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The Relationship of Science and Power

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I am delighted that Carl Sagan has arrived at his sixtieth birthday, that he has accomplished so much that such a book is more than appropriate, and that I have been invited to provide a paper on "Science and Power."

Science (the knowledge of the nature and function of the world and its parts) connotes power, if only sometimes the power to know when to get out of the way.

Intervention involves more often technology as well as (or instead of) science, and technology evolved for a long time independent of formal science. Now, of course, the advance of science has made it much more relevant even to older technology and essential to modern technology.

The encounter of scientists with military or political power has not always been pleasant. Whereas the death of Archimedes was an unsought consequence of war, Galileo's recantation was a victory of dogma over freedom of speech, if not freedom of inquiry.

Science provides power both absolute and relative – relative, that is, to the power of someone else. Absolute benefit may allow one's society to improve the quality of crops, to leam the nature of the planets. Relative benefit may be more immediately valuable, as in the tale of the two hunters, George and Mike, pursued by an enraged grizzly bear. Running as if his life depended on it, George after awhile called to Mike "I don't know why we're running, everyone knows you can't outrun a grizzly bear." And Mike replied, "I don't need to outrun a grizzly; I only need to outrun you."

So, while rulers may have sought a court scientist for novelty or for enlightenment, and eventually for practical contributions, it was the relative benefit, especially in military activities, that forged the closest links of science to temporal power.

That brings us to science in the service of competition, which is not the same as competitive science. Some scientists are competitive by nature – a quality that tends to be prized in modern life and that, with necessary regulation, underlies a lot of the wealth creation and advances of modern times. It is sometimes said about the competition inherent in horse racing that its purpose is to improve the breed and I suppose that is true; however, one can also win a horse race by drugging the opponent's horse or bribing the jockey.

One of the major forms of competition is war, with which science has had a long association. During World War II, scientists in Britain were motivated by patriotism and fear of conquest to see what they could contribute against the Nazi threat, and, spurred by refugee scientists, the United States mobilized its scientific community to produce the proximity fuse, to help develop and manufacture radar, and to create the atomic bomb – the first two nuclear weapons used against Japan in August 1945.

War is hardly a game, particularly when accompanied by a plan and a program for genocide. The goal of the Allies was both laudable and necessary – to stop the Nazi war machine and soon also the Japanese military. The means, though, was to destroy enemy fighters and equipment and, eventually, industrial support and people.

Through individual genius and genius of organization, combined with dedication and energy, this crucial battle was won. But science and technology were used effectively on the other side as well, notably in long-range rockets.

After the war, the United States was left with an enormous facility for producing weapons and what was seen to be an enormous science-based system for inventing and developing them. Aside from the personal tragedies and combat deaths, the United States did not suffer materially from the war and so was not faced with the immediate enormous task of reconstruction, as were its allies Britain and the Soviet Union, and the defeated or liberated powers like Germany and Poland.

In the immediate postwar atmosphere, there was no obvious military threat, but there was momentum created in the wartime laboratory efforts, together with the excitement and substantial government support. Most of the scientists left weapons work for university activities, with science now to receive substantial funding from a grateful government and people. Conventional industry, for the most part, really did not know what to do with science. American industry, however, had unmet consumer needs and went back to making automobiles, refrigerators, rail cars, and light bulbs.

A surprising amount of initiative was required, as reported by Simon Ramo, particularly, eventually to create a totally new science-based industry for modern weapons, their command and control, and intelligence.

But it was clear that if large-scale conflict should come, the United States would be better served by more advanced (even by less costly) versions of the weapons that had been so important during the war, and Los Alamos turned rather slowly to making improved versions of fission weapons, to introducing the concept of the boosted fission bomb, and eventually solved the problem of a practical approach to a thermonuclear weapon. From concept in early 1951 to ten-megaton explosion in less than twenty months was no sluggish program.

The advance of miniaturization of vacuum tubes and then the burgeoning of semiconductor electronics after the invention of the transistor at Bell Telephone Laboratories allowed the practical realization of enormous amounts of computing and control capacity within the weapons themselves and facilitated communication where such computation needed to be done off-board, so to speak. So the wartime advances in propulsion, structures, and particularly in industrial organization were followed by successive generations of weapons and weapon systems such as those devoted to air defense, integration of platform and weapons, and the like.

But at the same time that this enormous peacetime weapons industry arose, there was a potential enemy, even identified (and perhaps partially created) by some far-seeing individuals (or paranoid) during World War II itself. This was our only possible rival at the time – the Soviet Union. And Stalin was a formidable foe, ruthless with his own people. His organized terror was accompanied by personal terror, with the result that people feared to approach him to argue vigorously against activities that were harmful to the Soviet Union and even to the system that Stalin was trying to create. The destruction of Soviet biology by Stalin's elevation of Lysenko may have been prevented in physics only by Stalin's need for the physicists to create the Soviet atomic bomb.

About these matters, we have now a good deal of information, much of it from people whom we have grown to know quite well, such as Roald Sagdeev, Georgi Arbatov, and many others. In regard to the Soviet atomic bomb, we have now the scholarly book by David Holloway.

But on our side, we had no such individual terror that would act against people who spoke frankly to our presidents. Some did not have the opportunity, but all too often, those who did have the opportunity were unwilling (for what seemed to them good reason) to provide advice that might have helped. What are these reasons?

First, I suppose that there is self-doubt, although this is not high on the list of infirmities that one would ascribe to many of those in a position to talk with presidents.

Second, there is the desire to preserve one's influence for the future and not to sacrifice it on something that might be a lost cause. Perhaps a little more about this later.

If advice is secret, who knows what goes unsaid? But with regard to public advice to those in power, I don't remember a time when there has not been criticism from one side or the other, or more commonly from both. Several partial solutions have been achieved. First, one can try to have as advisors working scientists who bring with them the honesty and self-questioning that are essential to successful science. Furthermore, the peculiarly American mobility of individuals among the roles of outside expert and provider of congressional testimony, full-time government employee, and consultant is helpful, and we have had some success in spreading this to other countries.

The vast majority of scientists active and effective in public policy are based in universities, and universities in this way play a vital role in our democratic system. Cornell, Massachusetts Institute of Technology, Stanford, and Harvard have been among the universities from which the most effective contributors have come.

Beyond the universities, nonprofit public interest groups like the Federation of American Scientists (FAS), having its fiftieth anniversary in 1995, play an important role, largely in conjunction with academic scientists. You have read an article by an official of FAS, Ann Druyan, and you are reading one by another here, since I am Vice-Chairman of the FAS and Chairman of the FAS Fund.

Also particularly valuable in government service are people like Spurgeon Keeny, now President of the Arms Control Association, and the late James R. Killian, first head of the White House President's Science Advisory Committee (PSAC). These typify people who are not professional scientists but who have the integrity and the combination of confidence and self-questioning that are essential to science.

Accompanying scientific influence on important matters is the temptation to manipulate others. There is also the use of power and influence against the individual scientists, their colleagues, or even their institutions or families.

For instance, at a time when Edward Teller was pushing hard for a commitment to the hydrogen bomb, J. Robert Oppenheimer, as head of the General Advisory Committee of the Atomic Energy Commission (and fabled wartime Director of Los Alamos) stood in his way. It is only natural that one should try to accomplish one's goal, and also to remove the obstacles, and that is apparently what Teller tried to do in this instance.[1]

When Hans Bethe and I published in March 1968 our *Scientific American* article, "ABM Systems," the Secretary of the Army, Stanley Resor, signed a memo asking the Army to marshal support among scientists for the system that was threatened by our arguments.[2]

[1]I add that the advance of civilization derives in part by self-limitation from the natural.

[2]Stan Resor is now a staunch ally in the fight for rational, even real, defense, programs.

As an aside, from my own experience the more difficult problem for those interested in substance is not to counter individuals who are knowledgeable and committed on the other side, or individuals who are committed though ignorant, but rather to counter paid publicists, or legislators, or those who regard it as their job to be hired guns and to do whatever is not clearly illegal to further the goals of those who are paying them. In 1991, Ted Postol of Massachusetts Institute of Technology had the ingenuity to analyze television video of putative intercepts of Iraqi Scud missiles by Patriot air-defense interceptors in Israel and Saudi Arabia, and the courage to publish these results earned him organized attack by Raytheon, the Patriot system builder. The definition of a successful intercept now seems to be that an incoming missile was detected and an interceptor successfully launched.

The Strategic Defense Initiative (SDI) program initiated by President Ronald Reagan on March 23, 1983, with a television broadcast that surprised not only scientists outside his Administration but also the scientists and military inside, is instructive in the relation of science to power.

The Executive Summary of the SDI study led by James Fletcher in 1983, following (not preceding) President Reagan's announcement of the SDI program, did not fairly represent the contents and conclusions of the seven volumes of the study. When asked, Fletcher publicly acknowledged having had no influence on the Executive Summary and when asked who wrote it said, in my hearing, "Beats me. Someone in the White House, I suppose." But he did not contest publicly the substance of the summary. Programmatically, SDI dissected the necessary technological advances into manageable pieces that could be parceled out as contracts to industry – each one a reasonable or major extension of our capability. However, to reach the goals of SDI would have required success in a vast number of these elementary improvements, as well as the cooperation of our adversary, the Soviet Union – both inherently unlikely.

A Director of SDI, Lieutenant General James A. Abrahamson, was not appointed until almost a year after the Reagan speech. Both before that time and afterward, a major influence was played by Major (now Colonel) Simon P. Worden, an astrophysicist with whom many of us had vigorous and often unpleasant encounters in our analysis of prospects of success of SDI. Later, he apologized to some of us for his actions as self-acknowledged hired gun, but that did not help us or the nation at the time.

Unfortunately, it is rare for a hired gun to do what is required even in the most noncontroversial scientific field, and that is to provide a reasoned paper – not just a viewgraph. But I did have an extended correspondence with Peter Worden following his claim that a 10-meter diameter mirror in low Earth orbit could be used to focus sunlight to cause damage on the Earth's surface, as if there were not a totally

fundamental difference in this case between the disorganized light from the sun and that from a laser.

It is more than a quip that it is not so much what you don't know that will hurt you but what you think you know that isn't so. In this regard, I have repeatedly admired Carl Sagan's dedication to challenging his own tentative conclusions. I was not so pleased when a well-known scientist from the Lawrence Livermore National Laboratory, active in SDI activities, had not assimilated by 1985 a simple analysis of 1983 that emphasized a single point: If an offensive missile can be destroyed in its boost phase of four minutes' duration, by a very fast interceptor that needs a launch weight 100 times its payload to reach the required speed, then it will require an interceptor launch mass of 100×100 or 10,000 times its payload to destroy a missile with a two-minute boost phase.[3] It is irresponsible for scientists or others who are playing a role in advocacy not to know of the chief arguments of the other side.

Now consider three cases:

- If with gun in hand, I accost a prosperous-looking person on the street and demand, "Give me $100 or I'll kill you" and I am caught, I will be sent to jail for armed robbery.
- If without the gun in my pocket, I accost the same person and say, "Give me $100 or my brother will kill you" and I am caught, I will go to jail for extortion.
- But if I go on television and demand from the public, "Give me $300 billion for our military activities, or the Russians will kill you" I will be deemed a great patriot and perhaps will be elected to high office.

There are real hazards and opportunities in this world, and that is why we cannot always err on the side of caution in response to every claimed threat. Furthermore, matters of arms and the military must be considered together with possible perceptions and responses by other nations and the stability of the interactive system.

Arms control and disarmament are important options that we are finally beginning to use.

What scientists can do to help our country and our world is very much limited by the inefficiencies of our current political process. For the activities of some of those in public office, the outcry of attorney Joseph Welch to Senator Joseph P. McCarthy in the 1954 hearings of Senator McCarthy on alleged communist influence on the U.S. army is appropriate: "*Have you no shame?*"

[3]This simple analysis was essential to showing that pop-up interceptors have no future for defense against a responsive missile force – that is, one that takes into account the nature of the defense.

His personal power challenged in the academic porkbarrel activities, Representative John P. Murtha (D-PA), Chairman of the House Appropriations Defense Subcommittee, lashed out at Representative George Brown (D-CA), Chair of the House Science Committee, by deleting $900 million in academic research sponsored by the Department of Defense. Indeed, *Aviation Week and Space Technology* of October 3, 1994, has an editorial, "Abolish the R&D Porkbarrel".[4]

And while many, but not all, in the House and Senate posture for the electorate and admittedly spend the majority of their effort on amassing funds and credits for reelection, the staff of the two elected officials in the Executive Branch of the U.S. government have been doing the same for several decades. Our Legislative branch seems to be 90% posture and 10% performance; Common Cause (no surprise) has not achieved its goals of reform. Paradoxically, it may be that the United States could have a more coherent long-term policy if officials were limited to a single term in office, so that they could concentrate on doing the job to which they were elected.

The rare combination of outstanding scientific talent and dedication to the public interest so apparent among the invited guests of the Sagan sixtieth birthday symposium will be of no avail if our society cannot govern itself in those matters to which science is not central. Democracy, which we prize, contains the seeds of its own destruction. The power to choose includes the power to choose wrong.

In Russia there is a hazard of rejection of democracy, but also in the United States. Unless we provide more effectively the public goods of security against crime, of employment, and health care, I see a real threat of the electorate choosing remedies that will lead to disaster. If those of us who have some power don't address these problems because it is right to do so, we should do it because our future depends on their solution.

[4]The following week, the House–Senate conference committee reduced the cut to $200 M – about 10% of Department of Defense-sponsored university research.