-quarter of all U.S. jobs.[20] For employers, replacing full-time staff with short-term, project-related, or part-time employees provides a simple way to adjust for variations in demand. Work may be subcontracted to small fins, or to individuals. Subcontractors, in turn, may have people on call so that they can respond quickly. Firms that rely on contingent workers can lay off part of the workforce when times are bad, while avoiding some of the costs (e.g., fringe benefits) of a larger core of permanent employees.

Much as in more primitive economies where casual work is common, contingent workers act as buffers. Employers have been able to push much of the risk associated with business downturns, illness, and other interruptions in people's ability to work onto individuals. (While some contingent workers eventually become eligible for fringe benefits such

[20]Richard Belous, "Future Labor Force Requirements," presentational Congressional Research Service, July 26, 1989. Including illegal immigrants, work in the underground economy (most of which is simply unreported, not illegal or otherwise illicit), the self-employed, and those who work at home would increase the fraction significantly. *See International Competition in Services*, op. cit., footnote 14, chapter 7, from which portions of the discussion below draw.

Twenty percent of the 645 firms in the 1990 Towers Perrin/Hudson Institute survey reported that they have a core/contingen workforce; another 11 percent are moving in this direction. "Workforce 2000-Competing in a Seller's Market: Is Corporate American Prepared? A Survey Report on Corporate Responses to Demographic and Labor Force Trends," op. cit., footnote 3, p. 24.

as retirement plans, health insurance, and paid vacations, most do not.) Rarely does a contingent job represent one step on a career ladder; indeed, almost by definition, contingent workers have no access to internal labor markets, and thus little opportunity for on-the-job training.

But, like the "fire-and-hire" approach, reliance on contingent workers may be more expensive for companies than first appearances would suggest. By definition, contingent workers are hard to integrate into group-based production systems. Not only do they lack company-specific training, and commitment to corporate goals, they may not have needed task-specific skills-a particular problem in periods of rapid expansion. When companies design standardized jobs that can be performed by temporaries, whether brought in for 2 days or 2 months, they may be sacrificing efficiency. Over the longer term, companies that rely too heavily on part-time and temporary employees may find that they have substituted flexibility in numbers for the flexibility created by a workforce rich in experience-based skills and know-how.

CONCLUDING REMARKS

New technology in the workplace, new forms of work organization, and the overall shift towards service industries have accelerated the need for training in the U.S. economy. As companies move toward more flexible systems of design, development, and production, they must complement their investments in computer-based technologies with investments in better-trained workers. The needed training goes beyond skills for operating particular pieces of equipment. Restructured organizations cannot function without a workforce that is both well-trained and well-motivated. Increasingly, managements encourage shopfloor employees to view themselves as individually responsible, each in their own small way, for the continued success of the enterprise. Allocating more responsibility and authority to individuals and groups requires attention to both hiring practices and training.

While many plant managers believe that upper-level executives continue to undervalue manufacturing, a growing number of American companies realize that it will take renewed attention to the factory floor to solve their competitive problems. One result: training managers may become members of strategic planning groups-a status unheard of just a few years ago. With more training, workers become more comfortable in learning environments and better able to adapt to new production technologies. Companies that recognize this virtuous circle for what it is have taken a major step toward continued competitive success.

APPENDIX4-A-C0MPUTER-AIDED TECHNOLOGIES IN U.S. MANUFACTURING

Advanced manufacturing technologies come in many varieties. Companies seek lower costs through near-net shape processing (e.g., precision castings in place of machined forgings) and better functional performance through improvements in heat treatment or surface hardening. They specify new materials, including fiber-reinforced composites, which require new processes, and look to automated inspection procedures to locate one-in-a-million defects that would be impossible for human operators to spot.

This appendix first outlines major categories of computer-aided technologies used in manufacting-with no attempt to be comprehensive. The context is one of metalworking rather than the chemical or electronics industries (although many computer-aided technologies can be employed in a surprising variety of production settings). Later sections of the appendix discuss diffusion within American industry and the effects of programmable automation on skills.

Toward Computer-Integrated Manufacturing

Many if not most of the thousands of processes found in U.S. manufacturing share a common attribute: they depend, in one way or another, on computer-based control systems. For many years, the chemical industry has used automated process controls. Once, a control system would have had to be specially designed for a given application. Today, generic components can be programmed via software for abroad range of applications. In steelmaking, optical and electronic sensors monitor the chemistry and temperature of molten metal, feeding information to process control computers. In machining, numerical controls (NC) that once required off-line programming are giving way to controllers that can be used much like a PC.

The great advantage of the computer for automation lies in its flexibility: computers can be reprogrammed, not only for new applications, but to make minor modifications in existing processes. For many years, computers were too expensive to find many applications on the factory floor, but with the development of, first, minicomputers, then the microprocessor and the PC, hardware cost is no longer the chief obstacle. Rather, the cost barriers lie

mostly in software, and in integration. Software programs must not only be written for each new application, they must be debugged and maintained. Integration-locating and assembling equipment that can be linked together, devising software that effectively coordinates equipment from different vendors-often proves much more difficult than initially expected.

Computer-integrated manufacturing (CIM) thus remains an objective more than a reality. Yet many firms have moved quite a long ways down this road over the past two decades. And if some of the past efforts to implement computer-integrated manufacturing now seem overambitious, that should be no surprise. Technological innovation of any stripe brings with it unanticipated difficulties more frequently than unexpected serendipities. The great difference between adopting computer-based control systems for factory automation and computer-based systems, for, say, aircraft flight control is simply that American companies would normally put their best technical people to work on aircraft flight controls, and give them ample budgets, while leaving manufacturing systems to less competent people with less than ample budgets.

Programmable automation began in the 1950s and 1960s, with NC machining and early computer graphics systems. Gradually, these and other stand-alone applications began to be linked through networks and common databases. While the process of integration remains a long way from completion, CIM will eventually be commonplace. The companies that can most quickly and most effectively make something useful of acronyms such as those below will move ahead in international competition:

- CAD, or computer-aided design. In fact, most CAD systems remain limited to computer graphics, the automation of drafting and preparation of bills of materials. Some can generate NC part programs. Such tasks as maintaining databases of drawings and specifications, and making the changes called for during development-often running into the dozens, if not hundreds, for a single part-have become much more manageable.
- CAM, computer-aided manufacturing. Descendants of NC machining, CAM installations today typically link several machines, along with robots and materials handling equipment, to create an automated machining cell or a flexible manufacturing system (FMS-the difference is simply one of scale). Only a few hundred large FMS systems have thus far been built.

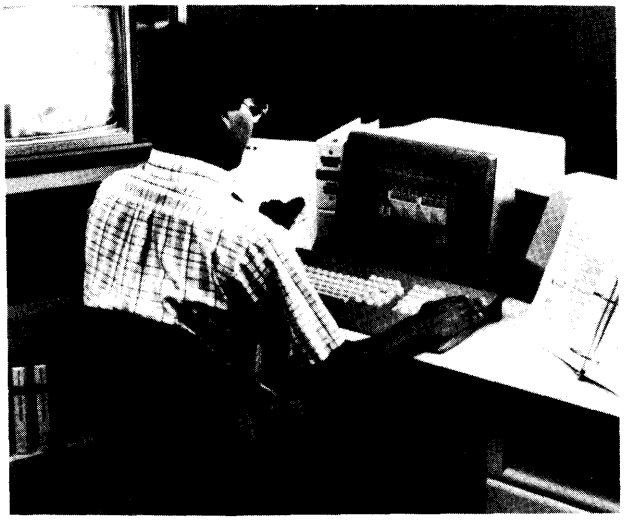


Photo credit: American Association of Community and Junior Colleges

Interactive video training in the use of a computer-aided drafting system.

- CAPP, computer-aided process planning. Many shops now schedule jobs and manage work-in-process inventories with the aid of small computers and commercially available software packages. More American firms make use of CAPP than any other computer-based manufacturing technology.
- CIM, computer-integrated manufacturing. CIM implies combining CAD and CAM, and typically CAPP as well. The primary objective: moving from design to production without an intervening stage of paper drawings and process plans-from CAD to CAM more-or-less automatically. For practical purposes, such systems do not yet exist, except for a few specialized cases such as very large-scale integrated circuits.

As these technologies develop and diffuse, some workplace skills will become obsolete-because taken over by automated equipment-while demand will grow for others, including systems analysis, programmingg, and maintenance of both hardware and software. A big part of the job for analysts, designers, and programmers is to put together CIM systems that are easy for unskilled workers to use. To the extent they are successful, training and retraining for users will be straightforward.

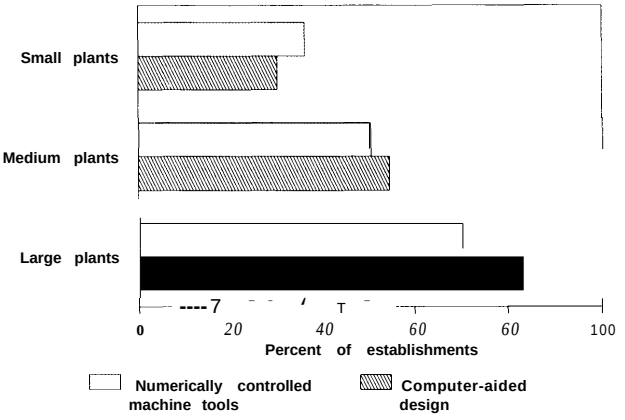
Penetration of Programmable Automation[21]

Surveys indicate that no more than10or11 percent of installed machine tools in the United States have NC capability (about the same as in Japan, although the Japanese machine tool inventory is substantially newer). Over 30 percent of these NC machines are at least 10 years old. Nearly 40 percent of the total consists of simple models that can read instructions but do not incorporate computer controls-technology that has been available for more than 25 years.

None of this should be very surprising. Machine tools have useful lives measured in decades. The stock turns over slowly, with companies retaining older tools as back-ups, even if they rarely use them. Moreover, investment in CIM-related equipment (including CAD, CAPP, programmable controllers, and local-area networks, as well as NC machines) grew at about 15 percent annually during the years 1983-1989-quite a high rate. Two-thirds of U.S. manufacturing establishments have implemented at least one CIM-related technology (and nearly half have at least one NC machine tool). More companies have invested in CAD and CAPP than in NC machinery because the investments are smaller-at the minimum, simply a PC and an off-the-shelf software package. In sum, computer-based manufacturing technologies seem to be diffusing at about the pace that would be expected based on past experience with other technological innovations. Vexing problems in practical application tend to counterbalance the economic driving forces. At the same time, many smaller companies have plainly failed to grasp the logic of programmable automation, and thus have not made investments that would be cost-effective.

Penetration varies with plant size and industry sector, with a relatively few firms, mostly large, accounting for most investments. In 1984, for instance, more than half of all industrial robots could be found in the plants of IBM plus the Big Three U.S. automakers. In 1986, one-quarter of all manufacturing establishments accounted for nearly 85 percent of the CIM-related investment total. According to the Census Bureau survey cited in footnote 21, large establishments make more use of programmable automation than smaller plants (figure 4A-l). Ninety-four percent of manufacturing establishments employing 500 or more people have invested in at least 1 type of computer-assisted technology, versus 67 percent of firms with fewer than 500 employees. Larger plants tend to have more types of programmable automation in place; 80 percent of the large establishments sampled had at least five different advanced technologies, but only 20 percent of small and medium-sized firms.

Figure 4A-l—Penetration of Numerically Controlled Machine Tools and Computer-Aided Design by Plant Size[a]



[a]Small plants have 20-99 employees; medium, 100-499; large, over 500

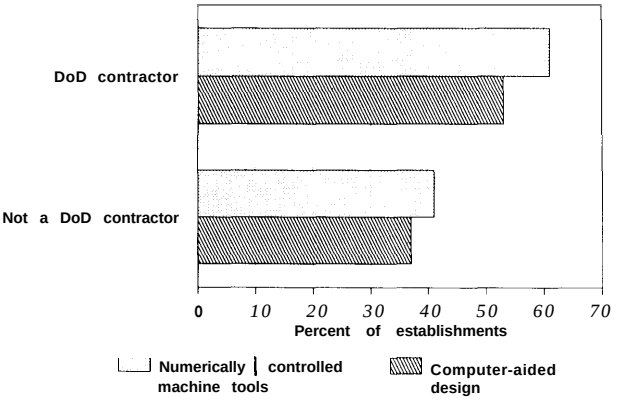
SOURCE: *Current Industrial Reports: Manufacturing Technology, 1988* (Washington, DC: Department of Labor, Bureau of the Census, May 1989), pp. 31,35.

Companies that do most of their business with the Defense Department or other Federal agencies (e.g., the National Aeronautics and Space Administration) make greater use of advanced technologies than those selling primarily to the private sector (figure 4A-2). In the Census survey, 87 percent of plants that viewed government as their primary customer had installed at least one CIM-related technology, compared to 62 percent of plants selling in other markets. Prime contractors and subcontractors show broadly similar patterns of adoption; regardless of their size, firms that make products to military specifications rely more heavily on programmable automation than others.

Most companies surveyed report that improvements in product consistency and quality (more than 80 percent) and reductions in labor costs (78 percent) have motivated their investments. Nonadopters often believe that available technologies are not applicable to their operations, or are not cost effective. Two-thirds of managers in establishments without computer-based equipment reported that their production mix (number of different part designs, average lot sizes) did not just@ automation. In

[21]This section summarizes the results of several recent surveys of the adoption by J.S. manufacturing f- of computer-assisted technologies. Most of the information comes from Maryellen Kelly and Harvey Brooks, "The State of Computerized Automatiorin U.S. Manufacturing," John F. Kennedy School of Government, Harvard University, October 1988; and *Current Industrial Reports: Manufacturing Technology 1988* (Washington DC: Department of Commerce, Bureau of the Census, May1989), as summarized in "U.S. Manufacturing: Problems and Opportunities in Defense and Commercial Industries," staff paper, Office of Technology Assessment, May 1990. Also see Edith Wiarda, *Frostbelt Automation: The ITI Status Report on Great Lakes Manufacturing (Ann* Arbor, MI: Industrial Technology Institute, September 1987). On the situation of smaller firms, see Philip Shapira, *Modernizing Manufacturing: New Policies to Build Industrial Extension Services* (Washington, DC: Economic Policy Institute, 1990).

Figure 4A-2—Penetration of Numerically Controlled Machine Tools and Computer-Aided Design Among Defense and Nondefense Firms



SOURCE: *Current Industrial Reports: Manufacturing Technology, 1988* (Washington, DC: Department of Labor, Bureau of the Census, May 1989), pp. 31,35.

many cases, these perceptions are no doubt accurate, but the survey results also suggest that some managers do not grasp the capabilities of programmable automation and the benefits to be gained.

Both adopters and nonadopters report difficulties in financing purchases. At the same time, some companies have invested in NC equipment, not because it fits their strategic plan or makes economic sense, but simply on an ad hoc basis when replacing worn-out conventional tools. One-quarter of companies that have purchased automated equipment made no further investments during the past 5 years. The surveys, finally, suggest a widening gap between adopters and nonadopters, with most of the new investments over the next few years likely to be made by companies that already have experience with programmable automation. Fewer than 1 in 10 of the establishments reporting no such equipment as of 1987 planned to make purchases over the next 3 years.

Impacts on Skills

Automation not only affects job opportunities, it changes skill requirements, sometimes in the direction of deskilling, sometimes upskilling.[22] At the level of the firm, automation often correlates with new hiring rather than layoffs because companies typically invest in new technologies when business is good Overtime, of course, since the intent is to increase productivity, the firm's employment may decline. For the economy as a whole, the effects of automation depend on the relative rates of growth in output and productivity. Both are uncertain, and none of the many predictions made over the past decade has won widespread acceptance.

When it comes to skill requirements-and the long-running debate over deskilling (whether or not automation, by reducing overall skill requirements, forces a growing fraction of workers to function simply as machine tenders)-the patterns are equally complex. When CAD programs ran on mainframe computers, for example, they were used mostly by engineers and computer specialists, who looked to CAD for help with complex geometrical tasks. In an aerospace company, the same people would often use the CAD system and modify the program (sometimes without telling anyone).

Today, high school graduates with relatively little specialized training can use the turnkey CAD systems available from numerous vendors.[23] So far, these systems have had most of their impact through the automation of such labor-intensive tasks as production of finished drawings based on preliminary sketches. In earlier years, these sketches would typically have been passed along from engineers to drafters who worked at a drawing board. Now the drafting function takes place at computer terminals. Not only drawings of mechanical parts and components, but architectural renderings, electrical, piping, and plumbing layouts, and highway routings can be produced in 10 or 20 percent of the time once necessary.

Though good basic skills are required to use these systems, it takes less training to become a capable CAD operator than to become a competent drafter. While CAD opens up new avenues for the design engineer, the drafter's job has been deskilled. Companies that rely primarily on CAD systems commonly hire people with vocational-technical schooling, but no more than, say, a year's manual drafting experience. They feel that those with more experience will be overqualified (and perhaps overpaid), and unable to adapt as well to an automated work environment.

Early generations of NC technology, somewhat similarly, depended on skilled technicians and engineers to keep the equipment running and improve performance (e.g., through efficient programming). The paper tapes that guided the machines had to be prepared using specialized and complex computer languages. The part programmers who prepared these tapes needed some design skills, as well as knowledge of machining prac-

[22]For a recent summary focusing on conceptual issues in this long-running debate, see Paul Attewell, "Skill and Occupational Changes in U.S. Manufacturing," draft prepared for the conference on Technology and the Future of Work, Stanford University, March 28-29, 1990. For sharply contrasting interpretations of data and projections for the future, see Lawrence Mishel and Ruy A. Teixeira, "The Myth of the Coming Labor Shortage: Jobs, Skills, and Incomes of America's Workforce 2000," Economic Policy Institute, Washington, DC, 1990; and John Bishop and Shani Carter, "The Deskilling vs Upskilling Debate: The Role of BLS Projections," draft, July 18, 1990.

[23]*International Competition in Services,* op. tit., footnote 14, p. 274.

tices. They also had to be well versed in programming. Skilled maintenance workers were needed to oversee the balky and unreliable electro-mechanical tape readers. Machine operators, however, became machine monitors. They were deskilled because the equipment was viewed as too complicated to permit them to write programs or intervene in operations; they loaded and unloaded parts, and watched for malfunctions.

Current generations of microprocessor-basedNC equipment feature help screens and prompts, much as found in software packages for word processing. With a week or so of training, most workers can begin using the simpler systems. Because the equipment is straightforward and reliable, semiskilled shopfloor workers can now do a good deal of programming themselves, limited not by their computer skills but by their knowledge of machining (just as word processing software can catch simple entry or spelling errors but not syntactical mistakes). Maintenance requirements have also changed with the shift from tape readers to direct computer control.

The surveys cited earlier in the appendix (footnote 21) indicate that about two-thirds of NC machine operators have at least "some programming" responsibility, with one-half having "major programming' responsibility. In effect, part programming has now been deskilled; operators and machinists can take back some of the responsibility. Machinists who prepare and debug programs find their jobs have been reskilled. Operators who once simply tended automated machines but now take on some part programming find their jobs upskilled. While few companies cite skill deficiencies as a barrier to purchases of CIM equipment, some report lack of skills to be a barrier to implementation, especially when it comes to maintenance.

Many of the mid-level skills will disappear, as NC systems grow still more sophisticated. Today, CAD systems can automatically generate only simple NC programs. As development of integrated CAD/CAM proceeds, more complex programming tasks will be automated. Eventually, the system will do everything except handle the exceptional cases. Because they are exceptional, these will have to be routed to highly skilled workers, perhaps engineers, who can resolve ambiguities and make decisions requiring trade-offs and design compromises.

As both the CAD and NC examples suggest, programmable automation deskills some jobs and upskills others. When, for example, GM's Linden, New Jersey, assembly plant installed robots for welding, painting, and glass sealing, skill requirements for production employees decreased while those for maintenance workers increased Effective application of CAPP requires considerable training, because complex scheduling algorithms replace the rules-of-thumb previously used. Interpreting the results and making effective use of them demands at least as much expertise and judgment as the older procedures—but expertise of a different sort.

Programmable automation shifts the mix from repetitive tasks (loading/unloading, checking dimensions, monitoring) toward set-up and maintenance, as well as preparing and editing programs. Skill shifts, moreover, may be cyclical, as in the case of NC machine operators—whose work was first deskilled through automation, then upskilled as programming became simpler, and in the end will probably be deskilled again, as programming itself is more fully automated. The general pattern appears to be one in which much of the early technology development is done by users. Typically, those users are highly skilled-often engineers. As the technology matures, vendors take over most of the development. The highly skilled work migrates from users to equipment suppliers, with jobs in the user firms generally being either deskilled (CAD operators in place of drafters) or reskilled (NC programming in place of manual machining).

At the same time, looking at the effects of new technologies on a task-by-task basis can be misleading. While any one task-or all the tasks for a given worker—may become easier, the job as a whole may become more difficult because of the mix of tasks or the speed of production. Often, new equipment operates faster. Moreover, the company will seek to keep it running to maximize the payback on its investment. Operator errors and downtime become more costly. (Japanese factories are notorious for the pressure placed on individual employees.) Preventive maintenance and process quality are likely to become more important. Emphasis on quality and avoiding mistakes requires a broad understanding of the production process. With companies pushing for flexibility (shorter production runs, more frequent product change), employees will find themselves engaged in a wider range of activities. These activities will change more frequently, putting a greater premium on alertness and diligence, as well as continuing on-the-job learning.

Chapter 5

Delivery of Training by U.S. Firms

CONTENTS

Box

Tables

Chapter 5
Delivery of Training by U.S. Firms

SUMMARY

U.S. companies spend billions of dollars each year to train workers. Still, the extent and quality of training vary dramatically, and firms seldom evaluate their efforts. Only 35 percent of workers say they had any form of training while at their current job.

As interest and investment in training grow, a few pioneering companies, large and small, are designing training programs to support strategic corporate goals. These firms often find that new instructional technologies can deliver high quality training at less cost than traditional teaching methods. Both efforts-to systematically integrate training with business strategy and to apply instructional technologies-are still in their infancy, however. (See ch. 7.)

New training organizations and support structures, including State assistance programs and industry consortia, are emerging. While these sources promise to enhance the scope and quality of training, their efforts are fragmented and not widespread.

While the data are poor, recent estimates of the total annual employer investment in formal classroom training range between $30 billion and $45 billion. Expenditures on informal on-the-job training could be greater, because few U.S. workers receive training in a formal classroom or laboratory setting. Most on-the-job training is unstructured—left to chance. Some U.S. firms have found that rapid technological change increasingly requires workers to have broader, more theoretical job knowledge that can be provided best through formal training. (Formal and informal training can be merged at the worksite through job aids, simulators, and other new forms of instructional technology).

Formally or informally, U.S. employers provide little training partly out of fear that well-trained employees will sell their skills elsewhere for higher wages. Human capital theory and subsequent empirical studies suggest that employers can use a variety of mechanisms to protect themselves from such risks. There is some evidence that the most highly trained workers are those least likely to quit or be laid off. Still, the fear of losing their investment as well as a lack of training knowledge and experience make many managers reluctant to spend major sums on formal or structured informal training.

U.S. workers receive training from many sources: colleagues and supervisors, in-house training departments, equipment vendors, private training companies, and public and private schools and colleges. When firms introduce new technologies and redesign jobs, they rely primarily on in-house training and training by equipment vendors. Once job descriptions become well-established, educational institutions provide more of the training.

The quality of training delivered by these sources varies greatly. In many companies, the in-house training department is seen as a wayside within the corporate hierarchy, and rising young executives hope not to be placed there. Outside sources, in contrast, are eager to serve client companies. However, many equipment vendors give only cursory training to a small group of employees-the vendor's frost concern is selling equipment. While many schools and colleges can provide more comprehensive, general training, employers see it as more than is actually required, and may not want to pay for it. Alternatively, there is a huge maze of for-profit training companies and consultants-3,500, by one estimate-and no way to judge their quality except by word-of-mouth. They sell both high quality products and services and untested, off-the-shelf training materials.

Over the past two decades, the States have expanded their business development efforts to include modest support for training. Today, State investments in worker training are aimed not only at wooing new firms to boost the State economy, but also at inducing existing employers to create new jobs or to avoid layoffs.

By the 1988-89 fiscal year, 44 States operated 1 or more company-customized training programs, with annual budgets totaling about $375 million. In addition to these formally budgeted programs, a few States have spent large sums on training as part of a package of incentives to attract new industries, especially new auto plants. Many State-subsidized educational institutions also provide customized training for employers on an ad hoc basis outside of any formal, statewide program.

Despite this growing investment, few States have evaluated their training efforts. One preliminary study indicates that State assistance has played a positive role in achieving the goal of enhancing the competitiveness of existing firms.

Small employers, who are most in need of training assistance, often need better technology and improved management techniques as well. However, current State technology assistance programs (which provide consulting services to firms seeking to upgrade their hardware, software, and management systems) are limited in scope and poorly linked with State training assistance. Neither State technology assistance nor State training assistance programs are adequate to meet growing employer demand. "One-stop" training and technology assistance for small employers lost in the jungle of public and private training providers is available only in Michigan, Massachusetts, and a few other States.

Growing State involvement in worker training raises important policy questions. Perhaps most fundamental is: Should government intervene in the training marketplace, and what criteria should govern its assistance given that State resources will never be adequate to aid all firms? Closely related is the question of substitution: Are companies using State training funds to support nontraining activities? If the money is being used correctly, would the firms have trained their workers anyway in the absence of State subsidy?

Raising these questions may be less necessary if companies are required to prove financial need and are limited to subsidies for formal training or systematic on-the-job training (such as trainers' salaries while on the shopfloor) which can be clearly identified as training time.

HOW MUCH TRAINING IS DELIVERED?

Accurate estimates of the extent of worker training do not exist. There are several reasons:

- Few firms respond to surveys; only a handful of firms keep track of training expenditures and these firms account for training costs in very different ways.[1]
- In employee surveys, workers' memories and perceptions of training events maybe unreliable.[2]
- Employers more often train their workers informally on the job than in formal classrooms, making it hard to differentiate between "training time" and "work time."34

Not surprisingly. therefore, estimates of the total employer investment in training vary greatly. (See table 5-l.)

Estimates of U.S. employers' investments in *formal training* range from $30 billion to $44 billions While these estimates could be off track, there is no doubt that employer-provided training is a large enterprise. How large is a matter of interpretation. The $44-billion estimate is less than 1 percent of 1988 Gross National Product (GNP) ($4.88 trillion). Averaged across an employed workforce of 114 million, investments in formal training are, at most, $385 per worker per year.

In contrast, the total cost to educate America's 58 million full-time students (those in primary, secondary, post-secondary education) in 1987[6] was about $311 billion[7]-$5,400 per student, or 13 to 20 times greater than the amount spent on workers. Because training is only a small component of most workers' jobs, its costs should not be nearly as great as those of the full-time education of students.

[1]Ann P. Bartel, "utilizing Corporate Survey Data to Study Investments in Employee Training and Development' discussion paper for the National Assessment of Vocational Education, February 1989.

[2]Nell P. Eurich, *Corporate Classrooms* (Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching, 1985), p. 7.

[3]Anthony P. Carnevale et al., *Best Practices: What Works in Training & Development—Organization and Strategic Role*, report prepared fOr U.S. Department of Labor (Alexandria, VA: American Society for Training and Development March 1989), p. 36.

[4]U.S. Congress, Office of Technology Assessment, Technology *and* the *American Economic Transition*, OTA-TET-283 (Springfield, VA: National Technical Information Service, May 1988), p. 129.

[5]The most recent estimate, for 1989, is $44 billion. This total was extrapolated from a survey of companies with 100 or more employees which received only a 16 percent response rate. The low response rate makes the accuracy of the extrapolation questionable. The survey was published in *Training Magazine,* October 1989.

[6]U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics 1989* (Washington, DC: U.S. Government Printing Office, 1989), p. 29.

[7]Ibid., p. 9.

Table 5-l—Estimates of Employer Investments in Training (total annual investment by U.S. employers)

Author	Total	Format	Informal	Comments
		(dollars in billions)		
Oberle (1989) [a]	NE	44.4	NE	The survey was sent to 20,000 business units with 100 or more employees in early 1989; 3,130 responded for a 16 percent response rate; estimate excludes wages of trainees. Three-fourths of the total was for wages of trainers. Excludes government training.
Mincer (1989) [b]	105-210	NES	NES	This study used wages while in training as a proxy for training costs. Includes government training.
Bartel (1989) [c]	NE	55	NE	The survey was sent to 7,765 business units in early 1987; 493 responded (6 percent response rate). One-third to one-half of responding units had formal training programs. Some respondents may have included trainees' wages in their cost estimates. Excludes government training.
ASTD [d]	120-210	30	90-180	The formal training estimate is based on average training costs multiplied by the number of trainees and courses from the 1978 Current Population Survey. ASTD excludes wages of trainees and government training from its formal training estimate. The low end informal estimate is based on a Bureau of Labor Statistics survey which found that informal training was cited three times more frequently than formal training as a source of qualifying training. [e] The high end informal estimate is based on Mincer's 1989 estimate ($210 billion) minus ASTD's formal training estimate ($30 billion).
Carnevale & Goldstein (1985) [f]	NE	10-21	NE	The study used 1978 case study survey data from 12 large firms, to determine training costs. This was multiplied by the number of courses from 1978 Current Population Survey. Includes government training. Higher estimate includes wages.
Craig & Evers (1981) [9]	NE	30-40	NE	Assumes average firm spends half AT&T's 1981 average per employee training expenditure of $1,500, and that half of all U.S. employees receive training. Includes government training. Excludes wages of trainees.

NOTE: NE -not estimated; NES not estimated separately.

[a] Joseph Oberle, "Training Magazine's Industry Report 1989," *Training Magazine, vol.* 26, No. 10, October 1989, P. 32.

[b] Jacob Mincer, "Labor Market Effects of Human Capital and of Its Adjustment to Technological Change," discussion paper for the National Assessment Of Vocational Education, February 1989, pp. 17,33. A December 1989 analysis by Mincer, using much the same methodology, resulted in a revised total of $240 billion to $330 billion for formal and informal training combined.

[c] Ann P. Bartel, "Utilizing Corporate Survey Data to Study Investments in Employee Training and Development," discussion paper for the National Assessment of Vocational Education, February 1989, p. 5.

[d] "Amount Spent on Training by American Businesses—Fact Sheet" (Alexandria, VA: American Society for Training and Development, no date).

[e] Max L. Carey, *How Workers Get Their Training,* U.S. Department of Labor, Bureau of Labor Statistucs, bulletin no. 2226, March 1985.

[f] Anthony P. Carnevale and Harold Goldstein, *Employee Training: Its Changing Role and An Analysis of NW Data* (Alexandria, VA: ASTD Press, 1985), pp. 77-82.

[9] As cited in Carnevale and Goldstein, in footnote f above.

SOURCE: Office of Technology Assessment, 1990.

However, training expenditures are also quite modest when compared with other employer investments in their workers. Forty-four billion dollars equals 1.8 percent of the total compensation that American firms and other private employers paid their workers in 1988 ($2.4 trillion). A few companies spend amounts equal to 4 or 5 percent of their payroll on formal training while others spend nothing. Overall, employers spent more (2.8 percent of payroll) on coffee breaks, lunch, and other paid rest time for their employees than on formal training.[9]

When the costs of informal training are included, cost estimates range from $105 billion to $210 billion or more per year (see table 5-l). However, the

[8] *Survey of Current Business,* vol. *69, No. 7,* July 1989, table 1.14, P- 45.

[9] U.S. Chamber of Commerce, "Employee Benefits," Survey *Data From Benefit Year 1988* (Washington DC: 1989), p. 27.

$210 billion estimate is not comparable with the other estimates in table 5-1, because, unlike the others, it assumes that workers share in the costs of training by accepting a lower wage than would otherwise be paid during the training period.

Most informal training is unstructured, consisting of experienced co-workers and supervisors showing newer employees how to do their jobs. Such training does not compare favorably with the highly structured informal training and the growing amount of formal training provided by firms in competitor nations (see ch. 3).

Training in Small Firms

Training is delivered unevenly across firms and among workers. While a few large corporations spend major sums on employee training, many small companies spend little or nothing.[10] Larger firms are more likely to provide structured training because they have lower labor turnover and greater access to capital to finance training.[11] It is also possible that the training tends to further reduce their labor turnover.

Although smaller firms invest little in formal training, they nonetheless do train their employees informally. Typically, workers at firms with less than 100 employees have greater training needs because, in comparison to workers at large fins, they tend to be less well-educated and have a less stable employment history. These needs are usually met by supervisors or co-workers informally teaching new hires.[12]

Strong management commitment at some smaller firms drives investment in formal as well as informal training. A few even develop their own in-house training. For example, General Tool, a family-owned machine tool job shop in Cincinnati, has a full-time training manager who designs and delivers both an apprenticeship program and ongoing off-hours courses for the company's 300 employees.[13] The company defrays part of these costs by allowing nonemployees to enroll in its classes for a fee.

Economic Barriers to Workplace Training[14]

According to human capital theory, worker training extends across a spectrum ranging from "general' training, which ''is useful in many firms besides those providing it,"[15] to "specific" training, which is useful only in the firm where it is provided. Because firms could lose part of their return from general training investments if a newly trained worker took a job with another firm, the theory states that, although firms might provide such training, they do not pay for it. Instead, employers pay a lower wage during the training period to cover the training costs. Employees accept the lower wage because they recognize that they will benefit from the general training. Another theorem of human capital theory is that firms and workers share the costs of specific training (the workers' share is paid in the form of a wage lower than their productivity would otherwise justify) since both parties benefit.[16] To guard against turnover, the theory says, firms pay higher wages following specific training than would be warranted based strictly on productivity.

Some subsequent empirical studies have called both of these basic premises into question, suggesting that firms sometimes pay for general training and that firms and workers do not always share the costs of specific training. More importantly, however, these studies found that, when firms do take the risk of investing in *both* general and specific training, they are less likely to lose their investment through quits or layoffs than the original human capital theory would suggest. This suggests that, at least in

[10]Jerome M. Rosow and Robert Zager, *Training: The Competitive Edge (San* Francisco, CA: Jossey-Bass, 1988), p. 1.; Eurich, OP. cit., footnote 2, p. 9; Sheldon Haber et al., "Employment and Training Opportunities in Small and Large Firms" (Potomac, MD: Simon & Co., under U.S. Small Business Administration Contract No. SBA-8587-AER-84, 1988), p. viii.

[11]John H. Bishop, ''On-the-Job Training of New Hires," working paper #89-1 1, Center for Advanced Human Resources Studies, Cornell University; presented at the symposium on market failure in training, LaFollette Institute of Public Affairs, University of Wisconsin, Madison, May 1989, p. 33.

[12]''Employment and Training Opportunities in Small and Large Firms, " op. cit., footnote 10, p. *90.*

[13]James Stewart, Director, Manufacturing and Engineering, General Tool Co., personal communication, May 4, 1989.

[14]This discussion is based on *a* working paper by Michael J. Feuer, OTA, "Economic Analysis of Workplace Training: Human Capital Theory and Beyond,'' August 1989.

[15]Gary Becker, Huron *Capital: A Theoretical and Empirical Analysis With Special Reference to Education*, 2d ed. (New York, NY: National Bureau of Economic Research and Columbia University Press, 1975), p. 19.

[16]''Eeonomic Analysis of Workplace Training," op. cit., footnote 14, p. 30.

some instances, training is less risky as an investment than many employers believe.[17]

A study of scientists and engineers found that those whose firms financed their general training (by paying for outside courses) earned just as much during training as those who were paying for their own education.[18] The same study found that quit rates were no greater among scientists and engineers whose firms paid for general training than among those who paid the costs of general training themselves, either through lower wages or by paying tuition for courses out of their own pockets.[19] Another study, based on a 1982 survey of over 3,000 employers, provides further evidence that firms do indeed pay at least some of the costs of general training.[20] T. recapture some Of these costs, wage rates following training were lower than the increased productivity of the workers would warrant. Despite the low wage, the workers were still unlikely to quit or be hired away by rival firms because their new skills were poorly "signaled" to the labor market-that is, rival firms were unaware of these skills and how they might benefit from them.[21]

An earlier study of manufacturing workers found that when workers financed a greater share of their specific training (by accepting lower wages), they were less likely to quit. When the firms paid a greater share of specific training, they were less likely to lay off the workers.[22]

In actual practice, firms rarely offer training that is purely general or purely specific. Instead, the two types of training blend along a continuum. Some empirical studies suggest that when general and specific training are offered jointly, turnover rates are reduced, so the likelihood of losing the investment is lowered.[23] More importantly, the "risk" of providing general, transferable skills may be outweighed by the benefit to the firm from increased efficiency in specific training.[24] Because employers are most likely to capture the benefits of specific training, and the costs of specific training are lowest when the employee possesses broad, transferable skill, the investment in general training may be worthwhile.

Both in its original formulation and in many subsequent studies, human capital theory suggests that employers can use a variety of mechanisms to minimize the real or perceived risks of training investments. Even so, some managers view training not as a strategic investment to improve human capital, but as either an avoidable expense or an expensive benefit. When profits are up, training increases; in lean years, it is cut back.[25]

Cost is not the only barrier to worker training. Many employers are reluctant to provide training because they do not know the best approach. Senior managers may not fit training into their plans to introduce new technology and/or new work processes.[26] Production managers are often reluctant to disrupt operations by releasing employees for training in the hopes of an elusive future benefit. Many inexperienced managers fear training will fail, while others who have had bad experiences with previous, ill-conceived training efforts are even more wary.[27]

Despite these barriers, the competitive pressures outlined in chapter 3 are forcing companies of all sizes to reevaluate their training needs. Small and mid-sized suppliers to larger companies will need better trained workers to meet the stricter quality requirements of the purchasing fins.

---

[17] Ibid., p. 37.

[18] Michael Feuer, Henry Glick, and Anand Desai, ' 'Is Firm-Sponsored Education Viable?" *Journal of Economic Behavior and Organization,* vol. *8, 1987, pp. 121-136.*

[19] Ibid.

[20] Bishop, op. cit., footnote 11.

[21] Ibid.

'Donald Parsons, "Specific Human Capital: An Application to Quit Rates and Layoff Rates," *Journal of Political Economy,* vol. *80, No. 6,* November/December 1972, pp. 1120-1143.

[23] Michael Feuer, Henry Glick, and Anand Desai, "Firm Financed Education and Specific Human Capital: A Test of the Insurance Hypothesis," invited paper, symposium on market failure in training, LaFollette School of Public Affairs, University of Wisconsin, Madison, May 1989.

[24] Masanori Hashimoto, personal communication, June 1989.

[25] Eurich, op. cit., footnote 2, p. 5.

[26] Peter A. Creticos and Robert G. Sheets, "Evaluating State-Financed, Workplace-Based Retraining Programs," forthcoming report to the National Commission for Employment Policy and the National Governors' Association March 1990, p. 56.

[27] Ibid., p. 58.

THE IMPACT OF EMPLOYER-PROVIDED TRAINING

A few companies have made major commitments to training. For example, International Business Machines Corp. (IBM) and Xerox Corp., spend 4 percent or more of payroll on training. Motorola, Inc. has a corporatewide policy of budgeting 1.5 percent of payroll for training and in fact often spends more (2.4 percent in 1987).[28] Motorola is now proposing that each employee receive at least 40 hours of education and training each year.

One recent study[29] urged American employers to spend 2 percent of their payroll on human resource development, with the ultimate goal of reaching 4 percent nationwide. However, simply throwing more money at training will not help firms function better.

Some companies have been able to reap substantial savings by evaluating their training programs in light of company goals. For example, in 1985, IBM's top managers found that they did not know what the corporation's total annual expenditure on training was. It took a 3-month study to reveal that IBM was spending $900 million a year (or 4.7 percent of total compensation) on education.[30] Top management called for a follow-up study to determine whether the $900 million total was justified in terms of the quality of training and its contribution to productivity.

With top-level commitment to acting on the results of the subsequent study, training was "recentralized,' under a Director of Education reporting to top management; training courses were redesigned, eliminated, and/or created to match them more closely to company jobs; and cost-effectiveness studies led to greater use of distance learning technologies. A new 5-year strategic plan for education, closely linked to business goals, is now halfway through implementation, and rapidly rising training costs have been contained.[31]

Other companies, too, have saved money by taking a closer look at their training programs and evaluating the cost-effectiveness of alternative delivery methods. NCR Corp. (formerly National Cash Register) expects to save $70 million per year in training costs by producing its own training materials on interactive videodisc.[32]

Effects on Job Performance

Most efforts to strengthen the quality of training focus on improved job performance. Recent research as well as anecdotal evidence from companies indicate that knowledge gained outside of the normal job context (such as in a classroom) is difficult to transfer back to the worksite.[33 34] There are many reasons for this nontransfer: Training departments are often left out of top corporate planning, line managers sometimes fail to reinforce application of the newly learned skills, and, in many cases, the course itself may not be really focused on the content of trainees' jobs.

There are techniques for more closely relating training to job performance. Companies that can afford to undertake job analysis, for example, can often improve their training programs. IBM's effort to create a more responsive training system resulted in dropping many courses while adding others to match the 85 major job categories in the company .35 This pruning used Instructional Systems Design ISD-see ch. 7 for a more complete discussion) to evaluate the previously existing array of courses for relevance to the content of specific jobs. Through the

---

[28] Paul V. Delker, "Worker Training: A Study of Nine Companies," contract report prepared for the Office of Technology Assessment, September 1988, p. 47.

[29] Anthony P. Carnevale and Janet W. Johnston, Training America: Strategies *for the Nation* (Alexandria, VA: *American* Society fOr Training and Development 1989, p. 5). The study was jointly sponsored by ASTD and the National Center for Education and the Economy.

[30] Ralph E. Grubb, "Training in the Workplace: An IBM Case Study," report prepared for the Office of Technology Assessment under contract L3-2830, February 1990, pp. 12-14.

[31] Patricia A. Galagan, "IBM Gets Its Arms Around Education," *Training and Development Journal,* vol. 43, No. 1, January 1989, pp. 35-41.

[32] Robert R. Miller, "Corporate Strategy and Industrial Training," contractor report prepared for the Office of Technology Assessment under contract L3-5240, February 1990, p. 41.

[33] Helen Kelly, "A Primer on Transfer of Training," *Training and Development Journal,* November 1982, p. 102.

[34] Lauren B. Resnick, "Learning In School and Out," *Educational* Research, No. 16, pp. 13-20; and others cited in David Stern, "Institutions and Incentives for Developing Work-Related Knowledge and Skill," paper presented at the Technology and the Future of Work Conference, Stanford University, Stanford, CA, Mar. 28-29, 1990, p. 6.

[35] Galagan, op. cit., footnote 31, p. 39.

use of ISD, the length of some courses was cut by 25 percent.[36]

The cost savings from eliminating "nice to know" information and keeping only "need to know" information may be substantial. However, managers seeking greater worker participation as part of their business strategy often find that the "need to know' category is quite large. According to one recent study of workplace training:

> What employees need to learn, beyond their immediate assignments, depends on what the employer wants them to contribute. Leading companies . . . tell them a great deal about corporate goals and plans, the operation of the job site, the jobs of peers and managers, the functions of adjacent work units, the technology in use, effective problem-solving methods, and actual costs.[37]

In some cases, training does not translate into improved job performance because other steps, such as reorganization of work, have not been taken. For example, operators in a large (900-employee) east coast cookie factory received training in statistical process control (SPC), problem-solving, and troubleshooting. However, their jobs remained unchanged, so that they had little opportunity to use their new skills. Thus, the training had little impact.[38]

In other cases, the lack of transfer is due to a lack of post-training follow up. One study found that students were most likely to apply time management skills learned in a short course when they attended a follow-up session where they set goals for applying their new skills.[39]

Linking Training to Management Strategy

Many observers note that training departments of large companies are often isolated from top management and that training content is often developed haphazardly, in response only to immediate needs.[40] Thus, lower level managers often justifiably doubt the usefulness of training because it sidetracks people from their "real" work with no apparent benefit.[41]

Responsibility for training is necessarily decentralized.[42] A 1988 survey of 12 large corporations revealed that, in all but one company, line managers controlled at least 75 percent of the total corporate investment in training.[43] Although local decisions are important for flexibility, company-wide training commitments may not develop without some centralized guidance. Some large corporations, like IBM, may gain economies of scale and tie training more closely to strategic goals by centralizing oversight of the entire training process at a point high on the organization chart. To be avoided is having a human resource development (HRD) department that produces training videos and courses that may not be used by operating divisions, while field managers act on their own to produce or buy a whole smorgasbord of other training services.

For small businesses, linking training to management strategy may be easier. Because most small companies cannot afford to hire a fill-time trainer, there is no danger that training can be isolated from corporate goals. In fact, top management sometimes *is the HRD* department."

Managers in many U.S. industries rank improving the quality of their products or services high among corporate goals. When the correct links are forged,

---

[36]Ibid.

[37]Rosow and Zager, op. cit., footnote 10, p. 14.

[38]Larry Hirschhorn, "Training Factory Workers: Three Case Studies, " contractor report prepared for the Office of Technology Assessment," July 1989, p. 5.

[39]Kenneth N. Wexley and Timothy T. Baldwin, "Posttraining Strategies for Facilitating Positive Transfer: An Empirical Exploration," *Academy of Management Journal,* vol. 29, No. 3, September 1986, pp. 503-520.

[40]Thomas J. Chmura et al., "Corporate Education and Train@," SRI International Business Intelligence Program Report No. 753, fall 1987, p. 7.

[41]Rosow and Zager, Op. cit., footnote 10, p. *5.

[42]Richard Gordon et al., "Proposalfor Creation of a Research Planning Group submitted to the Council for European Studies," December 1988, p. 3.

[43]Anthony P. Carnevale and Eric R. Schulz, *Best* Practices: *What Works* in *Training* & *Development: Accounting and Evaluation,* report prepared for U.S. Department of Labor (Alexandria, VA: American Society for Training&Development Mar. 31, 1989), p. 149.

[44]For example, the owner of one small manufacturing company in Cincinnati not only budgets for formal and informal training, but also delivers much of the employee training himself. Typically, he trains the foremen and coaches them as they train the production workers. George Wiles, President, Planet Products, interview of May 4, 1989.

training can play a critical role in quality improvements.

Training has played an important role in Ford Motor Co.'s quality improvement strategy. Following massive layoffs in the early 1980s, Ford instigated an Employee Involvement (EI) process for its unionized workforce. Training in joint problem-solving took place on company time, as did a subsequent program teaching managers how to work successfully with the more participative workers.

At the same time, Ford and the United Auto Workers were jointly developing a broad range of personal development courses offered off-hours. As discussed at greater length in chapter 8, these personal development courses made on-the-job training easier by enhancing participants' self-esteem, interest in learning, and basic skills. According to Ford's former Chief Executive Officer, Donald E. Petersen, training and EI played a major role in the firm's 1986 turnaround from near-bankruptcy to record profits. Petersen, who retired in 1990, views ongoing training as a key to the continual quality improvement needed to sustain profitability .45 (See box 4-D inch. 4 for further discussion of training in company efforts to improve quality.)

Training can play an important role in achieving other corporate goals too. For example, as global markets mingle, many U.S. corporations seek to increase exports. This requires employees who can operate effectively in other cultures and languages. Aetna's Corporate Education Institute provides courses in cross-cultural issues to support the company's attempt to break into foreign markets. Motorola's Training and Education Center briefs top management on the culture and history of Asia, to better understand the company's foreign competitors and to help tap Asian markets.[%]

Even firms who are not focused on exporting are finding that the demographics of their workforces are changing (see ch. 3). As the number of immigrants grows, language barriers will affect on-the-job training. More companies will need trainers and supervisors who are adept in multicultural and multilingual environments.

Evaluation of Training

Evaluation can improve training. Although it is rare, managers are becoming more interested in evaluation when they look more closely at their training expenditures and ponder what they got for their money.

A 1986 survey of training professionals in major corporations found that less than half of the training programs offered by their firms were evaluated at all.[47] Similar results were obtained in 1988, when ASTD surveyed several large companies known to keep excellent records of training costs. Of this small group, only 10 percent actually assessed the impacts of training on job performance, and only 25 percent looked at business results. In most of the firms, evaluation of training was limited to participant reactions and, to a lesser extent, knowledge gains.[48]

The ideal evaluation method for training measures:

1. reactions (how participants felt about the course);
2. knowledge/skill (through competency tests);
3. application (impact on job performance, judged by interviews with supervisors and peers following training); and
4. business results (such as increased sales or profits following training).[49]

The difficulty of applying this four-part model is illustrated by the experience of New England Telephone (NET), A rigorous evaluation of a technician training program took a full year to complete. With normal job turnover, the managers who had originally requested the study were gone by the time the favorable evaluation report arrived.[50] Today, NET relies primarily on reaction sheets and on focus groups held several months after training to

[45] "Donald E. Petersen: Chairman of Ford and Champion of Its People," *Training & Development Journal,* August *1988.*

[46] Chmura, et al., op. cit., footnote 40, p. 9.

[47] T. Meigs-Burkhart, *Employee Training in America:* A *Comparative Assessment of Training and Development* (Princeton, NJ: Opinion Research Corp., 1986).

[48] Carnevale and Schulz, op. cit., footnote 43, p. 142.

[49] Donald Kirkpatrick, "Evaluation of Training," in R.L. Craig and L.R. Bittell (eds.), *Training and Development Handbook* (New York, NY: McGraw-Hill, Inc., 1976).

[50] As cited in Carnevale and Schulz, op. cit., footnote 43, p. 117.

Table 5-2—The Skill-Training Life Cycle

Changes in jobs, skills, and training	Phase of technology development			
	Phase 1: Introduction	Phase II: Growth	Phase III: Maturity	Phase IV: Decline
Tasks	Complex	Increasingly routinized	Increasingly routinized	Narrowly defined
Job Skills	Firm-specific	Increasingly general	General; transferable	General; transferable
Skill training provider	Employer or equipment manufacturer	Market-sensitive schools and colleges	Schools and colleges more generally	Declining number of schools and colleges; some skills provided by employer
Impact on jobs	Job enlargement; new positions created with significant change in skills needs	Emergence of new occupations	Relatively rigid job hierarchy; occupations associated with formal education and related work experience requirements	Elimination of occupations

SOURCE: Patricia M. Flynn, adapted from *Facilitating Technological Change: The Human Resource Challenge*, T.J. Kozik and D.G. Jansson (eds.), The *Worker in Transition: Technological Change (New* York, *NY:* Ballinger Publishing Co., 1988), p. 19.

attempt to improve the quality of training and to increase its relevance to strategic business goals.[51]

Obviously, many other factors besides training can affect business results. Nevertheless, it is often possible to evaluate training in terms of bottom-line improvements. For example, customer-relations training should bring a reduction in lost customers and an increase in the accuracy of orders, both factors quantifiable in dollars.[52] When IBM trained all 1,500 employees at its Austin, Texas manufacturing plant to make better use of its continuous-flow manufacturing process, cycle time was reduced by over half, reducing inventory costs and avoiding the necessity of adding an expensive third shift.[53]

The potential payoffs of evaluation are great. Such analyses are necessary not only to justify growing corporate investments in training but also to weigh alternative delivery mechanisms and to improve the quality of training.

TRAINING PROVIDERS

When adults were surveyed in 1983 about job-related training, the most striking finding was how few workers received training. About 55 percent said they had needed training to acquire their current jobs, but only 35 percent reported receiving any subsequent formal or informal skill improvement training. Many adults reported receiving training from more than one source. Among those who said they had needed training to acquire their current jobs, almost 29 percent identified secondary or post-secondary schools, 28 percent said they were qualified through informal on-the-job training, and 10 percent obtained their jobs with skills learned in formal company training programs.[54]

Those who had received skill improvement training in addition to their basic qualifying training also frequently reported more than one source of this training. About 14 percent cited informal on-the-job training and 11 percent mentioned formal company training, while 12 percent said their skills were improved through secondary and post-secondary schools.

Many of those who used schools for job training were financially supported by their employers. Among those who reported that schools qualified them for their current jobs, 8 percent were sponsored by their employers, as were a full 41 percent of those receiving skill upgrading in schools.

Who provides training and where it is done may move through a ''skill training life cycle" as new technologies are introduced, develop, and mature.[55] As shown in table 5-2, the introduction of newly developed technology into a workplace can create

[1]Ibid., p. 171.

[52]Dana Gaines Robinson and Jim Robinson, ''Training for Impact,'' Training *and Development Journal*, vol. 43, No. 8, August 1989, p. 37.

[53]Grubb, op. cit., footnote 30, p. 25.

[54]Max L. Carey, *How Workers Get Their* Training, U.S. Department of Labor, Bureau of Labor Statistics, Bulletin No. 2226, March 1985, pp. 5-7.

[55]Patricia M. Flynn, *Facilitating Technological Change* (New York, NY: Ballinger, 1988), pp. 16, 27.

complex new tasks.[56] With the uncertain quantity and quality of skills required and the lack of a supply of appropriately trained workers, managers typically tack these tasks onto existing jobs. Because the skills needed are fro-specific, training is usually delivered either in-house or by the equipment vendor. Later, as the technology matures, tasks related to it become more standardized, new occupations related to it may emerge, and the supply of appropriately trained workers expands. Training for these new jobs, created by the adoption of relatively mature technologies, is more general (i.e., transferable among fins) and is more often provided outside the firms in schools and colleges.

According to one estimate, employers provide 69 percent of their formal training themselves and purchase 31 percent from outside providers.[57] (See box 5-A for a breakdown on the Federal Government's training expenditures on its own employees.) This reliance on in-house training maybe explained in part by the skill-training life cycle, which suggests that firms rely on in-house sources during periods of rapid technological change.

A 1985 survey of supplier firms to the Michigan automobile industry found such a pattern. Among firms that had adopted use of statistical process control (SPC), computer numerically controlled (CNC) and computer-aided design (CAD) technologies, most training was delivered informally on the job. The firms typically sent technicians or line managers to a formal training class; these individuals then trained the others informally .58

The quality of in-house training is directly affected by the skill of training personnel, many of whom lack professional training education. As the number of full-time trainers grows, many trade and professional associations have sprung up to assist

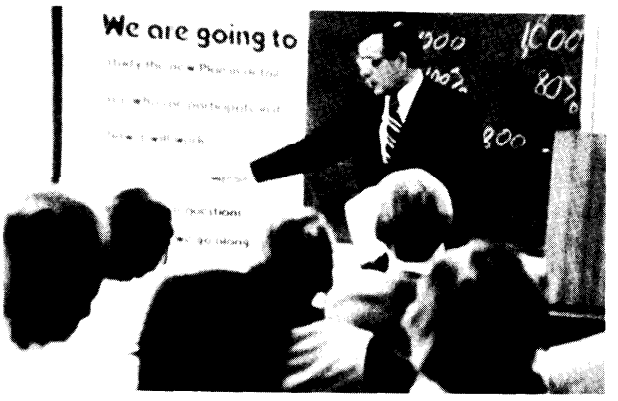


Photo credit: American Petroleum Institute

Employers provide most of their formal training in-house.

them, including the American Society for Training and Development (ASTD), the National Society for Performance and Instruction, the Society for Applied Learning Technology, and the American Management Association.[59] A recent industry directory lists 61 membership organizations serving the training profession.[60] These associations help advance the skills and knowledge of professional trainers through publications, conferences, informal networking, and, in some cases, training courses.[61]

When they turn to outside resources, U.S. firms purchase training from a wide variety of providers including equipment vendors, private training consultants, and public and private schools and colleges. These purchases are estimated to total about $9 billion per year.[62]

The relationship between in-house and outside training is complex. In-house trainers may assist in the design of a purchased course and maybe trained to teach it. On the other hand, some in-housetraining departments, such as AT&T's, have become so

[56]Patricia M. Flynn, "Introducing New Technology into the Workplace, " in *Investing in People: A Strategy to Address America's Workforce Crisis,* Background Papers, V. 1 (Washington, D.C.: U.S. Department of Labor, Commission on Workforce Quality and Labor Market Efficiency, September 1989), pp. 421426.

[57]Anthony P. Carnevale et. al., *Training Partnerships: Linking Employers & Providers* (Washington, DC: American Society for Training & Development 1990), p. 1.

[58]James Jacobs, ''The Training Needs of Michigan Automobile Suppliers" (Ann Arbor MI: Industrial Technology Institute, 1986), P. 7.

[59]Lee Gainer, ASTD, personal communication+ July 27, 1989.

[60]Lakewood Publications, *Training 1988-1989 Marketplace Directory,* p. 306.

[61]For e-pie, the Miami Florida Chapter of ASTD, working with Florida International University, developed a two-semester part-time program leading to certification as a professional trainer. The curriculum included courses in instructional design and evaluation training—Betsy Caster and Willabeth Jordan, "professional Trainers Go to School," *Training and Development Journal,* vol. 43, No. 7, July 1989, p. 78.

[62]*Training* magazine's 1989 industry survey estimates that $9.37 billion was spent on purchased training that year—*Training*, Op. Cit., footnote 5, p. 40. Carnevale estimates that31 percent of total employer investments of $30 billion, or $9 billion per year is spent on purchased training—Carnevale et al., (1989) op. cit., footnote 3, p. 1.

Box 5-A—The Federal Government as Trainer

Federal agencies spent $1.03 billion on training of their 2.1 million civilian employees in fiscal year 1988.[1] This amounted to nearly 1.7 percent of the government's payroll (salary, wages, and lump-sum payments, but not benefits) in 1988[2] (By contrast, some training intensive companies may spend 2.5 percent of payroll or more on training.)

Almost 60 percent of the training dollars was used for internal training by agencies. The other 40 percent was used to cover the costs of training provided by public colleges and universities, trade and professional associations, and private training institutions.[3] Managerial, executive, and supervisory employees accounted for approximately 15 percent of total training hours and expenditures; nonsupervisory employees accounted for the remaining 85 percent.[4]

While statistics on training are collected by the Office of Personnel Management, qualitative assessments are more difficult to find. In the years between 1978 and 1988 the number of employees receiving training almost doubled, and the hours spent on training increased by 90 percent. The cost per hour of training increased by 20 percent, while the average length of training received by Federal employees decreased by a quarter.[5] It does not appear to be known how much of this to attribute to use of more effective training methods and technologies and how much to attribute to agency efforts to compensate for rising costs by shortening training sessions.

In the years between fiscal years 1985 and 1987, time devoted to the design and conduct of training by Federal employees increased 4.5 percent. The mix of personnel involved in training activities shifted to involve more instructors, and fewer support and administrative staff.

The U.S. military budgeted over $18 billion for training in fiscal year 1990. This includes pay and allowances to trainees and trainers. As discussed in chapter 7 and in the appendix, the military has been a major source of research and development funds for learning research and for development of instructional technology. In fiscal year 1990, it spent $22 million on basic research and exploratory development for education and training, and another $73 million on subsequent or further development. It also spent $81 million for research and development of simulators and training devices.[6]

---

[1]This includes nonuniformed employees of the Department of Defense. It does not include postal employees.

[2]Information provided by Geraldine Hahn, Office of Personnel Management, July 1990.

[3]United States Office of Personnel Management, office of Employee and Executive Development, *Employee Training in the Federal Service, Fiscal Year 1988,* p. 5.

[4]Ibid., p. 7.

[5]Ibid., p. 10.

[6]E.A. Alluisi, L. Richards-Means, and E.B. ViCino, *Training and Personnel Systems: R&D Program Description, Fiscal Year 1989/90 (San* Diego, CA: Defense Technical Information Center, MATRIS Office, 1989).

successful that they are profit centers, selling training to other companies: In a few cases, these training divisions have been spun off into independent corporations, increasing the ranks of private training consulting fins. For example, Learning International, now an independent training vendor, formerly sold training as a division of Xerox (Xerox Learning Systems). The American Supplier Institute, which provides training to auto industry supplier firms, used to be a division of Ford.

Equipment Vendors

Like most training, that provided by equipment vendors is of mixed quality. Equipment vendors sell hardware and software, not training. It is not necessarily in their economic interest to provide training applicable to a competitors' products. But, because most companies install equipment from more than one vendor, their workers would benefit from broader training. When vendors provide initial training as part of a sales package, they design their courses to highlight their product's strengths rather than its problems. When downtime rises because workers lack maintenance skills, it can cut into the gains in productivity that would otherwise result from the purchase of new equipment.

Typically, vendors provide training on a short-term basis. Sometimes, companies develop longer term training relations with their vendors. Even these can be unpredictable. For example, one small

southern manufacturer of paper and plastic cups sent small groups of workers to its equipment vendor for intermittent training in machinery repair for many years. However, in 1989, the equipment manufacturer expressed reluctance to continue such training, and the manufacturer had difficulty in obtaining appropriate training from other outside sources.[63] Finally, the firm was forced to establish its own training center, near the equipment vendor's facility in Wisconsin. The manufacturer estimates that it costs about $1,000 per week, including wages and travel costs, to send an employee to the new training center.[64]

Despite these limitations, vendors are often the initial and sometimes the only source of formal training workers receive when using new technology. Some equipment vendors are in fact major training providers. For example, Allen-Bradley, a major manufacturer of programmable controllers, has trained over 4,000 maintenance workers in a year. The enrollment compares to a large community college or vocational school.[65]

In the "skill-training life cycle" (table 5-2), vendor-delivered training is especially important when employers purchase new, innovative technology, because only the vendor knows how to use it. For example, during the 1950s, some firms adopting electronic data processing sent their employees to the computer manufacturers' schools for as long as 8 weeks to develop the needed skills.[66] Today, with training in data processing available from a wide range of public and private schools and colleges, vendor training may last only a few days. An OTA study of office automation found that, when new equipment was purchased, vendor training was limited to a brief orientation; the users were then left on their own to experiment and learn what applications of the new computer system would best help them with their work.[67]

If vendors do not train everyone, they often instruct the client's key workers to train coworkers; unfortunately, the client firm often fails to give these key workers adequate time away from their ordinary responsibilities to train others. Worse, these lead workers may not be skilled trainers and may not reach all who will operate the equipment. A 1987 survey of large manufacturers and utilities found that vendors typically trained only the engineers, who were often poor teachers; they tended to assume a level of operator knowledge that was unrealistic. As a result, operators did not fully understand the new equipment and were not able to cope with system breakdowns.[68] Similarly, vendors of CNC equipment often train managers in small firms, rather than line workers who use the technology on a daily basis.[69]

A few equipment vendors are providing more generic in-depth training. For example, Allen-Bradley formed a joint venture with Control Data Corp. in the early 1980's to develop computer-based courses on programmable logic controllers, variable-frequency drives, and CNC fundamentals. These three courses, now marketed separately by the two firms, are applicable not just to Allen-Bradley equipment but also to other brands of controllers.[70]

New instructional Technology can be used to replace short, vendor-provided courses with ongoing instruction. For example, Control Data has developed a generic simulator of a programmable controller, which is produced and marketed by Amatrol, Inc., a vendor of fluid power systems.

---

[63]U.S. Congress, OH&of Technology Assessment, *Making Things Better: Competing in Manufacturing,* OTA-ITE-443 (Washington, *DC:* Us. Government Printing Office, February 1990), p. 182.

[64]Virgil Sperry, Imperial Cup, personal communication, July, 1990.

[65]Larren Elliott, former Allen-Bradley training official, personal communication, July 20, 1989.

[66]Patricia M. Flynn, "Technology *Life* Cycles and Career Paths," in T. J. Kozik and D.G. Jansson (eds.), *The Worker* in *Transition: Technological Change (New* York, NY: American Society of Mechanical Engineers, 1989), p. 250.

[67]U.S. Congress, Office of Technology Assessment, *Automation of America's Offices* , OTA-CIT-287 (Washington, DC: U.S. Government Printing Office, December 1985).

6SR$_{ov}$B. Helfgott, *Computerized Manufacturing and Human Resources* (Lexington, MA: Heath, 1988), p. 39.

[69]Maryellen R. Kelley and Harvey Brooks, "The State of Computerized Automation in U.S. Manufacturing" (Cambridge, MA: John FKennedy School of Government, Harvard University, 1988), p. V-21.

[70]Rosow and Zager, op. cit., footnote 10, p. 100.

Maintenance workers can use the simulator to practice troubleshooting; they are timed in how long it takes to repair each of the 47 simulated failures in the system.[71]

Amatrol's participation in this joint venture is based on its experience in training for its own equipment. The company trainers learned first that customers wanted more generic training because their manufacturing systems were typically made up of components from a variety of vendors and *second* **that** customers want to deliver more training in-house but lack the equipment to do so. To fill this market niche, Amatrol began manufacturing computerized training work stations.[72]

Private Training Consultants

Private training firms have experienced high rates of growth in recent years. Annual sales of outside services and off-the-shelf training programs and materials grew from $1.5 billion in 1984 to $3 billion in 1989.[73] Many entrepreneurs are attracted to this low-overhead business with its potentially high earnings.[74] One recent industry directory lists 500 training companies and consultants.[75] Another industry source estimates that there are at least 3,500 companies supplying training programs and seminars.[76]

As with other training sources, for-profit firms vary widely in quality. In theory, because of market incentives, private training firms can rapidly spread training techniques across the United States. They often respond to emerging training needs faster than public educational institutions.[77] For example, the number of private companies selling basic skills courses, both in print and through computers, is proliferating (see ch. 6).

The best consultants tailor training to meet the needs of individual employers. However, many others sell or rent off-the-shelf packages that may or may not apply to the employer's business goals and workforce. A few offer training techniques whose effectiveness is unproven. For example, several firms sell motivational tapes that purport to reach a deeper level of consciousness by sending messages separately to the two hemispheres of the brain. Studies by behavioral psychologists indicate that this technique fails to enhance learning.78 Independent evaluations, with experimental and control groups would be needed to substantiate the claims made about some training products. Such evaluations are seldom conducted.[79]

Even as more small firms enter the private training industry, larger, established firms are undergoing a wave of mergers and acquisitions. For example, Zenger-Miller, one of the largest supervisory and management training firms, was acquired in 1989 by Times Mirror Co., the Los Angeles-based newspaper publisher.[80] Times Mirror had earlier acquired Xerox Learning Systems, specializing in sales training, and Mirror Systems, Inc., an interactive video disc training firm. Since that time, Times Mirror has purchased Kaset, Inc., a company specializing in customer service training.[81] With corporate training directors looking for courses to meet a variety of strategic goals, including higher quality, better service, and improved productivity, such mergers could offer clients a one-stop shop.

Increased centralization of the private training industry could improve the efficiency of worker training. The Instructional Systems Association, a trade group representing the industry, reports that the most positive results of the merger and acquisition trend are additional funds, which could be used

---

[71] Larren Elliott, personal communication, July 20, 1989.

[72] Paul Perkins, Vice President for Marketing, Amatrol, Inc., personal communication, July 25, 1989.

[73] As cited in *Training Magazine*, October 1984 and October 1989.

[74] Carnevale et al. (1989), op. cit., footnote 3, P. 158.

[75] *ASTD Buyer's Guide& Consultant Directory,* (Alexandria, VA: ASTD, 1989), P. 3.

[76] Vincent W. Hope et al., "Packages and Seminars," in Robert L. Craig (cd.) *Training and Development Handbook,* 3d edition (New York, NY: McGraw Hill, 1987), p. 828.

[77] Patricia Flynn Pannell, "Occupational Education and Training: Goals and Performance, " in Peter B. Doeringer and Bruce Vermeulen (eds.), *Jobs and Training in the 1980's* (Boston, MA: Martinus Nijhoff Publishing, 1981), p. 64.

[78] National Research Council, Enhancing *Human* Potential (Washington, D.C.: National Academy Press, 1988), p. 21.

[79] Ibid., p. 17.

[80] "Zenger-Miller bought by Times Mirror: Consolidation A Trend, " *Training,* vol. 26, No. 1, January 1989, p. 14.

[81] Terry Broomfield, Executive Director, Instructional Systems Association, personal communication, July 26, 1989.

for research and development, improved delivery systems, and improved quality .82 However, it is also possible that mergers and acquisition will lead to greater emphasis on off-the-shelf packages and standardized approaches that fail to meet employers' unique needs.

Proprietary Schools

Privately owned and operated vocational schools traditionally fill an important niche in pre-employment training for young people. These proprietary trade and technical schools serve a population largely unreached by other educational institutions-low-income, young adult minorities-and have a lower dropout rate than their publicly funded counterparts. 83 On average, proprietary schools place 81 percent of their graduates, which suggests to some that their graduates' skills match labor market needs.[84] However, graduates of proprietary schools are more likely to wind up unemployed than are graduates of public post-secondary institutions.[85] Perhaps the narrow training proprietary school students get is useful for entry-level jobs but does not provide a good basis for further advancement. Small firms are more likely than larger firms to rely on these schools as a source of skilled workers.[86]

Many proprietary schools have excellent records. For example, over 95 percent of graduates of one Washington, DC school are placed as electronics technicians with large computer manufacturers.[87]

In contrast, reports of fraud and abuse of Federal financial aid[88] by other schools have hurt the reputation of the whole system.

For example, a computer school in New York City arranged for $25 million in guaranteed student loans for its enrollees between 1984 and 1987. Students testified that teachers frequently slept in class or did not show up at all. The school closed in September 1987, leaving its students without any appreciable skills but saddled with student loans averaging $2,500 each.[89] The U.S. Department of Education launched a new initiative in June 1989 to try to control loan defaults at proprietary schools.

Now that enrollment of young adults from the "baby boom" has ended, proprietary schools are beginning to offer employers their services as a source of upgrade training. For example, in 1985, National Education Corp. (NEC) operated 43 proprietary schools in 10 States and obtained about 65 percent of its revenues from federally guaranteed loans and grants.[90] By 1988, although the chain had grown to 53 schools, enrollment growth was modest, and NEC refocused its marketing toward employers. Through an agreement with United Auto Workers (UAW) and Ford, NEC launched technical literacy courses for over 1,000 Ford workers at 17 auto plants that year.[91]

The experience of some GM workers with proprietary schools turned out poorly: Shortly after the UAW negotiated generous tuition assistance payments with GM in 1985, a Lansing, Michigan computer training firm attracted UAW members to its classes by offering free computer components, but it provided little training. The Michigan Department of Education found that the firm employed "a janitor without experience or degree in the field, a

---

[82] Terry Broomfield, "ISA Survey on Mergers and Acquisitions" (Sunset Beach, CA: Instructional Systems Association, July 1989.

[83] Women Comprise approximately 10 percent more of the student enrollment than at public postsecondary institutions, blacks comprise 13 percent more, and Latinos approximately 7 percent more. Over half of proprietary school students have household incomes of less than $23,000 per year-is 20 to 40 percent more than the proportion of students with household incomes of less than $23,000 per year in public institutions), and are under 23 years old—U.S. Department of Education, *National Assessment of Vocational Education, Final Report, Vol. I (Washington DC, 1989),* p. 103. See pp. 104-106 for data on retention rates.

[84] JBL Associates, *Facts About Private Career Schools, Their Students, and the Postsecondary Education Context* (Bethesda MD: The Career Training Foundation, 1989), p. 3.

[85] U.S. Department of Education, op.cit., footnote 6, P. 109.

[86] U.S. Small Business Administration, Office of Advocacy, *Small Business in the American Economy* (Washington, DC: U.S. Government Printing Office, 1988), p.%.

[87] Nell Eurich (cd-), *Learning t. Work: Resources for Adult Training* (forthcoming from the Carnegie Foundation for the Advancement Of Teaching, 1990), p. 204.

[88] About 70 percent of all students enrolled in proprietary schools receive federally guaranteed loans—JBL Associates, "Facts About Private Career Schools, their Students and the Postsecondary Education Context" (Bethesda, MD: JBL Associates, 1989), p. 3.

[89] Gary Putka, "Shady Trade Schools Imperil Federal System of Loans to Students, " *Wall Street Journal, vol. CCXIII, No. 60, Mar. 28, 1989, pp.* Al, A12.

'Oppenheimer & Company, "New Recommendation: National Education" (New York, NY, 1985), p. 4.

[91] "National Education Corporation 1988 Annual Report" (Irvine, CA: National Education Corp., 1989), p. 3.

plumber, a waitress, a construction worker, a real estate salesperson, advertiser, minister, and dietician who apparently have no qualifications for the areas they are teaching."[92] The firm collected over $1 million intuition payments from the UAW-GM joint training fund before the UAW-GM Human Resource Center stepped into suspend payments.[93]

As proprietary schools become more involved in efforts to upgrade the skills of employees, employers will need to select carefully. Trade and technical schools with good reputations and track records clearly can offer useful training. Moreover, the better trade and technical schools respond quickly to changes in the labor market and technologies.

SHARED TRAINING

One way firms can find their way through the maze of training providers is by pooling their resources to jointly buy or develop training. Sharing the high costs of developing new courses could potentially make training financially feasible for many more firms, particularly small firms. However, until recently, such efforts have been quite limited in the United States. One factor in firms' general reluctance to pool their training efforts is the perceived threat of violating anti-trust laws.[94] As discussed in chapter 2, legislation now under consideration might alleviate this problem.

Despite the limitations, there are several avenues through which two or more firms can share training. They include:

- unions and professional associations;
- trade associations; and
- educational institutions.

In addition, as interest in training grows, firms may begin to form consortia specifically for training purposes.

Unions and Professional Associations

High quality training is expensive. To support the costs of such training within a company or an industry, the firm or industry must, in effect, tax itself. In unionized companies, collective bargaining provides a mechanism for collecting such fees. Because industrial unions typically seek uniform wages and benefits across an industry, they can be the catalyst for the formation of industry associations. This is most obvious in the United States in the construction industry, where local and national trade associations formed to bargain with strong unions. A key activity of these trade associations is development and implementation of apprenticeship training with the unions (see ch. 8).

Without unions, financing shared training can be more difficult. Industry associations may be unable to obtain voluntary contributions from member firms, and a single firm acting alone may be unwilling or unable to support such extensive training.[95] However, professional associations sometimes play a role similar to that of unions. For example, the Institute for Auto Service Excellence (ASE) operates a voluntary certification program for automotive technicians. Although ASE does not dictate what type or where the technicians receive their training, they must pass uniform tests to win certification. Another example is the National Council for Early Childhood Education, which has developed a competency-based curriculum for child-care providers. This curriculum includes modules that can be included or excluded, depending on the knowledge required to meet varying State licensing exams.

Trade Associations

Trade associations and industry groups in the United States are less involved in training than those in Europe.[96] In response to a 1987 survey, State and national trade association executives said that current training activities cost the associations more in terms of money and time than they made from the fees charged for training delivered. National trade associations were not as concerned as State and local associations, presumably because they had a larger funding base. A closely related problem is the incompatibility between training activities and trade associations' mission statements. In cases where the

[92]Stephen Franklin, "GM, Union Learn a Lesson on Retraining," Chicago *Tribune, Sunday,* Jan. 25, 1987, pp. B-1, B-13.

[93]Ibid., p. B-1.

[94]Lauri J. Bassi, "Multi-Employer Training Consortia: An Idea Whose Time Has Come" (Washington DC: NFIB Foundation 1990), p. 7.

[95]Robert W. Glover, "Expanding the Use of Apprenticeship," report submitted to the Bureau of Apprenticeship and Training, U.S. Department Of Labor, September 1988, p. 26.

[96]Bassi, op. cit., footnote 94, p. 6.

association did not have a specific mandate to deliver training, funding was available only through other programs, and a fair amount of work had to be done voluntarily by staff members with other job descriptions. [97]

These attitudes may help explain why a Federal effort to promote apprenticeship training through national trade associations in the late 1970's had little long-term impact. Once the Federal funds were gone, none of the national associations continued training programs on their own initiative. A few programs in unionized industries, such as fire fighters and health care workers, continue at the local level (see ch. 8). However, the fragmentation of industries such as auto repair made it impossible to develop a uniform curriculum and train a substantial number of apprentices.[98] There are notable exceptions to U.S. trade associations' generally poor track record in training. The National Tooling and Machining Association (NTMA) was founded in 1943 expressly to train machinists to replace those going to war. Today, the association has three training products: 1) curriculum modules, which they sell to fins; 2) a 4-year machinery training apprenticeship, or MTA; and 3) a 12-week, 40-hours-per-week, pre-employment screening and training program usually offered in conjunction with community colleges. The Chicago affiliate of NTMA operates a successful apprenticeship program that has now trained 50 journeymen. Although the effort received a small seed grant from the State Of Illinois, it is supported primarily by metier companies.[99] Another example is the American Institute of Banking (AIB), an arm of the American Banking Association. AIB currently trains about 300,000 workers per year and offers 3 levels of accreditation in banking skills.

The success of joint union-trade association training programs in construction has led a growing number of nonunion construction firms to pool their resources for training. For example, the Associated Builders and Contractors (ABC) operates apprenticeship programs for member firms. However, these programs are less formal and have higher attrition rates than those in unionized firms.[100] In 1989, ABC joined forces with three other construction industry trade associations, representing both union and nonunion construction firms, specifically to address expected shortages of skilled craft workers. Their new, nonprofit, Construction Industry Workforce Foundation, offers promise of developing shared training approaches throughout the industry.[101] The Business Roundtable, a national industry association located in New York City, launched a major effort to promote nonunion construction apprenticeship in 1989. This effort focuses on the creation of heal Users Councils (LUCs), or groups of local contractors, who would work together to influence the training curricula of local vocational schools to match their training requirements. The LUC in Baton Rouge, Louisiana appears to have had some success in developing the type of training they require.

Educational Institutions

Local educational institutions are a natural vehicle through which individual firms may pool their training resources. As discussed in the following section, more and more community colleges are providing training customized to meet the needs of an individual employer. In some cases, such efforts spin off improved curricula that can help meet the needs of a larger group of employers. For example, some educational institutions work with trade associations to develop generic training for an industry. In the survey cited above, the few trade association executives that reported that they delivered training to their members noted the cooperation of vocational education personnel as a key element of their success.[102] The availability of State funds to back cooperative training was also cited as a key element of a successful trade association training program.

customized training for individual firms can, over time, lead to more formalized structures, in which firms support the colleges' training and other programs on an ongoing basis. For example, the

[97]Wayne E. Schroeder and *Roy* L. Butler, *Improving Vocational Education Programming through Greater Involvement of Trade Associations* (Columbus, OH: National Center for Research in VocationalEducation, 1987), p. 29.

[98]Glover, 1988, op. cit., footnote 95, p. 28.

[99]Don E. Frey, Northwestern University, personal communication, May 25, 1990.

[100]Bassi, op. cit., footnote 94, p. 5.

[101]Judy Schriener, "Ganging upon work force problems," *Engineering News-Record,* vol. 224, no. 2 (January 11, 1990), p. 39.

[102]Schroeder and Butler, op. cit., footnote 97, p. 28.

Unified Technology Center (UTC) **at Cuyahoga Community College in** Cleveland, Ohio was initiated by the community college president in the early 1980' s.[103] The new program was aimed at helping industry with technology adoption and training. Although it was initially funded through the State and the community college, it currently receives half of its support from the private sector, one quarter from the community college, and another quarter from State and Federal funds (Federal funds come from designation as a National Institute of Standards and Technology technology transfer center). UTC now sells both training and technology consulting services, particularly to small and medium-sized fins.

The Southern Technology Council's (STC) Consortium for Manufacturing Competitiveness (CMC) has a similar mission on a regional scale. An offshoot of the Southern Growth Policies Board, STC includes representatives of Southern Governors, legislatures, and industry. CMC was formed with Federal as well as State support in 1988 with three goals:

1. to demonstrate that public vocational schools and community colleges can help small and medium-sized manufacturers with new technology;
2. to provide more information about the training needed for the factories of the future; and
3. to produce graduates who are able not only to adapt to technological change but to facilitate it.[104]

The 14 State-supported educational institutions that make up the CMC have expanded their services to employers and have leveraged private funding with consortium monies. For example, Southern Arkansas University Technical School has received business support to upgrade its CAD and computer-aided manufacturing (CAM) training and to serve as a demonstration facility for firms who want to pilot new processes there. The school has also equipped three mobile training facilities tabletop robotics laboratory, a CAD/CAM center, and a hydraulics and pneumatics laboratory-which travel to other

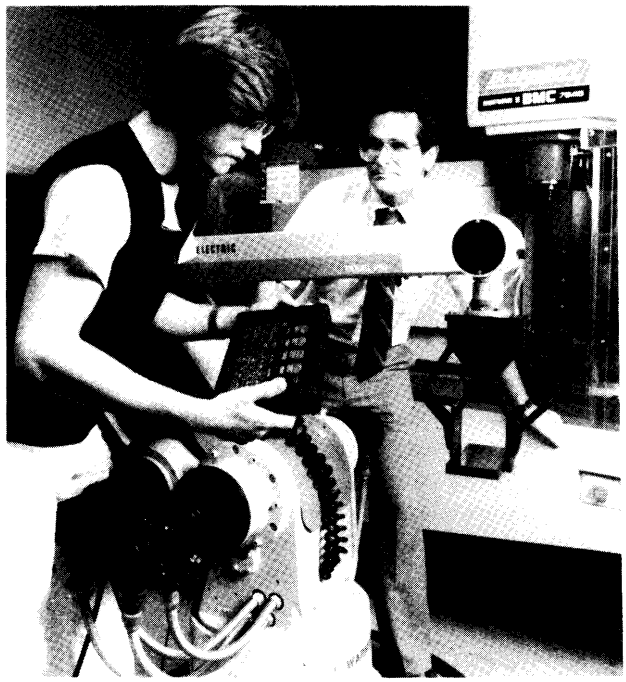


Photo credit: American Association for Community and Junior Colleges

Community colleges face the challenge of providing training broad enough to prepare individuals for a technically changing world, but specific enough to meet the immediate needs of employers.

colleges, vocational technical **institutes,** and manufacturing firms.[105] Thus, each member school in the consortium acts as a catalyst for its own local industries, providing a shared source of expertise on training and technology transfer. On a regional level, with support from the U.S. Department of Education, the Consortium is conducting an ongoing poll to assess the skill needs of small manufacturers who are in the process of automating.[106] This information may be used to revise school curricula throughout the region, to the benefit of many employers.

Like UTC, the CMC, since 1989, has received financial support from the National Institute of Standards and Technology. Funds come through the Southeastern Manufacturing Center at the University of South Carolina-one of three federally supported centers whose goal is to bring advanced

[103] Sandra Hodge, Cuyahoga Community College, personal communication Mar. 1, 1989.

[104] Southern Growth Policies Board, *Technical and Community Colleges: Leading the Way Into the Nineties* (Research Triangle Park, NC: Southern Growth Policies Board, 1989), p. 3.

[105] Ibid.

[106] Southern Growth Policies Board, *Turning to Technology: A Strategic Plan for the Nineties* (Research Triangle Park, NC: Southern Growth Policies Board, 1989), p. 26.

manufacturing technologies to small U.S. manufacturers. The Southeastern Manufacturing Center plans to use State community colleges to deliver these services throughout the region, and the CMC is seen as the link to these institutions.

THE GROWING STATE ROLE

State governments have fostered cooperation between educational institutions and employers for many years. In 1957, North Carolina launched anew program of customized training that helped induce New England textile mills to move south.[107] In 1964, this program was formalized in the creation of a community college system with the dual function of training young people for jobs in the newly industrializing North Carolina economy while also providing the customized skills needed by employers moving into the State.[108] Soon afterward, South Carolina and Oklahoma created similar networks of schools.

Over the past two decades, the States have expanded their uses of training as an economic development tool. Today, training is used not only to woo new firms, but also to induce existing employers to create new jobs and to help existing employers that are not expanding to improve their business performance.

Funding

In 1989,44 States operated 1 or more customized training programs, according to an OTA survey.[109] The 51 training programs identified in the survey spent approximately $375 million on customized training projects during their most recently completed fiscal year. Most of the programs served a variety of purposes, including industrial recruitment and aiding expansions of existing businesses. However, the States reported increasing demand for upgrade training of employed workers: Almost one-third of the State training programs spent more than 35 percent of their funds on in service training for firms that were not adding new jobs to the State economy.[110]

The $375 million that States spent on customized training programs is only a portion of their total expenditures on worker training. When recruiting large industrial firms, some States provide one-time training subsidies not counted in the figure above. The State of Illinois made a one-time expenditure of about $64 million in hiring and training assistance when it recruited a Mitsubishi/Chrysler joint venture plant to Normal, Illinois in 1988.[111] Most of this special spending was not part of the State's three customized training programs, which together had annual budgets of $36.3 million.

OTA also did not identify indirect forms of State support for vocational-technical institutes and community colleges that perform customized training on an ad hoc basis at employer request. Employers pay less for this training than they otherwise would because the State picks up some of the community colleges' costs for facilities and trainers.

The typical State customized training program is small. Half serve under 4,000 employees, and involve less than $2,500,000 in State expenditures. (See table 5-3.) California has by far the largest program, accounting for one-fourth of the spending. Three others (Illinois, Iowa, and Michigan) account for another quarter.

The most common uses for the State training funds are vocational skills upgrading, teamwork training, quality control, and managerial or supervisory training. As discussed in chapter 6, some States also offer workplace basic skills instruction with industrial training assistance.

The State programs serve companies of all sizes; however, firms with 200 to 500 employees seem to get much of the funding. A majority of the programs spend most of their funds to assist manufacturing firms.

---

[107] David W. Stevens, 'The Role of Vocational Education in Missouri's Economic Development What Can We Learn From Other States?'' (Jefferson City, MO: Missouri State Council on Vocational Education, 1989), p, 1.

[108] Commission on the Future of the North Carolina Community College System, *Gaining the Competitive Edge: The Challenge to North Carolina's Community Colleges* (Chapel Hill, NC, 1989).

[109] The survey only included programs that: 1) spend at least *50* percent of their funds for customized training projects with particular businesses of groups of businesses and 2) receive at least 30 percent of their funds from State sources. See Peter Creticos, Steve Duscha, and Bob Sheets, "State-Financed, customized Training Programs: A Comparative State Survey," report prepared for the Office of Technology Assessment under contract L3-381O, Feb. 18, 1990, p. i.

[110] Ibid., p. ii.

[111] State of Illinois, Office of the Auditor General, ''Management and Program Audit of the Department of Commerce and Community Affairs Economic Development Programs," July 1989, p. 106 (table VII-7).

Table 5-3-Selected Characteristics of State-Financed Customized Training Programs (most recent fiscal year)

	Median	Low	High
Number of contracts with firms	64	5	500
Average contract amount per program	$43,313	$6,500	$1,046,000
Range of total program expenditures among States	$2,400,000	$111,700	$106,000,000[a]
Number of employees trained in FY 1988-89	3,940	99	55,243
Expenditure per enrollee	$460	$75	$3,461

[a]Includes some carryover.

SOURCE: Peter A. Creticos and Robert G. Sheets, *State Financed, Customized Training Programs: A Comparative State Survey,* report prepared for the Office of Technology Assessment under contract #L330810, 1990, tables 4,6.

Effectiveness

State-subsidized customized training programs have an uneven track record. This is not surprising —most of the programs were not designed solely to train employed workers. Instead, most States expect the programs to serve mixed, often conflicting, goals —attracting new industries, avoiding layoffs at existing plants, aiding in company expansion, enhancing workers' careers, and providing benefits to the larger society.

Employed Worker Training

However, a National Governors' Association study of four State programs-New York, Illinois, California, and Missouri-suggests the programs have helped retain jobs by enhancing the effectiveness of existing firms.[112] The four programs represent the newest type of State training programs; they provide training grants to companies with very few strings attached, allowing the company to decide on the content and the provider. The researchers studied 24 companies that received financial and, in some cases, technical assistance for training. Although the purpose of the case studies was not to evaluate the success of the State programs but rather to develop a methodology for future evaluation, the results provide preliminary evidence of positive outcomes.

All 24 firms showed improvements in business performance from the training.[113] These improvements were due not to training alone; the training was part of a broader effort to improve productivity, quality, and profitability. For example, Northwestern Steel and Wire Co., in Sterling, Illinois, wanted to raise profits by bringing its costs down to meet those of other U.S. mini-mills. (An industry-sponsored study had shown that Northwestern's maintenance costs were much higher than the industry average). The company used a State grant to cross-train its maintenance workers; at the same time, Northwestern changed its product mix and took other steps to reduce maintenance costs. Taken together, all of these actions, including the training, succeeded in reducing maintenance costs.[114]

The 24 case studies also showed that the State funds allowed the firms to train more workers more quickly than was possible using only company funds and that top managers in all companies came to view training much more positively.[115]

Industrial Recruitment

Customized training has proven a valuable tool in attracting new industries. originally, Southern States used customized training delivered through their community colleges to attract northern firms, especially textile mills. As the pool of recruits has shrunk, both Northern and Southern States are recruiting foreign companies. For example, between 1986 and 1988, Michigan provided $19 million to train 3,000 new workers as part of a package that attracted Japan's Mazda Corp. to suburban Detroit.[116]

The States usually provide tax abatements, new infrastructure, and other incentives as well as training to recruit new industry. However, as busi-

[112]Creticos and Sheets, op. cit., footnote *26,* p. *83.*

[113]Ibid., p. 83.

[114]Ibid., p. 211.

[115]Ibid., p. 85.

[116]Louise Kertesz, "Injury, Training Woes Hit New Mazda Plant," *Automotive News,* Feb. 13, 1989, p. 52.

ness interest in a high quality workforce grows, training is becoming a central part of the incentive package. When the German silicon wafer manufacturer, DNS, was searching for a U.S. site, the company chose North Carolina over Colorado and Texas because of North Carolina's excellent community college system and its "carte blanche offer of assistance. ''[117] This assistance, provided by Durham Technical Community College, included hiring new faculty, sending them to DNS' plant in Italy, developing new training materials, and screening and training new employees.[118]

Despite its short-term effectiveness, some State officials now doubt the value of customized training in industrial recruitment:[119]

> . . . recruitment has been compared to the great buffalo hunts of the last century. The stampede is over; herds are no longer plentiful; and 1986 would be a bad year to go into the buffalo hide business.[120]

Questions about this economic development tool arise because many of the firms that initially relocated to benefit from a low-wage workforce trained to company specifications have now moved abroad in search of even lower wages.[121] Some research suggests that branch plants of nonlocal firms, which provide large numbers of new jobs in the short term, may offer less long-term benefit to local economies because of their tendency to relocate again, and because they provide relatively low-skilled jobs based on standardized production.[122]

Industrial recruitment was, and still is, considered an important tool for providing jobs in the South's rural counties, where wages are low and jobs are few. However, a detailed analysis of growth trends throughout the region demonstrates that, between 1977 and 1988, rural counties experienced high unemployment and declining real per capita income, despite attracting new factories. By contrast, Southern urban counties with better educated populations experienced strong job growth and lower unemployment.[123]

Other concerns have been raised about using training in industrial recruitment.[124] One is that short-term, company-specific training may not provide the broad skills workers need to survive in today's turbulent job markets. Also, existing businesses may suffer when their newly arrived competition is subsidized by the State.[125]

Community Colleges and Vocational-Technical Institutes

Many (19) of the51 State-customized job training programs in OTA's survey relied on community colleges or vocational-technical institutes.[126] These programs often serve existing as well as new firms.[127] In addition, many post-secondary institutions provide occasional customized training in response to the requests of individual employers. Estimates of the fraction of community colleges and vocational-technical institutes providing training customized to the needs of employers (whether through formal State programs or on an ad hoc basis) range from 63 to 75 percent.[128]

---

[117] Paul Delker, "Worker Training: A Study of Nine Companies, " report prepared for the Office of Technology Assessment under contract H3-6785, September 1988, pp. 14-15.

[118] Ibid., pp. 15-16.

[119] Southern Growth Policies Board, "Halfway Home and A Long Way To Go: The Report on the 1986 Commission on the Future Of the South" (Research Triangle Park, NC, 1988), p. 21.

[120] Ibid.

[121] Ibid.

[122] Patricia M. Flynn, "Vocational Education Policy and Economic Development: Balancing Short-Term and Long-Term Needs," *Design Papers for the National Assessment of Vocational Education (Washington DC:* U.S. Department of Education, National Assessment of Vocational Education, 1987), p. III-13.

[123] Stuart Rosenfeld and Edward Bergman, Making Connection (Research Triangle Park, NC: Southern Growth Policies Board, 1989), p. ix.

[124] "Taking Care of Business" *The Economist,* vol. 310, No. 7590, Feb. 18,1989, p. 28.

[125] Ibid.

[126] Creticos, Dusha, and Sheets, op. cit., footnote 109, p. 19.

[127] Examples include North Carolina's "Focused Industrial Training" program and Massachusetts' Bay State Skills Corp.

[128] Janet Swartz, "State and Local Response to the Perkins &~" report prepared by Abt Associates for the National Assessment Of Vocational Education, January 1989; personal communication with Jim Palmer, Associate Director of the Center for Community College Education, George Mason University, Mar. 22, 1990.

There are numerous examples of community colleges providing customized training for business. When the Boulder, Colorado, IBM plant changed its mission from manufacturing to software development in 1986, Front Range Community College retrained almost 1,200 of the 2,000 employees for new positions at the plant.[129] IBM now contracts with Front Range instructors to teach a ''programming fundamentals' course previously taught in-house.

In response to the increasing complexity of auto repairs, General Motors developed the GM Auto Services Education Program in 1980.[130] GM trains instructors, provides the curriculum, and donates between $90,000 and $100,000 worth of current equipment to each of 50 community colleges across the country. These community colleges in turn train between 600 and 800 GM technicians annually through a 2-year cooperative education program. GM also encourages the community colleges to design related courses for other local service stations and for GM technicians interested in maintaining and upgrading their skills. Other automobile manufacturers are developing similar programs.

Despite these successes, many employers perceive post-secondary schools to be ineffective and inefficient. A 1983 survey of 522 corporate trainers in the Southwest (which had a 72 percent response rate) found that allocations of training budgets reflected trainers' perceptions of the most effective sources of training. Not surprisingly, the trainers rated their own in-house training as the most effective source for both technical training and professional development, followed by private consultants. Trainers preferred delivering training through workshops, seminars, and custom courses as opposed to educational institutions' typical offerings of formal credit and noncredit courses.[131]

A 1987 survey of manufacturers in the South reached similar conclusions. Among the 104 firms responding to the survey, the vast majority (98 percent) relied on in-house training, while 84 percent also used training supplied by equipment vendors. Less than half (41 percent) reported using community colleges as training providers, and only 10 percent used universities.[132] The availability of community colleges was not considered important in the location decisions of these firms.[133]

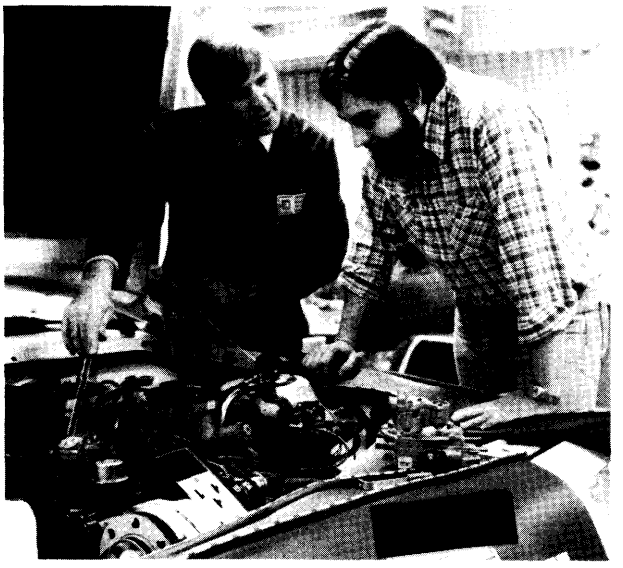


Photo credit: American Association for Community and Junior Colleges

Some U.S. automobile manufacturers have cooperative education programs with community colleges to train service technicians.

State-funded post-secondary institutions are not in business only to serve individual employers with customized training. Both public and private vocational training institutions try to simultaneously serve three masters-the individual, the employer, and society.[134] In many States, community colleges evolved out of junior colleges designed to serve individuals by providing a broad education in preparation for transfer to a 4-year college. Since the 1950s, State-supported, 2-year, post-secondary institutions have increasingly emphasized full-time

[129]Information from the American Association of Community and Junior Colleges Partnership Awards, 1989.

[130]Information provided by General Motors.

[131]Katherine Moser and Don Seaman, "Implications for Potential Linkages Between Business-Industry and Higher Education," *Adult Education Quarterly,* vol. 37, No. 4, Summer 1987, pp. 225.

[132]Stuart A. Rosenfeld et. al., *Reviving the Rural Factory, V.I: The Final Report* (Research Triangle Park, NC: Southern Growth Policies Board, 1988), p. xii.

[133]Ibid., p. 53.

[134]Patricia Flynn Pannell, op. cit., footnote 77, p. 50.

vocational courses for young people: this is now these schools' primary focus.[135]

Providing ongoing training to employed workers has only recently joined the many other goals of State-funded community colleges and vocational technical institutions, and State management of these institutions reflects this history.[136] Most States subsidize these institutions based on full-time equivalent (FTE) enrollments. Such funding formulas, originally developed for 4-year colleges whose students enroll full time, do not reward community colleges and vocational-technical institutes for providing the short courses employers want. For example, courses offered by Colorado community colleges must last at least 15 hours and use a standard, Statewide curriculum approved by a State board in order to qualify as "accredited" courses leading to FTE reimbursement.[137]

South Carolina is more lenient, reimbursing colleges for shorter, noncredit "continuing education' courses targeted to individual employers. However, here, too, student contact hours must be added up into FTEs, and courses must be approved by a State board.[138] These requirements are time-consuming, yielding relatively small rewards. The colleges can get more money more easily by either enrolling full-time students or tapping the State's program for new and expanding businesses.

Community colleges typically seek large employers that will fill up their classrooms, offering economies of scale. At the same time, the larger employers may have full-time training staff with the time and energy to seek out training assistance. Small firms are less likely to seek community college customized training services.

While some community colleges are beginning to target small businesses, the training offered is frequently designed for managers and entrepreneurs, rather than for nonsupervisory employees. Daytona Beach Community College, for example, runs the Mid-Florida Research and Business Center, providing counseling and seminars on topics ranging from contracts research to trade and export.[139] While this assistance is undoubtedly welcomed by local small businesses, it cannot replace customized training for employees.

Community colleges in North Carolina use a process called "DACUM" (Developing a Curriculum), to match their vocational curricula for full-time students to the changing needs of local employers. This process involves convening a panel of 8 to 12 expert workers who work with a college coordinator to identify lists of competencies needed in a particular occupation.[140] The competencies are used by community college instructors to match the courses more closely to real-world jobs. Use of such techniques, which require ongoing communication between employers and schools, can help overcome negative perceptions and encourage more companies to use educational institutions to train their workers.

Training and Technology Extension

Small employers often need better technology and improved management techniques as well as training assistance. However, current State technology transfer programs are limited in scope and poorly linked with State training assistance. About 10 States currently spend an estimated $25 million to $40 million on industrial extension services, which provide technical assistance to small manufacturers installing advanced technology.[141] Although these programs are often housed in State universities, their links to State training programs and 2-year institutions are typically weak. An exception is the Michigan Modernization Service (MMS) which provides training assistance and helps businesses obtain funds from State training programs.

On each site visit, MMS sends training and technology specialists to conduct the diagnosis and write the report, which includes an assessment of

---

[135] U.S. Department of Education, *National Assessment of Vocational Education Final Report, vol. 1* (Washington, DC: National Assessment of Vocational Education, 1989), p. 99.

[136] The role of postsecondary institutions in serving individuals is discussed in chapter 8.

[137] Shelli Bischoff, Red Rocks Community College, personal communication, Mar. 28, 1990.

[138] Joe Hopkins, South Carolina Board for Technical and Continuing Education, personal communication, Mar. 28, 1990.

[139] Example drawn from American Association of Community and Junior Colleges, Keeping America Working Through Partnerships with Small Businesses.

[140] Information provided by Kathryn Baker Smith, North Carolina Department of Community Colleges, Apr. 13, 1989.

[141] U.S. Congress, Office of Technology Assessment, *Making Things Better*, op. cit., footnote 63, p. 177.

training needs, and to help clients design or procure training.[142]

Massachusetts has also started to link industrial extension with training. The Center for Applied Technology (CAT), a division of the Massachusetts State Centers of Excellence Corp., promotes "skill-based automation."[143] Its agenda includes information and support, research, and technical assistance to small and medium-sized manufacturers. CAT consultants conduct audits not only of client firms' technology but also their workforces. Typically, the consultant forms a team of managers and shopfloor workers to identify both training and technology needs. Although CAT is less than 3 years old and has provided direct technical assistance to only 15 firms thus far, its initial efforts look successful.[144]

For example, at Pneumatic Scale Corp., a 100-year-old manufacturer of packaging equipment, a CAT consultant helped form a joint union-management committee. The committee involved shopfloor workers in designing training to integrate their mechanical work with the automated manufacturing cell that was to be installed. The workers identified a need for integrated training in machining and electronics. CAT worked closely with a State training agency—the Bay State Skills Corp.-to obtain funding for the training and found a local technical institute to provide it. The workcell was installed in September 1989, and 70 percent of the company's 60 shopfloor workers are currently enrolled in the newly designed training. The company president feels that CAT assistance has been vital to his attempts to increase both domestic and export sales.

In a smaller project for the Southbridge Sheet Metal Corp., CAT helped the company integrate its automated design and manufacturing systems. Over an 18-month period, CAT designed the software to link the two systems and worked with a private technical school to train the workers in how to translate the CAD drawing to the CNC punch.

State and Federal industrial extension services are slowly learning that small firms need more than just the latest hardware-they need help in benefiting from the technology, which includes training the workers. At the same time, studies of State training programs show that training is most effective when it is part of a broader strategy to achieve clear business goals.[145]

The Substitution Question

The growing State role in funding employer training raises important public policy issues. When the programs are focused exclusively on industrial recruitment, critics contend that existing businesses suffer from subsidized competition[146] In reply, many States have added programs subsidizing training for existing firms that create new jobs, and other States have created training programs for existing firms. But this effort to spread the subsidies more evenly can never be completely successful. The States cannot afford to provide training subsidies to all businesses, and those who are not helped can justifiably complain that they are being hurt by government intervention in the market.

Closely related is the substitution issue. There are two questions: 1) Are companies using State training funds to support nontraining activities? and 2) If the money is being used correctly, would the firms have trained their workers anyway, in the absence of the State subsidy?

The first question was raised by unhappy workers at Mazda Corp.'s Flat Rock, Michigan, plant, which received $19 million in State training assistance. The workers contend that many of the hours billed to the State as "on-the-job training" were actually spent in other activities, including production work with the assembly line at full sped, and maintenance.[147] This danger-that the employer can use the State training assistance for productive work—was assessed in the NEA study of training grant programs in California, New York, Illinois, and Missouri. The study concluded that the danger would be less if the States limited subsidies to formal

---

[142]Ibid., p. 181.

[143]Frank Emspak, "Skills-Based Automation: Can It Succeed in America? A Case Study," paper prepared for the 1 1th Annual Congress Of the International Federation of Automation and Control, Talinn, Estonia, July, 1990 (New York, NY: Pergamon Press, forthcoming in 1990).

[144]John Hoops, CAT, personal communication, May 30, 1990.

[145]Creticos and Sheets, op. cit., footnote 26, p. 7.

[146]"Taking Care of Business," op. cit., footnote 124, p. 28.

[147]Kertesz, op. cit., footnote 116, p. 52.

classroom or laboratory training, which can be clearly identified as training time.[148]

The second question appears less serious in light of the case studies of 24 firms that received State training grants. State funds helped the companies overcome many barriers to doing their own training—poor access to training experts, lack of knowledge about how training might improve business performance, poor labor-management relations, concerns about the loss of trained workers, and bad experiences with prior training efforts.[149]

Illinois' Prairie State 2000 Program requires firms to demonstrate financial need for the training grant. Although this requirement is an important way to safeguard public funds, most of the case-study firms saw training as a low-priority investment. Without State assistance, even those companies that did have the internal funds to support training were unlikely to spend it for this purpose.[150]

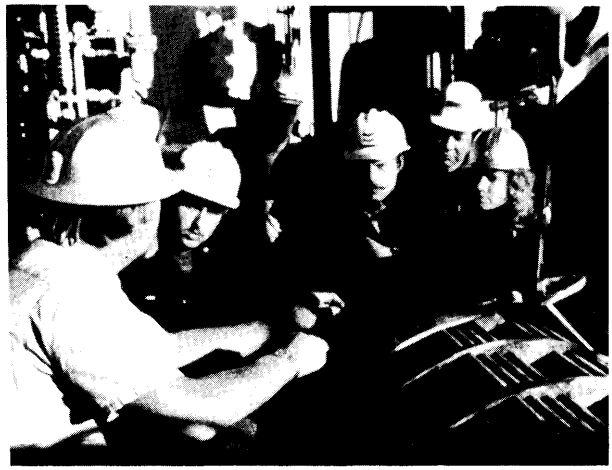


Photo credit: American Petroleum Institute

Many forces drive the need for increased investment in worker training. Here, offshore oil platform workers receive a briefing on safety procedures before starting to clean and replace a heat exchanger bundle.

[148] Creticos and Sheets, op. cit., footnote 26, p. 84.

[149] Ibid., p. 58.

[150] Ibid.

Chapter 6

Basic Skills and the Workplace

CONTENTS

Boxes

Figures

Tables

Chapter 6
Basic Skills and the Workplace

OVERVIEW AND SUMMARY

Workers need good basic skills-reading, writing, arithmetic, and oral communications-to handle many of today's jobs or to benefit from most formal and some kinds of informal training (e.g., reading manuals).[1] Yet, many American workers have poor basic skills. Some firms have found it necessary to frost upgrade the basic skills of 20 or 30 percent of their workers before introducing new technology or work practices.

Poor basic skills in the workforce affects national productivity and the standard of living. While the costs to business of basic skills deficiencies for business performance can only be crudely estimated, anecdotal evidence suggests they are high. In some regions with tight labor markets, employers are finding it more difficult to hire entry-level workers with adequate basic skills.

Of course, firms may exercise other options than remedial training. They can use technology to replace or deskill jobs, or relocate. American companies are able to take basic skills for granted in their operations in Japan or West Germany. Production workers in these countries may be assigned tasks that only supervisors or technicians perform here. The fact that several other countries have well educated (and sometimes less costly) labor forces will continue to be a drawing card for many U.S. firms across a range of industries.

As for the use of technology, managers often have the discretion to increase or decrease skill requirements. But, as is discussed in chapter 4, firms often underestimate the skills needed to employ new technology. Moreover, international competition is forcing firms in many industries to reevaluate past strategies for using technologies. Many firms that are most successful in adopting advanced technologies fully develop their workers' skills to make production systems more flexible.

In such organizations, workers usually need more than the traditional 'Three-R' basic skills. Because these workers often receive less supervision, they need to know when to seek clarification of instructions or information. More so than before, they may be expected to use their knowledge and skills to address new situations and unanticipated problems, or to use information to plan and coordinate with other work groups. These cognitive skills are important now in many jobs and could well become essential skills for a sizable portion of future workers. While some workers with limited basic education are excellent problem solvers on the job, strong basics make it easier for a worker to get and keep a job and to advance.

In discussing the basic skills issue, it is useful to distinguish between workforce basic skills and workplace basic skills. The workforce as a whole includes all people, employed or unemployed, who are in the labor market. For many years, federally supported adult basic education (ABE) has been available for people with poor basic skills, whether or not they were employed; several other programs (such as the Job Training Partnership Act and the Job Opportunities and Basic Skills program) may offer remedial education as part of training given to unemployed or economically disadvantaged people. Very recently, concern about the Three-R's and new work requirements have led to experimentation with basic skills programs that focus on the workplace, either to prepare job seekers for work in specific industries or to improve the basic skills of employees in conjunction with their jobs. To varying degrees, and with varying levels of success, these programs are intended to reflect the context of the workplace, and, in some cases, may be customized to meet specific workplace needs. This chapter focuses primarily on the workplace basic skills

[1]OTA uses the term "basic skills" in this report to refer to use of basic education *skills* (reading, writing, and basic mathematical concepts and operations) for work. The term also includes oral communications skills (speaking and listening). Except where required by the context, OTA has avoided terms like "functional illiteracy," "occupational illiteracy," or ''innumeracy.'' These terms can be misleading because they are often used interchangeably with the term, "illiteracy." Few Americans are unable to read or write at all in any language, the definition of illiteracy, and most Americans have some ability to add and subtract.

problem and programs designed to upgrade the basic skills of employed workers.[2]

Primary findings are:

- The problem is large. One-fifth of young adults (those aged 21 to 25) read only as well as the average eighth grade student, according to the federally sponsored National Assessment of Educational Progress (NAEP). Yet, most job-related reading materials require a tenth or eleventh grade reading level. In a technologically sophisticated economy like the United States, it would be a mistake to assume the basic skills problem belongs solely to those who are deficient or dysfunctional. The NAEP findings suggest that an unacceptably high portion of the young adults-half or more-cannot handle even moderately complex quantitative literacy problems.
- Very few companies now make much effort to upgrade their employees' basic education. A few companies, primarily large ones, have developed internal basic education programs. Some others give employees paid release time to take classes, or provide materials, facilities, or financial contributions to leverage limited public funds. It is far more common for companies to test job applicants for basic skills and to not hire applicants who fail. This strategy worked for firms in the 1960s and 1970s as large numbers of baby boomers entered the labor market, but is less likely to work in the future if low unemployment rates continue. Most companies consider it to be government's responsibility to correct deficits in basic education.
- Several workplace-oriented programs, mostly partnerships among employers and/or unions and educational institutions, have emerged in the last decade. Some receive Federal support, largely through demonstration projects funded by the U.S. Department of Labor or the U.S. Department of Education. The total spent by employers, government agencies, and unions on improving employee basic skills is not known precisely, but probably does not greatly exceed $1 billion per year.[3] By contrast, employers spend $30 billion to $45 billion per year on formal training at all levels.
- The most innovative workplace programs use materials and exercises that have a connection to the workers' job. A measure of success in these projects is whether the worker can better perform tasks typically needed in work settings. An even more crucial test will be whether these projects also give employees the generic basic skills they need to adapt to changing worklife conditions and their literacy needs outside of work. In this regard, the basic skills programs offered jointly by unions and management-the cooperative programs between the United Auto Workers and the American auto companies, the Communications Workers of America and the telephone companies, and most recently by the United Steelworkers-could provide models for dissemination. At this early stage, the joint programs have put only limited resources into program evaluation.
- Basic skills programs often can be enhanced through well-designed use of computers and other forms of interactive instructional technology. Many workers like computer-assisted instruction (CAI), and the available data suggests that projects using instructional technology compare favorably with traditional classroom instruction. While the amount of courseware specifically designed for adults is increasing, there still is a shortage of high quality materials. Moreover, evaluation of materials in terms of their suitability for adult workers is seldom done.

Given the magnitude of the basic skills problem in the United States, there is a pressing need for more research on how to upgrade workplace basic skills and basic skills generally. This research could help decisionmakers determine how much workplace basic skills programs will need to depart from the

?For discussion of basic skill needs of displaced workers, see U.S. Congress Office of Technology Assessment, *Technology and Structural Unemployment: Reemploying Displaced Adults,* OTA-ITE-250 *(Washington* DC: U.S. Government Printing Office, February 1986), pp. 64-66, 185-186, and pp. 271-314.

[3]As discussed subsequently and in table 6-C, widely varying estimates of employer involvement in basic skills programs exist, but the lower end estimates are more credible. At the Federal level, only a small amount (perhaps $20 to $25 million) specifically earmarked for workplace basic skills programs. However, several other Federal programs may serve employed workers in some circumstances. The overall level of Federal spending for adult basics is not known precisely; funds from several large social services or employment and training programs can be used to support basic skills training, but documentation of the amount spent is difficult. Many of these programs are targeted to specific groups of people in need.

traditional model of adult basic education. On a broader scale, greater emphasis and far more resources will need to be directed toward learning research, program evaluation, and best-practice dissemination if the Nation is to ever realize a goal of eliminating the adult basic skills problem.

WORKPLACE BASIC SKILLS DEMANDS

Most workers need basic educational skills to perform their jobs. One study of a cross section of occupations, ranging from forklift operators to executives, found that only 2 percent had no reading or writing requirements whatever; other surveys have found that reading tasks consume more than 1 hour of the average employee's workday.[4] Some surveys of job-related reading materials conclude that a majority require 10th to 12th grade reading ability.

What is more, academic skills and the skills needed to apply the basics on the job are not necessarily the same.[5] To avoid delays, workers often need to act quickly on written instructions—and to exercise judgment to recognize, question, or correct erroneous information. In short, they need to be confident about their ability to understand what they read.

In the area of mathematics, basic arithmetic will suffice for most jobs; more advanced mathematics is not necessary. However, using arithmetic in practical applications on the job may require work skills that require choosing, organizing and applying quantitative information-skills that are very different from the mechanical skills needed to solve arithmetic problems in a textbook.[6] Moreover, the vocabulary, manuals, forms, charts, and other kinds of written materials encountered at work seldom resemble classroom texts. While some reading materials can be simplified to help workers who are poor readers, this is expensive and cumbersome. Also, it is difficult to convey technical information and complex concepts in written materials tied at poor readers.

Some poorly educated workers do learn to cope quite will. Studies have shown that poor readers who know their business are much better at reading job-related material than they are at reading other things. Similarly, workers may learn how to develop solutions to work problems in practice that would stump them when written or described on an academic test. An example comes from Scribners study of workers at a dairy processing plant who fill orders by loading different-sized milk containers into uniform-sized cases. The more experienced loaders consistently filled the cases quickly and accurately, using the fewest number of moves and handling the fewest number of cases. Asked to reconstruct their reasoning, the loaders said they visualized the best combination to fit in a case. Probably, none of the workers understood the mathematical principles involved, yet they still came up with practical solutions to the task. Their better educated supervisors, when substituting for an absent loader, did not do as well.[7]

Job Skills and Education Levels

Changing workplace practices (such as statistical process control) and related demand for technical training are elevating the level of basic skills needed for many jobs. Some industries with workforces with many low-skill workers are confronting a need to upgrade their workers' basic skills as they adopt new technology and work practices. For example, the textile industry increasingly encourages employees to take advantage of workplace literacy programs offered by State and local agencies. Far from deskilling work, the industry's investment in automated equipment has created a demand for more maintenance and repair people. In 1985, textile firms had 3.5 laborers, operators, and service workers for every craft and technical worker-compared to 4.2 a decade earlier. While some low-skill jobs were eliminated by automation, many of the new jobs

[4]As cited in Larry Mikulecky, "Job Literacy: The Relationship Between School Preparation and Workplace Actuality, *Reading Research Quarterly*, vol. 17, 1982, pp. 400-419.

[5]For a more extensive discussion of this contrast, see Paul V. Delker, *Basic Skills Education in Business and Industry: Factors for Success or Failure, report* prepared for the Office of Technology Assessment under contract L3-1765, May 1990, pp. 3-6.

[6]As discussed in Paul E. Barton, "Skills Employers Need: Time to Measure Them?" *A Policy Information Proposal,* Educational *Testing* Service, Princeton, NJ, June 1990, p. 5.

[7]As discussed in Stephen F. Hamilton and Mary Agnes Hamilton, "Teaching and Learning on the Job: A Framework for Assessing Workplaces as I-earning Environments," paper prepared for the Bureau of Apprenticeship and Training, U.S. Department of Labor, March 1989, pp. 22-24.

required greater skill. (See box 3-A in ch. 3 for further discussion.[8])

Firms in several industries (e.g., apparel) are reevaluating past assumptions that automation and deskilling of jobs work well together. According to the Southern Growth Policies Board, 80 percent of southern factory managers found that advanced manufacturing technologies increased skill levels. Many of these firms faced impediments to effective use of the new technology because their workers lacked the basic skills for more advanced training.[9]

Some jobs are being restructured to require more formal education. For example, Texas Instruments (TI), a major producer of semiconductors, now requires its clean-room production workers in some U.S. plants to have 2-year technical degrees; previously, the company only required a high school diploma.[10] The change could reflect both more complex job responsibilities and uncertainty about the competence of job applicants for entry-level positions. TI uses high school graduates at its Japanese facility. Interestingly, new technology for this operation is introduced in Japan before being put into production in the United States. Of course, there could be many reasons why Japan is used to launch the technology. But, part of the explanation has to do with the confidence the company has in the educational background of workers in the two countries.

Of course, not all jobs are changing in ways that require more skill of workers. Some jobs continue to be deskilled or eliminated by automation, just as others are upgraded. There is disagreement about the overall direction of skill change, and how fast and pervasive the change is likely to be in the years to come. A recent study by the Economic Policy Institute, for example, concluded that skills upgrading was limited primarily to best-practice fins. The study found no evidence to support the notion that there would bean explosive growth in skill requirements in this decade. It concluded that, while occupational upgrading is occurring, the overall rate is slowing down compared to the 1960s and 1970s.[11]

The Hudson Institute, by contrast, reached the conclusion that there will be a major increase in occupational skill and education requirements by the year 2000.[12] Its *Workforce 2000* study found that more than half of the new jobs created between 1984 and 2000 would require people with some education past high school, and 30 percent of the new jobs would require a college degree.[13] (The comparable figures for 1984 were, respectively, 42 and 22 percent of all jobs.) But it's easy to overstate the implications of the *Workforce 2000* projections. It is not clear how much of the projected increase in education would reflect skills needed by workers to perform their jobs versus other factors. For example, some employers use educational background as a way to screen job applicants. Moreover, the projected growth in education requirements only pertains to the one in six jobs that will be new in the year 2000; the educational background needed for all jobs will not change as dramatically.[14] Also, there are jobs in well-paid occupations (e.g., several construction trades, mechanics, repairers, and many sales and marketing jobs) that do not require college degrees that are projected to grow faster than average, although some of these may entail post-secondary education or apprenticeship.

Both studies rely on data and projections made by the Bureau of Labor Statistics (BLS). BLS projects that occupations now filled by people with the most formal schooling are expected to grow at the fastest

---

[8]Lauren Benton. Thomas Bailey, Thierry Noyelle, and Thomas M. Standback, Jr., "Training and Competitiveness in U.S. Manufacturing and Services: Training "Needs and Practices of Lead Firms in Textile, Banking, Retailing and Business Services," report prepared for the office of Technology Assessment under contract No. L3-3560, February 1990, p. 69.

[9]Southern Growth Policies Board, *Looking Forward: The Report of the 1989 Committee on Southern Trends,* Research Triangle Park, NC, 1989, pp. 16-17.

[10]As discussed in Robert R. Miller, Corporate Strategy and Industrial Training, report preparedfor the Office of Technology AssessmentUndecontract L3-5240, March 1990.

[11]Lawrence Mishel and Ruy A. Teixeira, The *Myth of the Coming Labor Shortage: Jobs, Skills and Incomes of America's Workforce 2000* (Washington, DC: Economic Policy Institute, 1990), pp. 65-67

[12] William B. Johnston and Arnold H. Packer, *Workforce 2000: Work and Workersfor the 21st Century* (Indianapolis, IN: The Hudson Institute, June 1987) p. 97

[13]Ibid., p. 97

[14]See Russell W. Rumberger and Henry M. Levin, "Schooling for the Modem Workplace," *Investing in People: A Strategy to Address America's Workforce Crisis,* background papers, vol. 1, prepared for the Secretary of Labor's Commission onWorkforce Quality and Labor Market Efficiency, pp. 95-98 for a discussion of thedifficulties involved in estimating educational requirements in association with occupational projections.

Table 6-l—Projected Change in Employment by Occupation, 1988-2000, and Distribution of Total Employment by Years of School Completed, March 1988

Occupation	Percent change 1988-2000	Percent of total employment for occoupation held by workers with: Less than high school	High school	1-3 years of college	4 or more of college
Total	15	16	40	21	23
Executive, administrative, and managerial	22	5	27	24	44
Professional specialty	24	2	9	15	74
Technicians and support occoupation	32	3	29	36	32
Marketing and sales	20	13	39	24	23
Administrative support, clerical	12	7	51	30	12
Service occupations, e.g., household, security, food service, custodial	23	31	45	18	6
Precision production, craft and repair.	10	23	53	18	5
Agriculture, forestry fishing	-5	36	44	12	7

SOURCE: George Silvestri and Volm Lukasiewicz, "Projections of Occupational Employment, 1988-2000," Monthly Labor Review, vol. 112, No. 11, November 1989, p. 62.

rate through the year 2000.[15] There are exceptions, however. What BLS calls service occupations (which includes housekeepers, custodians, and other occupations not requiring much education) will grow at a faster than average rate. (See table 6-1.) Moreover, the U.S. economy will continue to create large numbers of low-skill or medium-skill jobs. (See table 3A-3 and discussion in the appendix to ch. 3.) Of the occupations projected to add the most number of new jobs by 2000, just two-nurses and managers -ordinarily require much postsecondary education. Others are in the midrange of education requirements (secretaries), or at the lower end (custodial workers).

In the end, there are several points that have come out of the debate about upskilling and deskilling:

1. The economy will continue to create many lower skill jobs. It seems unlikely that skill requirements for these jobs will change greatly over the next decade; some may be deskilled, a few may be upskilled. These jobs also will not require much formal education beyond high school.
2. Some jobs in some industries that have traditionally been defined as low-or medium-skilled will be upgraded as companies adopt new technologies and work practices. Current workers in these jobs will need retraining to develop new job skills; outside applicants will find the hiring process more demanding than in the past.
3. The fastest rate of job growth will be in high-skill professional, technical, and managerial jobs—jobs that traditionally have required post-secondary education or that are most likely to be filled by people with college degrees.
4. In many industries it has become more difficult for people without post-secondary education to progress from lower level positions within firms to higher level positions.
5. Many of the workers who will join the labor force between now and the year 2000 will not be well matched to the better jobs created by the economy. Roughly one-third of the new entrants will come from minority groups that have traditionally received less and poorer quality education. Immigrants, many of whom need to develop English language skills, also will be a more important source of labor force growth. (See box 6-A).

Moreover, workers at many levels need effective strategies for learning new ways of doing things when companies undergo rapid technological and organizational change, bring new processes online, or market new products. Many American employers see deficiencies in oral communications (giving and receiving verbal instructions effectively) as a major basic skills problem in the workplace. Other emerging skills, according to the American Society of Training and Development, include problem solving skills and effectiveness in group interactions[16]—

[15] George Silvestri and John Lukasiewicz, "Projections of Occupational Employment, 1988-2000," *Monthly Labor Review*, vol. 112, No. 11, November 1989, p. 62.

[16] Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, *Workplace Basics: The Essential Skills Employers Want*, ASTD *Best* Practices Series: *Training* for a Changing Work Force (San Francisco, CA: Jossey-Bass, 1990).

Box 6-A—Immigration and Basic Skills

There is a growing need to give workplace basic education to immigrants-especially courses in English language proficiency. Immigrants accounted for 22 percent of labor force growth between 1980 and 1987—more than twice their contribution during the 1970s when baby boomers and women entered the labor market in large numbers. Immigrants are projected to account for an even higher portion of labor force growth over the next decade.

On average, immigrants have roughly the same amount of formal schooling as do U.S. natives. However, there are differences at the extremes: a higher proportion of foreign born immigrants attend college than people born here; roughly one third of immigrants have only an elementary school education, and 13 percent had not progressed beyond the fourth grade (compared to 3 percent of people born in the United States.)[1] Many foreign-born immigrants who arrived in the United States between 1970 and 1980 spoke no English at all (this probably continues to be the case for new arrivals today). The fraction of non-English speakers varied by region: 17 percent in the West, 15 percent in the South, 11 percent in the Northeast and about 9 percent in the North Central region. This influx helps to explain why English as a Second Language is the fastest growing component of Federal Adult Education Act assistance.[2]

[1]U.S. Department of Labor, *The Effects of Immigration on the U.S. Economy and Labor Market* (Washington, D.C.: U.S. Government Printing Office, 1989), p. 36-38.

[2]Ibid., pp. 59-60. The information on English speaking is from the 1980 Census.

skills in the past ordinarily only associated with management. 'As skill requirements shift, the skills workers need will continue to evolve. (See box 6-B)

How Big is the Problem?

Estimates of basic skills levels among employed workers are usually based on data from only a few companies. In one study, about 20 percent of a manufacturing fro's hourly workers were unable to cope with technical training because of deficient basic skills; most of these employees were high school graduates who did not think they had a basic skills problem.[17] Some companies are discovering that half or more of their workers in some units need basic skills upgrading before they can train for some new technologies or processes.[18] OTA's earlier analysis of displaced workers found that 20 to 30 percent of adult workers entering displaced worker programs in the mid- 1980s needed to upgrade their basic skills.

National surveys of the adult population as a whole are either dated or make arbitrary breakpoints to define adequate performance. Estimates of 'functional illiteracy' made in the 1970s range from 15 percent to over half the U.S. population.[19] The still-used claim that America has 27 million functionally illiterate adults is based on extrapolation of a 1974 survey to the U.S. population in 1982.[20] In the next few years a better estimate of the nature and magnitude of the literacy problem among U.S. adults could be forthcoming. In its 1988 Amendments to the Adult Education Act, Congress directed the Secretary of Education to develop criteria to define literacy and to identify basic educational skills needed for "literate functioning."[21] The Education Department is to estimate the size of the illiteracy problem, reporting the results to Congress in 1993.[22]

[17]Larry Mikulecky, "Second Chance Basic Skills Education," *Investing in People: A Strategy to Address Americans Workforce Crisis,* background papers, vol. 1, op. cit., footnote 14, p. 236.

[18]Cindy Skrzycki, "The Company as Educator: Firms Teach Workers to Read, Write, " *Washington Post,* Sept. *22, 1989,* p. G1.

[19]As discussed in Richard L. Venezky, Carl F. Kaestle, and Andrew M. Sum, *The Subtle Danger: Reflections on the Literacy Abilities of America's Young Adult,* (Princeton, NJ: Educational Testing Service, 1987) p. 14.

[20]The survey referred to was the Adult Performance Level Study (APL), undertaken by the University of Texas in 1973 and 1974 anfunded by the U.S. Department of Education. APL concluded that 20 percent of American adults had such serious basic skills deficiencies as to be functionally incompetent; it characterized another 30 percent as marginally competent. By applying APL percentages to the 1982 population, the Education Department concluded that up to 74 million adult Americans had some need for further basic education.

[21]Section 383(b) of public Law 100-297.

[22] The Department of Education has contracted with the Educational Testing Service (ETS) to undertake the survey. ETS expects to USe the same definition and scales for literacy as it used in the National Assessment of Educational Progresses 1985 young adult literacy profiles. The definition: "using printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential." ETS expects to survey 13,000 adults 16- to 64-years of age in 1992. For further details, see "National Adult Literacy Survey," Education Testing Service, Princeton, NJ, (brochure).

Box 6-B—Evolving Concepts of Basic Skills

Employees who quickly learn new ways of doing things can make a big difference when companies undertake major changes in technology, work organization, or business strategies. Such skills are especially in demand when companies seek to implement workteam approaches. Thus, more companies are looking at ways to help their employees strengthen their interpersonal communications skills, their ability to learn, and their facility with problem solving.

Many consultants and vendors now offer programs aimed at developing these skills. Often, these programs were developed for nonindustrial settings. For example, while over 100 ''learning to learn' programs have been developed, many have objectives (such as improving standardized test scores) of little use in the workplace. According to American Society for Training and Development (ASTD), most also are not grounded explicitly in learning theory and the results are unpredictable.[1] Learning-to-learn programs differ from conventional instruction in that the learning process itself is under scrutiny, and different strategies for learning are explicitly discussed and applied.

Workplace applications of learning-to-learn approaches are still in their infancy. Some companies find it helpful to teach employees learning strategies when major change is planned, but specific training needs are hard to identify. Planters Life Savers Co., for example, made use of a learning management program before new technology was introduced at an Illinois plant. The training began before job task analysis could be done, when the manufacturing system for the new technology was still under design.[2]

More than likely, the concept of workplace basic skills will continue to evolve as the workplace itself changes. A Stanford University study, based on studies at several worksites, identified 13 competencies-e.g., cooperation, establishing goals, obtaining and using information-hat are often needed by workers to function effectively in new work settings.[3] These competencies are seldom stressed in U.S. primary and secondary schools. Thus, companies that stress "new model" work organization (see ch. 4) may find developing these skills to be a growing training requirement. According to ASTD, the full list of workplace basics could be enlarged to encompass 16 skills in 7 broad skill groups (ranging from the Three-Rs to organizational effectiveness and leadership). Of course, not all workers need such a broad spectrum of skills in the future. Nevertheless, the demand for such skills will grow if employers continue to reorganize work in ways that require workers to exercise more responsibility.

---

[1]Anthony p. Carnevale, Leila J. Gainer, and Ann S. Meltzer, *Workplace Basics: The Essential Skills Employers Want*, ASTD Best Practices Series: Training for a Changing Work Force (San Francisco, CA: Jossey-Bass, 1990), p. 42.

[2]1bid. p.60.

[3]As discussed in Russell W. Rumberger and Henry M. Levin, "Schooling for the Modem Workplace," *Investing in People: A Strategy to Address America's Workforce Crisis*, Commission on Workforce Quality and Labor Market Efficiency (U.S. Department of Labor: Washington DC, September 1989), p. 103.

In the meantime, the most authoritative survey of basic skills is limited to young adults (those aged 21 to 25).[23] Completed in 1986 by the federally sponsored National Assessment of Educational Progress (NAEP), the survey profiles literacy skills (including the ability to perform arithmetic operations to solve problems) among 3,600 young American adults. NAEP found that 94 percent of the young adults read as well or better than the typical fourth grader; about 80 percent equaled or surpassed the average level for an eighth grader, and 62 percent equaled or did better than the typical eleventh grade student.[24] While the NAEP findings show that the more extreme characterizations of the illiteracy problem in the United States are unfounded, it is not reassuring that one-fifth of young American adults read no better than a typical eighth grader. (The sports page of most newspapers is written at about an eighth grade level.)

Perhaps even more disturbing, the NAEP profiles show that very few young adults are proficient in moderately complex tasks-as was apparent in the exercises involving arithmetic. Nearly all (93 percent) of the young adults got the right answer when the quantities and arithmetic operations were explicit and obvious (such as adding two entries on a

---

[23]Irwin S. Kirsch and Ann Jungeblut, Literacy: *Profiles of America's Young Adults* Final Report (Princeton, NJ: National Assessment Of Educational Progress at Educational Testing Service, September 1986).

[24]Ibid., p. 40.

bank deposit slip). The respondents had far greater difficulty when numbers had to be extracted from printed forms or text, or when the arithmetic operation was not immediately obvious.[25] For example, less than two-thirds were able to reach the correct answer when the addition was part of a problem in which judgment had to be exercised to determine which numbers were superfluous.

Those with more years of formal schooling did better than those with less education; however, poor problem solving abilities were evident even among the more educated respondents. Only 52 percent of those whose education ended with high school graduation and 70 percent of those with 2- or 4-year college degrees or more could examine a menu, compute the cost of a specified meal and, then, determine the correct change from a specififed amount. Only 38 percent of those high school completers with no higher degree could then calculate the tip from the bill or estimate the price of an item from a grocery unit-price label. Among those with a 2- or 4-year degree or more, 31 percent were not able to calculate a price from a unit price label, and 39 percent were unable to calculate the tip after first identifying menu items and calculating change. Figure 6-1 shows sample questions and success level for high school graduates without a post-secondary college degree.[26]

The NAEP survey also gives some benchmark information about how literacy levels varied among young adults by occupation.[27] The data given in figure 6-2 applies to 21- to 25-year-old people who were out of school and who had worked full time for at least 1 year. Not surprisingly, professionals scored highest on the NAEP proficiency scale, followed by young adults in technical and managerial occupations. What is surprising is the generally low proficiency in occupational groups generally thought to be the most able. Of course, the study only shows the literacy level of people in these occupations, not the literacy level actually needed to perform these jobs.

The NAEP profiles show that many high school graduates do not bring to their jobs the caliber of basic academic skills that employers could reasonably expect. Why these deficiencies exist is poorly understood. Perhaps these poor readers have not learned to actively seek out the meaning of what they read. By contrast, good readers may employ strategies that allow them to extract what they need from written materials.[28] As has been mentioned, occupational requirements require active involvement of the reader-e.g., to follow written instructions, to remember information, to solve problems.

Studies that profile workplace requirements, at least at the same level of detail as the NAEP young adult profiles, are badly needed but have never been conducted. The Educational Testing Service (ETS) is now conducting a literacy profile of unemployed people for the U.S. Department of Labor, due to be completed in late 1990. ETS, which developed the NAEP young adult profiles, will inventory literacy levels for people enrolled in Job Training Partnership Act programs, people using the Employment Service system, and people receiving unemployment insurance. However, the inventory will not focus on the basic skills that employees need on the job.

The International Context

Very little information exists that allows comparison of basic skills levels among workforces of different countries. Thus, comparisons of educational levels are often used instead. Differences in national educational systems complicate analysis. However, the United States has one of the highest levels of participation in secondary and post-secondary education in terms of the number of years of schooling.[29] (See box 6-C.) But, as suggested by the several comparative studies discussed in chapter 3, the American primary and secondary education

[25] See Venezky, *et* al., op. cit., footnote 19, p. 28

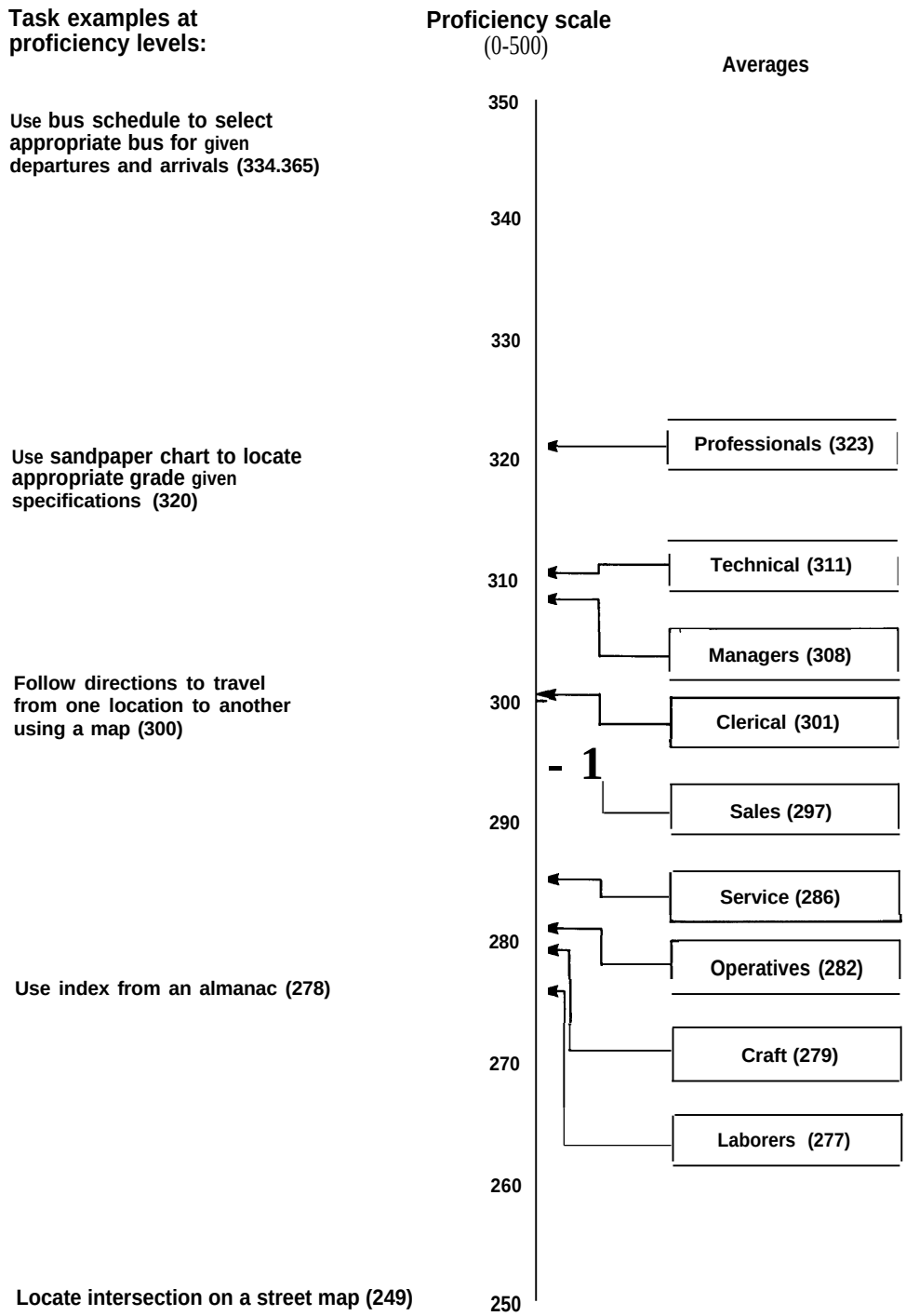
[26] The percentage figures cited above are based on the actual number of correct and incorrect responses to the survey questions. This unpublished data was provided to OTAby the Education Testing Service. These figures may differ from estimates based on the probability that a person showing a certain level of proficiency would get a correct answer on a specific question.

[27] Paul E. Barton and Irwin Kirsch, *Workplace Competencies: The Need to Improve Literacy and Employment Readiness,* forthcoming, as cited in *Information for National Performance Goals for Education: A Workbook,* (Educational Testing Service Policy Information Center, Nov. *30, 1989)* p. *47,*

[28] George A. Miller, "The Challenge of Universal Literacy," *Science,* vol. 241, no. 4871, Sept. 9, 1988, p. 12%

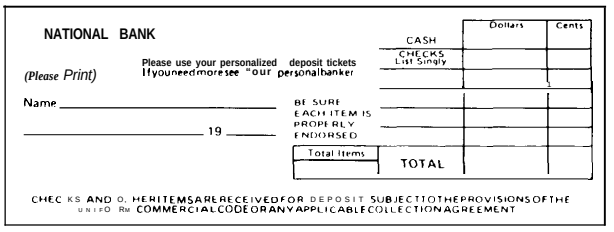
[29] Richard M. Cyert and David C. Mowery, eds., Technology *and Employment: Innovation and Growth in the Us. Economy* (Washington, DC: National Academy Press, 1988).

Figure 6-l—Document Literacy of 21 to 25-Year-Olds Who Work Full-Time for a Full Year, by Occupation



SOURCE: Paul E. Barton and Irwin S. Kirsch, Workplace *Competencies: The Need to Improve Literacy and Employment Readiness,* prepared for the Department of Education, Office of Educational Research and Improvement (Washington, DC: U.S. Government Printing Office, July 1990), figs. 1-3, table 2.

Figure 6-2-How Young High School Graduates* Fared on Selected Tasks From the National Assessment of Educational Progress' Young Adult Literacy Assessment



NATIONAL BANK

(Please Print)

Please use your personalized deposit tickets If you need more see "our personal banker

Name _____

_____ 19 _____

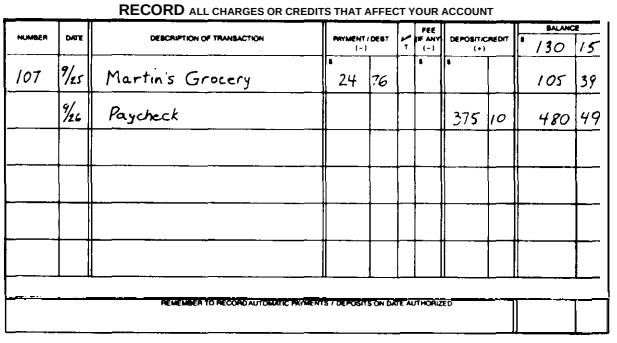
BE SURE EACH ITEM IS PROPERLY ENDORSED

	Dollars	Cents
CASH		
CHECKS List Singly		
Total Items		
TOTAL		

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE PROVISIONS OF THE UNIFORM COMMERCIAL CODE OR ANY APPLICABLE COLLECTION AGREEMENT

Q. You wish to deposit a $300 check and $57.23 in cash in a checking account. Fill out your deposit slip to do so. List both deposits and indicate the total amount deposited. Date your deposit slip May 22, 1985.

93°/0 of high school graduates without post secondary degrees answered correctly.



RECORD ALL CHARGES OR CREDITS THAT AFFECT YOUR ACCOUNT

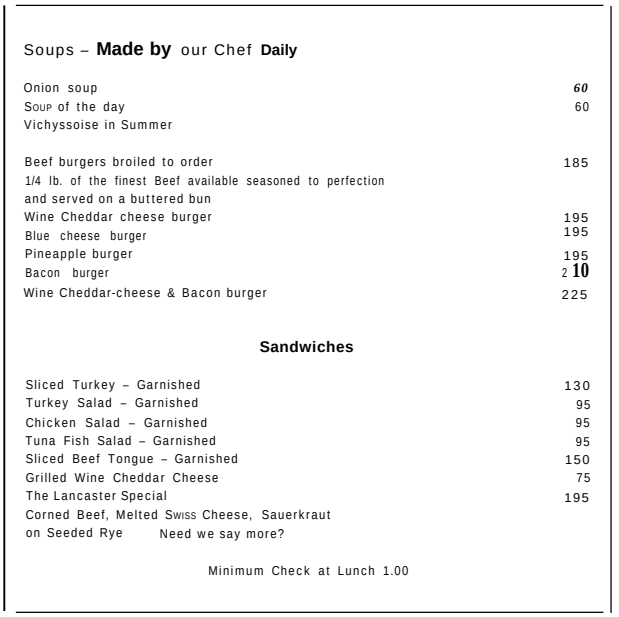
NUMBER	DATE	DESCRIPTION OF TRANSACTION	PAYMENT / DEBIT (-)	✓ IT	FEE (IF ANY) (-)	DEPOSIT/CREDIT (+)	BALANCE
							$ 130 15
107	9/25	Martin's Grocery	24 76				105 39
	9/26	Paycheck				375 10	480 49

REMEMBER TO RECORD AUTOMATIC PAYMENTS / DEPOSITS ON DATE AUTHORIZED

Q. Complete the check ledger for the month of September. Keep a running total of the balance and include the following:

- **$50 deposit on 9/27**
- **check 108 payable to Mr. Davis for $18.49 on 9/27**
- **check 109 payable to Electric Co. for $53 on 9/28**
- **the $5 monthly service fee for your checking account**

Correct responses among high school graduates without post secondary degrees ranged from 73% (for balance on check 109) to 81 %(for $50 deposit).



Soups – **Made by** our Chef **Daily**

Onion soup	60
Soup of the day	60
Vichyssoise in Summer	
Beef burgers broiled to order	185
1/4 lb. of the finest Beef available seasoned to perfection and served on a buttered bun	
Wine Cheddar cheese burger	195
Blue cheese burger	195
Pineapple burger	195
Bacon burger	2 10
Wine Cheddar-cheese & Bacon burger	225

Sandwiches

Sliced Turkey – Garnished	130
Turkey Salad – Garnished	95
Chicken Salad – Garnished	95
Tuna Fish Salad – Garnished	95
Sliced Beef Tongue – Garnished	150
Grilled Wine Cheddar Cheese	75
The Lancaster Special	195
Corned Beef, Melted Swiss Cheese, Sauerkraut on Seeded Rye Need we say more?	

Minimum Check at Lunch 1.00

Q. Suppose you had $3.00 to spend for lunch. If you order a Lancaster Special sandwich and onion soup, how much change would you get back?

52°/0 of high school graduates without post secondary degrees answered correctly.

Q. How much should you leave for a 10°/0 tip?

38°/0 of high school graduates without a post secondary degree answered correctly.

● **includes young adults 21 to 25 who completed high school but who had not received post-secondary degrees. The "correct answer" information is based on unpublished data on the actual percentage of survey participants answering the question correctly. The percent correct should not be confused with other data from the survey used to identify proportions of young adults performing at different proficiency levels on scales developed for the National Assessment of Educational Progress (NAEP). Individuals at a specified level on NAEP's scale have an 80 percent probability of correctly performing tasks used to illustrate that proficiency level. The percentage of people demonstrating proficiency at a given level tends to be lower than the percentage who answer a given task correctly.**

SOURCE: Survey instrument and questions are from Irwin Kirsch and Ann Jungeblut, *Literacy: Profiles of America's Young Adults, Final* Report(Pfinceton, NJ: National Assessment of Educational Progress, Educational Testing Service, September 1986), pp. III-29 - III-31. "Correct answer" information is based on unpublished data provided by the Educational Testing Service to OTA.

Box 6-C—Formal Education and the American Workforce

Despite basic skills problems at all levels, the years of schooling the typical American worker receives continues to increase. Roughly one-fourth of all adults (those between 25 and 64) in the civilian labor force are now college graduates; another 20 percent have some college, so that over 45 percent have at least some college. This compares to 37 percent with at least some college in 1978. Those in the adult labor force with less than a high school education declined from 24 to 15 percent. The remaining portion-those whose education ended with high school-has remained the same at 40 percent.[1]

Despite a narrowing gap, major racial and ethnic variations persist in years of formal education. Between 1978 and 1988, the proportion of both white and black workers with 4 or more years of college increased by 5 percentage points; similarly, there was also a 4 percentage point increase for Hispanic-origin workers. The net result was that by 1988,26 percent of white, 15 percent of black, and 13 percent of Hispanic workers attended 4 or more years of college.

The proportion of the adult labor force without a high school diploma also declined dramatically for all groups over the decade. However, 40 percent of the Hispanic labor force still had less than 4 years of high school in 1988, as did 23 percent of blacks, and 14 percent of whites.

Formal education is a major indicator of a person's likely employment history; nearly 90 percent of college graduates between 25 and 64 were in the labor force in 1988, compared with only 61 percent for those who had not completed 4 years of high school. Over the 1978-88 period, the labor force participation rates for men in all educational groups declined with the largest reductions occurring among those who had not attended college. In contrast, the participation rates for women were higher across the educational spectrum, especially among those with the highest educational attainment—from 62 to 75 percent for those who had completed 1 to 3 years of college and from 71 to 81 percent for college graduates. Of course, the amount of schooling by itself says little about educational quality or proficiency.

Groups with the most formal schooling have the lowest unemployment. The 1988 jobless rate for college graduates aged 25-64 was only 1.7 percent, compared with 3.7 percent for those with 1 to 3 years of college, 5.4 percent for high school graduates, and 9.4 percent for high school dropouts. Black college graduates still have more than twice the unemployment rate as white college graduates-3.3 percent compared to 1.5 percent.

There has been a trend toward reduced employment opportunities for the less educated, especially high school dropouts.[2] In some cities and States with large minority populations, 40 or 50 percent of students do not finish high school.

There are also significant regional differences. In 1980, for example, roughly 1 out of 4 Southern adults over age 25 had less than 8 years of school, compared with 1 in 6 adults nationally. Approximately 36 percent of adult Southerners lack high school diplomas. Within the South, rural residents have higher rates of functional illiteracy than urban residents.

Educational background is also important in determining whether a worker will qualify for a job requiring specific training or get upgrade training once employed. In 1983, the only year for which nationwide data is available, 55 percent of workers said they needed qualifying training to obtain their current job. The figure was just 42 percent for those with a high school diploma or less. Some 62 percent of those with some college, and 84 percent of college graduates, said they needed qualifying training for their job.[4]

---

[1] All figures on years of schooling are from U.S. Department of Labor, Bureau of Labor Statistics, "Educational Level of Us. Labor Force Continues to Rise," *News*, Aug. 29, 1988.

[2] Richard L. Venezky et al., *The Subtle Danger: Reflections on the Literacy Abilities of America's Young Adults* (Princeton, NJ: National Assessment of Educational Progress, Educational Testing Service, 1987). See, also The William T. Grant Foundation Commission on Work, Family and Citizenship, *The Forgotten Half: Pathways to Successor America's Youth and Young Families* Final Report (Washington DC: William T. Grant Foundation, 1988).

[3] National Center for Education Statistics, *The Condition of Education: 1988*, vo1. 1 (Washington, DC: U.S. Gov ernment Printing Office, 1990), p. 90. The figure falls to 13.5 percent for those between the age of 25 to 34.

[4] The proportions also varied by race and age. Fifty-seven percent of whites said they needed qualifying tr aining to get their job, compared with 44 percent of blacks and 54 percent of other minorities. Only 25 percent of the youngest workers (those 16 to 19) and 47 percent of those 20-24 reported that they needed qualifying training. See Max L. Carey, *How Workers Get Their Training,* Bulletin 2226, U.S. Department of Labor, Bureau of Labor Statistics, February 1985.

system is no longer a leader in quality. In fact, the quality of K-12 education in the United States is lower than several of our major trading partners.

One popular explanation is that the United States has such a heterogeneous population. However, even U.S. elementary students in a relatively homogeneous middle class suburb of Minneapolis scored far lower on standardized tests than comparable students in Japan and Taiwan.[30] Thus, while total U.S. education costs per pupil (measured in constant dollars) have nearly quadrupled since the early 1950s, there has been no evidence of a proportional improvement in scholastic performance.[31]

Even so, American school students have improved marginally in the basics since the early 1970s. The jury is still out as to whether these recent gains will continue. The most recent reading assessment shows that students read better in 1988 than they did in 1971.[32] However, some age groups did better in the early 1980s than in 1988. The most hopeful news in the 1988 assessment was the progress in reading levels made by black and Hispanic students.

American students also made progress in math and science, compared with their predecessors in the 1970s.[33] While encouraging, most of the gain was from routine exercises—such as elementary arithmetic or recitation of scientific facts-not in using knowledge effectively to think and reason.[34] The students did no better in inferring relationships or drawing conclusions from scientific information. Moreover, the students stayed even or did worse than their predecessors in computing with decimals, fractions and percents, solving multiple-step problems, or using basic algebra.[35]

As discussed in chapter 3, U.S. students do not measure up to students in South Korea, Japan, or West Germany. A recent international mathematics assessment found American 13-year-olds in last place among five other countries and several Canadian provinces.[36]

The poor performance of U.S. students has prompted great concern about the future science and engineering workforce.[37] But it is also worrisome that U.S. students in the two middle quadrants—students who will fill many of tomorrow's factory and office jobs-did poorly .38 South Korean youngsters scored best; only 40 percent of U.S. students were at or above the mean, compared to 78 percent of the South Korean students. (A typical problem at the mean required the student to select the correct average age of five students, given their individual ages.) Of course, educational performance at any age is not necessarily a predictor of individual performance on the job. However, it is clear that, without improvement in basic skills, the students who will comprise the future U.S. workforce are poorly equipped to keep up with the highly educated (and in many cases lower paid) workforces of our competitors.

Employer Views of Basic Skills

What skills and education do employers want most in their workers? What is the connection between these desires and job performance? The answers from the research are fragmentary. Most of the studies focus on what employers think are

---

[30] Ibid.

[31] Lewis J. Perelman, "Restructuring the System Is the Solution," *Phi Delta Kappan, September* 1988, pp. 20-24.

[32] Ina V.S. Mullis and Lynn B. Jenkins, The *Reading Report Card 1971-88: Trends from the Nation's Report Card,* (Princeton: NJ: National Assessment of Educational Progress, January 1990)

[33] Arthur N. Applebee, Judith A. Langer, and Ina V.S. Mullis, *Crossroads in American Education: A Summary of Findings* (Princeton, NJ: Educational Testing Service, February 1989), pp. 7-11.

[34] Ibid, p. 29.

[35] Ibid, p. 27.

[36] Archie E. Lapointe, Nancy A. Mead, and Gary W. Phillips, *A World of Differences: An International Assessment of Mathematics and Science,* (Princeton, NJ: Educational Testing Service, 1989) p. 13

[37] Several OTA reports have discussed education and training issues related to the scientific and engineering workforce. See, especially: *Making Things Better: Competing in Manufacturing,* OTA-ITE-443 (Washington, *DC: U.S.* GovernmentPrinting Office, February 1990), pp. 115-126, *and Educating Scientists and Engineers: Grade School to Grad School, OTA-SET-373* (Washington, DC: U.S. Government Printing office, June 1988).

[38] Basic skills problems are by no means limited to those who don't go on to college. In 1983-84, one-fourth of all students entering colleges and universities took remedial math courses, one-fifth took remedial writing, and 16 percent took remedial reading; 82 percent of all colleges and universities saw the need to offer such courses. U.S. Congress, Office of Technology Assessment, *Technology and the American Economic Transition: Choices for the Future,* OTA-TET-283 (Washington, DC: U.S. Government Printing Office, May 1988).

attractive attributes in entry-level workers, not the actual job requirements or the skills that successful employees need. Also, the surveys typically poll corporate-level executives or personnel officers who may view skill needs differently than, say, shopfloor supervisors or plant managers.

There are also problems in definitions. For example, employers often have a different concept of basic skills than the training or education community. A banking industry survey, for instance, asked employers for specific examples of basic skills problems in specific jobs (e.g., teller, customer service representative).[39] Many examples offered by the banking industry respondents-such as "not properly following procedures on opening accounts or cashing checks' '-could reflect carelessness, inattention, or, indeed, inadequate coaching by supervisors.

A review of 13 surveys found that employers generally view a positive attitude toward work as the most desirable characteristic in entry-level workers.[40] These employers also placed more importance on basic skills (including communications skills and problem solving skills) than specific occupational skills and also wanted entry-level workers to understand the business environment.

Several factors are contributing to employers' sharpened awareness of basic skills problems among their own workers. Employers are aware of the heightened attention the news media and government reports give this issue, and are also becoming aware of the implications of changing demography for the educational qualifications of entry-level workers.

According to a 1989 survey by the Omega Group, Philadelphia area executives saw basic education deficiencies reflected by problems in hiring qualified employees, higher wages for qualified entry-level workers, or the need to restructure work or downgrade job descriptions.[41] One employer found that some new hires, while able to learn the skills needed to perform a specific task, were unable to transfer those skills to different but closely related tasks.

Some of the executives said that literacy had a substantial impact on marketing and customer services-especially in telecommunications, banking, and retailing. In particular, as more companies use computer-based systems, they need entry-level employees who are able to respond to customer requests and process orders quickly.

For the most part, the executives did not consider literacy training to be a corporate responsibility. Their firms dealt with basic skills problems in several ways, including screening of job applicants, accepting higher rates of turnover, living with service problems or, in some cases, relocating. One insurance company executive noted that, when low-skilled workers became an issue, new technology could be employed to do the work, so that the firm could hire less-able people.

While they worry about basic skills deficiencies in future workers, employers are less worried about *current* workers. Three-quarters of employers responding to a recent survey by the Society for Human Resource Management said they had yet to experience a need for remedial training of their employees; these respondents either did not hire employees with basic skills problems or found little need for remedial training among their current employees.[42] But, employers often do not become aware that their workers have basic skills problems until they attempt to make a major change that requires training. (See box 4-C inch. 4 for discussion of Plumley Companies, an auto parts supplier that launched an employee education program on finding that most of its workers did not have the basic skills needed to train for or implement statistical process control.)

Recruiting and retaining skilled workers is a growing concern of small business. According to a 1989 Dun and Bradstreet survey, small business chief executive officers (those heading firms with less than $12 million in sales) who responded put finding qualified, motivated employees at the top of

[39] American Bankers Association, *Executive Summary: The American Banker' Association's Survey on Basic Skills in Banking*, Spring 1989, p. A2.

[40] Gary Natriello, "What do Employers Want in Entry-1evel Workers? An Assessment of the Evidence,' occasional paper No.7, National Center on Education and Employment, Teacher's College, Columbia University, April 1989.

[41] Omega Group Inc, Literacy i„ *the Workplace: The Executive Perspective,* A Qualitative Research Study, Bryn Mawr, PA, 1989. Twenty-eight top-level executives in manufacturing and service industry firms were interviewed.

[42] Society for Human Resource Management, *1989 Training/Retraining Survey,* Alexandria, VA, 1989, P. 19.

their problem list-followed by solving cash flow difficulties, containing costs, dealing with government regulations, and meeting increased competition.[43] Most of the respondents stressed in-house training, rather than more aggressive recruitment.

In similar vein, small manufacturers responding to a National Association of Manufacturers survey cited lack of skilled labor and lack of basic education skills as two of their major problems. Half of the responding employers said their employees had trouble solving problems on their own; 37 percent said math concepts were a problem; 30 percent said English fluency was a problem; and one-fourth said their employees had trouble training in operations. Nearly three-fourths of the responding firms said they found it fairly or very difficult to fill openings for skilled workers.[44]

Impact on Company Performance

While documentation is sparse, anecdotal evidence suggests that poor basic skills cost American companies quite a bit. One small Illinois company turned to a community college to teach English skills to its largely Hispanic workforce when an Hispanic employee ruined an $8,000 part through a language misunderstanding.[45] Inability to measure also can be costly. A Florida company that manufactures bellows estimates that it loses $1.2 million per year because its workers do not read blueprints correctly or incorrectly calculate the material needed to make products.[46]

Companies that must give workers remedial courses as a prelude to technical training face delays in implementing new technologies and work practices. Motorola expects to spend over $10 million per year for the next 3 years to bring its U.S. workforce up to sixth or seventh grade reading and math levels .47 Basic skills problems can also hamper employee participation in productivity and quality improvement efforts: for example, one major manufacturing firm found that one-fourth of its quality circles (which met without management to encourage free discussion) were unable to pass on written suggestions because no one could take notes well enough.[48] Basic skills deficiencies obviously add to company costs in screening job applicants and in hiring new employees.

Although imprecise and subject to great uncertainty, there have been some efforts to estimate the overall cost to companies of basic skills deficiencies. A study of the Atlanta metropolitan statistical area concluded that employed workers with educational limitations cost employers $840 million annually (or about $3,700 per employee) in lost time, inadequate performance, and higher personnel costs (e.g., health and safety, training). The study estimated that the total social and economic cost of functional illiteracy among all Atlanta area adults to be $2.6 billion annually.[49]

At the regional level, according to the U.S. Department of Labor, the costs of functional illiteracy among 3.6 million employed but undereducated workers in the eight Southeastern States amounted to $24.8 billion annually (or nearly $6,900 per worker) because of time lost, poor performance, and other employment related problems. It is not clear from the 2 studies why the regional costs per worker would be so much higher than those for Atlanta. (Total costs of functional illiteracy, including the unemployed, within the region were estimated to be over $57 billion) .50

Canada, too, has a basic skills problem. A Canadian business task force estimated that the costs of functional illiteracy to Canadian business was $4 billion annually. This figure could be used to

---

[43] James S. Howard, "Small Business CEOs: No Shortage Of Worries," D&B Reports, November/December 1989, p. 17.

[44] Job Skills, Education of Workers Big Problems for Small Manufacturers, NAM Survey Shows,' NAM *News*, June 2*, 1989. The NAM Small Manufacturers Operating Survey was mailed to over 9,500 small firms in the spring of 1989. Responses were received from 2,228 firms, for a 25.4 percent response rate. About 40 percent of the responding employers had tuition reimbursement programs.

[45] Jeanne Sadler, "Small Companies are Target of Efforts to Improve the Literacy of Employees," *Wall* Street *Journal, Nov. 3, 1988,* p. B2.

[46] "Business Teaching 3 R's to Employees in Effort to Compete," New *York Times, May* 1, 1988.

[47] "Four b, Four: How Can Businesses Fight Workplace Illiteracy?," *Training and Development Journal*, vol. 43, No. 1, January 1989, pp. 21-22.

[48] As cited in Larry Mikulecky, "S=ond Chance Basic Skills Education, "Commission on Workforce Quality and Labor Market Efficiency, *Investing in People: A Strategy to Address America's Workforce Crisis,* Background Papers Vol. 1, op. cit., footnote 14, p. 237.

[49] William A. Dealy, *Atlanta 2000: Its Changing Job Market and the Employment Readiness of its Workforce,* A Special Metropolitan Area Study Conducted for the Southeast Regional Office of the National Alliance of Business, 1987, pp.46-48.

[50] Richard A. Mendel, *Meeting the Economic Challenge of the 1990s: Workforce Literacy in the South,* A Report for the Sunbelt Institute (Chapel Hill, NC: MDC, Inc., September 1988), p.15.

guesstimate U.S. costs. If a 10-to-l conversion ratio (the approximate difference in the economies and populations of the two countries) were used, the cost in the United States would be $40 billion annually .51 Total costs to Canadian society were estimated to be $10 billion per year-the equivalent of $100 billion for the United States.

WORKPLACE-ORIENTED PROGRAMS[52]

Since the early 1980s, a number of workplace basic skills programs have been launched. These usually involve cooperative efforts by employers, unions, educational institutions, and government. The terms ''workforce' and "workplace" are sometimes used interchangeably in describing basic skills programs; in this report, however, OTA distinguishes between the two terms. "Workforce" programs are for people not currently employed who need improved basic skills or work readiness skills to enter the workworld, while "workplace" basic skills programs are for employees. The discussion below focuses mostly on workplace programs.

Company-run Programs

There are many individual examples of arrangements among companies, unions, and local adult basic education programs to provide services to adults. Most, however, are not workplace programs ***per se.*** For example, the Business Council for Effective Literacy, which works to foster corporate awareness of adult literacy issues, identified more than 800 corporate literacy actions of all kinds between 1984 and 1987. However, only 9 percent had to do with employee basic skills programs.[53]

Unfortunately, surveys of employer involvement in basic skills programs have been far from comprehensive. Most surveys have very low response rates. The surveys probably overstate employer involvement because they do not define such terms as "basic skills" or "remedial education. " For example, firms may consider remedial courses in blueprint reading, accounting principles, or statistics to be basic for specific jobs. Also, few surveys ask firms whether their basic education activities are companywide in scope. One common failing in all surveys is that small firms-those with fewer than 100 employees—are absent as a category or in proportion to their importance to the economy. Another shortcoming is the dearth of survey information about the features of the fins' activities (e.g., whether government funds are used, role of local educational providers, etc.).

Table 6-2 compares findings from four of the more inclusive employer surveys. The *Training Magazine survey* shows clearly that company-based remedial training often bears little resemblance to the Three-Rs of adult basic education. When remedial education was left undefined in the survey instrument, roughly one-third (31.79io) of the survey respondents (all companies with 100 or more employees) said they offered ''remedial/basic education. However, when firms were specifically asked if they provided remedial education in reading, writing, arithmetic, or English as a Second Language, only 11.3 percent said they did. (The survey asked respondents not to include such items as listening, creative thinking, or computer skills.)[54]

The Towers Perrin-Hudson Institute survey of large firms found that 8 percent of its respondents had remedial programs, and that they spent 3 percent of their training budget on these activities. Another 9 percent were conducting pilot projects.[55]

The American Management Association (AMA) found far fewer firms with basic skills programs. In a 1989 survey of its members, AMA found that one-third of the respondents tested job applicants or current employees for basic skills, but only 3 percent offered remedial training to correct deficiencies.[56] Nearly 90 percent of the responding companies said they refused to hire workers who failed basic skills test—perhaps an explanation for the few companies with corrective programs.

---

[51] As cited in Mikuleckly, op. cit., footnote 17.

[52] Portions of this section are drawn from Paul V. Delker, *Basic Skills* Education in *Business and Industry:* Factors *for Success or Failure, Op. Cit.,* footnote 4.

[53] Information provided by Gail Spangenberg, Business Council for Effective Literacy, JUne 1990.

[54] Chris Lee, "The Three Rs," *Training: The Magazine of Human Resource Development,* vol. 26, No. 10, October 1989, p. 68

[55] Towers Perrin, Hudson Institute, ''Workforce 2000—Competing in a Seller's Market: Is Corporate America Prepared?" A Survey Report on Corporate Responses to Demographic and Labor Force Trends, July 1990.

[56] Ellen Sherman, "Back to Basics to Improve Basic Skills," *Personnel,* July 1989, p. 22.

Table 6-2—Surveys of Employer Involvement in Workplace Basic Skills Programs

Source/Date/Response Rate	Business involvement	Comments
Training(1989):[a] Twenty thousand organizations with 100 employees or more were sent surveys; 3,130 surveys were returned for an overall response rate of15.7 percent. However, only half the surveyed firms were asked special questions in which remedial education was defined to limit to the Three-Rs.	11.3 percent of respondents said they offered remedial education in reading, writing, or arithmetic, or basic education for employees whose native language is not English; when remedial/basic education was left undefined, 31.7 percent of companies said they offered programs.	Only 2 percent of respondents picked remedial/basic education as the most critical challenge for their training and development function over the next 2 to 5 years. (Of the 13 choices, the largest challenge, picked by about one-fifth, was new market strategies, followed by technological change-roughly 16 percent; quality improvement-about 12 percent; and customer service-about 10 percent).
American Management Association (1989)[b] Survey of AMA members, of whom 1,005 responded.	Only 3 percent of respondents said they provide remedial education in basic skills. However, more than one-third of the respondents (34 percent) indicated that they used basic skills testing of job applicants, new hires, and in some cases, current employees and candidates for promotion. Nearly 90 percent of the respondents issuing testing said they do not hire applicants that fail basic skills tests. None of the companies said they automatically deny promotion to candidates when testing shows basic skills differences; most allowed the promotion but also assigned the worker to remedial training.	In addition to the survey, AMA profiled some 30 company programs. Costs of remedial projects ranged from nothing to nearly $1000 per employee, with the average cost around a few hundred dollars per employee. Programs averaged one session per week for 3 months or longer. Roughly half the profiled companies provided remedial training on company time.
Society for Human Resources Management (1989)[c] Survey was sent to a random sample of 4,600 SHRM members; 613 usable responses were received for a response rate of 13.3 percent. Some small firms (under 100 employees) were included in the sample.	Roughly one fourth (26 percent) of respondents said they provided remedial training, defined as "basic skills (i.e., writing, reading, math, English, etc.) that must be mastered before additional training or retraining can be undertaken successfully."	Survey found that firms rely far more on outside sources for remedial training than they do for other forms of training and retraining. (41 percent said all or a majority of remedial training was provided by outside providers, compared to 15 percent for other training and 12 percent for retraining.)
Towers Perrin, Hudson Institute (1990).[d] A questionnaire on human resource practices and concerns was sent to 4,000 firms; responses were received from 645 firms, for a 16.1 percent response. Most were large firms; the median firm had 1,953 employees; 25 percent had more than 6,200 employees; only 25 percent less than 765. Most respondents (73 percent) were in the East or Midwest. financial services accounted for 22 percent of the responses; manufacturing, 14 percent.	Overall, 8 percent of respondents undertook remedial education; another 9 percent had pilot projects; 14 percent planned activities. On average, the portion of training budgets for remedial education was 3 percent. Firms with strategic plans for addressing skills gaps were much more likely to have remedial programs than those that had yet to plan measures to address skills gaps.	Poor basic skills was a major cause of rejection of new job applicants. Among firms hiring at least 150 new employee each year, *40* percent of the respondents had to screen 6 to 10 candidates to hire one worker. Nearly 60 percent of the firms cited inadequate writing and verbal skills as the most common reason to reject a candidate, followed by inadequate adaptation to the work environment (36 percent). Another reason for not hiring, failure to pass medical or drug tests, was cited by 10 percent.

[a]Chris Lee, "The Three Rs," *Training: The Magazine of Human Resource Development,* October 1989, p. 68.
[b]Ellen Sherman. "Back to Basics to Improve Basic Skills," *Personnel,* July 1989, P. 22.
[c]Society for Human Resource Management, 1989 *SHRM Training/Retraining Survey,* Alexandria, VA, 1989.
[d]Towers Perrin, Hudson Institute, *Workplace 2000: Competing in a Seller's Market: Is Corporate America Prepared?* July *1990.*
SOURCE: Office of Technology Assessment, 1990.

At the high end, the Society for Human Resource Management (SHRM) survey reports that 26 percent of responding employers provided remedial training. As indicated in table 6-2, SHRM's question about remedial education is more open-ended than the *Training* Three-R survey question. SHRM found less than one-fifth of the smaller companies (those with fewer than 500 employees) had remedial training programs, while a third or more of the larger companies had programs. Companies tended to use outside providers to a greater extent for remedial training than for their other training activities.[57]

[57]Society for Human Resource Management, *1989 SHRM Training/Retraining Survey, Alexandria,* VA, 1989.

Contrary to the claims sometimes made, firms in most industries probably spend very little of their total training budget on remedial education, opting instead to rely on outside, publicly supported Federal, State, and local basic education programs. But there are exceptions. A recent American Bankers Association (ABA) survey found that 38 percent of bank survey respondents had established basic-skills programs for employees. These banks spent about 23 percent of their training budgets on these efforts. The ABA estimated that the banking industry as a whole spent between $23 million and $135 million per year on basic skills programs. (The smaller figure assumes that nonresponding banks spent nothing on basic skills; the larger figure assumes that banks responding to the survey were typical of the industry.[58]) It seems likely, however, that a portion of this expenditure would be for industry specific basic skills-not the Three-Rs.

The ABA, through the American Institute of Banking (its educational affiliate), is its industry's largest provider of basic skills assistance and is in the process of developing industry specific materials to enhance its efforts. As trade associations in other industries (e.g., textiles, printers) become more involved in developing basic skills materials, more companies may be encouraged to set up industry specific programs for their employees.

Some large companies most involved in basic skills education have developed their own internal courses-often as part of a broader employee development or training program. Examples include Polaroid, Motorola, Eastman Kodak, and Aetna. Polaroid has offered basic education to its employees since 1970. The company has developed a fundamental skills program for basic literacy and arithmetic, and a technology readiness program that involves some math and science, computer skills, and so called skills for sustained learning (like problem solving).[59] Most Technology readiness courses are at the high school level; however, some are second-year college courses. Courses take place onsite, mostly on company time.[60]

Aetna is another company that has developed its own basic skills curriculum, called the Effective Business Skills (EBS) School. EBS was developed by the company's Institute for Corporate Education to build employees' basic skills (math, reading, writing, and oral communications) and to help them use computers and apply adult learning strategies. It is now available to other Aetna divisions. To attract students who do not wish supervisors and coworkers to know they are taking remedial courses, Aetna offers evening courses as well as during shifts (with the supervisor's permission). Many employees prefer the evening course because registration is kept confidential even from supervisors. The EBS program is intended to complement Aetna's "general business skills' program, which is used by employees whose basics are adequate but want to upgrade their job skills.

One reason why Aetna set up EBS was its concern that it might not be able to hire as many workers with good basic skills as it would like. Aetna already has problems, particularly in the Northeast and in California, in finding new hires with strong basic skills. Also, Aetna was concerned that it might have too few employees with the qualifications and training needed to move up into better jobs when vacancies occur. (Job vacancies are made known internally before being advertised outside the company.)

Another reason is that jobs are becoming more complex. Many jobs within Aetna that were once routine in nature now require new skills from workers. The claims processor job, for example, has been fundamentally altered by the decentralized use of computers. Once, paper files moved back and forth through multiple stations as they were processed. Now, one worker is responsible for multiple tasks and must possess a range of new skills (such as keyboard skills, an ability to use electronic mail, or spread sheets).

While the company offers general skills training for employees and specifies the skills needed for new jobs, few lower level employees took the training needed to qualify for these positions before EBS. Some of these employees may not have felt

[58] The American Bankers Association.L *Executive Summary: The American Bankers Association's Survey on Basic Skills in Banking* (Washington DC: Spring 1989).

[59] Anne Skagen, cd., *Workplace Literacy,* AMA Management Briefing, no date, PP. 23-25.

[60] AS cited in National Alliance of Business, *Lessons Learned: Job Skills Education Program Final Report,* report prepared for the Employment and Training Administration U.S. Department of Labor, May 1990, pp. 64-65.

themselves qualified to take the general skills courses. Others may not have gotten their supervisors' permission to take training on company time. (Aetna has a corporatewide policy of charging the costs of training to the cost-code of the department involved when the training takes place on company time.)

The company's basic skills program is highly job-specific (and even Aetna specific) in content. For example, in setting up a special EBS program for security guards, the Institute discovered (from supervisory personnel) that faulty "incident reports" were a real problem. The incident report is used as a training vehicle in the EBS program, apparently to good effect. (By contrast, the general skills course uses more generic examples.)

Onsite literacy services like Aetna's are rare. Partnerships with existing community educational institutions are more common. In these, employers may provide some support (e.g., paid release time for employees to take classes, provision of funds, materials, or advisory services). Some of these programs are, in essence, conventional adult basic education (ABE) classes with that serve the employees of a few companies. As discussed at the end of the chapter, conventional ABE is seldom the best model to use when the purpose is to achieve specific, defined, job-related objectives—such as upgrading of basic skills for statistical process control.

Joint Initiatives Between Labor and Management

Joint labor-management cooperative training programs (discussed in detail in ch. 8) support basic education for many workers represented by the United Auto Workers (UAW) and the Communications Workers of America (CWA). The joint programs are still in their early stages; the oldest began in 1982. Nonetheless, their size (over 700,000 workers are eligible for joint program benefits) and their resources (over $300 million in 1988 for *all training* and tuition assistance activities) make them major training institutions. Depending on how well they implement their programs, these institutions could extend the sum of the Nation's knowledge about the most effective and appropriate ways to teach adults basic skills.

Photo credit: UAW-Chrysler National Traiining Center

Using computers in basic skills courses helps to familiarize workers with a technology increasingly needed at work.

While the joint programs are separate from corporate training operations, cooperation at the plant level frequently allows basic skills programs to be offered in close conjunction with corporate initiatives. For example, at Ford's Dearborn Engine Plant, the UAW-Ford local training committee has provided basic arithmetic training off-hours to help workers taking Statistical Process Control (SPC) training on company time. The SPC training was developed with union input, although it was initiated and funded by the company.[61]

In some cases, the joint programs provide broad training to develop teamwork or problem solving skills while upgrading basic skills. Such a combined program, called "technical literacy," is offered by the UAW-Ford National Education, Development, and Training Center.

Because so many workers might be involved, the joint programs could obtain valuable data and information about different approaches. However, most programs do not yet involve much evaluation. This could change. The UAW-Chrysler National Training Center, for example, plans to evaluate the success of various delivery approaches for basic skills instruction used for Chrysler employees.

[61] Margaret Hilton, "The Role of Labor Unions in Training of Employed Workers," working paper #2, OTA Worker Training Project, May 28, 1989, p. 41.

The joint programs also could be a testing ground for instructional technology used in basic skills upgrading— particularly since some joint centers have access to in-plant computers or other instructional devices. Options for encouraging more systematic evaluation of basic skills courseware are discussed in chapter 2.

So far, the most elaborate use of interactive technology for basic skills at the joint centers is for motivation, not instruction. The GM-UAW's Skills 2000 program consists of 8 hours of modules on auto industry changes that will affect worker skills; tests and lessons to help workers sample their reading, writing, numbers, charts, and communication skills; information about about educational opportunities available to GM employees; and plant-specific contacts. The program, partially funded by the U.S. Department of Labor, may eventually be delivered to workers at 1000 interactive videodisc terminals in 150 GM plants and worksites.[62]

An evaluation of the motivational program at two pilot sites found that it did prompt workers to consider ways to improve their skills, and that they were interested in educational development. However, the evaluators caution that Skills 2000 will be of little help unless it is combined with an overall strategy for improving worker skills.[63] Having developed the motivational program, the GM-UAW human resource center is now giving more attention to the type and quality of services available at local plants. Because the joint program is decentralized, it will be up to management and union leadership in each plant to make sure that employees, once motivated, get prompt attention and high quality educational services.

State Basic Skills Program

State governments have long been active in adult basic education as recipients of Federal Adult Education Act funds. Other State programs, as well, have had literacy components. More recently, the States have launched new literacy initiatives aimed at developing coordinated literacy strategies. At least 30 States have set up bodies to plan or coordinate various literacy activities.[64] These bodies serve several purposes; most, however, are attempting to develop an overall State literacy strategy to cover the diverse groups (school children, high school dropouts, employees, displaced workers, people on welfare) and the numerous government programs (adult basic education, Job Training Partnership Act, vocational education, Job Opportunities and Basic Skills Program, and so forth) that charnel funds for literacy programs to one population or another.

While few States now have strong programs for business involvement, this could change as the States move to implement the adult literacy component of the National Education Goals that the State Governors' adopted in 1990. The Governors' goal statement decried the fractured system for delivering adult literacy services and called for a public-private partnership in each State to create a "functionally literate workforce. ' '[65] (See ch. 2 for further discussion.)

Several States have launched separate workforce literacy initiatives that complement State adult basic education programs or job training programs.[66] These programs, for the most part, emphasize upgrading basic skills of economically disadvantaged people, many of whom are not now employed but want work skills. To a lesser extent, these programs also support employer-based activities. Some States—such as Connecticut-are adjusting their adult education programs to encourage employer involvement. A few special initiatives aim primarily at the workplace. State activity in this area could well increase if Federal legislation now under consideration in Congress passes (see ch. 2). Also, if Federal Adult Education Act funds for workplace literacy grows to $50 million, this program will be administered by the States, rather than nationally. (See box 6-E.)

Workplace Initiatives

Several States—Massachusetts, Illinois, and South Carolina among them-have developed new mechanisms for employer involvement. Created in 1986, the Massachusetts Workplace Education Initiative

[62]Delker, op. cit., footnote 5, p. 76.

[63]James Bosco, *Evaluation* Report *of Skills 2000*, Western Michigan University, June 1989, Executive Summary.

[64]*Adult* Lit$_{eracy:}$ *Programs, Planning, Issues, Business* Council for Effective Literacy, January 1988.

[65]National Governors' Association, *National Education Goals,* Feb. 25, 1990, p. 9.

[66]Judith K. Chynoweth, *Enhancing Literacy for Jobs and Productivity* (Washington, DC: Council of State Policy and Planning Agencies, 1989).

(WPE) is both a training delivery initiative and a research demonstration project.[67] WPE coordinates more than 20 workplace literacy programs, documenting each through a formative evaluation. The evaluation is used to track strengths and weaknesses of each model, identifying problems and offering technical assistance on an ongoing basis.

Organizers hope the evaluations will be instrumental in shaping a long term, systematic strategy for improving workplace literacy. WPE has attempted to develop and evaluate models applicable to a range of industrial needs, funding programs in both the manufacturing and service sectors, in unionized and nonunionized settings, for both native English speakers and immigrants.

WPE is a joint program of three Massachusetts State agencies, coordinated through the Commonwealth Literacy Campaign. In fiscal year 1989, WPE received approximately $750,000 ($600,000 from a Federal Workplace Literacy Grant and the remainder from State funds) and reached about 1,000 workers. A 3-year evaluation, conducted by an outside party, recommended that Massachusetts continue to invest in WPE, despite the current fiscal crisis facing the State.[68]

The Illinois Literacy Resource Development Project (ILRD) is a collective effort among six key literacy entities in Illinois, designed to help volunteer literacy and adult education programs garner additional resources.[69] At its inception in March 1987, ILRD set up task forces of local workplace literacy and adult education providers to develop implementation strategies. Examples included:

- marketing contractual literacy programs to business,
- soliciting corporate and foundation support,
- seeking individual donations,
- impacting local public policy, and
- exploring State implementation of literacy programs.

The task forces put grassroots providers in contact with prospective sources of support. In addition, the task forces produce 'how-to' manuals and organize workshops and conferences designed to help local members raise money, market their programs, and increase awareness among community leaders, legislators, and other policymakers. ILRD is an independent nonprofit organization supported by grants from the Illinois State Education Board and private foundations or charities. In fiscal year 1989, combined funding totaled approximately $130,000, enabling the ILRD to reach over 200 local organizations and 70 businesses, unions, and foundations.

South Carolina's Initiative for Work Force Excellence, launched by the governor in 1988, assists employers throughout the State in offering basic skills programs to workers. Each of the State's 16 two-year technical colleges now has a workforce specialist who serves as a basic skills consultant to employers and also meets with local business roundtables. By June 1989, the initiative had identified about 31,000 workers—about 2 percent of the State's employed workforce-in need of basic skills training, a figure considered lower than the overall need. About 5,000 workers were either in training or had completed training. The technical institutes, long involved in industry training, are developing programs and offering courses for the companies where the identified employees work.

Customized Training and Basic Skills

The capacity to offer workplace basic skills instruction in association with other kinds of industry training is an attractive feature of State industrial training programs. Where the objective is to improve workplace skills, programs that focus on specific needs in particular establishments may be more likely to succeed than general ABE or GED programs.

OTA'S State survey (discussed inch. 5) found that nearly all State industrial training programs authorize funds to be used for basic skills training, and two-thirds permit funds to be spent on English as a second language. While only about one-fourth of the

[67]The following discussion is based on information from the Massachusetts Workplace Education Initiative Program Summary and OTA Staff communications with Sondra Stein, June 1990.

[68]Paula Rauman and Laura Sperazi, Massachusetts *Workplace Education Initiative: Year 3 Evaluation Final Report* (Wellesley, MA: Stone Center, Wellesley College), 1989, p. 106.

[69]This discussions based on information from the Illinois Literacy Resource Development Project Task Force #1 Handbook on Marketing Contractual Literacy Services To Businesses, (Champaign, IL: ILRD), and OTA staff communications with Suzanne Knell, Executive Director, June 1990.

State customized training programs spend more than 10 percent of their funds on basic skills, there are exceptions .70

New York's Employer Specific Skills Training Program (ESSTP)-a program designed to help fill gaps between job demands and worker skills—offers workplace basic skills programs as a regular component of its assistance to business. ESSTP assists employers in assessing their workers' training needs, developing customized courses, and training workers. Often, basic skills instruction is carried out in conjunction with statistical process control training or with other workplace changes.

New York's program typically picks up most direct instructional costs; however, employers are expected to provide release time or paid time off to workers. Since release time can cost 3 to 10 times as much as the instructional costs, an employer's compliance is an important sign of commitment. Sometimes the release time requirement is eased for small businesses.

Some States are looking at tax incentives to encourage private sector involvement in basic skills programs. Mississippi, in 1989, became the first State to offer a tax credit to companies providing workplace basic skills programs that meet State qualifications.Tl The 25-percent tax credit can be applied to the wages of instructors (but not trainees), instructional materials and equipment, and construction and maintenance of training facilities. Several features of Mississippi's program aim to assure that the tax credit is focused on basic skills. The company must apply for the tax credit, and its chief executive officer must sign the application. The company must develop a training plan, a time schedule and a projected budget. Several State agencies, including the education department and the tax commission, are involved in providing technical assistance.

Mississippi has also become a leader among the States in investigating the potential to use instructional technology in basic skills instruction. The Governor's office has been instrumental in funding a pilot project to test civilian applications for the U.S. Army's computer-based Job Skills Education Program (see discussion in next section and box 6-D).

A few States have called for broad improvements in the basic skills of their workforce to meet economic development objectives. Michigan's strategy for building a competitive workforce, set forth by the Governor's office in 1988, includes improving the literacy skills of one million Michigan adults by 2000 to meet the State's projected occupational requirements. "Workforce literacy" and "work readiness" objectives have become driving forces behind the numerous State adult education and training programs. Michigan encourages employers to assess their workers' basic skills, and will conduct job analysis and needs assessments for skills. It plans to make remedial education available to currently employed workers.

Michigan's adult literacy task force has established "core groups" in each region of the State, comprised of representatives of each organization and institution involved in adult literacy training. With help from facilitators, core groups build cooperation by developing uniform procedures, forms, referral processes, and outreach techniques. Core groups also hope to simplify the adult literacy training system by reviewing the division of responsibilities and funds, encouraging subcontracting where there is repetition.[72]

The Michigan strategy includes some innovations, including the Michigan Opportunity Card, a novel effort to make the Michigan employment and training system more user friendly. (The Card—about the size of a credit card-stores enough information about applicants for State-sponsored services to allow them to avoid filling out new forms whenever they seek education or training.)

Adult Education Programs

For many years, States have funded local adult basic, adult secondary, and English as a Second Language projects, supported in part through the Federal Adult Education Act. At least 15 States have open-ended funding formulas for their adult basic education programs that can be used to cover instructional costs of workplace basic skills pro-

70Peter A. Creticos, Steve Duscha, and Robert G. Sheets, "State Financed Customized Training Programs: A Comparative State Survey," report prepared for the Office of Technology Assessment under contract L3-381O, March 1990, table 12.

71 Senate bill 2925

72 OTA staff communication with Judy Hollister, Governor's Council on Human Resources, June 7,1990.

Box 6-D—Trying To Transfer Military Training Technology: The JSEP Example

The effort to transfer the Army's Job Skills Education Program (JSEP) to educational institutions and the private sector reveals both the promises and pitfalls of using training materials in settings different from those for which they were originally intended. The Army developed JSEP at a cost of $11 million in the early 1980s. The attempt to transfer JSEP has been formally underway since 1986 through a joint effort by the departments of Defense, Education, and Labor, and is still not complete. The full JSEP program includes more than 300 lessons and 400 hours of basic skills instruction, built on analysis of educational proficiencies needed to perform 94 of the most common military occupational specialities (MOS). It includes a student management system that keeps track of performance data, and also gives individualized learning prescriptions based on pretest and other diagnostic information. JSEP also has learning strategy modules to help students develop time-management skills, test-taking skills, and problems-solving skills. Soldiers seem to prefer JSEP over conventional instruction, and their test scores generally improve if given enough time on JSEP.

Why transfer JSEP to civilian use? Many military and civilian occupations are very similar (e.g., health care aides, electricians, machinists, auto repair people, and computer operators) and require similar levels of basic educational skills. However, most of the JSEP materials use Army or military examples that seem foreign in a civilian setting. Hence, JSEP has been partially "degreened" or "civilianized" to facilitate transfer.

Several demonstration projects have been funded, including a Mississippi project involving a community college and an electronics company. An evaluation of JSEP by the National Alliance of Business (NAB) found that it can work in civilian settings, at least under pilot or test site conditions. However, NAB found many barriers that would inhibit immediate and widespread use of JSEP. For example, JSEP's computer system is either not compatible with most commercial systems or requires high-cost special equipment to use. Also, complex copyright issues about control of JSEP courseware exist. Another barrier is the limited technical assistance for civilian users of JSEP.[2]

[1]National Alliance of Business, *Lessons Learned: Job Skills Education Program Final Report,* prepared by the National Allaince of Business for the Employment and Training Administration of the U.S. Department of Labor, May 1990.

grams. Where such formulas exist, educational systems are likely to be more aggressive in serving workplace needs—and are better able to approach employers with project proposals. (Most other States operate from fixed appropriations that limit their flexibility to act on requests for additional services that have not been specifically planned in advance.)

Connecticut has been especially aggressive in offering industry basic skills assistance. It ranks ninth among the States in matching Federal dollars; it spends about $5 for every $1 in Federal Adult Education Act funds it receives. When an employer contacts the State education agency, the agency often acts as a broker between the firm and a local education agency (LEA) to provide the services. The State is willing when necessary to cross jurisdictional lines to find an appropriate service provider. In 1988, the Connecticut legislature made workplace programs more attractive to LEAs by allowing employers to ''cash match' for State funds on a needs-based formula.

Instructional Technology and Basic Skills[73]

When properly used, high-quality technology-assisted training programs can be effective in delivery of basic education to adults.[74] Most, but not all, evaluations of computer use in adult basic education have found positive effects. Generally, these studies conclude that adults in classes where the computer is used to assist the instructor require somewhat less instructional time to learn than students in conventional classes, and may score a bit higher.[75]

[73]Chapter 7 discusses instructional technology in greater detail.

[74]Many studies of school-age students have found that that well-designed programs that use instructional technology can reduce learning time compared to the average course taught by traditional means, as well. For a discussion of this research, see U.S. Congress Office of Technology Assessment, *Power On: New Tools for Teaching and Learning*, *OTA-SET-379* (Washington, DC: U.S. Government Printing Office, September 1988), pp. 44 et seq.

[75]See U.S. Congress, Office of Technology Assessment, *Technology and Structural Unemployment: Reemploying Displaced Adults,* OTA-ITE-250 (Washington, DC: U.S. Government Printing Office, February 1986) pp. 290-302, for a review of computer-assisted instruction in adult basic education.

While the initial costs of acquiring hardware and courseware can be high, computer-assisted instruction (CAI) can yield cost savings in classroom settings if students use the computers heavily and instructors take advantage of the computer to make more effective use of their time. One review of computer-based training in the military, for example, found it to cost 30 percent less than traditional instruction.[76] Other advantages of computers include flexibility in scheduling, individualized learning, privacy, and rapid feedback.[77] These features make computer-based systems attractive to adult learners, and to business, especially when firms already own the needed hardware.

Computer-assisted instruction has long been used in basic education.[78] Several large-scale, computer-managed systems exist. Two of these-the basic skills instruction offered by the Computer Curriculum Corp. (CCC) and PLATO (recently purchased by the National Education Corporation from Control Data)-have been used and revised for over two decades. WICAT, Jostens Learning Corporation's adult literacy program, and IBM's Principles of the Alphabet Learning Systems (PALS) are more recent. Although not necessarily computer-based, the Remediation and Training Institute's Comprehensive Competency Program (CCP), marketed by U.S. Basic Skills Corporation, has been used extensively in Job Training Partnership Act Title II programs for young adults.

Quite recently, the Federal Government has sought to transfer some military basic skills programs, including the Army's Job Skills Education Program (JSEP), to the private sector and educational institutions. By far the most extensive effort has involved JSEP, a version of which has been partially modified for civilian use. (See box 6-D.) A JSEP pilot project involving a Mississippi community college and a manufacturer of musical instruments has been a collaborative effort among the Governor's office, Federal agencies and the National Alliance of Business (NAB) .79 Interviews with the first 64 employees participating in JSEP and their supervisors suggested positive outcomes for job performance (as reflected in productivity, accuracy, attitude, and job knowledge). Positive reactions to JSEP were also expressed by students in a pilot project involving a White Plains, New York, adult education center.[80]

Technology-based delivery of basic education has the potential to greatly increase opportunities for adult workers to improve their basic skills. Technology-based basic skills programs are now in relatively common use in local training projects receiving funds through the Federal Job Training Partnership Act-especially projects aimed at economically disadvantaged adults.[81] Several large companies, sometimes in conjunction with unions, are also using computer-based delivery of remedial education for their employees. Company demonstration projects, including the JSEP pilot projects and several interactive videodisc projects funded by the U.S. Department of Labor, are raising awareness of technology-based delivery options.

Even so, barriers to wider use of these technologies exist. While computer-based instruction for adults can be quite effective, methodological issues complicate comparison among the different systems themselves and with conventional instruction.[82] Also, there is a lack of reliable information about the many different products and services now on the market. While many of these products aim for the adult basic education market, very few of them were specifically designed to meet the needs of mature adult learners. Many adults have difficulty relating to materials designed for young dropouts or high school students. There are also very few examples of computer-based materials that were developed spe-

---

[76]As cited in *Power On*, op. cit., footnote 74, p. 78

[77]Don F. Seaman and Joe Michael McAllister, *An Evaluation of Computer-Assisted Instructional Systems to Deliver Literacy Services for J.T.P.A. Participants at Houston Community College, The* Texas Center for Adult Literacy and Learning, College of Education, Texas A&M University, no date, p. 22.

[78]Alan Weisberg, "Five 'Big' Systems and One 'Little' Option,'' *Adult Literacy and Technology Newsletter,* vol.3, No.1, May 1989.

[79]Jorie W. Philippi, *Technology Transfer Partnership Project: Meridian Community Collge-Peavey Electronics Corporation: Lessons Learned* (Washington, DC: National Allicance of Business, Jan. *2, 1989).*

[80]National Alliance of Business, *Lessons Learned: Job Skills Education Program Final Report,* report prepared for the Employment and Training Administration U.S. Department of Labor, May 1990, p. 32.

[81]For example, see Education TURNKEY Systems, Inc., *The Job Training Partnerships Act and Computer-Assisted Instruction* (Washington, *DC:* National Commission for Employment Policy, August 1988).

[82]Ibid., p. 5.

cifically for workplace basic skills. Finally, problems in converting technology-based products from one system to another continue to exist. Many existing products, including many products developed under contract for Federal agencies, are not very portable because they were developed using unique features or systems that are not widely used.

To facilitate transfer of effective programs, strategies and approaches (including technology-based methods), some State officials have proposed creation of a National Basic Skills Consortium (NBSC). It would work to develop ways that States and other service providers could share assessment and testing tools, curricula, and other products and information. It would also promote joint development of needed products and programs. While still being formed, NBSC might become an effective instrument for disseminating information about successful approaches. It currently lacks startup funds and staff.[83]

IMPLICATIONS FOR POLICY: BASIC SKILLS, CORPORATE TRAINING, AND THE EDUCATIONAL SYSTEM

The workplace basic skills issue has emerged just as the Nation's general literacy problems are drawing public attention. The Nation's Governors, from among their national education goals, call for every American to be literate, with the necessary skills and knowledge to compete in the global economy and exercise good citizenship, by the year 2000. Similarly, the Secretary of Labor's Commission on Workforce Quality and Labor Market Efficiency called on the Federal Government and the States to work together to ensure lifetime access to basic skills education, with the objective of eliminating illiteracy by 2000.[84]

Major expansion in Federal support for workplace literacy (as well as for adult literacy in general) is under consideration by the 101st Congress. Bills in the House and Senate would amend the Job Training Partnership Act (administered by the Department of Labor) and the Adult Education Act (administered by the Department of Education). Both would substantially expand existing Federal support for workplace literacy. (See box 6-E.) More than likely, debate will continue on the Federal role in workplace literacy and its relationship to Federal support for general purpose literacy programs.

Workplace and General Basic Skills Programs

Where do workplace basic skills programs fit in developing national policy on adult education and training? Are these programs so different from traditional adult basic education projects that they should continue to be singled out for special emphasis in Federal and State policy? What is the relationship between workplace basics and broader efforts to develop the skills of the workforce? Will more assistance for employed workers cut into education and training for unemployed people and the economically disadvantaged? These and other questions will become more central in the coming years as experience with workplace programs grows.

There are good reasons for policymakers to treat workplace programs as different. Successful workplace programs use tasks and materials similar to those used at work to enhance retention.[85] Few general-purpose ABE programs can do this, even though many participants have job-related reasons for participating.[86] Employers are not likely to make major commitments to improving their workers' basic skills (such as giving people release time from their jobs) unless these programs pay off through better work performance.

In theory, better performance might induce firms to provide programs at their own expense. However, there also could be more competition for the limited

---

83 "New Basic Skills Consortium Formed," *Workforce Development Strategies*, vol. 2, No. 1, June 1990, p. 8.

84 *Investing in People: A Strategy to Address America's Workforce Crisis*, Op cit., footnote 48, report of the Commission p. 21. A similar goal, with a few more guidelines for implementation, is contained in Forrest P. Chisman, *Jump Start: The Federal Role in Adult Literacy*, Final Report of the Project on Adult Literacy Sponsored by the Southport Institute for Policy Analysis, January 1989.

85 A military study, for example, found that recruits given traditional basic skills training tended to lose their skills within 8 weeks. Those given job related training tended to retain their skills. See Thomas G. Sticht, *Basic Skills in Defense* (Alexandria, VA: Human Resources Research Organization, 1982) p. 27. Reasons why this is so are not well understood, but may relate to the continued opportunities for practice and higher motivation when the student learns from materials encountered daily on the job. See Mikulecky, "Second Chance Basic Skills Education," op. cit., footnote 17, p. 250

86 Anthony P. Carnevale, Leila J. Gainer, and Ann S. Meltzer, *Workplace Basics Training Manual*, ASTD Best Practices Series: Training fOr a changing Work Force (San Francisco, CA: Jossey-Bass, 1990), p. 3A-6.

Box 6-E—Workplace Literacy and the Adult Education Act

While the Federal Government has supported adult basic education (ABE) and adult secondary education (ASE) since the mid-1960s, its involvement in workplace literacy programs is recent. Funds from several Federal programs can be used to support basic skills instruction for employed workers under some circumstances. However, only a few activities-mostly demonstration projects funded by the U.S. Department of Education and the U.S. Department of Labor-focus on the workplace per se.

The largest Federal workplace literacy program is a demonstration grant program added to the Adult Education Act in 1988.[1] Under the program, the Secretary of Education can make workplace literacy grants for projects designed and operated by partnerships among businesses, labor organizations, and education, training, or community-based organizations. Among eligible services: English as a Second Language; updating basic skills to meet workplace needs; and improving worker skills in speaking, listening, reading, and problem solving. Child care and transportation services, as well as educational counseling, also can be provided. Grant recipients provide at least 30 percent of program costs.

In its first round of grants (made in late 1987), the Education Department funded 37 projects, serving about 40,000 workers, at a cost of $9.7 million. Evaluation information from the first round of projects was not available when this report went to press. A second round of grants for 43 awards-were made in the spring of 1990. Congress appropriated a total of $11.7 million for fiscal year 1989, and $19.7 million for fiscal year 1990. As is discussed in the policy options part of chapter 2, a major expansion of this program was under consideration in the 101st Congress as this report went to press.

The lion's share of Adult Education Act funds ($137 million in fiscal year 1989) is used not for workplace literacy but to assist States and localities in providing adult basic education (ABE), English as a Second Language (ESL), and high school equivalency (GED) projects to educationally disadvantaged adults. About 40 percent of the people in adult education programs are employed. Another 45 percent are unemployed but looking for work.[2]

ABE projects have diverse goals, ranging from helping people to function effectively in society to helping them become more employable. In 1987-88, AEA projects served roughly 3 million people; two-thirds received basic education or ESL; the remainder were in GED programs.

Federal funding for AEA programs, flat for several years during the 1980s, is now on the increase. Congress appropriated $193 million for AEA in fiscal year 1990-compared to about $162 million the previous year. The Bush Administration seeks $239 million for the program in fiscal year 1991, including $19.7 million for a separately funded workplace literacy program. The Department of Education estimates that the proposed 1991 funding level would allow services to reach nearly 4 million adults—1 million more than in fiscal year 1989.[3]

Funding from non-Federal sources for AEA has increased significantly. The States tripled their contributions, compared to the Federal Government, from about 25 percent in 1969-70 to 76 percent in 1986-87.[4] Many States spend several times more than their Federal grant on adult education, while some other States put in only the minimum needed to qualify for the Federal grant (a 15 percent cost-share in 1990).

---

[1]Section 371 of the Adult Education Act.

[2]Anthony p. Carnevale, Leila J. Gainer, and Ann S. Meltzer, *Workplace Basics Training Manual,* ASTD Best Practices Series: Training for a Changing Work Force (San Francisco, CA: Jossey-Bass, 1990).

[3]U.S. Department of Education, *Justification ofAppropriation Estimates for Committees on Appropriations for Fiscal Year 1991*, mimeo., vol. 1, p. H-54

[4]U.S. Departments of Labor, Health and Human Services, Education and Related Agencies Appropriations for 1990, Hearigs, House Appropriations Committee, Part 6, Department of Education (Washington DC: U.S. Government Printing Office, 1989), p. 692

Federal funds available for basic skills education.[87] To minimize competition for funds, complementary approaches to encourage firms to become involved in workplace basic programs might be considered. As discussed in chapter 2, a variety of mechanisms, ranging from training consortia to tax credits to training levies, have been proposed to induce employers to provide more training. Basic skills could be singled out for special emphasis, in the event that Congress adopted one or more of these approaches.

[87]Indeed, workplace programs are popular. The U.S. Department of Education received more than 350 applications requestinnearly $100 million for workplace literacy projects when it began its workplace demonstration grant program. Ultimately, only 37 projects and $9.7 million in funds were awarded. At the same time, some urban areas are experiencing waiting lists for general purpose AEA projects.

The Small Business Dilemma

Large or medium-size businesses set up most company-based workplace literacy programs. Small businesses seldom have the resources to undertake their own programs.

While generalizing may be risky, workers in small firms are often assigned abroad range of responsibilities[88] for which strong basic skills are useful.[89] Yet, small firm employees, on average, have less education than workers at large firms. Nearly 23 percent of employees of very small firms (those with under 25 workers) are not high school graduates, compared to 18 percent at firms with at least 500 employees.[90] Young adult workers with an eighth grade education or less are more likely to work at small and medium-size firms (4 percent compared to 1 percent in large firms).[91] It seems likely, therefore, that basic skills problems may be more prevalent and more serious in the small business workforce.

Small fins, for the most part, have few resources to devote to formal job training-let alone basic skills training. A firm with 50 employees, for example, will find it very difficult to provide paid leave or other on-the-job support for basic skills training, since there are few workers available to fill in the slack. Very few small businesses are able to assign personnel to training. Indeed, it is rare to find a full-time training coordinator at a firm with less than 250 employees. Many large companies, by contrast, not only have trainers but also assign staff to apply for public support for training activities, including basic skills.

Bringing basic skills programs to small businesses and their employees will be a major challenge for administrators. Some States have coupled basic skills training with technical training offered by their industrial training services. Involving several firms in the effort can also help. Dry cleaners in South Carolina are working to develop a program for entry-level workers that uses job-specific materials.[92] In New York City, for example, the Chamber of Commerce provided basic skills instruction to employees from several small businesses, with the Department of Labor providing funds. There is a clear need for more emphasis on small business in Federal workplace literacy projects. Only 1 of the initial 37 workplace literacy projects issued by the U.S. Department of Education had small business involvement as its primary objective.

The Role of the States

The States—already active in workplace basic skills programs— could assume a more prominent role in the years to come. While the Education Department's demonstration program is federally administered, the program could become part of the AEA's regular grants to the States if Federal funding increases to over $50 million per year. Some States also are integrating basic skills instruction with other kinds of industry training assistance-a feature bound to be attractive to fins. States also receive and are responsible for grants under several other Federal programs for basic skills and training—suggesting at least the possibility of more coordinated delivery of services.

State government policies toward community colleges and other potential providers of training also have an impact. Many businesses contract for training with community colleges, which are more familiar with business needs than typical ABE programs. A recent Department of Education survey identified at least five States that provide all ABE/GED training through community colleges. Another 10 States have active programs with community colleges.[93] However, some States continue to prohibit community college involvement in adult basic education programs 94

---

88 Anthony P. Carnevale and Leila J. Gainer, *The Learning Enterprise* (Alexandria, VA: American Society for Training and Development 1989) p. 18.

89 As suggested in *Workplace Literacy: Targeting the Future*, report of the First National Conference on Small Business and Workplace Literacy, hosted by the Office of Advocacy of the U.S. Small Business Administration, Washington DC, Oct. 3-4, 1988.

90 U.S. Small Business Administration, *Small Business in the American Economy* (Washington, DC: U.S. Government Printing Office, 1988) p. 79.

91 Ibid., p. 102

92 Ibid., pp 8-9.

93 U.S. Department of Education, Division of Adult Education, "ABE/GED in Community Colleges: A National Study" June 1988. 'r'he States were Iowa, North Carolina, Oregon, Washington and Wisconsin. Since only 15 States were surveyed, some other States may also rely exclusively on community colleges.

94 Carnevale et al., *Workplace Basics Training Manual* op.cit., footnote 86.

The question of how State capacities could best be tapped to address basic skills issues is part of a broader debate about improving workforce quality—and in particular the State and private sector role in implementing the national education goals adopted by the Governors' in 1990. The States are becoming more active in putting together public-private partnerships to improve the public education system; the States might well become a primary vehicle for delivering basic skills services to employees in partnership with industry. To that end, the National Governor's Association (NGA), using foundation support, set up a State literacy exchange in late 1989.[95] Among other things, the project will annually survey the States, provide technical assistance, and convene conferences on State literacy activities. The Governors and NGA are also defining alternative State options for enhancing workplace excellence through partnerships with business, labor, and education.[96]

Research and Dissemination Needs

There will be a continuing need for research on workplace basic skills programs, with dissemination of best practices to industry and the educational community. It seems clear that the traditional model for adult basic education or GED preparation needs to be refocused when applied to the workplace.[97] But it is also true that workplace programs can become too narrowly focused on the specific tasks required at work. There is not yet a consensus about how to offer a continuum of instruction that builds workplace specific skills while also developing more general skills.

Much of what is known about workplace basic skills comes from federally supported research, principally aimed at developing effective training methods for military personnel. While some findings from the military research are directly relevant to the private sector, more research needs to be focused solely on the civilian workforce. Given the new mix in workforce demography, rapidly changing technology, and new strategies for organizing work, what *is known* now about the most effective approaches needs to be effectively disseminated to practitioners in industry and government.

The military aside, little research is conducted on the factors contributing to successor failure in adult basic skills projects. Only about 1 percent of Federal Adult Education Act funds went to research in fiscal year 1990, for example. Moreover, from 1975 to 1988, no AEA funds were available for national programs, a key source of funds for basic education research, evaluation, and dissemination.

In 1990, the Department of Education, in conjunction with the Departments of Labor and Health and Human Services, announced a competition for an adult literacy center that would go part way toward accomplishing these needs. However, funding for the center (about $l0 million over 5 years) is modest. Far higher levels of funding for basic skills research and dissemination have been proposed. One recent study, for example, called for a $30 million center, with $10 million devoted to research, $10 million for technical assistance, and $10 million for monitoring basic skills levels 'and undertaking analyses useful for policy formulation.[98] The study also recommended an additional $7 million in research funds by the departments of Labor, Education, and Health and Human Services (which now administers one of the largest basic skills programs through the JOBS program). Another approach might be to target a portion (say 1 percent) of all Federal funding for basic skills programs to research and development; if total Federal funds were $1 billion per year, R&D would be about $10 million.[99]

More emphasis might also be given to evaluation and dissemination of best-practice information on the use of instructional technology in basic-skills programs. Several mechanisms for information dissemination, including clearinghouses and shared efforts such as the previously mentioned National Basic Skills Consortium either exist or are in

---

[95] National Governors' Association News Release, Dec. 7, 1989, "Governors to Establish State Literacy Exchange."

[96] National Governors' Association, *Excellence at Work: The Issues*, Washington D.C., 1990.

[97] To some extent this is happening on its own. For example, in one Alabama community, companies are providing job-specific materials that are used in basic skills and GED programs their workers are taking. See Carnevale et al., *Workplace Basics Training Manual,* op cit., footnote *86,* p. C.3.

[98] *Jump Start: The Federal Role in Adult Literacy,* Op cit., footnote 84, P. 24.

[99] The possibility of setting a 1 percent investment goal for total national spending on education research (including Federal, State, local, and private sector funds) is discussed *in Preliminary Staff Report on Education Research, Development and Dissemination: Reclaiming A Vision of the Federal Role forthe1990sandBeyond,* Committee Print prepared for the Subcommittee on Select Education of the House Committee oıEducation and Labor, 1989, pp. 9-1o.

formation. With sufficient support, these mechanisms could work to improve the application of instructional technology in basic skills projects.

A Concluding Note

Workers with strong basic skills are needed at all levels within the economy. Yet, today, employers are finding that an alarming fraction of workers cannot read, write, compute, or comprehend at a high school level. In the past, workers without strong basic skills may have had limited choices in terms of their own career choices, but few companies had difficulty in finding enough qualified workers. With an increasing number of countries possessing highly educated workforces, basic skills issues must now be considered in a broader context.

Ultimately, it is the responsibility of the public education system—not employers or the training community-to prepare young people with a foundation of skills needed for their worklives. The foundation of skills young people need includes not only the traditional Three-Rs, but also an evolving set of broader competencies (such **as the social skills** needed to function within workteams) **that** employers increasingly use. While the U.S. educational system is now undergoing substantial reforms, it will take years for the effects of reform to be reflected in the workforce. In the meantime, considerable resources must be focused on developing and enhancing the basic skills of people at work today.

Chapter 7

Training Technology

CONTENTS

Boxes

Figures

Tables

Chapter 7
Training Technology

SUMMARY

Training technology includes a wide range of systems for delivering work-related instruction. Typically, the training system substitutes for real equipment or situations, or for worker memory. In its broadest sense, training technology encompasses both hardware (e.g., television sets, satellite dishes, computers, overhead projectors) and software (such as computer programs, television programming, written materials, and their instructional design), as well as the setting in which training takes place (for example, a classroom, the shop floor). The quality of training depends on the appropriateness and quality of the hardware and software as well as the ability of the instructor.

Training technology spans the low- to high-tech spectrum, from lecture/lab instruction or job aids such as checklists, to elaborate simulators and advanced electronic classrooms with interactive teleconferencing. Technology-based training might be delivered at a worker's desk or on the shop floor, at a training center, in a classroom, or even at an employee's home. The training may be undertaken individually, or in small or large groups. The courseware might cover all aspects of a job, or impart only those steps a worker needs to perform a particular task, or provide an update on technical or policy changes. The courseware can involve basic skills (e.g., literacy and arithmetic-see ch. 6); technical skills, such as equipment operation, maintenance, or repair; or interpersonal skills, such as sales or job orientation.

The principal findings of this chapter are:

. Technology-based training incorporating sound instructional design is cost-effective in helping American workers learn to use new equipment and production methods and prepare for changing work environments. The training duration, degree of learning achieved, and employee satisfaction with instructional technology often equal or exceed traditional classroom lectures. Because technology-based training typically is faster and more convenient to deliver than classroom instruction, it saves travel expenses and time off work.

. The costs of technology-based training are coming down. The hardware and software have largely matured and are affordable to most large and medium-sized firms. Indeed, where workstations already incorporate computers, using them to deliver training is extremely cost-effective. Costs are still an issue, however—especially for smaller firms.

- *Innovations* that promise to reduce costs further include: software that substantially reduces time and labor costs for instructional design and development, equipment and courseware leasing options, and learning centers.

. Corporate adoption of technology-based training is accelerating. Large companies such as IBM, Ford, and Motorola expect that by the late 1990s over half of their corporate training and education will be delivered outside the traditional classroom using instructional technology.

. Several factors inhibit broader use of technology-based training today. Incorporating technology in courses requires significant development and preparation, and often additional capital investment. Many corporate training personnel have had little exposure to instructional technology and lack enough hands-on experience to use it confidently or design courses around it. Also, early experience with poor courses has soured many firms on this approach.

. Several developments promise to stimulate more widespread use of training technology and enhance its capabilities. These include: the increasing power and declining cost of personal computers and other workstations and their software, including networked systems that facilitate development of electronic classrooms; the ability to embed training in production and other technological systems, bringing it to the workstation; and advances in broadband digital networks that will allow information of any type-text, graphics, audio, video, software-to be transmitted anywhere affordable.

. To facilitate spread of these developments in the long term, training professionals (instructors and managers) will need to become more sophisticated about instructional technology. Senior management and human resource devel-

opment departments must place a high emphasis on training technology. Corporations and the Federal Government will have to increase their research and development funding for instructional technology design and for adult learning.

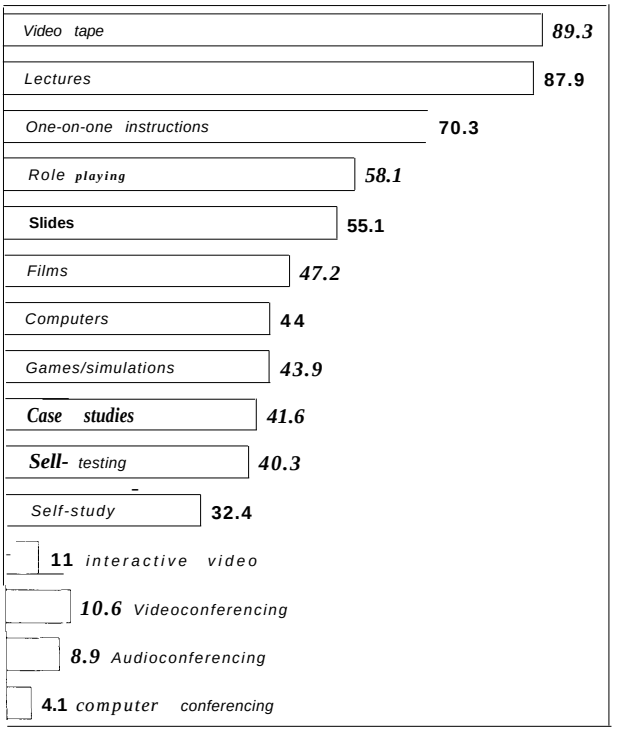
TECHNOLOGIES

Instructional technology is not just hardware. The supporting courseware and delivery setting also are part of the technology. Box 7-A gives brief descriptions of the training technologies in use today; table 7-1 summarizes their characteristics, costs, and potential advantages and disadvantages. The appropriate type of instructional technology to be used is determined by the training functions and goals identified during instructional design (see figure 7-1).

Regardless of its form or delivery setting, instructional technology is an increasingly important part of the work environment. Workers must adapt to new equipment, new production methods, and changing work environments (e.g, teamwork, just-in-time production methods, computer-assisted manufacturing, paperless workstations). Training departments must respond quickly with cost-effective ways for employees to adjust. Today, many training professionals look to uses for technology-based instruction in their efforts to reduce training time and increase achievement in test results or job performance (see discussion of effectiveness, below). Technology-based training also is available at the worksite and provides consistent quality and delivery.

Technology has the capacity to provide environments that can promote learning and work simultaneously if designed carefully. Computers, for example, provide an ideal environment for unstructured learning. They both give and respond to commands and empower users to monitor and assess their progress. Good videodisc and computer courseware increasingly include interactive components (see box 1-C in ch. 1) that involve several senses and provide practice, repetition, and feedback-all of which aid learning. These approaches are now also being adopted in vocational training through, for example, workstations with sensors and pneumatic or mechanized components to teach electronics, programming, robotics, and computer-aided design.

Figure 7-l—The Use of Instructional Methods, 1989



NOTE: This figure is based on data from a survey with a very low response rate. Hence, care should be taken in interpreting the results.

SOURCE: "Industry Report," *Training,* vol. 26, No. 10, October 1969, pp. 31-39.

Instructional technology may help hurdle the barriers between formal and informal learning. Successful training often occurs in practical and collaborative settings, such as apprenticeship, where the concepts learned are applied to daily tasks. Taking people away from the setting in which they are expected to use what they learn and putting them into classrooms risks teaching classroom practices only. Learning may have to begin again when trainees return to the worksite. Job aids and embedded training can contribute to on-the-job informal training—the kind most American workers receive.

Despite the potential advantages of technology-based training, lecture/lab instruction is still pervasive in the United States (box 7-B). Even training professionals usually learn about new training technologies in a traditional classroom setting. Yet, in terms of labor costs (and often travel), classroom instruction often is the most expensive form of formal training to deliver. Despite the higher initial development and hardware costs of technology-based training, it can be cheaper in the long run if

Box 7-A-Overview of Training Technologies

Television: The best-known and most widely-used technology-based instruction delivery system. The images, which are captured electronically, can be transmitted directly or stored on a medium such as videotape or disc. Telephone hook-ups can provide two-way audio capability for learner-instructor interaction. Transmission can be from microwave towers, through cable, or via satellite.

Videotape: A means of recording live or broadcast instruction. Video cassette recorders are inexpensive and highly reliable. Instructors can record programming to supplement their lesson plans; students can record classes, allowing them to "attend" whenever it is convenient. Students also can replay sections they did not understand the first time. A wide selection of commercially available programs cover most areas of training.

Analog Videodisc: Lasers store and read information—video, still pictures, text, computer graphics, audio-on discs. Video flames on a disc are made up from 525 horizontal scan lines with red, green, and blue components on each line. There are 54,000 frames per disc side. Videodisc currently uses a 12-inch plastic disc, but is moving toward smaller systems (8-inch dual-sided and compact disc) and digital technology.

Computer-Based Training: Computers can be the subject of instruction, as in courses on computer literacy, programming, or particular software packages; they can be used as tools for accomplishing other learning tasks, e.g., as word processors in writing courses or as design tools in graphics; they can be used to deliver instruction either prior to application (computer-assisted instruction) or at the time and place of application (embedded training); and they can be used to keep track of instruction (computer-managed instruction).

Teleconferencing: Teleconferencing, including audio, video, and computer conferencing, offers an increasing capacity to provide two-way (or more) communications. Teleconferencing can involve three technologies: telephones, television, and computers. Audioconferencing involves interaction among a number of participants via telephone bridges. Videconferencing uses either full-motion or slow-scan television for interaction. Computer conferencing primarily uses electronic message systems (e.g., voice or electronic mail, bulletin boards) via local area or wide area networks or modems.

Simuliztors: Devices that duplicate the behavior of real-life machines (like ships or airplanes) or complex systems (like subways and powerplants). They typically contain a computerized model of the real equipment, and, depending on their level of sophistication, may duplicate all of the hardware and operating characteristics of the equipment and its operational environment. The instructor or a computer-managed instruction system presents operational situations (e.g., negotiating difficult terrain, specific malfunctions) to which the trainee responds.

Job Aids: Devices for helping a person remember or learn how to do a task when that task is to be performed (e.g., checklists, templates). Job aids (as well as embedded training and performance support systems) are designed to reduce the reliance on recalled skills and knowledge; they ensure effective performance on jobs in which specific skills are used infrequently or when a series of tasks must be performed in a particular order.

Performance Support Systems: A computer-based advanced form of job aid. A performance support system might incorporate any combination of text, graphics, audio, still video, applications software to perform specific job tasks, databases, expert systems, interactive training programs, assessment systems, and feedback and monitoring systems.

Embedded Training: Embedded training is instruction that is an integral component of a product or system. Because microchips are incorporated into so many workplace devices, it is possible to embed training in the devices themselves. This is a form of computer-assisted instruction, but instead of providing training in anticipation of need, it is offered at the point of application.

SOURCE: Office of Technology Assessment, 1990.

there is a large enough trainee population over which to spread the costs, or if the hardware and/or software already are in place (e.g., computer-based training, embedded training). Moreover, some workers are uncomfortable in classroom situations, relating them to bad school experiences or associating them with remediation.

There are several reasons why so much training uses little technology.[1] First, print materials and overhead transparencies are convenient to use.

[1]Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the Office of Technology Assessment under contract No. L3-5615, February 1990.

Table 7-I-Characteristics of Training Technologies

Medium	Extent of Use[a] (percent)	Delivery settings	Degree of interactivity possible[b]	Estimated development time	Estimated delivery cost[c]	Potential advantaged	Potential disadvantages[d]
Lecture/lab	88	Group/ classroom	Potentially very high but depends on skill of instructor	1-30 hrs/hr	Usually very high, including trainee time off work; hardware is minimal	Familiar; provides social interaction; adaptable to any subject	Scheduling is difficult; often boring because trainee interest and involvement are so dependent on instructors skill; poor transfer of training to work
Television	90	Group/ classroom or individual	No branching; little feedback; little self-direction	80-240 hrs/hr	Low trainee time off; hardware is $1,000-$10,000 depending on equipment and type of programming	Familiar, available at numerous sites including home	Scheduling is hard without VCR; often boring; poor transfer of training to work; low interactivity; difficult to customize
Videotape	89	Group/ classroom or individual	No branching; little feedback; little self-direction	80-240 hrs/hr	Low trainee time off; hardware is $1,000--$5,000; courseware is $100-$1 ,000	Familiar; available at numerous sites including home; can be viewed at any time; courseware readily available	Little interactivity; difficult to customize, often boring
Videodisc	21	Group/ classroom or individual	Varies; extensive branching, feedback, self-direction possible	40-1,000 hrs/hr	Low trainee time off; hardware is $400-$10,000; courseware is $70-$12,000	High interactivity; eventually will be available at numerous sites including home and the work station; excellent transfer to work; adaptable to most subjects; wide content variety; can be used at any time	Hardware usually dedicated to training; high cost for high level of interactivity; existing courseware difficult to modify
Computer-based	44	Group/ classroom or individual	Varies; extensive branching, feedback, self-direction possible	8-300 hrs/hr	Low trainee time off; hardware is $1,000-$l0,000; courseware is $50-$10,000	High interactivity; available at numerous sites including home and the work station; excellent transfer to work; adaptable to most subjects; wide content variety; courseware is easy to modify; can be used at any time	if hardware has to be dedicated to training then cost is high; some trainees are intimidated by computers
Videocon-ferencing	11	Group/ classroom or individual	Dependent on group; little self-direction	1-40 hrs/hr	Low trainee time off; hardware is $2,000-$10,000 per site	Social interaction; provides feedback	Complex logistics; high rest; adaptable primarily to soft skills
Audiocon-ferencing	9	Group/ classroom or individual	Dependent on group; little self-direction	1-40 hrs/hr	Low trainee time off; hardware is telephone system	Social interaction; provides feedback; inexpensive; available at numerous sites including home	Scheduling is difficult; lack of visual presentation

Computer conferencing	4	or individual or team	Varies; extensive branching, feedback, self-direction possible	8-300 hrs/hr	Low trainee time off; hardware is $1 ,000-$10,000; courseware is $50 to $10,000	High interactivity; available at numerous sites including home and the work station; excellent transfer to work; adaptable to most subjects; wide content variety; courseware is easy to modify; can be used at any time	Low social interaction; computer intimidation; high cost for dedicated hardware
Simulators	NA	or individual or team	All levels	Months to yeas	Low trainee time off; hardware is $10,000 to millions	High interactivity; excellent transfer to work; avoids danger; presents wide variety of situations; saves real equipment costs	High cost for advanced hardware; low social interaction
Job aids	100	At worksite	NA	usually little	Minimal	Provides on-demand training; easily modified; excellent transfer to work	May not be used by workers
Embedded training	NA	At worksite	NA	Incorporated in equipment development (weeks to years)	Low trainee time off; hardware is incorporated in equipment cost; may add tens to thousands of dollars to those costs	Provides on-demand training; excellent transfer to work	Difficult to design; requires new approach to product engineering with significant advance planning

[a]Based on survey data from Fortune 500 and private companies with sales of $500 million or more.
[b]See box 1-C for a discussion of the various aspects of interactivity.
[c]Hardware and courseware costs usually can be spread over numerous training sessions; also, in the case of TV, videotape, and computer-based training, hardware may be used for other purposes.
[d]These will not occur automatically but depend on the quality of the training program, the appropriateness of the technology to the training function, the skill of the instructor (if any), and other variables.
SOURCE: Office of Technology Assessment, 1990.

31-463 - 90 - 7 : QL 3

Box 7-B-Classroom Training at NUMMI

New United Motor Manufacturing International (NUMMI), a joint venture between General Motors and Toyota in Fremont, California cross-trains maintenance mechanics who are responsible for all plant maintenance plus special projects such as building robots. Trainees spend 5 years studying five trades (plumbing, pipefitting, welding, electrical, and machinist). The program includes about 20 percent lecture (theory) and 80 percent lab (troubleshooting small equipment, making projects), supplemented with on-the-job training. It is much less intensive in any one trade than registered apprenticeship programs, however. Graduate trainees receive **a United** Auto Workers electrical journeyman card and **a State of California multi-craft journeyman card, neither of which would be recognized by other unions.**

Before entering the program, candidates take placement tests in both basic skills and their individual crafts. Basic skills deficiencies are remediated in class contexts (e.g., math skills in blueprint reading). Classes are 2 hours a day, at the end of each shift; during the most intensive training, classes meet 4 days per week (for this period, a trainee is in the workplace 48 hours per week). The lab component of each course includes 10-15 projects that the trainee has to complete satisfactorily. Each project has three basic steps: describe the process, make a materials list, then return the finished product for review of quality/quantity. The projects range in difficulty from trouble-shooting small electrical devices to machining parts to welding. Trainees have to pass each class with a score of at least 80 percent or repeat it. Training continues on the shop floor as those mechanics most skilled in one field assist their co-workers in maintenance tasks.

Training aids in the laboratory include basic electrical units (e.g., volt-ohm-meters, circuits, switches, small motors), machine tools, welding booths and equipment, and other equipment and tools common to the factory (most were scrounged rather than purchased).

The maintenance mechanics feel their productivity has improved as a result of cross-training (e.g., one cross-trained worker often can complete repairs that previously required two or three specialized maintenance workers). However, in some crafts-particularly electrical-the mechanics do not feel they have had sufficient training to tackle complicated repairs without assistance from a union-certified journeyman.

SOURCE: Office of Technology Assessment 1990.

Printed **materials are highly** reliable, relatively **inexpensive to develop and reproduce, and are portable and compact. Almost any kind of subject can be discussed in print, and a wide range of material is available. On the other** hand, print gets unwieldy for large **amounts** of information, and it is neither interactive **nor dynamic.** Overhead transparencies **also are** handy and have largely replaced the blackboard in training classes. Transparencies are easy **to** prepare, can be used many times, allow color and graphics, and can be written on the spot. The projectors are reliable, affordable, standardized, and require little skill **to** operate.

Second, many instructors have had little exposure to instructional technology. Even those who have had courses about training technology usually have not had enough hands-on experience with it to use it confidently or to design courses around it. Moreover, many **corporate training** personnel have little formal background in instruction. More often they are trained in human resource development or are subject-matter experts assigned training responsibilities.

Third, incorporating training technology in courses can require much **more development and preparation. Most instructors do not have the time or resources to prepare** such courseware. Even handwritten lecture notes take less time to prepare than good overhead **transparencies.** As **courseware moves** into videotape or disc, computer-based **material, or** teleconferencing, the amount and cost of development and preparation increase appreciably.[2]

Fourth, developing good technology-based training material often **requires a team approach. Instructional designers provide the learning approach; subject-matter experts provide the substance; technical experts do the computer programming or produce video materials. Yet teaching traditionally has been a solitary affair.**

Fifth, traditional classroom instruction has a major social component. It provides an opportunity to visit with colleagues rarely seen in the normal

[2]Ibid.

workday. Often, break-time conversations are as informative as the classes.[3] Some people also like the opportunity to travel.

Finally, some topics have not yet meshed well with technology-based delivery, particularly management skills.[4]

TRAINING TECHNOLOGY USE IN INDUSTRY TODAY

Few data are available on the extent to which instructional technology is used in industry. Most organizations do not systematically collect data about their training activities (e.g., number of students, types of courses). In large corporations, decisions to use training technology often are made on a departmental basis with no organization-wide accountability. Many applications of technology are considered experimental and are not included in descriptions of training. Other technologies such as overhead transparencies and videotapes are so mundane no one bothers to describe them.[5] Also, many companies do not respond to survey requests for training data.

Nevertheless, two sets of training technology survey data are available for 1989. One survey conducted by *Training* magazine obtained responses from around 1,500 companies with 100 or more employees about the kinds of training delivered, how, and to whom.[6] The survey had a very low response rate. However, the data are included in this report as a rough indicator of the level of use. Figure 7-2 shows the percent of companies using different instructional methods.[7]

A second survey conducted by the American Society for Training and Development (ASTD) polled 200 human resources executives in *Fortune 500* corporations and privately-held firms with annual sales over $500 million about their use of computer-based training (CBT), interactive videodisc (IVD), and teleconferencing.[8] The ASTD results show 81 percent of responding companies using computers in training, 50 percent using IVD, and 33 percent using teleconferencing (see figure 7-3).

One thing seems clear from the survey data—large corporations are more likely to use technology in training. For example, 44 percent of all corporations responding to the *Training survey* do computer-based training, but use increases to 64 percent for responding corporations with 10,000 or more employees. The figures were 11 percent and 34 percent for interactive video training.

Other sources indicate that small businesses are more likely to rely on informal on-the-job training, and on demonstrations and printed documentation provided by equipment vendors. Because personal computers (PCs) and viola cassette recorders (VCRs) are relatively common even in small businesses, they also use CBT courses for computer-related topics (e.g., a specific word processor) and videotapes for sales, customer service, or management skills.[9]

One way that instructional technology can affect small businesses is when it is used by their corporate customers or offered by government or professional organizations. Thus, a small business that supplies parts to a corporation practicing total quality management may have to use a specific training approach to maintain its supply contract. Also, State and local agencies may have extension or other outreach services to aid small business. For example, the Maryland State Department of Education developed an interactive videodisc called "The Business Disc' (TBD) that provides an introduction to starting and operating a business (e.g., type of ownership, location, salaries, capital investment, and cash flow). The videodisc simulates the first

[3]Beverly Geber, "Goodbye Classrooms (Redux),'' *Training,* vol. *27, No.* 1, January 1990, pp. 27-35.
[4]Kearsley, op. Cit., footnote 1.
[5]Ibid.
[6]In 1989, *Training* magazine mailed two versions of a survey to 20,000 org animations culled from a sampling of Dun & Bradstreet's directory of U.S. businesses and the magazine's subscriber list. Both versions included questions about training budgets, topics, and trainees. Half of the surveys had unique questions about interactive video and computers in training, and the other half bad unique questions about instructional methods. The former received 1,542 responses, and the latter 1,588 responses. Because of the low response rate, care should be taken in interpreting the data.
[7]''Industry Report,'' *Training, vol. 26, No.* 10, October 1989, pp. 31-63.
[8]The ASTD survey was distributed to their Human Resource Development Executive Survey panel, which includes 200 members; responses were received from 153.
[9]Kearsley, op. cit., footnote 1.

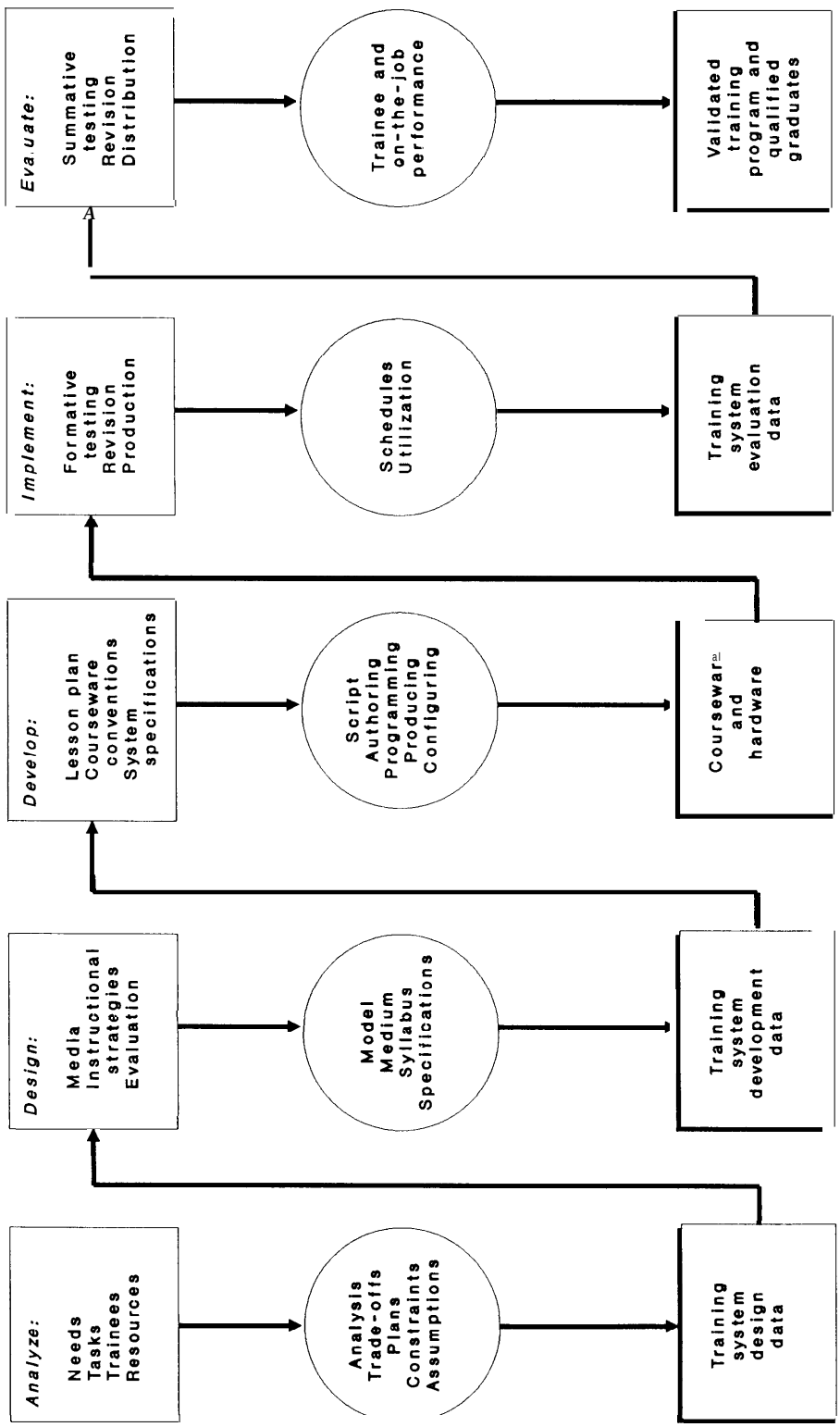
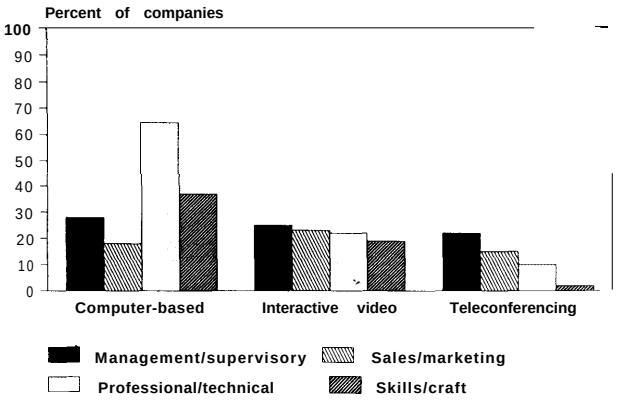


Figure 7-2—Instructional Systems Development Process

SOURCE: Office of Technology Assessment, 1990.

Figure 7-3-Technology Training Use



SOURCE: Based on American Society for Training and Development survey of 157 executives from Fortune 500 private firms wfth $500 million + in sales.

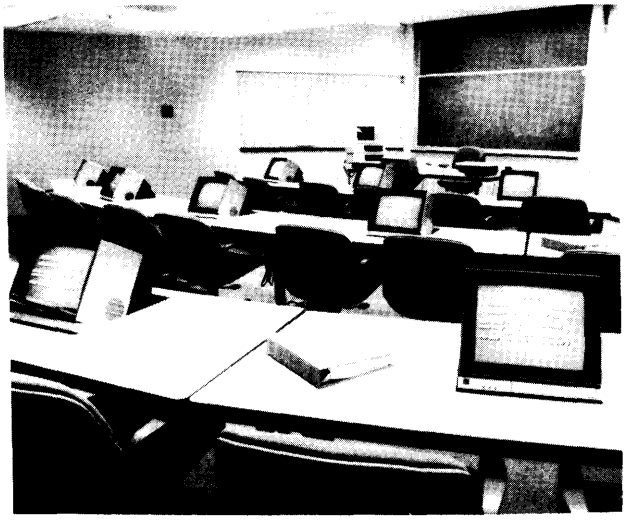


Photo credit: IBM

IBM's interactive television classroom

year in business based on decisions that users of the disc make in the planning stage. Typical business issues are presented such as rent increases, personnel policies, late deliveries, theft, and disgruntled customers. TBD has been used at a number of small business development centers and community colleges. For example, New York State has decided to install IVD workstations for TBD in 21 small business centers. At the community college level, the program is being used in business and marketing courses to allow students to try out business ideas they learn in class.[10]

Some small businesses are franchises, for which the parent organization encourages consistent product quality and management, and can afford to develop and distribute training materials. Chains such as Domino's Pizza, FoodMaker, and Southland Corp. (7-Eleven) use video and are experimenting with IVD to train basic employee skills at the worlmite.11

Television

Despite its popularity as an entertainment medium, 'broadcast television is not widely used for training (except for regular adult education) because of:

- high production costs and time for programming,
- lack of flexibility in scheduling,
- trainee boredom due to poor programming or instructors or lack of interaction, and
- regulation of the use of television frequencies.[12]

Current cable television use for training consists primarily of continuing education and similar instructional services provided by local community colleges and other educational institutions. In many cable franchise areas, these educational commitments plus commercial programming fill existing capacity. As cable systems expand their channel capacity, introduce two-way capability, switch to fiber optics, provide computer networking, and enroll more households, cable will become an increasingly attractive medium for instructional delivery .13

Satellites are making television-based training much more attractive. Training programs can be delivered directly to company sites without going through broadcast television or cable networks. Satellites also allow teleconferencing (see below) with two-way video for interactivity. Many large organizations have satellite uplink/downlink equipment at branches or plants and use television to

[10]R. France, "Experimenting in Business with IVD: An Evaluation," *Instruction Delivery Systems*, vol. 3, No. 5, September/October 1989, PP. 22-24.

[11]Kearsley, op. cit., footnote 1.

[12]Ibid.

[13]Norman D. Kurland and Associates, "The Role of Technology in the Education, Training snd Retraining of Adult Workers," contractor report prepared for the Office of Technology Assessment, October 1984.

Photo credit: IBM

Video control room for IBM's interactive television classroom.

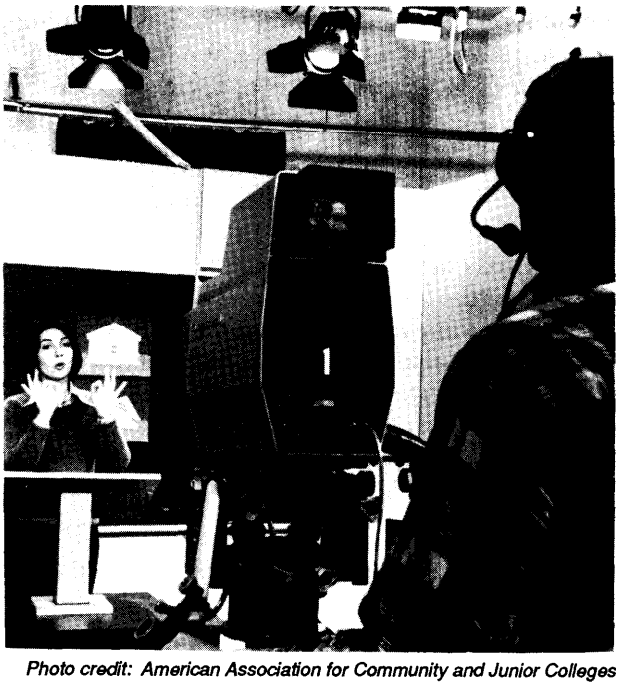


Photo credit: American Association for Community and Junior Colleges

Most instructional television is simply a broadcast version of standard lecture format.

broadcast training courses. This is especially attractive for multinational corporations and agencies with facilities all over the world. For example, IBM has four satellite networks, and Motorola, Ford, Hewlett-Packard, and Kodak also use satellite television in training.

The largest user of satellites for training today is National Technological University (NTU), which broadcasts hundreds of engineering courses to corporations and Federal agencies (see box 7-C). As satellite facilities become more common, more companies will emulate this proprietary network model. However, few organizations have yet addressed the remaining problems restricting television's use in training-high costs and low interactivity. Consumer applications of interactive television are being introduced now (e.g., play-along game shows, viewer-selected camera angles). In the short term, however, even with satellite transmission, television's use for training remains limited.[14]

Video

Videotape is a very popular training medium. Tape is portable and overcomes television's scheduling problems. Videotape players are inexpensive and highly reliable. A wide selection of commercially available programs cover most areas of training. For example, the American Management Association (AMA) and the American Media Center for Engineering Education (AMCEE) offer large libraries of training tapes. Many professional societies (e.g., Institute of Electrical and Electronics Engineers, American Bar Association) offer videotape self-study courses to meet continuing education requirements for their members. Most large companies and government agencies produce an extensive number of instructional tapes for their own use. Because many American homes have VCRs, videotape also is a viable medium for self-study .15

Despite its wide use, videotape has limitations as a training medium. It essentially is a linear presentation mode with only limited opportunities for student interaction. Systems have been developed to permit random access to tapes, but they are cumbersome compared with videodisc.[16] While it has been used successfully in technical training (e.g., mechanical repair and maintenance) when focused on narrow tasks, videotape is unsuitable for presenting a lot of factual information. As with television

[14]Kearsley, op. cit., footnote 1.

[15]Ibid.

[16]Kurland, op. cit., footnote 13.

Box 7-C—Natiional Technological University

The National Technological University (NTU) broadcasts programs originating at universities via satellite to corporate subscribers. There currently are 29 member universities, 55 corporations, and 15 other sponsoring organizations, with 242 receiving sites. In 1989, NTU offered around 450 graduate courses, plus numerous continuing education classes in non-credit Advanced Technology and Management Programs. Of the 3,000 graduate students, 655 are enrolled in degree programs. NTU estimates that around 30,000 people currently are taking short courses. NTU averages over 250 hours of live broadcasting weekly-more live programming than ABC, NBC, and CBS combined.

NTU graduate courses focus on engineering and computer science. They are taught by faculty members from the member universities. Even though the courses originate from universities, NTU grants the degree (M. S.—accredited-in either Engineering, Management of Technology, and Materials Science and Engineering). Corporate sponsors pay site fees to receive the programs and provide their own downlinks and classrooms. In courses requiring lab work the sponsoring organization agrees to maintain lab facilities, either onsite or through arrangements with nearby colleges or private facilities. The labs are subject to inspection by NTU at any time.

NTU also hosts many teleconferences (one-way video/two-way audio) as special programs for continuing education. The topics tend to be leading edge subjects in engineering and technology, such as superconductors, supercomputers, distributed networks, artificial intelligence, and automated manufacturing. These teleconferences allow engineers and their managers to stay abreast of the latest developments without having to leave their offices. The teleconferences add an interactive component to the broadcasts by allowing participants to ask questions and share experiences, making the courses more interesting and relevant. NTU also delivers interactive technical assistance programs to business entrepreneurs.

In **general, students praise the course subjects and the instructors (who often are leading experts in their field). However, most courses still follow the traditional television and videotape "talking head" format with little or no interactivity; they can be dull. Also, some university camera and transmitting equipment is substandard, resulting in poor picture quality. NTU is encouraging the member universities to upgrade their equipment and many have done so.**

Enrollment in NTU courses continues to increase; the number of graduate students admitted to degree programs doubled in 1989. NTU predicts that by 1993 it will be providing 10 percent of the advanced study opportunities for part-time graduate engineering students in the United States. Based on the 655 students actually admitted to degree programs today, within 5 years NTU will be among the top 10 schools in the nation in terms of number of M.S. Engineering degrees awarded. Although NTU is limited to engineering-related topics, it could serve as a model for professional education in fields such as law and finance.

SOURCES: Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the office of Technology Assessment under contract L3-5615, February 1990; and NTU annual report for 1989.

programming, videotape requires substantial development time and cost and is difficult to customize for specific situations.[17]

Less common (and relatively new) is interactive video training. About 34 percent of the large corporations responding to the *Training survey* were using some form of interactive video training (but only 11 percent for all responding companies with 100 or more employees). Of the responding interactive video users, 47 percent use a combination of videotape and personal computer, while 61 percent use videodisc. About 72 percent use interactive video for self-paced instruction and 40 percent in group or classroom instruction. The overwhelming majority (95 percent) use at least one off-the-shelf program; 29 percent have custom-designed program.[18] In the ASTD survey, interactive video applications were evenly divided among training for managers and supervisors, sales and marketing staff, professionals and technical workers, and skills and craft employees.

Analog videodisc has been used in training for several years. Interactive videodisc excites trainers because it combines the audio-visual power of television with a high level of interactivity that can be used in diverse delivery settings. It can present a

[17]Kearsley, op. cit., footnote 1.

[18]" Industry Report, " op. cit., footnote 7.

lot of text or graphic information as well as still or motion video and audio-often simultaneously (see table 7-2).[19] Compact discs for computers (CD-ROM) and digital videodisc (just now being introduced) provide even more storage capability (see table 7-3 and discussion of future technologies, below). The contents can be accessed randomly, information can be layered to give options on the depth and/or breadth accessed, items can be linked for browsing or cross-reference, and branching can be used for interactivity. Its other attractive properties include high information density and durability.[20]

Over the last few years, private developers and the government have produced numerous commercially available IVD training programs. For example, a courseware guide published by IBM lists over 500 multimedia programs related to personal computers, data processing, education, health/medical topics, industrial technology, management/professional skills, and other subjects.

The primary obstacle to further IVD use is cost—it requires more development time and more expensive equipment than videotape or computer-based training. Even if the price were reduced 50 percent, it would be beyond the resources of many companies that have a small trainee population over which to spread the cost. Furthermore, IVD usually is used for guided self-study, while the bulk of formal training is still conducted in classroom format. Therefore, IVD is unlikely to be adopted widely without a firm corporate commitment.[21]

The lack of industry-wide standards also is a continuing deterrent to greater investment in IVD. Each hardware manufacturer initially used a different operating system, and programs developed for one system would not play on others. The Interactive Video Industry Association is developing a standard set of operating commands, which most hardware and courseware producers are expected to adopt. The Association also is working on software that will translate existing programs to the standard commands. Variations in international television standards also make it difficult to deliver IVD to overseas locations. Users must either ship compatible hardware or custom tailor courseware to local conventions.

Table 7-2—Potential for Analog Videodisc Frame Use

Motion (minutes)	still frames	Compressed audio (hour)	Digital data (Mb)[a]
30	0	0.00	0
25	1,625	13.53	10
20	3,250	27.08	20
15	4,875	40.61	30
10	6,500	54.16	40
5	8,250	68.75	48
0	9,875	82.28	58
0	54,000	0.00	0
0	0	150.00	0
0	0	0.00	221

[a]Mb = megabyte.
NOTE: This table shows howthe 54,000 frames on an analog videodisc can accommodate various combinations of motion and still video, audio, and data. For example, a disc containing only one medium could hold 54,000 still pictures, or 30 minutes of motion video, or 150 hours of compressed audio, *or* 221 Mb of digital data. Alternatively, the media can be combined in various ways; e.g., 10 minutes of motion video *and* 6,500 still frames *and* 54 hours of compressed audio *and* 40 Mb of data.
SOURCE: U.S. Video Corp.

But many organizations believe that the training results are sufficiently improved to just@ the additional cost and equipment. For example, General Motors Corp. uses IVD extensively throughout the corporation for technical and sales training. The United Auto Workers (UAW) and GM have setup a joint Center for Health and Safety that offers dozens of self-study courses using IVD. According to industry figures, GM alone has bought over 10,000 videodisc players for use in training. Ford and Chrysler also use ND extensively for training. Finally, the military has made a major commitment to using IVD in training (see report appendix); the Army EIDS project ultimately expects to field 50,000 players (see box 7-D).[22]

Interactive video appears to be especially valuable in several particular training areas. It has been used extensively in the design of simulations (see below) for maintenance training. For example, Federal Express developed an IVD course to teach its aircraft mechanics how to troubleshoot and repair

[19]Joseph V. Henderson, "Design and Production of Interactive Multimedia Simulations," tutorial presented at 11th Conference on Interactive Videodisc in Education and Training, Arlington, VA, August, 1989.

[20]Kurland, op. cit., footnote 13.

[21]Kearsley, op. cit., footnote 1.

[22]Ibid.

Table 7-3-Capacities of CD-ROM, DVI, and CD-1

Medium	CD-ROM	DVI	CD-1
Text	325,000 pages	650,000 pages[a]	300,000 Pages[a]
Audio	72 minutes of CD quality	5 hours FM stereo, or 20 hours mid-range monaural, or 40 hours near-AM quality monaural	96 hours AM quality
Still pictures	500 high resolution	5,000 very high resolution, or 10,000 high resolution, or 40,000 medium resolution	7,000 very high resolution
Motion video with companion audio	30 seconds	1 hour full screen/full motion, or 4 hours, 1/4 screen/full motion, or 16 hours 1/8 screen at 1/2 frame rate	No full screen/full motion Can show partial screen/full motion Better suited to full screen/full motion animation
Mixed media example	Not available	20 minutes full motion video, and 5,000 high resolution stills, and 6 hours audio over stills, and 15,000 pages of text	Not available

ABBREVIATIONS: CD. compact disc; CD-ROM = compact disc read-only memory; DVI = digital video interactive; CD-1= compact disc interactive.
[a]The amount of text is actually the same for DVI and CD-1, but appears different due to the allotted characters per page.

SOURCES: G. David Ripley. "DVI—A Digital Multimedia Technology," and Karen A. Frenkel, "The Next Generation of Interactive Technologies." both in *Communications of the ACM*, vol. 32, No. 7, July 1989.

Box 7-D—The Electronic Information Delivery System

In the early 1980s, the U.S. Army began seeking a multimedia training delivery system to replace the slide-tape unit in use for many years. In 1983, the Army asked several companies to develop interactive videodisc prototypes. After field testing, a specification for the Army Electronic Information Delivery System (EIDS) was established in 1986. In December of that year, the Army awarded a contract to Matrox Electronics of Canada to supply the hardware and software. The initial contract called for a total purchase of 48,000 units over 4 years with a value of $223 million.

The EIDS work station consists of an IBM PC/AT-type computer employing EGA/VGA graphics and a 12-inch optical laserdisc player. The system is capable of overlaying graphics on video displays, playing over 1 minute of sound per still frame, and storing/reading computer programs on the videodisc (Level IV capability). In its most basic configuration, it has a commercial price of about $6,000 per workstation.

Actual EIDS delivery and courseware development has lagged behind due to procurement difficulties. In 1988, 14 solicitations to develop courses were authorized but none was awarded due to lack of funds. But, by 1989, approximately 10,000 units had been delivered to Army Training and Doctrine Command (TRADOC) schools and Army and Navy Reserve sites.

One of the strengths of EIDS is that several authoring systems are available. Computer Sciences Corp. developed the primary one, ASSIST, for the Army; it is provided to contractors for courseware development. At least 10 other commercially available authoring systems also can be used with a standard MS-DOS computer and laser optical videodisc player to create EIDS courseware. Several companies have developed "generic" courseware that can run on EIDS, and numerous vendors are capable of developing custom courseware for the military or for civilian clients.

EIDS could be a billion-dollar business opportunity for the IVD industry. How much courseware actually is developed will depend on EIDS' acceptance by the military training system and the amount of funding allocated for courseware. However, without specific technology transfer initiatives or an eager corporate champion, it is unlikely that EIDS will be applied to civilian training needs. The choice of Matrox Electronics as the primary contractor has not helped technology transfer because the company is practically unknown in the United States and has made little attempt to market the system outside of military circles. Furthermore, economies of scale have not materialized. Indeed, EIDS is more expensive than comparable systems available from other vendors or assembled from off-the-shelf components.

SOURCE: Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the Office of Technology Assessment under contract L3-5615, February 1990.

electrical problems. The course allows mechanics to take readings, test components, replace equipment, and evaluate procedures.[23]

The visual and motivating characteristics of IVD also make it valuable in improving basic skills.[24] For example, the Wisconsin Foundation for Vocational Technical and Adult Education has developed an IVD course called Interactive ModuMath designed to improve students' basic math skills. A wide variety of students in Wisconsin technical colleges use the course, and both students and instructors reportedly like it.[25]

Another interesting use of IVD is on the factory floor to support computer-integrated manufacturing (CIM). Apple Computer and Martin-Marietta both have high-tech plants that provide employees with workstations capable of displaying brief video sequences about different manufacturing processes. These sequences can provide "just-in-time" training to correspond to the complex nature of a CIM operation, which involves frequent shifting from one operation to another. Each station replaces hundreds of pages of printed material.[26] Central monitoring allows supervisors to pinpoint problems and deliver needed parts, but it also can provide data on employee performance and thus contribute to employee stress.

Finally, IVD is becoming valuable in teaching interpersonal skills, such as sales. Workshops are the most traditional training approach for such skills, but workshops are of inconsistent quality, provide little subsequent reinforcement, and have limited practice opportunities. Thus, any excitement and motivation workshops generate may not be transferred to job performance. IVD combined with role-playing now promises to provide an effective means of training in interpersonal skills (see box 7-E).[27]

Computers

Of all the technologies, computers have excited the most interest for instructional applications. Computers' vast capacity for handling information,

Photo credit: American Association for Community and Junior Colleges

Computer-based training can be delivered at the work station, or in a classroom or laboratory.

the variety of ways they can be programmed to respond to user commarids, and their rapidly declining cost and increasing power, make them seem to be the ideal "teaching machine." To the extent that PCs or other terminals already are available in the workplace, they become a natural and convenient way of delivering training. If computer equipment must be bought specifically for computer-based training (CBT), however, it is a relatively expensive approach.

Computer-based training can incorporate any information that can be stored on a floppy or hard disk-e.g., text, graphics, data. Recent advances in software design provide windows and branching. Developments in storage technology (e.g., CD-ROM and optical drives) add audio and still video capability. Connection with a videodisc player allows Ml-motion video. With artificial intelligence

[23]Ibid.

[24]The use of instructional technology in basic skills training is discussed in more detail inch. 6.

[25]Ibid.

[26]Ibid.

[27]William Ives, "Soft Skills in High Tech: Computerizing the Development of Interpersonal Skills," *Instruction Delivery Systems,* vol. 4, No. 2, March/April 1990, pp. 12-15.

Box 7-E—Automating Interpersonal Skills Training

Teaching effective interpersonal skills, such as selling, remains one of the biggest challenges in training today. In many of the top insurance companies, for example, at least 75 percent of the new sales personnel leave after 3 years, largely because they are unable to develop sufficient sales skills to make an adequate income from their commissions.

A combination of automated audio/video feedback and interactive videodisc or computer-based training (CBT) is now being used to teach sales skills (or to aid in early recognition that one is not suited to sales). One IVD system uses a laserdisc player, touchscreen monitor and a PC coupled with a videotape recorder, camera, and microphone. The IVD presents full-motion/audio demonstrations of skills such as presenting credentials, then provides review exercises with proper and improper examples of those skills. Trainees can interrupt the presentation of a skill when a mistake is made and offer a critique of the action. Feedback is given on the appropriateness of their critique.

The camera or audio recorder is then used to allow the students to demonstrate proper behavior. Trainees face anew customer (provided on the IVD) and practice the skill they just saw modeled.[1] Their performance is recorded on videotape along with the customer's conversation. Students can practice in privacy, then review their performance based on a set of criteria (from the IVD) and evaluate their own behavior. They can erase and repeat, practicing as many times as they wish. When they feel they have successfully transferred the training to their performance, trainees can show the tape to the supervisor, who provides advanced coaching.

In a pilot evaluation program, insurance agents using this training program had a 16 percent increase in calls, a 24 percent increase in kept appointments, and a 43 percent increase in approach interviews with clients. In addition, new hire training time was reduced 30 percent over traditional classroom methods, and the subsequent on-the-job learning curve decreased. For example, one agency that had been using the IVD system for over a year compared 10 agents who used the system with 17 trained by traditional methods. The 10 using the IVD program were at a level 18 months ahead of the control group after the completion of training. While it is difficult to separate the impact of the IVD training from other changes in the company, its revenues also have gone up since introduction of the system, and the agent retention rate has increased.

IBM also experimented with an IVD system coupled with a videotape camera for teaching sales skills. In a comparison with their traditional person-to-person role playing training, they found that trainees using the IVD system did much better in structuring their sales calls and developing sales skills.

A second, similar, program uses CD-ROM combined with audio feedback. Full-motion video will be available on CD-ROM within a couple of years. For some training situations, such as telephone sales, audio feedback is actually closer to the real job situation, and full-motion video is not needed. CD-ROM also costs approximately $2,000 less per training station than IVD, has larger storage capacity, and can be used more easily for non-training applications.

[1] Although the "customer" on the IVD cannot respond in all of the unexpected ways a real person might, this change with advances in artificial intelligence.

SOURCES: William Ives, "SoftSkills in High Tech: Computerizing the Development of Interpersonal Skills," *Instruction Delivery Systems*, March/April 1990; and Beverly Geber, "Goodbye Classrooms (Redux)," *Training*, vol. 27, No. 1, January 1990.

and hypermedia software, CBT can provide fourth- or fifth-generation interactivity (see box 7-B).

The advances in computer hardware and software also have revolutionized other areas of training. Computers control the interactivity in CBT and IVD. Sophisticated computer graphics and databases are integral parts of simulators. Packages such as authoring systems have largely obviated the need for computer programming in instructional design. Database management programs make it much easier to keep track of the elements when developing a complicated CBT or IVD program. Relational databases provide the underpinnings for performance support systems.[28] Computer technology also is at the heart of emerging systems such as electronic classrooms, digital networks, and virtual environments.

[28] Relational databases are currently the most powerful and flexible means of integrating the various components of a performance support system. In a relational database, the data are represented as tables in which no entry has more than one value. This makes it easier to link data so that complex queries can be handled rapidly.

Table 74-Computer Use in Training at U.S. Companies With More Than 100 Employees[a] (percent)

Number of employees	Use computers in training		Doing CBT		Use computers in data management		Use computers in word-processing or graphics		Not using but will by 1990
	1988	1989	1988	1989	1988	1989	1988	1989	1989
100-499	59.6	64.8	37.9	43.3	49.7	55.2	53.4	62.7	5.8
500-999	57.4	67.7	31.0	43.6	47.3	61.5	52.7	64.6	8.7
1,000-2,599	67.1	73.6	45.1	48.0	57.2	64.1	59.0	67.4	9.2
2,500-9,999	77.6	74.2	56.5	52.1	71.4	64.7	72.0	66.6	4.9
10,000 or more . . .	82.9	82.6	58.3	64.0	76.6	75.2	79.4	76.4	3.8
All sizes	60.8	66.2	38.6	44.1	51.1	56.9	54.6	63.4	6.2

[a]The data in this table oome from a survey that had a very low response rate. Thus they only provide a rough estimate of the extent of CBT.
[b]Refers to organizations reporting that they use computers in some way in connection with theirtraining efforts. This might include recordkeeping or other data management, word processing, or creating graphics for training classes.

SOURCE: "Industry Report, 1989," Training: *The Magazine of Human Resources Development*, vol. 26, No. 10, October 1989, p. 58.

All of these features combine to create a training medium with a vast capacity for imparting information in a truly interactive form. Moreover, the courseware can be edited or updated easily and at a much lower cost than videotape or videodisc. Finally, courseware can be sent anywhere in the world that compatible hardware is available, and can be used at the learner's convenience. These advantages can give CBT a substantial edge over television or videotape training.

Provided that courseware can be developed or purchased for a cost comparable to classroom instruction or videotape, CBT is likely to displace those methods of instruction in companies where terminals are available. The development of instructional design and authoring tools that reduce the cost and time to develop CBT is thus a key factor in making this training technology successful on a wider scale.

According to the *Training survey*, about two-thirds of responding companies with 100 or more employees were using computers in some aspect of training (see table 7-4). Most of the companies use computers for word processing or to create graphics; many also use them for data management (e.g., program evaluation, test scoring, survey processing). Around 44 percent of the companies use CBT. Of those, 80 percent use it to teach people to operate computers, 38 percent to deliver training on nontechnical subjects (e.g., management or interpersonal skills), and 37 percent to provide training in technical skills.[29] The ASTD survey indicates that 67 percent of the companies surveyed use CBT most often to train professionals and technical staff; 37 percent report its use for skills and crafts training.

A barrier to CBT use arises when workers are not familiar with computers. They often are afraid of the technology and are intimidated by a keyboard. The use of touch screens and light pens and the growing use of computers to provide public information at sites such as shopping centers and museums is overcoming this problem. Also many CBT users have been turned off by poorly designed programs that only transferred printed material to disk (see description of first-generation courseware in box 7-B). As with other training media, it is essential that CBT incorporate good instructional development principles, and that training managers follow such principles in developing or purchasing courseware appropriate to the skills to be imparted.

Today, CBT is used for a wide range of applications in industry, including technical, basic educational, and interpersonal skills (see boxes 7-E and 7-F). Although it was the PC that gave rise to CBT's current popularity, one of the largest uses still is on mainframe computers to teach data processing and other job-related skills in the insurance and banking industries (see box 7-G).[30]

CBT also is used in basic skills training (see ch. 6). Efforts are underway to transfer the U.S. Army's Job Skills Education program (JSEP) to adult and vocational education. McGraw Hill, in conjunction with Apple Computers, is developing a series of print and CBT programs to improve basic skills in six areas (health, automotive, business, construction trades, electronics, and office). The Adult Literacy

[29]"Industry Report," op. cit., footnote 7.

[30]Kearsley, op. cit., footnote 1.

Box 7-F-Computer-Based Training in Industry

Computer-based training (CBT) can be used to impart technical and other skills. Some examples include:

- *Anheuser-Busch in* St. Louis, Missouri is using a Micro TICCIT system to teach assembly-line workers to run beer can packaging machines. The choice of CBT is driven by a desire to improve quality control in manufacturing and an overall modernization effort in plants. This particular training task was chosen because it is one of the most critical aspects of beer packaging.
- *Burlington Northern* uses a MicroTICCIT system to teach train crews the rules of operation for railroads (e.g., switching signals). This is mandatory knowledge fora all train crew personnel, but classroom instruction had not proven very effective. CBT both upgrades the quality of training and facilitates its distribution to the field.
- *The Federal Aviation Administration has* used PLATO to train flight inspection and maintenance specialists for almost a decade; recently they began using CBT for air traffic controllers as well. Courses are delivered to approximately 50 sites around the country. The heavy training load—which is difficult to meet with classroom instruction-was the primary factor in choosing CBT.
- *Bell Atlantic* has developed a PC-based financial sales skills course for its telemarketing representatives. The course includes CBT case studies that simulate the selling process and a Lotus 1-2-3 cash-flow template to calculate lease versus purchase options. The company reports that the course improves the competence and confidence of sales representatives.
- *The Strategic Management Group* (SMG), in conjunction with the Port Authority of New York/New Jersey has developed a PC-based course entitled "Export to Win" to teach business people about exporting products to international markets.
- *Applied Learning offers hundreds* of data processing courses that run under the Phoenix mainframe CBT system. These courses are used to train staff about mainframe operating systems, applications software, and telecommunications.

SOURCE: Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the Office of Technology Assessment under contract L3-5615, February 1990.

and Technology Project coordinated by People's Computer Co. of California involves the use of commercially available education software in vocational education programs at community colleges and other training centers. The Technology for Literacy Center in St. Paul, Minnesota, uses computers in teaching adults and reports improvement in terms of continued enrollment, student satisfaction, and increased achievement.[31]

Computers also can be used to manage training. Computer-managed instruction (CMI) allows the instructor and/or trainee to track each trainee's progress through the various paths in an instructional sequence and to ensure that the right lesson and material are assigned and available at the tight time. With advances in storage technology and courseware design, CBT or IVD training programs increasingly have integrated computer management systems. They also can be used with lecture/lab, television, or other training methods.

CMI can range from simple reports on test performance to detailed monitoring and analyses of trainees' progress on hundreds of learning objectives, including comparing each trainee with the class, with all the trainees in a program, and with corporate or national standards. In many systems, not only can instructors, learners, and administrators obtain reports organized in any way that is useful to them, but they also can manipulate the data to get answers to questions that will help them improve course design or delivery and instructional program management.[32]

Such management is critical in any large-scale effort to tailor instruction to individual learners and to allow them to keep track of their own progress. With advanced interactive (third-generation and above) CBT or IVD courseware, learners begin with pretesting that ensures they start with a lesson that will neither bore them nor be beyond them. Then each time they sign on, the system can either start them where they left off or provide review of

[31] Ibid.

[32] Kurland, op. cit., footnote 13.

Box 7-G-Computer-Based Training in the Insurance Industry

The insurance industry has embraced computer-based training (CBT) more whole-heartedly than perhaps any other economic sector. Several factors explain its success in that industry. First, insurance companies already have a strong training tradition. When this is combined with the fact that insurance companies are heavily computerized, with almost every employee having a terminal, CBT becomes natural and cost-effective. Also, both CBT and the material to be learned-policy information and procedures—are well-suited to tutorial strategies.

CBT in the insurance industry has the same advantages as in other sectors: employee scheduling, tutorials and practice exercises to aid learning, and time/cost savings relative to classroom instruction. The first is probably the most important from the employees' perspective and the last from the firm's.

A large insurance company in the metropolitan Washington, DC area serves as an example. The company first got started with CBT in 1981 with an introduction to claims processing course. It failed, however, because the system was not reliable. A few years later, another course-still in use today-was tried on a more stable system. Today the system delivers around 20 courses with about 5 new courses being added annually. Thousands of employees are trained on the system.

While CBT provides effective training for this company, there is an ongoing problem developing and maintaining quality courses. The company finds it difficult to locate authors/designers who know how to develop good CBT and can work with the corporate computer system. One segment of the company relies solely on commercial courses that are then customized. Such purchasing reduces the development costs, but is limited to "generic" course topics (e.g., data processing, customer service).

The insurance industry has tried to encourage courseware sharing through the Society for Insurance Training & Education (SITE), which published a courseware catalog in 1987, with a new version in the works. This effort has not been very successful, however, because of system incompatibilities; confidentiality problems, poor courseware quality, and lack of customization capability. The industry hopes that vendors will market more generic courses and provide customization, but those services will not resolve industry concerns about confidentiality.

SOURCE: Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the Office of Technology Assessment under contract L3-5615, February 1990.

material they may have had difficulty mastering. Thus the system not only allows more options for instructor management, it also puts the pace of learning in the hands of the trainee-a factor that is particularly important for many adult learners.[33]

Teleconferencing

All forms of teleconferencing have been explored for training. The *Training survey* shows 11 percent of responding firms using videoconferencing, 9 percent audioconferencing, and 4 percent computer conferencing. In the ASTD survey, 33 percent of the firms use teleconferencing of some form, primarily for management and supervisory training.

Audioconferencing is relatively inexpensive, but is limited by the lack of visual presentations-most people find it hard to participate actively without visual cues to indicate who is to speak next. Moreover, the instructors have no way of telling if anyone is paying attention. Finally, demonstrations or hands-on experience can only be achieved for purely audio skills (e.g., telephone sales).

The Kansas Board of Regents has for years operated a statewide audioconferencing system, primarily for part-time adult learners. The courses focus heavily on continuing education in various professions. Students may participate either at conference centers located throughout the State or from their own phones. The primary advantage of the system is that it enables people to take courses who would not otherwise be able to do so or could do so only if the instructors went to numerous off-campus locations. Studies over the years indicate that students in the telecourses do as well as on-campus students.[34]

As the U.S. Public Switched Telephone Network (PSTN) becomes more digital with more capabilities, it may become less a telephone network and more a general purpose broadband network capable

[33] Ibid.

[34] Ibid.

of carrying all types of traffic, including audio, data, and video. Transmitting a live telecourse with full audio and video interaction may be no more difficult than making a telephone call is today .35

For training applications, teleconferences involving one-way video (i.e., broadcast television) with two-way audio (telephone) links are perhaps the best compromise in terms of cost and quality of information transmitted. This allows full presentation of visual information and lets participants ask questions or make comments at any time. A fax machine allows two-way transmission of hard-copy at little additional cost.[36] Compressed two-way video also is becoming more economically feasible for larger companies.

Many large corporations, including IBM, Motorola, and AETNA, have satellite-delivered television networks that are used for training teleconferencing. AETNA, for example, delivers a business writing skills course to over 1,000 employees at more than 50 branches via teleconference. In a classroom, the course takes 2 days; via teleconferencing it reduces to two 1.5-hour sessions (with some preclass work) .37

Until recently, teleconferencing was used only by the handful of organizations that could afford the equipment and could find instructors willing to try it. With the advent of large-scale digital networks and satellite links, the use of teleconferencing for training is likely to become more commonplace. However, it still will require significant preparation time and relatively complex logistics, which may deter many training departments. Nevertheless, increasing pressure to reduce travel time for training is likely to be a major boon for teleconferencing.[38]

Computer conferencing also is relatively inexpensive if the hardware is available, and it gets around the scheduling problems of audio- and videoconferencing. With the increasing prevalence of personal computers, more organizations are beginning to use computer conferencing as part of distance learning activities. For example, the Western Behavioral Sciences Institute has used computer conferencing for several years for high-level management seminars. Participants do not have to take time away from their jobs. Moreover, they can relate what they are learning in the seminar directly to their jobs because many of the exercises involve analysis of real problems in real time.[39]

The International School of Information Management in Irvine, California has a masters degree program using computer conferencing to conduct seminars and provide student/instructor interaction. Boise State University has a masters degree program in Instructional Technology that also uses computer conferencing for remote delivery of courses. This program is supported by, and designed to meet the needs of, the U.S. Army and the National Guard. Because most large corporations already have electronic mail systems in place, the potential exists to use these systems for training activities.[40]

Simulators

Until recently, good training simulators were too costly except for the most dangerous situations (e.g., flight training, nuclear reactors). With the advent of microchips and videodiscs, however, simulators' costs have come down (although the most sophisticated simulators are still too expensive for all but a few civilian applications). Moreover, manufacturers have developed commercial software packages for a variety of simulations.

The *Training survey* shows 44 percent of responding companies using simulations or games of some type. While many of these may not be technology-based, the response rate illustrates the growing recognition of the value of simulation in training. Simulators give trainees hands-on experience without the risk of personal harm or damage to an actual machine or system. Moreover, simulators help trainees prepare for equipment failure and other unpredictable events. Simulators can present a wider variety of malfunctions than is possible on operational equipment or systems. Also, with today's

[35]U.S. Congress, Office of Technology Assessment, *Linking for Learning: A New Course for Education*, OTA-SET-430 (Washington, DC: U.S. Government Printing Office, November 1989). See also U.S. Congress, Office of Technology Assessment, *Critical Connections: Communication for the Future*, OTA-CIT-407 *(Washington DC:* U.S. Government Printing Office, January 1990).

[36]Kearsley, op. Cit., footnote 1.

[37]Ibid.

[38]Ibid.

[39]Ibid.

[40]Ibid.

technology, the time between failures is so long that maintenance personnel rarely see some types of breakdowns. Rather than getting training they probably will forget by the time they need it, technicians instead can go through a simulation of a failure when it occurs.

In addition, simulators can be used at any time and can accelerate the rate of learning since more training opportunities can be provided in a shorter time than with real equipment. They can be designed to focus on specific learning objectives, and they provide consistent and accurate feedback on trainee performance.

Further, simulators may be less costly to produce and operate than actual equipment. Flight and driver simulators save wear-and-tear and fuel; gunnery simulators save ammunition. Simulators also can incorporate CMI and automatically maintain trainees' records, providing more information about their performance than is possible with actual equipment.

Common examples of simulators are in the training of:

- air crews for all types of aircraft;
- ships' officers in docking and navigating supertankers, with sophisticated simulators reproducing the conditions of the major world waterways including detailed graphic or video presentations;
- operators of nuclear and other energy plants;
- technicians in the operation of communications satellites;
- space shuttle crews;
- process operators in chemical plants and refineries;
- boiler operation and maintenance crews (see box 7-H); and
- driver simulators (box 7-1).[41]

The fields of computer graphics and animation now use low-cost simulators to prepare people for more powerful graphics design machines. High-speed animation also is useful in creating environments where it is impossible to film at all, e.g., to create an interactive microscopic world, or to model the human anatomy. Imaging systems can convert data into pictures that help people grasp even very abstract concepts. In medicine, for example, one aspect of physician training is learning how to relate blips on a screen with the organ generating the blips. Students can see arteries expand and contract under differing stimuli. These images are not merely simulations, but computer transformations of data into pictures. Thus students can achieve understanding of processes and interactions much more directly than ever possible before.[42]

Box 7-H—A Boiler Simulator

Lack of training was causing accidents and unacceptable downtime in organizations that use recovery boilers.[1] The problem was severe enough that insurance companies were threatening to cut off insurance for the machines. Yet recovery boilers are sophisticated pieces of equipment that cost $90 million and are 14 stories high; training operating and maintenance/repair personnel on a real boiler is dangerous, and demonstrating malfunctions could become expensive.

The J.H. Jansen Company of Woodinville, Washington, which makes Kraft recovery boilers for the paper industry, developed a boiler simulator called Recovery Boiler Tutor (RBT). The simulator, which uses an expert system, presents trainees with scenarios representing boiler inefficiencies, problems, or emergencies. These difficulties can be resolved in 20 to 30 moves, with the learner choosing options such as "add oxygen" or "open flue." When trainees get off track the system prompts them with comments such as "Have you noticed that the trend lines are askew?" or "The oxygen is much higher than it should be. "

Learners have three options for interacting with RBT: they can ask for a scenario that starts with a particular problem to solve or one that starts with the boiler operating normally and then develops a problem that must be diagnosed, or they can adjust simulated dials and meter readings to create a problem.

RBT took 18 months to develop, and is now used in more than 80 plants in the United States, Canada, and Europe. Within months of its first installations, several insurance companies offered discounts to plants that trained with RBT

[1]Recovery boilers are used to recycle chemicals by removing process water and concentrating them.

SOURCE: Peter R. Kirrane and Diane E. Kirrane, "What Artificial Intelligence is Doing for Training," *Training*, *vol.* 26, No. 7, July 1989.

[41]Ibid.

[42]Ibid.

A new twist in the use of simulators is the capability to network individual simulators for teamwork. DoD currently is implementing a concept called SIMNET, which connects simulators of armored vehicles as well as tactical aircraft and artillery and their field commanders to operate together for real-time combat exercises (see box 7-J). Networked simulators eventually could be relevant to civilian teamwork situations such as surgery and major equipment malfunctions (e.g., mass transit breakdowns, wide-area electric power blackouts); in the meantime, the computer graphics and network aspects are likely to make important contributions to the technology base.

Job Aids

Job aids are valuable whenever the skill or knowledge required is used infrequently, so that even if people were trained, much of what they are required to do might be forgotten when needed. Job aids also are used where workers must remember many detailed steps and do them in proper sequences. At the high-tech end, some forms of job aids are evolving into embedded training (see below).

Virtually every worksite uses job aids of some type, even if it is only a worker's handwritten list or notes. Job aids are more cost-effective than most

Box 7-I—A Truck Driver Simulator

Shell International Petroleum Company Limited, London, has a large truck fleet, and wanted to reduce its annual accident rate. Shell's safety experts determined that a lack of defensive driving was the primary problem, rather than inadequate driver skill. Using interactive videodisc IVD), they developed a truck driver simulator that teaches defensive driving, including constant alertness and readiness to respond to potential hazards before a situation becomes dangerous.

The main objective of the simulation is to encourage defensive driving through a series of cause and effect situations. Shell accomplished this by constructing and videotaping 20 different road hazards based on visual clues (from a driver' s-eye view) of potential danger ahead. The hazards include slippery and dark roads, pedestrians and cyclists, distractions within the cab, and other common causes of accidents.

Because timing is critical to defensive driving, learners must act within a certain time period when they think a hazard situation is developing. Thus each clue incorporates three time periods: in time, late, and too late. When the learner reacts, the program stops the action and displays a list of possible responses to the situation (with the "too late" time period offering no positive choices). The outcomes vary from complete avoidance of danger to realistic crashes and embarrassing newspaper headlines. The driver rating (defensive, inattentive, dangerous) for each hazard depends on the combination of timing and action selected.

A replay option explains the clues that led to each hazard, with text and graphic overlays including a timeline indicating at what point each clue occurred. Other options include a pre-drive vehicle safety check and a practice drive during which learners are encouraged to experiment with various combinations of timing and action. After practice, learners may select a test drive, which contains seven hazards in a row. As in real driving, each hazard can be dealt with only once. The program gives the final score and rating at the end of the test drive. The courseware also includes a database of facts about the 20 hazards, which the learner can access at any time.

Shell International has not yet undertaken a formal evaluation of Defensive Driving's effectiveness. Anecdotal reports from drivers suggest, however, that it is improving the way they think about road hazards The clue sequence, in particular, appears to help drivers form a mental model of the development of road hazards and sharpen observation skills.

The U.S. military also uses driver simulators (e.g., the M-1 tank simulator). A truck driver simulator also is a test program for DVI (see discussion of digital videodisc). Simulators have a potentially wide application in driver training, where they would be safer for preliminary training, and could save fuel and vehicle wear-and-tear. They also could be used in driver's license testing, where they would provide consistency and decrease cost and enhance safety.

SOURCE: Deborah H. Blank, "Defensive Driving: Shell's Interactive Commitment to Safety," *Instruction* Delivery Systems, vol. 4, No. 2, March/April 1990.

Box 7-J—SIMNET: Networked Simulators in Military Training

A continuing problem in military training is providing enough hands -on practice in the operation and repair of equipment, including weapons, support vehicles, telecommunications gear, and logistics hardware. In many cases, it is too risky or expensive, or physically impossible to use the actual equipment for training. Consequently, the military has become a big advocate of simulators (see appendix).

Even simulators historically have been unable to provide hands-on training in team skills and group coordination, however. To be effective on and off the battlefield, soldiers and their commanders must be able to function as a unit. SIMNET is a research project initiated by the Defense Advanced Projects Research Agency (DARPA) to connect simulators via local and remote networks. In its current configuration, SIMNET consists of 250 networked simulators at 11 sites (7 in the United States and 4 in Europe). Equipment simulated includes Ml tanks, M2/3 Bradleys, fighter aircraft, helicopters, command/fire control elements, and a battalion operation center. Evaluation is of both the combat soldiers and their commanders. Preliminary data indicate that SIMNET significantly improves unit performance.

While any of these networked sites can "fight' any other, incompatibility among programming and equipment (e.g., operating speed) is a continuing problem. The installed base of military simulators uses a wide range of databases (e.g., for terrain imaging), communications protocols, and levels of hardware sophistication that are incompatible. Thus a tank that moves behind a building on its simulated terrain may still be in plain view on its opponents' screens. Similarly, the amount of data flowing through the satellite network led SIMNET to adopt relatively simplistic rules for updating screen images. These provide unrealistic positioning of high-speed objects (e.g., fighter aircraft). Finally, SIMNET accommodates the varying levels of visual fidelity in simulators through a lowest common denominator, which fails to use the full capability of the more sophisticated (and expensive) systems. These problems do not make for realistic battle simulations.

The services and their contractors are now developing standards for databases and communication protocols that will alleviate these problems. Target completion date is May 1991.

SIMNET pushes the state-of-the-art in technologies related to computer animation and 3D graphics as well as packet-switched networks.[1] It also presents new training opportunities, such as replaying the recorded performance of a unit to analyze mistakes. In addition, it opens up the possibility of "what if" experimentation in combat situations-something not really possible in field exercises.

SIMNET is having major repercussions for the nature of future military training. It also is likely to influence civilian training in any application requiring teamwork, especially when multiple sites are involved (e.g., disaster preparedness). It also could be useful for interpersonal skills training in areas such as management, sale, and customer service, although teleconferencing is more likely to be used for these applications in the near term.

[1]Packet-switching was developed for data communication between computers. Digital information is packaged into small pieces called packets, each containing information about the source and destination of the data and the relationship of that piece to the whole message. The packets are transmitted separately through the network, sometimes taking different paths depending on which ones are free at the moment. See U.S. Congress, Office of Technology Assessment, *Critical Connections: Communication for the Future*, OTA-CIT-407 (Washington DC: U.S. Government Printing Office, January 1990).

SOURCES: Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the Office of Technology Assessment under contract L3-5615, February 1990; and W.A. Demers, "All Together Now," *Military Forum,* November/December *1989.*

formal training, often can be developed faster than an instructional program, are more timely in that they provide the training at the immediate point of need, are more easily updated than instruction, and often are more relevant to specific jobs. They also can aid in the transfer of training to job performance.[43]

Many of the most effective job aids do not require technological devices at all; well-designed print or graphic materials are often all that is required. For example, on an automobile production line, where torque requirements vary among components and models, a table printed in large type showing the needed torques might hang at the appropriate point

[43]Kurland, op. cit., footnote 13.

on the line. A similar table would be used at the quality control checkpoint. Such job aids do not differ much from old-fashioned maintenance manuals except in the attention that is given to their design and access.[44] Other examples of job aids include the checklist that flight crews use before a plane takes off, and computer keyboard templates that remind the operator which function keys do what.

Embedded Training

Embedded training is instruction that is an integral component of a product or system. In a computer, for example, it is easy to provide online training (help screens, tutorials) as part of the system (see box 7-K). Most other devices that use microchips now include diagnostic circuitry that speedily identifies any malfuction; some also describe how to repair it. Automated manufacturing systems also now include built-in training and documentation (e.g., the Martin Marietta and Apple factories discussed previously). DoD also is interested in embedded training, which has focused the interests of military R&D contractors on embedded systems, and may hasten their transfer to civilian technologies.[45]

The movement toward embedded training is being driven by a number of forces in contemporary technology, including the increasing capacity of microchips, their incorporation in more and more equipment, and the speed with which new technology is introduced. Equipment life is getting shorter. When a machine was expected to last 20 years or more, traditional training with a high initial cost was cost-effective. As the life expectancy of equipment has dropped to 5 years or less, it has become too costly to train workers in the traditional way every time a new machine is introduced. Embedded diagnostics and training reduce both the preservice training time and the onsite repair/maintenance time.[46]

Embedded training has many advantages over other forms of instruction. The most important is availability-training is always available when needed. Thus, embedded training is useful for applications where it is either impossible or not cost-effective to train everyone who uses apiece of technology about all of its operational characteristics. For example, office copy machines today often include graphic displays that show where a problem occurred (e.g., a paper jam) and list the steps needed to remedy it.

Second, embedded training is available at the work station and is focused on the worker's immediate needs for operation or repair. Third, it makes it possible to combine the sound instructional design principles of good formal off-the-job training with the best features of informal training (e.g., co-worker interaction, immediate opportunity to apply the results). Embedded training also simplifies the logistics of providing training to customers or employees because it is delivered along with the product or system.[47]

With embedding it also becomes possible to shift costs from employees to customers. One of the most visible examples is the automated teller machine. The next step is moving the teller function into the home via telephone and/or computer-a service now offered by many financial institutions. Indeed, as the technology of embedding improves, the skills needed by the end-user decrease to the point where vendors are now shifting the responsibility for installation and maintenance to the user.[48]

However, embedded training is difficult to design and many current efforts are not very successful. To be effective, the information must address the specific questions or problems that people might have when using or repairing equipment. A lot of empirical work with prototypes and typical users is needed to anticipate the full range of questions or problems that might arise. User-testing early in the design cycle is a relatively new concept in system development, and most engineers have not been trained in such data collection methods.[49] Also, if the training provided is too restrictive, it can inhibit

[44]Ibid.
[45]Kearsley, op. cit., footnote 1.
[46]Kurland, op. Cit., footnote 13.
[47]Kearsley, 0p. cit., footnote 1.
[48]Kurland, op. cit., footnote 13.
[49]Ibid.

Box 7-K—The Manpower Services Training System

In the early 1980s, Manpower, a temporary employment service for offices and factories, saw that with changes in technology it could no longer expect to find personnel who *were* able to use the full range of client equipment. Manpower searched unsuccessfully for an *existing training* system that would be time- efficient, cost-effective, and work for many people with widely varying backgrounds at dispersed locations. The company found the training programs and manuals supplied by equipment manufacturers too hard to understand. Moreover, it felt that most off-the-shelf training programs taught more than was needed to begin machine use. Overly ambitious programs might increase learners' fear of new technology, which were great enough already.

Instead, Manpower developed Skillware, a series of computer-based training programs to teach operators the hardware and software they will use on assignments. Skillware has modules that differ in difficulty (basic, advanced, and executive) and in application (special features, graphics, databases). It is personalized and contains humorous elements intended to help hold trainees' attention and reduce their fear of the equipment (see figure). Training may last from a few hours to 2 days depending on the module. Skillware is job-specific, teaching a temp only the skills that clients request. To achieve this, it uses scenarios; i.e., the trainee works for a fictitious company and has to complete a task for that company by the end of the course.

At a computer terminal, trainees proceed at their own pace through on- screen tutorials and instruction booklets (computer/software manuals written in clear language). Each tutorial/exercise segment can fit on a single screen and focuses on a basic operation (e.g., moving the cursor, printing a computer-edited document). A training administrator is available to answer questions, but Manpower prefers that trainees work themselves out of jams (as they might need to on assignment). At the end of training, the trainee is asked to compose a letter about the training program to Manpower's president; an acceptable letter is seen as a valid performance test. (Some letters have offered suggestions to improve training that Manpower has adopted.) After the training, each operator receives a "quick reference" manual (containing terms, functions, and replicas of tutorial screens) to take to the job.

Recently, Manpower initiated a skills assessment system for job applicants (including applicants for temporary light-industrial positions). As the company rejects few applicants, the system serves primarily to place people in appropriate positions. For office placement, Manpower uses a work-sample test to assess editing, proofreading, clerical, and word-processing skills and to determine applicants' training needs. The assessment system for light-industrial applicants includes performance tests to measure sorting and checking, tool-related assembly, printed circuit board and small-parts assembly, and coordinated rapid movement. Written tests assess aptitude for tasks such as inspection and logging production. (Manpower does not yet offer training to its light-industrial temporaries, but recognizes that the trend toward automated manufacturing could require such training soon.)

The company provides Skillware free to all employees, including its light-industrial temps. (A 2-day course costs Manpower $100 per trainee for equipment, material, and development.) The company feels Skillware is a powerful recruiting tool-people who know they can get free computer training may be more apt to sign up with Manpower than with another temporary agency. When not on assignment, office temporaries are encouraged to come to a Manpower office to learn another software program or familiarize themselves with new equipment.

The company has begun to train permanent workers at client organizations. For example, IBM hired Manpower to provide a training program for IBM's System/36 customers. In return for training those customers, Manpower gets access to pre-releases of IBM hardware and software so it can anticipate future needs in the temp market.

Manpower continues to invest in training research and development to stay on top of the ever-changing world of office hardware and software. (Currently the firm spends around $3 million annually, but it spent $15 million for R&D in the first 2 years of the Skillware project.) Manpower believes the success of its training and R&D efforts is reflected in its market success; in 1989, sales were $3 billion-double those of the nearest competitor.

workers' ability to use their intuitive knowledge and to foster innovation.[50]

Thus, good embedded training requires that instructional system design experts work with product design engineers. Traditionally, training materials are developed after the system or product is completed. The inclusion of training specialists as part of the design team often requires organizational changes and different skills in the training department. Finally, artificial intelligence techniques may be

[50]Institute for Research on Learning, *The Advancement of Learning,* undated pamphlet; John Seely Brown and Paul Duguid, "Design for Implementability," paper presented at the conference on Technology and the Future of Work, Palo Alto, CA, March 1990.

necessary to create embedded training programs that can pinpoint what the user wants to know.[51]

In time, the movement toward embedding could affect many aspects of workplace training. In theory, far less training would be needed prior to assignment to a specific task, reducing the cost of training. Moreover, embedded training occurs at the workstation, improving transfer of learning to work. The involvement of instructional systems experts in product design also improves the human factors aspects of equipment. Finally, fewer workers would be needed because equipment operators increasingly can also perform routine repairs and maintenance.

THE COST OF TECHNOLOGY-BASED) TRAINING

There are several elements in the cost of technology-based training. The easiest to fix are the purchase costs of hardware (e.g., PCs, IVD systems, satellite dishes) and off-the-shelf courseware. Additional costs may be incurred in adapting the courseware or retraining instructors. If off-the-shelf courseware is not available, custom courseware development costs also must be considered. If frequent updates are needed, they will add to the longer term costs. Other costs relate to the delivery setting (e.g., rewiring a classroom for teleconferencing, adding computer tables to switch from a lecture to a CBT format). Finally, the labor cost of delivery (time off work) must be considered. Table 7-5 shows the training budgets for various sized companies in 1989. These data suggest that the smallest companies spend less than $100 per employee on training while companies with more than 500 employees spend $100 to several hundred dollars per employee.

Classroom training often has a very low front-end cost. Most companies have a conference room or other area that can double as a classroom. Supporting hardware (blackboard, overhead projector, flipchart) and printed materials are relatively inexpensive and easy to obtain. Lab equipment usually can be scrounged from operating departments; class projects are even a way of saving repair and maintenance costs. The instructor often is a subject-matter expert from within the company or is hired on a contract basis. However, classroom training is consistently shown to be the most expensive in terms of the labor costs of delivery (time spent away from the work station) and travel to a central corporate classroom or a course offered by another organization. Costs rise dramatically for companies or agencies with offices throughout the Nation or around the world.

Table 7-6 compares the costs of other common technology-based training systems. All costs vary with the level of sophistication of the system and courseware. The number of participants also can affect direct costs (e.g., for satellite services). If a learning site needs to be rewired for satellite, teleconferencing, cable, or other services, these modifications will add substantially to the costs.[52]

Trade-offs between the convenience of off-the-shelf courseware versus the cost of programs tailored to specific needs also must be considered. Many training analysts argue that most good training has to be situation-specific and cannot be met with off-the-shelf or generic programs, no matter how good. Some floppy disks and erasable videodiscs can be updated or adapted to individual corporate needs with little effort; other programs cannot be altered easily or require remastering. Also, there is little independent evaluation of the claims for effectiveness of off-the-shelf programs.

Custom courseware development costs vary widely depending on the medium, program length, and, for CBT and IVD, level of interactivity and sophistication as well as the development tools used (e.g., authoring systems, supporting databases). A CBT courseware designer at Boeing Aerospace and Electronics estimates that he can design a 20-minute CBT course in about 4 hours (excluding any video or graphics work) using a relational subject-matter database. In contrast, the instructional design department at Stromberg-Carlson estimates that it takes them 300 hours to produce 1 hour of CBT compared with 30 hours to produce 1 hour of classroom instruction.[53] Estimates from consulting companies range from 50: 1 to 600:1 depending on the complexity of the course and its subject matter. The actual authoring may only take 15-20 percent of the

[51] Kearsley, op. cit., footnote 1.

[52] See ch. 3 and app. B of *Linking for Learning: A New Course for Education* provide detailed assessments Of the cost components of distance learning systems, OTA-SET-430 (Washington, DC: U.S. Government Printing Office, November 1989).

[53] Geber, op. cit., footnote 3.

Table 7-5—The Allocation of Corporate Training Budgets for Various Size Companies[a] (dollars)

Number of employees	Outside expenditures					Total outside expenditures	Facilities/ overhead	Trainer salaries	Total budget
	Seminars/ conferences	Hardware	Outside services	Custom materials	Off-the-shelf materials				
100-499	$11,258	$6,213	$4,419	$3,611	$4,153	$29,655	$9,093	$21,173	$59,921
500-999	16,911	11,502	8,726	8,359	8,340	53,838	27,207	42,854	123,899
1,000-2,499	30,321	23,676	29,027	13,129	14,834	110,987	62,471	146,996	320,454
2,500-9,999	125,180	89,805	52,487	54,541	56,852	378,864	124,318	1,000,515	1,503,697
10,000 or more ...	469.150	554,111	386,031	414,110	356,376	2.179.779	1,053,898	16,502,442	19,741,505

[a]The data in this table are derived from a survey that had a very low response rate. Thus they provide only a rough approximation of corporate training budgets. They are included here as an indication of how the budgets of responding companies are divided among various training categories.

SOURCE: "Training Magazine Industry Report, 1989," *Training: The Magazine of Human Resources Development*, vol. 26, No. 10, October 1989, p. 44.

Table 7-6-Technology-Based Training Costs

Medium	Equipment	Hardware	off-the-shelf courseware
Television	TV set	$250-$3,000	$0-cable or other subscription cost
	Satellite dish	$800-$10,000	$200-$5,000
Videotape	VCR	$150-$500	$100-$10,000 purchase $50-$200 rental
	Video camera	$700-$2,000	
CBT	PC	$750-$10,000	$50-$10,000
	Workstation	$10,000-$50,000	
	Authoring system	$100-$5,000	
IVD	Level I[a]	$400-$1,000	$50-$5,000
	Level II	$1,000-$2,000	$300-$5,000
	Level III	$5,000-$10,000	$500-12,000
	Authoring system	$500-$8,000	
Digital video	DVI	$2,000-$21,000	NA
	CD-1	$3,000	NA

ABBREVIATIONS: CBT. computer-based training; CD-1 = compact-disc interactive; DVI = digital video interactive; IVD = interactive videodisc; NA. not available; PC= personal computer; VCR = videocassette recorder.

[a]In this context, "level" refers to the type and capabilities of the hardware.

SOURCE: Office of Technology Assessment, 1990.

development time and initial design and testing/ quality assurance the remainder.

IVD course development costs also vary with the sources for the video/audio/graphic components. Some IVDs and CD-ROMs available today are "resource discs" with still frames, audio, or video for various situations. The purchase price may include royalty costs. If, however, original film and sound must be recorded, the production cost will drive up the price. Total costs for a l-hour course that uses available resources may be as low as $4,000, while a 5-hour course that requires filming, sound recording, and computer programming may cost several hundred thousand dollars.

Several innovations promise to reduce the cost of technology-based training. Authoring systems and other instructional design tools, resource discs, and relational subject-matter databases substantially reduce the development time and labor costs. Equipment and courseware leasing options reduce the front-end costs for training that is delivered infrequently. Some professional associations are promoting the concept of 'shareware" for training materials. Learning centers are being established that provide services such as satellite links and CBT and IVD training stations, with accompanying courseware.

THE EFFECTIVENESS OF TRAINING TECHNOLOGIES

The concept of "good" training has two distinct lines of thought that are only now beginning to merge. The first is adult learning theory, which has engendered a wide range of approaches to training, many of which have undergone little empirical evaluation. The second is corporate productivity—training is effective if it appears to improve job performance and reduce costs. While little empirical research has been done in this area, the focus on productivity gains did promote the use of standard instructional development principles to ensure that training was specific and relevant. This section evaluates the available data comparing technology-based training with conventional methods. The following section discusses adult learning theory and instructional systems design.

Few companies have the time or resources to compare the cost-effectiveness of different training delivery systems. Many training delivery decisions are made in an atmosphere of 'crisis management' and, while not arbitrary, are more often based on a combination of the available training funds and the training manager's experience with a particular system than on a measured consideration of short- and long-term benefits. Evaluation of training benefits and costs is usually informal and cursory-often

based on word-of-mouth feedback from participants and their supervisors.[54]

Most training managers are not themselves trained in benefit-cost analysis. Even if they understand the theory, there are practical obstacles to its application, including the difficulty of quantifying training benefits, the subjectivity and questionable nature of the assumptions underlying such analysis, the inability to separate the influence of training from other factors that might improve performance, and the time and financial resources needed for analysis. Benefit-cost analysis also is not usually a management priority, either because it is not seen as valuable or because training itself is not an integral part of the corporate operating strategy .55

The lack of benefit-cost analysis can mean that training departments can hide ineffective training—whether a bad program or course, or training that simply does not transfer to the workplace. For good training, however, benefit-cost analysis can elevate training to a line item that improves productivity and profits rather than a staff function that spends money. Thus, benefit-cost analysis might justify a separate corporate training department and contribute to making training part of a company's underlying business philosophy.[56] Increasingly, companies are shifting budget responsibility for training to operating managers to promote cost-effectiveness. This places greater demands on trainers to keep the operating managers informed about developments in instructional technology and available courseware.

Ironically, even when benefit-cost data are available, they may have little influence on decisions to use technology-based training approaches, which are often made on entirely different grounds. Sometimes the rationale for using training technology is for the training manager or corporation to appear to be on the "leading edge" and thus attract positive media attention. Another rationale is convenience (e.g., adopting CBT because the computer terminals are already in place) .57 On the other side, the potential long-term effectiveness may be overshadowed by front-end hardware or courseware costs (e.g., IVD).

When cost-effectiveness evaluations of technology-based training are conducted, they often compare a subject taught via conventional classroom instruction with the same subject delivered via technology. This is an oversimplification for three reasons. First, they may reflect the simplistic view of technology as hardware, and thus ignore variables such as the quality of the software or courseware or the skill of the instructor. Second, technology-based training usually requires a change in teaching strategy and media and often involves a shift in course content and approach as well as the delivery setting. Third, these comparative studies assume there is a simple dichotomy between classroom and technology-based instruction. But classrooms often use a range of technologies, and technology-based instruction may be delivered in a classroom setting. A typical training course involves several types of instructional activities, some of which are more suited to the use of technology and some of which require lecture or discussion.[58]

Yet thousands of comparative studies have been conducted, especially for CBT, IVD, and simulators. Despite any oversimplifications that may be inherent in the study design, the study conclusions have been corroborated with years of corporate, military, and government experience with technology-based training.

Table 7-1 summarizes some of the potential benefits from various types of instructional technology. None of these will occur automatically; they require the right combination of instructional skills and courseware design with training appropriate for the task being learned. (Similarly, the potential disadvantages listed in the table depend on a wide range of variables.) Figure 7-4 illustrates ASTD's survey data on the cost-effectiveness of three training technologies.

One of the most consistent findings about the cost-effectiveness of good technology-based instruction is that training duration can be reduced

[54]Cynthia A. Lombardo, "Do the Benefits of Training Justify the Costs?" *Training & Development Journal,* vol. *43, No.* 12, December 1989, pp. 60-64.

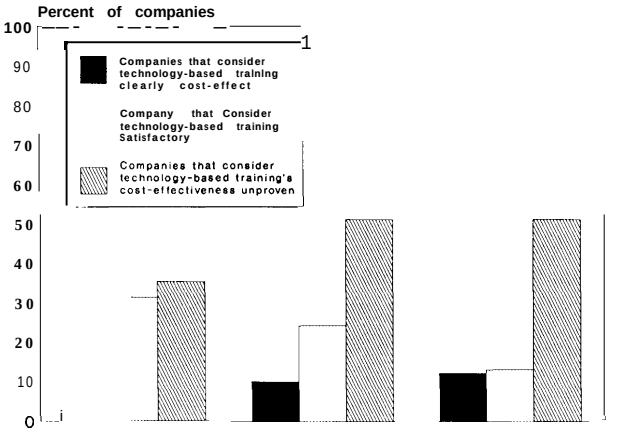
[55]Ibid.

[56]Ibid.

[57]Kearsley, op. cit., footnote 1.

[58]Ibid.

Figure 7-4-Reported Cost-Effectiveness of Training Technology



SOURCE: Based on American Society for Training and Development survey of 157 executives from Fortune 500 private firms with $500 million + in sales.

30-40 percent relative to traditional classroom lectures. This reduction appears to occur because of the design and delivery elements of technology-based training (adaptable to individual learning styles, self-paced, more private; see boxes 7-L and 7-M). This reduction in training time translates to large cost savings in less time away from the job and often lower travel costs. Organizations also can deliver more training over a given period.[59]

The best technology-based training also shows increased achievement in terms of test results, retention, and/or job performance (although the latter is difficult to measure). When coupled with computer-managed instruction, such training can provide automatic collection of data on student performance and help identify training problems. Moreover, many students report that they find technology-based training more interesting and enjoyable than classroom lectures. Students also have less fear of giving a wrong answer than in a group situation. Because the courseware is delivered in the same way each time, its quality is more consistent and reliable than classroom instruction. Fluctuations in the number of trainees and their backgrounds can be accommodated more readily. In most cases, the training also is available when and where the employee needs it without waiting for travel or course scheduling. This also improves access for the disabled. Finally, trainees can learn and practice more types of procedures without downtime or damage to real equipment, and without safety concerns on dangerous equipment (see box 7-1).[60]

The appropriateness of the training technology to the task being learned is an important element of effectiveness. Most training professionals agree that high-tech delivery systems are best suited to technical skills. Teaching someone the series of steps in processing an insurance claim or assembling equipment is a good application for CBT or IVD. Most trainers also agree that traditional settings such as classrooms and workshops are needed for imparting interpersonal skills, management training, and corporate culture building. Yet high-tech systems are beginning to make inroads here also (see box7-and the discussion of performance support systems, below), and their use probably will increase as artificial intelligence techniques make video simulations of personal interactions more realistic. The delivery setting also can influence technology effectiveness (see box 7-N).

Most of the evidence about the cost-effectiveness of training technology comes from the armed services. A recent Institute for Defense Analyses survey examined data from 100 studies on the cost-effectiveness of CBT, flight simulators, and maintenance simulators, with most studies showing that technology-based training saves time and results in higher achievement.[61] A survey of 31 studies of IVD training (15 military, 3 industrial, 13 higher education) concluded that IVD was more effective than conventional instruction in almost all cases. The more interactive features used, the more effective the IVD) training appeared to be (see box 1-C in ch. 1).[62]

Stromberg-Carlson, a Florida telecommunications company, devised an IVD simulation of new telephone switching equipment it produces and compared the simulation with training on the actual equipment. The IVD program was faster because more students could use it at any given time, and the

[59]Ibid.

[60]Ibid.

[61]J. Orlansky, "The Productivity of Training," J. Zeidner (ed.), *Human Productivity Enhancement* (New York, NY: Praeger, *1956),* VOL L

[62]J.D. Fletcher, "Report on the Potential of Interactive Videodisc Technology for Defense-and Education" (Alexandria, VA: Institute for Defense Analyses, 1989).

Box 7-L-The Effectiveness of Interactive Videodisc in Training

Although its use has grown slowly, IVD is becoming an increasingly common training technology. Evaluations-when conducted-seem to be uniformly positive. Some examples are:

- *Goodyear Tire & Rubber* compared a videodisc training program for mechanics on using an oscilloscope and multimeter with the same training via videotape or classroom. In actual job performance tests after training, the IVD approach produced the best results. Furthermore, trainees indicated a preference for the IVD course.
- ***McDonnell Aircraft Company in*** conjunction with Digital Equipment Corp. developed a videodisc training program for computer-aided design (CAD). The program cut training time for this course from 12 hours to less than 8 hours for all trainees, decreased the cost per student hour, reduced teaching loads, and resulted in better retention of the material.
- ***IBM*** conducted research at its Corporate Management Development Center comparing three ways of using IVD (instructor-led, small groups, and self-study) with classroom instruction for an employee relations course. Learning gains scores and mastery levels in the IVD approaches were better than classroom instruction alone.
- ***GTE of California*** compared IVD with classroom instruction in training technicians to troubleshoot a statewide data network. The IVD training was superior in retention and was well liked by the employees.

SOURCE: Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the Office of Technology Assessment under contract L3-5615, February 1990.

retention rate was higher because students had more access time.[63]

INSTRUCTIONAL DESIGN

Worker training's cost-effectiveness is always an issue. Some training fails to impart the appropriate skill for the job, misses some aspects of the skill, includes irrelevant information, or does not match the trainees' backgrounds and learning styles. This can mean ineffective training for a cost that is higher than necessary. To help training become relevant, complete, lean, and suitable, a set of principles and procedures has been devised to guide instructional development. First devised in the mid-1950s, these principles have evolved with changes in adult learning theory, and now are used widely throughout industry, government, and the military. In recent years, these principles and procedures have become partially automated with computer programs for designing and authoring instruction.

Adult Learning

In 1973, Malcolm Knowles, then a professor at Boston University, argued that the traditional pedagogical approach to teaching children is inappropriate for teaching adults in most situations.[64] He introduced a new approach—termed *andragogy*-that was more flexible, participative, experience-based, and problem-centered.[65] While it has been challenged on several grounds, andragogy's most important contribution probably is that it created a greater sensitivity to the needs and interests of the learner.

Today, training developers use needs analysis (see discussion of instructional development, below) to determine the best approach to imparting a task. For some training situations, pedagogical methods make the most sense-for extremely technical topics, for example, or for tasks that follow rigid performance steps, or for subjects entirely new to learners.[66]

At the same time, good training programs increasingly recognize the tremendous diversity among adults, including the wide range of ages, attitudes, educational backgrounds, learning styles, and instructional goals and settings. For example, adults with the most formal schooling are more likely to

[63] Geber, op. cit., footnote 3.

[64] Malcolm Knowles, *The Adult Learner: A Neglected Species*, (Houston, TX: Gulf Pub. Co., 1973).

[65] Dale Feuer and Beverly Geber, "U'h-oh. . . . Second Thoughts about Adult Learning Theory," *Training*, vol. 25, No. 12, December 1988, pp. 31-39.

[66] Ibid.

Box 7-M—A Comparison of IVD Delivery Settings

Historically, research comparing group and individual learning for lecture/lab has shown that the group settings are superior in promoting achievement and productivity. Studies that compared CBT using pairs and individuals found similar results. Only one such study has been performed with IVD. It compared group, paired, and individual instruction on the same courseware, with the pairs yielding the highest achievement, followed by groups and then individuals.

The predominant instructional setting with IVD has been individual instruction. Its major advantages include self-pacing to accommodate individual learning rates, knowledge levels, and training needs; and flexibility in scheduling and the physical setting. Using IVD in pairs also allows self-pacing (if the trainee pair was chosen properly), is only slightly less flexible in scheduling, plus it cuts collective learning time in half, facilitates learning through discussion, and builds rapport among trainees, which can encourage networking between departments and can resolve multicultural differences. Larger group instructional settings for IVD are gaining popularity. They provide: an opportunity to tailor generic courseware to a company's needs, in that the instructor can add to or modify the IVD to create discussions or skip sections; the dynamics of group interaction and debate; the popularity of group socialization (e.g., coffee breaks); and, in some cases, more cost-effective training. However, scheduling becomes less flexible, self-pacing usually is sacrificed, and there is more fear of giving wrong answers.

Each training situation will be different, however. Companies need to conduct trials with different delivery settings to determine which is best for their training needs. The advantages of paired or group learning may be insufficient to overcome the costs of multiple training stations or scheduling conflicts.

SOURCES: Richard P. Lookatch, "Options for Interactive Video," *Training & Development Journal,* December, 1989; J. Vadas, paper presented at Sixth Conference on Interactive Videodisc in Education and Training.

feel comfortable in structured classes and lectures.[67] Many trainees do not want to examine options and decide for themselves how to perform a task; they may consider it a waste of time when the instructor could tell them what to do and they could get back to work and do it. Similarly, some adults enjoy andragogical activities such as group role playing, while others find it silly or are intimidated by the situation. Finally, some people learn best by listening, some through group discussion, some by reading, others through visual cues, and still others through experiencing and practicing.

Adult learning theory has stimulated much debate over the last 20 years. Yet there is little basic research or evaluation of different approaches to applying the research in training. Despite the enormous sums spent on education and training, and despite the shortcomings evident in both systems, applied learning research has never been well supported except by DoD. Much of the current focus is on how to fix schooling. Yet the rapid pace of change in technology and work means what people need to learn is in constant flux. To promote more flexible and effective learning, more research on adult learning and how the results of that research can best be applied in the workplace is needed.[68]

There are several different areas that need further exploration. For example, more research is needed about the different combinations of learning approaches most likely to help people learn on the job (e.g., ways to combine formal and informal instruction, the roles of co-worker guidance and repeated practice). The apprenticeship model, for example, can promote flexible, powerful reasoning that transfers to other situations. Embedded training systems can be designed that take advantage of equipment operators' intuitive skills while helping them develop a deeper understanding of the processes involved.[69] Performance support systems have the potential to provide structured on-the-job training in a wide range of situations.

Instructional Systems Development[70]

Based on the current understanding of adult learning, a model or procedure for instructional systems development (ISD) has evolved that can

[67] Ibid.

[68] Institute for Research on Learning, op. cit., footnote 50.

[69] Ibid.

[70] Unless otherwise noted, the material in this section is drawn from Michael De Bloois, Interactive Training Seminar, Alexandria, Virginia, November 1989, and Eagle Technology, Inc., personal communication to OTA.

contribute to more effective training. The five basic stages of the ISD process are: analysis, design, development, implementation, and evaluation (see figure 7-l). This model is now followed in the military, by many large corporations' training departments, and by many designers of custom training programs. Instructional systems development also is offered as a degree program or included in the human resource development curriculum at some universities (the ASTD database shows 2 undergraduate ISD degree programs, 27 masters' programs, 13 PhD, and 8 cetificates). However, many human resource development personnel or subject matter experts assigned training responsibilities have not been exposed to ISD. Also, ISD principles rarely enter into training decisions made in a crisis management atmosphere (as many such decisions are), or in informal on-the-job training (the kind most workers receive). Moreover, while ISD can save money in the long run, the upfront costs can be considerable.

The first stage of ISD, analysis, helps corporate trainers (and managers) define training needs more precisely (or determine whether training is the appropriate solution to the problem) by describing the tasks or skills to be imparted and developing a trainee profile. This analysis contributes to the overall design of the training project, including the medium (e.g., lecture, videotape, computer, IVD) most appropriate for the training. The design decisions are then developed into a combination of courseware and hardware (or a decision to purchase off-the-shelf courseware).

In theory, before full-scale implementation, ISD also includes some field testing-formative evaluation-of the behavior of people using the training package. Revisions can then be made before the finished product is produced for the training site. Ideally, the training program also is evaluated (and revised as needed) after implementation to determine how well the training transfers to employee performance, both at the end of training and on the job. In practice, however, few companies devote substantial efforts to evaluation.

Depending on the type of training package being prepared and the resources available, ISD may involve a team of experts or one or two people. For an involved IVD simulation, a team might include instructional designers, subject matter experts, computer programmers or video producers, and writers. On the other hand, a simple CBT package (e.g., how to fill out a corporation's forms) now can be produced by training personnel well-versed in ISD principles working with instructional design tools, resource discs, and a good authoring system.

There are several issues surrounding the ISD process. First, many corporate trainers are administrators, not designers. They may fail to determine whether off-the-shelf courseware was developed following ISD principles before they purchase it. Next, development of a good, comprehensive training program can cost hundreds to thousands of dollars. Task analysis, trainee profiles, and evaluation are especially costly, and companies often bypass or abbreviate them in order to save money. Yet these are key steps in the production of good training materials.

Establishing the medium also is critical for quality and cost considerations. A well-designed videotape or lecture (with supporting visuals or other tools) may be all that is really needed to impart the information, but translating that information to a computer program might save trainee time away from the worksite. On the other hand, the computer program might cost too much more to develop and implement. Some companies have chosen CBT or IVD as the medium because it is the leading edge without considering whether the medium is appropriate to, or its cost justified by, the task. They frequently are dissatisfied with the training results.

Automating Instructional Development

Training programs are generally hand-crafted and relatively labor intensive. Until recently, quality of the programs was almost entirely dependent on the developers' skill and experience. Now, however, software tools are becoming available to aid in training design. These include both instructional design and authoring tools.

These tools can facilitate the development and implementation of cost-effective training materials. The tools promise to be a major area of research and commercial activity within the next 5-10 years. Authoring systems already are established as an important category of software tools for training departments. Work on automated instructional development systems that cover all aspects of analysis, design, and evaluation is in its nascency. The application of expert systems to instructional devel-

opment also is at an early stage but is likely to catch on quickly.

The overall effect of these tools will be to make it easier and faster to develop cost-effective training programs. Less expertise (either ISD, computer programming, and/or subject-matter) will be needed to create high quality training materials.

Instructional Design Tools

Instructional design tools are software packages that help designers in the analysis, design, and early development stages of ISD-everything up to authoring. The software also may provide project management capabilities for the ISD process. These automated instructional development systems are new (only a few are available commercially) and it is difficult to generalize about their features. Because many of them were developed for military projects, they often are linked to military design specifications and integrated logistics support requirements.[71] The key parameters to look for in such a system include the amount and type of built-in expertise, whether a system is advisory or operational, the skill needed to use it, the number of tasks it performs, the types of training technology it supports, its flexibility, and the hardware platform it requires.[72]

The amount and type of expertise built into the software ranges from basic online help systems to elaborate programs using artificial intelligence. How much expertise is required depends on the type of training package being developed and on the designer's skill. Some software includes a variable amount of expertise that can be accessed (turned up or down) as needed. Software maybe targeted either to ISD experts or subject matter experts. Some packages are advisory only; they provide checklists, flowcharts, templates, and other job aids for the designer. Others actually do the production based on the data entered (e.g., they perform the task analysis). The number of tasks the software performs also varies. Some programs do only one step, some do several. Those that include the entire process are still in the development stage. The software may be generic, in that it applies to all types of training technology, or it may be specific to CBT, IVD or large machine simulators (ships, planes, tanks). Finally, they may run on anything from a PC to a large mainframe.[73]

Instructional design tools have the potential to improve the productivity of training developers in many ways. By automating mechanical tasks such as sorting information or drawing charts, developers save considerable time. Easily accessible databases also speed up the development process. As job aids, such tools can compensate for a developer's lack of either ISD or subject matter expertise and can help maintain consistency in the quality of training programs. Combined with project management software and electronic mail, these tools can improve project tracking.[74]

To date, however, most of these systems were designed as part of research projects to investigate how automated tools could improve the quality or efficiency of training development. The research merely demonstrated that working systems can be built. No studies have been done yet that compare training packages developed with instructional design tools with those prepared manually, either in terms of quality or time/cost savings. Moreover, development of these tools has been on a path separate from the development of authoring systems, which focus primarily on CBT and IVD. The front-end results of instructional design tools do not yet feed directly into scripting and authoring.[75]

A special category of instructional design tools is available for expert systems and intelligent tutors. Indeed, one of the more important applications of expert systems in training may be to provide intelligent job aids for instructional system design. Some programs provide "shells" for the creation of expert systems or intelligent tutors. These shells are prewritten programs that help a designer develop an expert system/tutor without programming skills. As with other design tools, the system suggests organizational or teaching strategies and/or makes recommendations about design approaches based on the

[71] Kearsley, op. cit., footnote 1.

[72] Virginia Anderson, "An Overview of Software Tools for Instructional Design," paper presented at 8th conference on Interactive Instruction Delivery, Orlando, FL, February 1990.

[73] Ibid.

[74] Ibid, and Kearsley, op.cit., footnote 1.

[75] Kearsley, op. cit., footnote 1.

content information provided. They also may provide advice about evaluation and course administration.[76]

Expert system/tutor shells also face the general problem of the current lack of knowledge about how to design effective training materials. Also, there have not yet been any comparative evaluation studies. Conceptually, such shells are easier to construct than ISD tools because all the designer needs is several experts who can consistently perform a task with good results.[77] However, translating that knowledge into rules and programming it may still be difficult and time consuming.

Authoring Tools

Authoring tools use high-level language programming to create interactive computer-based courseware (either CBT or IVD). Authoring languages are either standard computer languages (e.g., BASIC, C) or a language designed for creating instructional material; they require skill in programming. Authoring systems are programs that help people write other programs. The systems allow an instructional designer or subject matter expert with no programming background to create computer-based courseware.[78]

Authoring systems followed quickly on the heels of the PC. In 1985, there were around 12 authoring systems; the number expanded to over 100 and then shrank to around 80 today.[79] Most of them support interactive video and provide computer-managed instruction. For some of the more popular systems, there are also user groups and consultants available for training or contractual development. Several firms are now adapting authoring systems for digital videodisc (see discussion of future technologies).[80]

Authoring systems vary widely in their sophistication and capabilities. Most present menus that allow the developer to choose input from a variety of sources (databases and resource discs of video, audio, and computer graphics), specify types of interactivity, select features such as windows and overlays, and choose presentation styles (such as video wipes or other transitions). Once these are specified, the system automatically generates a program that should be bug-free. Eliminating the need for programming and debugging can reduce development time substantially .81 Authoring systems do vary in their flexibility-the extent to which the user can shape the process. Menu-driven systems often are easy to use and learn, but they can restrict flexibility. Others are transparent in the sense that a programmer can change code.[82]

Authoring systems have evolved to the point that programming is no longer a major consideration in the development of computer-based instructional materials (other than which system to use). However, knowledge of ISD principles usually is still necessary. Unless they are trained in the design of interactive instruction, most training developers do not have a clue which options to select to make effective training materials. Eventually, automated instructional design tools will increase productivity in this area, but the developer's skill will still be critical. Another problem is the lack of hardware standards for operating systems and for peripherals such as videodisc players, so that authoring software would work with all types of devices. Standards for interfaces (e.g., CD-ROM drives) also are needed.[83]

FUTURE TRENDS FOR TRAINING TECHNOLOGIES

The rate of increase in the adoption of technology-based training is accelerating. By 1993, 93 percent of the executives from large firms polled by ASTD project 'some' or ''substantial' CBT applications, with substantial use more than doubling over 3 years, from a current 12 percent to more than 29 percent (see figure 7-5). IVD applications are projected to increase to 71 percent use, with substantial use growing from 7 percent in 1989 to 15

[76]Clay Carr, ''Expert Systems: What Do They Mean for Training'?" *Training,* vol. *26, No.* 12, December 1989, pp. 41-48.

[77]Kearsley, op. cit., footnote 1.

[78] Ibid.

[79]CEIT Systems, Inc., personal communication to OTA.

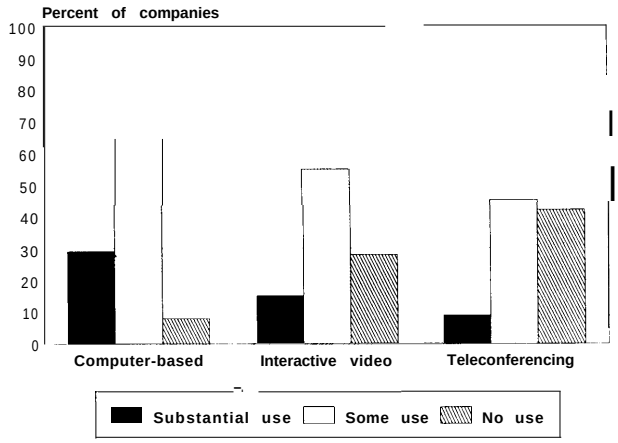
[80]''Authoring System Now Available for DVI Technology,'' *Intel Interactivities*, vol. 1, No. 3, winter 1989, p. 1.

[81]Kearsley, op. cit., footnote 1.

[82]Pinnacle Courseware Inc., personal communication to OTA.

[83]CEIT Systems, he., personal communication to OTA.

Figure 7-5-Projected Use of Training Technology, 1990-92



SOURCE: Based on American Society for Training and Development survey of 157 executives from Fortune 500 private firms with $500 million+ in sales.

percent in 1992. The executives project teleconferencing to increase to 54 percent by 1992.

At IBM, technology was used to deliver no more than 5 percent of the company's education in the early 1980s. At the beginning of 1990, training technology use had increased to 30 percent. Moreover, IBM adopted technological delivery media at a much faster rate from 1985 to 1990 than during 1980-85. IBM projects that by the end of the 1990s about 60 percent of the company's training will be delivered outside the traditional classroom using some form of technology. Northern Telecom Inc. also is moving rapidly toward technology-based training. Although 90 percent of its training still takes place in classrooms, as recently as 5 years ago that figure was 100 percent. The corporate training director projects that the rate of shift will increase rapidly, with ultimate plans to move toward the performance support system concept (see below).[84]

Several factors explain the more rapid shift toward technology-based training. First is hardware and software maturity and the availability and lower cost of off-the-shelf programs. An installed base of training technology platforms (e.g., computer terminals, satellite dishes, VCRs) makes it difficult ***not*** **to use** technology-based training. The entry of more computer-literate students into the workplace also will spur the growth of technology-based training. Finally, the limitations of most classroom training in terms of retention and transfer to job performance will lead managers to be more open to technology-based approaches.[85]

Many technological advances that are or could be available in the near future could spur this shift and greatly affect worker training of all types. Almost all of the advances use hardware, software, and concepts that exist now but are not yet used for instructional purposes or that will be used in radically new ways. Advances in storage, speed, and peripherals will make computers much more accessible for training. Software improvements will result in improved courseware. Electronic classrooms and digital networks will make multimedia training available anywhere at any time. Longer term advances will radically alter the way people interact with computers and provide an entirely new environment for simulations.

These changes will allow more learning on demand-usually at the normal workstation but increasingly in the field or at home-as well as more training that is controlled by the learner, more embedded training, and multimedia training is responsive to the individual trainee's learning style and pace. In the long term, these developments also could profoundly change the way many people work (e.g., by eliminating the need for a fixed or regular worksite in service industries) as well as the way they learn. Training would become even more integral to work and not separate from it.

Computer Technology

Advances in computer technology should greatly increase its utility for training. Options currently requiring a host of equipment may be incorporated in one unit. This integration will facilitate embedded training and **performance** support systems. Low-cost, easily usable optical character readers will increase access to information resources, particularly in rapidly developing fields. The storage capacity of future PCs will be enormous based on some form of optical disk such as erasable CD-ROM. Cellular modems will allow users access to electronic message systems and online databases without the need for a phone jack. An integral fax will provide hard copy. Built-in television reception

[84]Geber, *op. cit.*, footnote *3.*

[85]Ibid.

will give access to broadcast services.[86] Voice synthesis will allow access for the disabled and reading deficient and will enable workers of all types to receive instructions without taking their eyes away from their work. Over the longer term, speech recognition could reduce the time and effort needed to learn to operate complex machines or software systems, and enable anyone to generate multimedia programs without a keyboard, mouse, or touch-screen.[87] Voice recognition systems already are used in data collection to enable personnel not trained in computers to work effectively in a computerized environment. In automobile quality control, for example, voice recognition has proven faster than manual data input, and allows the inspector's hands to remain free for tactile tasks (e.g., feeling paint scratches) .88

The evolution of personal computers has a number of implications for training. First, the projected increase in the use of computers in the workplace and at home will make it unnecessary to buy them specifically for training (except for electronic classrooms). The increasing portability of computers will facilitate embedded training, performance support systems, and just-in-time training-putting the means to pull information into the workplace at the time and in the form it is needed. With the evolution of multimedia workstations, computer and videodisc training will accommodate individual learning styles more easily.

Even though personal workstations will eliminate many of the current problems associated with CBT hardware, there will still be compatibility and quality issues. Various operating systems will have differing capabilities and will run only particular types of courseware. Some displays will look better than others, some machines will access/display information more quickly, some machines will sound better than others. This range in performance characteristics usually will be determined by price, and access to the most advanced CBT will be limited by the training budget.

Software

Software developments that axe especially promising for training include hypertext and hypermedia systems that enable the construction and use of relational databases, and applications of artificial intelligence to learning. Automation of instructional systems design and improved authoring systems (discussed above) also show great promise.

Hypermedia

Hypertext or hypermedia (if it's multimedia) is the term for a new method for organizing online databases that allows users to pursue connections among different items of information, rather than being confined by a hierarchical structure such as a menu system. The authors link information (documents, graphics, or audio or video sequences), create paths through a body of related material, annotate existing texts, and create notes that point readers to either bibliographic data or another referenced text. Users also can make notes and add annotations or create their own links and paths. Systems that support multiple users allow researchers, instructors, and learners to communicate and collaborate within the context of a database.[89]

Emerging hypermedia systems will include more sophisticated navigational tools. These might show what links a reader followed to get to a document, which would facilitate incorporation of an intelligent tutor or computer-managed instruction system. Filtering would allow users to bypass links and concentrate only on those of particular interest. Alternatively, hot links would force the user down a particular path.[90]

Hypermedia presents a new paradigm for sharing information in an integrated fashion. Once instructional designers become familiar with its capabilities, hypermedia is likely to have wide-ranging impacts on courseware. To date, most instructional uses have been in education, but hypertext and hypermedia are beginning to be applied to embedded training and performance support systems. They will be less useful in applications where the task to

[86] Kearsley, op. Cit., footnote 1.

[87] Kurland, op. cit., footnote 13.

[88] John Martin, "Speak Up for Quality," *Manufacturing Engineering*, vol.103, No.10, October 1989, pp. 67-68.

[89] Nicole Yankelovich et al, "Issues in Designing a Hypermedia Document System," Sueann Ambron and Kristina Hooper (eds.), *Interactive Multimedia* (Redmond, WA: Microsoft Press, 1988).

[90] Ibid.

be learned is highly structured and needs to be learned quickly.[91]

Artificial Intelligence

Research has been conducted for many years on the application of artificial intelligence (AI) techniques to instructional material design. AI typically focuses either on intelligent tutors or expert systems. Intelligent tutors are computer-based instruction programs with a large amount of background information. They include associative networks, the capability to draw inferences from programmed rules, and the ability to build models of students' behavior based on their interaction with the program in order to diagnose misconceptions and assess learning. Intelligent tutors and have the potential in time to provide much more effective learning tools.[92]

Expert systems are programs that incorporate the rules, facts, concepts, procedures, calculations, and rules of thumb used by experts in a field. This knowledge base is then applied to generate conclusions about the learner's input (see box 7-N). Expert systems also can ask questions about an equipment malfunction and diagnose the problem. In real-time systems (e.g., in manufacturing or military settings), data come from sensors rather than answers to questions. When applied to training, expert systems can be used to help students understand the factors involved in making decisions or judgments. Alternatively, expert systems can be used as sophisticated job aids that reduce or eliminate the need for training on a specific task.[93]

Few intelligent tutors have actually been used in training. Developing tutors takes an enormous amount of time and expertise in artificial intelligence. Despite the amount of research in this area (mostly funded by DoD), there are many fundamental issues in adult learning and cognitive theory that need to be resolved before it is clear how to design intelligent tutors that really work.[94]

In contrast, expert systems are much faster to develop and do not require AI experience to use. The current generation of authoring tools for building expert systems is relatively easy to use and inexpensive. Instructors could even have trainees develop simple expert systems to help them learn a subject while producing a job aid that will carryover into the work environment.[95]

Performance Support Systems

A performance support system is an advanced type of computerized job aid. It has more information available than CBT, and the user controls access to the learning or information rather than the machine.[96] Indeed, performance support systems provide structured on-the-job training that could substitute for some kinds of formal training.

Performance support systems (PSS) are a new concept and few exist; thus generalizations are difficult. Examples are provided below to illustrate some of the features and uses to date. A PSS might incorporate any combination of text, graphics, audio, still video, applications software to perform specific job tasks, databases, expert systems, interactive training programs, assessment systems, and feedback and monitoring systems. With the development of digital technology, full-motion video also will be possible.[97]

Two major recent developments have promoted performance support systems. First, storage technology for PCs and portables has advanced. Second, innovations such as hypermedia gave rise to the crucial underpinning of a PSS—the relational database which ties all of the above elements together.[98]

Today, a PSS often is not initiated by the training department. It might begin in customer service, with a need for a relational database that makes large amounts of information easily accessible to telephone customer service representatives. The same information is then found valuable in sales, and

[91] Kearsley, op. cit., footnote 1.
[92] Ibid.
[93] Ibid.
[94] Ibid.
[95] Ibid.
[96] Geber, op. cit., footnote 3.
[97] Ibid.
[98] Ibid.
[99] Ibid.

31-463 - 90 - 8 : QL 3

Box 7N-The Flight Plan Critic

The Flight Plan Critic is an instructional expert system developed jointly by WICAT Systems, the University of North Dakota, and Northwest Airlines to help aviation students learn how to plan a cross-country flight. The Flight Plan Critic was developed using the WISE authoring system linked to OPS5—an expert system development language-and runs on a WICAT work station. It represents one of the first instructional expert systems to be used in a real training setting with a commercially available CBT system.

The student begins by developing a flight plan using a variety of information about the aircraft and its load, maps, and weather conditions. All the students' steps used in calculations and decisions are recorded. When the student completes the flight plan and 'files' it, the plan is analyzed by an expert system for correctness. If mistakes are found, the expert system diagnoses the source of the error and provides feedback to the student including prescriptions for improving performance.

Development of The Flight Plan Critic presented several CBT design challenges. Extracting enough information from student responses to diagnose problems was difficult and required the adoption of a "mixed initiative" approach in which the expert system would present its advice but let the student decide what to do with it. Determiningg when to give feedback and what kind also presented design problems. These stem from the inadequacies in our current understanding of how learning occurs.

The Flight Plan Critic is now being tested with aviation students and fine-tuned based on the test data It demonstrates that existing authoring tools can be extended to accommodate expert system and intelligent tutor capabilities. It also illustrates that development of new forms of interactive instruction will require substantial research about learning and teaching.

SOURCE: Andrew S. Gibbons, "TheExpertFlight Plan Critic," paper presented at 1 1th Conference on Interactive Videodisc in Education and Training, Arlington, VA, August 1989.

adapted for use there. Later, more elements, including training modules, maybe added to the system.[99]

A PSS (called "The Source") was developed for Prime Computer to put all the information needed by field personnel in one accessible place. The field personnel had entire bookcases full of data about the company's products, its customers and how they use the products (e.g., for computer-aided design), and its competitors' products. In addition, Prime had the usual training retention problems among their field personnel. Its PSS now provides most of this information on a portable computer that is networked to a mainframe for access to spreadsheets (allowing comparison of alternatives), the most recent cost data, and new product information. The PSS also includes job aids such as tables comparing Prime products with their competitors'.[100]

Ford Motor Co. is introducing a PSS called the Worldwide Engineering Release System. The mainframe CBT system, which cost $77 million to develop and implement and was translated into five languages, lists 400,000 automotive parts and more than 300 million pieces of data about them. It contains information useful to engineers about every part used in Ford products worldwide, including a part's engineering history, how long it has been used, its metallurgical makeup, and any current information about the part. For example, if a part isn't fitting into a bracket, the engineer can tap into the system to find out if any other plants have had similar problems and how they might have solved them. The system includes 25,000 training screens about parts, 1,600 simulations, and 1,500 assessment exercises. It also includes training on how to use the system.[101]

Another PSS was developed to assist insurance underwriters analyze risk. Risk analysis can take one of a number of approaches, and each underwriter is different. Thus, the sponsoring company felt that underwriters would resist an expert system that used one approach and made a decision. The company also felt that such a system would inhibit learning. Finally, a learner-controlled system was needed to address different experience levels and learning

[99]Ibid.

[100]Barry J. Raybould, "Building a Performance Support System: Comparing Alternate Development Platforms," paper presented at 8th conference on Interactive Instruction Delivery, Orlando, FL, February 1990.

[101]Geber, op. cit., footnote 3.

styles-to incorporate text, graphics, pictures, and sound. The relational database structure of a PSS filled these requirements.[102]

A final example is a PSS developed for Codex Corp. as a prerequisite for technical training. In essence, the PSS provides new hires with an introduction to their work environment by simulating a communications management job. It simulates the floor plan (complete with furniture and equipment) as well as the co-workers (animated computer graphics with audio). Databases provide information about the workplace (e.g., co-workers' backgrounds). Moving among rooms and selecting objects provide entry and exit points to the subject matter databases. Familiar office imagery (e.g., to-do lists, calendars, telephones) helps new hires get started. Opportunities to interact with colleagues and to get feedback from a mentor help trainees respond to increasingly complex challenges posed by the boss.[103]

Although technological developments made performance support systems feasible, technology alone will not promote their use, as it did with CBT. A PSS is difficult and costly to develop. Because the PSS is a new concept, decisions related to hardware and software are still experimental. An organization has to have a strong need to try something so different from normal training methods. One factor promoting PSS use (along with embedded training) is the frequent inability of conventional training to transfer to the job. In addition, a PSS can accommodate reams of information that can be updated easily and quickly. These systems also can adapt readily to different learning and working styles.

Digital Videodisc

Digital videodisc gets around the space limitations of analog systems. In general, the higher the quality of the audio or video reproduction, the more space it takes on a disc. A normal CD-ROM, for example, can store about 325,000 pages of text, or 72 minutes of CD-quality audio, or fewer than 500 high-resolution still images, or 30 seconds of full motion video.[104] Moreover, it would normally take over an hour for a PC to play back the 30 seconds of motion video from a CD-ROM. Compressing and digitizing the audio and video greatly expand CD-ROM storage and speed up the PC interaction. Digital encoding allows simpler delivery systems (with a single monitor handling digital text, graphics, images, video, and audio all played back from a single optical disk). Digital encoding also offers fine control of the contents and of each frame.[105]

Two forms of digital videodisc are being introduced-digital video interactive (DVI) and compact disc-interactive (CD-I). DVI uses an IBM PC/AT type platform with three custom boards and accompanying driver software, audio amplifier and speakers, and standard CD-ROM drive.[106] DVI eventually will compete directly with analog videodisc in training and education applications. IBM and Intel are collaborating to develop and market DVI for IBM's PS/2 line of PCs based on its micro-channel architecture. Both are sponsoring the development of several authoring systems. Moreover, they are establishing a joint technology center in Princeton, New Jersey to facilitate DVI acceptance, solicit customer requirements, disseminate technology information, and support application development.[107]

CD-I also will use CDs that store video images, audio, text, graphics, and data plus the software to support interactive use.[108] However, CD-I is being developed primarily for the consumer market. It is a packaged system, with its own unique hardware (player) that is hooked up to TV monitors and stereo systems, and has a UNIX-like operating system.

Digital videodisc provides all of the same potential advantages of analog in training applications, plus greater storage capacity. Because of its ability to integrate media, digital video has great potential in simulations. For example, split-screen capabili-

[102]Ann Farley, "The Individual Performance Accelerator: A Demonstration" paper presented at 8th conference on Interactive Instruction Delivery, Orlando, FL, February 1990.

[103]Madeleine Butler, "An Experiential Model for Learning Using Interactive Multimedia," paper presented at 11th Conference On Interactive Videodisc in Education and Training, Arlington, VA, August, 1989.

[104]G. David Ripley, "DVI—A Digital Multimedia Technology," *Communications of the ACM, vol. 32, No. 7,* July 1989, pp. 811-822.

[105]Edward A. Fox, "The Coming Revolution in Interactive Digital Video," *Communications of the ACM, vol. 32, No. 7,* July 1989, pp. 794-801.

[106]Development of DVI began in 1983 at RCA's David Sarnoff Research Center in Princeton, NJ. In 1988, Intel acquired the technology from General Electric, RCA's parent company.

[107]Karen A. Frenkel, "The Next Generation of Interactive Technologies," *Communications of the ACM, vol. 32, No. 7,* July 1989, pp. 872-881.

[108]CD-I was invented in the mid- to late-1980s through a collaboration among N.V. Philips (a Netherlands company), Sony Corp., and Microware Corp.

ties allow users to compare images selectively, either still or in motion. High-quality graphics can be combined with video for a trainee to display, for example, a cut-away schematic of a piece of machinery on one part of the screen, examine and manipulate a model of the machinery on another part, while hearing an explanation of the machinery's operation or repair. The trainee can also access other windows to get textual information on parts availability, different model numbers, and costs. High-speed animation can be used to simulate environments where it is impossible to film.[109]

Several of the test applications of DVI are in training. Applied Optical Media and duPont are developing a truck driver safety simulator. It is installed in a full-size truck cab (the whole unit can be moved with a forklift) in which all driver functions are simulated, with a DVI display providing views of 12 safety scenarios for the front windshield and both rear view mirrors. First a larger wide-angle view is decompressed, the portion of the view corresponding to the truck's current lane position is selected, and then the view is skewed to keep the distant horizon relatively fixed. This last step results in smooth, real-time lane changes, and is an example of the flexibility of digital video. Bethlehem Steel and Lehigh University are developing a casting simulator, Arthur Andersen is using DVI for manufacturing process analysis, and Carnegie Mellon has a workplace simulation for entry-level trainees.[110]

Because military training makes extensive use of simulation, digital videodisc may find a potentially large market there. One company is developing a DVI application for submarine maintenance training; another firm is developing an air defense program in which the operator identifies and tracks targets through actual terrain; a third is working on weapon maintenance training. (See report appendix for further discussion of simulation in the military..)[111]

However, digital videodisc still faces difficult technical problems. The cost of compression is high, special hardware and software are required, and efficient tools and environments for authoring and editing are still nascent.[112] Thus, digital videodisc probably will not supplant analog for at least 5 years and probably longer.[113]

Electronic Classrooms

While the availability of personal workstations and the extensive use of networks will make self-study and distance learning very common, a lot of training still will be classroom based for social interaction. Many future classrooms will have video projection capability, large monitors for PC projection, sound-activated cameras for remote interaction, and transponders to record learner responses. Instructors will show multimedia materials, access online databases, participate in teleconferences and videoconferences, and display real-time learning results.

Such electronic classrooms and meeting rooms already are being installed at some corporate learning centers and universities. IBM's Management Development Center at Armonk, New York, has 10 advanced technology classrooms in which the instructor uses a PC to control all audio and visual devices in the room including videotape, videodisc, slides, computer display, and lights. Each student has a keypad to respond to questions. The instructor and class can immediately see a display of the tabulated results of the class responses.[114] IBM found that students retain 83 percent of the information presented in the electronic classroom compared with 68 percent retention in traditional classroom training.[115]

In another concept, every learning station would have networked multimedia PCs, with the instructor controlling the displays. Introductory material could be presented to the entire class, and then students could proceed at their own pace. Feedback on student progress, aided by intelligent tutoring sys-

---

[109] Ripley, op. cit., footnote 104.

[110] Ibid; see also Sandra Morris, "Digital Video Interactive Technology Application Sample," paper presented at 11th Conference on Interactive Videodisc in Education and Training, Arlington, VA, August 1989.

[111] Ibid.

[112] Fox, op. cit., footnote 105.

[113] Frenkel, op. cit., footnote 107.

[114] Kearsley, op. cit, footnote 1.

[115] Geber, op. Cit., footnote 3.

terns, would enable the instructor to identify individual learning problems and display remedial materials.[116]

The more widespread use of PCs by instructors reinforces the trend toward electronic classrooms. If instructors become accustomed to preparing training materials on the PC (e.g., presentation slides, other graphics, multimedia programs), they will want to have a computer in the classroom to make use of the software. Similarly, computers in the classroom will promote their use in class preparation.[117]

Electronic classrooms are more expensive to build than conventional ones, however, and are beyond the reach of all but the largest corporate training budgets. Learning centers are one option for increasing access. Furthermore, because computer and media technology are evolving so quickly, the equipment installed in these classrooms becomes obsolete rapidly.[118]

Digital Networks

As noted in the discussion of teleconferencing, the U.S. Public Switched Telephone Network (PSTN) is moving toward a digital system with more capabilities. Eventually, the Integrated Services Digital Network (ISDN) will allow users to send audio, data, and video signals over the same line simultaneously, thus allowing transmission of electronic messages and other signals associated with CBT, teleconferences, and hypermedia. Although not all the relevant standards have been worked out, manufacturers are already making narrow band ISDN equipment (which does not allow full-motion video transmission), and there are more than 60 trials underway (none involving distance learning). Wideband applications of ISDN including video are not expected to appear until 1995 or be widely available until 2000. The services probably will include videoconferencing, high-speed data and fax, and HDTV.[119]

These networks will make the transmission of multimedia as inexpensive as voice. With technical and financial obstacles to tele- and videoconferencing reduced, network use should increase substantially. In conjunction with other developments in computer hardware and software, digital networks will greatly facilitate embedded training and distance learning. In many cases, training will become more informal and self-directed.

Glass Boxes

Smart job aids, such as computer help screens and automotive diagnostic tools, replace mechanical processes with information processing and radically change the way people use tools. Although they have reduced the need for retraining by transferring the burden of keeping pace with innovation from the worker to the systems designer, such aids also can stifle workers' use of intuitive skills. Good specialized auto mechanics, for example, are renowned for their intuitive grasp of how cars work and what to do when they stop. But opaque electronics have now replaced many of a car's mechanical systems-to the point that some modern cars are computationally more powerful than the average PC. Repair shops also have widely adopted electronic diagnostic systems that issue instructions without necessarily making either the diagnosis or the prognosis explicit. Both the car's electronics and the diagnostic system are ''black boxes' to mechanics, who must blindly follow instructions, and who are no longer able to monitor, reflect on, and correct their own working procedures. Nor do mechanics have much opportunity for useful conversation about their work—which traditionally has contributed to shared workplace knowledge. Mechanics are particularly helpless in the face of misdiagnosis or failure of the diagnostic system.[120]

A smart job aid that is under development to overcome these problems is a ''glass box' '—a transparent system that will help workers develop a deeper understanding of the process in which they are involved. Glass box tools are, like the journeyman or office expert, both a tutor and a fully operational component of the workplace. Glass boxes would break a task down into constituent parts that a trainee can understand and master separately.

116'Classroom of the Future Addresses Student's Needs," *IST Review*, summer 1989, pp. 2-3.

117Kearsley, op. cit., footnote 1.

118Ibid.

119Office of Technology Assessment, *Linking for Learning*, OTA-SET-430, op. Cit., footnote 35.

120Institute for Research on Learning, op. cit., footnote 50.

121Ibid.

They also would provide **a means** for collaborative learning and for discussion of the task.[121]

In sophisticated machinery, however, the representation of working procedures is an extremely complex task requiring detailed research on the interaction between machines and workers. Much more work is needed in this area before good user interfaces can be designed that, with the help of multimedia devices, will provide workers with an adequate understanding of tasks while still allowing them to develop and use intuitive knowledge, thus fostering worker flexibility and innovation.[122]

Virtual Environments

Researchers also are working on systems that will allow people to interact with computers in profoundly new ways. In prototype systems, people wearing a special helmet and gloves feel immersed in three-dimensional computer-generated worlds and can control the computer by using their hands in a natural manner. Such advanced simulation systems are called artificial realities or virtual environments. The helmet contains two small television screens (one for each eye) that provide three-dimensional images and a sensor that keeps track of the position and orientation of the wearer's head. As the head turns, the computer-generated scene shifts accordingly. The glove has optical fiber sensors that detect how the hand is bending. A separate sensor determines the hand's position in space. A computer-drawn image of the hand appears in **the** display, allowing the user to guide the hand to objects in the simulation.[123]

Virtual environments are still in the basic research stage (a complete system may cost $100,000 to $200,000 and **an** enormous amount of computer capacity is needed to generate the images), but commercial and military interest is beginning to develop. Virtual environments could substantially reduce the size requirements for flight simulators, for example (see appendix). They also would be useful for manipulating remote objects (e.g., robot arms) and for work in space. The glove alone already is being used in computer-aided design in lieu of a keyboard or mouse (and in advanced video games). Companies also are researching full body suits that would allow types of body movement to control a simulation, and allow incorporation of two or more people in a virtual environment (e.g., a pilot and copilot, a virtual meeting). The participants would not need to be in the same location, but could be linked on digital networks.[124]

---

[121] Ibid.

[122] Ibid.

[123] Andrew Pollack, "What Is Artificial Reality? Wear A Computer and See," *The New York Times,* Apr. 10, 1989, p. A-1.

[124] Ibid.

Chapter 8

Training and Workers' Careers

CONTENTS

Boxes

Figures

Table

Chapter 8
Training and Workers' Careers

SUMMARY

Transferable training, useful in more than one job or company, is hard to get at any age. High school vocational courses poorly track the changing needs of the workplace, and noncollege youth receive meager help in finding gainful employment. Once employed, younger workers receive little company training because of their high turnover. Even when their careers stabilize, shopfloor workers get little attention, because companies tend to save training dollars for white-collar managers, professionals, and technicians. Finally, older workers are often undertrained because of age-related stereotypes.

Nonsupervisory workers who are trained at work may find that their narrow, job-specific skills do not transfer easily to a new job or a new employer. Further education outside of work often provides transferable skills and better earnings; however, barriers such as cost, family responsibilities, and fear of failure in a school setting prevent many adults from attending outside courses.

Only a small fraction of nonsupervisory workers receives transferable training. This includes those who participate in formal apprenticeship programs, joint union-management training, and innovative programs to tap the skills of older workers.

Apprenticeship has declined in the United States, where only 0.16 percent of the workforce is enrolled in governmentally registered apprenticeship programs. Nevertheless, the quality of apprenticeship training as measured both by workers' wages and productivity remains high. Major expansion of apprenticeship, both in its traditional stronghold of manufacturing and to the service sector, could potentially aid U.S. competitiveness as well as enhance workers' careers.

Some of the largest U.S. unions and companies have created joint training programs through contract negotiations. During 1989, these joint programs controlled about $324 million and made training accessible to about 709,000 workers. Other, smaller, joint union-management programs have also provided training that has benefited both firms and workers. With only 16 percent of the American workforce represented by unions, these programs have a limited direct impact. However, large nonunion employers may well develop similar programs, to maintain competitive rank or, ironically, to block unionization drives.

Workers with transferable skills are more likely to be employed and to continue working longer than others. Whether employers will support development of such skills remains in question. It is possible that the shrinking pool of younger workers may encourage more employers to adopt apprenticeship and other forms of enhanced training for that age group while also increasing their training of older workers to keep them on board.

ACCESS TO TRAINING AT WORK

Training is a major route to career advancement, especially within companies: several studies show that workers who are trained at work earn 10 to 30 percent more than their untrained counterparts and are less likely to lose their jobs.[1] The earnings advantage of the trained workers can last as long as 13 years following training. Training has been shown to benefit a broad spectrum of workers—while managers enjoy the greatest increase in earnings, the wage advantage of trained semiskilled workers lasts the longest.

However, access to training is limited. Workers under age 25 and workers over age 44, as well as most nonsupervisory workers and minorities receive a disproportionately small share of company-provided training.[2] For example, in a 1983 Bureau of Labor Statistics (BLS) survey asking about all types of post-school, job-related training, white males made up 52 percent of those who said they had received upgrade training once employed (they made up 50 percent of the employed labor force at that time). By contrast, black males made up only 7

[1]Stephen L. Mangum, "Evidence on Private Sector Training," investing *in People* (Washington DC: U.S. Department of Labor, Commission on Workforce Quality and Labor Market Efficiency, 1989), p. 354.

[2]Hong W. Tan, "Private Sector Training in the United States: Who Gets It and Why," discussion paper prepared for the National Assessment of Vocational Education (Washington, DC: National Assessment of Vocational Education, February 1989), p. 5.

percent of those who had received upgrade training, even though they made up 9 percent of the labor force.[3] Hispanics and other nonwhite minorities, who made up 3 percent of the workforce, accounted for only 2 percent of upgrade training.

Younger workers, who most often need training, are least likely to get it. In the 1983 BLS survey, when 55 percent of all workers reported that they had needed some type of training to qualify for their current jobs, only 25 percent of workers aged 16 to 19 and 47 percent of workers aged 20 to 24 said likewise. Once employed, only 14 percent of the younger workers between 16 and 24 years of age reported receiving any upgrade training, yet this group made up 19 percent of the U.S. labor force.[4]

Nonsupervisory workers of all ages, especially those in lower level jobs, are unlikely to receive or take training. While the overall average of workers reporting they needed qualifying training in the BLS survey was 55 percent, only 37 percent of machine operators, 36 percent of transportation workers, and 16 percent of laborers said they needed such training. In contrast, 93 percent of professionals and 71 percent of executives and managers needed training to obtain their jobs.[5] Those individuals with limited formal schooling also face limited training opportunities in the workplace and hence lower future productivity, income growth, and employment stability as well.[6] Formal training is most often delivered to managers and more highly educated employees; entry-level workers and minorities are less likely to receive training on company time.[7]

The 1983 BLS survey showed that on average only about' 35 percent of workers had received any type of upgrade training once employed. This small amount of training was delivered unevenly across occupations. Figure 8-1 shows **that** workers in some occupations received far more than the average amount of training while those in other occupations received less. For example, three-fifths of professionals, more than half of technicians, and nearly half of managers reported receiving upgrade training. By contrast, shopfloor workers, such as machine operators and laborers were much less likely to receive training (22 percent and 14 percent respectively, received upgrade training).[8] When companies install new equipment, they frequently hire the equipment vendor to train the workers, but this training is often provided only to plant engineers and/or managers, rather than to the nonsupervisory workers who will use the new technology on a daily basis.

Workers who receive company-specific training can find that their skills are not marketable elsewhere. For example, during a 1986 layoff, American Telephone and Telegraph, Inc. (AT&T) set up a telephone hotline so that other companies could recruit the laid-off workers. While the potential employers wanted clerical workers with excellent typing and word processing skills, many of the AT&T workers only knew how to use one specialized data or word processing package.[9]

Employer-supported training leading to formal credentials is more transferable than informal on-the-job training. One recent study found that workers who had completed apprenticeships or school-based training earned higher wages with their current employers than those in the same company who had not. However, on-the-job training with a previous employer did not appear to lead to higher wages with a current employer.[10]

---

[3]Max L. Carey and Alan Eck, *How Workers Get Their Training* (Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1985), p. 42. As discussed inch. 5, the accuracy of such surveys depends on individuals' memories and their understanding of what constitutestraining.

[4]1bid., p. 20.

[5]Ibid., p. 21.

[6]Tan, op. cit., footnote 2, pp. 18-19.

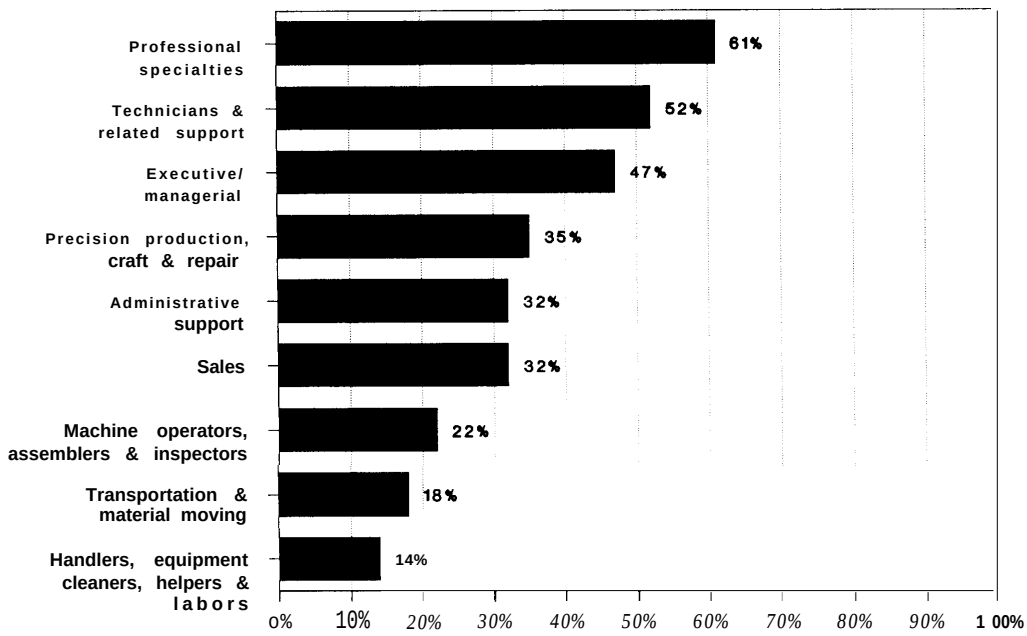
[7]Lee A. Lillard and Hong W. Tan, *Private Sector Training: Who Gets It and What Are Its Effects?* (Santa Monica, CA: Rand Corp. for U.S. Department of Labor), p. vii.

[8]Carey and Eck, op. cit., footnote *3,* pp. 18-19.

[9]Discussion based on information received by MargaretHilton, OTA, when employed by the Communications Workers of America in 1986.

[10]Lisa M. Lynch, "Private Sector Training and Its Impact on the Earnings of Young Workers" (Cambridge, MA: M.I.T., Sloan School of Management November 1988).

Figure 8-I—Upgrade Training by Occupation
(percent of workers reporting upgrade training)



[a]NOTE: On average, 35 percent of all workers received skill improvement training for their current job.

SOURCE: Max Carey and Alan Eck, *How Workers Get Their Training* (Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1985), p. 18-19.

Lack of Training for Older Workers[11]

Older workers, those age 45 or older, are unlikely to get adequate training at work.[12] Surveys of workers, such as the one conducted by BLS, show that older employees receive a smaller share of both on-the-job training and outside courses than younger workers,[13] and that training declines with age within the older worker population.[14] Some older workers compensate by taking outside courses, but most do not. Among the 14 percent of adults who took adult education courses in 1984, only one-fourth were 45 and older, compared with 60 percent who were between 25 and 44 years of age.[15] In 1983, these two groups constituted 31 and 51 percent of the workforce respectively,[16] indicating that older workers are underrepresented in adult education courses.

Employers invest less in training older workers because they believe the company cannot recapture all of its investment during the employee's remaining worklife.[17] The fact is that older workers change jobs less frequently than younger workers (see ch. 3). The Age Discrimination in Employment Act (ADEA) prohibits denying access to training on the basis of age (see box 8-A). However, budgetary constraints inhibit enforcement of ADEA provisions.

---

[11]The material on older workers in this chapter is based on F. R. Rothstein, with D. J. Ratte, "Training and Older Workers: Implications for U.S. Competitiveness," report prepared for the Office of Technology Assessment under contrac N3-1630, March 1990.

[12]The "older" worker is variously defined. The Federal Age Dis crimination in Employment Act includes workers as young as 40 among those covered. Some Federal assistance programs for older workers limit assistance to those 55 and over. In thi report, OTA uses 45 as the beginning point as did the National Commission for Employment Policy i *Older* Workers.' *Prospects, Problems, and Policies,* report No, 17 (Washington, DC: National Commission for Employment Policy, 1985).

[13]Carey and Eck, op. cit., footnote 3, p. 42.

[14]Ibid., p. 20.

[15]Susan T. Hill, *Trends* in *Adult Education* 1969-19&# (Washington, DC: Department of Education, Center for Education Statistics, 1987), p. 23 (table 8-B).

[16]Carey and Eck, op. cit., footnote 3, p. 42.

[17]R. J. Vaughan and S. E. Berryman, *Employer-Sponsored Training: Current Status, Future Possibilities (New* York, NY: Institute on Education and the Economy, 1989), p. 5.

Box 8-A—ADEA: Two Cases[1]

The Age Discrumination in Employment Act (ADEA) of 1967 specifically prohibits companies from denying training to workers on the basis of age. Older workers have successfully sued because they were denied training given to younger workers and suffered adverse consequences as a result.

Case 1. CBS Inc. switched from film canisters to videotape and trained their newer, younger workers in the new technology. The older workers sued when they were disproportionately affected by a subsequent layoff because they had not received the training.

Case 2. In a 1989 case, an office machines serviceman in Kansas City, Missouri, successfully sued his employer, Monroe Systems for Business, Inc. The employee was the oldest of six servicemen in the Kansas City office. He had been discharged as part of a layoff because he lacked photocopier training, although he had repeatedly requested it. Younger men who received the training that he lacked were not discharged.

There have been similar cases, against Westinghouse Electric Corp. and NCR Corp., when age-based denial of training resulted in subsequent job loss. The faster technology changes and the more sophisticated the senior lobby becomes, the more likely are suits of this kind.

[1]F.R. Rothstein, with D.J. Ratte, "Training and Older Workers: Implications for U.S. Competitiveness," report prepared for the Office of Technology Assessment under contract N3-1630, March 1990, pp. 56-57.

Another factor in employers' reluctance to train older workers is the negative attitude of managers and executives.[18] Surveys show that older workers are generally seen as loyal, with good work habits (e.g., attendance, punctuality), a commitment to quality, and a strong work ethic, but managers often rate them lower on flexibility, adaptability, and aggressiveness. [19] In 1985, for example, employers in industrial settings were found reluctant to hire and

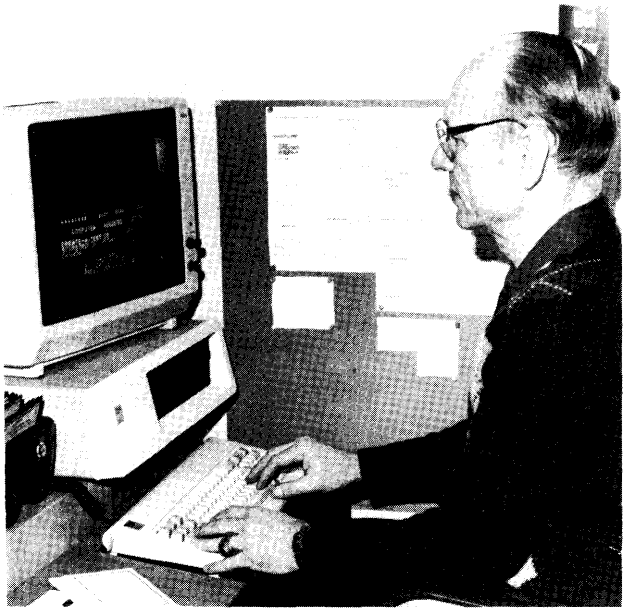


Photo credit: American Association for Community *and Junior Colleges*

Demographic changes and increasing sensitivity to age discrimination may increase interest in tapping the experience of older workers.

train new employees over 40 or to retrain those already on the payroll-despite evidence that those workers are healthy, dependable, and productive, with low accident rates.[20]

Despite management attitudes, many older workers want to stay employed and to pursue further training. Three out of four adults would prefer to work part-time instead of retiring completely .21 A recent survey found that workers between 40 and 49 were especially interested in training for a new position whereas workers between 50 and 62 were most interested in training to update their current job skills. Even workers over 62 expressed a high level of interest in training.[22]

Reflecting these views, organized labor, which traditionally has sought pension and early retirement benefits for older workers, is beginning to press

[18]S. *H.* Rhine, *Managing Older Workers: Company Policies and Attitudes (New* York, NY: The Conference Board, 1984), pp. 16-17; B. Rosen and T. H. Jerdee, "Investing in the Older Worker," *PersonnelAdministrator,* April 1989, No. 34, p. 71; TheYankelovich Group, *Business and Older Workers* (Washington, DC: American *Association* of Retired Persons, 1989), P. 20.

[19]Helen Dennis, *Fourteen Steps in Managing an Aging Work Force* (Lexington, MA: Lexington Books, 1988), P. 145.

[20]HarveyL. Sterns and Dennis Doverspike, "TrainingandDeveloping the Older Worker: Implications forHuman Resource Management," in Dennis, op. cit., footnote 19, p. 98.

[21]American Association of Retired Persons, *Workers 45+ Today and Tomorrow* (Washington, DC:1986), p.19.

[22]American Association of Retired persons, *Work* and *Retirement: Employees Over 40 and Their Views* (Washington, DC: 1986), pp. 11-12.

management for retraining and job redesign to keep its more senior members at work.[23]

Educating managers on age issues can be effective in changing their perspectives and decisions vis-a-vis training older workers, and in challenging their concerns about the return on investment in older worker training.[24]

EMPLOYMENT SECURITY AND TRAINING

Workers' careers are affected by many factors, including layoffs, voluntary quits, and the creation and destruction of firms (see ch. 3). Increased international competition and the globalization of production are rapidly changing the structure of the U.S. economy, and hence, job opportunities. About two million workers are displaced each year due to layoffs or business closures, fewer jobs are available in large fins, and most new jobs are in the service sector, paying relatively low wages.[25] In the midst of this shakeout, few U.S. firms have been willing or able to make company-wide commitments to maintain full employment, retraining and redeploying a stable workforce in response to changing product and skill requirements. As a result, most American workers must be prepared for unwanted as well as desired job changes.

Barriers to Further Education

Diplomas have clear benefits for workers. Among males, in 1987, college graduates earned 41 percent more than high school graduates, and high school graduates earned 21 percent more than high school dropouts.[26] While the real earnings of female college graduates rose 16 percent between 1979 and 1987, earnings of females with only a high school diploma rose only 2 percent, and females without diplomas saw their earnings *drop* by *4* percent. 27 More highly educated workers of both sexes are also less likely to experience unemployment than those with fewer years of schooling (see box 6-D).

Many employers provide tuition assistance to help workers further their education. One study estimates that nearly three-fourths of U.S. firms sometimes pay in part or in full for outside courses taken by their employees. This study further estimates that employers spend about 0.2 percent of payroll, or $1.8 billion per year, on such benefits.[28] On average 3 to 5 percent of those eligible in any given year[29] take advantage of employer-provided educational assistance.

Barriers such as poor basic skills, lack of information about educational opportunities, lack of money, family responsibilities, and fear of failure in school settings often prevent nonsupervisory workers from extending their formal education outside of working hours. Even when employers provide tuition assistance, some workers cannot afford to pay tuition up front and wait for reimbursement following successful course completion. In addition, some employers use these programs quite selectively for a few chosen managers, while other firms fail to publicize their programs because they feel that in-house courses are more beneficial than outside education.[30]

Unions have negotiated improvements in tuition assistance programs that help to overcome many of these barriers. These improvements include eliminating requirements that courses be strictly job-related, moving courses to the workplace, greatly increasing educational and career counseling, providing tuition in advance instead of after course completion, reimbursing workers for child care and transportation expenses, and providing basic skills classes in a comfortable environment so that workers are better prepared for outside courses. As shown in

[23]Judith Wineman, "Age Issues in the Work Place: A Labor Perspective, " in Dennis, op. cit., footnote 19, pp. 180-182.

[24]Dennis, op. cit., footnote 19, pp. 148-151.

[25]Peter B. Doeringer, *Turbulence in the American Workplace (New* York, NY: Oxford University Press, forthcoming).

[26]John Bishop, "Incentives for Learning: Why American High School Students Compare So Poorly to Their Counterparts," *Investing in People* (Washington, DC: U.S. Department of Labor Commission on Workforce Quality and Labor Market Efficiency, 1989), p. 11.

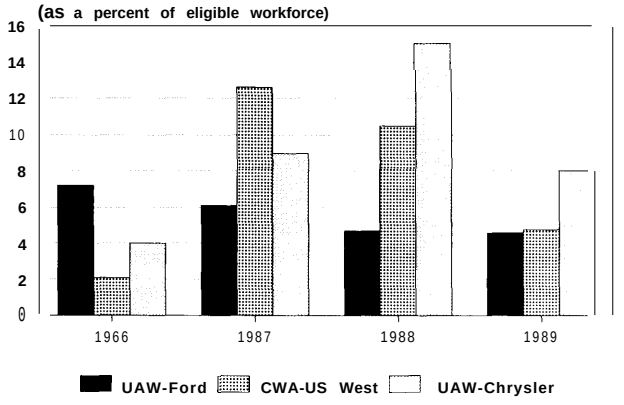
[27]Commission on the Skills of the American Workforce, *America's* Choice: High *Skills or Low Wages!* (Rochester, NY: National Center on Education and the Economy, 1990), n.p.

[28]This estimate must be approached with caution because it is based on a 1988 survey with a response rate of O@ 11.3 percent. The group surveyed was selected to represent a cross-section of U.S. business by industry, firm size (including firms with less than 100 employees), and geographic region—U.S. Chamber of Commerce, Research Center, *Employee Benefits: Survey Data From Benefit Year 1988* (Washington, DC: 1989), pp. 22, 33.

[29]Gerard G. Gold, *Employment-Based Tuition* Assistance: *Decisions and Checklists for Employers, Educators, and Unions* (Washington, DC: National Institute for Work and Learning, 1985), p. 9.

[30]Ibid.

Figure 8-2-New Enrollments in Joint Union-Management Tuition Assistance Plans



SOURCE: Based on information supplied by the joint programs to the Office of Technology Assessment, 1990.

figure 8-2, the proportion of workers who use tuition assistance in the joint programs has increased.

As discussed in chapter 2, Federal income tax policy also affects workers' choices. Most tuition assistance benefits, including those for courses taken to prepare for new careers as well as those related to workers' current jobs, are exempt from an employee's income tax.[31] However, the exemption will expire on September 30, 1990 unless extended by Congress. In part of 1989, when Congress allowed the exemption to expire temporarily and employers began withholding income taxes on the value of tuition benefits paid, there was a marked dropoff in participation in some tuition assistance plans (see figure 8-2). Continuing uncertainties about taxation of tuition benefits could have a dampening effect on workers' participation in off-hours education.

Workers' increased awareness of the links between education and employment security, together with active recruitment by educational institutions and employer-provided tuition benefits, have led more adults to further their educations. About 10 percent of adults participated in adult education in 1969, while, by 1984, 14 percent were involved.[32] However, those who do take outside courses are generally those who are more educated to begin with.[33] Like training at work, further education outside of work usually misses nonsupervisory workers.

EDUCATION AND TRAINING FOR NONCOLLEGE YOUTH

More and more employers are requiring postsecondary education for jobs formerly held by high school graduates. Workers holding only a high school diploma face increasing difficulty in the job market: their real earnings dropped by 28 percent from 1973 to 1986, and the gap between their earnings and college graduates' widened.[34] Some employers who formerly hired high school graduates and "trained them up" to higher level positions, now look for young people with specific skills obtained from technical school, the military, or college. Internal job ladders have been weakened (see ch. 3).[35]

Young people who do not go on to college are often unprepared for work. A General Accounting Office report recently concluded that "insufficient attention is devoted to preparing U.S. noncollege youth for employment."[36] Several major industrial nations-including Japan, West Germany, and Sweden—invest proportionately more money and effort in education and training of their noncollege youth than does the United States. Young people in these other countries receive not only stronger basic education in school, but also much more assistance in preparing for the world of work and in finding jobs.

Once employed, younger American workers with only high school diplomas typically get little training.[37] This is partly because of the kinds of jobs they find-companies most likely to provide good jobs

[31] Public Law 95.600. Prior to this act, IRS regulations limited the tax exemption only to those educational benefits paid for courses directly related to the worker's current job.

[32] Hill, op. cit., footnote 15, p. 5. The last such survey was conducted in 1984.

[33] Ivan Charner and Bryna Shore Fraser, "Different Strokes for Different Folks: Access and Barriers to Adult Education and Training" (Washington, DC: National Institute for Work and Learning, 1986), p. 49.

[34] Educational Testing Service, Policy Information Center, "From School to Work" (Princeton, NJ: ETS, 1990), p. 27.'

[35] Thierry J. Noyelle, *Beyond Industrial Dualism* (Boulder, CO: Westview Press, 1987), p. 15.

[36] U.S. General Accounting Office, *Training Strategies: Preparing Noncollege Youth for Employment in the U.S. and Foreign Countries*, GAO/HRD-90-88 (Washington, *DC: May* 1990), p. 2.

[37] Lillard and Tan, op. cit., footnote 7, p. vii.

with career ladders are less likely to hire young workers (those aged 16 to 20) than other companies offering low-skill, low-paid jobs with little chance of career advancement.[38]

Apprenticeship is one source of transferable training, but it serves much less than 1 percent of the workforce and is rarely available to young people just finishing high school. Other forms of company-provided training are often narrow and job-specific, limiting young workers' marketability to other employers. The net effect of poor basic education and a lack of broad, structured training at work is that many young people flounder through a series of low-wage jobs.

Vocational Education

Advances in technology and work organization are altering the skills needed for jobs typically filled by noncollege youth (see chs. 3,4, and 6). There will continue to be many jobs for which advanced education will be unnecessary. However, the best among these jobs-those that offer better wages and career advancement-will go to job applicants whom employers believe can learn new skills and can adjust to new work circumstances.

These changes will require the American school system to radically improve the quality of education so that more young people can function successfully in the workforce. Most importantly, high school graduates will need a stronger foundation in basic skills-reading, writing, and arithmetic. They will also increasingly need a broader set of competencies: social skills to interact with co-workers, problem solving abilities, and good communication skills to interact with customers. Those young people who are comfortable with computer-based technology, recognizing that it will continue to change during their worklives, will fare better than those who are not.

Public high school vocational education can make an important contribution to workforce preparation. The vocational system was initially developed for youths entering technical trades. Today, nearly all high school students (97 percent) enroll in at least one vocational course.[39 40] However, only about 30 percent of high school students concentrate on vocational courses in preparation for a specific occupation.[41]

The evidence is mixed about how well high school vocational education prepares young people for today's job market. Compared to college-bound students and those in a general education curriculum, vocational concentrators are more likely to be employed and working more hours per week in the year following graduation.[42] Although this is not surprising, considering the fact that graduates from the other two groups were more likely to be full-time postsecondary students, it is also interesting to note that, among those from all three groups who *were* working, vocational graduates had the lowest unemployment rates.

At the same time, however, most students graduating from vocational programs do not take jobs in their fields of concentration,[43] and those who do find skilled work rarely use their occupational courses.[44] Since other variables, such as the characteristics of the local labor market, affect students' employment prospects, low placement rates alone are not sufficient to judge the performance of vocational education.[45] Moreover, there are exceptions to the generally low placement rates, most notably in secretarial fields.[46]

---

[38]Stephen F, Hamilton, *Apprenticeship for Adulthood: Preparing Youth for the Future (New* York, NY: Macmillan, 1990), p. 3.

[39]U.S. Department of Education, National Assessment of Vocational Education, *First Interim Report* (Washington, DC: January 1988), PP. 1-5.

[40]U.S. Congress, Office of *Technology* Assessment *Performance Standards for Secondary School Vocational Education—SET Staff Paper* (Washington, DC: OTA, April 1989), p. 12.

[41]U.S. General Accountin, Office, op. cit., footnote 36, P. 28.

[42]Sue E. Berryman, "Vocational Education and the Work Establishment of Youth: Equity and Effectiveness Issues" (Santa Monica, CA: The Rand Corp., 1980), p. 21.

[43]The William T. Grant Foundation Commission on Work, Family and Citizenship, The Forgotten *Half: Non-College Youth in America* (Washington, DC: January 1988), p. 50.

[44]U.S. Department of Education, *National Assessment of Vocational Education, Final Report, Volume 1: Summary of Findings and Recommendations* (Washington, DC: 1989), p. xiii.

[45]U.S. Congress, Office of Technology Assessment, op. cit., footnote 40, P. 5.

[46]Senta A. Raizen, *Reforming Education for Work: A Cognitive Science Perspective* (Berkeley, CA: National Center for Research in Vocational Education, December 1989), p. 29.

Although vocational graduates seldom use their specific technical knowledge on the job, the best vocational courses help students develop good work attitudes (such as self-confidence and reliability) and general skills that can be used in a wide range of occupations. For example, students in agricultural education courses often learn about management, finance, and marketing by setting up income-generating business projects or experiments. A researcher visiting a class of 18 vocational agriculture students in West Virginia in 1986 found that only 1 student planned to become a farmer-the others were attracted to the blend of business skills and adaptability taught in the course, which they found superior to the traditional business program also offered at their high school.[47]

Given the changes now occurring in the workplace, both academic and vocational courses might benefit from a greater blend of theory and practice. Recent research suggests that people of all ages often learn both practical and theoretical skills most easily when working together as a team to accomplish a concrete task.[48] For example, a group of New Hampshire high school students designed and constructed a solar-powered car during the 1989-90 school year as part of an applied science class. The students made all decisions as a team, requiring them to learn decision-making, leadership, and management skills. As they consulted their peers in metalworking, drafting, and electricity classes, they began to assume responsibility for their own learning. The project leader, along with half of those on the team, were college-bound, but were attracted to a chance to get away from ''book-centered learning. ''[49] At a forum on this project, which was sponsored by the National Council on Vocational Education, one corporate training official stated that the skills these students learned matched those his company is seeking in new hires.

While incorporating practical tasks, an improved vocational curriculum would not limit learning to job-specific knowledge that rarely transfers to new contexts.[50] Instead, the goal would be to help students develop the flexibility and adaptability needed to adjust to changes in their lives and jobs. This can be accomplished by incorporating academic skills into vocational courses and by offering both academic and vocational courses at the same high schools (as many schools do now), rather than creating separate facilities for vocational concentrators. Students can learn mathematics quite effectively within the context of vocational courses such as business math and vocational math.[51] Academic coursework might help vocational graduates advance beyond entry-level jobs and pursue post-secondary education later in their careers.

Photo credit: American Association for Community and Junior Colleges

The **best vocational programs combine both academic and occupational skills.**

The largest effort currently underway to better integrate vocational with academic education is a project of the 13-State Vocational Education Consortium of the Southern Regional Education Board.[52]

[47]Stuart A. Rosenfeld, ''Vocational Agriculture: A Model for Education Reform, '' *Education Week,* Sept. *26, 1984,* p. 24.

[48]Lauren B. Resnick, "l-earning in School and Out,'' *Educational Researcher,* December 1987, p. 18.

[49]Anne Mytych-DelPonte, ''N.H. High Schoolers Learn Technical Work Skills by Building Solar Car," *Employment and Training Reporter,* July 7, 1990, p. 971.

[50]Sue E. Berryman, *Breaking Out of the Circle: Rethinking Our Assumptions About Education and the Economy* (New York, NY: Columbia University, Teachers College, National Center on Education and Employment, June 21, 1987), p. 5.

[51]Raizen, op. cit., footnote 46, p. 29.

[52]Educational Testing Service, op. cit., footnote 34, p. *O.

The group has begun to design, implement, and evaluate a high school program combining both elements. When completed, this project could provide valuable models for educators throughout the United States.

Vocational programs also can help familiarize students with the kinds of technology they are likely to use in the workplace. Several "technology literacy" programs have been developed in recent years. Some use mobile training centers equipped with small replicas of advanced manufacturing technology and with industrial simulators; one example, the Advanced Center for Technology Training, is discussed in chapter 7. Computer-based learning can also help familiarize students with rapidly changing technology. For example, several companies, vocational schools, and other service providers in the Cincinnati area have developed an interactive video disk training program in machine tool and fabrication skills.[53]

Some public schools are beginning to offer technology familiarization courses to younger students. With funding from the Michigan Department of Education and the Federal Job Training Partnership Act, the Jackson, Michigan school district is orienting at-risk youth in middle school to manufacturing technology. Short summer courses on technology applications give students and teachers a ''taste' of what skills and knowledge are required to work in the growing number of advanced manufacturing plants located in the Jackson area.[54] 1n the past 2 years, about 100 14-year-olds, 50 teachers, 5 guidance counselors, and 12 principals have attended these courses.

Vocational education might have greater impact if students knew more about what jobs were available in their local labor markets. Now, students graduate with little job placement help from the school.

As a practical matter, greater job search assistance as well as the other reforms outlined above would require more extensive employer involvement in the schools. For example, cooperative education, which includes periods of classroom instruction and paid or unpaid work, could be used much more extensively and effectively. Currently, less than 3 percent of all high school students participate in cooperative education.[55]

Critics contend that time spent in cooperative education jobs is often wasted, as students lose valuable school time only to learn narrow, job-specific skills. This problem can be eased by placing the students in a series of jobs, rather than a single position. But the real key is a commitment by both the employer and the teacher to make sure that the student learns the broader principles behind particular tasks while working.

Another avenue for greater collaboration between employers and high schools, paid or unpaid internship, is available only in a few locations. One successful experiment in New York City paired selected students with business executives in a semester-long, full-time work experience taking the place of coursework. Like other successful internship programs, this program bridged the gap between work and school by employing teacher/coordinators, who supervised work placements and organized seminars and projects that related students' work experiences to academic subjects.[56]

Yet another approach is being tried by the Chamber of Commerce and the local school district in Fort Worth, Texas. In the project's initial phase, local employers, supervisors, and workers were surveyed about the skills needed in their positions (e.g., reading, computer literacy, math, communications, problem solving) and the required proficiency level (from "rudimentary" to "adept"). They were also asked to predict what those skills and proficiencies would be 5 years from now and a decade from now.[57] This information is currently being inte-

[53] An organization, the Greater Cincinnati Industrial Training Corp., was set up to develop and market this curriculum. Part of the startup funds for the courseware was provided by the U.S. Department of Labor.

[54] Bob Carlton and Allaire George, Jackson County Community College, Jackson, MI, personal communication, June 26, 1990.

[55] William T. Grant Foundation, Commission on Work, Family and Citizenship, op. cit., footnote 43, p. 42.

'Ibid., p. 43.

[57] Presentation of Stefsen Palko before the Secretary's Commission on Achieving Necessary Skills (SCANS), May 18, 1990. SCANS, established by Labor Secretary Elizabeth Dole in the Spring of 1990, has a similar mission at the national level as the Fort Worth project has locally. It is charged with developing national competency guidelines that reflect work readiness to aid in the development of curricula for schools and training programs at the State and local levels.

grated into a new school curriculum, which will be tested in the fall of 1990.[58]

Finally, Jobs for America's Graduates, a private initiative, has brought the business community and schools together to provide realistic employment counseling, job placement, and follow-up support groups. The program, based on a similar effort in Delaware, is aimed at all seniors not bound for college and was operating in 16 States in 1990. Although placement rates among the 292 participating schools vary from 48 to 89 percent, depending on local labor market conditions, the programs are finding other "positive outcomes," such as post-secondary education and military service, for high school graduates.[59]

The 101st Congress is considering legislation to initiate some of the reforms outlined above through the reauthorization of the Carl D. Perkins Vocational Education Act,[60] the major Federal program supporting State and local vocational education. As this report went to press, a House-Senate conference committee had just completed action to resolve differences between House and Senate passed bills.[61] The bill reported by the conference committee, the proposed Carl D. Perkins Vocational and Applied Technical Education Act Amendments of 1990, emphasizes support for curricula that integrate vocational and academic methodologies, and that provide a coherent course sequence through which academic and occupational skills could be measured. Among many other provisions, the bill also would authorize support for tech-prep education programs that encompass the 2 years of secondary school preceding graduation with 2-year post-secondary or apprenticeship programs. It also would authorize, as discussed in chapter 2, business-labor-education partnerships for training.

Although this bill, if enacted, should help bring vocational education closer to emerging workplace needs, it cannot accomplish all of the changes needed. First, Federal funding accounts for less than 10 percent of all support for vocational education; thus the actions of the States and local school disticts are crucial. Second, Federal funds are targeted mostly for schools, not employers. The links between vocational education and the world of work can become stronger only with active, ongoing employer commitment. The new bill encourages, but cannot guarantee, more active involvement.

Apprenticeship: The Past As Prologue?

Although the U.S. apprenticeship system has declined over the past two decades, there is growing interest in revitalizing and expanding it. As recent research into learning theory suggests, the apprenticeship model, combining theoretical classroom instruction with hands-on practice and skill-building, is a very effective method of developing the ability to think and learn as jobs and technology change.[62]

Proponents of apprenticeship note that it could help address some of the challenges raised by the Hudson Institute's *Workforce 2000* report:

1. rising skill requirements in many occupations;
2. a shrinking supply of younger workers;
3. increased training needs in the service sector, where job growth will predominate and productivity lags; and
4. the need for more systematic training in smaller fins, where most of the employment growth in the service sector will occur.[63]

Nevertheless, attempts to expand apprenticeship face big barriers. Currently, apprenticeship plays a very small role in training of U.S. workers. Between 1970 and 1987, apprentices in federally registered programs fell from the already small proportion of 0.3 percent of the U.S. civilian workforce to only 0.16 percent.[64] Formal apprenticeship does little for

---

[58] "Ft. Worth Businesses, Schools Join to Develop Work-Readiness Curriculum," *Employment and Training Reporter,* June *20, 1990,* p. *939.*

[59] Educational Testing Service, op. cit., footnote *32, p. 25.*

[60] Bills included H.R. 7, as passed by the House, and S. 1109 as passed by the Senate.

[61] The conference report on H.R. 7 was published in the *Congressional Record, Aug. 2,* 1990, PP. H6336-H6382.

[62] Resnick, op. cit., footnote 48, p. 16.

[63] U.S. Department of Labor, Employment & Training Administration, "Apprenticeship 2000 Issue Paper and Initiative; Notice and Request fOr Comments," *Federal Register,* Dec. 2, 1987, p. 45905.

[64] U.S. Department of Labor, *Work-Based Learning: Training America's Workers* (Washington, DC: U.S. Government Printing Office, 1989), p. 8.

the average high school graduate-the median age of U.S. apprentices is 25.[65] By contrast, apprentices make up 6 percent of the labor force in West Germany (see ch. 3), where apprenticeship is the major vehicle for helping young people aged 16 to 19 move from school to work.[66]

To be registered with either the Federal Bureau of Apprenticeship and Training (BAT) or a State Apprenticeship Council (SAC), apprenticeship programs may be sponsored unilaterally by a single employer or by a group of employers (with no union involvement), or jointly by a single employer with a union or by a group of employers with a union.[67] In addition to registered programs, some employers and professional associations operate formal apprenticeships that are not registered. It is estimated that, in addition to the 300,000 apprentices now enrolled in federally registered programs, there are about 100,000 more in nonregistered programs.[68]

Although 85 percent of the more than 40,000 federally registered apprenticeship programs are operated unilaterally by employers, most of these are quite small, offering only one or two training slots. By contrast, over half of all U.S. apprentices work in the unionized construction industry and another 20 percent are employed in unionized manufacturing.[69]

The recent decline in apprenticeship parallels the falling rates of unionization in construction and manufacturing. Although there is no legal barrier to the creation of nonunion apprenticeship programs, there is a practical one-financing. Apprentices in the United States typically attend evening classes two or three times per week, receive on-the-job instruction, and take tests at regular intervals over a 3-year period.[70] To support these costs, the firm or industry must, in effect, tax itself. In unionized companies, collective bargaining provides a mechanism for collecting the fee. Without unions, industry associations must solicit voluntary contributions from member firms; a single firm acting alone may be unable to support such extensive training.[71]

Sustaining apprenticeship programs is particularly difficult in the manufacturing sector. Although manufacturing and construction workers are equally unionized (unions represent about 22 percent of workers in both industries)[72], industry associations in manufacturing are weaker and less likely to support training.[73] With neither union pressure **nor** broader support from a trade association, many nonunion manufacturers, including Cincinnati Milicron and Bell & Howell dropped their formal apprenticeship programs as part of broader cost-cutting efforts in the recessionary late 1970s and early 1980s.[74] 75 Although unionized companies such as the "Big 3" U.S. auto manufacturers did maintain their programs during this difficult period, they greatly reduced the number of trainees. Today, U.S. automakers have shortages of skilled craft workers.

---

[65] Stephen M. Hills and Beatrice G. Reubens, "Youth Employment in the United States," in Beatrice G. Reubens (cd.) *Youth at Work: An International Survey* (Totowa, NJ: Rowan and Allenheld, 1983), p. 273.

[66] Nick Kolb, Bureau of Apprenticeship and Training, personal communication, NOV. 15, 1988.

[67] Robert W. Glover, "Apprenticeship: A Route to the High-Paying Skilled Trades for Women?" Sharon L. Harlan and Ronnie J. Steinberg (eds.) *Job Training For Women: The Promise and Limits of Public Policies* (Philadelphia, PA: Temple University Press, 1989), p. 272.

[68] Robert Glover, Senior Research Associate, Center for the Study of Human Resources, the University of Texas at Austin, personal communication July 1990.

[69] Glover, 1989, op. cit., footnote 67, p. 272.

[70] The average cost for one apprentice to attend evening classes in the sheet metal industry are estimated to be about $2,500 per year—David Harrington, Sheet Metal and Air Conditioning Industry, National Training Fund, personal communication June 27, 1990. One rough estimate of employers' and unions' total annual investment in apprenticeship, including wages, is $8 billion to $10 billion—Roberts T. Jones, Assistant Secretary of Labor, testimony in Hearings before the Committee on Appropriations, U.S. House of Representatives, Thursday, Mar. 9, 1989 (Washington DC: U.S. Government Printing Office, 1989), p. 559.

[7]1 Robert W. Glover, "Expanding the Use of Apprenticeship," report submitted to the Bureau of Apprenticeship and Training, U.S. Department of Labor, September 1988, p. 26.

[72] "Union Membership Down to 16.4 Percent of Workers in '89," *Daily Labor Report, No. 27* (Washington DC: Bureau of National Affairs, Inc., Feb. 8, 1990), p. 1.

[73] Glover, 1988, op. cit., footnote 71, p. 21.

[74] James W[illegible]y, Corporate Director, Personnel Development/Compensation/Bends, Cincinnati Milicron, personal communication, May 4, 1989.

[75] Don Frey, former Chief Executive Officer, Bell & Howell, personal communication, Apr. 12, 1989.

Joint Apprenticeship Programs

In construction, apprentices are usually new hires (often with some work experience and/or college), while in manufacturing, apprenticeships are allocated to employed workers on the basis of seniority and aptitude tests. In both cases, demand for apprenticeship slots exceeds supply, and, in some trades, there are commonly four applicants to every one apprentice accepted.[76] Currently, about 20 percent of all apprentices are minorities, while 7 percent are female.[77] Unless the limited number of apprentice positions expands, it is unlikely that apprenticeship will become an important vehicle for moving women and minorities into high-paying jobs in the near future.

Apprenticeship training trust funds originated in local contracts covering the mechanical and electrical trades within the construction industry following World War 11.[78] These local funds are overseen by Joint Apprenticeship Training Committees (JATCs). As a condition of receiving training from union-negotiated funds, apprentices must agree that they will not work for a nonunion contractor for a certain period of years. Administrators of JATCs have successfully sued journeyman who have taken such action, winning back the training costs.

In the mid-1950's, unions and employer associations began establishing national training trust funds, overseen by national joint committees, to support their local apprenticeship programs. These national funds work in concert with local JATCs, which actually deliver the training. The national committees focus on making training more portable throughout the Nation by certifying journeymen as training instructors, purchasing training equipment at bulk rates, and developing standard curricula for the industry, while the local JATCs oversee local programs and select the apprentices.[79] For example, the National Training Fund (NTF) of the Sheet Metal and Air Conditioning Industry develops courses on video disk, providing them free to the local JATC's, and also uses mobile trailers to teach welding techniques near major construction sites.

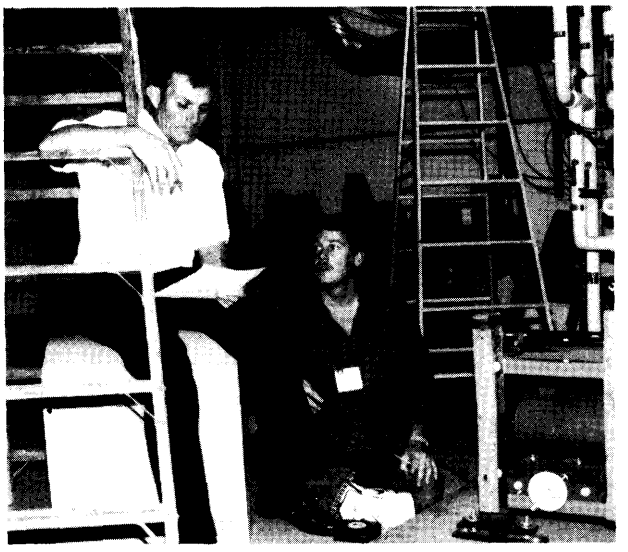


Photo credit: National Training Fund, Sheet Metal and Air Condoning Industry

Apprenticeship training provides long-term career benefits for young people. Here, an apprentice sheet metal worker learns on the job by working with a master craftsman.

Among the largest national finds, the NTF, had a 1987 annual budget of $5.2 million. These funds were contributed by employers; the national union (Sheet Metal Workers International Association) requires each local contract to include a clause requiring a contribution to the NTF of $0.07 per hour worked by each journeyman.[80] The National Ironworkers and Employers Apprenticeship Training and Journeyman Upgrading Fund is less well-funded; Local contracts may, but are not required to, include contributions to the fund of $0.02 per hour worked.[81]

Today, joint apprenticeship trust funds in the construction industry control about $500 million annually. These funds are used not only to train some 200,000 apprentices, but also to upgrade the skills of journeymen and to train apprentice instructors. For example, the United Association of Plumbers and

[76]Glover, 1989, op. cit., footnote 67, p. 286.

[77]Calculation from data supplied by the Bureau of Apprenticeship and Training (AMS Report 001, Mar. 30, 1989).

[78]Glover, 1988, op. cit., footnote 71, p. 22.

[79]Ken Edwards, International Brotherhood of Electrical Workers (IBEW), phone interview, Feb. 23, 1989.

[80]*National* Training *Fund Annual Report 1988* (Alexandria, VA: National Training Fund, Sheet Metal and Air Conditioning Industry); and personal communication with Gerald Olejniczak, Assistant Administrator, NT'F.

[81]Ray Robertson, International Association Of Bridge, Structural and Ornamental Iron Workers, personal communication, Mar. 15, 1989.

Pipefitters, which has about 24,000 apprentices in full-time training, provided short upgrade courses to about 80,000 journeyman in 1987.[82]

Journeyman upgrading is increasingly important as construction technology changes: The joint program in the electrical industry provides fiber optics training to journeymen, while the sheet metal industry's NTF has provided courses in such diverse skills as solar energy installation and architectural sheet metal skills for historic renovation.[83] The Laborers-Associated General Contractors of America (AGC) Education and Training Fund, which celebrated its 20th anniversary in 1989, provides journeyman upgrade training in leadership skills, hazardous waste clean-up, and asbestos abatement, with financial support from the Environmental Protection Agency.[84]

Legal Framework

The legal framework for apprenticeship in the U.S. has remained largely unchanged since 1937, when the National Apprenticeship Act chartered the creation of BAT within the Labor Department. BAT was given four missions:

1. to formulate labor standards to safeguard the welfare of apprentices;
2. to extend application of these standards in apprentice contracts;
3. to bring together employers and labor with the goal of developing apprenticeship programs; and
4. to cooperate with State agencies engaged in developing standards for apprenticeship.[85]

Within this framework, a patchwork system involving BAT and some States has developed. At the national level, BAT promotes apprenticeship, formalizes national training standards developed by industry associations and unions, registers and services approved apprenticeship programs, and certifies graduate journeymen. Twenty seven States, the District of Columbia, Puerto Rico and the Virgin Islands have State Apprenticeship Councils (SACS) established by State laws and formally recognized by BAT SACS perform many of the same functions as BAT, which has offices and staff in all States. Most SAC and BAT personnel agree that promotion should be left to BAT, while the SAC concentrates on registering programs and both entities develop and service programs. However, this division of responsibilities is rarely spelled out in a formal agreement, causing confusion and sometimes conflict between the agencies.[86]

On successful completion of a registered apprenticeship program, the graduate journeyman may receive a certificate of completion from BAT or the SAC. As discussed above, manufacturers typically operate individual programs, rather than working through industry associations to establish uniform national training curricula approved by BAT This decreases the portability of the journeyman certificate, because a certificate granted by one State may not be accepted by employers in another State.[87]

As part of a broader effort to enhance traditional apprenticeship, BAT is reviewing and revising its policies related to Federal and State roles in apprenticeship. However, any attempt to increase Federal control will be limited by the fact that the 27 SAC States contribute far more in support of apprenticeship than does the Federal Government. During the 1986-87 fiscal year, SACS spent $15.25 million on apprenticeship administration, while BAT spent only $7.75 million in support of State programs in both BAT and SAC States.[88] (The remainder of BAT's $13 million budget for that year was spent on national and regional operations.) Perhaps because they are willing to financially support greater

[82] Glover, 1988, op. cit., footnote 71, p. 18.

[83] Nell P. Eurich, *Learning to Work: Resources for Adult Learning (The* Carnegie Foundation for the Advancement of Teaching, draft manuscript forthcoming in 1990), p. 180.

[84] *Training Update*, n. 10 (December 1989) (Pomfret Center, CT: Laborers-AGC Education and Training Fund, 1989), pp. 3,5.

[85] William G. Whittaker, *Apprenticeship* Trainin, *in America; the* "Fit, ldA, t" *(1937-1987)* (Congressional Research Service Report 87-902 E, 1987), p. CRS-4.

[86] Kenneth W. Tolo, Robert W. Glover and John A. Gronouski (eds.), *Coordination of State and Federal Apprenticeship Administration*, A report by the Apprenticeship Project, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin (Austin, TX: Board of Regents, the University of Texas, 1980), p. xiii.

[87] U.S. Department of Labor, Employment and Training Administration, "Apprenticeship 2000: Focus Paper on Support Activities and Linkages," *Federal Register*, Jan. 25, 1989, p. 3758.

[88] Meridian Corp., "Apprenticeship2000: Project 3C: Analysis of State Roles and Responsibilities," reported submitted to U.S. Department of Labor, Sept. 30, 1988, p. 2.

outreach efforts, the SAC States have about twice as much apprenticeship activity, (with an average 1,100 registered programs and 6,200 apprentices per State) as the BAT States, which have an average of 500 registered programs and 3,300 apprentices per State.[89]

Quality of Apprenticeship

Despite the patchwork legal framework, the quality of current, legally registered apprenticeship programs appears quite high, especially from the worker's perspective. Workers who have completed apprenticeship are generally well satisfied with their training, usually continue working at their crafts, and often move into supervisory positions.[90]

One recent study compared matched samples of 1972 high school graduates who either entered apprenticeships, received other formal on-the-job training from their employer, or received no training. Those who had completed apprenticeships earned significantly more ($4,700 annually, for males) than those who received no formal training, while those who had received other types of formal on-the-job training from their employer earned more, but not as much more ($3,900 annually, for males) .91 As noted above, another recent study found that apprenticeship training was more likely to result in increased earnings with a subsequent employer than other forms of employer-provided training.[92] This is because apprenticeship, especially in the construction trades, leads to a widely recognized, portable journeyman's certificate. Like formal education, apprenticeship offers a key benefit to workers—a recognized credential.

Of course, not all workers successfully complete their apprenticeships. A problem that has affected U.S. apprenticeship programs since the 1940s is a high dropout rate, currently estimated to be over 50 percent.[93] Although high, these dropout rates are moderate compared with those from school-based vocational education: Only 19 percent of high school graduates who enter community colleges complete a certificate or degree within 4 years of their high school graduation.[94]

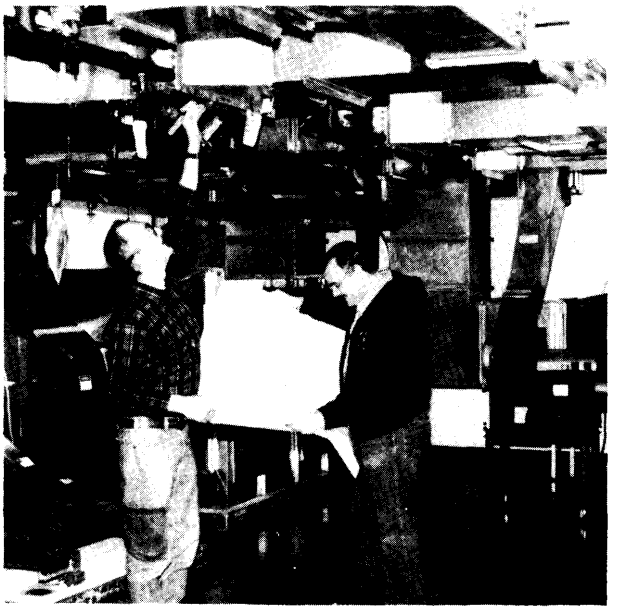


Photo credit: National *Training Fund, Sheet Metal and Air Conditioning Industry*

As technology advances, journeyman upgrading courses have become an important component of joint union-management apprenticeship training programs.

Although hard evidence is lacking, some trends point toward improved quality in apprenticeship training. For example, a growing number of joint apprenticeship programs, including those in sheet metal, masonry, and iron work, are collaborating with colleges and universities to provide in-depth technical and pedagogical instruction to apprenticeship instructors.[95] In recent years, joint programs in carpentry, bricklaying, insulation, and painting have updated their curricula and developed new national standards for apprenticeship training. And, as discussed above, journeyman upgrade training to keep workers abreast of new technology is increasing.

'%'bid., p. 1.

[90]Glover, 1988, op. cit., footnote 71, p. 12.

[91]Westat, Inc., "Analysis of Apprenticeship Training from the National Longitudinal Study of the High School Class of 1972'(Rockville, MD: March 1989), p. 4-1.

[92]Lynch, op. cit., footnote 10.

[93]Glover, 1988, op. cit., footnote 71, p. 17.

[94]U.S. Department of Education, National Assessment of Vocational Education, op. cit., footnote 44, 1989, p. xvii.

[95]Glover, 1988, op. cit., footnote 71, p. 17.

Potential for Expansion

In 1987, the U.S. Department of Labor launched a two-pronged effort, "Apprenticeship 2000" which is aimed at both strengthening traditional apprenticeship and expanding the apprenticeship concept (formal and on-the-job training leading to a credential) beyond its present concentration in the construction trades. While BAT found considerable support for expansion among business, labor, academia, and State and local officials, initial discussions also revealed several barriers. These include:

- cost, especially for small employers;
- perception of union control;
- fear of "pirating" of apprentices;
- lack of support structure (i.e., a joint apprenticeship committee) for nonunion employers, especially small employers.[96]

To overcome these barriers, the agency is studying a number of alternatives for strengthening traditional apprenticeship, including expanded promotion of and technical assistance for apprenticeship by BAT and the States; use of competency testing or other devices to make apprenticeship certificates more portable across States; approaches for replicating the joint apprenticeship committee model in nonunion settings; loans to employers; subsidizing the costs of related instruction (this is currently done by the States); improving linkages between apprenticeship programs and educational institutions, JTPA, the Job Corps, and the Employment Service; and improving consistency in State implementation of apprenticeship.[97]

BAT has too few resources to implement these alternatives. The agency for some time has not been able to service all employers who have or wish to have apprenticeship programs. For example, in the mid-1970's, in Utah, BAT serviced the larger joint union-management apprenticeship programs while the SAC serviced smaller, nonunion programs. Neither agency had the resources to develop apprenticeship programs in the rural, northern part of the State.[98]

This situation has worsened. Despite inflation, Congressional appropriations for BAT have remained almost constant, growing only from $13.86 million in fiscal year 1978 to $14.02 million in fiscal year 1990. BAT's real spending ability in constant (1982) dollars has fallen by more than one half since its high point in 1978. This is reflected in the agency's staffing, which has fallen from its 1978 level of 495 people to only 247 people.[99] With fewer staff and almost no travel budget, BAT has made fewer visits to potential sponsors of apprenticeship programs and fewer onsite reviews of existing programs.[100] These reductions in outreach could feed the widespread perception that BAT services only union apprenticeship programs, thus discouraging more nonunion employers from participating.

Despite the cuts in funding for its traditional mission of strengthening and expanding traditional apprenticeship, BAT has received a share of JTPA research and development funding in addition to its basic budget. These funds are earmarked for the second part of the Apprenticeship 2000 Initiative developing new approaches to apprentice training. In mid-1989, the agency granted $1.8 million of these funds to three organizations, the 70,001 Training and Employment Institute, the National Alliance of Business, and the AFL-CIO's Human Resource Development Institute, to research and develop innovative apprenticeship programs.[101] The first organization is working with small businesses in Indiana to adapt the apprenticeship concept to training of child care workers; the second is developing structured on-the-job training for bank tellers in conjunction with the American Banking Association, and the third is developing upgrade training for aircraft manufacturing and health care workers in the State of Washington.

In early 1990, BAT was made part of the new Office of Work Based Learning (OWBL) within the Department of Labor. OWBL also has program responsibility for retraining displaced workers and trade adjustment assistance. The new office is evaluating proposals for demonstration programs

[96] U.S. Department of Labor, Employment & Training Administration, "Apprenticeship 2000: Focus Paper on Support Activities and Linkages," *Federal Register,* Jan. *25, 1989,* pp. 3757-3758.

[97] Ibid.

[98] Gary B. Hansen and Mark H. Skidmore, "Closing the Rural Employment and Training Gap: A Utah Experiment" *Thrust,* April 1985, p. 52.

[99] Information supplied by the U.S. Department of Labor, Jan. 6, 1990.

[100] Roberts T. Jones, testimony, op. cit., footnote 70.

[101] Manpower Information, Inc., *Employment and Training Reporter,* vo1. 20, No. 46, p.1239.

enhancing school-to-work transitions for young people. A total of about $3.5 million will be given out during 1990 to support these research and demonstration programs.[102]

If successful, these new demonstration projects, as well as those described above, could help spread concepts of apprenticeship. In the American context, these concepts may have more potential than traditional, legally-registered apprenticeship. An effort to expand legally registered apprenticeship programs, the National Industry Promotion Program, launched in 1976, had only limited impact. All of the industry associations ceased their national apprenticeship activities when the flow of Federal funds was stopped in 1979. At the local level, a few programs involving unions such as the fire fighting apprenticeship, continued, but those in nonunion industries floundered. For example, in the auto repair industry, the lack of industry association support meant that there were never a substantial number of apprentice auto mechanics.[103] Without strong trade associations or another avenue of collaboration, few firms continued comprehensive, structured, work-based learning.

By contrast, General Motors has developed a highly successful training program modelled on the apprenticeship concept. (The program is not registered.) Each student entering the program is sponsored by a GM dealership and is paid a competitive training wage during the on-the-job training portion of the 2-year program. Launched in 1980, this program provides classroom training through local community colleges. Approximately 2,400 GM repair technicians have completed this program since its inception. Although graduates have a guaranteed job with the sponsoring GM dealership, an increasing number are going to work for other auto repair shops as the quality of the training becomes known.[104] As discussed in chapter 5, other auto manufacturers are now developing automotive technician training programs similar to GM's.

Whether legally registered or not, most U.S. apprenticeships are filled by young adults, rather than teenagers. This is primarily due to the limited scope of apprenticeship-with demand for training slots exceeding supply, apprenticeship sponsors can choose carefully, looking for prior work experience as evidence that a young adult will succeed in apprenticeship.[105] Nevertheless, successful School-to-Apprenticeship programs, linking high school vocational students with formal apprenticeships, do exist in a few locations. Expanding such programs would make an important contribution to improving the amount and quality of training for younger workers. In addition, school-based internships and nontraditional apprenticeships, such as those discussed in the vocational education section above, would greatly help young people make the transition from school to work.[106]

JOINT UNION-MANAGEMENT TRAINING PROGRAMS

Many unionized workers receive transferable training and career counseling through contracts negotiated with their employers. Although unions represent a small and declining share of the labor force (from a peak of 35 percent of the workforce in 1954 to 16.4 percent in 1989),[107] their influence on workplace training has been disproportionately large. Some features of union-negotiated retraining programs for laid-off workers, such as income support while in training, advance notice of layoff, and remediation of basic skills, have been adopted into Federal programs[108] for workers laid off by nonunion as well as union firms. But unions also influence training programs for employed workers.

---

[102]Irene Lynn, Office of Work-Based Learning, U.S. Department Of Labor, personal communication, August 1990.

[103]Glover, 1988, op. cit., footnote 71, p. 28.

[104]Jim Choulochas, General Motors, personal communication, June 1990.

[105]Fedrau & Associates, "Linking the Secondary Vocational Education System with Apprenticeship," paper submitted to the Bureau of Apprenticeship and Training, U.S. Department of Labor, Oct. 17, 1988, p. 29.

[106]For a comprehensive discussion of school-based apprenticeship models, see Stephen F. Hamilton, *Apprenticeship for Adulthood* (New York, NY: Macmillan, Inc., 1990), pp. 158-185.

[107]"Union Membership Down to 16.4 percent of Workers in 89," *Daily Labor Report,* op. cit., footnote 72, p. 1.

[108]Public Law 100-379, the Worker Adjustment and Retraining Notification Act requires all employers of 100 or more worker to give advance notice of layoffs and Public Law 100-418, the Omnibus Trade and Competitiveness Act of 1988 provides funds for income support and mediation of basic skills during retraining of workers served by the Federal JTFA Title III displaced worker program.

For a variety of reasons, large nonunion employers frequently match or better the wages, benefits (including training programs) and working conditions negotiated in unionized companies.l@ Perhaps the most notable recent example was the United Auto Workers' (UAW attempt to organize Nissan's Smyrna, Tennessee auto plant in 1989. According to one observer, the extensive cross-training and expanded job responsibilities given to workers at the plant was the key factor in the union's defeat.[110] In addition, Nissan had maintained full employment during a sales slump; employment security is a key UAW goal, but union-negotiated protections with the 'big three" U.S. automakers allow layoffs when sales fall. Like Nissan, a growing number of nonunion employers may begin to provide training packages similar to, or even better than, those offered through the large joint union-management programs discussed below.

Since 1982, contract negotiations in the auto and telecommunications industries have led to the establishment of five large, joint, union-management training corporations. They are: 1) The United Auto Workers (UAW)-Ford National Educational Development and Training Center; 2) The UAW-GM Human Resource Center; 3) The Communications Workers of America (CWA)-U.S. WEST Communications Training Partnerships, Inc.; 4) The Alliance for Employee Growth and Development (a joint venture of AT&T, CWA, and the International Brotherhood of Electrical Workers); and 5) The UAW-Chrysler National Training Center. In early 1989, the United Steel Workers of America (USWA) ratified contracts with several major steel companies which will create similar corporations.

As shown in table 8-1, in 1989, these five entities offered training to a total of 709,000 workers and had annual budgets totaling about $324 million. On average, $460 is available per worker per year. However, most workers do not take advantage of the training, and much more than the average is available in some of the companies.

Three of the joint training programs (UAW-Ford, UAW-GM, and the Alliance) were born in times of crisis in response to mass layoffs.[111] This initial focus on retraining laid off workers led all of the joint training programs to emphasize broad, transferable skills and career counseling. Over the past few years, most of the five corporations have targeted the majority of their funds at upgrading the skills of employed workers; however, the focus on transferable skills has not changed. Courses are typically offered outside of regular working hours at the plant site. They include basic skills, computer literacy, career and educational counseling, financial management, and preretirement planning.

Photo credit: The UAW-Chrysler National Training Center

Joint union-management training programs offer technical preparation courses in auto plants after hours.

Although the new joint union-management corporations have captured the public eye, some unions and their employers have developed successful joint training efforts without creating separate training entities. Two examples are the joint training programs developed by the Communications Workers of America (CWA) and Pacific Northwest Bell, which have enhanced both workers' employment security and company revenues, and the joint "Career Ladders" program developed by Hospital Workers, Local 767 of the Service Employees International Union and Cape Cod hospital (see boxes 8-B and 8-C). There are many other examples of local unions and employers throughout the United States developing a variety of training programs

[109]Fred K. Foulkes, "Large Nonunionized Employers," Jack Stieber et al. (eds.), *U.S. Industrial Relations 1950-1980: A Critical Assessment* (Madison, *WI:* Industrial Relations Research Association, 1981), p. 156.

[110]"Training Kept UAW Out of Nissan," *American Machinist,* October 1989, p. 37.

[111]These programs are discussed in greater detail in Margaret Hilton, "The Role of Labor Unions in Training of Employed Workers," Working Paper #2 OTA Worker Training Project, May 28, 1989.

Table 8-l-Joint Union-Management Training Corporations

Name (year created)	1989 budget (in millions)	Number of workers covered	Amount potentially available per worker in 1989
U/W-Ford National Education, Development and Training Corporation (1982)	$63"	105,000	$600
UAW-GM Human Resource Center (1982)	$200b	360,000	$556
PATHWAYS' (1984)	$5	40,000	$125
UAW-Chrysler National Training Center (1985)	$45	79,000	$570
Alliance for Employee Development, Inc.[d] (1986)	$11.3	125,000	$90
Total	$324.3	709,000	$457.40

NOTE: Contract negotiations during 1989 led to creation of three new joint union-management training programs: 1) The United Steel Workers of America's Career Development Institute, with Bethlehem, Armco, Inland, and LTV Steel companies, has an annual budget of $10 million to serve about 50,000 steelworkers, or $200 per worker per year; 2) The CWA-BellSouth Corp.'s Employment Security PARTNERSHIP program is funded at $130 per worker peryear, starting in January, 1990; 3) The Aeorospace Machinists Industrial Lodge 751 -Boeing Company's Quality Through Training program is funded at about $12 million per year for 42,000 workers, or about $286 per worker per year.

[a]Excludes local funds, which go directly to joint local Committees.
[b]Very decentralized. Total includes $5o million which is allocated directly to local joint training committees.
[c]Joint venture of Communications Workers of America (CWA), International Brotherhood of Electrical Workers (IBEW), and U.S. WEST Communications.
[d]Joint venture of CWA, IBEW, and AT&T.

SOURCE: Office of Technology Assessment, 1990.

dealing with basic skills, health and safety, productivity, quality, and other common concerns.

Joint union-management training programs have the potential to broaden workers' access to training. For example, due to continuing layoffs of less senior employees, many union members are now middle-aged or older. In 1988, when workers between aged 45 and over made up 26 percent of the total labor force, they comprised 35 percent of workers represented by unions.[112] Although company-provided training might bypass these workers, the joint programs use techniques such as peer counseling, context-based basic skills courses, and onsite classes to encourage older workers' participation.

Relationship of Joint Programs to Company Training

Most of the new joint training corporations are designed to supplement, not supplant, the parent corporation's regular, job-related training. Only at General Motors is the joint program viewed as a primary delivery mechanism for training of hourly workers, including job-related, on-hours training as well as more generic courses after hours.[113] (See ch. 4.)

In reality, however, all of the joint programs do have links with the corporate training system. For example, at Ford's Van Dyke plant, 14 UAW-represented workers sit on the 16-member technical training committee, which identifies on-hours training needs for the hourly workforce.[114]

As at Ford, joint training committees in Chrysler plants work closely with corporate trainers. The committee at Detroit Axle-a plant that had been threatened with closure-helped the company successfully install new technology. As part of a larger program to maintain competitiveness, Chrysler decided in 1987 to add truck front-drive axle production to the plant, which had previously produced rear axles only. The local joint training committee designed an 8-week training program in operation of newly purchased Okuma CNC machine tools, including four weeks in class with four weeks of hands-on experience operating the machines using dummy parts. In total, 37 new jobs involving computerized machining of axle parts were created. Although obviously aimed at job-specific skills, this training was financed with joint funds and conducted on company time.[115]

[112] "Union Membership Falls to 16.8 Percent in 1988," *Daily Labor Report,* op. cit., footnote 72 (table 1), p. B-14.

[113] Paul Delker, "Worker Training: A Study of Nine Companies," report submitted to OTA under contract #H3-6785, September 1988, p. 110.

[114] Beverly Geber, "The Resurrection of Ford," *Training,* vol. 26, No. 4, April 1989, p. 26.

[115] "Trainees Fill 37 New Jobs," NTC *Newsline,* vol. 1, No. 1, *1987,* p. 4.

Box 8-B-CWA-Pacific Northwest Bell

Pacific Northwest Bell (PNB) was one of three Bell Operating Companies that were combined to form U.S. WEST Corp. when AT&T was split up in 1984. Until 1987, when it was merged into U.S. WEST Communications, the company operated somewhat independently. Headquartered in Seattle, PNB provided local and long-distance telephone service in the States of Washington and Oregon. In 1987, the company employed 14,500 workers, including about 10,000 represented by the Communications Workers of America (CWA) and the International Brotherhood of Electrical Workers (IBEW).

According to PNB's Director of Employee Relations, ''the company and the unions are constantly looking for common ground and common issues that will give us an umbrella under which joint activities can take place." [1] This approach to labor relations evolved slowly, beginning in 1980, when CWA proposed a joint union-management Quality of Worklife (QWL) process during national contract negotiations with AT&T Based on that contract language, which applied to the whole Bell System, the company and union agreed to jointly train labor and management facilitators who would lead shop-floor committees in addressing issues of concern to the union, management, or both.

In 1984, PNB and the union expanded the QWL process by appointing three organizational change consultants (OCCs), reporting to management, CWA, and IBEW respectively. In 1985, this team merged with the company's Organizational Development Group and received a $50,000 grant from the Federal Mediation & Conciliation Service (FMCS) to develop and promote innovative approaches to labor-management cooperation.

The OCC's were soon called in after management had tried and failed four times to teach Installation and Maintenance (I&M) technicians, how much they could charge for work on equipment and wiring not owned by PNB. The company, seeing little revenue generated by the labor hours spent, had stopped marketing the technicians' services, and layoffs appeared likely. The company's concern was money; the union's concern jobs. A jointly developed training course, delivered by specially trained technicians to their peers throughout Washington and Oregon, helped meet both needs. One year after the training was delivered, a total of $1.4 million had been billed for the technicians' work, and demand for their services had increased so much that surplus workers from other job titles were able to move into these jobs.[2]

As the OCC group worked with various union-management committees, other training programs were developed. For example, a survey showed that Systems Technicians, who work on computer-telephone hookups and other special systems, were unhappy with the quality of their training. A joint union-management team spent 4 months in 1985 developing a basic electronics course, which was subsequently delivered on company time to about 400 technicians and their supervisors at a Vocational Technical School outside Seattle. The total cost of the 3-week course, was about $1.2 million. Another example: onsite classes offered by community colleges at worksites in Seattle, and Portland, beginning in 1986. Local union and management committees identified the need for courses in basic arithmetic, writing, computer programming, and electronics and arranged the logistics.[3]

Although the 1986 contract between PNB and CWA provided no money specifically for training, the commitment to Jointness has resulted in expenditures of large sums of money in addition to those described above. For example, a joint task force created in 1985 to deal with future surpluses of Central Office Technicians due to digitalization of central switching offices identified a broad need for career counseling and retraining of all workers to minimize future layoffs. To deal with this need, the joint task force helped local managers and CWA officers develop pilot education fairs in Yakima, Washington and Eugene, Oregon in early 1987. Representatives of local colleges as well as internal company and union training programs setup booths at the l-day fairs. Attendance was so high and response so enthusiastic that the joint task force ultimately helped local joint committees in 25 cities create similar ''Opportunity Expositions. " The total cost to PNB was about $50,000, in addition to lost wages for those workers who attended on company time. The successful creation and delivery of a wide range of training programs at PNB demonstrates that joint training can be one of many offshoots of a strong, cooperative, labor-management relationship.[4]

1''A Conversation with Arnold Manseth,'' *Labor Relations To&y (U.S.* Department of Labor, Bureau Of Labor-Management Relations and Cooperative Programs), May-June 1987, vol. 2, No. 3.

2Margaret Hilton and Ronnie Straw, ''Cooperative Training in Telecommunications: Case Studies,'' *Monthly LaborReview, May* 1987, p. 35.

3Ibid.

4Annie Hill, Chair, CWA-PNB Training Advisory Board, personal communication March 1988.

Box 8-C—SEIU-Cape Cod Hospital

The Service Employees International Union (SEIU) represents about 875,000 service workers, the majority of whom work in public or private health care.1 In 1979, the union received a $300,000 grant from the U.S. Department of Labor's Bureau of Apprenticeship and Training (BAT) to determine the feasibility of applying apprenticeship to the health care industry. Later, with the assistance of two more BAT contracts, SEIU's national office developed a modified apprenticeship model, termed LEAD, or Lifelong Education and Development.

By 1984, the LEAD program included staff at both SEIU international headquarters in Washington, DC and in 11 regions of the country. Although staff were laid off when Federal funds were cut off the following ye@, several successful LEAD programs continue to operate at the local level. One such example is found at Cape Cod Hospital.

During 1981 contract negotiations, SEIU's national LEAD director helped Hospital Workers Local 767 win the broad outlines of a comprehensive upgrading program for its members. Local 767 represents all nonmanagement workers except Registered Nurses (RNs), or about 650 of the hospital's 1,100 employees. As called for in the contract, a Joint Career Development Committee was created. The group met weekly for over a year to negotiate on the qualifications required for every represented job, ranging from the lowest paid Housekeepers and Pot Washers to the highest paid Pharmacists.[3]

The result was a comprehensive joint training program, dubbed "Career Ladders,' which has been continued and expanded during subsequent contract negotiations. A key element in the program is a Career Ladders booklet describing requirements for about 100 jobs and listing 6 in-house training programs and 12 traineeships available to meet those requirements. Normal attrition and turnover combined with continuous introduction of new technology creates a continuing demand for skilled workers at Cape Cod and other hospitals.

Under the Career Ladders program, workers know exactly what they must do in order to be promoted.[4] For example, an entry-level housekeeper knows that, to become a Unit Clerk s/he must complete training in Medical Terminology (offered at the hospital) and be able to type 35 words per minute. At least one worker has made this transition, involving an increase of three levels in pay grade, within 6 months.

Union and management agree that the Phlebotomy traineeship has been quite successful. The Phlebotomists, who draw blood, are in great demand, especially in the summer months, when tourists swell the population of Cape Cod and its hospital. In 1984, about 30 workers successfully completed training and were promoted to the Phlebotomist position. In early 1989, the Joint Career Development Committee agreed to offer new traineeships in Phlebotomy and the higher level job of Histology Technician.

In comparison with many other joint union-management training programs, the Cape Cod Hospital program is much more explicitly aimed at equal opportunity for minorities and women. From the vantage point of the Local President, the key benefit to the union members is that opportunities for training and promotions are now based on seniority, rather than being left to the discretion of management.

The hospital's Director of Labor Relations describes the program as "an employee benefit with significant benefit to the employer." The hospital does not provide its own formal training; all training of nonmanagement employees is done through Career Ladders.

The overall approach to training appears to benefit both union and management, but is difficult to transfer to new locations without the support of the national union and Federal funds.

---

[1] Jean Ross, SEIU, personal communication, November 1988.

[2] The initial contract was one of several "New Initiatives" contracts to labor unions and other organizations interested in developing apprenticeship programs. These funds were appropriated to the Department Of Labor as discretionary funds under the Comprehensive Employment and Training Act (CETA), and channeled through BAT. In 1977, BAT disseminated about $15 million of these funds for research, development, and demonstration projects related to apprenticeship. However, funds were cut back in 1978, and after 1980, there were almost no "New Initiatives" contracts and grants. SEIU was one of few organizations to receive more funds during the 1980s.

[3] Fred Bodensiek, ''Union, Hospital Are Enthused With Success of Ladder Program,'' *Cape Cod Register,* June 23, 1983.

[4] The following discussion is based on February 1989 interviews with William Pastreich, President, Hospital Workers/SEIU Local 767; Theresa Belmont, Director of Labor Relations, Cape Cod Hospital; and Jeanne Savoy, SEIU Representative to Career Ladders Committee.

During 1987 and 1988, two divisions of AT&T (operator services and long-distance services) designated the Alliance as the "official response for career development needs. "[116] In other words, these divisions of the company will not develop a separate package of career counseling for employees, but will rely on the Alliance to provide these services. It appears, then, that joint training programs *are* increasingly linked to the companies' strategic goals.

Mixed Quality of Training

Joint union-management training programs are often quite decentralized. Typically, a corporate-level joint committee often supported by a staff, sets overall policies and funds development and delivery of some training courses, while more detailed funding and training decisions are made by joint training committees at the local level. In addition, many training decisions are made by the workers themselves who use employer-paid tuition assistance to take courses. A variety of public and private training consultants, as well as in-house trainers, are used within this decentralized structure.

One result is a wide range in the quality of training supported by joint union-management programs. As discussed in chapter 5, one unscrupulous training company attracted UAW members to its classes by offering free computer components, but providing little training. This happened early in the history of the UAW-GM joint Human Resources Center, a highly decentralized entity that sends about one-fourth of its $200 million annual revenue stream directly to joint training committees in the plants.[117]

To improve quality, the joint training programs have tried to increase the expertise of local committees and at the same time provide career and educational counseling to help workers in their selection of educational providers. Today, each local joint UAW-GM joint training committee is staffed by full-time local joint training coordinators, who are trained by the Human Resource Center in development, design and evaluation of training.[118] UAW-Ford and UAW-Chrysler have hired full-time career counselors to assist local joint committees with design of training and selection of training providers as well as to counsel individual workers. However, within the UAW programs, career and educational counseling remains strictly voluntary, and workers may sign up for courses without prior counseling.

The two joint training corporations negotiated by the Communications Workers of America (CWA) require career counseling. Workers must meet with a counselor and develop a career plan in order to be eligible for prepaid tuition. Courses must be related to the career plan in order to be eligible for assistance. Other rules apply as well. For example, CWA-U.S. WEST Communications will not pay for flying lessons as a hobby but will pay for ground school and instruction if it leads to a commercial pilot's license.[119]

Tuition Assistance

Most of the joint programs offer workers tuition assistance to take courses on their own time. Such courses may be job-related, for personal development, or to prepare for new careers.[120] As shown in figure 8-2, use of tuition assistance grew as the programs have paid tuition assistance directly to schools, removed penalties for noncompletion of courses, and provided career and educational counseling. More recently, perhaps due to tax changes (see below) participation in some of the programs has dropped off. Nevertheless, a large fraction of each workforce has benefited, when cumulative enrollments over time are considered: At UAW-Ford, 27 percent of the workforce has taken accredited courses atone time or another since the program was instituted in 1984. At UAW-Chrysler, the comparable figure is 36 percent, including personal development courses. PATHWAYS enrolled 30 percent of its workforce in its first 3 years of providing tuition assistance. These programs are very beneficial to workers, because many enroll in courses leading to 2- and 4-year degrees-the formal, widely recognized credentials that are most likely to enhance their careers and earnings. Al-

---

116*The Alliance: Annual Report* (Somerset, NJ: The Alliance for Employee Growth& Development Inc., 1989), P. 8.

117Don Davis and Rich McMillan, Co-Directors, UAW-GM Human Resource Center, personal communication Apr. 27,1989.

118Ibid.

119Herb Hackenburg, "Pathways' Presentation: It Sells Itself," *MB Times,* vol. 7, No. 15, July 29, 1987.

120The Alliance purchases most training for groups of workers, rather than relying on individual use of tuition assistance @on Treinen, The Alliance, personal communication, Aug. 30, 1989).

though tuition assistance programs are expensive, they are much less costly than on-hours training, because the employer can avoid paying workers' salaries while in training.

As the joint programs were gathering momentum, tuition assistance benefits paid to workers for all types of courses—those related to their current jobs and those taken to prepare for new careers-were not taxed as income. As discussed above, this changed temporarily when Congress made tuition benefits for non-job-related courses taxable between December 21, 1988 and November 1989.[121] Although Congress restored the tax-exempt status of all tuition benefits retroactively to January 1, 1989, participation in the joint union-management programs fell during the long period of uncertainty (see figure 8-2). As discussed in chapter 2, making the tax exemption permanent would remove any tax impediments to worker participation in qualified tuition assistance programs, whether sponsored unilaterally by employers or jointly with unions.

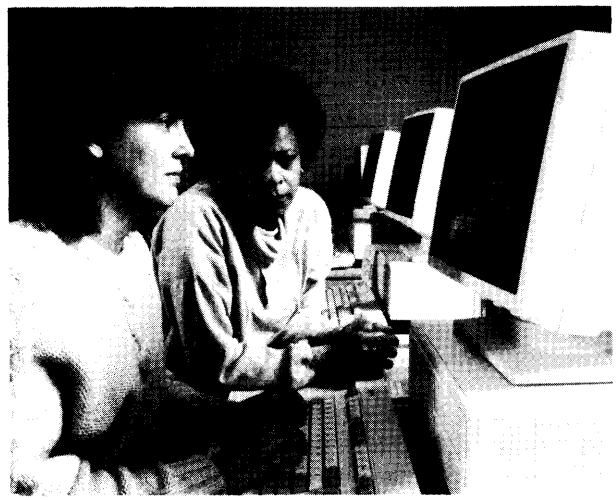


Photo credit: The Alliance for Employee Growth and Development, Inc.

Joint union-management training has spread from the auto industry to telecommunications. Here, a union-represented AT&T employee receives one-on-one coaching from her instructor.

Future Outlook

The future prospects for joint union-management training appear bright. At General Motors and Ford, union and management have reaffirmed their commitment to the joint corporations through three rounds of collective bargaining, Chrysler and UAW renewed their commitment to joint training in 1988, and the CWA and AT&T agreed to continue the Alliance even before opening formal contract negotiations in 1989. Participation in voluntary training programs offered by the five corporations has dramatically increased since their inception, and each corporation has had to add staff to accommodate this growing demand. Cumulative enrollments in all types of training programs offered by each corporation range from 16 to over 50 percent of the eligible workforce.

There are three factors which could threaten joint union-management training:

1. lack of evaluation to demonstrate the quality of training provided;
2. deterioration of the current cooperation between the unions and managements; and
3. further decline in the unionization of U.S. workers.

First, most joint union-management training programs are not evaluated. This is not surprising: As discussed above, very few company training programs receive rigorous evaluation because of the time and expense required. Evaluation of joint programs is particularly difficult because they are designed to achieve a variety of goals. Nevertheless, it is possible to assess the quality of individual courses and programs. The CWA-U.S. WEST Communications program has conducted several studies of specific programs and services, and all three of the UAW joint programs have begun to evaluate their major programs. The results of these studies could be useful to the broader training community as well as to the joint programs themselves.

The second threat-a decline in union-management cooperation, which forms the basis of the joint training corporations-is real, but is unlikely to affect joint training in the near future. Although a vocal minority within the UAW has raised awareness of some of the flaws of ''jointness, ' the top-level leadership remains firmly Committed to cooperation when it is in both the unions' and management's interests. Training is seen as such as area. The CWA has strongly supported joint training even while reducing its commitment to joint 'Qual-

[121] Public Law 1oo-647, approved Nov. 10, 1988, retroactively extended Section 127 from Jan. 1, 1988 (it had expired on Dec. 31, 1987) through Dec. 31, 1988. This *law also disqualified* formerly eligible graduate level courses.

ity of Worklife" programs aimed at other areas of labor-management cooperation.

However, as the unionized percentage of the workforce shrinks, the possibilities for joint union-management efforts, not only in the area of training but also in other productivity and quality issues, are diminished. Since 1960, the percentage of private sector workers covered by union contracts has plummeted, while the percentage of government employees represented by labor unions has increased. In 1989, union members made up 37 percent of employment in government, compared with only 12 percent in the private sector.[122] The decline in private sector unionization in the United States is in sharp contrast to the situation in Canada, where labor law makes union organization much simpler and allows less scope for management opposition.

RETAINING THE SKILLS OF OLDER WORKERS

The U.S. population is aging. The proportion of the population age 45 and older will increase steadily from 1991 to about 2010 when the last of the baby boomers enters this age group. At the same time, a decrease in the youngest age group from which workers are drawn, those 16 to 24, is projected.[123] One way that companies can compensate for projected workforce shortages is to retain older workers in greater numbers and/or for more years. However, an increasing proportion of older workers in the labor force means that it will be important to know how advancing age affects the various skills that contribute to job performance, and if there are negative effects, how to reduce or compensate for them. If age-based physiological changes do not have a significant effect on performance, there is still the question of whether older workers receive adequate training to match their skills with changing technology. This chapter defines older workers as those 45 years old and older (see footnote 12). Hence the discussion covers not only those **at the young** end of the older worker group, but also those who are now typically retired (65 yearn old and older), because there may be more job opportunities for such people in the years ahead.

Laboratory studies show gradual declines in sensation and perception, motor control, learning, and memory with age, but how these changes affect job performance has not been well-researched.[124] Laboratory tasks may be poor surrogates for workplace tasks. In addition, people become more heterogeneous with age. Accordingly, chronological age is a poor predictor of significant reductions in the productivity or trainability of any particular worker. Better information on the relationship between laboratory test results and job performance would facilitate development of more accurate predictors of productivity and trainability than chronological age.[125]

Despite age-related physiological changes, age-related declines in performing traditional tasks in most occupations seem to be gradual and slight, and it appears that the ability to produce and learn is unaffected in healthy workers beyond the age of 65.[126] The explanation for the apparent lack of performance declines may be that judgment and experience of older workers compensate for some age-related physiological declines or because people with significant age-related deficits remove themselves from the workforce, or both.

Sometimes the decision to leave the workforce is not due to diminished capacity to accomplish job tasks per se, but due to other deficits that indirectly affect performance and/or enjoyment of work. The hard-of-hearing person is often mistakenly perceived to be inattentive, slow-thinking, or aloof, when instead the person has simply not heard a question or instruction or has heard it incorrectly. Such misconceptions may cause workers with age-related deficits or disabilities to leave the workforce prematurely.[127]

122"Union Membership Down to 16.4 Percent of Workers," *Daily Labor Review,* op. cit., footnote 72, p. B-8.

123The data for those aged 16 to 24 is from Howard N. Fullerton, "New Labor Force Projections Spanning 1988 to 2000," *Monthly Labor Review,* vol. 112, No. 11, November 1989, p. 8.

124F.R. Rothstein, with D.J. Ratte, op. cit., footnote 11, pp. 1-30. Much of the discussion in this section is drawn from this report.

125Ibid.

126D. Baugher, "Is the Older Worker Inherently Incompetent?" *Aging and Work,* fall 1978, p. 248.

127F. R. Rothstein, "Reducing the Impact of Age-Related Hearing Loss," unpublished concept paper for the National Council on the Aging, November 1982, p. 2.

Even without adequate data on age-related physiological changes and job performance, common sense leads to several conclusions. First, most jobs do not demand performance at maximum physical capacity; jobs requiring physical strength and a rapid work pace would be most affected by advancing age. Conversely, work that depends on experience or on building a clientele puts the older worker at an advantage.[128] Second, declines in heavy manufacturing and increases in service jobs will likely reduce the impact of age on job performance. Finally, the great variability among workers in the same age range means that policy with respect to the older worker should be flexible and individualized rather than uniform.[129]

Practices That Compensate for Age-Related Changes

Efforts to compensate for age-related deficits focus either on the worker or on the job. When the focus is on the worker, one approach is to try to reduce the deficit. Company-based health promotion programs have the potential to improve the health and thereby the overall job performance of middle-aged and older workers.[130] Another approach is training. While research is limited, some evidence suggests that training can overcome some age-related deficits. Hearing loss, which accounts for the largest number of all sensory loss disorders with age,[131] is an example. A promising training approach tested in a nursing home and yet to be tried in an employment setting involves training both older persons and those with whom they interact in new communication techniques.[132] The training is not Sign language but teaching heightened sensitivity to the possibility of misunderstanding or partial understanding. Such techniques are likely to be applicable to the workplace.

When the focus is on the job, the number of hours worked can be reduced and/or the characteristics of the job can be modified to facilitate retention of older workers. Part-time work can meet business needs for peak-time coverage and for workforce flexibility. On the other hand, employers may use part-time work as a way to avoid offering benefits. Nonetheless, part-time work is an attractive option for some older people.[133]

Part-time work arrangements include job-sharing, phased retirement, and, increasingly, reemployment of retirees on a part-time or contingent basis (postretirement employment). Travelers Insurance Co. uses 16 retirees as job sharers in four positions staffing a consumer hot-line.[134] As an example of phased retirement, Polaroid offers workers a 'try-out retirement' option, in which they can reduce or even terminate their work schedules with the option of returning to full-time responsibilities if they change their minds.[135] Postretirement employment comes in a variety of forms. Depending on pension provisions, retirees can return to their previous employer as part-time employees, as contract workers, through an outside temporary agency, or as part of a job bank or internal temporary work pool.[136]

Job modifications include job transfer, job redesign, and job accommodation. Stouffer Foods Corp. allows older workers to transfer from the faster-paced retail assembly lines to the slower-paced institutional lines if their work slows down or compromises safety.[137] In job redesign, the work is changed to reduce lifting, climbing, or prolonged standing. Job redesign is often informal and individ-

---

[128] P.K. Robinson, "Age, Health, and Job Performance," J.E. Birren, P.K. Robinson, and J. E. Livingston (eds.), *Age, Health, and Employment* (Englewood Cliffs, NJ: Prentice Hall, 1986), pp. 70-71.

[129] Rothstein, with Ratte, op. cit., footnote 11, p. 33.

[130] Robinson, op. cit., footnote 128, p. 71-72.

[131] Some hearing loss to pure tones can be measured in nearly everyone after the middle 30s. Impairments in speech comprehension under adverse conditions begin as early as the 40s. Rothstein, with Ratte, op. cit., footnote 11, pp. 8-9.

[132] Developed by the Regional Council on Aging (RCOA) in Rochester, New York, "Eliminating the Sound Barrier," improved communication between hard-of-hearing older people and professionals who worked with them.

[133] American Association of Retired Persons, *Workers 45+: Today and Tomorrow* (Washington, DC: 1986) p. 19.

[134] F.R. Rothstein, "Older Worker Employment Opportunities in the private SectOr," R. Morns, and S.A. Bass (eds.), *Retirement Reconsidered: Economic and Social Roles for Older People (New* York, NY: Springer Publishing Co., 1988), p. 154.

[135] L.S. Root and L.H. Zarruch," Personnel Practices fo, an Aging Workforce: Private-Sector Examples," paper prepared for the U.S. Senate Special Committee on Aging, February 1985, pp. 40-42.

[136] H. Axel, *Job Banks for Retirees (New* York, NY: The Conference Board, 1989, pp. 6-7.

[137] Root and Zarrugh, op. cit., footnote 135, p. 47.

ualized and can involve mechanization to reduce physical effort, changing job content through task redistribution, or minimizing distractions.[138] [139]

A recent survey of human resource professionals suggests that companies are not enthusiastic about job transfer and job redesign, and these adjustments are used infrequently. Older workers who cannot keep up with new technology and procedures often stay in their current jobs, at the same pay, but many of their duties are reassigned to more capable staff members, resulting in attitude and morale problems.[140]

Job accommodations are sometimes made to retain a long-term employee whose capacities are diminished after a heart attack, stroke, or other disabling incident. A simple example of job accommodation is found in McDonald's Corp.: older workers who assemble salads sit on stools rather than standing up. The Job Accommodations Network, a hotline for employers to exchange information about the modifications they have made to retain employees with various impairments, estimates that most employee accommodations cost less than $1,000.[141]

Training To Update Skills

For most older workers, the need is not methods to compensate for age-related physiological declines but training to upgrade skills that have become outdated by new technology. Federal support for older worker training programs has been limited and corporate training departments and private for-profit training vendors have shown little interest in developing training packages tailored to older workers.[142] [143]

Demographic changes make continuing education programs an increasing source of retraining. In the last two decades, as the baby boom has moved out of the traditional college and postgraduate years, universities have begun seeking older students. Still, targeted marketing and tailored teaching methods will be necessary to attract more older students and to mitigate fears they may have of competing in the classroom after many years away from formal teaching.

The main question with university-based retraining is who pays. While recent legislation (the Higher Education Act of 1986) has opened up financial aid opportunities for part-time students,[144] full-time retraining is out of reach financially for most employees.[145]

Vocational schools have long been instrumental in training and retraining people for work. Older workers have not been a major component of their student populations. However, former American Vocational Association president Gene Lehrmann predicts that the role of vocational education in retraining older people for second careers in high demand occupations will grow.[146]

Apprenticeship is another source of training. Formerly limited to people under 45, apprenticeships are now available regardless of age, and older people are beginning to take advantage of the opportunity. Many older apprentices come into the program as dislocated workers. There are no differences in the training or work processes for older apprentices. However, a new practice that helps some of the older dislocated workers is that as incoming apprentices they get credit for prior experience, which allows them to come in at higher levels. In February 1990,4 percent of apprentices in

---

[138] Robinson, op. cit., footnote 128, PP. 72-73.

[139] K.D. Miller, *Retraining the American Workforce (Reading, MA:* Addison-Wesley, 1989), p.130.

[140] American Society of Personnel Administration/Commerce Clearinghouse, "Managing the Aging Workforce: The 1988 ASPA/CCH Survey," *Human Resources Management,* June *28, 1988,* p. *3.*

[141] K.J. Marion, Human Factors Consultant, Job Accommodation Network, personal communication, 1990.

[142] American Society of Personnel Administration/Commerce Clearinghouse, op. cit., footnote 140, p. 6.

[143] J.Camery, Senior Research Analyst, *Training magazine, personal* communication, January IWO.

[144] L.B. Shaw, "Special Problems of Older Women Workers,' M.E. Borus et al. (eds.), *The Older Worker (Madison, WI:* Industrial Relations Research Association, 1988), p. 66.

[145] G. Kearsley, "Introducing New Technology Into the Workplace: Retraining Issues and Strategies," *Investing in People: A Strategy to Address America's Workforce Crisis,* Background Papers, vol. 1 (Washington DC: Commission on Workforce Quality and Labor Market Efficiency, U.S. Department of Labor, September 1989), p. 478.

[146] K.M. Roberts, "Retirement is a New Beginning, " *Vocational Education Journal,* January/February *1950,* p. *25.*

the Bureau of Apprenticeship Training's database were 45 or older.[147]

Companies could find it to their advantage to help finance if not to provide, training of older employees as fewer younger workers enter the labor market. In theory, the Age Discrimination in Employment Act (ADEA) encourages such activities. One purpose of ADEA is "to help employers and workers find ways of meeting problems arising from the impact of age on employment." Although virtually nothing has been done toward accomplishing this purpose, ADEA clearly opens a door for Federal involvement on a "carrot" rather than a "stick" basis.

Experience With Training Older Workers

Two-thirds of the human resource managers who participated in a 1987 survey acknowledged that special training techniques may enhance efforts to update skills among older employees. Self-paced learning, experiential training, on-the-job coaching, pragmatic or application-oriented training, and training that senior employees help design were among the techniques cited.

However, according to the survey, efforts to train older workers are hampered by several factors. Fifty-nine percent of the managers reported moderate to great resistance to training among older employees, and 52 percent reported that older employees have trouble mastering new concepts, ideas, and approaches. Despite high awareness that older workers have distinct training needs, only 38 percent of the companies represented conduct an annual assessment to identify training needs, and only 29 percent offer training and development for older employees.[148]

Experience with older workers and computers shows that older workers can be effectively trained in new technologies and that they benefit from training methods tailored to them. The attitudes of management are the greatest hurdle older workers face (see box 8-D).

Training managers on age issues can change their perspectives and decisions vis-a-vis training older workers. An evaluation involving 100 organizations using a course that emphasizes the benefits of effective use of older workers showed that, 3 months later, the training continued to have a positive effect on managers and their feelings about their own aging, their commitment to involving older persons in their human resource planning and their decisions on performance reviews, retraining, and retention of older workers.[149]

There is general agreement on some of the characteristics of training that benefit older workers. Because stress has a greater negative effect on older trainees than on their younger counterparts, methods that minimize stress are particularly important for the older trainee. Programmed teaching minimizes stress, and thus may be more successful with older workers than traditional teaching methods. Even with programmed teaching, however, there is evidence that older people require more time to complete a learning program; 67- to 84-year-olds needed 103 minutes to complete a learning program that 16- to 32-year olds finished in 45 minutes.[150]

Testing is a cause of stress, and some experts suggest that testing of older trainees be minimized. When testing is necessary, frequent feedback on results can help accustom the older trainee to testing.[151]

Reducing the need for memory by job aids and embedded training (or improving memory by mnemonics) and minimizing distractions can increase successful learning by older workers.[152]

Programs for reentry women and dislocated workers find it effective to provide motivational and confidence-building sessions prior to skills training to combat the self-fulfilling prophecy of those who

---

147 M. Miller, Acting Director, Bureau of Apprenticeship Training, U.S. Department of Labor, personal communication, 1990.

148 American Society of Personnel Administrators/Commerce Clearing House, op. cit., footnote 140, p. 6.

149 Dennis, op. cit., footnote 19, pp. 149-151. The course was "Age Issues in Management," available from* Conference Board.

150 M. Doering, S. R. Rhodes, and M. Schuster, *The Aging Worker: Research and Recommendations* (Beverly Hills, CA: SaGE Publications, 1983), p. 113.

151 Miller, op. cit., footnote 139, p. 138.

152 Ibid., pp. 129-130.

expect to do poorly in training and then proceed to do so.[153]

Such techniques could help in skills training of the older worker, particularly when computers are involved.[154]

Malcolm Knowles has probably had the greatest influence on development of adult learning principles. Knowles pioneered andragogy, the art and science of helping adults learn, based on the learner as an active participant in designing and delivering the learning program.[155]

Knowles' principles as applied to older workers can be summarized as follows. First, the physical environment and psychological climate of the training setting need to accommodate the declines in physiological functioning that affect older people to varying degrees. Second, traditional classroom methods such as lectures are less effective than group discussions and problem-solving, in part because the latter techniques more closely emulate real-life work processes and in part because they mitigate the anxiety many older adults feel about returning to the classroom after decades away from it. Third, the extensive job and life experiences of the older worker can enrich the training experience and must be integrated into the learning program. And fourth, the motivation of older workers in work-related learning is directly related to whatever career and life changes they are undergoing.[156]

Retirement and Public Policies

Improvements in retirement income packages have been a major factor affecting retirement decisions.[157] These improvements, which have enabled more workers to retire earlier, have also reduced pressure on the government and corporations to develop programs and policies to expand older worker training and employment opportunities.[158]

Congress recently began requiring employers to recognize earnings tier age 65 for pension contribution and benefit purposes. This pension policy removed a disincentive toward continued work past 65, but pension plans may still limit the ability of retirees to work part-time for their former employer because pension payments are jeopardized.

Amendments to the Age Discrimination in Employment Act first moved the mandatory retirement age from 65 up to 70, and in 1988 the age limit was outlawed altogether for most jobs. However, enforcement by the Equal Opportunity Commission is minimal because of severe budget constraints.[159]

The Social Security system affects continued employment in several ways. For instance, the earnings test restricts the amount that Social Security beneficiaries between 62 and 69 may earn without jeopardizing their benefit levels. However, low income workers do not generally earn enough to affect their benefits. The earnings limit will be relaxed somewhat beginning in 1990. Moreover, few people understand that the earnings test does not apply to those who are 70 or older; that is, that the benefit levels of such workers are *not* affected by earned income.

On the other hand, the 1983 Social Security amendments included several incentives for continued work. The gradual rise in age eligibility for full benefits from 65 to 67, which will begin in the year 2000, could encourage baby boomers to stay longer in the labor force. Gradual increases in the delayed retirement credit for employees who continue working beyond age 65 should have a similar effect.[160]

---

[153] F. L. Alegria and A. Lordeman, *Serving Older Individuals Under the Job Training Partnership Act: State Initiatives and practices* (Washington, DC: National Governors' Association and National Association of State Units on Aging, June 1988), p. 13.

[154] American Society of Personnel Administration/Commerce Clearing House, Op. cit., footnote 140) p.14.

[155] M. S. Knowles and Associates, *Andragogy in Action (San* Francisco, CA: Jossey-Bass, 1984), PP. 14-18.

[156] H. L. Sterns and D. Doverapike, 'Training and Developing the Older Worker: Implications for Human Resource Management' inDennis, op. cit., footnote 19, p. 99.

[157] R. V. Burkhauser and J. F. Quinn, "Labor Force Participation of Older Workers," *Investing in People: A Strategy to Address America's Workforce Crisis,* background papera, vol. I (Washington DC: Commission on Workforce Quality and Labor Market Efficiency, U.S. Department of Labor, September 1989), pp. 1084, 1099-1100.

[158] S. E. Rix, Director of Research, Women's Research and Education Institute, testimony at a joint hearing before the Select Committee On Aging and the Subcommittee unemployment opportunities of the Committee on Education and Labor, U.S. House of Representatives, on "The State of the Older Worker: Current and Future Needs," 1989, Serial Number 90-614, p. 58.

[159] J. K. L. Morse, Attorney, Office of the General Counsel, Equal Employment Opportunity Commission, personal communication, 1990.

[160] Axel, Op. cit., footnote 136, p. 9.

Box 8-D-Older Workers and Computers

Rapid technological change and pervasive use of computers and computer-assisted tools are common in the workplace today. Yet, there is little documentation about whether there is a differential effect on older workers when computers are introduced into the workplace. Of the few age-specific studies that have looked at adult performance in computer training, most relate to the older worker's ability to learn to use computers for word processing:

- A recent study examining older women's computer trainability and attitudes toward computers found that women 55 to 70 years old performed as well as young (25 to 39) and middle-aged (40 to 54) women.[1]
- A study comparing younger adults (20 to 39) with older adults (50 to 84) found that the older adults took twice as long to learn but achieved nearly equal performance levels. The older adults requested help two to three times as frequently. Performance in training and attitude toward computers were directly related.[2]
- When older adults (65 to 75) and younger adults (18 to 30) without prior computer experience participated in two training sessions a week over several weeks, the older adults proved able to learn computer word processing skills and to use that expertise to solve problems. Information recall about the word processing program was similar in both groups, and both carried out computer operations equally correctly and efficiently. However, the older adults needed more time to select and carry out procedures and more assistance during editing tasks.[3]

Gist, Rosen, and Schwoerer compared older and younger people in computer familiarization and spreadsheet training using two different training techniques. Both age groups showed learning gains, but the younger trainees performed better than those over 45 with both training techniques.[4]

The above studies suggest that older workers can adjust well to computerized word processing. However, older workers tend to take longer to learn and need more assistance while learning to use computerized word processing.

A growing body of anecdotal information indicates that older workers are more likely to accept computers if introduced to them in ways deliberately designed to reduce their anxiety: older instructors, smaller classes, and abundant time to practice.[5]

Despite evidence that older workers can become both comfortable and accomplished with computer technology, many managers believe otherwise. A recent survey showed that only 22 percent of human resource executives felt that older workers were comfortable with new technologies such as computers. Three-quarters of the respondents agreed that "our younger employees represent the future of the industry and we should focus our training and development efforts on them." G

---

[1]National Council on the Aging, "Research Findings: Older Persons Can Excel on Computers," *The Aging Workforce*, vol. *3, No.* 1, March-April 1989, p. 5; S. J. Czaja, unpublished research on older adults and computer training for Advanced Automation Concepts, Inc., Buffalo, NY.

[2]E. Zandri and N. Charness, "Training Older and Younger Adults to Use Software," *Educational Gerontology, vol.* 15, *1989,* pp. 623-625.

[3]A. A. Hartley and J. T. Hartley, 'The Older Adult as Computer User,'' P. K. Robinson, J. Livingston, and J. E. Birren (eds.), *Aging and Technological Advances (New* York, *NY:* Plenum Press, *1984)* p. 348.

[4]M. Gist, B. Rosen, and C. Schwoerer, "The Influence of Training Method and Trainee Age on the Acquisition of Computer Skills," *Personnel Psychology,* vol. 41, 1988, pp. 261-262.

[5]F.R. Rothstein with D.J. Ratte, "Training and Older Workers: Implications for U.S. Competitivenewss," report prepared for the Office of Technology Assessment under contract N3-1360, March 1990, pp. 83-84.

[6]The Yankelovich Group, *Business and Older Workers* (Washington, *DC:* American Association of Retired Persons, 1989), p. 13.

The employment section of the Americans with Disabilities Act requires any private company with 15 or more employees to provide "reasonable accommodation' to employees with disabilities unless such provision causes the business "undue hardship." The Act may offer legal remedies to older workers affected by age-related disabilities —this interpretation has been called the Act's ''sleeping giant'. ' [161]

Specific Federal commitment to training older workers involves only two programs-the Job Training Partnership Act (JTPA) and the Senior Community Service Employment Program, also

[161]B. Fretz, Executive Director, National Senior Citizens Law Center, speech at National Association of State Units on Aging Conference, Jan. 18, 1990.

known as the Title V program of the Older Americans Act. Title V and the older worker provisions in JTPA are limited to assisting low income individuals 55 and over and neither has the resources to meet the needs of this population.[162] Neither program emphasizes training for older workers. The JTPA's targeted older worker services have emphasized assistance in job search rather than skills enhancement.[163] The one nonmeans-tested JTPA program, which is designed to serve dislocated workers regardless of income, has disproportionately underserved older victims of economic dislocation.[164] The Title V program places low-income seniors in part-time jobs with community service agencies, and they are generally paid the minimum wage. While some training occurs, most Title V programs have income maintenance as their primary goal.[165]

Lack of Data on Access, Costs and Effectiveness of Older Worker Training

Inadequate information on access, costs, and effectiveness makes it difficult to formulate policy about training older workers. While the Bureau of Labor Statistics conducts regular labor force surveys, these surveys do not seek information on worker training.[166] The one comprehensive household survey conducted by BLS and the Census Bureau in 1983 has not been updated.

Most companies could probably produce age data on their trainees by examining personnel files. However, a study prepared for OTA[167] found no companies that do so as a matter of course. Furthermore, if companies do compile such information they might hesitate to make it public for fear of violating ADEA provisions. Not all human resource development specialists interviewed for this report[168] realized that collection of age data on training participants is not prohibited under ADEA.

Nor does access to training by older workers appear to be on the research agenda of national trade associations. The National Association of Manufacturers, which represents many of the companies at the center of the restructuring and retooling activities of the past decade, has not focused on age as a factor important to the human resource development needs and practices of its members.

Just as data on access are limited, so also are data on the costs and effectiveness of methods of training older workers. Only 11 percent of companies in one survey reported that they analyze the costs and benefits of training employees over the age of 50.[169] Little useful information has been compiled from experience with publicly funded training.[170] Federal budget constraints, combined with a shift of the Administration on Aging away from research on employment, have resulted in sharp cuts in grant support for such research. Nonetheless, the aging of the American workforce means that better information on access, costs, and effective methods for training older workers will be increasingly important.

---

[162] Rothstein, with Ratte, op. cit., footnote 11, p. 47.

[163] F. R. Rothstein, *Continuing to Work: JTPA and the Older Worker* (Washington, DC: National Association of Counties, 1989), p. 19.

[164] U.S. Congress, General Accounting Office, *Dislocated Workers: Local Programs and Outcomes under the Job Training Partnership Act* (Washington, DC: General Accounting Office, *1987),* pp. 39-40,46.

[165] S. Sandell, *Older Workers: Prospects, Problems and Policies*, 9th Annual Report (Washington, DC: National Commission for Employment Policy, 1985), p. 27.

[166] Philip L. Rones, Economist, Bureau of Labor Statistics, personal communication, February 1990.

[167] Rothstein, with Ratte, op. cit., footnote 11, p. 72.

[168] Ibid., p. 73.

[169] B. Rosen and T. H. Jerdee, op. cit., footnote 18, p. 72.

[170] For example, *Job Training Partnership Act: Information on Set-Aside Funding for Assistance to Older Workers* (Washington, DC: General Accounting Office, 1990), a January 1990 report from the General Accounting Office, probably offers the most complete cost information on the set-aside program to date. Yet it examines only expenditure rates and numbers of participants terminating from the program, with no attention to the cost-effectiveness of various types of training, i.e., the relationship between types of intervention and outcomes.

Appendix

Appendix A
Training in the U.S. Military

The U.S. military recruits and trains large numbers of young people. Parts of the military training model resemble apprenticeship, except that the "related instruction" (which takes place alongside on-the-job training in private sector apprenticeship) is front-loaded in the military. That is, new recruits receive intensive instruction at the beginning of their tour, followed by on-the-job training coupled with written and practical skills tests.[1]

Aside from the very different missions, there are several basic differences between military and conventional private sector training. One is the scale and scope of training. Private firms often give little training to young entry level workers because they expect them to move on within a year. The military recruits for 3- to 4-year tours of duty, and trains all recruits. Some remain in the military for a 20-to 30-year career. Further, the military model is up or out; if recruits do not pass training and move up, they may be discharged. Military training also is aimed more at specific performance standards, based on job analysis, than most private sector training. Also, military training is evaluated and improved constantly, with the trainees' commanders providing feedback. Instructors are rotated, conducting training for 3 or 4 years at a time and then returning to the field. Thus they maintain and upgrade their duty skills.

Instructional technology also is more prevalent in military training than the civilian sector. The military has a keen interest in training technology for several reasons. The portability and consistency of instructional technology make it very atttactive for the military's large worldwide trainee population and high turnover. The military also frequently introduces new equipment with sophisticated and complex capabilities that are particularly well suited to technology-based training. Finally, the Department of Defense (DoD) can afford the startup costs associated with hardware and software development. Because DoD's training budget is so large (DoD spends approximately $3,500/person annually on training compared with perhaps $100 to several hundred dollars per employee in the private sector), the military's investments in training research have the potential to yield large cost savings if they produce more effective or efficient training methods.

The military services have a multibillion dollar inventory of training material. For example, in 1986, the Naval Training Systems Center processed more than $1.0 billion for research, testing, and development of training systems, and provided logistics support for over $3 billion worth of training material and systems in use throughout the world. Because of its increasing emphasis on training technology, the military training market is one of the few U.S. defense markets that is growing.[2]

Scope of Training[3]

The Department of Defense had almost 5 million personnel in 1989 (see table A-l). The 3.8 million uniformed personnel received the equivalent of 250,000 years of training, with 81 percent going to active forces and the rest to Guard/Reserve personnel (see table A-2).

The figures in table A-2 only cover what DoD calls "individual training and education," or training of individual uniform members in formal courses conducted by organizations whose major mission is training. Training by units—roughly equivalent to on-the-job training—is not reported in the DoD ***Military Manpower Training Report.***

DoD divides individual training programs into six categories:

1. ***Recruit Training:*** given to enlisted personnel with no previous service by the Branch they join. Recruit training is more akin to socialization than to skills building. An individual coming from duty in another Branch may need modified Recruit Training.
2. ***One-Station Unit Training (OSUT):*** initial training given only by Army Combat Arms (e.g., Infantry, Armor, Artillery). OSUT combines Army Recruit Training with advanced individual training.
3. ***Officer Acquisition Training:*** now includes six general programs (Service Academies, Recruit Officers Training Corps, Officer Candidate Schools, Off-

[1]Unless otherwise referenced, the material in this appendix is from Douglas Copeland, personal communications to OTA, October 1989-January 1990; and Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the Office of Technology Assessment contract No. L3-5615, February 1990.

[2]Steve Hull, "Hot Markets," *Military Forum,* vol. 6, No. 3, November/December 1989, p. 5.

[3]The information presented below is derived from the *1989 Defense Almanac*, the Department of Defense *Military Manpower Training Report* (MMTR) for fiscal year 1990, and the Department of Defense, Office of the Assistant Secretary of Defense Manpower, Installation, and Logistic, *Occupational Conversion Manual.* In some cases, these data will address requirements for fiscal year 1991. This fiscal year 1991 information is part of the MMTR and is required by the U.S. Congress in accordance with 10 U.S.C. 138(d)(2). The MMTR for 1990 was prepared in March 1989. It should be noted that this reflects neither the Presidential Budget presented to the Congress in January of 1990, nor any increased demands due to the 1990 Iraqi invasion of Kuwait (e.g., call up of reserve forces).

Table A-l—Department of Defense Personnel (as of March 1989)

Active duty personnel:	
Army	*764,259*
Navy	581,050
Marine Corps	194,860
Air Force	575,604
Total	2,115,773
Guard and Reserve:	
Army	1,063,437
Navy	241,448
Marine Corps	83,233
Air Force	268,254
Total	1,656,372
Civi/Service:	
Army	430,480
Navy	354,491
Air Force	263,437
Other	96,679
Total	1,145,087
Total DoD	4,917,232

SOURCE: Departmentof Defense, *Defense Almanac, 1989.*

Campus Commissioning, Enlisted Commissioning, and Health Professions Acquisition). There are sub-elements to some of these programs, as well as special programs unique to each service.

4. ***Specialized Skill Training;*** prepares personnel for specific jobs in each service. Initial Specialized Skill Training includes most formal training that follows Recruit Training.The training is for specific jobs listed for: I) Military Occupational Specialty (MOS) for the Army[4] or Marine Corp,2) Navy Enlisted Classification (NEC), or 3) Air Force Specialty Code(AFSC). Following initial training, personnel usually are assigned field duties. Those showing particular aptitude may get Advanced Enlisted Technical/Skill training—usually after they have gained on-the-job experience in their specialty. The advanced training also may qualify trainees for a new occupation code. Personnel may go to several advanced courses during the military career,either for advanced technical areas or management or supervisory positions.

5. ***Flight Training:*** provides basic flight operation skills and knowledge for those seeking to be pilots (aviators} Naval Flight Officers (NFOs), and/or navigators. Often called Undergraduate Pilot Training (UPT), its graduates are awarded their wings and designations and assigned to specific aircraft training squadrons for qualification. For example, a newly designated Air Force pilot who is jet-qualified may be assigned to an F-15 training squadron prior to assignment to an F-15 operational squadron.

Table A-2—Department of Defense Requested Training Loads for Fiscal Years 1990 and 1991[a]

	FY 1990	FY 1991
Active military[b]		
Army	79,667	74,760
Navy	67,224	66,517
Marine Corps	21,656	22,235
Air Force	39,575	37,757
Subtotal	208,122	201,269
Guard and Reserve[c]		
Army National Guard	19,168	18,667
Army Reserve	15,377	15,963
Naval Reserve	3,237	3,259
Marine Corps Reserve	4,179	4,178
Air National Guard	2,941	2,939
Air Force Reserve	1,752	1,774
Subtotal	46,654	46,780
Total	254,776	248,049

[a]DoD defines "Training Load" as the average number of students and trainees participating in formal individual training and education courses during the fiscal year. For a full fiscal year, training loads are the equivalent to the total number of years of training taken by students/trainess.
[b]Each service's training load is the amount of training needed by members of that service. However, some training will be done by other services, in DoD schools, or by outside institutions. The figures above are consistent with the President's Budget for fiscal years 1990-91, submitted in January 1989.
[c]Includes formal school training provided by active military training establishments.

SOURCE: Department of Defense, *Military Manpower Training Report,* fiscal year 1990.

6. *Professional Development Education:* provides education and training to career personnel in preparation for complex duties. It encompasses a range of goals and subjects (e.g., military science, engineering, instructional technology, management, and medical areas). While most professional development is for the officer corps, some programs are for senior enlisted personnel. Some service school programs range from 22 weeks (Armed Forces Staff College) to 4244 weeks (Army, Navy, Marine Corps and Air Command and Staff Colleges).

Load and course data for initial and advanced skill training and pilot training are presented in table A-3. The number of ***initial*** entry-skill training courses shown is large; it also is relatively insensitive to reductions in personnel. DoD would still have to instruct in the entry level skills, but to fewer trainees. Personnel reductions (or increases) would have an impact on course load and thus costs.

In contrast, ***advanced skill training courses are*** given to fewer personnel. Much of the advanced training is in support of specific weapons systems (e.g., F-15 aircraft, M1A1 tank) or weapons platforms (for example, SSBN

[4]Army OSUT satisfies the concept of 'specialized skill training' because it combines the skill training with recruit training in a single program or course (an MOS may be awarded).

Table A-3-Skill, Flight, and Professional Development Training Loads[a] (fiscal year 1990)

Military branch	Initial skill courses (number)	Initial skill load (man-years)	Advanced skill load (man-years)	flight training load (man-years)	Professional development load (man-years)
Army	319				
Active		21,854	*9,503*	1,131	3,641
Reserve		5,855	*656*	114	79
Guard		7,032	*952*	246	86
Navy	172				
Active		23,269	12,563	2,084	2,376
Reserve		1,285	318		123
Marine Corps	342				
Active		5,899	2,276	583	966
Reserve		1,221	93		47
Air Force	*597*				
Active		*13,651*	5,563	2,788	3,632
Reserve		*980*	134	73	49
Guard		*1,446*	408	203	40
Total active		*64,673*	29,905	6,586	10,615
Total Reserve/Guard		*17,819*	2,561	636	424
Total DoD	*1.430*	*82.492*	32.466	7.222	11,039

[a]This table does not include advance individual/team technical training conducted bythe Services. It does include some prior-service trainees and some eross-traineesfrom other skill areas.

SOURCE: Departmentof Defense, *Military Manpower Training Report*, fiscal year 1990.

Ohio class ballistic missile submarine, DD-963 Spruance class destroyer). This advanced skill training includes the equipment associated with the various systems. As an example, some of the equipment on the new U.S.S. ***Arleigh Burke (DDG-51)*** destroyer that requires unique advanced technical training includes: harpoon missile system, Mk-41 Tomahawk launcher system for the Tomahawk antiship cruise missile, SQS-53C hull-mounted SONAR system, **SQQ-9** ASW system, 5"/54 gun system, Phalanx CIWS, and SQR-19 tactical towed-array SONAR system.

Any modification to weapons systems or other equipment will require additional training in operation and/or maintenance. This will in turn affect both the number of courses and student load. Because these might be conducted under contract as factory training or new equipment training (see discussion of providers, below), it is difficult to determine the actual number of these programs or their costs.

Training Delivery Costs

Table A-4 shows funding for ***individual*** military education and training for fiscal year 1990 by type of training. The estimates include military pay and allowances for both trainees and the military and civilian workforce used in the support of initial entry and skill training.

DoD has established the Interservice Training Review Organization (ITRO) to review its training programs. Part of the ITRO mission is to reduce training costs and the duplication of training programs and courses among the services; the mission of the services is central to the evaluation. This program is headed by the commanders of the major training commands.[5]

Training Providers

The DoD and the services use military and civil service personnel as well as civilian contractors to conduct their education and training programs at the military training bases. Each branch conducts its own recruit training program to meet its specific needs and mission. Each service also designs its flight training program to meet the needs of the mission and operational equipment. For example, Navy and Marine trainees designated for the fighter/attack jet training pipeline may be required to complete aircraft carrier take-off and landing qualifications. Some training is provided by other services in DoD Schools, or in some cases by institutions outside DoD. As an example, all explosive ordinance disposal (EOD) personnel are trained in Navy schools. There also is some interservice flight training (the Navy UPT program provides training to the Marine Corps and Coast Guard).

[5]These are: 1) Army Training and Doctrine Command, 2) Chief of Naval Education and Training, 3) Marine Corps Combat Development Command (Marine Air-Ground Education and Training Center), and 4) Air Training Command. ITRO is divided into committees and subcommittees addressing the many areas of military education and training. These include Initial Skill Training, Advanced Technical Training, Flight Training, Training Technology, Contract Training, Training Support, and other areas.

Table A-4-Funding of Individual Training by Service and Type[a] (millions of dollars)

Type	Army	Navy	Marines	Air Force	DoD
Recruit	$ 383.0	$ 531.1	$ 256.4	$ 185.1	$1,355.0
Officer acquisition	128.4	198.4	21.2	152.8	500.8
Special skills	1,532.2	1,784.7	584.9	802.2	4,704.0
Flight	334.6	1,208.7	45.8	902.7	2,501.8
Professional development education	191.8	203.4	53.9	216.7	665.8
Army OSUT	378.3				378.3
Medical	354.9	172.3		222.1	749.3
BOS/direct support	2,191.0	1,039.3	221.6	1,045.2	4,497.1
Management HQs	61.5	27.1	0.4	57.0	146.0
PCS	165.5	142.9	46.4	108.6	463.4
THY	852.8	39.7	17.7	409.4	1,319.6
Reserve/Guard pay	793.1	56.1	66.1	146.8	1,062.1
Total costs	$7,377.2	$5,403.7	$1,314.2	$4,248.6	$18,343.7

[a]Includes military pay and allowances for trainees and for military or civilian trainers andsupport staff, funding fortraining base operation and maintenance, seleeted overhead eosts, and other administrative costs.

ABBREVIATIONS: BOS=base operating support; HQs=headquarters; OSUT=one-station unit training; PCS=permanent change of station ; TDY=temporary duty.

SOURCE: Department of Defense, *Military Manpower Training Report,* fiscal year 1990.

Professional development programs for both officers and enlisted personnel are conducted at military and civilian institutions. Each service maintains Intermediate and Senior Service Schools and Colleges for their officers. In addition, DoD runs joint institutions to prepare military and civilian personnel for special assignments in program and project management, or for very high positions.[6]

Each service also has an office responsible for developing, procuring, and maintaining training systems. The Naval Training Systems Center (NTSC), in Orlando, Florida, for example, defines Navy training requirements, writes contracts, and manages delivery. Most of its development work is contracted out. A similar function is performed by the Army's Project Manager Training Devices (PM TRADE-located in the same building in Orlando). The Marine Corps and Air Force have liaison offices in Orlando. These groups try to coordinate efforts by sharing knowledge and avoiding duplication of efforts. They may work together to develop training systems, or provide them to other branches. For example, about 30 percent of NTSC's procurement budget comes through development and production of Army training devices.[7]

State and local educational agencies sometimes contribute to defense training efforts. For example, recruits at the Naval Training Center (NTC) in Orlando, Florida who need remedial reading or math before taking individual skills training are assigned to the Job Oriented Basic Skills (JOBS) Program, taught by instructors from the Orange County Public Schools System. (The JOBS curriculum was developed and written by Naval personnel.) Orange County does not charge the Navy for this service in recognition of the Navy's large contribution to Orlando's economy. This saved the Navy over $150,000 in instructor salaries between 1984 and 1989.[8]

Individual skills training is sometimes contracted out. A few years ago, for example, a Navy sponsored study concluded that it would be more cost-effective to contract out initial electrical/electronics skills training. A l-year contract (since renewed for 5 years) was awarded to San Diego Community Colleges to provide this service for the Orlando Naval Training Center. An onsite San Diego Dean (retired from the Navy) and an assistant oversee administration and hire instructors, many of whom are also Navy retirees in the Orlando area.[9]

DoD also uses civilian contract instructors for new operational systems coming into the military inventory. This is referred to as Factory Training or New Equipment

[6]Senior DoD and Service Colleges are the National Defense University (NDU—including the National War College and the Industrial College of the Armed Forces), Army War College, Navy War College, Air War College, Defense Intelligence College, Defense System Management College, and the Uniformed Services University of Health Sciences. Intermediate DoD and Service Schools include the Armed Forces Staff College (incorporated into the NDU in 1981), the Army Command and General Staff College, Air Command and Staff College, the College of Naval Command and Staff, the Marine Corps Command and Staff College (the Marine Corps University at Quantico, VA, consolidates Marine professional development programs under one command.) A separate system serves noncommissionedofficers.

[7]Naval Training Systems Center, "Poised for the Future," undated pamphlet.

[8]L.D. Wheatcraft, Naval Training Center, Orlando, Florida, personal communication to OTA, October 1989.

[9]Naval Training Center, Orlando,Florida, personal communication to OTA, October 1989.

Training. Inmost cases this contractor-conducted training is used only until the service is ready to take over the program. There are times, however, when the contractor will conduct the training for the life cycle of the equipment. Contract instructors are expected to follow military training standards.

Defense contractors who develop training programs are required to use the same development documentation and guidelines as the uniformed services. This is based on the "Interservice Procedures For Instructional Systems Development' or ISD. The Marine Corps uses the same system but calls it "System Approach to Training" or SAT ISD/SAT follow the same principles of instructional systems development discussed in chapter 7. This system was implemented service-wide in 1972 and continues to go through modifications.

Basic changes are occurring in the military's training procurement process. Historically, training packages for new military technologies were budgeted, contracted, and managed separately from the equipment itself, and often delivered later. In the case of the B1-B bomber, for example, Boeing delivered the first weapon system trainer 2 years after Rockwell delivered the last aircraft, and aircrews chalked up as many as 600 hours in the plane before getting access to the trainer.[10]

Now, the same program manager is more likely to handle both the military system and the training system, with the training an integral part of the program budget and provided by the military system prime contractor. For example, a Navy contract for a new program for initial jet training includes the T-45 training aircraft, the flight simulators, other training devices, instructors, logistics support, and the training sites. The theory is that the prime contractor will be better able to ensure concurrency with the training system. The change is affecting the military training industry by forcing contractors into joint ventures or requiring systems experts to suddenly also become training experts.[11]

Basic Skills Training

The more technical the requirements of the service mission, the more likely many high school graduates will need remedial training. Each service has programs to remedy educational deficiencies.

Recruits are given the Armed Services Vocational Aptitude Battery test for entry into initial skills training. Those who fail are assigned to remedial training in verbal and math skills (e.g., the Navy JOBS program, the Air Force JORP program, and the Army's JSEP program described inbox 6-E of ch. 6). The curriculum is designed to teach basic skills in the context of the recruit's assigned technical skill. Thus, remedial math instruction for the Navy's quartermaster (navigation) A School might teach the math skills needed to determine the distance, range, and bearing of another vessel based on its radar position.

Trainees who do not pass the remedial training may still go to the first level of initial skills training. If they again fail, they either are discharged or assigned low skill duties. Those in the latter group who perform their duties well and are motivated may be able to reenter initial skills training.

The various services have ongoing research programs to remedy deficiencies in basic education. The Navy Personnel Research and Development Center, the Naval Training Systems Center, the Office of Naval Research, and the Chief of Naval Education and Training have projects to address these problems. The services often contract with civilian organizations or universities to do much of the research and development. For example, the development of JSEP, which was initiated by the Army's continuing education system and monitored by the Army Research Institute, was undertaken by Florida State University and the Hazeltine Corp., now part of Ford Aerospace.

Both DoD and the services also have training programs for newly enlisted personnel in English as a Second Language. The DoD runs such a program at the Defense Language Institute at Lackland Air Force Base. Another program is conducted by the Puerto Rico Army National Guard. This remedial training, including English as a Second Language, is conducted prior to the newly enlisted going to basic training at Fort Jackson.

Training Technology

Current applications of instructional technology in military training are diverse and involve all of the technologies discussed in chapter 7. DoD also has numerous instructional technology research projects; only some of these will move into an operational status. Military training is an enormous enterprise with no centralized coordination. As a result, it is very difficult to provide a comprehensive description of DoD's use of instructional technology. Thus, this section will try to provide snapshots of the kind of activities being conducted.

Two military basic skills projects involve instructional technology: JSEP (see box 6-E in ch. 6) and the Spatial Data Management System (SDMS) project. SDMS was an attempt to demonstrate the use of interactive videodisc (IVD) through basic skills instruction in the context of map reading and navigation. This project was conducted by the Human Resources Research Organization for the

[10]Lawrence C. Grossman, "Prime Time," *Military Forum,* vol. 6, No. 3, November/December 1989.

[11]Ibid.

Army Research Institute in the early 1980s. It did not continue into an operational phase, although it served to demonstrate the potential of IVD for basic skills training.

For initial skills training, the basic model is still lecture/lab, but with numerous training aids in the classroom and laboratory. For example, classroom aids used in torpedo maintenance and repair training at NTC-Orlando include drawings and working cut-away models of torpedoes (full and partial scale), and all the component parts of torpedo propulsion, fueling, and targeting systems. Laboratories range from trouble-shooting benches for propulsion, fueling, and targeting (with actual torpedoes with inert warheads) to a full-scale submarine torpedo loading facility (with all currently used equipment and torpedoes). For firing exercises, a computer-managed system provides post-mission review.[12]

Quartermaster school at NTC-Orlando begins with classroom theory of navigation-learning to read charts, use nautical almanacs (e.g., tide and current tables, light lists), set courses, use dead reckoning, and plot positions. Trainees then move to a classroom with chart tables similar to those aboard ships with radar screens alongside. Videotape provides radar patterns corresponding to the navigation aids on charts plus the associated shorelines and possible other ship traffic.[13]

The Navy also has used teleconferencing for training. In 1989, for example, it initiated an "electronic schoolhouse" project at its fleet combat training center in Dan Neck, VA. The project links the training center with classrooms at navy bases in Norfolk, VA, Charleston, SC, and Mayport, FL, using two-way compressed video delivered via satellite. Each classroom has two cameras, large monitors, microphones, and an audio speaker, and accommodates 30-50 students. Ten courses were taught focusing on soft skills and basic concepts. The preliminary results showed a net savings of $50,000 (a total of 294 students, average 23 per session, a savings of $155,000 in travel and per diem over 5 months, and a cost of $105,000 for the teleconferencing). The students' grades were as good or better as when they traveled to the course, and they were able to train more students per session.

The Army logistics Management College also uses Satellite teleconferencing (one-way video, two-way audio) to teach logistics at over 30 sites. The televised courses have been taken by over 13,000 students.

Computer-based training and interactive video can be used in most military environment-n ships, for example. The Chief of Naval Education and Training (CNET) is monitoring some initiatives for reducing the costs of shore-based training, including mobile pierside trainers, onboard CBT packages, and teletraining. CNET has analyzed a number of existing onboard packages on computer literacy, ship maneuvering, and the Rules of the Road (part of navigation), as well as basic skills (functional and applied). It is examining physical characteristics of hardware and software (i.e., suitability of hardware for onboard spaces), and user characteristics. It found that some sailors were bored by and did not use many training packages. However, the packages did accustom people to computers. This is seen as a major need as more operational systems on ships become computerized.[14]

Military training technology increasingly involves simulators. Simulation is as old as organized warfare. The combat and technical training requirements of World War II, however, marked the beginning of what would become the contemporary simulation and training technology industry.

Simulators are crucial in military training because some tasks are too complex, costly, or dangerous to rehearse or to practice using real equipment. Simulators range from individual weapons simulators (see box A-l), to computer- or videodisc-based simulations of combat situations, to full-scale motion-based simulators, to networked versions of all of these.

The CNET analysis discussed above found that mobile pierside trainers are used more frequently than other CBT packages and contribute to computer literacy. An example is a computer-based simulator-the 20B5 pierside combat system team trainer-that the Navy uses for tactical gaming. It is housed in a trailer equipped with fiberoptic cables for radar and SONAR simulations and communications. The simulation capability arises from the computer programming and auxiliary equipment. For example, a digital general purpose radar indicator driven by the computer simulates combat radar signals. The Navy's current thrust is to introduce the tactical gaming packages dockside and to then move them onboard.[15]

Simulation, usually involving CBT and more recently, interactive videodisc, is also under development for maintenance. For example, in 1987, the Air Force Communications Command fielded 92 interactive video systems for electronics maintenance training on the AN/GRN radar and test equipment. The IVD system delivered on-the-job training for skills that had previously

[12]Naval Training Center, Orlando, Florida, personal communication to OTA, October 1989.

[13]Ibid.

[14]Naval Training Systems Center, personal communication to OTA, October 1989.

[15]Ibid.

Box A-l—The Marksmanship Expert Trainer

The Marksmanship Expert Trainer (MET) is a nonfiring M-16 automatic weapon (actual size and weight) that evaluates the trainee's aim and firing behavior. It simulates recoil and firing noise. When the trainee pulls the trigger, a light pen (instead of bullets) hits a target screen (either 72-inch projection screen or a computer monitor). A breath sensor tells whether the trainee is holding his breath, a trigger sensor determines squeeze/jerk, and an overall sensor evaluates stance. Initial targets are single and fixed; a computer management system shows where each shot went, how many hit the target, how far off the misses were, and the sensor results. More advanced targets pop on and off the screen at random; for each target the management system shows the path the trainee took to aim, how long it took to aim, and how many shots it took to hit the target. The expert systems reduce instructor requirements and sense things a live instructor cannot. The MET also does not require ammunition or a special target range area and thus is less expensive than training on real weapons. It is also safer than real bullets, has low maintenance, eliminates weather delays, and trains more quickly and more accurately.

SOURCE: Naval Training Systems Center, ***Marksmanship Expert Trainer,*** undated **pamphlet.**

been learned only through apprenticeship. The project involved a detailed followup on 160 trainees; however, no comparative evaluation of the IVD system versus apprenticeship only was conducted. The followup study indicated that the system was effective when used but difficult to integrate into the workplace.

Other examples of simulation using CBT or IVD training include:

The Computer Assisted Medical Interactive Video System (CAMIS), **Medical** Heath Sciences Education & T***raining Comman***d, Naval Medical Command: over ***25*** interactive videodisc courses in basic medical skills and medical knowledge areas have been fielded and many more are in development.

GUARD FIST II, Army **National Guard: a simulator employing IVD and computer-generated imagery will be used to provide tactical training in simulated battlefield scenarios. The simulator includes all equipment normally used by the Forward Observer MOS.**

Piloting and Navigation Team Trainers, U.S. Navy: a set of simulators are used to train naval officers on ship navigation and piloting skills. These simulators provide realistic presentations of shipboard equipment and use a variety of hydrographic databases.

OBT-89 ASW ***Trainer,*** **U.S. Navy: a simulator that** provides embedded training for the **AN/SQQ-89** sonar systems installed on surface ships for Anti-Submarine Warfare (ASW). The OBT-89 allows an instructor to program the AN/SQQ-89 for training exereises.

Networking also is increasingly important in military training (see box 7-J, ch. 7). Networking permits many groups to participate in the same training exercises. In addition to equipment, it requires databases for environmental simulation and expert systems for evaluation.

In most Navy ports, networks connect ships in the harbor to signal generators for training exercises. Some ports have master scenario generator/controller systems for battle simulation. Participants use personal computers (PCs) linked by a local area network (LAN) and telecommunications to other groups of participants at other PCs. The defense data network can be used for enhanced naval warfare gaming. An anti-submarine warfare tactical team trainer, with 300 students networked in one building, also is used. Networks involving 22 computers are used in Navy flight trainers to coordinate flight training domes. Simulation exercises can be global in reach: for example, scenarios generated by the Lamps helicopter weapon trainer system can be satellite broadcast to ships at sea and at foreign bases.[16]

As simulation databases have proliferated, the lack of standardization has complicated networking efforts. The B-52 training system, for example, has a database that cannot be used for the B-1 or the C-130. Integration can be a problem even within a single weapons system trainer if different contractors provide individual elements (e.g., the visual image generator and the radar simulator). The services are now working on a standard database that will be interoperable among all simulators, due to be completed in May 1991.[17]

Research on military training technology currently focuses on improved sensor (e.g., radar) simulation, low-cost graphics and image generation, embedded training, part-task training, and team training. In visual scene technology, the cost trade-offs are in the display and the image generator. Display costs for achieving the resolution required for certain training applications have come down significantly. For example, a passive sonar (LOFAR) trainer cost at least $35,000 when a minicomputer had to be used to achieve the high resolution, colors and shading needed for this application. The cost today

[16]Ibid.

[17]W.A. Demers, "All Together Now, " *Military Forum,* **vol. 6, No. 3, November/December 1989.**

can be as little as $5,000 when a 386 PC and video graphics array (VGA) monitor are used. Advances in high definition television (HDTV) will bring further cost reductions for high-resolution simulators. A second consideration is how much of an image a particular simulation actually needs. An F18 operational flight trainer for take-offs and landings uses three computer monitors; air combat maneuvers require a full dome, and battle simulators typically have a five-dome network. The alternative to the domes could be helmet-mounted displays and other features of virtual environments.[18]

Embedded training is attractive to the military for several reasons. First, complex military systems have proliferated to the point that conventional training simply is not adequate-there is too much to learn and remember, especially when duty assignments between training episodes frequently span a year or more. Second, most military training occurs at training centers while military systems are in the field; embedded training puts both in one place. Third, embedded training takes much less space than a classroom or even dedicated training equipment-an especially attractive feature on ships, or in facilities where space is limited. Fourth, embedded training is consistent with efforts to make training technology part of the prime system contractor's responsibility.[19] For all these reasons, current Army policy is that embedded training is to be considered the preferred training alternative for new systems.[20] Still, little is known yet about the design of effective embedded training (see ch. 7).

Performance support systems (PSS) are also getting DoD's attention. A PSS has been developed to help new Army Corps of Engineers employees figure out the complex details of the Army's military construction program. The PSS contains a database, which can be updated, covering each of the hundreds of projects underway throughout the world. An employee assigned to a project could use the PSS to get a list of project tasks, the steps needed to complete each task, and help in accomplishing it. For example, based on situations commonly arising in construction projects, the PSS might point out the need for a high priority letter, display model letters from the database, provide a word processor for editing a model, and print and send the approved letter. It also updates project status, suggests ways to level the workload to avoid crunches, and in other ways helps the employee stay on top of the job.[21]

Part-task trainers address the problem of how to train more people with fewer instructors for less cost. Using portable (often desktop) systems, they are aimed at teaching specific skills that combine in the performance of more complex tasks. Once the specific skills have been mastered in isolation, they can be combined effectively in complex and higher cost group or team simulations. NTSC is incorporating expert systems and interactive videodisc in part-task trainers.

Present military team training often is based on "practice devices" for individual skills used in a team situation. They have few embedded educational features, or evaluation and debriefing capabilities. The goal of current research is to produce effective teams that monitor their own performance, are self-correcting, get task and motivational reinforcement, adapt to unpredictability, and use closed-loop communications. Research on networking also will aid this effort.[22]

Technology Transfer

Because military training is a multibillion dollar enterprise that is increasingly technology-based, technology transfer to the civilian sector has become a major issue. Yet there are few visible examples beyond the use of flight simulators in commercial airlines and the National Aeronautics and Space Administration. Some trainers argue that military training is too specific to military missions (combat and weapons systems) to be applicable in the civilian sector (the so-called "green problem," which refers to the appearance of specific uniforms in training materials). A more basic problem is that the developers of military training technology are simply unaware of potential civilian applications, and potential civilian users are unaware of the military technology. For example, the developer of a military training R&D effort on bulldozer terrain imaging saw its obvious application to civilian earthmoving in construction projects, but failed to imagine its usefulness for open-pit and surface mining. Bridging this awareness gap is going to be extremely difficult.

A third problem is budget-related. If a research project does not have immediate military applications, it is not funded for development or demonstration. Technology transfer does not have a high priority in DoD's budget in general, and training technology is just one of many candidate technologies for transfer. Still transfer efforts are growing. For example, NTSC recently began adapting

[18]Naval Training Systems Center, personal communication to OTA, October 1989.

[19]Ibid.

[20]"Study Plan to Focus Embedded Training Research," *Training Systems and Devices,* vol. 1, No. 4, Fall 1989, p. 6.

[21]Harold Hunter, "The Knowledge Worker Performance Support System, " paper presented at Eighth Conference On Interactive Instruction Delivery, Feb. 21-23, 1990, Orlando, FL.

[22]Naval Training Systems Center, personal communication to OTA, October 1989.

educational software for public schools. It also is exploring medical applications for hand-held sonar trainers.[23]

Often, it is not the training technology per se that transfers, but its concept. Simulators are an example of a military training concept that is now finding a wide range of civilian applications. Thus, tank-driver simulators laid the groundwork for current truck- and auto-driver education units. It was the increasing capacity of PCs and their linkage to IVD that made simulator technology cost-effective for civilian applications that do not have so large a trainee population over which to spread the costs. Similarly, the nuclear submarine simulator led to simulators for nuclear powerplants and eventually for all types of powerplants. Exposure of the general population to motion-based simulators in amusement parks is likely to speed awareness of their potential for civilian training uses.

Yet in these examples, the connection between military and civilian uses was obvious. In most other Federal agencies that are successful at transferring training technology, either a connection is obvious (e.g., firefighting training conducted by several agencies), or the research is targeted directly toward transfer (e.g., the National Institutes of Health, the U.S. Bureau of Mines).

For training technology transfer to become more widespread, DoD would first have give it priority. This is especially important for R&D funding. Second, developers of military training materials would need to make an extra effort to identify potential civilian applications and civilian trainers would need to become more aware of military training systems. Third, both groups would have to hurdle the 'green problem' and realize that adaptation is cheaper than ground-up development.

Skills Transfer

Personnel trained by the military frequently are highly valued in the private sector, either for specific technical skills or for more basic interpersonal and self-discipline skills. The military apprenticeship model can lead to Bureau of Apprenticeship Training (BAT) certification as a journeyman. Even without certification, the military's own recognition of journeyman status is widely accepted by the civilian sector. Moreover, military trainees learn how to test, maintain, and repair the primary equipment ***and*** the testing, maintenance, and repair equipment.

Over the past several decades DoD and the Department of Labor have maintained separate compilations of occupational specialties in the workforce. There are cross data in the identification of these occupational skills that identify DoD officers, enlisted, Civil Service (General Service-GS, and Wage Board), and in the case of the Labor Department, civilian positions. Each occupational area is assigned an identification number based on careful analysis of the job to be performed. In most cases duties, tasks, and job functions are grouped together by service. These specific positions may not be identical, however, due to the equipment, mission, and personnel structure of the individual service.

In most service occupational fields, there are career paths for both officers and enlisted personnel. As an example, the Marine Corp Occupational Field 35, Motor Transport, includes the operations and maintenance functions within the tactical and commercial motor vehicle services. A Marine in this field will participate in a number of formal schools and can progress from Private (E-1) as, for example, a Body Repair Mechanic (MOS 3513), to a Motor Transport Operations Chief with the rank of Master Gunnery Sergeant (E-9). That Marine also may have the opportunity to participate in a formal apprenticeship program that leads to BAT certification.

This field requires skills and knowledge widely needed in the civilian economy. The MOSS include: 3500-Basic Motor Transport Marine, 3513-Body Repair Mechanic, 3521-Organizational Automotive Mechanic, 3522-Intermediate Automotive Mechanic, 3523-Vehicle Recovery Mechanic, 3524-Fuel and Electrical Systems Mechanic, 3525-Crash/Fire/Rescue Vehicle Mechanic, 3529-Motor Transport Maintenance Chief, 3531-Motor Vehicle Operator, 3533 -Tractor/Trailer Operator, 3534-Semitrailer Refueler Operator, 3537-Motor Transport Chief, and 3538-Licensing Examiner.

Other military occupations such as pilot, aircraft maintenance, air traffic controller, powerplant operator, firefighter, cook, medical assistant, or marine navigator also have direct civilian counterparts. While the equipment may not be identical, the skills are readily transferable with little or no additional training. Other skills training such as electrical/electronics provides valuable background for a wide range of civilian occupations.

Finally, some DoD professional development and education concepts may have application to the leadership and management of American industry. Likewise some Government training programs, such as Total Quality Management (TQM—now being used in the military as well), have proven useful in civilian industry.

[23] Ibid.

Index

Index

Related OTA Reports

. *Technology and Structural Unemployment: Reemploying Displaced Adults.*
OTA-ITE-250, 2/86; 448 p.; NTIS order #PB 86-206 174/AS.

• Trade Adjustment Assistance: New *Ideas for an Old Program.*
OTA-ITE-346, 6/87; 80p. NTIS order #PB 87-203741.

. *Plant Closing: Advance Notice and Rapid Responses.*
OTA-ITE-321, 9/86; 68p. NTIS order #PB 87-118 212/AS.

• *Making Things Better: Competing in Manufacturing.*
OTA-ITE-443, 2/90; 244p. GPO stock #052-003-01 178-6; $11.00.
NTIS order #PB 90-205469.

. *International Competition in Services: Banking, Building, Software, Know How . . .*
OTA-ITE-328, 7/87; 412p. NTIS order #PB 87-212 403/AS.

• *Technology and the American Economic Transition: Choices for the Future.*
OTA-TET-283, 5/88; 521p. NTIS order #PB 88-214 127/AS.

• *Linking for Learning: A New Course for Education.*
OTA-SET-430, 11/89; 192 p. GPO stock W52-003-01170-l; $9,00.
NTIS order #PB 90-156 969/AS.

• Power *On! New Tools for Teaching and Learning.*
OTA-SET-379, 9/88; 260 p. GPO stock #052-003-01125-5; $11.00.
NTIS order #PB 89-114 276/AS.

• Educating scientists and Engineers: ***Grade*** *School to Grad School.*
OTA-SET-377, 6/88 136 p. GPO stock #052-003-01110-7; $6.00.
NTIS order #PB 88-235 973/AS.