

What physicists can do in Washington

Following their increasing involvement in government affairs since World War I, both on the domestic and international scenes, what will scientists' role be in the future?

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The history of physicists in Washington is now well into its fourth phase. During World War I the interaction between science and government seemed to be on an individual basis; when I was a beginning graduate student at Columbia, I appreciated the fact that many of my professors had served as naval officers in the war, many of them in areas involving mine warfare. Of course scientific input was wider, but it did not have the organized structure that we are accustomed to today. The pattern was that of a physicist in uniform.

During Phase II, which started between the two wars, the structure did not change much—even though the National Research Council (set up to coordinate American scientific efforts during World War I) continued to exist. When World War II came, many physicists enlisted or picked up their reserve status to work as scientists directly in the service. Others simply went as individuals to war laboratories such as the Aberdeen Proving Grounds and the Naval Ordnance Laboratory.

More farsighted leadership recognized the implications of the atomic nucleus, culminating in the Manhattan Project and in developments in electronics that yielded the proximity fuse and tremendous advances in radar. In this way "big science" became coupled to government, and "Phase III" was born, although Ernest Lawrence's work at Berkeley just before the war was the precursor.

This development was the apparent reason for the creation of the National Defense Research Council—to organize science in the prosecution of the war and manage these large projects. Most of the

working scientists did not fully understand the implications at the time. When the early elements of the uranium-hexafluoride diffusion project were being put together at Columbia, most of the scientists believed that there was perhaps six months' or one year's work to do and then "the project will be turned over to the engineers and we can all enlist in the Navy!" Even at the younger scientists' level the transformation in attitude during the course of the war was apparent. In 1941 and 1942, the work in the laboratory began with the same approaches as before—sealing wax, string, do-it-yourself for everything. By the end of the war the sophistication in budgets, equipment, procurement and travel had risen sharply, and physics had become an entirely new game.

It was this new level of operation, coupled with the public awareness of what physicists accomplished during the war, that contributed to the post-war expansion and proliferation of physics in the United States. The current phase, phase IV, began within the last few years and is the development that has resulted in scientists in general, and physicists in particular, being represented at many levels of government.

The problems that link the physicist to government are now in bewildering array. They start with the straightforward physics issues such as accelerators, radiotelescopes, support of solid-state physics, and so on; but other problems of a more public and general nature such as disarmament, SST, the environment and energy occupy the physicist as well.

Given this wide range, I was perhaps foolhardy in accepting the assignment to write this article about physicists in Washington. It would take ten times more space, and far more study and organization than I could apply, to do the

subject justice. What I have done is put together some disjointed generalizations that attempt to arrive at some understanding of the role of the physicists in Washington today, and their probable role in the future, in contrast to what has gone before. The reader should remember, however, that we are discussing what a physicist does in Washington, and just a little of what Washington does to the physicist, not what physics is being done in Washington.

Early difficulties

Today we look back at the period between the end of World War II and about 1965 (roughly my "Phase III") with some nostalgia for its simplicity. The largest fraction of the technical interaction between us and the government was with the Department of Defense. As an example, let me cite my experiences from when I served on three successive President's Science Advisory Committee panels on undersea warfare. The problems were almost purely technical, and they were discussed on that basis. But the disagreements and disputes that developed were not on technical matters, but rather on their geopolitical worth. As a good example, the first panel concluded that antiballistic missiles were useless against ballistic missiles launched from submarines lying off the US coast. We found that we had no disagreement with the Director of Defense Research and Engineering on the numbers—I believe we found about 10–20% effectiveness in the ABM system—it was just that he maintained it was worthwhile proceeding with the design even at that low level.

I contrast that example with the experience I had more recently as Chairman of the National Advisory Committee on Oceans and Atmosphere, a Presidential committee. In one instance, we were te-

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PHYSICISTS AND WASHINGTON



Large-scale involvement of physicists in national affairs began during World War II, as for example here at the Los Alamos Scientific Laboratory. The photograph shows an award for excellence, known as the "Army-Navy E," being presented to the laboratory just after the war. Holding the flag are (left to right) Robert Oppenheimer, the director of the labo-

ratory; General Leslie Groves; Robert Serber, president of the University of California, and Commodore W. S. Parsons, associate laboratory director. The University of California has operated the laboratory since its inception in 1943, originally under contract to the Army and later to the US AEC and, now, to the Energy Research and Development Administration.



I. I. Rabi has been particularly successful at using science to help build bridges between nations. In this 1958 photograph from the Department of State, Rabi (third from left) has just been sworn in as a member of the NATO Science Committee, which was about to meet in Paris. With him are Wallace Brode, Science Adviser to the Department of State (left); Christian Herter, Under Secretary of State (second from left), and James Killian, the President's Science Adviser (right).

diously questioning senior officials of the Environmental Protection Agency, trying to understand why so many of their regulations made so little technical sense. We assumed that it was because they had received so little scientific advice. That was not so. They had adequate and good advice at the beginning of the regulation-writing process. The reason was simply that the procedure is so long, complex, tedious and presumably political that, as they put it, "there was no way to identify the science in the output." This situation is becoming a common occurrence and is primarily because the scientist has neither the time nor the desire (and often not even the permission) for monitoring the rule-making process to maintain the integrity of the scientific input. We are outnumbered by all the other actors on the Washington scene.

Another problem is that many technical operations continue through some kind of inertia, even though the failure rate is high. Here is an example from my experience: In 1966, the PSAC panel on oceanography discovered that more than 50% of coastal projects that were built had failed. Failed in the sense either that the structures collapsed or were destroyed, or that they failed to accomplish their purpose. In about 1974 when this was replayed before the Army Corps of Engineers, they admitted that the situation was unchanged. I can only assume it still is, and the annual cost remains great. We keep asking ourselves where we failed in being unable to translate into action our concern about the missing R&D. This problem is common in the social sciences,

but in that field we are willing to pay the costs of the large social programs because of strong human feeling that doing something to alleviate distress is better than doing nothing. It is curious that we follow the same argument in the physical sciences, where presumably the fundamentals are on a much sounder basis.

Because of the wide spectrum of problems and the necessary combination of science, science politics, statesmanship, knowledge of the government and related bodies required for an effective contribution, the number of useful operators on the scene grows very slowly. Understandably a certain number quit to spend full time back at the shop, because of the frustrations or their unwillingness to devote the time and patience necessary for a useful result. Experience and *savoir faire* are needed to know when an idea is ripe to be moved forward or, in other words, how to set priorities on one's efforts. There are many examples both ways. A negative one was the PSAC energy-panel report in the early 1960's. An excellent report—it was produced at a high level of government—it nevertheless had no perceptible effect. The lesson of this venture and others like it is that probably at least as much effort should be spent in preparation for delivery of recommendations as in doing the analysis, and that preparation should begin even before the work itself is begun.

As a positive and effective example, I often cite PSAC's interventions into machine language translation. In the late 1950's and early 1960's there was much research support going into computer

language translation. My own experience with international organizations revealed that a major mechanical bottleneck in operations was in document translation. It is hard for the uninitiated to comprehend, but both real and diplomatic slowdown occurs when authenticated official texts are not available. I, along with many others, was told that French-English machine translation was solved and the current research was on the more difficult Russian-English. Because French-English was the NATO problem, I followed this report with some vigor.

Fortunately, at the time, PSAC was completing its own thorough report demonstrating that we were far removed from any possibility of machine translation. This report not only spread a sense of realism, but had the effect of channeling resources into parallel, and related, research fields that are more profitable. The collection of disciplines known as "cognitive studies" should eventually pay off in many other applications than just automatic translation.

Developing a relationship

Because the physicist was very much in evidence in Washington immediately after World War II, due to the success of the Manhattan Project, the various radar efforts, the proximity fuse and similar ventures, it was inevitable that science was going to be an important item in government and that scientists would be advising on many fronts and on many levels. The researchers in basic science were largely in the university at the time, so it was inevitable that an apparatus such as the Office of Naval Research would be constructed. What was not inevitable was that it would be done so wisely and so well. The early population of ONR was composed mainly of physicists—the first directors also were physicists.

This pattern (support of and connection to the non-governmental research centers) was picked up by the new science agencies as they were formed—the Atomic Energy Commission, the National Science Foundation, the National Institutes of Health and others. More interestingly, science advisers to agency heads began to appear in State, Commerce, Interior, several in the DOD that eventually developed into assistant secretaries, the Advanced Research Projects Agency, and Defense Research and Engineering culminating in the President's Science Adviser position and PSAC. (This last statement is hierarchical, not time-ordered; the Science Adviser was instrumental in establishing the other positions.)

A very vital function of each agency adviser was to establish a connection with the outside technical community. This link provided an important flow of information to the government in the form of consultants, panels and working groups at a time when the government was in-

ternally poorly equipped to make decisions on technical questions. There were exceptions, of course, such as the Geological Survey and the Bureau of Standards, but they were rare. A concurrent development was the buildup of university-associated laboratories, such as those of the AEC, NASA and the NSF. The military quickly learned the value of this pattern, and they formed their own, not so university-associated, laboratories like RAND, IDA, ORD, MITRE, Aerospace Corporation and others. Throughout this development, the National Research Council of the National Academy of Sciences played a vital role and formed many committees (some *ad hoc*, but mostly permanent), that wrote reports and advised the government on a whole variety of issues.

In addition intergovernmental coordination, improved through such devices as the Federal Council on Science, Engineering and Technology, had the effect of making technical talent transfer between agencies possible, with agencies such as the AEC and NSF becoming technical resources for other agencies.

The development of talent inside the government and in specialized companies effected a genuine change in the role of the physicists in Washington. We must recognize that the physicist is *in* Washington. He is no longer only an outsider, a consultant, or an advisory committee member. We need only look at the top levels of government, starting with Harold Brown as Secretary of Defense, Robert Frosch as Head of NASA, Hans Mark as Undersecretary of the Air Force, and John Martin as Assistant Secretary of the Air Force for R&D. As the President said, in effect he has a physics adviser in his Secretary of Defense.

With the permeation of physicists into government, the postwar pattern of supplying scientific advice has to change. Much is now being done "inhouse." To cite an example: Fifteen years ago any international delegation would have drawn almost all of its working advice from panelists outside of government. Today such a delegation would be peopled mostly by government scientists, with a few from outside. I believe that this change defines a new relationship between physicists outside government and the government. One result, for example, is that Washington is now able to assemble advisory groups (either *ad hoc* or permanent) on its own without the intermediary of external organizations. This means that the academic physicist, for example, will be sought directly—without agents—for help by the government, a general procedure that is becoming a current way of life.

However, government scientists, even at the high levels they now fill, have little time to devote to forward planning for emerging problems and even less to the quality and quantity of support for the



Climate research—an example of a complex scientific problem that is of great interest to many government departments and agencies. The upper photograph shows part of the computer at the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory in Princeton; below it is an example of the computer-modelled atmospheric-circulation patterns produced at this laboratory. This one reproduces a simulation of Earth's tropical circulation.

associated basic science. Thus the necessity of maintaining good contact with the total world of basic science is more important than ever.

A case study: climate research

A very good example of an emerging problem is that of climate research leading to some ability to predict. The first point to note is that many departments and agencies are (or should be) involved with this problem. To be categorical, a partial list is the National Oceanic and Atmospheric Administration, Agriculture, Defense, Treasury, Commerce, Interior, the Central Intelligence Agency and the Office of Management and Budget. In developing prediction capability, NOAA would appear to be the appropriate lead agency but NSF, DOD and Interior have important roles in supporting and helping develop the basic science. The subject has become so vital in government thinking on energy, water supply and severe environmental fluctuations that Congress is considering direct legislation somewhat similar in institutional approach to that adopted for other problems such as cancer—with varying success. (Actually the Congress is now getting very good scientific advice, some from its own members. However, practically by definition, their actions are limited to institution or structure building. This is very difficult when the issues touch on the forefront of science, and some difference of opinion is inevitable.)

Despite the fact that NOAA is the likely lead agency technically, the President's Science Adviser, Frank Press, will have to take the lead role in seeing that the nation will have the best program. The Committee on Oceans and Atmosphere of FCCSET will be an important coordinating tool for the Science Adviser, but he will have to use particularly chosen consultants from both in and out of government because of the very nature of the problem.

Many geophysical (and some biological!) phenomena contribute to climate fluctuations. It is not clear that all the significant inputs are presently recognized. In addition, Man's specific intervention is believed to be one cause of climate change. Furthermore, distinction must be made between global and local climate variations; global averages change much more slowly than those with a wavelength of the order of a continental dimension or less. Putting all of this together requires a physical basis. For many years it was believed that with adequate computers—yet to come—and a sufficiency of initial data and appropriate boundary conditions, the Navier-Stokes equation could be integrated forward to give the weather at any future time. However, Edward Lorenz showed that this is not so. In the real world, the best that can be achieved is about two weeks. This result has led to the seeking of other avenues for the climate problem, particularly large computer modeling and the

introduction of statistical concepts.

The thinking on scales of length had been dominated by the Kolmogorov spectrum for many years. Here, too, there has been an important change. Ragnar Fjørtoft has shown that for the two-dimensional fluid there is an additional constant of the motion (besides energy) that alters the Kolmogorov spectrum. The physical effect for climate, that large-scale phenomena can build up and persist, was not unknown in nature, but the theoretical demonstration has profoundly altered the concepts being employed in climate research. (This two-dimensional fluid effect had been noticed years earlier by Lars Onsager and T. D. Lee.)

Now the climate problem can be defined as the study of the fluctuation of average weather over periods of six months to hundreds of millions of years. The practical problem from the Washington viewpoint is concerned with time periods up to no more than one hundred years at the most. This time period is the same as that of other catastrophic possibilities, such as major earthquakes and violent storms. But much can be learned from the study of the longer intervals that can illuminate the practical problem.

The array of historical indicators is bewildering and growing: tree-ring analysis, isotope abundance, paleo-climatology in land and in the oceans, the carbonate cycle, the study of pollen and so on. The physical phenomenology includes solar fluctuations, the air-sea interaction, the polar ice caps and glaciology, cosmic-ray physics, vulcanology, the CO₂ cycle, atmospheric particulates and other perturbations.

As a result, we can safely predict that the problem will never be "solved" in the normal sense of the word. Rather, our understanding and our ability to project will improve with time, just as it has in the shorter-term problems of weather. New theoretical approaches will be developed, new phenomena will be added, better and more observations will be made. With this complexity and the growing importance of climate in today's world, there must be a constant interchange between the technical world and government—government, as we noted earlier, in almost all of its branches.

In earlier years it would not have been conceivable that this connection could be successfully accomplished. However, today, when scientists in general and physicists in particular occupy positions at all levels in Washington, the technology transfer from the working discipline to government will be continuous and effective. Conversely, the governmental response in application of the new knowledge and the feedback in support to the climatologists will be prompt and efficient. This linkage to government via a common language is the big change that will make possible the development and

utilization of knowledge in climatology.

I chose climatology as a current example of a complex field of concern. There are others, such as the environment, energy and natural resources, that are of the same nature and will also be "unsolvable" problems in the same sense. Further, they are also linked—energy and climate for example—in a way that demands a kind of "renaissance" scientist.

If we continue to maintain the same spectrum of scientists in and out of government, working on and organizing for these aggravated problems of modern society, I am convinced that we will keep ahead of the problems. I don't mean to imply that in such matters the differences and heat will disappear. The exchanges will, however, take place at an informed level between individuals and groups who use a common language. One of the results will be closer attention to the legislative and administrative results to see, first, if it bears some relation to what goes in and, second and even more important, to see that the newly created institutions are useful, given the state of the science.

International relations

A physicist involved in governmental affairs quickly observes that, like one member of an extended family, "Washington" translates to many of the world's capital cities. This relationship is significant because it turns out to be a very important aspect of science in government—an effective bridge between nations. I. I. Rabi, one of our country's greatest scientist-statesmen, understood this point and used it very well in the period immediately after World War II. His perceptions led to many significant results, not the least of which was the formation of CERN.

We can identify two features of science that contribute to this international bridge. One is its universal intellectual appeal, and the other is its implied utility. For the first, we must remember that the recognized scientist has always been regarded as an international figure, in a fashion similar to artists and musicians. It is said that, during the Napoleonic period, scientists of both England and France travelled freely between the two countries despite the state of war. Since that time, the second attribute of science has become more evident to government, with the result that there is only a remnant left of that original freedom. This remnant has been enough, however, to develop effective and meaningful exchanges between peoples; in today's world it is being employed positively as a tool to enhance individual freedom and dignity.

The usefulness of science in the promotion of international relations is so publicly evident that during my tenure as Assistant Secretary General of NATO for Scientific Affairs, my staff and I would enjoy predicting the outcome of the many

visits by heads of state. A protocol for joint efforts in science was inevitable, and in that period the field was often oceanography. Unfortunately, these initiatives became ritualistic to some extent—by that I mean that the propositions were developed with no consultation with the scientific community of the countries involved. The high (or low?) point came when Dixy Lee Ray resigned as Assistant Secretary of State for the Bureau of Oceans and International Environmental and Scientific Affairs. She alleged that her action was motivated, among other reasons, by the appearance of a "cooperation-in-science" text, in an agreement with Japan, on which she had not been consulted.

One of the results of this proliferation of protocols is a current evaluation of all US bilateral agreements in science by at least three different high-level groups. This review is important, not so much to maintain credibility with the lay public—who seem to have unbounded faith in science and scientists—but rather to maintain credibility with our own fellow scientists who, after all, will be doing the work.

For the United States, the second attribute of science on the international scene—utility—is particularly important. The US has been the first country, overall, in science and technology since World War II. Even the advanced Western countries unabashedly make the transfer of US technology the first priority in the conduct of their foreign affairs. The USSR, in making this their top priority too, shows clearly their feeling that economic parity is impossible without this technology transfer. US technology is thus in the same category as US wheat or Arabian oil, with a similar array of policy conflicts. Even when we leave aside considerations of national defense, we find concern being expressed about "giving away" this technical expertise. In specific economic terms, this concern can refer to the dollar value received for US patents—the question being whether the return properly represents the corresponding value of the country's total R&D investment that led to the patents. The discussion can become sharp when the other country is of a strongly conflicting ideology.

These considerations are in policy conflict with the idea that free exchange in science is an important element in improving relations between people. Perhaps the analogy with Arabian oil is too extreme; an analogy with medicine would be extreme the other way. In any event, science has become an important element in international affairs, but an intelligent appraisal of its value cannot be made without input and guidance from the science community. We touched on the organizational structure of this input earlier, but its structure is more complicated than might be supposed at first.

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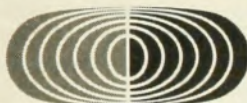
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Physicists in Washington are now not only consultants or advisers; they occupy some of the top levels of government. Two of them are shown

here—Robert Frosch, head of the National Aeronautics and Space Administration (left) and Harold Brown, Secretary of Defense, (right).

For example, we must first make sure of the capability, or the desire, of the scientists to be involved in a proposed program. It is pointless and of negative effect to governments to impose an operation that has no interest to the working scientists in the respective countries. The genuine leaders of the appropriate disciplines must be involved from the beginning of the discussions, or at least proper consultation must be undertaken with the working scientists. I believe that this was very well done by R. M. White as Head of NOAA in setting up the joint US-USSR Committee on the World Oceans. This is one of many good examples, but there is an even larger number of bad examples that have led to empty relations. My own experience would indicate that the outcome varies less with the relevant government agency than with the quality of the individual bureaucrat's adviser.

The economics issue

A far more complex problem, and one that couples to the entire scientific and technical establishment, is the economics issue. I have lived through many oscillations of attempted policy formulation on this point in my role as adviser-at-large to the State Department. During a fifteen-year period, there was first the "technology gap," then the "management gap," and then an untitled operation based on a concern that the US was being overtaken technologically.

Weaving in and out during this interval was the "brain-drain" problem. Each was important in its time, but the real problem usually bore no relation to inferences from the description—brain drain or technology gap or management gap—which usually presumed the answer to the studies before they even started.

We clearly cannot review the history of all of the attempts to deal with these so-

called issues, but one I found particularly revealing started about six years ago. The State Department was the lead agency on this occasion. The concern was growing that certain countries—particularly Japan—had caught up technologically with the US, and were going to take away our traditional markets, both external and internal, in a wholesale fashion. A few of us did not believe this would happen, and we managed to convince our government that it would not. Thus (together with some fortuitous occurrences) drastic and probably counterproductive action by our government was prevented. Our recommendation was based on what many of us believe—that a healthy basic science-and-technology program would continually feed the economy by providing the innovations needed for a better life and a better competitive position internationally. In this particular instance, Japan's support of basic research was poor in money and attitude, compared to the situation in the US. The fortuitous circumstance was our development of microminiaturization of electric components, which dealt a severe setback to the newly introduced Japanese hand-held computer. The Hewlett-Packard HP 35 was indeed a revolution. It was followed by the crystal-controlled digital watch, which not only set back the Japanese, but also the Europeans.

This group of scientists in Washington has a difficult multiple role—it acts as adviser on internal and external affairs, on basic and applied aspects of science, and on the economic implications of scientific advances. The same scientists have to man many stations in State, Commerce, NSF, Interior and the DOD. In addition, OMB on one hand and the Congress on the other have ideas of their own. On one side we must continue to remind the government of the vital role of basic R&D in the country's development and the

need for encouragement and support. At the same time, the merging developments in particular disciplines and the implications of these developments have to be folded in at the policy level of the various branches of government.

In the Japanese case cited, it was not their technical innovation that brought them success; rather it was good management and a very special social decision that, in effect, gave each worker a lifetime job with the economy. This arrangement is fine if technology is stable or changes little in the useful lifetime of a worker—the training cost can be amortized over a very long period. But today technology changes far more rapidly, and the country that innovates has the opportunity, in principle, of earlier and better planning for production. The "lifetime-job" policy of Japanese companies has been greatly weakened in recent years as a result.

Closely related is the patent question raised earlier. I do believe that it is a matter of national concern as to whether we are getting an appropriate return on the sale of patents. Their real worth is complicated by the consideration of rapid change in high-technology industries. It could be that by the time a high-technology patent is purchased, its value is on the wane and a company (or country) that lives on this basis will never catch up. I know from my own contacts in NATO and the OCED in the early 1960's that most Western European industrial managers were contemptuous of investment in research; they felt that it was an invitation to disaster—that it was cheaper and safer to buy the results. I have no doubt that may have been their experience (the disaster part, that is), but I am also sure that the policy was the result of excluding good technical people from upper levels of management. I become equally discouraged when, periodically and in specific instances in US industry

and government, technical expertise in top management is replaced by other considerations.

Brain drain

Before leaving this issue, it is worth summarizing the "brain-drain" affair. Here, too, wiser heads prevailed against policies proposing restricted immigration, on the advice of scientists who clearly saw the contradiction in limiting exchange of people by government action. The phrase developed about twenty years ago when it was noted that many brilliant scientists from the lesser-developed countries, who had been retrained in the Western countries (particularly the US) eventually chose permanent positions in the West—and frequently the US. The trend was apparently vitiating one of the aims of the exchange programs—that is, developing and strengthening science in the lesser-developed countries. During this period, when the US science-and-technology establishment was booming, the demand for scientists soon outstripped the supply. The result was another "brain drain," in which scientists from Western countries migrated in large numbers to the US. In the case of Great Britain the problem was particularly acute because of the lack of a language barrier. The situation appeared so bad to some that a prominent, respected and otherwise very sensible British physicist called for the imposition of emigration restrictions on British scientists who wished to leave. He justified his proposal in terms of the financial investment in the education of these would-be immigrants.

In the long run, a period developed when US scientists went the other way; it is perhaps reversing again. As far as the lesser-developed countries are concerned, many scientists in the first wave of exchange would probably have not stayed at home in any event. In time, a generation did develop that did return and establish schools, departments and research centers in their home countries. On the whole, the various exchange and development programs have worked well. A principal result was the more attractive environment the host government had to create to keep their talent home. Our advice and restraint was correct—more so than might have been anticipated diplomatically, considering the pressures now being put on the USSR to permit greater freedom for their scientists to emigrate if they so choose.

The involvement in foreign affairs illustrates the importance of scientific representation at the many points in government that are needed to feed into foreign affairs. The State Department has not fully developed a bureau that can handle all aspects involved. Input comes through many channels—other government agencies, the NAS and NAE, and consultants. The interaction has become

very intricate because of the whole variety of other issues such as that of the environment, population, food, energy, climate and the relations with the specialized international agencies. In the past, the President's Science Adviser has played a vital role in coordinating these diverse inputs, and I expect that Frank Press and his office will be very effective in re-establishing this role.

The near future

For a number of years now, leading physicists have warned that, as our establishment grew in capital investment and budget, it would receive more and more attention from the Congress and Administration. This attention is not of the kind that the community was well prepared for.

After all, with accelerators costing several hundred million dollars, the Very Large Array (a radiotelescope) of the same order in dollars, the Orbiting Space Telescope as well as an overall NSF budget approaching one billion dollars a year, the operations would come under much closer scrutiny. Political pressures grow, and conflict of interest becomes a non-trivial issue. Worse, officials of universities and research institutions are not above using their congressional representatives to intervene in what should be, in principle, a peer-review process. Because of the recognized importance of new science centers, competition can be fairly severe. A most recent example was the competition for the Solar Energy Research Institute required by law and set up by ERDA. The nationwide competition that developed seemed out of proportion to the size of the institute proposed by ERDA. On the whole, the Washington technical establishment has handled these problems well.

Another interesting question is what the future position of a physicist in Washington will be. It is interesting to speculate on the basis of similar developments in the life cycle of companies in various industries. The chief executive officer changes disciplines as the company develops and ages. For example, in the early stages he might very well be an engineer. Later, as the company expands, the principal problems may be labor relations, and a lawyer takes over as chief executive. At a later stage, in a mature company, bankers or other financial experts take over. This does not necessarily happen in every case, but it is typical. It could well be that we are seeing the beginning of a process where the scientist in government will be displaced by other kinds of talent such as political scientists, economists and lawyers. I am very nervous about this. The change, if it occurs, is a political one, in the sense that the particular agency has reached a point in its life cycle where considerations other than technical managerial ability are used to select the administrator. □

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LABORATORY Temperature Controller



Model 5301-E

With an input circuitry designed to accept resistance or voltage generating temperature sensors such as GaS-diodes, thermocouples, Ge & Pt Sensors, Carbon Resistors and Thermistors. The 5301-E, three mode controller offers temperature regulation to better than 0.01°K (or °C) in Vacuum chambers, Cryogenic dewars, Optical ovens, Tensile strength test apparatus, etc. for physics, metallurgy, chemistry and other scientific fields where the control and temperature range requirements are broad or change frequently. Set point readout is either directly in mV or Ohms (4-terminal measurement), with unlimited temperature range. Proportional, rate and reset modes are all internally adjustable, allowing to tune the controller to the thermal time constants of the process. 100 Watts, DC output or up to 5KW with Model 2202.

artronix

INSTRUMENTATION

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