

U.S. Science Policy at a Turning Point?

by

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Abstract:

Those of us who are involved day-to-day in science and technology are confronted, perforce, with reality, but in government science policy there are strong motivations to avoid reality either in the formulation of programs or in the analysis of their success. Some of these problems arise from our democratic system, which, according to Winston Churchill in 1947, is "the worst form of government, except for all those other forms that have been tried from time to time." Improved science policy mechanisms should include the elimination of earmarks for public programs, especially in science and technology; the upgrading of the President's Science Advisor and of his staff and support; the reconstitution in modern guise of an effective President's Science Advisory Committee-- PSAC; and for the Congress, a restoration of the highly successful Office of Technology Assessment-- OTA. The problems that must be faced squarely are the provision for the U.S. government and the Congress of proper analyses of our present societal problems and opportunities and their susceptibility to solution by S&T programs. High among these is the general level of S&T talent in the United States, where our current immigration and visa regulations and practices deny us what used to be a steady stream of talent into the country either in the short term or for graduate work in S&T, where the scientist, mathematician, or engineer would very likely stay to work in the United States. Other needed reforms are to change the present emphasis on marginal science and technology to those programs that could really make a difference. In the talk, I provide some examples of these problems and of some rousing successes and how they came about.

Of the many problems and opportunities facing the United States, there are hardly any that have not been and could not be further transformed by the appropriate choice and implementation of S&T. But unlike the highly successful Manhattan Project to produce the first nuclear weapons and the NASA Apollo Program to put astronauts on the Moon, with safe return within the decade, many of the potential programs would interfere with ongoing business or government activities. The current participants have enormous power, whether they be Fannie Mae, Freddie Mac, or an aircraft manufacturer, or a grower of corn. And although the lobbying profession and those that employ them swear that they do not buy decisions, they certainly do buy access, and with a finite amount of time of those in Congress, that is all that is required to overwhelm the whisper of truth and to warp the backbone of democracy.

Similarly, in the national security area, there is much pressure to keep funds and programs going to continue to manufacture from existing production lines, or to have a replacement program that exactly fits the interfaces and boundaries, thus stifling even modest amounts of innovation. In a White Paper widely acclaimed within the U.S defense and weapon establishment, the Tony Blair government of the United Kingdom justified a replacement

fleet for the Vanguard submarines (the UK equivalent of the Trident submarine) on the grounds that the future is uncertain and therefore one needs to maintain the submarine-launched nuclear weapon deterrent. France similarly cited the uncertain future, but no link was made in either case between the nature and number of the weapons to be retained or replaced, and the threat. The U.S. Defense Department under the able leadership of Defense Secretary Robert Gates is moving down the same path, ill-advised by the civilian nuclear weapon advisors who seem to have learned nothing from the last 14 years of Science-Based Stockpile Stewardship. And the Department of Energy, that develops and pays for the nuclear warheads, and in particular the National Nuclear Security Administration-- NNSA-- is arguing for the "Reliable Replacement Warhead" as a replacement for the W-76 warhead on the Trident submarines. The claim lower cost for the system, including that for manufacturing and caring for the warheads, but no document exists that shows cost estimates for the RRW, much less for the mixed fleet of Legacy weapons and RRW(s) that will coexist for decades under any reasonable replacement program. Nor is there a document that evaluates the overall safety and security of the system.

In the energy field, it is all too evident that petroleum suppliers have recognized (perhaps through their own extensive modeling of markets and behavior) that they can make far more money while conserving their resource by limiting supply, both of petroleum and of refinery capacity, and that is what we have, despite voices from the industry that a price of oil per barrel above \$60-80 is not understandable at present. This paragraph was written in early August, 2008, when the world oil price was \$120/bbl, down from a peak of \$143 the previous month and compared with some \$58/bbl today.

So far as nuclear power is concerned (and especially traditional fission reactors), among the other problems there is said to be no assurance of supply beyond the 4 million tons of uranium in known terrestrial reserves. Yet there are 4000 million tons of uranium in the oceans, and some of that has been extracted in recent years at the kilogram level by means of ion-exchange polymers. Yet I have been unable to have the United States provide any significant support for a university and laboratory program that could determine whether the cost of extraction is bounded by \$150/kg or \$1000 per kg of uranium, even though that information (although far above current costs of terrestrial supply) is absolutely crucial to any decision

that would involve saving uranium (about 20%) by reprocessing of fuel from light-water reactors, or the decision to change to breeder reactors.

Much is to be gained by greater openness and competitive analysis of options in these fields. Both invention and analysis are necessary. One caution: the Manhattan Project that culminated in nuclear weapons benefitted from its tremendous secrecy as did work in the early programs for satellite reconnaissance.

***So much to discuss, and so little time.* But that is our circumstance in everyday life and in our profession. We can incorporate some useful material by reference, and through the magic of the Web, can make it available, as I said in my Berkeley Physics graduation speech of May 19, 2000, *"from Berkeley or North Dakota or a village in Turkey."* This is more efficient in reading than in oral presentation.**

If I tell you to go to the Web and even to my website, *www.fas.org/RLG/*, you may not find it so easy to locate that speech. Here is the beginning of the list of papers and presentations for the 21st century:

The Garwin Archive - 2000-2008



- [What the U.S. Can Do Now To Reduce the Hazard of Nuclear Weapons](#) by R.L. Garwin. Talk at Qingdao University Symposium, Qingdao, Shandong Province, China, 29 October 2008
- ["Ballistic Missile Defense and Space Weapons."](#) by R.L. Garwin. Seminar on International Security: Building a Harmonious World, Qingdao, Shandong Province, China, 26-30 October 2008
- ["Submission to the Nuclear Regulatory meeting on Security and Radioactive sources."](#) by R.L. Garwin, S. Leivesley, A.L. Moore, and Wilson, Docket ID: NRC-2008-0419, Submitted September 2008
- ["The Single Most Important Enabler of a Nuclear Power Renaissance: Geologic Repositories."](#) by R.L. Garwin. Presented at a conference on The Future of Nuclear Energy, September 25-26, 2008.
- ["Responding to the Prospect of Dirty Dust \(the residue from a radiological dispersal device\)"](#) by R.L. Garwin. Permanent Monitoring Panel on Mitigation of Terrorist Acts (PMP-MTA). Presented at the Scientists General Meeting, Erice, Sicily, August 23, 2008.

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[\[PDF\] Pief's Contributions to Arms Control and Nuclear Disarmament](#)

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Recruited to **Berkeley** by his Los Alamos colleague Luis Alvarez after the war, Pief. worked with him on the proton linear accelerator and the MTA ("Materials ...

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Some sentences of the speech of May 2000:

This is a good time. The economy zooms; the nation is at peace, both externally and without much strife within (that in Congress being a notable exception).

We can all relax; or can we? No more than we can safely remove the control rods from a freshly fueled nuclear reactor, where, after all, there are only a few neutrons from cosmic rays instead of the million trillion per second captured in normal operations by those same control rods.

...

However, in hundreds of days of meeting with our armed services, Pentagon, and defense contractors, it was apparent that "the better is the enemy of the good (enough)". All too often, capabilities that were vitally needed were delayed or never provided because our colleagues were more interested in research or perfection than in solving the problem at hand.

...

Among the potential counters [to nuclear-armed ICBMs from Iraq, Iran, or North Korea] are diplomacy, buying off the threat, deterring the use of such missiles by the promise of nuclear retaliation, deterring the deployment or even the development by such a deterrent threat, and passive defense against biological weapon attack.

As for active defense, the Administration has chosen to consider the deployment of a system for mid-course intercept of the warheads in the vacuum of space by actual collision with the warheads at 10 km/s speed. We have indeed demonstrated such intercepts against our own test bodies several times (and failed many more times). But this approach, even if successful technically, will be totally ineffective in the face of the strategically most effective attack with biological warfare agents delivered in hundreds of bomblets released just after the ICBM reaches its full speed.

And a nuclear warhead in the vacuum of space can be protected by enclosing it in a balloon, which facilitates the use of dozens of realistic similar empty balloons as decoys.

But what does that mean to us?

In fact, in an unusual action, the Council of the American Physical Society (with 42,000 members) has this month issued a statement urging that a decision to deploy a national missile defense not be made until the proposed system has demonstrated that it can defeat realistic countermeasures such as the bomblets and the anti-simulation balloons.

The Rumsfeld Commission [of 1998] stated that any of these countries could sooner, more effectively, more accurately, and more cheaply provide a similar threat by the use

of short-range ballistic or cruise missiles launched from ships against one or more U.S. coastal cities. And the Commission also particularly called out the threat from BW agents in bomblets, not as a counter to a defensive system, but because the offensive missiles could be four to ten times smaller or fewer for a given effectiveness, if the BW payload were delivered in the form of bomblets.

...

The other unfortunate thing that is happening as Congress exercises its power was the rejection in the Senate last October of the Comprehensive Test Ban Treaty, which would extend the limitations on nuclear testing to ban all nuclear weapon explosions, including those underground which have been permitted since 1963 when all the others were banned by treaty. This action, unless reversed in the next Administration, will surely encourage more nations to have nuclear weapons. We used to regard nuclear weapons as the great equalizer against the enormous armies of the Soviet Union and its allies. And they still are the great equalizer but now we are the equalizee. This is not a good path for us to take. There were no hearings of sufficient length and no hearing reports on the Comprehensive Test Ban Treaty. The whole thing was called up for a vote and was over in less than two weeks.

I think that much of the antagonism to the Treaty was simple dislike of the President by the members of the Senate. There were arguments raised against the Treaty that it could not be verified; that we would not be able to maintain nuclear weapons safe and reliable without nuclear testing. All of these concerns could have been met by a proper

set of hearings such as has been held on every other important treaty. I think much of the opposition comes from a tendency to regard the United States as a nation very different from others. Since we are law abiding, we don't need laws. Criminals won't obey the laws and we don't need the laws. But if you consider on the domestic scene a society without laws, you won't like it for very long.

The other problem is that people tend to regard Russia, a former superpower which still has probably 18,000 nuclear weapons each of which could kill half-a-million people (if they were not already dead), as no longer a superpower—but as an economic weakling that lost the Cold War and deserves to be punished. This is not the way to establish the security of the United States. Some say that the Russians cannot afford to maintain operational more than a thousand nuclear weapons, and we have about 10,000 that are operational. Why not eliminate all arms control agreements and we will be able to maintain this superiority? But how would we ever use this 9000 nuclear weapon advantage? It is far more important to us to get rid of the 17,000 extra nuclear weapons that are lying around in Russia, that might be used by them or transferred to others, than to maintain a superiority in number of nuclear weapons.

There are vast changes in the world, in the opportunities in physics and in the role for physicists and astronomers. In computation, for instance, the first nuclear weapons were built in 1945 with the aid of card-programmed calculators (punched IBM cards) that computed at the rate of perhaps ten operations per second. Now your desktop PC

computes at 500 million operations per second and you can buy one for less than \$1000. And tens of millions of people in the world know how to use computers, in contrast to a few hundred in 1945.

Communications have accelerated, as well-- not only telephone, but the Internet, providing almost instant communications worldwide for almost zero cost. In a way, this is not such an improvement as one might imagine; a hundred years ago in Paris or New York, I believe that the post was delivered four times a day, and a pneumatic tube system underground communicated letters from one point in the city to another within about ten minutes. On the other hand, the Internet is a phenomenal good in allowing worldwide access to libraries and online data—from Berkeley or North Dakota or a village in Turkey.

It is hard not to envy people who come into a world of physics so richly endowed with affordable tools that were unknown or dimly conceived when I began in the late 1940s. You have a wonderful life ahead of you. The frontier problems in physics are harder now, but these tools which can attack those problems can be put to everyday use-- and are-- where problems that used to be difficult simply vanish before them.

While you are enjoying your work, occasionally seized by the divine passion for solving a problem, put some time aside regularly to think about your role in preserving your society against ignorance and unreason. Particularly should you be aware and work to

understand and communicate your views on questions such as the national missile defense or Comprehensive Test Ban Treaty that I have described.

Looking back, we see that such comments may have had some effect. The Missile Defense Agency no longer claims that the defense it is deploying will protect against biological agents—perhaps because the bomblet threat was compelling. But I doubt that supporters of missile defense in Congress have understood this essential point.

It is clear that as President and Vice President, Barack Obama and Joe Biden will have an enormous task rebuilding the idea of government of this country, as well as the substance of government to serve the people's needs. They are well aware of the necessity of getting the best people and the best organization or (I emphasize) a good enough organization in order that the best not be the enemy of the good.

In particular, George W. Bush didn't announce the selection of his Science Advisor until five months after he took office on January 20, 2001, and John Marburger did not occupy that office until November of that year-- time and influence wasted. With the new spirit of "country first" espoused by both presidential candidates, we can hope that Senate approval of administration nominees will be more rapid and less idiosyncratic, and that the President and his staff will move quickly to make the key nominations.

For a Defense Secretary, I would hope that Robert M. Gates might be persuaded to continue to serve at least for a couple of years. For President's Science Advisor and Special Assistant to the President, the new President should consider people of the quality of the two I identify here:



Shirley Ann Jackson



John P. Holdren

Shirley Ann Jackson, President of Rensselaer Polytechnic Institute, former President of the AAAS, and former chair of the Nuclear Regulatory Commission, would be a fine choice, as would John P. Holdren, Professor of Environmental Policy and other important posts at Harvard, Director of the Woods Hole Research Center, and also a former President of AAAS. And they should be supported by a

working President's Advisory Committee on Science and Technology, with multiple continuing panels that do real work in various areas that have a large technical component. But either could fill other key roles in the Obama administration.

The President's Science Advisory Committee (PSAC) was created, or rather brought into the White House, by Dwight D. Eisenhower, soon after he succeeded President Harry S. Truman in 1953. Eisenhower relied on "his scientists" to guide him, particularly in matters of national security such as space and nuclear weapons. The 18 members of PSAC served four-year terms, met as a Committee two days each month in the Old Executive Office Building and had at any time perhaps 10 standing or *ad hoc* panels such as my own on Military Aircraft, Antisubmarine Warfare, Naval Warfare, or the Strategic Military Panel of which I was a member but never chaired during my two PSAC terms and many years of service as a consultant to PSAC.

Edwin H. Land, of Polaroid fame, led a panel for the President's Science Advisor (and the Deputy Secretary of Defense and the Director of CIA) on "Overhead Reconnaissance" – the "Land Panel" that brought us first the U-2 spy plane, then the Mach-3 SR-71, the Corona film-return satellites (1960-1973) and the current electro-optical near-real-time systems on which the new 0.5 m resolution GeoEye is patterned. Edward Purcell, Harvard physicist, was a key player in these activities.

Paul Doty and Frank Westheimer were two chemists on PSAC, and Sid Drell and the late W.K.H. (Pief) Panofsky two physicists. President Nixon abolished PSAC and the office of Science Advisor in 1973 because he and his political staff felt it insufficiently supportive of his goals, especially in the deployment of antimissile defense and the commercial supersonic aircraft, despite his having encouraged PSAC members to testify in Congress regarding the ABM system.

It was at a PSAC session where I was accustomed to sitting next to John Tukey, Princeton and Bell Labs statistician, Land-Panel member, and a real innovator, that I saw him writing Fourier sums. [story of FFT].

More directly related to PSAC and its panels is a one-day workshop that we organized in 1965 on Airport Noise. [State Dept. reception area and aircraft landing at DCA. 20 dB reduction].

The government needs to avail itself of competent technical people particularly in the field of modelling, not limited to the reactors, space missions, and nuclear weapons that come to mind. In support of regulation and legislation, we need to model the health care system and also the financial system, not to mention conventional energy markets and the justice system. Our colleagues in Physics and Math who have had jobs in Wall Street can make major contributions to the public good by simulations that help to understand the complexities of modern society and

finance, instabilities of the system, and the influence of regulations that might be adopted. You can bet that financial firms will use advanced computer simulations and will lobby to obtain the regulation they want; the Executive and the Congress need similar tools to achieve public goals.

The market place of ideas needs to be emphasized. Even if some of the programs need to be delayed, they should not be forgotten. One example is the Air Traffic Control System sketched as our preferred approach in the 1971 PSAC Air Traffic Control Panel Report-- an activity that I chaired and that had several of the most capable and experienced people in ATC, together with those newer to the field but with extensive experience and ability in technology that might be employed in air traffic control. In particular, our recommendation was to move within a decade or so to a data based system for the three functions of ATC-- communication, monitoring of position, and navigation. Our Report was suppressed from publication in the Nixon Administration by pressure from the Department of Transportation and the Federal Aviation Administration-- FAA-- and was saved from oblivion only by the action of our canny Executive Secretary, who had it committed to and available from the National Technical Information System-- NTIS. I have recently posted this on my website. Search in the Google search box with:

site:fas.org/RLG/ "air traffic control"

In this case there are 16 hits, and the one you want is "The Garwin Archive - 1970s". Because the scanned PDF text is not itself searchable, most of the hits are on others of my papers referring to that ATC Report.

In any case, I have recently written and posted on my website "An air traffic control system for the twentieth(!) century," published in the on-line archive of the Bulletin of Atomic Scientists, November 5, 2007. When Jay Keyworth was named Science Advisor by President Reagan in 1981, I tried to persuade him that the satellite-based ATC system of our 1971 PSAC report would be a fitting project to help modernize our infrastructure and to provide leadership and a high-tech product and service for the rest of the world. Perhaps in the modern world of empowered terrorists, disruption of such a system by jamming the satellite receivers is too great a threat, but this is an example of a modern technology program that should be analyzed and modeled in a prompt and competent fashion.

Yesterday at a workshop in DC on countering potential terrorist use of radiological dispersal devices—"dirty bombs," "dirty dust"-- I was asked about priorities for protection against attack on chemical facilities, BW attack, etc. My reply is that we have a big government and that we need to make the best use of it by getting good people to head the various departments and agencies, give them orders and tactical independence. Trust them, evaluate them, and fire them if they don't perform The

organization of this meeting of Sigma Pi Sigma, the Society of Physics Students shows how much can be done by dedicated effort.

We should not neglect the all-powerful but not all-competent Office of Management and Budget, which should insist on adequate analysis of programs and alternatives from the various departments.

I've talked almost exclusively about science policy as "science for government" and not at all about government policy for the direction and support of science. In this regard we should treasure small science, despite the fact that NSF finds it much easier to spend its money on large projects. Nor should we shy away from large programs such as the Hubble Space Telescope with its spectacular results and dramatic rescue from the gross manufacturing error of its mirror. It is time, too, to learn from the public appreciation for the success of the Mars rovers and the long history of exploration of the planets and their moons by robotic spacecraft, that the focus of NASA should shift to the extension of human intelligence and spirit by such means.

We need a real energy research program of scope appropriate to the problem and to the potential—including nuclear energy (e.g., uranium from seawater, breeders and their fuel cycles), but also on carbon sequestration, methane hydrates, cellulosic ethanols, biofuels from algae, and the like. No more “next-generation vehicle” program of the Clinton administration, “hydrogen economy” of the George W. Bush administration, but multiple programs that can provoke real change.

Comments or questions?