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STATE OF THE NATION

It takes some getting used to--and few of us have yet managed to do so.

Most of us were young during World War II. We took chauvinistic pleasure in the postwar position of the United States as the world's greatest military and economic power, undisputed leader of world science and technology and global defender of democracy. Few expressed doubt when Jack Kennedy said that America would "pay any price, bear any burden and take upon itself any hardship, stand by any friend and oppose any enemy to secure the existence and victory of freedom." No candidate for high office this year would dare to echo that sentiment.

Inflation is rampant; unemployment refuses to decrease below 6 percent; the stock market is depressed despite the high earnings of many companies there represented; the bond market is chaotic and interest rates are fantastic--all reflecting the uncertainties of the economy.

The Vietnam experience damaged our national pride, dampened our messianic zeal to defend freedom and democracy everywhere, and deeply injured our national unity. The immense financial burden of the Vietnam war--over $150 billion--was assumed at the same time as the costs of the "Great Society" programs of the Johnson Administration--but without an increase in taxes. Hence, the inflation rate rapidly rose from 2 to 6 percent, the dollar began to weaken, and the United States' position in the world economy began to degrade. 1971 witnessed the first American balance of trade deficit in this century--and matters have deteriorated since. The once overwhelming American nuclear weapon superiority gave way to an effective strategic parity, hence the policy of "mutually assured destruction," while the Soviet Union continues to build the most powerful military machine that the world has ever known, armed with non-nuclear but scarcely conventional tactical weaponry.

The firm support of Israel by every President since Truman has given way to a nervous even-handedness enforced less by principle than by the parlous dependence of the economies of the United States and of its major trading partners on oil supplies from the Persian Gulf, a circumstance aggravated by our humiliation in Iran and by concern for the ultimate meaning of the cruel Soviet invasion of Afghanistan.

The nation is beset by doubt, uncertainty and foreboding. Our internal circumstances are complicated and aggravated by the declining influence of our major political parties, by the emergence of single-issue politics, by lack of party discipline in the Congress, by the weakened Presidency that resulted from Vietnam and Watergate, and by the chaotic influence of the Congress in affecting foreign policy, now dominated by an almost isolationist concern for American national security, retreating from the ideal that led Mr. Kennedy, on 11 February 1961, to accept the advice of Dean Rusk and Robert McNamara to dispatch U.S. troops to Vietnam.

Withal, we still remain the nuclear guarantor of the non-Communist world. The American economy is immense, well over $2 trillion per year, three to four times the size of the next largest economy, that of the Soviet Union. And although our relative economic position has declined, the U.S. still produces about 20 percent of the world's output of goods, conducts about 10 percent of all foreign trade and is the major exporter of food. Most importantly, the U.S. remains the critical margin in world affairs, the only available political and moral leader in a world community that grows evermore heterogeneous politically. But our leverage is not what it once was. The position of America on the world stage has changed dramatically since that fateful day in 1961 and it takes a lot of getting used to.

STATE OF SCIENCE

It is against that backdrop that I would like to discuss some issues concerning the status of science and technology in our country.

Before World War II, when the pace of science was leisurely and costs were modest, there was no thought that the conduct of science of itself is a responsibility of a Nation-State, much less a purpose of society. Modern science and its institutions arose from the ashes of World War II which, for the first time, witnessed in several countries full-scale mobilization of national scientific resources directed to the most critical circumstance of the moment--and the accomplishments were prodigious.

When the guns were silent, that demonstration remained alive in the minds of the world's political leadership. Uniquely, North America emerged from the war richer, stronger, and physically unharmed. "Science, The Endless Frontier," by Vannevar Bush, laid out the United States' credo with respect to science. It called upon our government to share the faith of scientists that science and the technology which it makes possible are unqualifiedly in the public interest, that scientific knowledge, in its own right, is a good to be cultivated, legitimately to be fertilized by public funds. It asserted the deep conviction that applications of that knowledge would make a nation militarily more secure, increase the food supply, improve the public health, expand the economy and, in diverse ways, enhance the quality of daily life. Recognizing that both the findings and the fruits of science are unpredictable, it averred that the support of the very best scientists in all disciplines will, in time, redound to the national interest. Acceptance of that credo--which took the specific form of creation of the National Science Foundation--was a historic landmark, the formal marriage of science and the Nation-State, an indissoluble tie that has dramatically and permanently altered the history of both.

The principal features of the American system for support of research and development emerged rapidly. First ONR and then other federal agencies developed competitive mechanisms for the award of research grants to individual investigators. The evolving Peer Review System assured democratic accountability for the quality of the judgments thus made and our scientific enterprise burgeoned. Pari passu, but without explicit decision,

universities, collectively, became the primary locus for basic research. The funds so provided made possible on campus much of the science physical plant as well as support for faculty, graduate students, postdocs, instrumentation, supplies, travel, and visiting seminar speakers.

In addition, diverse patterns of agency funding and of organizational and managerial responsibility were utilized to create the special laboratories of "big science," usually centered about one or more major pieces of research equipment--an accelerator, a telescope, or ocean-going vessels, for example, as well as certain large aggregations of smaller science in in-house laboratories such as the NIH at Bethesda, the regional laboratories at the Department of Agriculture, and diverse laboratories of DoD and NASA. Concomitantly, industry developed its own laboratories on a comparable scale, their organizational patterns varying with the perceived needs of each company.

Led, in some part, by scientists driven from Europe by Hitler, this enterprise became prodigiously successful. Science rapidly grew more sophisticated and, hence, more expensive. Within two decades, federal funds became the principal support of both private and public universities that aspired to front-rank fundamental research. Federal support of fundamental research for 1981, projected at $5.5 billion per year, includes about $4 billion in support for research on university campuses. And that endeavor, in turn, serves as the intellectual substrate both for the $30 billion of federally-funded applied research and development and for an effort of approximately equal magnitude sponsored and conducted by industry in its own laboratories.

This research endeavor has been spectacularly successful in all disciplines and was never more productive than today. And yet not all is well with this enterprise.

Last year, I spoke of the detailed bureaucratic control of the conduct of fundamental research and the monstrous amount of paperwork that now characterizes the operation of this partnership. Today, I would enlarge somewhat on that theme.

Universities and the Federal Government

Because there never was an explicit, formally negotiated, mutally agreed-upon decision to utilize universities as the primary locus for the conduct of federally funded basic research and because no one anticipated the extraordinary growth of that venture, the terms of the bond between the universities and the federal government were never expressly stated. It began as a marriage hurriedly arranged in the stress of World War II. And in the years that followed, as American academic science flourished, few complained that there was no marriage contract, no explicitly stated philosophy that recognized and reconciled the considerable differences between the traditions, purpose, and societal roles of the government and of the universities respectively.

For some years, complaints were few--both because of the extraordinary success of the venture and because the difficulties were papered-over with more and more money. Divorce has become unthinkable because of the total dependence of each partner on the other and the lack of any alternatives. With its huge investment in place on campus, the government is in no position to walk away and create an equivalent set of research institutes independent of the universities. And the costs of modern science are such that there can be no conceivable alternative to federal funding of the research component of the university's responsibilities. The endowment required to yield an income sufficient to replace current federal grants and contracts to universities would be in excess of $80 billion.

Two grievances particularly affect the tranquility of the marriage. One is the expressed willingness of government to withhold all payments in support of research as a sanction to be imposed as a means of enforcing regulations intended to achieve social goals irrelevant to the research enterprise *per se*, most notably "affirmative action" in appointment to the faculty of women, blacks and other minorities. In the course of a few such enforcement proceedings, the government has sought and obtained university records concerning the

details of individual faculty appointments--explicit affirmation by government that it considers other criteria to be as significant as academic competence, if not more so, in appointments to the faculty. Yet, nothing can so damage the future of a university as an appointment to the faculty of anyone less than the best whom the university might otherwise have attracted to its company.

The second grievance is the detailed procedure intended to ensure "accountability," particularly the requirements stipulated in OMB Circular A-21 which now so concern our Vice President. That Circular demands time-accounting for members of the faculty who serve as investigators under federal research grants and contracts as well as estimates of the time of other members of the faculty in order to establish the relative magnitudes of total expenditures for administration, teaching, and research. The principal difficulty with that circumstance does not arise from the intrinsic impossibility of making an honest appraisal and so reporting; the difficulty does not arise from the fact that the easiest way for the faculty to respond is simply to lie--as many surely will; it does not arise from the indirect costs engendered by the very fact of attempting to comply with these regulations. No, the principal difficulty arises from the purely business-like, financial, contractual character of the relationship between government and the university; something like A-21 was inevitable! As costs generally have risen, university administrators have, perhaps out of necessity, become evermore adept at manipulating the system to maximize payments for indirect costs; and there have been both institutional and individual abuses. The government's accounting mentality has responded accordingly. Hence A-21. But, meanwhile about a third of that $4 billion will be transferred for indirect cost payments while investigators are inadequately funded.

In a sense, both classes of difficulty partake of the sacrilegious. Let me explain. In both instances the relationship of the government to the university is indistinguishable from the behavior of the government vis-à-vis major industrial contractors providing goods or services directly to the government, yet without the benefit of provision of a fee for such services.

Yet "Science, The Endless Frontier" appreciated that the university and the government share belief that the search for objective truth is itself a very purpose of organized society, stemming from the inner nature of human beings. It indicated that the university is the most appropriate instrumentality of our society for the conduct of science not because it has a supply of cheap labor--as it does--or appropriate physical facilities--as it may--but because faculty and students are bound together in a common quest of essentially spiritual character which has been in process for centuries. It should have followed that that circumstance would make for an avowed partnership, a shared sense of responsibility for that spiritual quality. Instead, governmental behavior now does injury to that very quality.

Continuity of spiritual purpose was probably easier to preserve when higher education was the privilege of a few. Beginning with the G.I. Bill and nurtured by the affluent society, higher education rapidly became a birthright of all Americans who could meet the requirements for graduation from a secondary school, and became a principal mechanism for upward social mobility. Government, which had catalyzed development of a racially integrated society by forced integration of the primary and secondary school systems--a process which, overall, must be held to have been notably successful--found it logical and easy to catalyze further change in American society by forcing formal affirmative action upon the university in order to accelerate a desirable process already under way. But, in the doing, it substituted the government's social values for scholarly excellence, the most cherished value of an autonomous university.

As the academic research enterprise grew, the government increasingly came to treat the university as a purveyor of research services. Totally dependent on the federal government for financing the immense commitments in place, the university lacks staying power if it attempts to fight off either type of invasion of its own autonomy. If the research-performing universities are not to be unduly injured by the consequences of their very success, it is imperative that our society soon fashion that delayed marriage contract and bring to it

some of the love, tenderness, and shared values one expects in a marriage contract. The recommendations of the Commission on Research go some way in that direction. But, only the faculty and administration of the university are entitled to judgment with respect to new appointments to the faculty. And only they can reasonably judge how the faculty should spend its time, no isolated component of which should be for sale.

Payments for faculty salaries from government grants and contracts should not rest on detailed time and effort reporting, nor should the federal contribution to indirect costs.

Funds ultimately to be paid to members of the faculty as salary should flow only through the indirect cost provisions of grants or contracts, thereby permitting the university to retain control of its destiny and minimizing the transfer of professorial loyalty from the university to the funding agencies. Who is loyal to his landlord?

Instead, formulae should be developed whereby the government explicitly recognizes that it shares with the other sponsors of the university--state governments and the private sector--responsibility for the financial stability and continuing healthy existence of the total university as an autonomous academic institution. This need not entail any increased net expenditures on the part of the federal government since there would be ready agreement that the extent of federal sharing should be related in some way to the magnitude of the direct costs of the research which it is providing--somewhat analogous to state calculation of the total university budget based on student enrollments. The government, in turn, must accept that it will fund, in some part, all of the academic functions normal to the university, thereby helping to maintain the very intellectual climate in which research itself flourishes.

Moreover, I would urge that such a new formula for indirect costs payments contain provision for a modicum of what is called, in contracts between industrial contractors and the Defense Department, IR&D--independent research and development--providing a kitty for new research starts which, if successful, will one day be brought to government for enlarged direct financing.

Surely, such an arrangement is just as logical in the relation of government to non-profit academia as it is to profit-making industry.

Last year, I spoke of the problems generated by declining undergraduate enrollments, a situation which will not begin to turn around until about 1995. This circumstance threatens loss to the system of a significant fraction of potential young faculty for whom tenure-track positions will simply not be available. As a transient measure to cope with that situation, I proposed federal funding, on campuses, of research institutes, each of a character to be determined by the university at which it is to be located. Numerous models of such institutes already exist. And it was with all these thoughts in mind that I asked the Committee on Science and Public Policy to examine alternate arrangements for the organization and funding of fundamental research, seeking a new model appropriate to the changing American scene. They accepted this challenge and are currently so engaged.

Meanwhile, these various thoughts should not remain simply the stuff of which speeches are made. The essence of the relationship between the university and the United States Government is being needlessly corroded--to the ultimate disadvantage of both and, hence, to the disadvantage of the nation itself. It requires serious attention.

THE AMERICAN RESEARCH ENDEAVOR

Allow me to turn next to the scale of our research endeavor. The fortunes of war gave to the American scientific community almost two decades of a headstart into the modern era; in the 1950's, American science was surely two-thirds to three-quarters of the world's total; that it was prodigiously successful in all disciplines has been abundantly evident. As Japan and the nations of Europe slowly emerged from the debris of World War II, they, too, developed scientific enterprises of their own. Worldwide annual expenditures for fundamental research are now about $15 billion, and the relative position of American science on the world scene has diminished

considerably. We are perhaps one-third of the world total, albeit I think still the most productive one-third; West Europe and Japan together constitute a second-third, although Japanese expenditures for basic research are disproportionately low; and the East European nations represent a more or less equivalent sized third major bloc. Certain to become significant in the next few decades are the laboratories of China, India, Brazil, and so forth. Hence, inevitably, American preeminence in world science must subside--not because we will do less well--but because we shall encounter evermore powerful competition.

American science is still at the forefront of all disciplines. But if we continue, as we have for some years, to devote an ever-decreasing fraction of our GNP to research, while other nations such as Japan, Germany, France and the Soviet Union continue to expand and develop their capabilities, I can too easily imagine a scenario in which we congratulate ourselves on our current crop of Nobel Prizes, for yesterday's research, while science elsewhere overtakes and perhaps surpasses ours.

Small science in much of Europe has been affected by financial pressures similar to those at work in this country and, with the exception of Germany, appears to be in the doldrums. With respect to big science, however, the unification of Europe proceeds apace, driven by the high costs of major scientific instruments. A network of cooperative endeavors is growing within Western Europe and, increasingly, national barriers cease to confine European science. As their common strategic planning waxes, the strength of their scientific relations with this country will undoubtedly wane unless we exert special efforts. And that makes particularly ironic the decline in the number of young American scientists who can arrange meaningful experiences in European laboratories--when the benefits of such experience are now greater than ever. There is no reason why American science need lead all the world in every subdiscipline of science. But we should be keenly aware of the nature and extent of this competition, and of lines of research not being followed here. I have asked the Foreign Secretary's office to take a closer look at this changing set of relationships, to ascertain whether we are losing touch with European science and whether any important trends may be discerned.

Nor is the competition confined to Western Europe and Japan. Intent on using what they term "the scientific and technological revolution" to strengthen their socialist societies, the nations of East Europe, particularly the Soviet Union, develop their scientific capabilities with the same steady support and determination evident in the buildup of their military capabilities. It would be foolish in the extreme to believe that their R&D investment will continue to be relatively ineffective and unproductive. They are led by capable scientists who are evermore handsomely supported, and who have hard currency available to them for the acquisition of Western instrumentation. In at least one Academy institute that I visited with Harrison Shull, significant numbers of graduate students have been invited into the laboratory, thereby deliberately blending the best of our system with the best of theirs, an arrangement that will surely bolster their scientific quality. And their construction program will give them, in a few years, an entire new physical plant--reminiscent of the new industrial plant of Germany and Japan, perhaps.

Moreover, we have given little attention to what purports to be a revolution in Soviet primary and secondary school education, wherein today each pupil mandatorily studies geometry, algebra, and two years of calculus in high school while also receiving two to three years each of physics, chemistry and biology. If these reports are true, and there is genuine substance in that curriculum, this will not only serve to qualify and identify the most talented youngsters for further education for scientific and technical careers, it should also produce the most highly qualified industrial labor force in the world.

In fine, our unique place in the scientific sun also lasted for but a few decades. To the extent that competitive economic and military success will rest on scientific leadership, our nation will surely find it necessary significantly to expand the support of science itself and to look to the health of the institutions in which research is performed. The alternative is unacceptable.

INDUSTRIAL R&D

Since Thomas Edison, marriage of the most advanced science to the development of new technologies has been a primary characteristic of the American scene. Until recently, however, what was called "Yankee ingenuity" consisted largely of adapting European science to the creation of novel industrial technology. As postwar American science assumed its primacy, much of the technology introduced worldwide rested for the first time on the findings of American science.

Many of you will be aware of rising concern for an alleged decline of innovation in American technological industry--a process that, if real, might still be of little concern were it not for the massive invasion of the American market by superior products produced in Japan, Germany, and Switzerland, for example, exacerbating the negative balance of payments for petroleum. Until recently, the success of that invasion has surely not been due to an absolute decline in American innovation; rather, it has been the consequence of intense first-rate industrial competition which grew in parallel with the scientific development of the same countries, together with full exploitation of American technological know-how purchased by royalty payments.

I have not been able to estimate the extent to which regulation has dampened American innovation but readily agree to the likelihood that it has done so. Nor can I assess the historic impact of our tax structure. But high interest rates, inflation, and general economic uncertainty certainly now combine to shorten the investment strategy of American industry; if payout will not commence in two to three years, a new project now commands little attention in the Board Room. And that bodes ill for the years ahead, almost guaranteeing yet greater shares of the American market to our competitors.

Moreover, I should note a curious dilemma. On one side, we confront a potential military adversary deliberately allocating a far-larger fraction of its GNP to military preparedness than we are willing to do in peacetime. Our philosophy has been to attempt to make up in quality what we lack in quantity; hence our budget

of about $16 billion per year for defense R&D. And I strongly suspect that a somewhat disproportionate fraction of our most talented physical scientists and engineers are drawn into that defense research, drawn in by its great intellectual challenges and its relatively generous support. Meanwhile, those nations which are our most successful competitors in the international marketplace invest very little in military R&D; hence, their competitive success may rest, at least in some part, on the fact that their brightest physical scientists and engineers, protected by the American military umbrella, are happily designing superior consumer products for the American market.

No easy solution to that dilemma is evident, but we should surely encourage those nations that are our competitors and trading partners to do more basic research, to help fund some of our own expensive big science and, hopefully, to pay a larger share of the costs of their military protection.

After listening to innumerable discussions of industrial innovation, I can only conclude that since protectionism is unacceptable, our government must lower the barriers created by self-imposed handicaps and recede somewhat from its adversarial stance vis-à-vis industry: It could, for example, create a more favorable tax climate; reform patent policies; ease off the hand of regulation; refrain from antitrust suits against arrangements that facilitate successful American competition in the world market; and, by appropriate incentives, catalyze formation of useful bridges between academic and industrial laboratories.

Like the expanded support of science itself, none of that can happen until the American public has indicated its willingness to support that philosophy. That will require educating the public to what is at stake, educating the public to understand relative risks, and to help in the choice among them; it will require that scientists take issue with those who have traded on public fears to put in place the nay-saying philosophy that has gripped us for a decade. If the scientific community will not unfrock the charlatans, the public will not discern the difference and science and the nation will suffer. There is in short a large burden upon the scientific community to be seen as constructive in dealing with real problems, as ever straightforward, forthcoming, honest and courageous--not intimidated as all too many have been.

THE WORK OF THE ACADEMY

The National Research Council

The National Research Council is vigorous and functioning very well. It is served by a highly competent and devoted staff and, as ever, is made possible by the services of almost 10,000 volunteers. A recent Letter to Members indicated the numbers of members of this Academy, of NAE, and of IoM who participated in the work of the NRC last year--about one-third of their total memberships which I find rather satisfying.

The Chairmen of the Commissions and Assemblies of the NRC are an effective, competent, and diligent group of our colleagues to whom we are particularly indebted and whom I warmly commend to you: Julian Wolpert who has served for one year as Chairman of the Assembly of Behavioral and Social Sciences; Frank Putnam who has just completed a term as Chairman of the Assembly of Life Sciences; Jake Bigeleisen who has just completed a term as Chairman of the Assembly of Mathematical and Physical Sciences and is about to be succeeded by Herb Friedman in that capacity; Guy Stever who accepted the Chair of the Assembly of Engineering in mid-winter and has been doing superbly ever since; Harrison Shull who vigorously leads the Commission on Human Resources; Gilbert White who is coming to the end of his term as the wise Chairman of the Commission on Natural Resources; Elliott Montroll who some months ago took over from Harvey Brooks as Chairman of the Commission on Sociotechnical Systems; and of course the Foreign Secretary who also serves as Chairman of our Commission on International Relations. These members of the Academy serve us very well, indeed, and we are indebted to them all as we are to their colleagues who serve on the Commissions and Assemblies and their 800 committees, and to those members who have so diligently and scrupulously assisted in the review of NRC reports, our principal quality control measure.

The monthly News Report brings you informative summaries of a fraction of our most interesting and significant reports--the selection is made by Gerry Schatz of our Public Information Office. It will shortly emerge

in a more attractive format with somewhat enlarged coverage. We hope that you will like it. The Annual Report of the National Research Council--edited by Norman Metzger--is especially informative. Each Assembly and Commission Chairman contributes a thoughtful essay relevant to some aspect of the work of his component of the National Research Council; each easily warrants the time required to read it. Four Annual Reports have been prepared in the current format and we would very much appreciate hearing from you as to whether you find these interesting or useful. The Annual Report also provides a listing of all reports to emanate from the NRC during the previous year, each of which is available to you for the asking. That listing always reveals the astonishing diversity of the work of the Council.

Time will not permit me to direct attention even to our major study efforts of this past year. But I must take note of the report of our Committee on Nuclear and Alternative Energy Systems (CONAES). Four years were required to integrate the contributions of 400 individuals into a principal document and perhaps a dozen supporting reports, at a cost of almost $4 million. This was a traumatic experience: The problems themselves are intrinsically complex and difficult; the relevant "facts" kept changing while the report was in preparation so that they were continually shooting at a moving target. The Committee was polarized from the beginning and, four years later, that polarity remained, as is evident in the footnotes with which the report bristles. What is remarkable, however, is not the extent of their differences but the large body of analysis to which they were agreed. The report has just been published by the W. H. Freeman Company and, from the advance sale, it is clear that it is destined to be something of a bestseller. By and large, the reviews have been highly favorable, even though the reviewers include both energy hawks and energy doves. We feel certain that, for some years, it will remain the most definitive analysis of the nation's energy circumstances. That this demanding enterprise came out as well as it did is owed to the extraordinary efforts of Ed Ginzton and Harvey Brooks. We are truly grateful.

Risk Assessment and the Regulatory Process

As I noted in the last NRC Annual Report, risk assessment is an evergrowing aspect of the work of the NRC. Even now, at work are two committees, one examining the methodologies that have been used by NRC committees so engaged, the other addressing the manner in which risk assessments and risk/benefit analyses have been used in public decision-making, both undertaken on our own initiative. Substantial external pressures seek to enlarge our role in such endeavors. These come from bodies concerned with whether current institutional mechanisms for determining estimates of risk are adequate, viz., what entities in American society should make decisions in respect of the existence and magnitude of a given "risk"; what entity establishes whether the research undertaken to assess risk has been properly performed; can regulatory agencies be trusted to undertake such judgments? And various proposals seek to take advantage of the Academy's credibility in these regards.

Congressman Wampler has introduced a Bill that would establish, within the OSTP, a "National Science Council" whose function would be to make final decisions on risks relating to health hazards, removing such decisions from the regulatory agencies. The Bill assigns to the Academy responsibility for nominating the members of the Science Council. A consortium of chemically oriented companies would like to encourage legislation that would call upon the Academy to study and render judgments on risks of all types associated with chemicals utilized in industry; the size of that task is appalling.

Another group of companies has requested us to sponsor a meeting on "The Role of Science in Guiding Public Policy in Regulating Carcinogens"; and from government we have a request for a study that includes among its questions: "What is the 'trigger' that should cause a regulatory agency to seek an external (independent) peer review."

Institutionally, we have no interest in what any given regulatory decision may be. When called upon, occasionally, we offer scientific judgments that regulatory agencies may use at their discretion, almost

always based on less evidence than needed truly to compel judgment. But most such regulatory decisions are made by the agencies without such recourse to the NRC. Hence, the unease concerning how available scientific information is used to formulate regulatory decision. Should the NRC be utilized regularly and systematically to deal with such questions? Perhaps, but only within the constraints of a clear understanding that we are the National Academy of Sciences and not of public policy. To the extent that we can advise those who seek our advice concerning how this area of science may be used but without infringing on agency authority to make regulatory decisions, we may learn to be increasingly helpful.

Five Year Outlook

This year also marked the publication of our first attempt at production of a Five Year Outlook for Science and Technology. The manuscript was delivered to the National Science Foundation, the White House, and the Congress a year ago. The printed version--published by W. H. Freeman--did not become available until mid-winter, since when it has received extraordinarily favorable reviews. And in this case also, I am told, sales are relatively brisk. The Outlook is a pithy summary of much that is current and choice in selected areas of science and technology together with concise statements concerning what the near future may hold for each. As you know, Ralph Gomory was the principal honcho in this effort; he cajoled the contributors to confine themselves to the assigned limitations of space and to utilize a style acceptable to the intelligent informed lay reader, while assuring a high quality of substantive discussion. We are most grateful to him. Copies of the Outlook are available for those of you who may be interested.

Already we are embarked on the second Five Year Outlook, which, at this time, seems slightly more ambitious than the first. Frederick Seitz leads this effort and is already at work. Dozens of highly qualified individuals, including quite a few members in this hall, have already agreed to participate in this endeavor; their draft manuscripts are due about six weeks from today.

The first Five Year Outlook has drawn only praise, including from the Congressional staff which was to have been its principal audience. But, of itself, our report does not meet the requirements established by the Congress when preparation of a "Five Year Outlook" was mandated to the Office of Science and Technology Policy. In addition, there is required a statement from the Executive Branch indicating the principal aspects of its planning for the near term. Patently, a five year plan for the federal research and development enterprise is scarcely feasible and certainly not believable. As I understand matters, the Congress still expects from the Executive Branch some indication of medium term planning and would expect that that planning should in some way relate to the problems and opportunities revealed in the Five Year Outlook as prepared by the Academy. We await the first of these companion statements from the government with considerable interest. Meanwhile, we remain committed to preparation of succeeding Five Year Outlooks on a biennial schedule.

As many of you will know, last summer Robert M. White succeeded John Coleman as our seniormost Administrative Officer. In the short period he has been with us, Dr. White has put in place a number of administrative arrangements which will serve us well. Accordingly, I am all the more sad that he is leaving to become the Chairman of the Board and President of UCAR (the University Consortium for Atmospheric Research). We wish him very well indeed.

This fall David Hamburg will leave the Presidency of the Institute of Medicine to take up an academic post at Harvard. He has been an inspiring leader of the IoM and we regret his departure at a time when that part of our shop should be attaining maturity. He is to be succeeded by our member Frederick Robbins who will give up Deaning at Case-Western Reserve. Fred is admirably qualified for his new responsibilities and I look forward to his full-time presence on these premises where we have already seen much of him as he participated in various IoM/NRC studies. Welcome, Fred.

The current arrangements among NAS, NAE and IoM were fashioned six years ago and are working smoothly. Nevertheless, it is, at best, a metastable state, requiring little activation energy to cause it to degrade.

Accordingly, I have proposed to Dr. Perkins that a small joint committee review our circumstances and report when the Councils of NAS and NAE meet jointly in Woods Hole, next August.

Some Glimpses of the Washington Scene

The Budget. I need not dwell on the current status of the budget proposed by the President for the federal support of science next year. Much has appeared in the press, and you recently received from the Academy a summary of the effect upon certain elements of the science budget of the recent pruning. As we indicated, in general, the effects of that exercise upon science seem rather minimal. Given the potential attractiveness of this large budgetary item as a target for budget-cutters and given our lack of political clout in an election year, the outcome must be judged as most extraordinary. I particularly regret deletion of a $14 million item in the NSF budget that might have permitted the beginning of a program for rehabilitation of the now aging and deteriorating science physical plant. It was only a token, but an important token. And I was greatly distressed to discover that NIH will fund no new fellowships or training grants in FY81. I hope that these items may yet be restored.

I doubt not that all of us are indebted to Frank Press and his colleagues for the large measure of protection afforded the science budget as that exercise proceeded. Unfortunately, rumor has it that the Congressional Budget Committee is inclined to be less generous than was OMB and the budget will have to be carefully defended in its specifics as it works its way through the appropriation process. It seems ironic that R&D, key to the national future, must be so defended, item by item, when unbalancing of the budget derives daily from inflation's impact on indexed social security payments and federal pensions. Indeed, contrariwise, budget balancing is accomplished very largely by inflationary bumping of salaries into higher tax brackets. We shall need to be vigilant and pronounce at every opportunity the fact that federal science funding is inadequate and is shortchanging the national future.

Until recently, the set of science administrators put in place by this Administration had remained relatively intact. However, John Deutch has left the Department of Energy, and Dick Atkinson and George Pimentel are scheduled to leave the National Science Foundation this summer. The scientific community is much indebted to them and wish them well as they all return to the academic life.

These events serve to remind us that we are in a Presidential election year. Undoubtedly, the platforms of both parties will speak glowingly of the significance of science and technology to our national life. Each will hold out promise. Regrettably, party platforms no longer seem to be particularly meaningful. No office-holder is held to account for departure from such platforms. Still, some of you will surely be called upon to help draft such planks; I hope that you will respond--but primarily because of the opportunity it affords to educate the politicians so engaged.

And you may also be called upon in a different way. Conceivably, there may again arise attempts to bring into being organizations called "Scientists and Engineers for Whomever." The first such activities occurred in the Johnson vs. Goldwater election of 1964. It was a heady experience for many, and similar groups have been organized in subsequent elections. Although I participated fully in 1964, by 1968 I had awakened to the great undesirability of any such organization. I consider it a potential disaster thus to split the scientific community with respect to an issue which is essentially external to the scientific endeavor itself. Scientists desiring to work on behalf of the Presidential candidates will not lack for other opportunities to do so.

The Academy as Versatile Servant of the Scientific Enterprise

In the course of a year, the Academy, unnoticed, performs a host of small services on behalf of science. We help locate qualified individuals for public service; comment on dozens of draft bills; answer technical queries; make social arrangements that smooth the course of events, etc. A few special instances seem particularly noteworthy.

Scientific Publications. Pending in the House of Representatives is H.R. 5424, a bill entitled "The National Publication Act of 1980." At first glance, this seemed to be concerned only with reorganization of the Government Printing Office and improvement of government printing services. But careful reading of the definition of what constitutes a "public document" indicated that any officious bureaucrat could readily conclude that all scientific publications based on work supported by a federal grant or contract are "public documents" and, hence, subject to a variety of specified restrictions and mandatory patterns of distribution. Happily, the House Committee readily accepted our suggestions for clarification of the definitional language, an example of the benefit of staff vigilance and of sophistication in the ways of this city.

Regulation of Exposure to Laboratory Hazards. As some of you will know, OSHA declined to defer its course of action in respect to regulations that, when in place, will be applicable to laboratories, regulations that will create generic classes of chemicals of graded seriousness of hazard and then will describe the precautions, monitoring procedures, and the medical surveillance to be adopted. Most thoughtful commentators find this course objectionable. We have hoped to offer as an acceptable alternative a guide to safe practice in the laboratory. This report, from the Office of Chemistry and Chemical Technology/AMPS, has been completed and is now out for a large-scale review. It will surely be of great value of itself but it is too soon to know whether our effort to substitute such guidance for OSHA regulation will succeed. Conceivably, nothing will do but to secure a clarifying amendment to the basic OSHA legislation.

Freedom of Scientific Communication. You will have read of the incident wherein officials of the Department of Commerce interfered with the course of a meeting of the American Vacuum Society concerned with "bubble memories" for computers, to which foreign nationals had been invited. The intervention by Commerce aroused a flurry of protest from the scientific and technical community. Seeking clarification and understanding, I addressed a detailed inquiry to the Secretary of Commerce.

After recapitulating our understanding of the episode, I said: "I would welcome a more definitive statement of the Department's view of the facts surrounding this incident and of the legal framework within which the Department took its actions." The letter then cited a report from Commerce to the Congress that stated:

> "The free flow of scientific information is essential to the progress of scientific and technical research. This calls for preserving the conditions in which this type of technical data is freely and unhesitantly published and exchanged."

and went on to say:

> "This position is consistent with general principles of freedom of scientific communication, the U.S. policy of recent years to encourage the holding of international scientific conferences in the United States, and the resolution of the International Council of Scientific Unions regarding free circulation of scientists.
>
> "It would be helpful to have from you a clarification, and hopefully a reaffirmation, of basic Departmental policy on these fundamental issues. In addition, I am sure that you share my concern that Commerce Department regulations designed to achieve legitimate governmental objectives not be rigidly administered in a vague, overly broad, or inflexible manner that might deter perfectly legal and constitutionally protected scientific exchanges."

In a subsequent phone conversation, I emphasized that I was less interested in assigning fault in the episode in question than I was in understanding whether it was a regrettable, clumsy incident or whether there has been a change in policy, some new determination to prosecute under existing legislation.

The particularly meaningful statements in Secretary Klutznick's reply are as follows:

"....Your expression of concern on behalf of the American scientific community is in turn a source of concern to me. I hope that through our discussions we can clarify the understanding of the scientific community concerning the scope of the government's restrictions on transfer of sensitive technology to unfriendly nations, and allay fears concerning possible overly broad application which could unnecessarily restrict the valuable process of free scientific exchange.

"The Export Administration Act of 1979--like its predecessors--requires that export controls be used where necessary to restrict the export of goods and technology which would make a significant contribution to the military potential of any other country or combination of countries which would prove detrimental to the national security of the United States.

"Regulations implementing this requirement with regard to technical data have been in effect for 25 years. They serve an important public purpose, and the Department has a statutory duty to enforce them. However, they have not caused serious problems for basic scientists because in general they restrict only export of technology that (1) deals with manufacturing or other applications, (2) is highly sophisticated, (3) has potential military application by adversaries, and (4) is not already available from public sources....

"....I would like to reaffirm the previously expressed views of the Department of Commerce referred to in your letter. We do not attempt to restrict transfer of technical data that is already generally available in the public domain or scientific data not related to technology which deals with manufacturing or other applications (with the exception of certain data contained in patent applications which are withheld for national security reasons). We recognize that pre-publication review and control over public availability of data, or post-publication withdrawal of such data from public access, would involve severe consequences for freedom of speech, press, and scientific exchange.

"It has been our experience that applications technology that is not already available from public sources is not normally the subject of disclosure at international scientific conferences, since it is usually proprietary to specific companies. However, we encourage organizers of international scientific conferences in which sensitive technical data is to be discussed to consult with the Department during the planning stages for guidance regarding the requirements of the Export Administration Regulations for the transmittal of material to foreign nationals to determine whether a validated license or written assurances are required.

"The Department's statutorily-directed concern with national security should rarely conflict with the tradition of free scholarly scientific communication, and serious problems seldom have occurred. We are always prepared, however, to discuss this question with you and the other government agencies that are involved in the deliberative process governing export controls on sensitive technology.

"It is indeed regrettable that there remain in today's world conditions requiring us to impose limited restrictions on the availability of those technologies indispensable to the security of our Nation. Our laws have struck a delicate balance. Within their limitations we must strive to maintain the free and open exchange of information in keeping with the ideals of our Nation...."

I am grateful to Secretary Klutznick for his prompt reply. It suffices to persuade me that the specific conference that gave rise to these questions was a confused test case that, regrettably, was handled rather clumsily by the Compliance Division of the Department of Commerce. But I stand reassured that we are not about to witness an invasion of the freedom of scientific exchange by the Department of Commerce which, at the top, fully appreciates what is at stake.

Three Mile Island. Our meeting, last year, convened shortly after the episode at Three Mile Island. Discussion, on this floor, centered about our offering to be of assistance with respect to upgrading the training of nuclear plant personnel. Discussions with agency staffs were interrupted by the work of the Kemeny Commission whose subsequent report underscored the same human factors and the same needs. It is not clear whether we can, in fact, be of service in this regard, but we shall return to the matter as soon as useful opportunity affords.

Foreign Affairs

Human Rights. Our institutional concern for human rights continues unabated. The Chairman of our Committee on Human Rights will shortly report on the activities of his Committee. The Council's action with respect to our exchange program with the Soviet Union, precipitated by the internal exile of Andrei Sakharov by the Soviet Government, appears to have received wide approbation in the scientific community and among the public generally. In so doing, the Council was concerned for the welfare both of Sakharov the man and Sakharov the symbol. The Council was fully cognizant that the action of the Soviet Government was, by Soviet standards, extraordinarily mild. Many have suffered far more for much less. The Council is aware, for example, of the relative harshness of the fate accorded to Yuri Orlov and Sergei Kovalev merely for attempting to appraise the extent to which the Soviet Government lives up to the commitments made in the Helsinki Accords.

We are moved by the case of Andrei Sakharov because he is truly a distinguished physicist, a foreign associate of this Academy. His offense was to speak out with courage and candor concerning wrongs that he perceives within his own country. The immediate trigger for his exile appears to have been his expressed objection to the invasion of Afghanistan, an objection not dissimilar to the objections some of you voiced concerning America's role in Vietnam. He was and is a loyal citizen of his own country who has engaged in nothing that external observers might consider disloyal or treasonous acts. Accordingly, the Council and the Committee on Human Rights deem it imperative that we publicly voice protest concerning his fate.

Yet it is difficult to hold hope that his situation will be alleviated; indeed, the contrary would seem to be more likely. He will surely engage in what his government deems to be objectionable behavior, and with the passage of time they will increase the severity of his circumstances. Each such action will confront this Academy with the need for yet another decision. We will need better to understand our own values and to articulate more clearly the principles that we defend. I trust that when that has been done, we will live in keeping with those principles.

As you know, I led the American delegation to the Scientific Forum convened in Hamburg by the Conference on Security and Cooperation in Europe. Various of the relevant documents have been made available to you. We had two principal concerns: (1) the human rights of scientists and (2) appropriate behavior with respect to exchanges, participation in international meetings, the granting of visas, etc.

(1) In retrospect, we were more successful than we expected. The views of our delegation were fully shared by all other Western delegations, most of which made opening statements to the plenary generally in keeping with ours. This Western solidarity continued through the two weeks of debate and negotiation leading to the final report. The latter may seem a very small accomplishment. Perhaps it is. But we did succeed in getting into the report a link between the human rights provisions of the Helsinki Act and the conditions for scientific cooperation, a link which was not made explicit in the Helsinki Accord itself and which the Soviet Union has, hitherto, consistently put down by referring instead to that principle of the Helsinki Accord which denies any right to intervene in the internal affairs of another sovereign nation.

(2) We engaged in days of feckless debate in which we attempted to insert into the report as a condition for scientific cooperation, "freedom to study science, freedom to pursue scientific inquiry, freedom to engage in the wide communication and travel that are part of the scientific enterprise." The word "freedom" itself proved to be the taboo. When we substituted for "freedom"

the phrase "equitable opportunity"--defining "equitable" as meaning "fair, just and reasonable"--we obtained agreement to the idea that equitable opportunity to study science, to pursue scientific inquiry and to engage in wide communication and travel are conditions necessary to international scientific cooperation. The next few years will establish whether Soviet agreement to such language will, indeed, provide leverage enabling us to ease the difficulties we have known. There is little doubt that it will prove to be of assistance to scientists in the other East European countries; that was the principal reason that kept many of us from leaving Hamburg on several occasions.

Withal, it is not clear to me that our members are of one mind in these regards. Some consider the question of human rights to be outside our purview; some object that we defend the human rights of scientists only; some consider the Council's action too harsh or even unwarranted; some consider that such actions taken in the absence of a united front and common course of action among Western scientists may ultimately be counterproductive. I look forward to your discussion of these matters later in our agenda so that the Council may be better guided in the future.

ISTC. Our Foreign Secretary, his advisers and staff had much to do with devising and promoting the idea of an Institute for Science and Technology Cooperation as an independent agency empowered to assist developing nations in building their capacities to utilize science and technology for their own development, including support of research, largely that applied to the problems of health improvement, food production, resource use and small-scale, labor-intensive industry. Although the Bill was approved by the Congress, that body now prefers that any such program be funded through AID--which has amply demonstrated its incapacity to operate a program of this character.

The thought has arisen that the funds be transferred from AID to the Academy which would then establish suitable arrangements and directly operate the program. That is not an entirely novel role--we operate RERF, conduct the National Cooperative Highway Research Program,

judge proposals for the Army Research Office, and, most importantly, already provide technical advice on specific problems of development through our Board on Science and Technology for International Development. Concern arises largely out of whether, in view of its political history, the program in question would seriously shorten the arm's length between us and the government. Your views would be deeply appreciated.

Arms Control and National Security. This institution has a long tradition of assistance to the military. And we continue in that tradition, rendering useful service, we think, to each of the armed services. The most recent contribution of the Naval Studies Board is an effort of which we can be particularly proud. But I have felt frustrated by our lack of meaningful contribution to the search for a path that combines military security with meaningful arms control and, one day, effective nuclear disarmament. We share with the American Academy of Arts and Sciences, in part, in the responsibility for American participation in the Pugwash Movement. But all omens indicate that that will be a decreasingly effective instrumentality to these ends. Accordingly, I am pleased that we have taken the first steps to bring into being a Board on International Security and Arms Control for which we plan a highly qualified professional staff and a distinguished membership. And I am particularly pleased that Murph Goldberger has agreed to serve as its Chairman. I consider this a momentous event in the Academy's history; no committee has ever been offered a greater or more significant challenge. Again, those of you who wish to contribute your ideas concerning this venture will be most welcome.

And so I conclude as I began. It takes a lot of getting used to. The Pax Americana was all too brief. Our special place in the world has diminished--but only somewhat. We shall continue to pursue the American dream, but it requires more careful guarding than it did yesterday.

We erode that dream by encouragement of children to think of their ethnic or cultural backgrounds as more precious than their entry into the wondrous American melting pot, by news media that disseminate scare stories regardless of their factual basis, by

publishers with reckless regard for truth if only their publications will sell. We threaten our dream by a newfound passion for a risk-free world that can never be and might not be worth having, by living beyond our energy and mineral resource means, by endless debate concerning our energy situation instead of vigorous measures to assure energy conservation and equally vigorous determination to assure an energy supply independent of the capricious behavior of politically unstable foreign powers. We can lose our dream by failure to remember that our economic strength is permanently bound to world economic growth and stability and, hence, upon a firm, consistent foreign policy and an adequate but not excessive military posture, by failing to understand that democracy is a viable political mode only if there is prospect for continuing economic growth and, hence, ever-improving personal prospects for the poorest among us, the only alternative, apparently, being a repressive, authoritarian society. And, most assuredly the dream will become unattainable if our nation withholds support from our universities or from our scientific and technical community, our principal means of preparing for tomorrow.

Thank you.