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OA/ID Number: 62080
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Folder Title:
President's Council of Advisors for Science and Technology: Megaprojects [1991]

Stack:	Row:	Section:	Shelf:	Position:
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3/8/91

JMC

Flip side of prob. of
ind. prod. inv.

Domestic + Int. components

FECSET effort
EC
OECD
USSR - May
Japan - Oct

DOE/Morre

Megaprojects - DAB: Mt. Kisco, EC
Balance of Intellectual Trade Deficit
Opportunity + Danger

Tipping of funding profile
Good examples
CERN
Crenoble reactor

Competitiveness argument used by politicians
Support for SSC in Tokyo, Munich?

Long scale - 20 yrs funding

US track record poor
Different countries, different priorities, eg fusion
How to balance off fields
fusion, HEP, space

Need to balance engineering contracts
reflect funding that goes in

Issues:

Do we want more rational int. framework

Players

How communicate internally DOE, NASA, NIH, NSF

Get thru Congress?

Who deal w/ externally
G-7, OECD

autonomy

McTague mtg in Japan EC, US, Japan

OSTP ahead of curve

Deal w/ agency priorities
Congress

Practical int. relationships

Doing it now, one at a time; do more rationally

PCAST effort - ad hoc - end of year

People

Schultz

Friedman

Fletcher, Hammers, Beggs

Money - Role of scientists

Mc - Bottoms up < NASA - proj, add science

Comary - need witnesses from abroad < HEP - works too well

Watson / Hannon < Weiskopf
CERN director
Money endorses

Comary - how about 10%

danger of setting precedent in basic sciences, to be
applied to short range (inf.) areas

DAB - grandfather existing projects
role of sci. comm. - Int. Em. on Big Accelerators / ICSU
cost sharing

immediate problem: Rubbia - charge for hourly cost?
reciprocal discount - way of getting operating costs

Nathans, Bachsbaum - good idea

Money - bad idea

Comary - 2 horrors - ① barter bad

② market mech. bad for - funding process too slow

THE IMPORTANCE OF "SMALL" SCIENCE

G. BRENT DALRYMPLE

My subject is "small" science—not small in physical dimensions or significance, but science done by capable individuals or small teams of scientists who are motivated solely by curiosity about how nature works. I mean science unencumbered by the goals, direction or guidance of administrators, funding agencies, or politicians. I mean science done without the slightest consideration of its practical worth to society or humankind.

How important is "small" science? I think it is the single most important thing that has made possible the technological revolution of the 20th century. This is by no means a new idea; it was expressed 45 years ago by Vannevar Bush, who wrote, "New products and processes are founded on new principles and conceptions which, in turn, are developed by research in the purest realms of science."¹ I also think, however, that the contributions of small science to the wealth and welfare of humankind are

not well recognized today, either among the population at large or among those who fund science. It is fairly obvious to anyone who has looked at research budgets over the past decade or two that small science is being increasingly neglected in favor of big science and of science directed toward perceived national and global problems. In the long run this neglect will be detrimental to society, and the trend must be reversed.

These days, such a view may seem self-delusional, incredibly naive, unconscionably selfish, or all of the above. For those who view undirected science as heretical, however, I assure you that I am not demented. We want precisely the same thing—that is, to get the most out of science for the benefit of humankind by the most efficient means; we differ only in method. I see small, fundamental science as the essential base for nearly all practical applications of science. I hold the view that without small science, the progress of science, and therefore of technology, industry, well-being and civilization itself, will be greatly curtailed.

DEFINITION OF SMALL SCIENCE

I would like to justify my outrageous opinions about small science by examining the ways in which science contrib-

utes to society, by looking at how science works and at the importance of small science in the process. To begin with, let me refine what I mean by small science. Consider science as undirected or directed, either of which can be big or small. Undirected science is commonly known as basic or fundamental; it is driven purely by the scientist's curiosity without regard to any particular preconceived goal or end-product. Its only objective is to learn a bit more about how nature works, to explain some interesting phenomenon, or to discover how things came to be. As work progresses, the scientist is free to follow new directions as they arise, and even to abandon the original experiment to pursue something unexpected that may be more interesting, unusual, important, or exciting.

In contrast, directed or applied science is done in pursuit of specific goals—usually, but not necessarily, practical ones. The goals are determined beforehand, most often by an administrator, politician, or committee of scientists responding to a perceived need, and may focus on product development or seek the solution to a specific industrial or societal problem. The scientist is in charge of methodology and instrumentation, but sets the research goals only within narrow limits determined by others. Within this directed environment, the scientist may not be free to deviate

G. Brent Dalrymple is president of the American Geophysical Union. His article is adapted from an address before the University of Toronto's Geophysics Sesquicentennial celebration, November 3, 1990. The article is reprinted from EOS, Vol. 72, No. 1 (January 1, 1991), a publication of the American Geophysical Union, Washington, D.C.

from established goals unless the new goals are approved by those in charge.

Science can also be big or small. The division between these is arbitrary, but I would restrict the definition of small science to research done by a single researcher or a small group of two to four, with modest technical support and budget levels. Most small science budgets are less than a few hundred thousand dollars per year, including salaries, but I don't want to be too restrictive, so let's say less than about \$1 million per year. The project typically involves no more than two levels of hierarchy—scientists and technicians or students—and the organization is invariably informal. There are no permanent or full-time administrators within the research project, although the institution will invariably provide some administrative structure and support. The only formal reporting requirements are the publication of results in the scientific literature and perhaps the occasional progress report to the funding entity. This type of research is most commonly done in universities and usually involves students to a substantial degree.

Big science, on the other hand, involves many people and is of sufficient scale and complexity that the research project itself will have a formal administrative structure with at least three levels (administrator, scientists, technicians) and often more. The project may generate internal reports as well as those for the scientific literature. Budgets may range from a few million to billions of dollars per year.

Obviously, this classification oversimplifies the infinite range of possibilities between big and small science. Undirected and directed science overlap to some extent, and big science, out of necessity, is more often directed than small science is. But let's ignore the complexities because they are not important to my thesis. My concern is really over small, undirected science—the category that I believe is not receiving the attention or funding it deserves.

SCIENCE'S CONTRIBUTION TO SOCIETY

I don't think that the overall value of science to society is generally questioned. It seems that the public has a pretty fair sense that our economy, our health, and many of our pleasures derive in no small measure from the accomplishments of science and technology. To be sure, we occasionally get blamed for inventing the bomb or for devising new and better ways to pollute the planet, but the average citizen is comfortably supportive of science and amazingly tolerant of scientists' continuing endeavors to poke and prod Mother Nature. But the public also has the erroneous idea that science is a well-orga-

THE CONTRIBUTIONS OF SMALL SCIENCE...ARE NOT WELL RECOGNIZED TODAY, EITHER AMONG THE POPULATION AT LARGE OR AMONG THOSE WHO FUND SCIENCE.

nized, efficient, and multi-purpose tool that can be aimed at will in any direction to solve whatever problem, or invent whatever technology we need, by today or, at most, tomorrow. Sadly, too many of us scientists and science administrators help to reinforce this myth in our constant struggle for funding. It is easier for us to "go where the money is" than to spend a bit of our time and effort explaining the value of small, undirected science.

The public's positive attitude toward science is amply justified because science gives society more than a fair return on investment in a variety of documentable ways, including contributions to cultural enrichment, improvements in the human condition, economic growth,

new inventions and improved products, and solutions to the problems caused by the use and misuse of technology. But from what kind of science do these benefits derive? Are directed science and big science necessary? Of course; directed science is the avenue to invention and product development, the critical link between pure science and industry. Directed science also ensures that sufficient scientific resources are applied to time-critical problems, such as ozone depletion, global warming, earthquake prediction, ocean pollution, and control of the AIDS virus. Big science, too, is important because some problems, both basic and applied, cannot be addressed in the small college laboratory, or by a handful of individuals. Big science projects typically, but not necessarily, require some large facility without which certain lines of inquiry would be impossible—a particle accelerator for studying the fundamental building-blocks of matter, a space telescope for looking back in time at parts of the universe as they were billions of years ago, a deep-sea drilling vessel for exploring the oceanic crust.

OUTLOOK FOR SMALL SCIENCE

Big science and directed science, however, must be balanced by a reasonable amount of small science, and that balance is currently tipped in the wrong direction. Let me illustrate with a few data from the U.S. science budget. In 1967, during the height of the Apollo lunar program, the government spent about \$46 billion for research and development in science and technology, including the military, adjusted for inflation. In 1990 that figure was \$48 billion. But while U.S. spending for research and development has remained relatively constant over the past two decades, the funding devoted to big scientific instruments with costs exceeding \$25 million has risen by a factor of 26. Over the next decade, the situation promises to become even worse. A few of the big

science projects proposed for the 1990s, for example, are: the Space Station (estimated cost, \$30 billion), the Cassini Saturn Probe (\$800 million), the Human Genome Project (\$3 billion), the Earth Observation System (\$17 billion), the Advanced X-ray Astrophysics Facility (\$1.6 billion), the Superconducting Supercollider (\$8 billion), and the Advanced Photon Source (\$455 million). If history is any guide to the future, these costs may be greatly underestimated.

The outlook for the small investigator, on the other hand, is bleak. Even though the budget for the National Science Foundation (NSF) rose from \$1.72 billion in 1988 to \$2.12 billion in 1990, the funding designated for small grants in mathematics, physics, chemistry, engineering, biology, and computer science fell during the same period, when adjusted for inflation. The average NSF grant for the individual investigator shrank in constant dollars from \$68,000 in 1983 to less than \$62,000 in 1989. Adjusting these figures for inflation, the decline is even more apparent. The average success rate for individual grant applicants has also declined from 39 percent in 1983 to 30 percent this year.² Small science in the earth sciences is faring no better.

It is difficult to understand why small science is such a low priority. Even a casual student of science history knows that the major proportion of the important, fundamental discoveries in physics, chemistry, biology, and the earth sciences has come either directly from small research projects, or depends heavily on previous discoveries made by small, undirected science. Recent advances in electronics, communications, medicine, computer technology, and resource development have all relied heavily on the discoveries of small science. Progress in technology invariably draws heavily on the pool of fundamental scientific knowledge that is replenished primarily by those scientists who work alone or in small groups and are driven primarily by curiosity. This has been

true throughout the history of natural science, it is true today, and there is no reason to believe that it will not remain true for the foreseeable future.

THE UNPREDICTABILITY OF SCIENCE

So what unique characteristic makes small, undirected science essential to the overall progress of science and technology? The answer is diversity—because none of us is able to predict with any degree of reliability which scientific discoveries will be important or how they will be put to use for future scientific or technological advances. No one predicted that the discovery of the electron by Thomson and Lorentz would lead to the variety of useful products that come from today's electronics industry, nor that the theoretical work of Maxwell and the discovery of electromagnetic waves by Hertz would lead to revolutionary new ways to communicate. No one predicted that Mendel's fascination with variations in the characteristics of peas would one day offer the possibility of cures for genetic disease, nor that the curiosity of a handful of geophysicists about the phenomenon of reversed magnetism in rocks would provide a critical key to formulating the theory of plate tectonics. And no one predicted that Wilson's inquisitiveness about the electronic band structure of semiconductors would lead to the invention of the transistor. Who knows what the value will be of strong theory, or quarks, or neutron stars, or seismic tomography in the future?

Not only administrators and leaders of science are inept at making such predictions. Scientists are equally unable to forecast the importance of their research. As far as I know, not one of the scientists in the examples just listed knew where their research would eventually lead. They were driven simply by their curiosity about observable phenomena and their desire to discover beauty and order in nature.

A notable example is Lord Rutherford, who commented in 1933 on the structure and energy of the atomic nucleus: "Anyone who expects a source of power from transformation of these atoms is talking moonshine."³ That was only five years before the demonstration of nuclear fission.

My personal experience in science does nothing but reinforce this view. Allan Cox, Richard Doell, and I had not the slightest inkling that our experiment on geomagnetic field reversals in the early and mid-1960s would provide the "Rosetta Stone" to allow Vine, Matthews and Morley to decipher the meaning of the magnetic strips on ocean floors and to initiate the formulation of a new paradigm, known as the theory of plate tectonics, for understanding the earth. We were motivated by our fascination and curiosity about the possibility that the earth's magnetic field had reversed in the past and thought only that geomagnetic reversals would be a wonderful thing to study and either to demonstrate or disprove.

There are several obvious reasons for the unpredictability of science. I have already alluded to the first—that none of us can foresee but a small fraction of the possible future uses for our results. Each of us brings to science a different experience and a different way of looking at things, so that perhaps only one in a thousand or a million is capable of seeing as obvious what is obscure to the rest of us.

The second reason is the well-known phenomenon of accidental discovery or serendipity. Since we don't know precisely how nature works, we cannot predict in advance what we will find and how those new findings will open up new avenues of inquiry. To quote Alfred North Whitehead, "there is always more chance of hitting on something valuable when you aren't too sure what you want to hit upon." Examples of chance discoveries are common and most scientists have experienced this firsthand to one degree or another. Velcro, x-rays,

electric current, teflon, synthetic rubber, pulsars, rayon, insulin, nuclear fission, aspartame, penicillin, polyethylene, and even corn flakes are all the result of accidental discoveries.

The third reason for the unpredictability of science is the long lead time between discovery and application. This lead time varies, of course, but it is commonly on the order of decades rather than months or years, and probably occurs because other discoveries, experiences, or needs are necessary before the application is obvious. For example, the phenomenon of nuclear magnetic resonance was discovered in the 1940s, but the first NMR imaging device—forced to await developments in electronics, computer technology, and conceptual need—did not come on the market until the 1970s.

Another example is the theory of plate tectonics, formulated in the mid-1960s and dependent on a wide variety of previous discoveries or hypotheses. A few of the more prominent that come to mind are: Hopkins' 1939 idea of convection in the earth; the hypothesis of continental drift by Snider in 1858 and Wegener in 1910; the hypothesis that the earth's magnetic field may reverse, proposed by Brunhes in 1906 and Mercanton in 1926; the hypothesis of sea floor spreading by Holmes in 1928; the discovery of Benioff zones by their namesake in 1949; and so forth. These discoveries and ideas, essential for plate tectonics, were ahead of their time. They were each an unobvious part of a large and complicated intellectual structure whose shape and form was recognized only when all of the evidence was at hand—not until the mid-1960s, more than a century after Snider first proposed that the continents had moved.

Our proven inability to predict which research will lead to significant findings means to me that a substantial proportion of science must be undirected. The only way we can ensure that science continues to progress as we wish and expect is to recognize the unpredictability

of science and to ensure that a sufficient and ongoing diversity of small science is being done. As abhorrent as it may be to administrators and politicians, a substantial fraction of scientists must be left to follow their curiosity, unencumbered by the need to justify what they do in practical terms and unfettered by near-term goals. We must accept that science is not particularly efficient and that some research may never lead to anything important or practical. We must recognize that, in the long run and despite the inefficiency, undirected science is very profitable indeed and we must support it for, if we don't, science will lose its vitality.

Big undirected science versus small is a different sort of problem. The need for some big science is undeniable, but it has now captured far too much of the available science funding and threatens to capture even more. As with undirected versus directed science, the question of small versus big is one of balance, and in my opinion the balance is presently unfavorable.

HOW MUCH SMALL SCIENCE?

How much small, undirected science is enough to ensure the diversity necessary for the vitality of science? I don't have a definitive answer, but I will guess that something less than 20–25 percent of the total science done, as measured by the funds expended, might be sufficient. It must be enough to guarantee the diversity of science, to protect the essential infrastructure upon which all scientific progress depends and to provide an adequate training ground for future scientists.

I like to think about the pool of knowledge that results from scientific research as a bank account. Into this account we deposit our discoveries, hypotheses and theories, and from it we draw information for further research, both fundamental and applied, and for technological development. The knowledge we put in is the principal—our investment in the

future. The information we withdraw and apply is the interest—our reward for being wise enough to invest. Today, however, we are not wise investors, for we are withdrawing more than we are putting in; in effect, we're spending the principal and, after a while, there may be no interest to collect.

What can we as scientists do about this situation? We can better inform the public, and those responsible for allocating funds, about the ultimate practical and economic value of small, undirected science. We can resist jumping on the latest bandwagon simply because that's where the money is today. We can support our colleagues who are doing and publishing the results of good, fundamental science. We can teach our students—the scientists and administrators of the future—about the value and necessity of small, undirected science.

I am asking society to loosen the fetters a bit and give scientists more of a free hand in doing what they do best—investigating nature. In exchange, we must recognize that we have some responsibilities as well. We have the duty to select interesting problems, to be productive, to communicate our findings effectively to our colleagues and the public, to husband the resources that society grants us, to be aware of and responsive to societal needs, to refrain from promising too much and to educate the next generation. Above all, we must put more in than we take out. To quote the late Richard Feynman, "Our responsibility is to do what we can, learn what we can, improve the solutions, and pass them on."⁴

REFERENCES

- ¹Bush, V., *Science, the Endless Frontier*, U.S. Office of Scientific Research and Development, Washington, D.C., 1945.
- ²Palca, J., NSF: Hard times amid plenty, *Science*, 248, 541, 1990.
- ³Weisskopf, V.F., The significance of science, *Science*, 176, 138, 1972.
- ⁴Feynman, R.P., *What Do You Care What Other People Think?*, Bantam Books, New York, 255 pp., 1988.

DRAFT

May 6, 1991

DRAFT PCAST MEMORANDUM

FROM: JOHN McTAGUE, ON BEHALF OF PCAST

SUBJECT: INVESTING IN THE FUTURE - FOLLOW THROUGH WITH CONGRESS

The Council reiterates its support for the important investment in the future proposed in your FY 1992 Budget submission, particularly in the areas of research and development. At the March PCAST meeting you noted the lack of a natural political constituency for research, especially individual investigator efforts. This makes all the more important strong White House follow-up with the Congress, particularly as consideration moves to the appropriation process.

From the authorization hearings and budget resolutions to date, it is becoming increasingly clear that sustaining your R&D priorities will require your personal and visible participation. If you were to call together both Republican and bipartisan Congressional leaders to highlight the priority this investment has for the nation it would be particularly effective. The Council recommends such an action, realizing the many demands on your time and political capital.

(1)

The Council reiterates its support for the important investment in the future ~~that is~~ proposed reflected in your FY 1992 Budget submission, particularly in the areas of research and development. At the ~~most recent~~ ^{March} PCAST meeting ~~you were able~~ ^{you noted} to ~~attend~~ the lack of a natural political constituency for research, ~~particularly~~ ^{especially} individual investors efforts ~~was discussed~~. This makes ~~at~~ all the more important ~~for~~ strong ~~at~~ White House followups with the Congress, particularly as consideration moves to the appropriation process.

and budget resolutions (2)

From the authorization hearings to date, it is becoming increasingly clear that sustaining your R & D priorities will require your personal and visible participation. If you were to call together both Republican and bipartisan Congressional leaders to highlight the priority this ^{investment} area has for the nation it would be particularly effective.

The Council recommends such an action, ~~in~~ ^{realizing} ~~realization~~ ~~the full knowledge~~ of the many demands on your time and political capital.

THE WHITE HOUSE
WASHINGTON

May 9, 1991

MEMORANDUM FOR JOHN McTAGUE

FROM: D. ALLAN BROMLEY *Alan*
SUBJECT: TERMS OF REFERENCE FOR THE PCAST PANEL ON
MEGAPROJECTS IN THE SCIENCES

You are requested to establish a PCAST Panel on Megaprojects in the Sciences.

The purpose of the Panel is to develop information and policy options to provide a base for PCAST advice to the President on national and international policy issues related to the planning, financing and organization of large scale projects in the sciences, otherwise known as megaprojects.

Megaprojects in the sciences are unique in character and are so costly that it is becoming increasingly difficult for one country to fully finance them. Even when the burden of costs is borne by one country, the benefits are often shared by many nations. They require long lead time for planning and construction. They affect scientists in many nations, either via distributed research projects or widespread use of central facilities. Thus, they are inherently international in nature even when totally financed by one country.

This topic is particularly timely. Its importance was discussed recently at the Informal Meeting of Science Advisors To Heads of Government at Mount Kisco, New York and at the first meeting of the US-European Commission (EC) Joint Consultative Group in Washington in February, when it was agreed to establish a US-EC task group to discuss megaprojects in preparation for the Spring 1992 Organisation for Economic Co-operation and Development (OECD) Ministerial Meeting, at which megaprojects will be a major topic.

PCAST advice is also important because of increased pressures on funding for individual principal investigators in the face of constrained budgets. Thus, escalating costs of scientific instrumentation and facilities, coupled with these budgetary constraints, point to a need to consider international cooperation in funding megaprojects.

A subcommittee of the Committee on International Science, Engineering and Technology (CISSET) of the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) is currently examining this issue. It is expected that the

PCAST panel will utilize studies prepared for the CISET deliberations on megaprojects.

The Panel on Megaprojects in the Sciences shall:

- 1. Address the relative roles of megaprojects and smaller investigator-initiated science projects.**
- 2. Characterize the role of the scientific community in terms of the proposal and planning of megaprojects.**
- 3. Advise on an appropriate approach to the planning and coordination of such projects domestically. This might include identification of lead agency responsibilities and consideration of whether megaprojects should be handled all together or considered individually.**
- 4. Advise whether a comprehensive international framework for coordination and cooperation is desirable, and how countries could cooperate to ensure that the cost and benefits of big science projects are shared equitably.**
- 5. Suggest the most appropriate international fora, governmental and scientific, in which such cooperation could be further discussed and coordinated (for example, OECD, United Nations, International Council of Science Unions (ICSU), and/or the group of seven economic summit countries (G-7)). The US is currently developing a position regarding megaprojects for the Spring 1992 OECD Ministerial Meeting.**
- 6. Examine mechanisms and criteria for country participation. How can country participation in planning and organization be ensured without jeopardizing the design and organization of the projects? Some observations of successful and unsuccessful administrative/executive arrangements relating to past or current international megaprojects would be useful.**
- 7. Consider ways to increase continuity of commitment and sustained life-of-project funding by the United States. Many countries are reluctant to cooperate with the United States on large scale projects due to U.S. difficulties in ensuring funding over a long term, even after we have a Presidential commitment. Consideration of highly credible arrangements, such as treaties would be examined.**

The Panel will be established on a temporary basis and will complete its charge in six to nine months. In addition to providing the advice on the specific items listed above, the Panel will serve as a sounding board on related topics/issues in the interim and possibly after its charge is complete.

The Panel will submit a preliminary report to PCAST within three months after the Panel's first meeting.

The Office of the Associate Director for Policy and International Affairs, Office of Science and Technology Policy will sponsor the Panel. Dr. John McTague will serve as Chairman of the Panel and Dr. Harold Shapiro will serve as Vice Chairman.

Determination

I hereby determine that the formation of the PCAST Panel on Megaprojects in the Sciences is in the public interest in connection with the performance of duties imposed on the Executive Branch by law, and that such duties can best be performed through the advice and counsel of such a group.

The Terms of Reference for the PCAST panel on Megaprojects in the Sciences include no assignment requiring Panel members to participate personally and substantially in the conduct of any specific procurement, or place any member in the position of acting as a "procurement official."

Approved:



D. Allan Bromley
The Assistant to the President
for
Science and Technology

May 9, 1991
Date

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION

DOCUMENT NUMBER: 9121475

FROM: BEGGS, James M.: SPACEHAB

TO: DR. BROMLEY

FILE

DATE OF
CORRESPONDENCE: 05/21/91

SUBJECT: ACCEPTANCE OF THE INVITATION TO SERVE ON THE PANEL
ON MEGAPROJECTS.

ASSIGNED TO:

ACTION REQUIRED:

SENDER'S DUE DATE:

OSTP DUE DATE:

DATE COMPLETED:

COPIES TO: D. Allan Bromley
Jenifer Bond
PCAST

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DATE RECEIVED: 05/21/91

FILE: PCAST

91 MAY 21 AIO: 59

OFFICE OF THE
DIRECTOR

May 17, 1991

Dr. D. Allan Bromley
The Assistant to the President for Science and Technology
The White House
Washington, D.C.

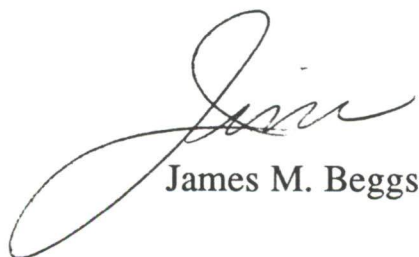
Dear Dr. Bromley:

Thank you for the invitation to serve on the Panel on Megaprojects in the Sciences. I accept with pleasure. It will be nice to work with Dr. John McTague again and I will look forward to hearing from him.

This is an important time in the development of our Nation's plans for large scale projects with the increasingly competitive environment in the world. We must use our resources for Science and Technology efficiently and effectively if we are to maintain our leadership position. I believe that a Panel such as this should be able to assist in this effort.

With all good wishes.

Sincerely,



James M. Beggs

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5/21/91

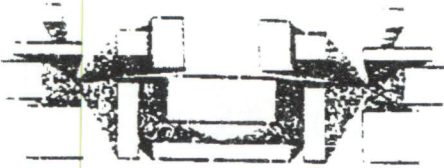
*FILE
PCAST
Panel on
Megaprojects*

Dr. Ed Frieman called to accept your invitation to be on the PCAST panel on Megaprojects in the Sciences.

He also wanted to tell you that he had spoken with Vic Reis who wanted you to know that he would be delighted to work with you in any way.

Marian

In Love Ratsch Ind



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

DATE: May 24, 1991

TO: Dr. John McTague
Vice President of Research

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Telephone Number: (313) 322-7105

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FROM: Dr. J. Thomas Ratchford
Associate Director

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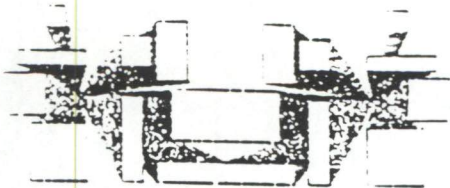
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TO: Dr. John McTague
Vice President of Research

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Number of Pages (including cover sheet): 2

SPECIAL INSTRUCTIONS:

Please see the attached for your information.

Meeting with PCAST Megaproject Experts July 12, 1991

Jim Beggs observed that the idea of trying to establish a better framework for international collaboration in large science projects is a very good and timely idea. He noted that DOD and NASA have a number of successful international collaborative projects in which they had made significant concessions in letting foreign partners have a part in direct oversight and coordination boards. These projects were carefully monitored to ensure that partners did what they promised. Projects that ran into problems generally did not have a mechanism established early to address and solve problems in their initial stages before they became major issues.

Beggs pointed out that the Europeans have a long cultural history of collaboration in a variety of areas--not just science--with those they didn't like when it was to their mutual benefit. They are therefore more accustomed to scientific collaboration than are US scientists. It is also easier for them to sustain funding for collaborative projects in parliamentary forms of governments. Even so, they do suffer cost overruns of equal magnitude to any of ours.

John McTague pointed out that each agency follows its own procedures and rules and has its own Congressional committees and ways of dealing with Congress. It is therefore difficult to have an organized approach to megaprojects in the budget. He noted that even within a single agency there are different approaches to the organization of megaprojects. For example, within the Department of Energy, ITER has been done on an international

partnership basis from the beginning and is therefore more successful than the SSC which was first begun as a national project.

Beggs stated that he thought that Congress would be ready to deal with funding decisions for megaprojects in a more organized and comprehensive fashion if they thought there would be support in scientific community. What is needed is a spokesman from the scientific community to champion the cause. We need politicians (perhaps the Vice President or Jack Danforth) to begin to make public statements about the importance of international cooperation.

The problem is that the US scientific community generally is not ready to share science funding if they don't have to do so. They believe that "what is theirs is theirs and what is yours is ours." Also there are still lots of cold warriors that worry a great deal about national defense implications. However, it is important to realize that we no longer are as dominant in the world economy or in world science as we once were. We need to be cooperating from a purely practical point of view.

John McTague noted that in large measure, international cooperation in science megaprojects is a political problem. Beggs noted that scientists like to be the ones to select the projects and are somewhat short-sighted in terms of maintaining political friends. If a President selects a project as a high priority, they often don't like to support it. This is true even for Presidents who are very supportive of science. Two examples are President Reagan and the SDI, and President Bush and the Space Council.

McTague noted that he would like the PCAST panel and the experts to consider and propose practical solutions. For example, they might want to address whether or not it is feasible to establish a domestic capital budget for science and is there an appropriate international forum for discussing and planning international cooperation in megaprojects?

Lloyd Cutler observed that it might be wise to start with a few well chosen projects rather than to begin from a universal or theoretical point of view. which could attract international constituents and which could interest strong lobbying groups. Global change and oceanography projects could be examples. They would attract such strong public interest groups as the World Wildlife Fund or Greenpeace. One needs to begin with projects that have intrinsic appeal and strong public interest.

Cutler noted that the EC has had lots of experience and have been handling joint ventures for a long time (not always well). For example, he has been involved with the AMADEUS project, a consortium of airlines organizations in Europe. International collaboration can lead to greater overhead and complexity. For example, AMADEUS has its headquarters in Spain, its marketing office in Paris, and its computer center in Munich. There are several European organizations and projects which have overlapping country memberships with the EC, for example EURATOM, ESA and CERN.

Cutler also pointed out that in any international framework it would be important to consider cooperation with the Soviet Union. McTague agreed and noted that the ITER project involves the Soviet Union.

Beggs and Cutler each suggested that it would be good to look at 2-3 past collaborative efforts and examine the lessons learned. There are several European projects/facilities such as CERN which are models and from which we could learn. One of the reasons CERN is successful is that it has established protocols and procedures for voting on research directions and investments. Some of these procedures might be adaptable to other projects. One important feature of CERN and many other European projects is that when a project is approved support is generally ensured for the life of the project.

Tom Ratchford commented that the Europeans frequently rely on the force of treaties to guarantee greater stability in the terms of reference for international collaboration. Dr. Ratchford reported that the Germans (i.e., Lust) appear to have a preference for such arrangements even though they are characterized by greater inertia in the initial stages.

Several people were suggested as potential resources for the PCAST panel:

Elliot Richardson for his experience in negotiating the "Law of the Sea."

John Logsdon who is doing a study of the space station.

Walter Rosenblith for global change projects.

Plans for the NSF-EC Workshop on Megaprojects were discussed. Beggs and Cutler agreed to try to come to the Brussels meeting in October.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

FILE

August 23, 1991

MEMORANDUM FOR JOHN MCTAGUE

THROUGH: J. THOMAS RATCHFORD *JSB for JTR*
FROM: JENNIFER SUE BOND *Jennifer*
SUBJECT: SEPTEMBER PCAST MEETING

The September PCAST megaprojects meeting is scheduled for September 13 from 12:00PM to 2:00PM in Room 22 of the Old Executive Office Building. It will be part of the regular PCAST meeting as we discussed.

The following people are planning to attend:

Tom Ratchford
Harold Shapiro
Jack Sandweiss
Jim Beggs
Lloyd Cutler (unless the Thomas hearings interfere)

Jim Baker and Ed Frieman regret that they cannot attend. Jim Baker will be attending the October EC workshop and you may want to try to see him separately sometime when you are in Washington. Unfortunately, Ed Frieman will not be able to come to the meeting in Brussels but wants to participate in follow-on megaprojects work. He suggested that EOS might make a good case study. There is a draft in the package I sent you yesterday which might need to be revised a little given the new proposal.

I don't know if you want a formal agenda for the September 13 meeting, but you might want to have a presentation by Bill Blanpied of the paper and concepts. Since you mentioned this as a possibility, I have asked him to be ready to do so if you so desire. Please let us know. The September meeting would offer a good opportunity to begin to decide who will lead discussions of specific topics at the EC Workshop.

Everyone has been notified by phone and reminded of the September meeting. I am attaching a short note from you to send out to those who are coming, a draft agenda for the September meeting, and the draft agenda for the October Workshop which we discussed earlier and which has been generally adopted by the EC. Please rework these as you see fit.

I will be in a four-week management course at the Federal Executive Institute in Charlottesville as part of my Senior Executive Service Training Program. I will, however, be back for the September 13 meeting and in my absence, Sara Bowden (202-394-4626) or Bill Blanpied (202-357-9632) are willing to help you in any way. I can also be reached at (804)-980-6302.

Science Megaprojects Discussion

PCAST Meeting

September 13, 1991

12:00-2:00 PM

Room 22, OEOB

PCAST Terms of Reference and Purpose of Panel John McTague

International Cooperation in Science Projects Bill Blanpied
(Presentation of paper)

Outline of Other Domestic, Bilateral and Tom Ratchford
Multilateral Activities re Cooperation in
Megaprojects

Ideas & Issues Experts

DRAFT

NOTE

**TO: Harold Shapiro
Llyod Cutler
Jim Beggs
Jack Sandweiss**

Our discussion of science megaprojects will take place at noon in Room 22 of the Old Executive Office Building on 17th Street and Pennsylvania Avenue. We shall start at noon with a working lunch and aim to end around 2:00 PM. Our session will be incorporated as part of the September meeting of the President's Council of Advisors on Science and Technology (PCAST). Our discussions will include the upcoming NSF-EC Workshop on International Cooperation in Science Megaprojects.

Building security will request a picture ID and your date of birth. Please call Virginia Rosell at (202) 395-7396 with this information.

I look forward to seeing you in September.

- DISCUSSION DRAFT -

US-EC Workshop on International Cooperation in Science Megaprojects

Objective: The joint US-EC Workshop on International Cooperation in Science Megaprojects will provide an opportunity for cooperative development of the issues related to this important topic. The informal nature of the workshop will allow maximum interaction and frank exchange of views between the participants.

Date: October 6, 7, 8, 1991

Place: In or near Brussels, Belgium

Sponsors: National Science Foundation and
DG XII, Commission of the European Communities

Logistics Support for US participation: SRI International, Arlington, VA

Expected Outcomes: A better understanding of the principles involved in successful international cooperation in megaprojects (very large projects) in the sciences. Both single facility (e.g. CERN) and distributed (e.g. global change) megaprojects will be addressed. Inventories, case studies and analyses will be presented, covering both successful and unsuccessful examples of international cooperation.

The results of this workshop will assist in preparations for both the US-EC Joint Consultative Group meeting in November and the OECD Spring 1992 Ministerial.

Participants: US and EC experts from both the private and public sectors.

US PARTICIPANTS

J. Thomas Ratchford
OSTP

Henson Moore
Department of Energy

Frederick Bernthal
NSF

Peggy Finarelli
NASA

John Boright
State Department

Philip Schambra
NIH

Dan Taft
OMB

John McTague
Ford Motor Company

Harold T. Shapiro
Princeton University

D. James Baker
Joint Oceanographic Institutions, Inc.

James M. Beggs
SPACEHAB Inc.

Lloyd Cutler
William, Cutler and Pickering

Edward A. Frieman
Scripps Institution of Oceanography

Jack Sandweiss
Yale University

US-EC WORKSHOP ON INTERNATIONAL COLLABORATION IN SCIENCE MEGAPROJECTS

I. Purpose of the Workshop

II. Policy Context of the Megaprojects Issue

III. Framework of the Workshop

IV. Case Studies and Lessons Learned

Energy

Space Sciences

Global Change Research

Human Genome

V. Principles for International Collaboration

VI. Fora for Discussion

VII. Roles for Government and Non Government Bodies

VIII. Decisionmaking Processes

NOTE: Presentations by both US and EC participants could lead off the discussion in each agenda item.

Status Report of the PCAST Panel on Megaprojects in the Sciences
September 12, 1991

The PCAST Panel Chair, John McTague and Vice Chair Harold Shapiro met informally with Tom Ratchford during the July meeting to discuss objectives and strategies. The Panel's goal is to develop practical advice--something realistic and effective--for policy issues related to the planning, financing and organization of science megaprojects at the national and international levels. Such advice will be developed after discussions with individual experts on megaprojects, consultations with international experts and policymakers, and careful analysis of lessons learned from past experience. Following this strategy, a number of activities have or will soon occur:

A meeting was held during the July PCAST meeting with two of the Panel experts--Jim Beggs and Lloyd Cutler--to solicit their ideas and input. Some of the factors that they pointed out include the importance of partners having an input in direct oversight and a clear mechanism to address problems in their initial stages before they become major issues; the wisdom of learning from the experience of the Europeans who have a long history of working toward common goals for mutual benefit; the need to acknowledge that decisions have a political component as well as a scientific basis, and that there could be a benefit from the support and involvement of public interest groups.

Dr. McTague plans to meet in October with Professor Fasella, of the EC and Dr. Mori of Japan to discuss mutual concerns, issues and ideas related to science megaprojects.

Plans have been made for a joint US-EC Workshop on International Cooperation in Science and Megaprojects to be held in Brussels October 6-8, 1991. The PCAST Panel and many of the PCAST Panel experts will be attending as well as other US and EC experts on megaprojects. A US background paper has been produced which outlines the various issues. Discussions will include case studies and lessons learned from fields such as high-energy physics, thermonuclear fusion, space sciences, global change, human genome, high-performance computing and communications networks, and continental and deep-sea drilling. We expect the frank and open discussions will result in a better understanding of the principles involved in successful international cooperation in megaprojects, lessons learned from previous projects, pros and cons of potential fora for discussion, and possible roles for government and non-government bodies.

The Megaprojects Panel will meet on September 13 to hear the ideas of the PCAST experts concerning issues related to megaprojects and to plan for the EC meeting. It is expected that the results of the US-EC workshop and our meetings with the PCAST Panel experts could be the basis for initial discussions of the issues related to megaprojects in the sciences with the President at the October PCAST meeting.

COVER SHEET**EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
NATIONAL SECURITY AND INTERNATIONAL AFFAIRS
SPECIAL STUDIES DIVISION**NUMBER OF PAGES: 5
(EXCLUDING COVER SHEET)DATE: 9/23/91TO: Monni RaulAGENCY & ROOM NO.: OSTPOFFICE NO.: x 7396TELEFAX NO.: x 3719FROM: Don TaitAGENCY: OMB, NSIA/SSDOFFICE NO.: 202-395-3664TELEFAX NO.: 202-395-5157**SPECIAL INSTRUCTIONS:**

DRAFTG. Options for Consensus Building

8/30/91

Modes of Formal Agreement

Bilateral Agreements. At present, the preferred option for international collaborative agreements with respect to megascience projects seems to be a network of bilateral agreements, or memoranda of understanding, negotiated between counterpart agencies in the participating countries. At a higher level, memoranda of understanding between counterpart agencies could be elevated to the status of executive or Presidential-level agreements.

Multilateral Agreements. ~~If bilateral agreements are relatively easy to negotiate, they are also relatively easy to abrogate.~~ ^{Another} ~~A more satisfactory~~ arrangement (that has been invoked in the case of Space Station Freedom) might be to negotiate international collaboration and cost-sharing arrangements multilaterally. However, there are several problems with a multilateral approach:

First, multilateral negotiations typically require considerably more time than a related series of bilateral negotiations.

Second, the result of multilateral negotiation may often be a "least common denominator," determined ^{now} on political rather than scientific grounds.

DRAFT

8/30/91

G. Options for Consensus Building**Modes of Formal Agreement**

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First, multilateral negotiations typically require considerably more time than a related series of bilateral negotiations.

Second, the result of multilateral negotiation may often be a "least common denominator," determined ^{now} on political rather than scientific grounds.

DRAFT

~~Finally, there is presently no readily identifiable multilateral organization that appears to be adequately equipped to preside over such negotiations.~~

International Treaties. One frequently invoked solution to the problem of assuring long term stability for internationally collaborative megascience projects that has rarely been invoked by the United States, is to ^{make} ~~make~~ such agreements in the form of treaties. The successful negotiation and ratification of a treaty for each proposed project would almost certainly require considerably more time and effort than negotiation of a series of bilateral arrangements at the executive level or even a conventional

~~multilateral agreement.~~ ^{for addition, a treaty would also require the appropriation of funds.} ~~For that reason, the treaty option has often been~~

~~put forward in conjunction with a comprehensive funding mode of collaboration in which a group of nations would agree to contribute support, based on a pre-negotiated formula, to a pool of megascience projects over a time horizon extending over a generation or more.~~

~~There are many approaches that could be taken in negotiating such a treaty. A possible option would be one in which participating governments would be asked to ratify a treaty incorporating an obligation on the part of each country to support an agreed upon group of megaprojects over a period of several years, with a set amount (or range) of support provided each year.~~

*Needs further review
Not realistic at this time.
Let's develop informal consultation
mechanisms first.*

DRAFTInternational Fore

Several distinguishable sets of issues with respect to international collaboration on megascience projects may require consideration at the international level, ranging from discussions and agreement of general principles, to working out the details of specific collaborative arrangements. For example:

- o What broad categories of megascience projects should be considered under a set of general principles?
- o What specific level-of-effort criteria should be used to delineate genuine megaprojects from projects that are merely large and complex?
- o Should a set of general principles seek to distinguish between central-facility projects and distributed projects, and between sub-categories within those two classes?
- o Should categories of megascience projects be considered generically, or should each project be considered on a case by case basis?
- o Should an international organization charged with establishing general principles be the same organization whose good offices

"This section is not clear. What are the 'general principles'? Should be deleted or clarified."

DRAFT

are used to facilitate the negotiation of details of specific agreements?

- o What data are required? Where should data gathering and analysis activities to be pursued? In parallel national organizations? Or in an intergovernmental organization in cooperation with a non-governmental organization such as ICSU?

It is probable that, at least initially, more than one international organization may need to be involved in the task of establishing more systematic and coherent mechanisms for facilitating ^{coordination of} international collaboration and cost-sharing ~~negotiations~~, and for providing infrastructure support for successful collaborations. To be viable, any such organizations will need to include, at a minimum, those countries that presently provide a major share of R&D investments (ie, the G7 countries ~~and the Soviet Union~~). The Organization for Economic Cooperation and Development (OECD) might provide an appropriate forum for an initial discussion of issues and principles, and for the exchange of data and other requisite information.

In the short term, international collaboration agreements may have to be reached on a case-by-case basis. ~~However, there may also be some merit to the idea of working simultaneously toward the creation of a special multinational consultative body that could exchange information about potential megascience projects, as well as providing collaborative and cost-sharing guidelines for specific projects. The charter, national composition, and evolution of such a group might be an appropriate set of~~

*These ideas need to be developed within
USG before moving internationally.*

DRAFT

~~issue for discussion by the Ministers of Science (or their equivalents)~~
~~among countries providing most of the world's R&D investments.~~

An initial outcome of international discussions with respect to megascience projects might be to identify multinational organizations appropriate to each task, and to discuss the feasibility of creating new organizations ~~were none presently exist.~~ *consultative mechanisms*



John P. McTague
Vice President
Technical Affairs

Ford Motor Company
The American Road
P. O. Box 1899
Dearborn, Michigan 48121-1899

FAX TRANSMITTAL SHEET

DATE: 30 September 1991

TO: Dr. Tom Ratchford

TELEPHONE: (202) 456-3894

FAX: (202) 395-3719

FROM: John McTague

TELEPHONE: (313) 322-7105

FAX: (313) 845-0512

NUMBER OF PAGES (INCLUDING COVER SHEET): 4

MESSAGE:

**PRIME MINISTER'S
COUNCIL FOR SCIENCE AND TECHNOLOGY**

Kasumigaseki 2/2/1, Chiyoda-ku, Tokyo, 100 JAPAN
Phone: (81) (3) 3581 1357, Fax: (81) (3) 3581 307

September 30, 1991

Dr. John McTague
Vice President-Technical Affairs
Ford Motor Company
Scientific Research Laboratories Building
20000 Rotunda Drive
Dearborn, Michigan 48121
U.S.A.

Dear Dr. McTague:

Thank you very much for your accepting our invitation to the first EC-Japan-US Trilateral Meeting to be held in Tokyo on October 14-15, 1991. I would like to inform you a draft agenda of the meeting.

DRAFT AGENDA

As to the participants from the CST, Professor W. Mori and Mr. H Osawa will participate in the meeting. The meeting will be held in the same way as the meeting of this January 21-22. The working language will be Japanese and English. We will prepare a word for word interpreter. The meeting should be based on noncommittal base to ensure the discussion from a free viewpoint. We prepare a draft agenda as attached. Our idea is; the meeting will consist of 4 sessions and each session, if possible, should be led by the participant from each country. In Opening, Professor Mori will present a welcome speech. In Session 1 to be led by Mr. Osawa, the current topics on science and technology policy in each country including current activities of each council will be reported by each participant from the country for about 20 minutes including short questions and interpretation. In Session 2 to be led by

Professor Mori, exchange of researchers among EC-Japan-US and cooperation in the field of basic research should be reported for our common understanding. We would like to ask you to speak on such theme for 20 minutes. In Session 3 to be led by Prof. Fasella, East-West problems such as cooperation with Eastern Europe countries and Soviet Union etc.. should be discussed. The first, we would like to ask Prof. Fasella to speak on such theme for 20 minutes. The next, we would like to ask you to speak on same theme for 20 minutes. The last, Professor Mori will speak on it. In Session 4, we would like to ask you to lead the session, international cooperation in the field of "Megascience" would be discussed. The first, we would like to ask you to speak on the current US activities in the field of "Megascience" for 20 minutes. After that, both of Prof. Fasella and Prof. Mori will present their opinions for 20 minutes each other. We showed you our idea of the agenda. Please send your opinions on it as soon as possible by fax.

OTHERS

Please let me know your schedule in detail as soon as possible. I was informed from ATT Japan that Mr. Solomon Buchsbaum would participate in the meeting. If you have other participants from PCAST, please send their name and position by fax.

I would appreciate it if you would reply as soon as possible.

Sincerely yours,



Mitsugi Chiba

Director,

Office of Planning

Fax: (03) 3581 3079

Phone: (03) 3581 1357

at the Council for Science and Technology

Oct. 14 (Mon.)

Opening : 10:00-10:10 Welcome Speech [Prof. Mori]

**Session 1 : 10:10-12:00 "Current Topics on S&T Policy in Each Country
including Current Activities of Each Council
[led by Mr. Osawa]**

10:10-11:10 Presentation by Mr. Osawa, Dr. McTague and Prof. Fasella

11:10-12:00 Free Discussion

[Working Lunch 12:00 -13:45]

Session 2 : 14:00-15:45 "Exchange of Researchers among EC-Japan-US
and Cooperation in the field of Basic Research"
[led by Prof. Mori]

14:00-15:00 Presentation by Prof. Mori, Dr. McTague and Prof. Fasella

15:00-15:45 Free Discussion

15:45-16:00 Break

Session 3 : 16:00-17:30 "East-West Problems" [led by Prof. Fasella]

16:00-17:00 Presentation by Prof. Fasella, Dr. McTague and Prof. Mori

17:00-17:30 Free Discussion

[Dinner 18:30-20:30]

Oct. 15 (Tues.)

Session 4: 10:00-11:45 "International Cooperation in the field of
Megascience" [led by Dr. McTague]

10:00-11:00 Presentation by Dr. McTague, Prof. Fasella and Prof. Mori

11:00-11:45 Free Discussion

Closing Session : 11:45-12:00 Closing Remarks [Prof. Mori]

rec'd 10/20/91

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DIRECTORATE STATUS

FROM: CRAWLEY, G. M.: NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY,
MICHIGAN STATE UNIVERSITY.

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 10/07/91

SUBJECT: OFFERING CONGRATULATIONS ON DR. BROMLEY'S STANCE ON
THE INTERNATIONALIZATION OF MAJOR SCIENCE PROJECTS.

DIRECTORATE
ASSIGNED: STAFF
ASSIGNED:

ACTION
REQUIRED: STAFF
ACTION:

OSTP DUE DATE: SENDER'S DUE DATE:
DATE COMPLETED: STAFF DUE DATE
DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

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OSTP RECEIVED: 10/10/91
FILE: INTERNATIONAL
DEPT RECEIVED:

NATIONAL SUPERCONDUCTING CYCLOTRON LABORATORY
MICHIGAN STATE UNIVERSITY

Professor Gary Crawley
NSCL/Cyclotron Laboratory
Michigan State University
East Lansing, MI 48824-1321 USA

RECEIVED

Telephone: (517) 353 5956
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TELEX: 5104019207 NatSupCycLab

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October 7, 1991
OFFICE OF THE
DIRECTOR

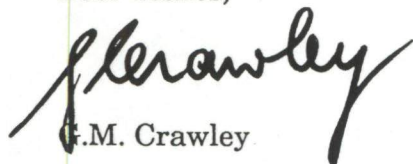
Dr. D.A. Bromley
Executive Office of the President
Office of Science and Technology Policy
Old Executive Office Building
Room 360, 17th and Pennsylvania Ave.
Washington DC, 20506

Dear Dr. Bromley,

I just wanted to write to congratulate you on your stance on the internationalization of major science projects. I recently read a quote from you on this subject in the September 5, 1991 edition of Science and Government Report. For many years I have believed that we in the US should try much harder to truly internationalize a number of our large scientific projects along the lines you suggest. This has advantages even beyond the obvious budgetary ones, as I am sure you are aware. When I was Director of the Physics Division, I tried hard to internationalize the LIGO project to a greater extent and I still believe that such international cooperation would be very useful.

Once again my congratulations.

Best wishes,


G.M. Crawley

...of debris. Lastly, Nextel sprays of debris. Nextel could offer significant weight savings over other debris protection ideas, Crews told *Space News*. NASA's Crews and Burton Cour-Palais, a specialist in shielding technology for the McDonnell

Nextel multishock shield concept.

"We're thinking we may have to send the station up at first with a certain amount of shielding, to get it through a number of years, then augment later," Crews said.

"As to what areas will require the augmented shielding, and the methods of applying the new protection material, we're not there yet. We're still working the problem," Crews added. The newer shielding would enhance the safe-

Experts Say International Programs May Not Translate into Lower Costs

By DOUGLAS ISBELL
Space News Staff Writer

COLLEGE PARK, Md. — International cooperation in space exploration may foster political goodwill, but practical drawbacks such as costly schedule delays may offset the benefits, according to several space experts.

Even the conventional wisdom that international cooperation naturally cuts costs for each nation should be viewed skeptically, according to David Acheson, vice chairman of the Atlantic Council of the United States, Washington, a non-profit bipartisan public policy institute on East-West relations.

Speaking at a space policy lecture October 17 at the University of Maryland, several high-ranking space officials said countries with large space projects to share should give the disadvantages of international cooperation equal consideration with the benefits.

"Cost-sharing certainly is desirable, but introducing international partners [to a project] is far from certain to reduce costs," said Acheson, who also served as a member of the Presidential Commission on the Challenger Disaster in 1986.

Juggling the political deadlines of a half dozen different parliamentary cycles leads directly to delays for all participants when one deadline is missed, Acheson said. Any shortfall by one nation then is viewed by the others as a breach of faith.

Norman Augustine, chairman and chief executive officer of Martin Marietta Corp., Bethesda, Md., said international space projects have attractive potential to reduce the cost and risks involved with advanced aerospace technology. However, at-

tempting to manage such international projects has proven to be "one of the toughest challenges I've faced in my management career," said Augustine, who chaired the 12-member Advisory Committee on the Future of the U.S. Space Program established by the White House last year.

When questioned after the lecture, Augustine said that the cost-sharing involved in such programs is overrated. "The political benefits must be very, very great," he told *Space News*. "Otherwise, there are easier ways to do these things."

Acheson also said faltering cooperative international projects can have the exact opposite effect intended. "You run the risk of turning amicable cooperation into recrimination," he said. "It does not help the United States to have repeated experiences that end with bad accusations from a partner," such as in the space station program, he added.

Road Sagdeev, director of the Soviet Space Research Institute (IKI) from 1973 to 1988 and now a professor of physics at the University of Maryland, said he was in "complete agreement" with such concerns.

However, Sagdeev told the audience he continues to believe in the value of "the coupling between space goals and high-level politics," especially since the Soviet Union has "decided to withdraw its membership from the class of [world] superpowers."

The loss of Cold War competition with the United States could cause "serious problems" in the Soviet space program, he said. "Perhaps we should look for international cooperation."

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Space News Oct 28-Nov 3 1991 p. 25

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WASHINGTON, D.C. 20506

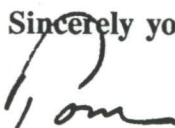
November 1, 1991

Dear John:

Attached is the draft report on the Brussels workshop, which arrived just after our conversation yesterday. The DOE report on international S&T is being sent to you and Harold directly by the Department.

I'll be happy to help with your preparations for the next PCAST meeting in any way you wish.

Sincerely yours,



J. Thomas Ratchford
Associate Director

cc: D. Allan Bromley
Harold Shapiro

Dr. John P. McTague
Vice President, Technical Affairs
Ford Motor Company
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REPORT ON THE EC-US WORKSHOP ON SCIENCE MEGAPROJECTS

BRUSSELS, 6 - 8 OCTOBER 1991

Introduction

- A. Under the aegis of the EC-US Joint Consultative Group (JCG) on Science and Technology an EC-US workshop on science megaprojects was held in Brussels from 6 to 8 October 1991. The workshop was a follow-up action to the first meeting of the JCG which took place in Washington on 25 February 1991. The purpose of the workshop was to define the terms of reference of science megaprojects; to exchange views on and draw conclusions from a series of specific examples; and to discuss principles for international collaboration and problems involved.

It was agreed that a report would be submitted to the next JCG meeting in Brussels on 25 - 26 November of this year, in preparation for the spring 1992 OECD Ministerial meeting on science and technology.

- B. The workshop was co-chaired by Dr. Thomas Ratchford, Associate Director, Policy and International Affairs, Office of Science and Technology Policy and Professor P. Fasella, Director-General, Science, Research and Development, of the Commission of the European Communities. A number of high level scientists and government officials from both sides participated. A list of participants as well as the programme of this meeting are attached.
- C. In preparation for the workshop the US side circulated a background paper entitled "Megaprojects in the sciences : issues for international discussion". The Commission of the EC provided background material relating to a number of specific megaprojects. The discussions had an informal and open character.

II. General outcome of the workshop

The detailed review of a series of specific megaproject-cases ⁽¹⁾ (reviewed in

⁽¹⁾ High Energy Physics; Thermonuclear Fusion; Space Sciences; Global Change; the Human Genome; Deep Sea Exploration and Marine Geosciences; High Performance Computing and Very High Speed Communication Networks.

detail under point III) served to illustrate and underpin the general discussion about the characteristics of science megaprojects, the appropriate fora for their discussion, processes for decision-making and principles of international collaboration. This led to the following conclusions.

A. General characteristics of science megaprojects

The discussions in general confirmed the broad definition of a scientific megaproject as spelled out in the US background paper : a science megaproject is a scientific undertaking "which encompasses the facilities, instruments, human resources, and logistic support required to address a set of scientific problems of such significance, scope, and complexity as to require an unusually large-scale collaborative effort".

It was further stressed that megaprojects are a typical characteristic of all sciences in our time and that one was probably only noticing the beginning of the megaproject era.

The discussion also confirmed the fact that mainly two types of megaprojects can be distinguished : central-facility (or vertically integrated) projects and distributed - facility (or horizontally integrated) projects. Both types may offer specific advantages depending on the nature of the project, and involve specific managerial, budgetary and scientific approaches.

It was felt that although megaprojects had a lot in common, each project was unique. Costs, potential savings and funding were thought to be very important aspects for any megaproject but they were not the only ones. The high costs involved and the limited financial resources available unavoidably led to conflicts : "small science" versus "big science"; conflicts between different scientific disciplines; conflicts within megaprojects. However such conflicts may also have positive effects in that they stimulate competition between projects and scientists. It was agreed that there was strength in the diversity of organisation of megascience.

International cooperation should lead to an optimal use of limited resources. At the same time it de-provincializes science. In this connection it was also felt that it was equally important to maintain sufficient support to local, national science and to avoid that all efforts be drawn towards one or a few megaprojects sited partly or totally in a particular country.

As far as human resources are concerned the question was raised repeatedly whether one would have enough scientists available for the expanding number and scope of megaprojects. In addition to the actual research a lot of people are needed for data - handling and analysis. That might raise problems for the future.

B. Fora for discussion; processes for decision-making: international collaboration

In addition to expected financial advantages in terms of cost-savings (likely to be less than anticipated in a number of cases because of high "overhead" costs

for international collaboration), international collaboration in science megaprojects is also driven by a search for better science at the best possible sites. With regard to the initiative for launching a megaproject there was a general feeling that a bottom-up approach was to be preferred i.e. that the initiative for big science projects ought to come from the scientific community. However, in implementing the megaproject a top - down approach will also be necessary to some extent. There ought to be some middle ground between the two levels where the roles of policy-makers and budgetary authorities meet the role of the science community.

Confronted with limited financial and human resources priority-setting is very important. Here not only the scientific community, both at the national and international levels (international scientific unions like the International Council of Scientific Unions (ICSU), the International Committee for Future Accelerators (CFA) or the Human Genome Organisation (HUGO) have a role to play but also public authorities both national and international, i.e. political decision - makers and funding authorities (for example the G-7 + the USSR, the OECD and other existing bilateral and intergovernmental fora) as well as public opinion.

As far as public opinion is concerned the necessity of scientific education and information of the public at large (scientific literacy) was underlined. That should be a real two-way interaction. Finally, also the producers of technologies, i.e., industry ought to be involved.

Other points underlined were the need to develop long-term views in megaprojects, to reassess regularly their development (for example, quality control of data and their treatment), to take into consideration the risks involved in setting priorities for a given strategy as well as the need for flexibility in order to ensure the continuity of support for a given project.

In the decision-making process it was desirable to couple scientific and financial decisions as much as possible in order to maintain a link between the selection of the best scientific programs and the allocation of resources according to priorities across various fields. Decisions in terms of scientific priorities and the allocation of funds are to be taken both within and across disciplines. Anyway, the instruments of decision-making ought to be reliable both in their domestic and international components. Early consultation and possible invitation of partners were a necessity.

It was stressed that the relationship between initiative/conception, decision-making and implementation on a given megaproject was not a linear process. Many of the participants felt that a flexible approach was necessary in which a variety of organisations could contribute in various ways. The implementation requires repeated political decisions. The question was raised whether there was a need for an international body to provide for the overall collection and analysis of the funding and investments made in megaprojects. That organisation might also assume the role of a clearing-house for new ideas or a place where informal discussions on potential projects could take place. It was thought that existing fora were presently sufficient for covering most of the tasks included in the conception, decision-making and implementation phases of megaprojects.

Finally, it was stressed by several speakers that an appropriate participation of scientists both from the developing countries and other countries with lesser financial and human resources ought to be foreseen throughout the various phases of the decision-making process. One place of doing so were the international scientific unions.

In connection with international collaboration it was felt that projects selected on the basis of a bottom-up approach should be of the highest scientific and societal priority so as to ensure their continued support from the scientific community and the public and funding authorities over the long haul needed. A capable and sustained commitment to the project on behalf of the partners is an absolute necessity. Administrative structure should be kept at a minimum needed for the execution of the project. There should be an equitable sharing of benefits and responsibilities, including funding responsibilities. Finally, certain questions such as intellectual property rights ought to be clearly settled from the outset.

III. Summary reports of the discussions of specific megaproject cases

HIGH ENERGY PHYSICS

H.J. ALLGEIER

HEP enjoys outstanding international collaboration in a spirit of scientific competition and cooperation with minimal administrative effort. It has a longstanding tradition of a bottom-up approach giving a solid scientific base and a broad consensus for choices to be made for successive steps while assuring maximum complementarity between the major programmes. There has been some duplication which could not be considered harmful - it was justified by scientific demand.

CERN provides the major focus for HEP in EUROPE and worldwide with some 50% of scientists in the field using the rich combination of interlinked projects at CERN. This is the result of a deliberate strategy which is also reflected in the allocation of financial resources. For some 20 years, new projects have been provided for by a roughly constant budget for the lab which reserves some 30% for new construction. This also applies to the LHC : consensus of the scientific community for a bottom-up approach - no "additional" resources are required for its construction; in fact the overall CERN budget will fall in the coming years from a maximum of 0.014% GNP (1975) to below 0.01% GNP of the Member States. LHC is a cost-effective next step - in a sense not a MEGAPROJECT.

The SSC and the LHC will have the same goals, whereas the LHC has the advantage of the existing lab environment in regard to both human resources and interconnected facilities providing opportunities for a broader range of science.

The SSC will be an order of magnitude more expensive; it will raise the US commitment to HEP from a level similar to the European effort to one three times the amount in terms of relative GNP. It will be up to the US to make sure that HEP science in the US does not suffer from the overwhelming cost of such a project. Both Europe and the US must be vigilant that this strong imbalance does not put undue strain on a cooperation which works well.

European (financial) strategy does not allow for substantial SSC support; there appears to be little scientific incentive to participate in the SSC. While there is the feeling that the SSC is perhaps not the real/ideal next step after the LHC, it is not possible to define today what should be such a next step. Even if it were so, there appears to be little scope and incentive to modify present models of cooperation. A world lab is not a solution in HEP.

THERMONUCLEAR FUSION

K. PINKAU

I

Aims of Fusion

The European fusion programme has the aim to produce the knowledge required for the construction of a fusion power station.

II

Properties of Fusion Research

The equipment is the experiment; the equipment is not a facility to allow experimentation as in elementary particle physics or large astronomical telescopes.

Fusion is an empirical science, progress is by trial and error.

The capability of a fusion device depends on the product science and size. Fusion now cannot be promoted by small experiments. Reactor relevant plasmas can be produced in experiments of power station size.

We have almost reached breakdown conditions in JET. When full scale tritium-deuterium experiments will be done in the middle of the 90's, JET will produce 20 MW of alpha-particle power. This gives us the confidence to extrapolate to a reactor plasma, i.e. to ITER.

III

International Collaboration

We have a fully integrated fusion programme in Europe since 30 years. It is carried out by national fusion institutes, the "Associations", which are coordinated by the fusion directorate in the EC.

Coordination is done by providing 25% basic support, and an extra 20% preferential support for projects after their international scrutiny and approval.

Even below the level of megaprojects, work on medium sized devices in the Associations leads to clustering, where several Associations work on one project. These projects provide the support to leading projects, like JET or ITER, and they provide the breadth of the programme, like work on stellarators or the reversed field pinch.

THERMONUCLEAR FUSION (K. Pinkau) Cont'd

JET is a joint undertaking, a project with a defined end in time. It is supported by Euratom, and the Associations. It is staffed from the Associations, with individual return tickets. The Director has the power of management by having budgetary control. There is no geographical distribution of return.

Europe and the international fusion community were well prepared for ITER through the INTOR and post-Versailles process. INTOR came to an end because the international fusion programme was not ready to proceed then.

ITER is being fully supported and the data base exists to justify it being done now. The conceptual design phase has successfully been completed and we are ready to enter the engineering design activity EDA now. We are practically ready to sign now and we should do so in order not to lose momentum. 200 professionals will have to work for 6 years to provide the blue-prints for construction. The last 2-3 years should be devoted to site-specific design, thus the ITER construction site should possibly be known during the middle of the EDA phase.

There should be equal contributions to the ITER EDA-phase. There is not agreement at this time to construct jointly. If no agreement is reached, each party can use the results for its own programme.

IV

Issues and Observations

As the apparatus is the experiment, there can be no fusion world laboratory. Since progress of science depends on constructive criticism and competition, some duplication of effort is essential.

ITER EDA becomes the focus of all 4 large world fusion programmes. We can't afford a failure. Two points are particularly important : the technical objectives of the device should be limited to the essential (ignition and long burn) to reduce the risk, and the stability of the collaboration should be guaranteed.

The issue of siting the international device is the most difficult one; we have no convincing model to solve it. Governments should decide possibly in the middle of the ITER EDA phase. A possible widening of the scope of the collaboration in fusion (for instance to include an intense neutron source for materials testing) could perhaps be of help. The problem arises because the choice of a site is seen as international recognition of pre-eminence. On the other hand, a site could often be extinguished by an international project because government support for national effort might vanish after the selection.

THERMONUCLEAR FUSION (K. Pinkau) Cont'd

The international project must be a technical success; it must have clear and good management. Political wishes and boundary conditions often go against requirements of good management. Politics must not be allowed to come here.

Fusion, being an empirical science, the standard of the trade must be maintained by doing. ITER must therefore not remain the only project; the home bases must remain lively in order to be able to retrieve the knowledge from the international project.

Finally, ITER, being a project on the way to a commercial reactor, will require the nations to duplicate some of the R&D effort which inside the project has been given to other nations. This they must do in order to finally remain technically competitive.

SPACE SCIENCES

J. ARETS

European programmes in space represent 1/5 to 1/10 of American programmes (excluding or including DOD).

Transatlantic cooperation was essential in the 60's for the start of European programmes.

Increase in the cost, sophistication of programmes and worldwide dimension will lead to more bilateral/multilateral cooperation.

Cooperation developed in three space fields :

- sciences;
- manned space activities;
- earth observation.

Differences in nature of the cooperation :

- coordination/ongoing decentralised projects;
- cooperation (earth observation);
- integration (space station).

Lessons learned from experience :

- need for long term financial commitment;
- continued negotiation/consultation in case of changes;
- need for a scientific support as background and political commitment (coherence) bottom to top/top to bottom;
- data policy;
- flexibility needed to changing role : major contributor in one project, junior in the following.

GLOBAL CHANGE

PH. BOURDEAU

1. Includes WCP
IGBP
Human response
Responding to public
Perception of problem
Identified by scientists
2. A megaproject (2-3 B. ECU per year) - multidisciplinary
International in nature
Decentralized
Need of action globally.
3. Program defined by scientists (bottom-up)
Need for adequate funding plan (at least in Europe) Mechanisms ?
4. Logistics and facilities needed for
 - observations (satellites, aircraft, ships) - GCOS EOS
 - modeling (supercomputer, networking)
 - data management : distributed networks regional centers (start)
5. Possible US-EC cooperation
 - distribution of tasks e.g. IGBP core projects, antarctic ice coring
 - sharing of remote sensing facilities
 - computer networking
 - data management
 - regional centers

DEEP SEA EXPLORATION

PH. BOURDEAU

ODP is a megaproject which has succeeded : bottom-up, light admin. floating university.

The future :

- need for more shallower holes (global change)
- prospects :
 - Japanese ship,
 - USSR ship (uncompleted)
 - NEREIS (boring and sea bed)
 - ECOPS (ESF + CEC)
 - plans for European marine research

HUMAN GENOME

M. SINISCALCO, H. VAN DEN BERGHE, A. KLEPSCH

1. Even though the human genome is not megascience (it is a great deal of small science), it does seem to fit the criteria in the document for a "megaproject" i.e.:

- it is a truly global collaborative effort;
- it is "bottom-up" and enjoys scientific consensus;
- the issues relate to data management and intellectual property (IP).

Although the Human Genome is very different from projects centred on large facilities there are some arguments in at least considering it as a megaproject.

2. A key objective is to establish and refine the genetic (linkage) map (i.e. to reach a satisfactory resolution with evenly spaced markers). To reach this goal no one country has sufficient manpower and expertise either to do it alone or persuade others that it should be the overall "manager"; therefore the "human genome" should be considered at least in its current stage an "intrinsically distributed project".
3. The Human Genome project is coping fairly well without formal agreements although:
 - there is an informal "concordat" relating to the support of single chromosome workshops;
 - there is a single data resource at present (GDB) for the human genome and the possibilities of making it "international" are being canvassed at present (a meeting will take place in Paris on 16 December 1991);
4. There is a need for co-ordination: HUGO, whose avowed aim is "fostering collaboration between genome scientists worldwide" is best placed to undertake this and has made a start. However, HUGO needs funds to continue the work. Funding agencies are considering ways to support HUGO.
5. In addition to HUGO's "bottom-up" efforts, there is a need for "top-down" co-ordination in at least 2 areas - IP and databases.

A series of bi-lateral agreements would be very slow to implement and even slower to have any effect on the research. A single international agreement which provided support for HUGO, GDB and other databases and also clarified the IP issues has a lot to commend it. It could be relatively simple, because the scientists initiating the Human Genome project themselves defined at the outset many of the conditions governing this collaboration.

HUMAN GENOME (M. Siniscalco, H. Van Den Berghe, A. Klepsch) Cont'd

6. It is thought that a special case for collaboration would be the study of human diversity within human genome programmes.
7. In the EC and the US specific initiatives (ESLA in the EC, ELSI in the US) have been undertaken and funds have been allocated to deal with the ethical, social and legal aspects of human genome analysis. The scope of these initiatives is not limited to the research activities as such, but has been extended to the implications and applications of the possible results of this research.

Through mutual and systematic information (e.g. observers attending workshops and committee meetings) the co-operation between the EC and the US should be stepped up.

HIGH SPEED COMPUTING AND NETWORKING

B. RANDELL

High speed networking and high performance computing have become inextricably interlinked and together provide the infrastructure needed for research in general and especially for crossborder collaborative research programmes.

The ability to store, process and communicate massive amounts of information - from text and numerical data to high quality moving images - is transforming many research fields and revolutionizing international collaboration.

The impact of high performance computing when combined with high speed networking is already becoming central to accelerated progress in fields as diverse as high energy physics, human genetics, global change climatology, and many other well identified scientific megaprojects.

This impact, however, goes well beyond megaprojects and benefits equally well such a broad range of research fields and services that it is difficult to think of any that is or will not be seriously affected.

To be effective, transatlantic research and development cooperation requires a fully adequate computing and networking infrastructure. Indeed, without such an infrastructure, it is increasingly difficult to envisage how such cooperation could possibly succeed.

The importance of these issues has been recognized on both sides of the Atlantic, and elsewhere.

In the US the High Performance Computing Act, and NREN testify to this, as do parallel efforts being launched in Europe.

HIGH ENERGY PHYSICS

J. SANDWEISS

High energy physics (HEP) has a long tradition of international cooperation exemplified by the following :

- 1) the CERN laboratory, an international lab operated by 16 member states which has become one of the world's leading institutions in HEP. The majority of European HE physicists use CERN as do other scientists from around the world;
- 2) general acceptance worldwide of the ICFA policy "... experiments will be approved on scientific merit and technological capability independent of country of origin ...");
- 3) many major experiments in U.S. labs and CERN and in Japan have been built and financed by international teams;
- 4) the recent construction of the HERA (e-p) collider at the DESY lab in Hamburg with Germany as the lead country but with significant (30%) in kind contributions from abroad (HERA model).

The reasons why international collaboration has worked (and it has no failures) may be

1. the high degree of unity worldwide amongst HEP researchers as to the goals and means to each team;
2. the early training in cooperative work, even small experiments need teams;
3. HEP has used the "minimum" administrative structure needed for the various collaborations;
4. history - world war II audits aftermath.

There has been some duplication but it was healthy and provided needed opportunities for HEP physicists to carry out experiments.

HEP is now in a period where not all possible new facilities will be possible. CERN faces a more or less constant budget (inflation corrected) and in the U.S. after some adjustment for the SSC a similar situation holds.

In the discussion several points were brought out.

- a) The European budget in toto for HEP is about twice the CERN budget if the universities and national facilities are included.
- b) The question was asked whether the SSC LHC initiatives were planned in knowledge of each other or "just happened inadvertently". The answer was that they were planned for good reasons both in the US and CERN.

HIGH ENERGY PHYSICS (J. Sandweiss) Cont'd

A considerable discussion occurred on the relative merits and costs of LHC vs SSC. Each has unique strengths - SSC has highest energy (by at least x 2) and will have ultimately the same luminosity. It also is the most conservative technically (6.7 T at 4° R vs 9.7 T at 2° R...) and has considerably greater (x 4) space for experiments and related facilities at the machine.

LHC is an excellent use of the existing LEP tunnel and infrastructure. Its location within the CERN complex of accelerators offers exciting and complementary extensions with potential for e-p collisions and high energy heavy ion collisions.

Some discussions of the relative costs of LHC and SSC ensued. The numbers presented by Professor Rubbia were questioned because of the need in any such comparison to be attentive to such matters as : whether or not in house manpower is counted; whether detector costs are included; whether or not similar contingencies and inflation have been assumed; and finally whether proper account of the relevant exchange rates have been used. As it was not germane to the meeting, this discussion was not pursued.

MAGNETIC CONFINEMENT FUSION

W. HAPPER

The ITER program is generally viewed as successful by the four parties. Japan the United States, the European Community and the Soviet Union. The magnetic fusion community has reached a consensus that a large tokamak, comparable in size to that of a commercial fusion power plant, is needed for progress toward the common goal of commercial fusion power. The large cost of such a machine, at least \$ 5×10^9 makes it difficult for any of the parties to build the machine alone. The commercialization of fusion power, even at the completion of ITER activities, will be sufficiently distant that intellectual property rights are not a major issue. Thus, it was natural for ITER to be selected as a showcase for international cooperation at the highest policy level of Gorbachev, Mitterand and Reagan.

Participation in ITER has been facilitated by the phased structure of the agreement. The parties are free to leave ITER at the completion of any phase before proceeding to the next more costly phase. The first phase, the conceptual design activity, has been successfully completed. The second phase, the engineering design activity has been successfully launched with three design co-centers, located in Naka, San Diego and Garching. While a single center would have been preferable, the co-centers are an acceptable compromise. Negotiations on a single construction site should begin quickly to work out an agreement which all parties perceive as just and to allow the engineering design activity to focus on the licencing requirements and other particularities of the site. The parties must quickly agree on the appropriate balance of physics and engineering for the machine. Maintaining the health of the national fusion communities during the construction of ITER is essential and will be costly.

SPACE SCIENCES

M. FINARELLI

Margaret Finarelli, NASA's Associate Administrator for Policy Coordination and International Relations, and Roger Bonnet, ESA's Director of Scientific Programmes, spoke about the full range of US-European cooperation in space activities.

Both sides agreed that decades of experience collaborating in extremely ambitious projects had proved mutually beneficial and had led to strong mutual trust and respect. Marred by only a few failures, the joint projects spanned the spectrum from data exchange activities, through flight of scientific instruments on each other's satellites and spacecraft, to provision of major elements of space infrastructure hardware. International cooperation has, in fact, become a necessity due to the global nature of earth observations science efforts and also to the increasing cost and sophistication of all space missions.

In conducting these activities, many lessons have been learned about the elements which undergird successful space cooperation :

- science priorities and programs should result from "bottoms-up" development of science community consensus. Early collaboration among scientists maximizes international cooperation and minimizes duplication of efforts;
- "Tops-down" political support is often required, particularly for large scale, long-duration programs;
- projects must be scientifically and technically valid; they cannot be driven solely by the purpose of international cooperation;
- project concepts and designs must respect the competitive aspects of the nations' aerospace activities. To this end, technology transfer is minimized by developing projects with clean managerial and technical interfaces and by ensuring that each site retains full financial and technical responsibility for its elements;
- collaborative efforts must simultaneously satisfy the domestic policy priorities of all partners to the greatest possible extent. The stage of cooperation must provide both programmatic and political benefits to all sides;
- effective long-term project implementation requires the commitment of all partners to a process of continuous negotiation, consultation and compromise.

The largest challenge currently facing international space cooperation is the budget situation in both America and Europe. Project stability is critical to maintain good cooperative activities and relationships. Specifically, US failure to continue with Space Station Freedom would have a chilling impact on future US - European collaboration not only in the space area, but also in all other areas of large-scale science.

GLOBAL CHANGE

A. BERNTHAL

Is global change a megaproject - yes but different.

Pro :

- The costs are at a level of a megaproject : \$ 100 Billion in expenditures worldwide in 2020; thousands of scientists.
- It is intrinsically a global problem; it must involve a wide range of countries including developing countries.
- The level of complexity requires a large coordination effort between a wide range of expertise and disciplines and interaction between large and small projects.

Differences include :

- Global change is the only project discussed which began with a strong political motivation.
- It is a response to a perceived common threat to humanity.
- It has an incremental approach (like Human Genome) (no siting problems because of diversification of projects).
- Primarily faces a coordination problem - especially for data management and communication.

It was pointed out by the Europeans that ICSU has developed the IGBP - an international scientific plan involving many nations establishing cross disciplinary priorities. This bottoms-up approach needs to be better linked with government funding sources - perhaps with the newly formed IGFA (Int'l Group of Funding Agencies).

HUMAN GENOME PROJECT

WILLIAM RAUB

Charting the chromosomal locus of each of the 50,000 - 100,000 human genes would yield almost incalculable benefit with respect to diagnosis, treatment, and prevention of genetic diseases. The quest to create such a map - with markers spread equidistantly at reasonably fine spatial resolution (e.g. 1-2 Centimorgane or approximately 1-2 million base pairs) - is underway in the US, the ULC, France, Japan, Italy, and several other nations; important multinational initiatives have been launched by the Commission of the European Communities and the Human Genome Organisation (HUGO). Experts predict that a useful map will be achieved within 5 years.

The independent national and multinational gene-mapping efforts will generate considerable data. To accommodate such data and enhance their utility, the US now is supporting the Genome Data Base (GDB) at Johns Hopkins University. Satellite operations already exist in the UK and Germany. An international conference to discuss the desirability and feasibility of the GDB as a global archive is scheduled for December, 1991 in Paris.

The US plan envisions the complete sequencing of the human genome within a decade following the availability of a high-resolution map. Toward that end, special emphasis goes to improving sequencing technology through improved DNA-handling methods and robotics; the objective is to reduce the cost per base pair by one order of magnitude - i.e., from \$ 5 to 50 cents. Complementary efforts are focused on the creation and operation of the shared data base of nucleotide sequence (GENBANK) as well as associated research and development in informatics. The GENBANK work is coordinated closely with sequence data bases at the European Molecular Biology Laboratory and in Japan. Improvements in sequencing technology and information services have the ancillary benefit of facilitating the work of the hundreds individual scientists who are attempting to sequence particular genes for their own purposes independent of any Genome Project.

Much of the current international communication about gene-mapping is organized on a chromosome-by-chromosome basis. HUGO plans to convene a succession of chromosome-specific workshops during the next several years. The US, the CEC, and other active parties view this favorably.

The explosion of tools and data for genetic analysis also offers unprecedented opportunities to assess and understand human variation, especially as it is manifest in special populations and as it chronicles the interactions between humans and their environments. HUGO is forming a new study committee to explore how best to foster international collaboration in this area. With stable funding and independence from individual national priorities, HUGO itself might be the appropriate organisation to take the lead.

HUMAN GENOME PROJECT (W. RAUB) Cont'd

The shared data bases should have an important unifying effect on the several national and international ventures into gene-mapping and sequencing. In addition to facilitating the exchange of information, the data bases also could serve as sentinels to monitor the effectiveness and efficiency of international collaboration. For example, regular inspection of the databases could reveal instances of unproductive duplication or gaps in data that merit special efforts to fill. Seeking international consensus on whether and, if so, how to use shared data bases in this way as a management tool seems a worthwhile endeavor.

OCEAN DRILLING AND MARINE GEOSCIENCES

D. JAMES BAKER AND GOTTHILF HEMPEL

Dr. Baker summarizes the operations and status of the international Ocean Drilling Program, noting that it had begun in 1983 in its current form and presently had participation from 20 countries. The Program operates a scientific drilling ship, the JOIDES Resolution, which collects samples of the Earth beneath the sea for study of the structure and composition of the Earth's crust, evolution of continents, the history of climate and life, and the links of biogeochemical cycles. The ship is equipped with a seven story state-of-the-art laboratory.

The Ocean Drilling Program is a successful example of international cooperation. The USA, through the National Science Foundation, provides slightly more than one-half of the program costs while the non-US partners provide slightly less. Scientific advisory committees made of representatives from all partner countries decide the scientific objectives of the program and carry out detailed planning for each specific aspect of the program. Administrative overhead of the program is kept to a minimum.

The success of the program is built on several points : it represents a consensus among a large group of scientists about priorities; the different approaches and needs of scientists from different countries are respected; viewpoints from academia, industry, and government are represented; committee members rotate so new ideas are continually available; there is immediate shipboard interaction among scientists in the laboratory; and engineers from many countries collaborate on technical developments.

Dr. Baker noted that the Ocean Drilling Program operates with similar activities. For example it is now actively cooperating in developing an Ocean Seismic Network that would enable scientists to probe the deep structure of the Earth through techniques of seismic tomographic imaging.

For the future, the Ocean Drilling Program is planning for renewal in 1993, and most of the partners have informally agreed to a five-year extension. The success of the program has also led to interest in several countries in considering the feasibility of building ships with drilling capabilities including France (who have proposed an EC "NEREIS" facility), Japan, and the USSR. Dr. Baker reported that discussions were ongoing about how to incorporate these potential new facilities into future science planning for ocean drilling.

Dr. Hempel reported that from the European point of view the Ocean Drilling Program was indeed successful, providing as it was a floating geosciences university with proposal-driven (bottoms-up) science and minimal bureaucracy. He noted that the joint ESF/EC ECOPS committee was coordinating planning for the European NEREIS facility and reiterated the need for incorporating plans for new facilities into future science planning.

OCEAN DRILLING AND MARINE GEOSCIENCES (D. J. Baker and G. Hempel)
Cont'd

Dr. Hempel also discussed proposed new programs in polar science which emphasis on ice coring. He noted the importance of such data for study of paleoclimates, and summarized an international activity now planned for the collection and study of ice cores in the Antarctic. On a broader topic, he noted the successful international collaboration on polar research ships in the past and urged that it continue with new facilities now being planned in the U.S.

Division of International Programs

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PH: 395-3622

One page follows

Comments:

Tom:

Here are your notes from the wrap up session of the Brussels Megaprojects Workshop on October 8.

Jenni

2 Xerox
~~off~~
File
PCAST
Megaprojects
Brussels EC
Workshop

Cost - Hopper report valid - do not nec. save \$ on individual project
Savings come in priority setting
Optimize over larger base/ensemble
(single saturation)

Type of Returning

Decision making processes

- ① - Domestic & Trade agencies, State Dept. Sci. Groups, WH, State Dept. Sci. Groups, G-4 + USSR, Existing Orgs, govt + sci
- ② - Scientific - scientific program
- ② - Financial - allocation of resources $\rightarrow$ coupling
- ③ - Within disciplines $>$ priorities/funding
- ③ - Across disciplines $>$ Tradeoffs - sites, funding, equality

General - e.g. planetary sciences

Specific - e.g. fusion, ocean drilling

- ④ - Negotiating forum
- Discussion forum

- ⑤ - Instruments of decision $\leftarrow$ credible, reliability domestic, intl.

Many problems simple - boundary cond. complex
International Boundary Conditions: Changes

- 1 - End of Cold War & space
- 2 - Rise of new ^{political} concerns - env./global change
- 3 - Trade & competitiveness - IP, GATT, subsidies,
- 4 $\leftarrow$ Increase of concern for small science
- 4 $\leftarrow$ Increase in ^{cost of} illegal projects $\leftarrow$ 90 budget R+D, outyear mortgages
- 5 - "Equity" in support of basic research / mapping

Mechanistic vs ^{statistical} quantum mechanical
~~statistical~~ forbidden transitions

Trade off - higher barrier
greater reliability

Shapiro - Risk - some strategies more risky than others

cost

U.S. Asks Japan to Help Pay for Atom Smasher

Energy Secretary Gets Brushoff in Search for Over \$1 Billion in Supercollider Funds

By T. R. Reid
Washington Post Foreign Service

TOKYO, Dec. 4—As Americans were marking this week's 50th anniversary of Pearl Harbor and the U.S. entry into World War II, a U.S. cabinet member made the rounds of Tokyo offices today plaintively seeking financial assistance from the country America defeated in the war.

Energy Secretary James D. Watkins went from one office to the next in Kasumigaseki, Tokyo's version of the Federal Triangle, asking Japanese government officials to contribute something over \$1 billion to his agency's largest research project, the Superconducting Supercollider now under construction on the north Texas plains.

In his discussions here and a speech to the Japanese press, Watkins alternately challenged, flattered, cajoled and pleaded with his hosts for a "substantial investment."

At times, the secretary sounded like a television evangelist, assuring the Japanese that they need not send money right away as long they make a pledge to pay later.

"We're not coming here asking for money right now," he told Japan's finance minister, as Watkins related the conversation later. "In the 1992 budget cycle, we ask for nothing but a commitment.... But perhaps in the '93 budget year you might commit to something like [paying for] a collider ring. That would be about \$1.25 billion."

And the Japanese share, Watkins noted, could be payable in installments, "stretched out over a seven-year funding period."

In his speech today, Watkins waxed poetic about the possibilities if the two countries together fund the supercollider, an enormous doughnut-shaped atom-smasher in which subatomic protons will be maneuvered into collisions at nearly the speed of light to splinter into smaller, short-lived particles that could advance scientists' understanding of the nature of matter.

"We would have... a facility where one [proton] carries the Rising Sun, one carries the Stars and Stripes, and they collide in harmony to bring us the scientific answers

That leaves about \$1.75 billion to raise, probably from foreign governments. Since the European countries are committed to their own atom-smasher project, Japan is the only country left with the kind of money the Energy Department needs.

One reason the Japanese have been hesitant about the supercollider is their unhappiness about U.S. cooperation on joint research in space.

The Japanese have contributed about \$2.5 billion to build part of the U.S. space station Freedom, only to see the project repeatedly delayed by the U.S. Congress. After

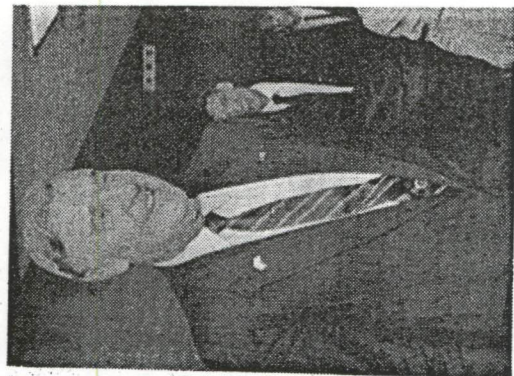
waiting years for NASA to fulfill its promise to carry a Japanese astronaut into orbit, Japan finally got its first spaceman last year—by purchasing a seat for \$12 million on a Soviet rocket.

Asked about this today, Watkins conceded that "the credibility of the American government to [carry out] very large science projects has been questioned." But, he said, "my country has made a firm commitment to proceed" with the supercollider.

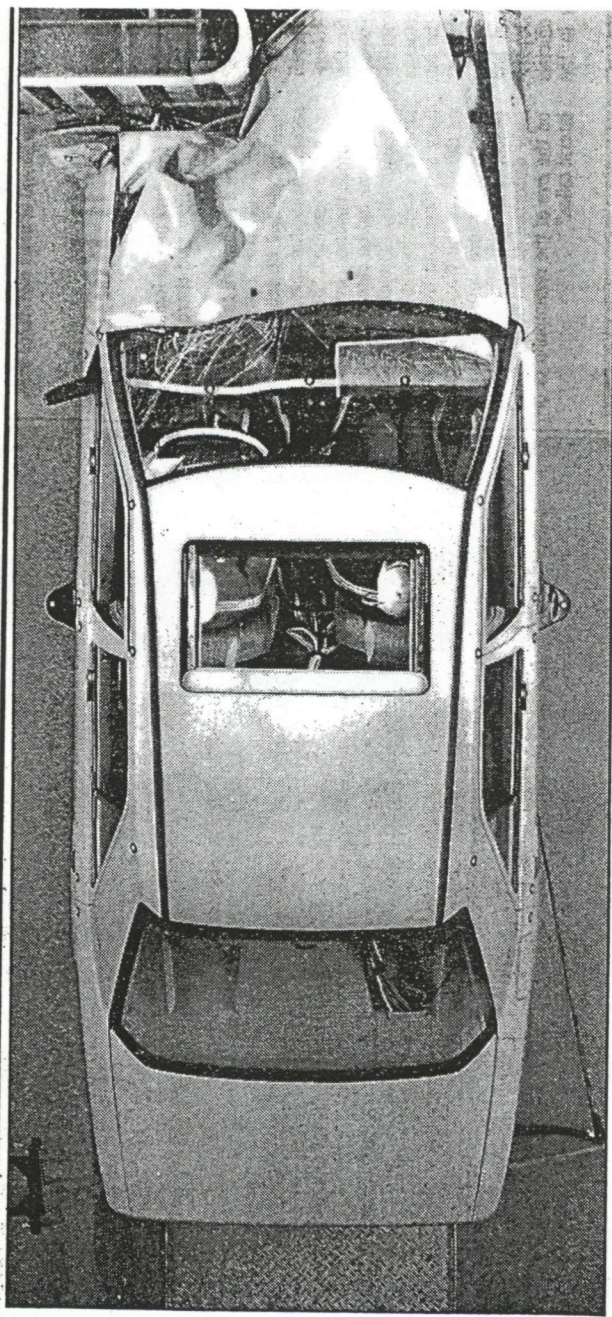
Despite the disappointments so far, the United States has a couple of strong cards to play in this endeavor.

First is the Japanese government's acknowledgement that this wealthy country has so far failed to contribute its fair share to international research. Japanese government and industry are sensitive to the charge that they have enjoyed a "free ride" on other countries' research.

The other American ace in the hole is George Bush. The president will travel here in January, and Japan's government is determined to send him home happy. Watkins reminded the Japanese today that "one of the issues [Bush] will be talking about is this [supercollider] project."



Watkins arrives for talks with Japanese Fore

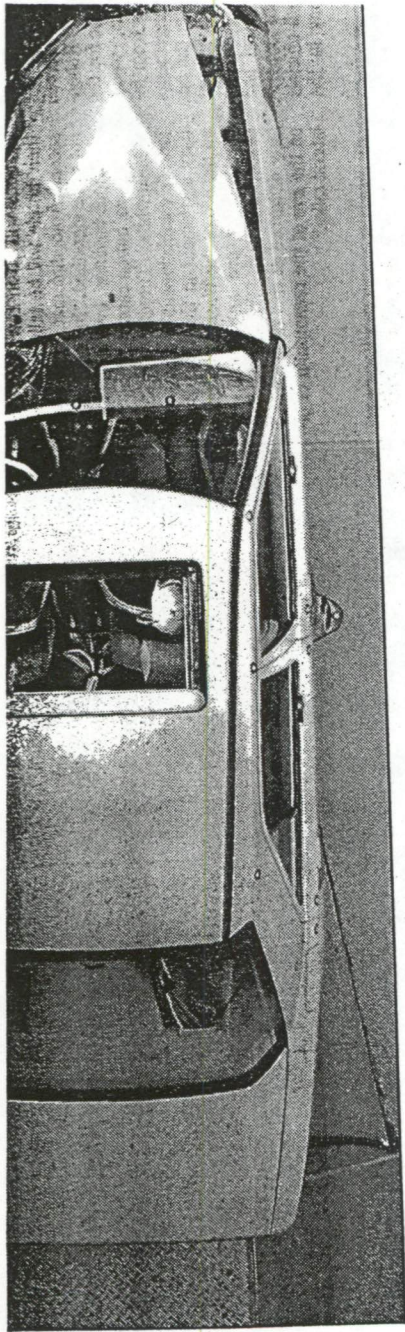


There's no more secure,



PCAST
negoprojects

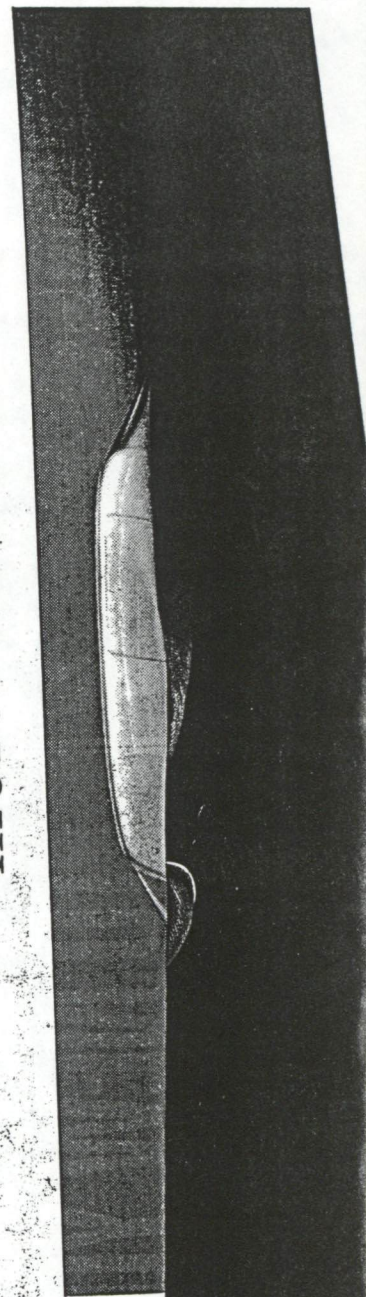
* See note



There's no more secure,



more comfortable,



the Japanese that they need not send money right away as long they make a pledge to pay later. "We're not coming here asking for money right now," he told Japan's finance minister, as Watkins related the conversation later. "In the 1992 budget cycle, we ask for nothing but a commitment. ... But perhaps in the '93 budget year you might commit to something like [paying for] a collider ring. That would be about \$1.25 billion."

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"We would have ... a facility where one [proton] carries the Rising Sun, one carries the Stars and Stripes, and they collide in harmony to bring us the scientific answers we need," the secretary said.

But despite these lyric importunities, and despite the attractive Japanese-language brochure he brought along to sell the supercollider idea, Watkins won no clear promise of the aid he was seeking.

According to Japanese press reports, Finance Minister Tsutomu Hata agreed with Watkins that Japan should contribute more to basic scientific research but said that the country will do so "by building up research laboratory facilities within Japan."

Japanese officials have been offering similar brushoffs for years to various American officials who have come here hat in hand seeking financial help on the supercollider.

The giant atom-smasher, a ring 27 miles in diameter, will cost \$2.25 billion at current estimates. In the face of today's large budget deficits, the Bush administration says at least one-third of the money must come from someplace other than the federal treasury.

The state of Texas has committed \$1 billion to the project.

"Document Control"

TYPE: Information DOCUMENT NUMBER: 9125114
ORIGINATOR: 05 STATUS DIRECTORATE STATUS C

FROM: BOWDEN, SARA

TO: RATCHFORD

DATE OF
CORRESPONDENCE: 12/05/91

SUBJECT: OECD MINISTERIAL PREPARATIONS

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

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OSTP RECEIVED: DEPT RECEIVED: 12/05/91
FILE: OECD
CENTRAL FILES:

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

cal.

December 5, 1991

MEMORANDUM FOR TOM

FROM:

SARA *SB*

SUBJECT:

OECD MINISTERIAL PREPARATIONS

Jenni Bond and I will co-chair a meeting on December 12 at 4:00 to discuss OECD Megaprojects preparations. We are inviting staff level individuals but asking them to coordinate with their principals prior to the meeting. There is nothing controversial, but it is worthwhile to keep focused on the Ministerial.

We need to decide within the next couple of weeks, who should be invited to accompany Dr. Bromley to the Ministerial. I have asked State Department to give us the delegation list from the last ministerial and to provide any input for this years meeting. March is not far away and we will need to get this onto people's calendars.

Finally, John Boright will attend an OECD Steering Committee meeting on January 9-10. I think it would be worthwhile to have a meeting with Dr. Bromley, you, John and perhaps someone from Commerce and NSF, prior to the steering committee meeting. If you agree, I will ask Ginny to schedule such a meeting for January 2.

cc: Rosell
Huguelet

1/2

✓ TR

✓ SB

✓ John Boright (State)

Deborah W. Wince-Smith (Commerce) *Call tomorrow 12/11*

✓ *for Bernthal* - (NSF)

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

FILE
PCAST Panel

December 10, 1991

MEMORANDUM FOR D. ALLAN BROMLEY
GENE WONG
TOM WELCH

FROM: STEVE OLSON

SUBJECT: STAFF COMMENTS ON PCAST PAPER

Attached is an annotated version of the PCAST paper "Technology and the American Standard of Living" showing the comments that we received from the offices of Roger Porter, Michael Boskin, and Fred McClure. The other staff members who had actions on the paper (Scowcroft, Darman, Demarest, Gray, and Holiday) had no comments.

Gene has asked that this paper not be distributed further until a decision is made on the best way to respond to these comments.

I've also attached a letter from Tom Murrin to Ralph Gomory commenting on the paper.

Attachments

DRAFT

[December 10, 1991]

TECHNOLOGY AND THE AMERICAN STANDARD OF LIVING

The everyday world that we experience today has been created largely by the technologies and manufacturing skills of the last 150 years. Change accelerated with the steam engine powering the factories of the industrial revolution; iron, steel, and coal soon became plentiful, and railroads and the telegraph were invented and penetrated the rural isolation in which most of the world's population had always lived.

With this remarkable surge of invention of new products and with the equally remarkable ability to manufacture those products in volume, the modern world appeared. Much of that modern world was invented and made in America. [Porter: This is true, but much of the modern world was invented abroad as well. Accordingly, while we strongly support strengthening U.S. science and manufacturing, we should also make it clear that we oppose technological protectionism or believe that it will improve our position.]

This great surge forward in the standard of living can be continued. But it will not happen automatically, and to some extent it is not happening in the United States. [Boskin: Replace last half of previous sentence with "To maintain the world's highest standard of living, which the United States now enjoys, the nation must raise its growth rate of productivity."]

All the ingredients for great steps forward are at hand. To the creativity of the individual inventor we can add today the great power of invention represented by science. The great strides made by science -- a field in which the United States leads the world -- have given us an unprecedented understanding of the fundamentals of nature. This understanding will allow us to develop new materials that are lighter, stronger, and more durable than those of today. Fundamental knowledge of the workings of living organisms is leading us toward cures for diseases once thought incurable. The computer and new modes of communication, such as optical fibers, are creating whole new worlds of possibility.

America led the world through the first industrial revolution, and our standard of living became a goal toward which the rest of the world aspired. We must now make it our goal to lead the world through the next industrial revolution. In doing so, we will steadily raise our standard of living and see to it that our children and grandchildren will live far better than we do today.

We need to do three things to achieve this goal:

1. We must ensure the continued flow of new ideas and new understanding that are essential for the creation of new materials, new means of communication, new standards of health care, and the protection of the environment.

2. We must be expert at translating new ideas and new technologies into significant new products. This translation often requires that we face great and unpredictable uncertainties and it sometimes requires many years of trial and error, but it can result in the creation of whole new industries. [Boskin: Delete "and unpredictable."]

3. We must revive the great American tradition of manufacturing and developing so that we not only start but also build and retain great industries. [Boskin: Replace "revive" with "build upon" and "build and retain" with "strengthen."]

Listed below are possible actions that will contribute to these ends. However, nothing listed here is as important as a Presidential commitment to American industrial leadership and a commitment to using technology, not increases in the numbers of hours worked, to raise the American standard of living. [Boskin: Replace "not increases in the number of hours worked" with "and increasing productivity."] This country has the people and the technology needed to rebuild American industrial leadership. [Boskin: Replace "rebuild" with "strengthen."] If the President were to make it a highly visible goal, as he has education, many ways to move toward that goal will emerge. [Boskin: Delete final sentence.] [Porter: Although the report discusses the role of the federal government, it says little about the role of the private sector. Yet the private sector must play the key role in funding long-term U.S. research and development into commercial technologies and accelerating the process of bringing new technologies to market. Mention of this fact might be useful.]

To support the first of the three objectives, we must provide an adequate and balanced support of university-based individual investigator basic research. We propose a federal initiative to revitalize the university research infrastructure and ensure its vitality in the future. This is a necessary step if this country is to continue to lead the world in the generation of new ideas. [Porter: No description of the content of this proposal is made.]

The evolution of new ideas into new products and processes can be difficult and slow, yet it is enormously important. Some technologies take a long time to develop, and the developer takes great risks and may not capture all of the benefits because of the time lags involved. For these important technologies, the government can help to support the development of generic advanced technologies in close cooperation with those who use them. [McClure: What technologies?] Its support of such technologies in the past -- such as agricultural, aeronautic, and computer technologies -- was instrumental in building key sectors of the U.S. economy. [Porter: While the Administration has endorsed government support for "generic enabling

technology at a precompetitive stage of development," this term has never been well defined. In the absence of a clear definition, some advocates of an "industrial policy" appear to regard it as another way of channeling government subsidies to selected industries or technologies. Thus, the PCAST recommendation could usefully be clarified to indicate what type of assistance is contemplated.]

The hundreds of federal laboratories can make major contributions to the development of generic technologies. [McClure: Should define "generic technologies" more clearly.] The federal government can assign new missions to some of these laboratories in such a way that they become new sources of civilian technologies.

The federal government can also have a substantial impact on manufacturing and development. It can stress manufacturing in its support of engineering education, award fellowships in research on manufacturing technologies, and recognize great achievement in manufacturing as it does today in science and technology.

In general, the support of education helps industrial leadership. Presidential goals in education are therefore complementary to the goal of industrial leadership. Furthermore, there are certain aspects of education that are especially supportive of the second and third objectives listed above. Practical education, education for work, and the practical aspects of the engineering curriculum must be elevated both in content and in prestige. Today the development of such skills is far more advanced in other countries than it is in the United States. Federal initiatives can support the development of practical curricula and put the prestige of the federal government behind the dignity of this work.

We would suggest that the President hold a series of meetings with industry, labor, and educational leaders -- reflecting the diversity of these groups -- and/or one large and visible meeting like the Education Summit. The visible commitment of the President to industrial strength as a major national goal will make a great difference. [Boskin: Delete final paragraph. Porter: Much more thinking needs to be

undertaken before advancing the notion of major Presidential meetings, ala the Education Summit, to deal with "industrial strength as a major national goal." Many Presidential summits fail to meet the high expectations that inevitably accompany such an effort. This suggestion deserves to benefit from much more thought and planning regarding goals and how it would be implemented. Until this idea is more clearly thought through, I suggest dropping reference to it in the paper, since it could easily become public that the Administration is considering such an idea.]

#



DUQUESNE UNIVERSITY

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FAX (412) 642-9106

OFFICE OF THOMAS J. MURRIN
DEAN OF THE A.J. PALUMBO SCHOOL OF BUSINESS ADMINISTRATION

December 10, 1991

Dr. Ralph Gomory
Sloan Foundation
630 Fifth Avenue
Suite 2550
New York, New York 10111-0242

VIA FAX: 212-757-5117

Dear Ralph,

I have received and reviewed your Draft Statement on Technology and The American Standard of Living --- and it appears that you have provided an excellent framework for the planned PCAST Report on this subject!

Congratulations and Thanks!

In the following, I'm suggesting some additions to the draft. Though I welcome any refinements, I hope that the substance of the statements is considered openmindedly.

It seems appropriate that we start (in the final form) with a short, substantial EXECUTIVE SUMMARY --- which includes about five or six actionable recommendations ...

- The President has been providing enlightened leadership in regard to this subject. For example, he has stated that:

"We lead in science --- and can surely do so in technology and commercial products as well"; and

"Reducing the cost-of-capital is a top priority".

And the President's speeches have referred to

Scientific and Technology Leadership --- and supporting generic technologies; and to

Incentives for Investment in R&D --- and Productivity.

And Dr. Michael Boskin has wisely testified to the Congress that:

"The nation cannot take economic growth for granted. Unless sound policies are followed, there is no guarantee that American living standards will continue to rise substantially from one generation to the next, or that the United States will remain the world's leading economy".

"The nation must recognize that the U.S. has very serious challenges and formidable policy problems to address if we are to ensure, indeed enhance our long-term economic growth."

"Long-term economic growth is the dominant factor in the success and failure of nations."

"Growth and Productivity are our Top Priorities"; and

"The federal government has an appropriate role in supporting the development of some pre-competitive generic technologies"

(Much of the above --- and some related information ... is due to Dr. Rube Mettler's excellent chairing of the Manufacturing Forum.)

•Accordingly --- and recognizing the invaluable role of the National Security Council in contributing to our Nation's Military and Political Goals --- it is recommended that its Mission be expanded to comprise Technology Superiority, Economic Growth and Global Competitiveness. That is, in addition to a World-Class National (Military and Political) Council, we will soon have also a World Class National (Technology, Economy, and Competitiveness) Council.

•Recognizing that consensus has substantially been achieved in regard to identifying our Nation's Critical Technologies, OMB and OSTP should continue their promising cooperative efforts relating to FCCSET coordination and Cross-cut analyses so that our National Technology Assets --- such as the National Laboratories --- can assign priority projects to assure global pre-eminence in these Critical Technologies. This should, for example, soon be reflected in the Key Objectives and Annual Budgets of the involved Agencies.

•Similarly, the Administration should vigorously support such promising initiatives as the Advanced Technology Program, managed by the Department of Commerce (and originally sponsored by Congressman Don Ritter R-Pa.; et al).

•Following the President's support for Incentives for Investments in R&D --- and Productivity, it is recommended that

Stimuli be provided for private and public investments in Commercial R&D, in general and in Manufacturing Technology, in particular, to levels competitive with other leading industrial nations;

R&E tax credits be expanded to cover would-class Manufacturing developments; and that

Tax Code changes be made to motivate U.S. firms to do their R&D in the U.S. --- and not overseas.

•Our Government should soon use its Acquisition policies-and-procedures to help assure our superior technology and standard-of-living, by

Applying the National Quality Award Process to its Contractors --- for example, at the Department of Defense; and to its in-house activities --- such as at the Department of Commerce with its Annual Commerce Quality Award;

Use incentive-type contracts to motivate Contractors to also radically shorten their cycle times by the effective application of Concurrent Engineering --- and to achieve would-class Manufacturing capabilities by Flexible Systems (which allow an Economic Ordering Quantity of one --- rather than EOQs of hundreds or thousands of produced items) and by TQM Systems (which reduce defect rates to a few units per million --- rather than several rejects per hundred; that is, a several-thousand-fold improvement in quality) ...

Happy to discuss!

cc: Dr. Mary Good - Allied Signal
 Dr. Harold Shapiro - Princeton University
 Dr. Allan Bromley - OSTP
 Dr. Charles Herzfeld - OSTP
 Dr. Tom Welch - OSTP
 Dr Eugene Wong - OSTP



DUQUESNE UNIVERSITY
SCHOOL OF BUSINESS AND ADMINISTRATION

ATTENTION: Dr. Allan Bromley --- OSTER

FROM: Thomas J. Murrin

DATE: Decmeber 10, 1991

SUBJECT: See attached notes

NO. PAGES: 4 (including cover sheet)

COMMENTS:

If you do not receive the number of pages stated above, please
contact us immediately at (412) 434-~~5701~~.

5157.

Our FAX # is (412) 642-9106.

"Document Control"

TYPE: Information

DOCUMENT NUMBER: 9125150

ORIGINATOR: 05

STATUS

DIRECTORATE STATUS C

FROM: KOLB, CHARLES: WEST WING

TO: RATCHFORD

DATE OF
CORRESPONDENCE: 12/17/91

SUBJECT: THANK YOU FOR PARTICIPATION IN "ENGINEERS FOR
EDUCATION" MEETING

DIRECTORATE
ASSIGNED:

STAFF
ASSIGNED:

ACTION
REQUIRED:

STAFF
ACTION:

SENDER'S DUE DATE:

OSTP DUE DATE:

STAFF DUE DATE

DATE COMPLETED:

DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
Arthur Sheekey
CHARLES DICKENS

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OSTP RECEIVED:

DEPT RECEIVED: 12/19/91

FILE: MATH & SCIENCE EDUCATION

CENTRAL FILES:

THE WHITE HOUSE
WASHINGTON

December 17, 1991

Dear Tom:

Many thanks for joining us last week at the meeting with "Engineers for Education." Your remarks could not have been more helpful or inspiring, and I hope that we will be able to enlist the sustained involvement of the many education groups represented at the meeting.

Again, thank you for taking the time to join us.

Sincerely,



Charles E.M. Kolb
Deputy Assistant to the
President for Domestic Policy

Dr. Thomas Ratchford
Associate Director, Policy and International Affairs
Office of Science & Technology Policy
The White House
Washington, D.C. 20500

THE WHITE HOUSE

WASHINGTON

December 17, 1991

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Sincerely,



Charles E.M. Kolb
Deputy Assistant to the
President for Domestic Policy

Dr. Thomas Ratchford
Associate Director, Policy and International Affairs
Office of Science & Technology Policy
The White House
Washington, D.C. 20500

NATIONAL SCIENCE FOUNDATION
1800 G STREET, N.W.
WASHINGTON, D.C. 20550

Division of International Programs

FAX Transmission Cover Sheet

Date:

12/20

FROM: William A. Blanpied

FAX: (202) 653-5929

PH: (202) 653-5387

E-MAIL: wblanpied@note.nsf.gov

TO:

Tom Ratchford

FAX:

395-1571

PH:

0

Pages follow.

Comments:

Tom:

Marcel Bardon has apprised your request, conveyed via Fred Berthal, for my assistance RE the PCAST Megaproject Enterprise.

I await your pleasure!

Happy Holidays!!

Paul

PCAST merge-
projects
panel

ITER EDA UNDERSTANDINGS RESULTING FROM QEN-3

SITE*	PERSONNEL ASSIGNMENT	DEPUTY DIRECTORS*
-------	-------------------------	----------------------

INTEGRATION	US	DIRECTOR	EC**	PRINCIPAL	JA**
OUT-OF-VESSEL	JA	COUNCIL CHAIR <i>Uzelkov</i>	SU	EC CO-CENTER	US
IN-VESSEL	EC	CO-CHAIR/MAC CHAIR	JA	US CO-CENTER	SU
COUNCIL SEAT	SU	TAC CHAIR	US	JA CO-CENTER	EC

(ready vice-chm, Council)

- * SPECIFIC ASSIGNMENTS OF TASKS TO BE MADE BY DIRECTOR AND APPROVED BY COUNCIL
- ** LOCATED AT US CO-CENTER

NOTES
EDA TO BE CONDUCTED UNDER AUSPICES OF IAEA
CONSIDERATION WAS GIVEN TO THE EXPLORATION OF POSSIBLE FUTURE
BROADENING OF COLLABORATION IN FUSION

Broadly representative
US initiative: those involved?
Medians - status of RFX participation? Russia's influence? (DAIS) (Fukushima)?
Subgroup talks - wants to build together

FILE
peaks
panel

1

Technology and the American Standard of Living

The everyday world we have today is the creation of the technologies and manufacturing skills of the last 150 years and of the American institutions that made such effective use of them. Change began with the steam engine powering the factories of the industrial revolution, iron, steel, and oil became plentiful, railroads and the telegraph were invented and penetrated the rural isolation in which most of the world's population had always lived. The inventive capability and ingenuity of individuals brought forth one striking invention after another. Electricity for lighting supplanted the dim light of candles and kerosene and this in turn was followed rapidly by telephone and radio linking the world together.

With this remarkable surge of invention of new products and the equally remarkable ability to manufacture them in volume, the modern world appeared, and *in the last hundred years much of that modern world was invented and made in America*. Television followed radio, the automobile followed the railroads, airplanes provided unprecedented speed and linkage over vast distances. All this made possible a standard of warmth, cleanliness, food, medical care, transportation, and entertainment at home, that were not even thought of 150 years ago.

This great surge forward in the standard of living *can be continued*, but it is not automatic and to some extent the leadership and initiative is no longer resident in the United States.

All the ingredients for great steps forward are at hand. To the role of the individual inventor we can add today the great power of invention represented by organized scientific research. The great strides taken by science, an area in which the U.S. leads the world, have led us to an understanding of the fundamentals of nature that is unprecedented. This understanding will allow us to develop new materials that are lighter, stronger, and more durable than those of today, the new fundamental understanding of the workings of living organisms is leading us toward the cures of diseases once thought incurable. The computer and new modes of communication, such as optical fibers, will allow us whole new worlds of possibilities, new modes of work done from the home, a whole new level of intelligent machinery, and will point the way toward a new world and to a higher standard of living.

And with the knowledge we have today we can make these transformations with a knowledge of our environment and a concern for it that can avoid the negative environmental impacts of the earlier industrial revolution.

Nevertheless in the United States over the last fifteen years we have seen little increase in productivity as measured by output per hour worked, Our Gross National Product continues to improve, but this is largely due to the increase in the labor force as more and more households have two working parents. America is producing more, but it is by working more hours. Yet in most other industrialized countries productivity continues to increase. How can we change this?

America and American institutions responded to the technologies of the first industrial revolution and as a result our standard of living was what the rest of the world aimed at. We must take it as our goal to play a leading role in the next industrial revolution as well, and, by steadily raising our standard of living see to it that our children and grandchildren will live far better than we do today.

To do this we need three basic things.

1) We must assure the flow of *new ideas and new understanding* that are basic to the creation of new materials, new communications, a new standard of health care and the care of the environment. New ideas can occur anywhere, on the production line, in industrial laboratories and in the great systematic scientific developments based on the American university system. This nation and this government must be sure that America leads the world in the generation of ideas and hence in basic research.

2) We must be expert at translating new ideas and new technologies both into significant *new products*. This can often call for facing great and unpredictable uncertainties, and sometimes many years of trial and error, but it can result in the start of whole new industries. It is important that the United States *continue to be a leader in the development of truly new technologies*.

3) We must revive the great American tradition of *manufacturing and developing* so that we not only start but also to build and retain great industries. American manufacturing ability built and then steadily improved the first great fleets of automobiles at a time when automobiles were still a toy of the rich in the rest of the world. That same ability poured out the great armadas of tanks and planes that turned the tide of World War II. Today there are new ways of manufacturing which must be mastered, and the steady process of improving existing products, often based on *new process and product technologies* must be mastered if we are not to invent new products, start new industries and then see them go overseas as others manufacture improved versions of what we invented. And this is what we have seen in significant industries such as automobiles, semiconductors, and consumer electronics.

Many of these new technologies also hold out the possibility of significant advances in the service industries as well. These industries make up much of today's economy, and progress in these must also be a significant part of what we aim at.

All three of these things are necessary. Ideas without product can not produce increasing prosperity. New products or approaches that do not lead to sustainable industries are also not adequate. We must invent, commercialize, manufacture and improve.

We will now list some possible actions. However nothing listed here is as important as a

Presidential commitment to American Industrial Effectiveness, and to using technology, organization, and knowledge, not more hours, to raise the American standard of living. We have the technology and the people to do this, if the President makes this a visible goal, like education, formulations of that goal and many ways to move toward it will emerge.

In support of the first of these objectives we must provide an adequate and balanced support of university based basic research. The Federal government has a long and proud history of supporting basic research since World War II, and many of the great possibilities of the future, particularly the health improvements based on molecular biology owe their existence to the Federal support that made fundamental understanding possible.

However there has been a natural tendency to support people at the expense of facilities with the result that today many of our finest scientists work in labs and use equipment that are out of date and inadequate or behind those in use in other countries. For this reason we propose a Federal initiative to *revitalize the university/research infrastructure* and ensure their uptodateness in the future. This is a necessary step if we are to continue to lead the world in the generation of new ideas.

The evolution of new ideas into a form that can become a product can be difficult and slow. enormously important, since the gap between idea and product can be great and its bridging can be the work of many years and sometimes of decades. In this area of developing new technologies we are being challenged today as never before by a new and long range Japanese effort, and by the rapid growth of new Japanese laboratories and capabilities.

Here the economic climate can play an important role by being one in which the formation of new entrepreneurial companies can take place, and one in which established companies will continue to invent and invest in the improvement of existing product. But some technologies take a long time to develop and the developer takes great risks and may not, because of the time lags involved, capture all the benefits. For these important generic technologies the government can play a role through helping support *generic advanced technologies* in close cooperation with those who use them, as it did in the past in agriculture, or in supplying key facilities as it did effectively in the early days of the aviation industry with...(wind tunnels etc). Today there are new technologies, such as biotechnology, whose potential in many areas going far beyond health care, that offer whole new worlds of possibilities.

In this area of advanced technology, our national labs offer a major resource. Today we spend \$Xbillion a year on national labs which contain scientific and technical work of a high technical level. However many of the missions of these labs had their origins in, or were influenced by, the long history of the cold war. These labs have served our country well in the past, we must be sure that they serve it well in the future. In the more benign atmosphere of the post cold war world there is the possibility of redirecting this great force toward bettering our standard of living rather than to warding off a threat that now has greatly diminished. The Federal Government *should undertake a process of assigning new missions* to some of these laboratories in such a way that they become sources of new technologies that contribute to

conservation technologies, to better energy technologies, to a better environment, or to better industrial products.

On the third point *manufacturing and development* are necessary if these ideas are to provide new products and new jobs. Manufacturing today is neither dull nor routine nor static. It has changed and continues to change enormously in organization and management and in its technology. and in It is an important area of invention and new processes for manufacturing, and new techniques for product design and improvement, are an important source of this countries' progress. We should take it as one of our national goals to lead the world in manufacturing or we will not benefit from our own ideas. The Federal Government can help though stressing manufacturing in its support of engineering education, through the award of fellowships in research on manufacturing technologies, and through recognizing great achievement in manufacturing as it does today in science and technology, (national medal of Manufacturing?) and by a continuing stress on and recognition of quality as it does today in the Malcolm Baldrige award. And we need to find ways to building up the use of technology in the large and important service sector.

In general the *support of education helps industrial leadership*, so that the Presidential goals in education are complementary to the goal of industrial leadership. However there are certain *aspects of education that are especially supportive* of (2) and (3). Practical education, *education for work*, as well as the education for manufacturing and production in the engineering curriculum must be raised both in content and in prestige, and this can be supported by Federal initiatives that make curriculum development practical as well as putting the prestige of the government behind the dignity of this work. Training for work, development of the skills needed on a manufacturing line, etc are far more developed in Japan and Germany for example, than in the U.S.. This is in part a question of prestige. In the U.S. there is a feeling that not going to college is second rate, and that more abstract knowledge is better than being able to do things. We need to change this point of view to a recognition that both matter. This downgrading of practical skills has already, over a period of many years lead to a downgrading of manufacturing within companies, and an insufficient reward and recognition of manufacturing skills. Training for work need to be revitalized in the nations schools, and in community colleges. *Training in industry* must be encouraged for the present work force. Investing in worker's skills should be a normal part of industrial life, we cannot wait for revitalized schools to produce a whole new work force.

While we have discussed measures that are across the board, and not particular to particular industries, in reality industries are very different, and the emphasis that they will place on these or other measures are quite different. For that reason we suggest a *series of meetings* for the President with industry and labor and educational leaders and/or one large and visible meeting like the education summit. It is important for the President to enlist the industrial leadership in an area in which they are so important and to hear from them what particulars would make a difference to their particular industries, and this must go beyond the platitudes of a balanced budget etc. The resulting visibility of the President committing to industrial strength as a major national goal alone will make a great difference.

Appendix: Administration statements supportive of these directions.

The President has said:

"We lead in science --- and can surely do so in technology and commercial products as well"; and

"Reducing the cost-of-capital is a top priority".

And the President's speeches have referred to

Scientific and Technology Leadership --- and supporting generic technologies; and to
Incentives for Investment in R&D --- and Productivity.

Michael Boskin has testified to the Congress that:

"The nation cannot take economic growth for granted. Unless sound policies are followed, there is no guarantee that American living standards will continue to rise substantially from one generation to the next, or that the United States will remain the world's leading economy".

"The nation must recognize that the U.S. has very serious challenges and formidable policy problems to address if we are to ensure, indeed enhance our long-term economic growth."

"Long-term economic growth is the dominant factor in the success and failure of nations."

"Growth and Productivity are our Top Priorities"; and

"The federal government has an appropriate role in supporting the development of some pre-competitive generic technologies".

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EXECUTIVE OFFICE OF THE PRESIDENT
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WASHINGTON, D.C. 20506

Tom
FILE
PCAST
Megaprojects
Panel

May 2, 1991

MEMORANDUM FOR JOHN MCTAGUE

FROM: Jennifer Bond *Jennifer*
THROUGH: Tom Ratchford
SUBJECT: Talking Points for May PCAST Meeting

The following are some points you could discuss during your progress report:

Allan has selected the list of prospective members of the panel. (Thank both Bernadine Healy and Harold Shapiro for their good suggestions.) They are as follows:

PCAST Megaproject Panel Members Selected to Date:

John McTague, Chairman
Harold Shapiro, Vice Chairman

Large single site:

Ed Frieman (former DOE)
James Beggs (former NASA)
Jack Sandweiss (high energy physics, Yale)

Distributed projects:

Jim Baker JOID- Oceanography
Life Scientist -- See attached suggestions from NIH

US diplomatic-international law experience:

Lloyd Cutler (William, Cutler, & Pickering)

Future Interaction with the EC:

At the February meeting of the US-EC Joint Consultative Group on Science and Technology (JCG), both sides agreed to a joint task force to prepare for the spring 1992 OECD Ministerial on Science and Technology's agenda item on international cooperation in science megaprojects.

Since our last PCAST meeting, Tom Ratchford and Jennifer Bond met with Paolo Fasella (Director of the EC's DG XII) and Gilbert Fayl, EC Science Counselor.

The EC is establishing a high level panel of experts who will conduct an inventory of current European megaprojects as well as potential future needs and possible community action regarding these projects. This is a mixed panel comprised of both government and non-government people. It is what a joint FCCSET/PCAST panel might look like in the United States. However, the panel was selected on the basis of their expertise rather than their positions. They will be addressing a number of the same questions we are in terms of guidelines for access to large installations, time horizons necessary for planning, questions of staffing, funding, intellectual property rights and just returns, etc.

The tentative EC panel membership is:

Humberto Colombo (the new President of the European Science Foundation) (Italy)
Reimer Lust (FRG)
Schopper (FRG)
Sir John Kendrew (UK)
Horowitz (CEA of France)
Mr. Haarder (Minister of Science and Education in Denmark)

Tom suggested that our PCAST and FCCSET panels and the EC panel exchange information on our parallel studies, and that we consider meeting together in September to share findings and discuss the issue. This would be preparatory to the Joint Consultative meeting in November.

COSEPUP Role

Tom Ratchford also discussed our activities in megaprojects with the Committee on Science and Engineering and Public Policy of the National Academy of Sciences. They are considering the possibility of a study on megaprojects.

Discussions at the US-Japan Joint High Level Advisory Panel Meetings in Tokyo

You may wish to refer to your Joint High Level Advisory Panel Meetings, for example, discussions of potential cooperation in the Human Frontiers Science Program and the SSC.

Discussions with the USSR

Dr. Bromley, Tom Ratchford and John O'Neil will be going to Moscow soon to attend the US-USSR Joint Commission on Basic Sciences. International cooperation in megaprojects is on the agenda.

Suggestions from NIH for life scientists to serve on the Megaprojects panel

Suggestions from Bernadine Healy:

1 Human Genome

**Dr. James Watkins-----NOTE: We decided not to ask him
Columbia Harbor, NY
Director National Center for Human Genome Research
(516)367-8310**

**Dr. David Borstein
Stanford**

2. Imaging & Computing

**Jerry Cox
Washington University**

**Saul Amarel
Rutgers University**

3. Pharmacology

**Ed Skonick
Merck Pharmaceutical Co.**

Other suggestions from Phil Shambra (NIH):

Don Fredrickson (former Director NIH)

Hans Mark (former Deputy Adminr NASA & Undersecy Air Force)

**Maxine Singer (President of Carnegie Institute of Washington)
NOTE: We don't have any women on the panel**

**Vince Devita National Cancer Institute/ Am. Bd. Coord. Council Cancer
Research & past Pres. Assoc. of Cancer Research)**

Ted Cooper Chairman Bd. & CEO Upjohn Co.

Joshua Lederberg President Emeritus Rockefeller

Book, N.J., 1977-82; sr. v.p. Rochelle Park, N.J., 1982-
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27, 1943 (div.); children: Mallory C., Rodney W., Ian C.;
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-48, asst. advt. dir., 1948-55; exec. bus. dept. Reader's Digest,
58, advt. dir. internat. edits. Reader's Digest, 1958-60, pres.
1960, asst. gen. mgr., 1960-66, dep. gen. mgr. internat. edits.,
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Opera Assn., 1973-83; bd. dir. Am. Hosp. Instabul; trustee
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st. to maj. AUS, World War II. Decorated Bronze Star medal,
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pres. 1962-64), Assn. Ex-Mem. Squadron A, XIIIth Corps
Fgn. W. Assn. U.S. Army (v.p. N.Y. chpt.), Fgn. Policy
Fedn. Periodical Press (v.p. 1978-79), pres. 1979-81, chmn.
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1970, The Political Culture of the United States, 1972,
Work? Liberty and Justice in America, 1978, Reagan Elec-
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9, Co-author Criminal Procedure, 1960. Bd. dirs. Youth
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1968-85; mem. re. assembly, chmn. rules and calendar com.
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to U.S. and Can. govts. Recipient Vanier award,
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97, A.B. Merrimack Coll., 1959; M. Pub. Admin. U. Mich.,
Nat. War Coll., 1969-70. Instr. Lowell (Mass.) Sch.
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1962-64, asst. Vietnam affairs, 1964-66, post-off. in
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Affairs, Dept. State, Washington, 1983-84; asst. dir.
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- COOPER, ROBIN D G**, b Eastbourne, Eng, Sept 26, 38; m 70. **ORGANIC CHEMISTRY**. Educ: Univ London, BSc, 59, PhD(org chem), 62, DIC, 60; FRIC, DSc, 84. Prof Exp: Glaxo res fel org chem, Imp Col, Univ London, 62-63; Nat Acad Sci vis res assoc, US Army Natick Labs, 63-65; sr res chemist, 65-70, res scientist, 70-75, res assoc, 75-84, RES ADV, ELI LILLY & CO, 84. Mem: Am Chem Soc; fel Royal Soc Chem. Res: Structural determination and synthesis of antibiotics, especially penicillin and cephalosporins; B-lactam biosynthesis; author of numerous publications. Mailing Add: Dept MC 930 Lilly Corp Ctr Eli Lilly Co Bldg 88-2 Indianapolis IN 46285
- COOPER, RONDA FERN**, b Schenectady, NY, June 20, 43. **MEDICAL MICROBIOLOGY, HEALING & PARAPSYCHOLOGY**. Educ: Okla State Univ, BS, 64; Kans State Univ, MS, 66, PhD(microbiol), 71. Prof Exp: Res assoc & instr path, Kans State Univ, 67-73; asst prof biol, Univ NMex, 73-74; asst prof microbiol, La State Univ, Baton Rouge, 74-77; from asst prof to asst prof microbiol, New Eng Col Osteop Med, 78-87; CONSULT, 87. Concurrent Pos: Lalor Found fel, 75; mem, Conf Pub Health Lab Dirs. Mem: Am Soc Microbiol; Am Soc Psychol Res; Inst Noetic Sci; Sigma Xi. Res: Interaction of microbiol toxins with host tissues and other aspects of host-parasite relationships; psychic and spiritual effects of bioplasmic energies on microbiol growth. Mailing Add: 19 Twin Island Acres Biddeford ME 04005
- COOPER, SHELDON MARK**, b New York, NY, Dec 5, 42; m 66; c 1. **RHEUMATOLOGY, CLINICAL IMMUNOLOGY**. Educ: Hobart Col, BS, 63; New York Univ, MD, 67; Am Bd Internal Med, dipl, 73; Subspecialty Bd Rheumatol, dipl, 76. Prof Exp: Teaching fel rheumatol & immunol, Med Ctr, New York Univ, 70-72; from asst prof to asst prof, dept med, Sch med, Univ Southern Calif, 74-82; assoc prof med, 82-86, DIR RHEUMATOL & CLIN IMMUNOL UNIT, DEPT MED, COL MED, UNIV VT, 82-. PROF MED, 86-. Concurrent Pos: Attend med, Los Angeles County-Univ Southern Calif Med Ctr, 74-82 & Med Ctr Hosp Vt, 82-. Mem: Am Asn Immunologists; Am Rheumatism Assn; Reticuloendothelial Soc; Am Fedn Clin Res. Res: Investigation of the immunologic mechanisms that are involved in the pathogenesis of autoimmune diseases such as rheumatoid arthritis and systemic lupus erythematosus. Mailing Add: Rheumatol & Immunol Unit Dept Med Univ Vt Given D-301 Burlington VT 05405
- COOPER, STEPHEN**, b Brooklyn, NY, Aug 6, 37; m 60; c 2. **MICROBIOLOGY, GENETICS**. Educ: Union Col, NY, BA, 59; Rockefeller Inst, PhD(microbiol), 63. Prof Exp: NSF res fells, Univ Inst Microbiol, Copenhagen Univ, 63-64 & Med Res Coun Microbial Genetics Res Unit, Univ London, 64-65; res assoc biol chem, Med Sch, Tufts Univ, 65-66; asst res prof pediat, State Univ NY, Buffalo, 66-70, asst res prof biochem, 67-70, lectr biol, 69-70; assoc prof, 70-78, PROF MICROBIOL, SCH MED, UNIV MICH, 78-. Concurrent Pos: Fogarty Int fel, Imp Cancer Res Fund, London, 76. Mem: AAAS; Am Soc Microbiol. Res: Biochemistry and genetics of viruses; protein synthesis; control of DNA replication and cell division in bacteria; microbial genetics; development of dictyostelium. Mailing Add: Dept of Microbiol Sch of Med Univ of Mich Ann Arbor MI 48109
- COOPER, STEPHEN ALLEN**, b Philadelphia, Pa, Apr 11, 46; m 71; c 2. **ANALGESIOLOGY, ANXIETY AND PAIN CONTROL**. Educ: Adelphi Univ, BS, 68; Univ Pa, DMD, 71; Georgetown Univ, PhD(pharmacol), 75. Prof Exp: Asst prof pharmacol, Georgetown Univ, 75-78; assoc dean res, Dent Sch, Univ Med & Dent, NJ, 78-85; ASSOC PROF, ORAL SURG & PHARMACOL, 86-. UNIV PA, SCH DENT MED, 87-. DIR, DIV PHARMACOL & THERAPEUT. Concurrent Pos: Vis prof, Georgetown Univ, 78-; consult, Hosp Ctr Orange, East Orange, NJ, 80- & United Hosps, Newark, 81-; clin prof dept of med, Med Col of Pa. Mem: Am Soc Clin Pharmacol; Am Pain Soc; Am Asn Dent Res; Sigma Xi. Res: Clinical evaluation of analgesic drugs; clinical evaluation of drugs used for intravenous sedation. Mailing Add: 1016 Mount Pleasant Rd Bryn Mawr PA 19010-1826
- COOPER, STUART L**, b New York, NY, Aug 28, 41; m 65; c 2. **BIOMATERIALS**. Educ: Mass Inst Technol, BS, 63; Princeton Univ, MA, 65, PhD(chem eng), 67. Prof Exp: From asst prof to asst prof, 67-74, PROF, UNIV WIS-MADISON, 74-. CHMN CHEM ENG, 83-. Concurrent Pos: Vis assoc prof, Univ Calif, Berkeley, 74; bd trustees, Argonne Univ Asn, 75-81; vis prof, Technion, Israel, 77. Honors & Awards: Argonne Univ Asn, 75-81; Soc Biomat, 87; Mat Eng & Sci Div Award, Am Inst Chem Engrs, 87. Mem: Am Chem Soc; fel Am Phys Soc; Am Inst Chem Engrs; Soc Plastic Engrs; Am Soc Artificial Internal Organs; Soc Biomat. Res: Structure-property relations of polymers including polyurethanes, ionomers and related block polymer systems; application of light and x-ray scattering, rheo-optical and thermal methods in polymer characterization; studies of protein and thrombus deposition on polymers used in biomedical applications; polyurethane for biomedical applications. Mailing Add: Dept Chem Eng Univ Wis-Madison 1415 Johnson Dr Madison WI 53706
- COOPER, TERENCE ALFRED**, b Oxford, Eng, Feb 8, 41; m 66; c 2. **POLYMER CHEMISTRY**. Educ: Oxford Univ, BA, 62, BSc, 64, DPhil(phys org chem) & MA, 66; Drexel Univ, MBA, 73. Prof Exp: Res staff chemist, Sterling Chem Lab, Yale Univ, 66-68; res chemist, Elastomers Res Lab, 68-80, RES ASSOC, POLYMER PROD DEPT, EXP STA, E I DU PONT DE NEMOURS & CO, INC, 80-. Mem: Am Chem Soc; The Chem Soc; Am Inst Chem Engrs. Res: Materials science and polymer engineering; colloid chemistry; adhesives; sealant and coatings. Mailing Add: 15 Stage Rd Newark DE 19711
- COOPER, TERRANCE G**, b Wyandotte, Mich, Aug 14, 42; c 2. **IMMUNOLOGY, MICROBIOLOGY**. Educ: Wayne State Univ, BSc, 63, MS, 67; Purdue Univ, PhD(biol), 69. Prof Exp: Fel biol, Mass Inst Technol, 69-71; asst prof biochem, Univ Pittsburgh, 71-75, assoc prof biochem & genetics, 74-81, Audrey Avinoff prof biol, 81-84; VAN VLEET PROF MICROBIOL & IMMUNOL & CHMN DEPT, HEALTH SCI CTR, UNIV TENN, MEMPHIS, 85-. DIR, MOLECULAR RESOURCE CTR, 85-. Concurrent Pos: Vis prof, Microbiol Lab, Univ Libre de Bruxelles, Belg, 75; vis scholar, Dept Biol, Univ Calif, Santa Barbara, 79-80; distinguished lectr, Concordia Univ, 82; vis heritage prof, Univ Alta, 86. Honors & Awards: Brown Hazen Award, Res Corp, 72. Mem: Am Soc Biol Chemists; Genetics Soc Am; Am Soc Microbiol; AAAS. Res: Regulation of gene expression; identification of the protein-nucleic interactions that mediate the control of transcription. Mailing Add: Molecular Resource Ctr Univ Tenn 801 Path Bldg Memphis TN 38163
- COOPER, THEODORE**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY, PHARMACOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat Acad Sci; Am Physiol Soc; Am Col Cardiol; Am Col Chest Physicians; Am Fedn Clin Res. Res: Experimental and clinical cardiovascular physiology and pharmacology. Mailing Add: Chmn Bd Upjohn Co Kalamazoo MI 49001
- COOPER, THOMAS D(AVID)**, b Dayton, Ohio, Apr 7, 32; m 53; c 3. **PHYSICAL METALLURGY**. Educ: Univ Cincinnati, MetE, 55; Ohio State Univ, MS, 64. Prof Exp: Metall engr, Westinghouse Elec Corp, 55-56; proj engr light metals, 56-59, proj engr high temperature metals, 59-60, tech mgr, 60-64, high strength metals, 64-66, chief, Processing & Nondestructive Testing Br, 66-72, chief, Nondestructive Testing & Mech Br, 72-73, chief, Aeronaut Sys Br, 73-77, CHIEF MAT INTEGRITY BR, US AIR FORCE, MAT LAB, 77-. Mem: Fel Am Soc Metals Int; assoc fel Am Inst Aeronaut & Astronaut; Am Inst Mining, Metall & Petrol Engrs; Sigma Xi; fel Am Soc Nondestructive Testing. Res: Promoting optimum applications of materials during development of aeronautical systems; operational organizations, including failure analysis, corrosion control, NDE, materials selection, specification and standards. Mailing Add: Mats Lab Air Force Wright Aeronaut Labs/MLSA Wright-Patterson AFB OH 45433-6533
- COOPER, THOMAS EDWARD**, b Lindsay, Calif, May 31, 43; m 68; c 1. **MECHANICAL ENGINEERING, BIOENGINEERING**. Educ: Univ Calif, Berkeley, BS, 66, MS, 67, PhD(mech eng), 70. Prof Exp: Actg asst prof mech eng, Univ Calif, Berkeley, 70; asst prof, 70-76, ASSOC PROF MECH ENG, NAVAL POSTGRAD SCH, 76-. Concurrent Pos: Consult, Lawrence Radiation Lab, 70-Res: Thermal modeling of heat transfer processes occurring in tissue surrounding cryosurgical and radio-frequency probes; biological thermal property determinations. Mailing Add: Dept of Mech Eng Code 59Cg Naval Postgrad Sch Monterey CA 93940
- COOPER, TOMMYE**, b Bandana, Ky, May 17, 38; m 61; c 1. **AGRICULTURE, STATISTICS**. Educ: Murray State Univ, BS, 60; Univ Ky, MS, 62, PhD(dairy sci, statist), 66. Prof Exp: Anal statistian, 66-67, chief methods & ops unit, Comput Lab, 67-68, actg dir, Data Sys Appln Div, 68-70, dir, 70-73, DIR, FT COLLINS COMPUT CTR, US DEPT AGR, 73-. Mem: Am Dairy Sci Assn; Am Soc Animal Sci; Am Asn Comput Mach. Res: Dairy cattle reproductive and genetic research using digital computer and statistical techniques to achieve these goals. Mailing Add: 1502 La Porte Ave Fort Collins CO 80521
- COOPER, WILLIAM (LILIAM) EUGENE**, b Erie, Pa, Jan 11, 24; m 46; c 5. **PRESSURE VESSELS, NUCLEAR SYSTEMS**. Educ: Ore State Col, BS, 47, MS, 48; Purdue Univ, PhD(eng mech), 51. Prof Exp: Instr eng mech, Purdue Univ, 48-52; consult engr, Knolls Atomic Power Lab, Gen Elec Co, 52-63; eng mgr, Lessells & Assocs, Inc, 63-68; sr vpres & tech dir, Teledyne Mat Res Co, 68-76, CONSULT ENGR, TELEDYNE ENG SERV, 76-. Concurrent Pos: Sr vpres codes & standards, Am Soc Mech Engrs, 81-84. Honors & Awards: William M Murray lectr, Soc Exp Stress Anal, 77; B F Langer & Nuclear Codes & Standards Award, Am Soc Mech Engrs, 78; Pressure Vessel & Piping Award, Am Soc Mech Engrs, 83, Codes & Standards Medal, 86. Mem: Am Soc Mech Engrs; Soc Exp Mech; Nat Acad Engrs. Res: Structural analysis and evaluation; application of material properties to design; pressure vessel and pressure piping codes and standards. Mailing Add: Teledyne Eng Serv 130 Second Ave Waltham MA 02254
- COOPER, J. WALTER**, b Clairton, Pa, July 18, 28; m 53; c 2. **PHYSICAL CHEMISTRY**. Educ: Washington & Jefferson Col, BA, 50; Univ Rochester, PhD(phys chem), 57. Prof Exp: From res chemist to sr res chemist, 56-66, RES ASSOC, EASTMAN KODAK CO, 66-. Mem: AAAS; Am Chem Soc; Am Phys Soc; Sigma Xi. Res: Gas-phase kinetics; photographic theory; solid state chemistry of silver halides; luminescence properties of dyes. Mailing Add: 63 Skyview Lane Rochester NY 14625
- COOPER, WILLIAM ANDERSON**, b Archer City, Tex, Feb 4, 27; m 52; c 4. **ZOOLOGY, PHYSIOLOGY**. Educ: N Tex State Univ, BS, 48, MS, 50; Tex A&M Univ, PhD(zool), 57. Prof Exp: Instr natural sci, Paris Jr Col, 53-54; asst biol, Tex A&M Univ, 54-55, instr, 55-57; assoc prof, 57-65, PROF BIOL, N TEX STATE UNIV, 65-. Concurrent Pos: Res assoc, Am Soc Mech Engrs, 57-65; Found, NIH, 55-57; Authority, Nat Park & Tex Parks & Wild, 57-65; Sigma Xi. Res: Effect of white rats; limnology. Mailing Add: Dept of Biol W
- COOPER, WILLIAM**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat Acad Sci; Am Physiol Soc; Am Col Cardiol; Am Col Chest Physicians; Am Fedn Clin Res. Res: Experimental and clinical cardiovascular physiology and pharmacology. Mailing Add: Chmn Bd Upjohn Co Kalamazoo MI 49001
- COOPER, WILLIAM**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat Acad Sci; Am Physiol Soc; Am Col Cardiol; Am Col Chest Physicians; Am Fedn Clin Res. Res: Experimental and clinical cardiovascular physiology and pharmacology. Mailing Add: Chmn Bd Upjohn Co Kalamazoo MI 49001
- COOPER, WILLIAM**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat Acad Sci; Am Physiol Soc; Am Col Cardiol; Am Col Chest Physicians; Am Fedn Clin Res. Res: Experimental and clinical cardiovascular physiology and pharmacology. Mailing Add: Chmn Bd Upjohn Co Kalamazoo MI 49001
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- COOPER, WILLIAM**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat Acad Sci; Am Physiol Soc; Am Col Cardiol; Am Col Chest Physicians; Am Fedn Clin Res. Res: Experimental and clinical cardiovascular physiology and pharmacology. Mailing Add: Chmn Bd Upjohn Co Kalamazoo MI 49001
- COOPER, WILLIAM**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat Acad Sci; Am Physiol Soc; Am Col Cardiol; Am Col Chest Physicians; Am Fedn Clin Res. Res: Experimental and clinical cardiovascular physiology and pharmacology. Mailing Add: Chmn Bd Upjohn Co Kalamazoo MI 49001
- COOPER, WILLIAM**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat Acad Sci; Am Physiol Soc; Am Col Cardiol; Am Col Chest Physicians; Am Fedn Clin Res. Res: Experimental and clinical cardiovascular physiology and pharmacology. Mailing Add: Chmn Bd Upjohn Co Kalamazoo MI 49001
- COOPER, WILLIAM**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat Acad Sci; Am Physiol Soc; Am Col Cardiol; Am Col Chest Physicians; Am Fedn Clin Res. Res: Experimental and clinical cardiovascular physiology and pharmacology. Mailing Add: Chmn Bd Upjohn Co Kalamazoo MI 49001
- COOPER, WILLIAM**, b Trenton, NJ, Dec 28, 28; m 56; c 4. **PHYSIOLOGY**. Educ: Georgetown Univ, BS, 49; St Louis Univ, MD, 54, PhD(physiol), 56. Hon Degrees: DSc, Col Osteopath Univ, 81; LHD, Loyola Univ Chicago, 79 Univ Rochester, 79 & Sch Med, Georgetown Univ, 77 & 81; LHD, Loyola Univ Chicago, 79. Prof Exp: Intern, St Louis Univ Hosps, 54-55; sr asst surgeon, Nat Heart Inst, 56-58, asst res cardiovascular surg, 58-59, mem staff clin surg, 59-60; from asst prof to prof & chmn dept pharmacol, Sch Med, Univ NMex, 66-68; dep asst secy health, 74-75, asst secy health, HEW, 75-77; dean med col & provost med affairs, Cornell Univ, 77-80; exec vpres, 80-84, vchmn bd, 84-87, CHMN BD & CHIEF EXEC OFFICER, UPJOHN CO, 87-. Concurrent Pos: mem pharmacol & exp therapeutic study sect, USPHS, 64-67; sci adv bd, Leonard Wood Mem, Am Leprosy Found; bd dir, Nat Health Coun, Inc; expert adv panel cardiovasc dis, World Health Orgn; med & sci adv coun, Nat Hemophilia Found; vis fel, Woodrow Wilson Nat Fel Found; bd trustees, Milton Helpen Libr Legal Med; sci adv comt, Gen Motors Corp; tech bd, Milbank Mem Fund; med adv comt, White House Conf on aging, 81; dir, Nat Heart & Lung Inst, 68-74. Honors & Awards: Harvey W Wiley Medal, Food & Drug Admin, Pub Health Serv, Silver Springs, MD, 76; Tom A Spies Medal Award, Int Acad Preventive Med, 77; Albert Lasker Award, 78; Ellen Browning Scripps Medal, 80. Mem: Inst Med-Nat

- MARION, WILLIAM W.**, b Hillsville, Va, Feb 3, 30; m 54; c 4. **FOOD SCIENCE**. Educ: Berea Col, BS, 53; Purdue Univ, MS, 55, PhD(food technol), 58. *Prof Exp*: Instr poultry husb, Purdue Univ, 55-58; from asst prof to prof animal sci, 58-74, chmn dept poultry sci, 68-71. **PROF FOOD TECHNOL & HEAD DEPT, IOWA STATE UNIV**, 74- *Mem*: Inst Food Technol; Am Oil Chem Soc; Poultry Sci Assn; Am Inst Nutrit. *Res*: Structure and composition of muscle lipids; post-mortem biochemical changes in muscle. *Mailing Add*: Dept Food Technol Iowa State Univ 102A Dairy Hud Ames IA 50011
- MARIS, HUMPHREY JOHN**, b Ipswich, Eng, Apr 25, 39. **SOLID STATE PHYSICS**. Educ: Imp Col, Univ London, BSc, 60, PhD(physics), 63. *Prof Exp*: Fel physics, Case Inst Cleveland, 63-65; from asst prof to assoc prof, 65-76. **PROF PHYSICS, BROWN UNIV**, 76- *Concurrent Pos*: Vis fel, Univ EAnglia, 72-73, Chalmers Inst, 73, & Nat Ctr Sci Res, Grenoble, France, 73. *Mem*: Am Phys Soc. *Res*: Low temperature physics; ultrasonics; lattice dynamics. *Mailing Add*: Dept of Physics Brown Univ Providence RI 02912
- MARISCAL, RICHARD NORTH**, b Los Angeles, Calif, Oct 4, 35; m 74; c 4. **MARINE BIOLOGY, INVERTEBRATE ZOOLOGY**. Educ: Stanford Univ, AB, 57, MA, 61; Univ Calif, Berkeley, PhD(zool), 66. *Prof Exp*: Asst entom, Univ Calif, Berkeley, 60-61, asst zool, 61-64, lectr, 66; fac asst, Te Vega & Int Indian Ocean Expeds, Hopkins Marine Sta, Stanford Univ, 64-65; NIH fel, Lab Quant Biol, Univ Miami, 67-68; from asst prof to assoc prof, 68-78, assoc chmn grad studies & res, 77-79. **PROF BIOL SCI, FLA STATE UNIV**, 78- *Mem*: Fel AAAS; Am Soc Zool; Ecol Soc Am; Asn Trop Biol; Am Inst Biol Sci; NY Acad Sci. *Res*: Cnidarian nematocyst physiology, biochemistry and morphology; prey-predator interactions and symbiosis between cnidarians, fishes, crustaceans and molluscs; invertebrate behavior, ecology, physiology, electron microscopy and x-ray microanalysis; sensory receptors of cnidarians. *Mailing Add*: Dept of Biol Sci Fla State Univ Tallahassee FL 32306
- MARISKA, JOHN THOMAS**, b Fairbanks, Alaska, Feb 25, 50; m 72; c 2. **ASTROPHYSICS, ASTRONOMY**. Educ: Univ Colo, BA, 72; Harvard Univ, AM, 73, PhD(astron), 77. *Prof Exp*: resident res assoc space sci, 77-79, res physicist, 79-81. **ASTROPHYSICIST, E O HULBERT CTR SPACE RES, NAVAL RES LAB**, 81- *Mem*: AAAS; Am Astron Soc; Am Geophys Union; Int Astron Union. *Res*: Solar and stellar physics; structure of the solar corona; extreme ultraviolet spectroscopy. *Mailing Add*: Code 4175M Naval Res Lab Washington DC 20375-5000
- MARK, EARL LARRY**, b Ogden, Utah, Dec 13, 40; m 62; c 4. **PHYSICAL CHEMISTRY**. Educ: Weber State Col, BS, 65; Univ Idaho, PhD(phys chem), 70. *Prof Exp*: Res chemist, Amalgamated Sugar Co, 70-73; dir res, Water Refining Co, 73-74; **PROD MGR, BLACK CLAWSON CO**, 74- *Mem*: Am Chem Soc; Filtration Soc; Am Soc Testing & Mats. *Res*: Ion exchange; surface adsorption; use of radiotracers in adsorption studies; activated carbon adsorption; liquid-solid separation; liquid filtration. *Mailing Add*: 3111 Whispering Trails Carmel IN 46032-3954
- MARK, HANS MICHAEL**, b Mannheim, Germany, June 17, 29; nat US; m 51; c 2. **PHYSICS, ENGINEERING**. Educ: Univ Calif, Berkeley, AB, 51; Mass Inst Technol, PhD(physics), 54. *Hon Degrees*: ScD, Fla Inst Technol, 77; DEng, Polytech Inst NY, 82. *Prof Exp*: Asst, Mass Inst Technol, 52-54, res assoc, 54-55; jr res physicist, Univ Calif, 55-56, physicist, Lawrence Radiation Lab, 56-58; asst prof physics, Mass Inst Technol, 58-60; from assoc prof to prof nuclear eng, Univ Calif, Berkeley, 60-69, chmn dept, 64-69, physicist, Lawrence Livermore Nat Lab, 60-69; leader exp physics div, 60-64, dir, Ames Res Ctr, NASA, 69-77; undersecy, Air Force, 77-79, secy, 79-81; dep adminr, NASA, 81-84; **CHANCELLOR, UNIV TEX SYST**, 84- *Concurrent Pos*: Lectr, dept appl sci, Univ Calif, Davis, 69-73; consult, Inst Defense Anal, US Army, DC; consult prof, Sch Eng, Stanford Univ, 73-84; consult, US Air Force, US Army & Inst Defense Anal; dir, Pennzoil Corp, 84-87; trustee, MITRE Corp, 85- *Mem*: Nat Acad Eng; Am Geophys Union; fel Am Phys Soc; Am Nuclear Soc; fel Am Inst Aeronaut & Astronaut. *Res*: Nuclear and atomic physics; nuclear instrumentation; astrophysics. *Mailing Add*: Off Chancellor Univ Tex Syst 601 Colorado St Austin TX 78701
- MARK, HAROLD WAYNE**, b Chanute, Kans, May 2, 49. **PHYSICAL ORGANIC CHEMISTRY, SULFUR CHEMISTRY**. Educ: Univ Kans, BS, 71; Northwestern Univ, PhD(chem), 75. *Prof Exp*: res chemist, Phillips Petrol Co, 75-80, sr res chem, 80-88; **SR RES CHEMIST, WESTVACO CORP**, 88- *Mem*: AAAS; Am Chem Soc; Sigma Xi. *Res*: Sulfur chemistry, catalysis, carbonium ion chemistry and nucleophilic substitution reactions. *Mailing Add*: Westvaco Corp PO Box 2941105 North Charleston SC 29411-2905
- MARK, HARRY BERST, JR.**, b Camden, NJ, Feb 28, 34; m 60; c 3. **ELECTROCHEMISTRY, ANALYTICAL CHEMISTRY**. Educ: Univ Va, BA, 56; Duke Univ, PhD(electrochem), 60. *Prof Exp*: Assoc, Univ NC, 60-62; fel, Calif Inst Technol, 62-63; from asst prof to assoc prof chem, Univ Mich, Ann Arbor, 63-70; **PROF CHEM, UNIV CINCINNATI**, 70- *Concurrent Pos*: Vis prof, Free Univ Brussels, 70; cong legis Counr, Am Chem Soc, 74- *Mem*: AAAS; Am Chem Soc; Electrochem Soc; NY Acad Sci; Am Inst Chem. *Res*: Heterogeneous electron transfer kinetics; electrical double layer phenomena; electroanalytical techniques; neutron activation analysis; kinetic methods for the analysis of closely related mixtures; bioelectrochemistry; environmental analysis methods. *Mailing Add*: Dept Chem Univ Cincinnati Cincinnati OH 45221
- MARK, HERBERT**, b Jersey City, NJ, June 10, 21; m 45; c 3. **MEDICINE, CARDIOLOGY**. Educ: Columbia Univ, AB, 42; Long Island Col Med, MD, 45; Am Bd Internal Med, dipl, 53. *Prof Exp*: Resident med, Montefiore Hosp, New York, 48-49; resident, Vet Admin Hosp, Bronx, 49-50; asst med, 51-64; asst prof med, NY Med Col, 64-67; asst prof med & med, Albert Einstein Col Med, 67-69; clin assoc prof med, NY Col Med, 69-73, prof med, 73-75; **CHIEF, MED SERV, VET ADMIN MED CTR, BRONX, NY**, 75- *Prof*, Mt Sinai Sch Med, 75- *Concurrent Pos*: Fel cardiologist, Montefiore Hosp, New York, 50-51, mem staff, assoc attend physician, 61-67, attend physician, 67-75; attend physician, Vet Admin Hosp, Bronx; assoc chief med, chief cardiologist & assoc attend physician, Bird S Coler Hosp, 64-67; assoc attend physician, Flower & Metrop Hosps, 64-67; dir ambulatory serv, Montefiore-Morrisania Affiliation, 67-69; chief med, Jersey City Med Ctr, 69-75; adj attend physician, Med Serv, Mt Sinai Hosp, New York, 75- *Mem*: Am Fedn Clin Res; fel Am Col Physicians; fel Am Col Cardiol; Am Heart Assn. *Res*: Vectorcardiography; electrophysiology; congenital heart disease. *Mailing Add*: Dept Med Mt Sinai Sch Med Fifth Ave & 100 St New York NY 10029
- MARK, HERMAN FRANCIS**, b Vienna, Austria, May 3, 95; nat US; m 22; c 2. **POLYMER CHEMISTRY, ENGINEERING**. Educ: Univ Vienna, PhD, 21, Dr rer nat, 56. *Hon Degrees*: EngD, Univ Leige, 49; PhD, Uppsala Univ, 42, Lowell Technol Inst, 57 & Munich Tech Univ, 60. *Prof Exp*: Instr physics & phys chem, Univ Vienna, 19-21; instr org chem, Univ Berlin, 21-22; from res fel to group leader, Kaiser Wilhelm Inst, Dahlem, 22-26; res chemist, I G Farben-Indust, 27-28, group leader, 28-30, asst res dir, 30-32; prof chem, Univ Vienna, 32-38; adj prof org chem, 40-42, prof, 42-46, dir polymer res inst, 46-70, **EMER DEAN, POLYTECH UNIV NEW YORK**, 70- *Concurrent Pos*: Assoc prof, Karlsruhe Tech Inst, 27-32; tech consult, US Navy, Qm Corps, US Army; NSF ed, J Polymer Sci, J Appl Polymer Sci; Series on Highpolymer, Rev in Polymer Sci, Resins, Rubbers, Plastics & Natural & Synthetic Fibers; chmn tech comt wood chem, Food & Agr Orgn, UN; chmn comt macromolecules, Int Union Pure & Appl Chem; chmn comt macromolecules, Nat Res Coun; vpres in-chg proj res, AmComt, Weizmann Inst, Israel & Gov Inst; chmn, Gordon Res Conf Macromolecules & Textiles. *Mem*: Nat Acad Sci; AAAS; Am Chem Soc; fel Am Phys Soc; Soc Rheol. *Res*: Use of x-rays and electrons in the synthesis, characterization, reactions and properties of natural and synthetic macromolecules. *Mailing Add*: 333 Jay St Polytech Univ Brooklyn NY 11201
- MARK, J CARSON**, b Lindsay, Ont, July 6, 13; US citizen; m 35; c 6. **MATHEMATICS, MATHEMATICAL PHYSICS**. Educ: Univ Western Ont, BA, 35; Univ Toronto, PhD(math), 38. *Prof Exp*: Instr math, Univ Man, 38-43; scientist, Montreal Lab, Nat Res Coun Can, 43-45; scientist, Los Alamos Sci Lab, 45-46, mem staff, theoret physics div, Los Alamos Sci Lab, Univ Calif, 46-73, div leader, 47-73; **MEM ADV COMT, REACTOR SAFEGUARDS OF US NUCLEAR REGULATORY COMN**, 76- *Concurrent Pos*: Mem, Sci Adv Bd, US Air Force; sci adv, US Deleg, Conf Experts Means of Detection Nuclear Explosions, Geneva, 58. *Mem*: Am Math Soc; Am Phys Soc. *Res*: Finite group theory; transport theory; hydrodynamics; neutron physics. *Mailing Add*: Los Alamos Nat Lab MS 210 PO Box 1663 Los Alamos NM 87544
- MARK, JAMES EDWARD**, b Wilkes-Barre, Pa, Dec 14, 34; m 64; c 2. **POLYMER CHEMISTRY**. Educ: Wilkes Col, BS, 57; Univ Pa, PhD(phys chem), 62. *Prof Exp*: Res chemist, Rohm & Haas Co, 55-56; res asst, Stanford Univ, 62-64; asst prof chem, Polytech Inst Brooklyn, 64-67; from asst prof to prof chem, Univ Mich, Ann Arbor, 67-77; **PROF CHEM, CHMN PHYS CHEM DIV & DIR POLYMER RES CTR, UNIV CINCINNATI**, 77- *Concurrent Pos*: Consult var indus, 63-; vis prof, Stanford Univ, 73-74; spec res fel, NIH, 75-76; lectr short course prog, Am Chem Soc, 73- *Mem*: AAAS; Am Chem Soc; Am Phys Soc; NY Acad Sci. *Res*: Statistical properties of chain molecules; elastic properties of polymer networks. *Mailing Add*: Dept of Chem Univ of Cincinnati Cincinnati OH 45221
- MARK, JAMES WAI-KEE**, b Calcutta, India, Aug 29, 43; US citizen. **PLASMA PHYSICS, ELECTRIC ENGINEERING**. Educ: Univ Calif, Berkeley, BS, 64; Princeton Univ, PhD(astrophys sci), 68. *Prof Exp*: Res assoc plasma physics, Plasma Physics Lab, Princeton Univ, 68-69; C L E Moore instr appl math, Mass Inst Technol, 69-70, from asst prof to assoc prof, 70-79. **RES SCI, INERTIAL FUSION ENERGY, LAWRENCE LIVERMORE NAT LAB**, 79- *Concurrent Pos*: Vis scientist, Kitt Peak Nat Observ, 75-76; vis assoc prof, dept phys & astron, Univ Md & vis scientist, Univ Groningen, The Netherlands, 77; res scientist, Mass Inst Technol Res Lab Electron, 77-79. *Mem*: NY Acad Sci; Am Phys Soc; Inst Elec & Electron Eng; Int Astron Union. *Res*: Inertial-fusion targets; gaussian-quadrature beam illumination; ion beam fusion; galaxy spiral structure and bending waves; high current particle beams; magnetized plasmas; ballooning modes second stable region; magnetic-reconnection; asymptotics and numerical simulations; rotating stars. *Mailing Add*: Lawrence Livermore Nat Lab Mail Stop L-477 PO Box 808 Livermore CA 94550
- MARK, JON WEI**, b Toysun, China; Can citizen; m 64; c 2. **COMPUTER COMMUNICATIONS, SPREAD SPECTRUM COMMUNICATIONS**. Educ: Univ Toronto, BAsC, 62; McMaster Univ, MEng, 68, PhD(commun), 70. *Prof Exp*: Engr, Can Westinghouse Co, Ltd, 62-67, sr engr, 68-70; from assoc prof to assoc chmn dept, 70-82, **PROF ELEC ENG, UNIV WATERLOO, ONT**, 78-, **CHMN DEPT**, 84- *Concurrent Pos*: Consult, Westinghouse, Can, Inc, 74-, Can Dept Commun, 78-; res scientist, IBM, Thomas J Watson Res Ctr, 76-77; resident consult, Bell Labs, Murray Hill, NJ, 82-83; assoc ed, Inst Elec Electronic Engrs Trans Commun, 83-85, ed, 86- *Honors & Awards*: Fel, Inst Elec Electronic Engrs. *Mem*: Inst Elec Electronic Engrs. *Res*: Computer communication; local and metropolitan area networks; multiple access systems; network modeling and analysis; digital signal processing; antijam and spread spectrum communication; integrated services networks. *Mailing Add*: Dept Elec Eng Univ Waterloo Waterloo ON N2L 3G1 Can
- MARK, LESTER CHARLES**, b Boston, Mass, July 15, 18; m 46; c 2. **MEDICINE**. Educ: Univ Toronto, MD, 41; Am Bd Anesthesiol, dipl, 52. *Prof Exp*: Intern, Jewish Mem Hosp, 41-43; asst resident surg, Grace Hosp, New Haven, Conn, 43; resident anesthesiol, Hosp Soc Surg, New York, 47-48; clin instr, Col Med, State Univ, NY, 52-53; assoc, 53-54, from asst prof to prof, 54-84, **EMER PROF ANESTHESIOLOG, COL PHYSICIANS & SURGEONS, COLUMBIA UNIV**, 84- *Concurrent Pos*: Res fel, Res Serv, NY Univ-Bellevue Med Ctr & Goldwater Mem Hosp, 48-51; Am Heart Assn res fel, 49-51; travel award, Int Cardiol Cong, Paris, 50; Guggenheim fel,

- of War, 48; Ricketts Award, Univ Chicago, 51. *Mem:* AAAS; hon mem Am Soc Microbiol; Am Soc Immunologists; Am Soc Trop Med & Hyg; Am Pub Health Assn; Am Soc Bact (vpres, 59-60, pres, 60-61). *Res:* Neurotropic viral diseases; rickettsial diseases; viral infections of man and animal; living trivalent polio vaccine; living virus vaccines, human and veterinary; causative organism. *Mailing Add:* PO Box 937 Hamilton MT 59840
- COX, HIDENTOY**, b Greenville, SC, Mar 3, 17; m 43; c 1. PLANT MORPHOLOGY, PLANT ANATOMY. *Educ:* Furman Univ, BS, 36, BA, 37; Univ NC, MA, 39, PhD(bot), 47. *Prof Exp:* Asst prof biol, Howard Col, 41-46; assoc prof bot, Agnes Scott Col, 46-49; from assoc prof to prof, Va Polytech Inst, 49-55; dep exec dir, Am Inst Biol Sci, 53-54, exec dir, 55-63; coord res, 63-67, dean sch letters & sci, 67-71, PROF BIOL, CALIF STATE UNIV, LONG BEACH, 71- *Concurrent Pos:* Asst admin pub affairs, NASA, 61-62; Beattie lectr, 64; mem, Calif Curric Comm, 65-66, 67-69; chmn, Calif Sci Adv Comt, 66-67. *Honors & Awards:* Distinguished Serv Citation, NASA, 62. *Mem:* Fel AAAS; Sigma Xi; Asn Advan Biomed Educ. *Res:* Comparative wood anatomy; plant embryology. *Mailing Add:* Dept of Biol Calif State Univ 1250 Bellflower Long Beach CA 90840
- COX, HOLLACE LAWTON, JR**, b Oak Park, Ill, Nov 17, 35; m 83; c 1. LASERS & ELECTROOPTICS, INTEGRATED OPTICS. *Educ:* Univ Rochester, AB, 59; Ind Univ, Bloomington, PhD(chem physics), 67. *Prof Exp:* Mem tech staff, Tex Instruments, Inc, 67-69; Robert A Welch res fel, Baylor Univ, 70-73; Robert A Welch res fel path, Univ Tex Syst Cancer Ctr, M D Anderson Hosp & Tumor Inst Houston, 73-75, res fel physics, 75-76; instr, Mallinckrodt Inst Radiol, Washington Univ Sch Med, 76-77; asst prof, Dept Radiation Oncol, Univ Kans Med Ctr, 77-80; assoc prof, Therapeut Radiol Dept, Sch Med, 80-83, lectr, 83-85, ASST PROF, ELEC ENG DEPT, UNIV LOUISVILLE, 85- *Mem:* Inst Elec & Electronics Engrs; Sigma Xi; Am Phys Soc; Optical Soc Am; Soc Photo-Optical Instrumentation Engrs. *Res:* Lasers and electrooptics; integrated optics, optical communications; fiber optics; nonlinear optical interactions in materials for use in integrated optical devices; laser spectroscopy; stopping power of alpha particles. *Mailing Add:* Dept Elec Eng Speed Sch Eng & Sci Univ Louisville Louisville KY 40292
- COX, J E**, b Waco, Tex, Aug 29, 35. MECHANICAL ENGINEERING. *Educ:* Southern Methodist Univ, BS, 58, MS, 60; Okla State Univ, PhD(eng), 63. *Prof Exp:* Engr, Astronaut Div, Chance Vought Corp, 56-59; instr, Okla State Univ, 61-63; prof mech eng, Univ Houston, 63-81; DIR GOVT AFFAIRS, AM SOC HEATING, REFRIG & AIR CONDITIONING ENGRS, 81- *Concurrent Pos:* Am Soc Mech Engrs cong fel with Sci & Technol Comt, US House Rep, 75. *Mem:* Fel Am Soc Mech Engrs; Am Soc Heating Refrig & Air Conditioning Engrs; Am Soc Asn Execs; Sigma Xi. *Res:* Heat transfer; fluid mechanics; thermodynamics. *Mailing Add:* PO Box 57104 Washington DC 20037
- COX, JAMES ALLAN**, b Chisholm, Minn, Sept 19, 41; m 65; c 2. ANALYTICAL CHEMISTRY, ELECTROCHEMISTRY. *Educ:* Univ Minn, BS, 63; Univ Ill, PhD(chem), 67. *Prof Exp:* Lectr chem, Univ Wis, 67-69; from asst to assoc prof, 69-78, prof chem Southern Ill Univ, Carbondale, 78-87; PROF & CHMN, DEPT CHEM, MIAMI UNIV, 87- *Mem:* Am Chem Soc; Soc Appl Spectroscopy. *Res:* Trace methods for anions; ion exchange membrane applications to trace analysis, modified electrodes, sensors. *Mailing Add:* Dept Chem Miami Univ Oxford OH 45056
- COX, JAMES LEE**, b Wayne Co, Ind, Oct 5, 38; m 63; c 2. ANIMAL NUTRITION. *Educ:* Purdue Univ, BS, 61; Univ Ill, MS, 63, PhD(animal nutrit), 67. *Prof Exp:* Sr res physiologist, 67-71, animal sci data analyst, 71-74, RES FEL, MERCK SHARP & DOHME RES LABS, 74- *Mem:* AAAS; Am Soc Animal Sci; Poultry Sci Asn; Sigma Xi; World Poultry Sci Asn. *Res:* Design and analysis of animal experiments; environmental effects on pregnant animals; mineral nutrition and physiological functions; influence of drugs on growth of animals. *Mailing Add:* Animal Sci Res Merck & Co Inc Box 2000 Rahway NJ 07065
- COX, JAMES LESTER, JR**, b Reidsville, NC, Nov 12, 42; m 63; c 2. PLASMA PHYSICS. *Educ:* NC State Univ, BS, 63, MS, 65, PhD(physics), 69. *Prof Exp:* From asst prof to assoc prof, 69-83, PROF PHYSICS, OLD DOMINION UNIV, 83- *Concurrent Pos:* Asst dean, Col Scis, Old Dominion Univ. *Mem:* Sigma Xi; Am Phys Soc; AAAS. *Res:* Relativistic electron beams. *Mailing Add:* 905 Bentley Heath Common Virginia Beach VA 23452
- COX, JAMES REED, JR**, b Nashville, Tenn, Mar 25, 32. ORGANIC CHEMISTRY. *Educ:* Vanderbilt Univ, BA, 54, MA, 55; Harvard Univ, PhD(chem), 59. *Prof Exp:* NSF fel chem, Univ Munich, 58-59; from asst prof to assoc prof, Ga Inst Technol, 59-66; ASSOC PROF CHEM, UNIV HOUSTON, 66- *Mem:* Am Chem Soc. *Res:* Structure-reactivity relationships; mechanisms of reaction of organic and bio-organic chemical systems. *Mailing Add:* Dept of Chem Univ of Houston Houston TX 77004
- COX, JEROME R(OCKHOLD), JR**, b Washington, DC, May 24, 25; m 51; c 3. ELECTRICAL ENGINEERING. *Educ:* Mass Inst Technol, BS, 47, MS, 49, ScD(elec eng), 54. *Prof Exp:* Asst, Acoust Lab, Mass Inst Technol, 48-52; acoust engr, Liberty Mutual Life Ins Co, 52-55; from asst prof to assoc prof, 55-61, dir, Biomed Comput Lab, 64-75, PROF ELEC ENG, WASH UNIV, 61-, CHMN & PROF, DEPT COMPUT SCI, 75- *Concurrent Pos:* Res assoc, Cent Inst Deaf, 55-64; Nat Adv Res Resources Comt, NIH, 65-69; chmn comput labs, Wash Univ, 67-; co-chmn, Comput Cardiol Int Conf, 74-; pres, Biomed Res Panel, 75-76; cardiol adv comt, Nat Heart & Lung Inst, 75-78; chmn, Nat Inst Gen Med Sci Panel, 77-78, Div Comp Res & Technol Review Comt, 83-84; prophet adv panel, NIH, 83-88. *Mem:* sr mem, Inst Med of Nat Acad Sci; fel Acoust Soc Am; fel Inst Elec & Electronics Engrs; Asn Comput Mach. *Res:* Computer design; biomedical engineering; statistical communication theory; acoustics; medical imaging; computer networking. *Mailing Add:* Dept Comput Sci Box 1045 Washington Univ St Louis MO 63130
- COX, JOHN DAVID**, b San Juan, Puerto Rico, Oct 5, 54; US citizen; m 80; c 2. ENGINEERING PHYSICS, IMAGING SYSTEMS. *Educ:* Univ Fla, BS, 78, ME, 79, PhD(eng physics), 82. *Prof Exp:* Res engr, RTS Labs, Inc, 81-85; CHMN, FUTURETECH INDUST, INC, 85-; VPRES ENG, GEN IMAGING SYSTS, 85- *Concurrent Pos:* Res scientist, nuclear eng dept, Univ Fla, 80- *Honors & Awards:* Tech Achievement Award, NASA, 84. *Mem:* Inst Elec & Electronic Engrs; Am Nuclear Soc; Am Soc Non-destructive Testing; Soc Photo-optical Instrumentation Engrs. *Res:* Solid-state x-ray imaging sensors and imaging systems. *Mailing Add:* PO Box 13455 Gainesville FL 32604
- COX, JOHN E(DWARD)**, b Danville, Ill, Mar 28, 23; m 56; c 2. CERAMIC ENGINEERING. *Educ:* Univ Ill, BS, 50, MS, 51, PhD(eng), 53; Univ Hartford, BS, 68. *Prof Exp:* Res engr, NJ Zinc Co, 53-54; res fel, Mellon Inst, 54-60; dir res & develop, O Hommel Co, 60-62; sr res scientist, United Aircraft Corp, 62-68; dir res, Ceramic Dept, R T Vanderbilt Co, 68-73; midwest mgr, O Hommel Co, 73-75, mat mgr, 75-78; mgr coatings, Alpha Metals, 78-81; SPEC PROJ MGR, O HOMMEL CO, 81- *Mem:* Am Ceramic Soc; Am Soc Testing & Mat. *Res:* Porcelain enamel, glass and related ceramic materials; metal fibers. *Mailing Add:* 1500 Cochran Rd Unit 403 Pittsburgh PA 15243
- COX, JOHN JAY, JR**, b Pa, Apr 1, 29; m 53; c 2. METALLURGY. *Educ:* Carnegie Inst Technol, MS & ScD, 53. *Prof Exp:* Res supvr mat tech, Eng Dept, 53-64, res supvr chlorine prod sect, 64-66, develop mgr electronic prod, 66-70, mgr electronic packaging, 70-74, tech mgr, 74-78, prod mkt mgr, 78-81, dir sales, electronics prod dept, E I Dupont De Nemours & Co, Inc, 81-84; CONSULT, 86- *Concurrent Pos:* vpres, Opers Semiconductor res cord, 84-86. *Mem:* Sigma Xi; Am Inst Mining, Metall & Petrol Engrs; Int Soc Hybrid Microelectronics; Am Soc of Metal; Inst Elec & Electronics Engrs; Int Electronic Packaging Soc. *Res:* Physical metallurgy; phase equilibria; precipitation from solids; x-ray diffractions; alloy development; electron microscopy; structure of crystalline polymers; thick film electronic materials. *Mailing Add:* Seven Tilbury Ct Chapel Hill NC 27514
- COX, JOHN LAYTON**, b Pendleton, Ore, Dec 30, 43; m 66; c 2. INORGANIC CHEMISTRY, PHYSICAL CHEMISTRY. *Educ:* Eastern Ore State Col, BS, 66; Univ Wyo, PhD(chem), 71. *Prof Exp:* Res scientist coal gasification, Natural Resources Res Inst, Univ Wyo, 71-72, dept mineral eng, 72-73; sr res engr fossil fuels, Battelle Northwest Labs, Battelle Mem Inst, 74-78; mgt basic res, Gas Res Inst, 78-85; PRES, SEPARATIONS TECHNOL ASSOCS, INC, 85- *Mem:* Am Chem Soc; Sigma Xi. *Res:* Synthetic fuels from fossil fuels; kinetics and catalysis; gas separations. *Mailing Add:* N 7625 Howard Spokane WA 99208
- COX, JOHN PAUL**, b Ft Myers, Fla, Nov 4, 26. THEORETICAL ASTROPHYSICS. *Educ:* Ind Univ, AB, 49, MS, 50, PhD(theoret astrophys), 54. *Prof Exp:* Asst, Ind Univ, 49-54; from instr to asst prof astron, Cornell Univ, 54-62; vis scientist, Courant Inst Math Sci, NY Univ, 62-63; vis fel, Joint Inst Lab Astrophys, 63, assoc prof, 63-65, PROF ASTROPHYS, UNIV COLO, BOULDER, 65- *Concurrent Pos:* Cotterell res grant, 56; consult, Smithsonian Astrophys Observ, Cambridge, Mass, 57, 59 & 60; asst engr, Pratt & Whitney Aircraft Corp, Conn, 58; consult, Los Alamos Sci Lab, 60-; vis prof math, Monash Univ, Melbourne, 72; res lectr, Coun Res & Creative Work, Univ Colo, 80. *Mem:* Int Astron Union; Sigma Xi; Am Astron Soc; Am Phys Soc; NY Acad Sci. *Res:* Theory of stellar variability; stellar interiors and evolution. *Mailing Add:* Astro Geophys Jila A850 Univ of Colo Boulder CO 80309
- COX, JOHN THEODORE**, b Airborn, Ohio, June 27, 50. PROBABILITY THEORY, INTERATING PARTICLE SYSTEMS. *Educ:* Harvey Mudd Col, BS, 72; Cornell Univ, MS, 75, PhD(math), 76. *Prof Exp:* Asst prof math, Ga Tech, 76-77; asst prof, Univ Southern Calif, 77-79; from asst prof to assoc prof, 79-86, PROF MATH, SYRACUSE UNIV, 86- *Concurrent Pos:* Vis prof math, Cornell Univ, 87-88. *Mem:* Am Math Soc; Inst Math Statist. *Mailing Add:* Dept Math Syracuse Univ Syracuse NY 13244-1150
- COX, JOHN THOMAS**, physics, materials science, for more information see previous edition
- COX, JOHN WILLIAM**, b St Louis, Mo, Aug 31, 28; m 50; c 1. MEDICAL EDUCATION, CARDIOLOGY. *Educ:* St Louis Univ, MD, 51, PhD(physiol), 53; Am Bd Internal Med, dipl. *Prof Exp:* Chief res, Labs, Vet Admin Hosp, St Louis, 53-54; US Navy, 54-, chief cardiopulmonary lab, Dept Internal Med, US Naval Hosp, San Diego, 54-56, resident internal med, 56-59, staff supvr, Dept Internal Med, US Naval Hosp, San Diego, 59-61, chief med & dir clin serv, US Naval Hosp, Subic Bay, Philippines, 61-63, head cardio-respiratory dis br, US Naval Hosp, Philadelphia, 63-65, chief med & dir res, 65-69, head training & clin serv br, 69-72, dir med educ & training, Navy Dept, 72-77, cmdng officer, Naval Health Sci Educ & Training Command, 75-77, asst chief, Bur Med & Surg, 77-78, cmdng officer, Naval Regional Med Ctr, San Diego, 78-80, cmdng officer, Naval Health Sci Educ & Training Command, 75-78, cmdg officer, Naval Regional Med Ctr, 78-80, Surgeon Gen of the Navy, 80-83; assoc dir Grad Sch Pub Health, San Diego, 83-86; DIR HEALTH SERV, SAN DIEGO COUNTY, 87- *Concurrent Pos:* Assoc prof med, Jefferson Med Col, 64-72; Navy deleg, House Deleg Am Med Asn, 72-84. *Honors & Awards:* Borden Award Med Res, 51. *Mem:* Fel Am Col Physicians; Am Col Chest Physicians; Am Col Cardiol (treas, 74-79); Am Heart Asn; Asn Mil Surg US. *Res:* Clinical investigations; cardiopulmonary physiology. *Mailing Add:* 5929 Del Cerro Blvd San Diego CA 08854
- COX, JOSEPH ROBERT**, b Lafayette, Ind, Mar 15, 34; m 56; c 3. PHYSICS. *Educ:* Harvard Univ, BA, 56; Ind Univ, MS, 57, PhD(physics), 62. *Prof Exp:* Asst prof physics, Univ Miami, 62-64; from asst prof to assoc prof, 64-76, PROF PHYSICS, FLA ATLANTIC UNIV, 76- *Concurrent Pos:* Res assoc, Yale Univ, 67-68. *Mem:* Am Phys Soc. *Res:* Scattering theory. *Mailing Add:* 1601 NW 7th St Boca Raton FL 33432

- AMANN, RUPERT PREYNOESSL**, b Boston, Mass, Dec 27, 31; m 63; c 2. **REPRODUCTIVE PHYSIOLOGY**. Educ: Univ Maine, BS, 53; Pa State Univ, MS, 57, PhD(dairy sci), 61. Prof Exp: Asst reprod physiol, Pa State Univ, 55-61, res assoc, 61-62; NIH res fel, Royal Vet & Agr Col, Denmark, 62-63; from asst prof to prof dairy physiol, Pa State Univ, 63-79; **PROF PHYSIOL**, **COLO STATE UNIV**, 79- **Concurrent Pos**: Vis prof, Dept Physiol Biophys, Colo State Univ, 75-76. **Honors & Awards**: Physiol & Endocrinol Award, Am Soc Animal Sci, 79; Res Award, Nat Asn Animal Breeders, 82; Physiol Award, Am Dairy Sci Asn, 84. **Mem**: AAAS; Am Dairy Sci Asn; Am Soc Animal Sci; Soc Study Reprod (dir, 67-69); Brit Soc Study Fert; Am Soc Andrology (dir, 77-80, secy, 83-86, pres, 89-90). **Res**: Male reproductive physiology; testicular and epididymal physiology; spermatogenesis; spermatozoan maturation; semen physiology; reproductive capacity and sexual behavior of the male. **Mailing Add**: Animal Reproduction Lab Colo State Univ Ft Collins CO 80523
- AMARA, ROY C.**, b Boston, Mass, Apr 7, 25; m 49; c 3. **SYSTEMS SCIENCE, POLICY RESEARCH**. Educ: Mass Inst Technol, BS, 48; Harvard Univ, AM, 49; Stanford Univ, PhD(elec eng), 58. Prof Exp: Jr res engr control systs, Stanford Res Inst, 52-53, res engr digital comput, 53-55, sr res engr systs eng, 55-61, mgr systs eng, 61-64, asst to pres, 63, exec dir systs sci, 64-68, vpres inst progs, 68-69; exec vpres, 70-71, **PRES, INST FOR FUTURE**, 71- **Concurrent Pos**: US deleg, First Int Fedn Automatic Control, Moscow. **Mem**: AAAS; Inst Elec & Electronics Engrs; Inst Mgt Sci; Opers Res Soc Am. **Res**: Information systems; communication networks; technology assessment; methodologies for long range planning; decision analysis; private-public sector interfaces; future of the city; corporate planning. **Mailing Add**: 491 La Mesa Dr Menlo Park CA 94025
- AMAREL, S(AUL)**, b Saloniki, Greece, Feb 16, 28; nat US; m 53; c 2. **COMPUTER SCIENCE**. Educ: Israel Inst Technol, BS, 48, IngEE, 49; Columbia Univ, MS, 53, DEngSc, 55. Prof Exp: Res engr, Sci Dept, Israeli Ministry of Defense, 48-52 & 55-57; res engr, Electronics Res Labs, Columbia Univ, 53-55; head comput theory res, RCA Labs, 57-69; dir, Rutgers Res Resource Comput Biomed, 71-83, info sci & technol off, Defense Advan Res Proj Agency, 85-87, **ALAN M TURING PROF COMPUT SCI, RUTGERS UNIV**, 87- **Concurrent Pos**: Comt mem, Int Joint Artificial Intel Conf, 81-, gen chmn, 83; trustee, Ramapo Col NJ, 69-73; mem chem/bio info handling rev comt, Nat Inst Health, 71-75, mem exec & adv comt, SUMEX-AIM, 74-; dir, Rutgers Res Resource Comput in Biomed, 71-; vis scholar, Stanford Univ, 79, vis sr res scientist, Carnegie Mellon Univ, 85, vis res fel, SRI Intern, 83. **Mem**: Fel AAAS; Asn Comput Mach; Soc Indust & Appl Math; Sigma Xi; fel Inst Elec & Electronic Engrs; Am Asn Artificial Intel. **Res**: Artificial intelligence; computer linguistics; theory of algorithms; applications of artificial intelligence to medicine, science and engineering. **Mailing Add**: Dept Comput Sci Busch Campus Rutgers Univ New Brunswick NJ 08903
- AMAROSE, ANTHONY PHILIP**, b Oneonta, NY, Mar 17, 32. **BIOLOGY, CYTOLOGY**. Educ: Fordham Univ, BS, 53, MS, 57, PhD(cytol), 59. Prof Exp: Asst biol, Fordham Univ, 56-57; instr, Marymount Col, NY, 57-59; resident res assoc, Argonne Nat Lab, 59-61; res assoc radiobiol, Cancer Res Inst, New Eng Deaconess Hosp, Boston, 61-62; asst prof cytogenetics & lectr path, Albany Med Col, 63-66, res assoc prof, 66-67; asst prof, 67-71, **ASSOC PROF OBSTET & GYNEC, CHICAGO LYING-IN HOSP, UNIV CHICAGO**, 71- **DIR, CYTOGENETICS LAB**, 77- **Concurrent Pos**: Fel gen path, Harvard Med Sch, 61; personal consult to Shields Warren, MD, Cancer Res Inst, Mass, 62-67; abstractor, Excerpta Medica Found, 63-; consult, Albany Med Ctr Hosp, 63-67 & Inst Defense Anal, Arlington, VA, 65-67; hon trustee Charles A Berger Scholar Fund, Fordham Univ, 66-; mem int ed bd, Excerpta Medica Found, 73- **Mem**: AAAS; Am Soc Cell Biol; Am Inst Biol Sci; Environ Mutagen Soc; Am Soc Human Genetics; Sigma Xi. **Res**: Pharmacogenetics, radiation cytology; prediction of fetal sex; chromosomology; human bone marrow; cytogenetics of animal test model system in drug testing. **Mailing Add**: Dept of Obstet & Gynec Chicago Lying-In Hosp Chicago IL 60637
- AMASSIAN, VAHE EUGENE**, b Paris, France, Nov 11, 24; nat US; m 56; c 1. **NEUROPHYSIOLOGY**. Educ: Cambridge Univ, BA, 46, MB, 48. Prof Exp: House physician, Middlesex Hosp, London, 48-49; from instr to assoc prof physiol, Sch Med, Univ Wash, 49-55; prof, Albert Einstein Col Med, 57-72; **PROF PHYSIOL & CHMN DEPT, STATE UNIV NY DOWNSTATE MED CTR**, 72- **Concurrent Pos**: Markle Found scholar, 52-59; mem postgrad training comt, USPHS, 59-63. **Mem**: Am Physiol Soc. **Res**: Neurophysiology of cerebral cortex; brainstem and sensory systems. **Mailing Add**: Dept of Physiol State Univ NY Downstate Med Ctr Brooklyn NY 11203
- AMATA, CHARLES DAVID**, b Agata, Italy, Feb 11, 41; US citizen; m 61; c 3. **PHYSICAL CHEMISTRY**. Educ: John Carroll Univ, BS, 64; Univ Notre Dame, PhD(chem), 68. Prof Exp: Res asst chem, Parma Tech Ctr, Union Carbide Corp, 60-64, res scientist, Carbon Prod Div, 67-71; sr res scientist, Addressograph-Multigraph Corp, 71-74; mgr corp res, 74-80, tech dir, Plastics Div, 80-83, VPRES, **CONWED PLASTICS CORP**, 83- **Mem**: Am Chem Soc; Soc Plastics Engrs. **Res**: Molecular luminescence and energy transfer; thermal degradation of polymeric systems; organic photoconductors; high temperature inorganic fibers; composites; specialty plastics. **Mailing Add**: 770 29th Ave S E Minneapolis MN 55414
- AMATO, R STEPHEN S.**, b Brooklyn, NY, July 11, 36; m 83; c 3. **HUMAN GENETICS, PEDIATRICS**. Educ: Manhattan Col, BS, 53; Columbia Univ, MA, 59; NY Univ, PhD(genetics), 68; Univ Nehr, MD, 73. Prof Exp: Instr basic sci, St Johns Riverside Hosp, Yonkers, NY, 60-63; asst prof biol, State Univ NY Westchester, 63-65; asst genetics, NY Univ & Beth Israel Med Ctr, 65-67; asst geneticist, Div Lab, Beth Israel Med Ctr, 68; asst prof human genetics, Univ Nehr Med Ctr, Omaha, 68-72, instr pediat & anat, 72-76, dir lab med & molecular genes, 76-76, med geneticist, Muscular Dystrophy Clin, 74-76 from assoc prof to prof pediat, Med Ctr, WVA Univ, 76-86, dir med genetics, 76-86, **CLIN PROF PEDIAT, GREATER BALTIMORE MED CTR**, 86-, **CLIN PROF PEDIAT, UNIV MD**, 86- **Concurrent Pos**: Lectr pediat, Johns Hopkins Univ, 86- **Mem**: Am Soc Human Genetics; Am Soc Cell Biol; Am Genetics Soc; Pub Health Asn. **Res**: Chromosome structure and function; cell cycle and nucleic acid synthesis; slow virus infections and the central nervous system; genetic counseling and delivery of genetics and pediatrics services. **Mailing Add**: Greater Baltimore Medical Ctr 6701 N Charles St Baltimore MD 21204
- AMATO, VINCENT ALFRED**, b New York, NY, July 20, 15; m 43. **PLANT PATHOLOGY, HORTICULTURE**. Educ: Mich State Univ, BS, 54, MS, 55; Tex A&M Univ, PhD(plant path), 64. Prof Exp: Res instr hort, Mich State Univ, 54-56; asst exten horticulturist, WVA Univ, 56-57; instr floricult, Tex A&M Univ, 59-60 & plant path, 60-64, res asst plant physiol & microtech, 64; from asst prof to assoc prof, 64-73, **PROF HORT, SAM HOUSTON STATE UNIV**, 73- **Mem**: Am Phytopath Soc; Am Soc Hort Sci. **Res**: Horticultural crops; microtechniques; pathological and physiological plant parasitism. **Mailing Add**: Dept Agr Sam Houston State Univ Huntsville TX 77341
- AMAZEEN, PAUL GERARD**, b Portsmouth, NH, Mar 24, 39; m 61; c 1. **ELECTRICAL ENGINEERING**. Educ: Univ NH, BS, 61; Worcester Polytech Inst, MS, 64, PhD(elec eng), 71. Prof Exp: Res assoc physics, Univ NH, 61-62; instr elec eng, Worcester Polytech Inst, 64-70; chief engr, Vitacomp, Inc, 70-72; prog mgr, Raytheon Med Electronics, 72-74; opers mgr, Rohe Sci Corp, 74-76; **ENG MGR, FOLSOM OPER, GEN ELEC CO**, 76- **Concurrent Pos**: Partner, United Eng Consult, 67- **Mem**: Inst Elec & Electronics Engrs; Am Inst Ultrasound Med; Sigma Xi; Am Soc Echocardiography. **Res**: Communication-information theory; signal processing, especially in biomedical situations such as processing of ultrasound echo signals. **Mailing Add**: 27195 Via Aurora Mission Viejo CA 92691-2161
- AMBEGAOKAR, VINAY**, b Nagpur, India, Jan. 16, 34; m 56; c 2. **SOLID STATE PHYSICS, THEORETICAL PHYSICS**. Educ: Mass Inst Technol, MS & SB, 56; Carnegie Inst Technol, PhD(physics), 60. Prof Exp: Res assoc physics, Niels Bohr Inst, Copenhagen, 60-62; from asst prof to assoc prof, 62-68, **PROF PHYSICS, CORNELL UNIV**, 68- **Concurrent Pos**: Dir, Inst Theoret Physics, Univ Helsinki, Finland, 69-71; vis scientist, IBM Watson Res Lab, 76-77; Guggenheim fel, Univ Calif, Santa Barbara, 83-84. **Mem**: Fel Am Phys Soc. **Res**: Theory of condensed matter physics; superconducting tunnel junctions; equilibrium and transport properties of superconductors; superfluid helium 3 and superfluid helium 4 films; properties of semiconductors and disordered systems. **Mailing Add**: Cornell Univ Clark Hall 514 A Ithaca NY 14853
- AMBELANG, JOSEPH CARLYLE**, b Bellevue, Ohio, Nov 7, 14; m 48; c 2. **ORGANIC CHEMISTRY, RUBBER CHEMISTRY**. Educ: Univ Akron, BS, 35; Yale Univ, PhD(chem), 38. Prof Exp: Asst chem, Yale Univ, 38-40; instr, D'Youville Col, 40-42; res chemist, Firestone Tire & Rubber Co, 42-56; sr compounder, Goodyear Tire & Rubber Co, 56-61, prin compounder, 61-83, res & develop assoc, 83-84; **CONSULT**, 84- **Honors & Awards**: Dinsmore Award, 61. **Mem**: Am Chem Soc; Am Soc Testing Mat. **Res**: Pyrimidines; synthesis and catalytic hydrogenation; rubber chemistry; softeners; tackifiers; age-resistors; textile treating; antiozonants; curing agents; vulcanization; heat flow; analysis of test data. **Mailing Add**: 366 Dorchester Rd Akron OH 44320
- AMBERG, CARL HELMUT**, chemistry, for more information see previous edition
- AMBERG, HERMAN R(OBERT)**, b Germany, Feb 10, 20; nat US; m 47; c 3. **SANITARY & CHEMICAL ENGINEERING**. Educ: Syracuse Univ, BS, 43; Rutgers Univ, MS, 49, PhD(sanit eng), 51. Prof Exp: Res engr, Johns-Manville Res Ctr, 46-48 & Eng Exp Sta, Ore State Col, 51-56; proj leader cent res dept, Crown Zellerbach Corp, 56-61, mgr chem & biol res, 61-71, dir environ serv, Cent Res Div, 71-85; **RETIRED**. **Mem**: AAAS; Am Chem Soc; Am Tech Asn Pulp & Paper Indust; Water Pollution Control Fedn; Am Soc Civil Engrs. **Res**: Chemical and sanitary engineering research on industrial wastes from pulp and paper industry. **Mailing Add**: 2713 Balboa Dr Vancouver WA 98664-9182
- AMBLER, ERNEST**, b Bradford, Eng, Nov 20, 23; nat US; m 55; c 2. **CRYOGENICS, SCIENCE ADMINISTRATION**. Educ: Oxford Univ, BA, 44, MA & PhD(physics), 53. Prof Exp: Physicist, Metall Lab, Armstrong Siddeley Motors, Ltd, Eng, 44-48; physicist, Cryogenic Physics Sect, 53-65, head div inorg mat, 65-68, dir, Inst Basic Stand, 68-73, dep dir, 73-75, act dir, 75-78, **DIR, NAT BUR STANDARDS**, 78- **Concurrent Pos**: Guggenheim fel, 63; US Rep to Int Comt Weights & Measures, 72; chmn, Consult Comt Ionizing Radiation, 74; exofficio pres, Nat Conf Weights & Measures, 78; Dept Com mem bd gov, Israel/US Bi-Nat Indust Res & Develop Found, 81. **Honors & Awards**: Arthur S Flemming Award, 60; John Price Wetherill Medal, Franklin Inst, 62; Samuel Wesley Stratton Award, 64; William A Wildhack Award, 76; President's Award for Distinguished Fed Civilian Serv, 77. **Mem**: Am Phys Soc; fel AAAS. **Mailing Add**: A-1134 Admin Bldg Nat Bur Standards Gaithersburg MD 20899
- AMBLER, JOHN EDWARD**, b Bidwell, Ohio, Apr 5, 17; m 62; c 1. **PLANT NUTRITION**. Educ: Marshall Univ, BS, 52, MS, 53; Univ Md, PhD(plant physiol), 69. Prof Exp: plant physiologist, Stress Lab, USDA, 56-78; **RETIRED**. **Mem**: Soc Am Plant Physiologists; Am Soc Agron. **Res**: Effect of stress-nutrition, temperature, water, ultraviolet B light, on growth and development of food and fiber crops. **Mailing Add**: 28 Mantled Ave Hampton VA 23661-3443
- AMBLER, MICHAEL RAY**, b Wichita, Kans, Feb 20, 47; m 68; c 1. **POLYMER CHEMISTRY**. Educ: Wichita State Univ, BS, 68; Akron Univ, MS, 71, PhD(polymer sci), 75. Prof Exp: Develop engr, 68-75, proj leader, 75-77, sect mgr, 77-87, **DEPT MGR, GOODYEAR TIRE & RUBBER CO**, 87- **Mem**: Am Chem Soc; AAAS. **Res**: Polymer characterization; polymer rheology; physical chemistry of colloidal and macromolecular species; analytical chemistry; spectroscopy; emulsion polymerization; structure property relationships; process engineering. **Mailing Add**: 28 Mantled Ave Hampton VA 23661-3443

THE WHITE HOUSE
WASHINGTON

May 9, 1991

MEMORANDUM FOR JOHN McTAGUE

FROM: D. ALLAN BROMLEY *Alan*
SUBJECT: TERMS OF REFERENCE FOR THE PCAST PANEL ON
MEGAPROJECTS IN THE SCIENCES

You are requested to establish a PCAST Panel on Megaprojects in the Sciences.

The purpose of the Panel is to develop information and policy options to provide a base for PCAST advice to the President on national and international policy issues related to the planning, financing and organization of large scale projects in the sciences, otherwise known as megaprojects.

Megaprojects in the sciences are unique in character and are so costly that it is becoming increasingly difficult for one country to fully finance them. Even when the burden of costs is borne by one country, the benefits are often shared by many nations. They require long lead time for planning and construction. They affect scientists in many nations, either via distributed research projects or widespread use of central facilities. Thus, they are inherently international in nature even when totally financed by one country.

This topic is particularly timely. Its importance was discussed recently at the Informal Meeting of Science Advisors To Heads of Government at Mount Kisco, New York and at the first meeting of the US-European Commission (EC) Joint Consultative Group in Washington in February, when it was agreed to establish a US-EC task group to discuss megaprojects in preparation for the Spring 1992 Organisation for Economic Co-operation and Development (OECD) Ministerial Meeting, at which megaprojects will be a major topic.

PCAST advice is also important because of increased pressures on funding for individual principal investigators in the face of constrained budgets. Thus, escalating costs of scientific instrumentation and facilities, coupled with these budgetary constraints, point to a need to consider international cooperation in funding megaprojects.

A subcommittee of the Committee on International Science, Engineering and Technology (CISSET) of the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) is currently examining this issue. It is expected that the

PCAST panel will utilize studies prepared for the CISET deliberations on megaprojects.

The Panel on Megaprojects in the Sciences shall:

- 1. Address the relative roles of megaprojects and smaller investigator-initiated science projects.**
- 2. Characterize the role of the scientific community in terms of the proposal and planning of megaprojects.**
- 3. Advise on an appropriate approach to the planning and coordination of such projects domestically. This might include identification of lead agency responsibilities and consideration of whether megaprojects should be handled all together or considered individually.**
- 4. Advise whether a comprehensive international framework for coordination and cooperation is desirable, and how countries could cooperate to ensure that the cost and benefits of big science projects are shared equitably.**
- 5. Suggest the most appropriate international fora, governmental and scientific, in which such cooperation could be further discussed and coordinated (for example, OECD, United Nations, International Council of Science Unions (ICSU), and/or the group of seven economic summit countries (G-7)). The US is currently developing a position regarding megaprojects for the Spring 1992 OECD Ministerial Meeting.**
- 6. Examine mechanisms and criteria for country participation. How can country participation in planning and organization be ensured without jeopardizing the design and organization of the projects? Some observations of successful and unsuccessful administrative/executive arrangements relating to past or current international megaprojects would be useful.**
- 7. Consider ways to increase continuity of commitment and sustained life-of-project funding by the United States. Many countries are reluctant to cooperate with the United States on large scale projects due to U.S. difficulties in ensuring funding over a long term, even after we have a Presidential commitment. Consideration of highly credible arrangements, such as treaties would be examined.**

The Panel will be established on a temporary basis and will complete its charge in six to nine months. In addition to providing the advice on the specific items listed above, the Panel will serve as a sounding board on related topics/issues in the interim and possibly after its charge is complete.

The Panel will submit a preliminary report to PCAST within three months after the Panel's first meeting.

The Office of the Associate Director for Policy and International Affairs, Office of Science and Technology Policy will sponsor the Panel. Dr. John McTague will serve as Chairman of the Panel and Dr. Harold Shapiro will serve as Vice Chairman.

Determination

I hereby determine that the formation of the PCAST Panel on Megaprojects in the Sciences is in the public interest in connection with the performance of duties imposed on the Executive Branch by law, and that such duties can best be performed through the advice and counsel of such a group.

The Terms of Reference for the PCAST panel on Megaprojects in the Sciences include no assignment requiring Panel members to participate personally and substantially in the conduct of any specific procurement, or place any member in the position of acting as a "procurement official."

Approved:



D. Allan Bromley
The Assistant to the President
for
Science and Technology

May 9, 1991
Date