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CARNEGIE COMMISSION
ON SCIENCE, TECHNOLOGY, AND GOVERNMENT

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TO: Commissioners, Advisory Council members, consultants, friends of the Commission

FROM: David Z. Robinson David Robinson

DATE: March 1, 1995

SUBJECT: Update on Commission activities

A number of exciting developments have occurred in the six months since my last report. Many people involved with the Commission are still actively promoting the ideas, and a few who moved to government are still involved in issues that concerned them when they were contributing to the Commission. Institutional innovation in the congressional, judicial, and states programs will have significant long term effects.

It is too early to determine the effect of the 1994 election changes on science and technology programs. The programs most at risk are those involving commercial technology and environmental regulation. The important role of government in support of basic research is strongly supported by House members on both sides of the aisle. Major changes in the way that Congress itself operates may have substantial impact on programs involving science and technology.

Congress

1. Carrying out one of the major recommendations of the Commission, the American Association for the Advancement of Science (AAAS) has established the AAAS Center for Science, Technology, and Congress. The Center will have a 10-person advisory board co-chaired by **John Brademas** and **Bill Green**. The Center was funded with a two year grant from Carnegie Corporation. **Bonnie Bisol Cassidy**, former director of the Washington office of the Commission, will be staffing the center under the direction of Albert Teich. The press release announcing the establishment of the center is attached (Item A-1).

2. **Bill Golden** and **Joshua Lederberg** wrote a letter to Speaker Gingrich in February calling attention to the Commission report dealing with OTA in reaction to reports that the Republican majority was considering abolishing the agency. A copy of their letter is attached (A-2).

Judiciary

1. The Federal Judicial Center (FJC) published its *Reference Manual on Scientific Evidence* in January 1995. Prepublication copies were discussed at a meeting with federal judges in December. The final version was released at a second meeting for about 55 federal judges in San Francisco on January 23-24. The publicity over the section of the manual on admissibility of evidence prepared by **Margaret Berger** (who also drafted the Commission's *amicus* brief to the Supreme Court in the *Daubert* case), far from calling the manual's utility into question, apparently merely served to whet the appetite of potential readers. The manual is a tremendous success. In addition to the distribution to about 5,000 federal judges and staff, eight private publishers are reprinting it. (The FJC did not copyright the manual; in fact, copies of the publisher's disks were given to anyone who wanted to reprint it.) The FJC says that 20,000 copies are now in print, and 100,000 copies will probably be distributed by the end of the year! Attached are copies of stories about the manual, and a copy of the very warm and gracious letter from Judge William Schwarzer, director of the center, to **Helene Kaplan**, chair of the Commission's Task Force on Judicial and Regulatory Decision Making (A-3, A-4).

2. **Gil Omenn**, a member of the task force, wrote an interesting article in the September issue *Environmental Health Perspectives*, entitled *Enhancing the Role of the Scientific Expert Witness*. A copy is attached (A-5).

States

1. **Dick Celeste** (Task Force Chair) and **Dick Thornburgh** (Advisory Council) are continuing to strengthen the role of the State–Federal Technology Partnership which they established in 1993. The Commission and the American Society of Mechanical Engineers cosponsored a symposium on the Partnership in Washington on January 26. Two hundred and seventy people attended, and speakers came representing Congress, the Executive Branch, and the states. At the meeting, which Thornburgh chaired, Jack Gibbons endorsed the concept of the Partnership, and announced that he was asking Celeste and Thornburgh to establish a task force to make recommendations about what the Administration needs to do to enable the states to be more involved in decisions affecting federal technology policy. **Chris Coburn** will be helping to establish the task force. Other speakers at the meeting included Governor Howard Dean of Vermont (Chair of the National Governors' Association), who promised NGA cooperation with the task force, and Representatives Constance Morella (R-Md) and George Brown (D-CA). The symposium received wide coverage. The best review, by Wil Lepkowski of *Chemical & Engineering News*, is attached (A-6).

2. The final version of *Partnerships: A Compendium of State and Federal Cooperative Technology Programs* was released at the January 26 symposium, and was very well received. This 641-page document is a first-ever comprehensive profiling and analysis of these programs.

The material was put together under the leadership of Chris Coburn. The foreword by Dick Celeste and Dick Thornburgh discusses the need for a better federal-state partnership. Vice President Al Gore contributed a prologue expressing strong White House support for an enhanced partnership. **Jeannette Aspden** of the Commission staff edited and supervised the publication of the book, which was published by Battelle Press.

3. Dick Thornburgh was the main speaker at a December 7 meeting in Vermont on state technology programs. The meeting, sponsored by the University of Vermont, was aimed at developing state technology strategies.

Linking S&T to Societal Goals

The National Academy complex submitted a proposal to Carnegie Corporation, which, if funded, would support the establishment of two panels to review aspects of national goals in S&T. This experiment follows the recommendations of the Task Force on Establishing and Achieving Long-Term S&T Goals, chaired by **Guy Stever**.

S&T and the President

1. The first meeting of the new PCAST (President's Committee of Advisors on Science and Technology), whose members include **David Hamburg** and **Norman Augustine**, took place October 25-26 in Washington. President Clinton, who had planned to meet with the group, had to go to the Middle East to oversee the signing of the Israel/Jordan Peace Treaty. The group met instead with Vice President Gore. A review of the meeting from *Physics Today* is attached (A-7).

2. The "Carnegie Group"—which consists of the science advisors of the G-7, Russia, and the European Community—held its eighth semi-annual meeting in December near Brussels, hosted by the European Community. **Bill Golden,** whose idea it was to convene the group, continues to attend the opening dinner. Following another idea of Bill's, the December meeting of the group was preceded by a meeting of the present members with previous members where Allan Bromley gave a lecture on the history of the Carnegie Group.

3. In June 1994, Jack Gibbons, Director of OSTP, asked the Commission to prepare a report on international cooperation in big science projects and programs for the December Carnegie Group meeting. **David Beckler** and **David Robinson** prepared the report, which was reviewed by selected Commissioners and Advisory Council members and given to Gibbons in time for the Carnegie Group December meeting. A copy of the report is attached (A-8).

Defense

The Clinton Administration has introduced legislation that would reform the procurement system, emphasizing the use of commercial technology. Not surprisingly, these changes are in line with the goals of the Commission report drafted by Commissioner **William Perry** and Advisory Council member **Ashton Carter** before they went to the Department of Defense. A December 1994 report to Perry (by TASC and Coopers & Lybrand) on the DoD regulatory cost premium cited the Commission's report.

Environment

Jesse Ausubel now serves on the Executive Committee of EPA's Science Advisory Board. He reports that the Commission's work on environmental R&D, risk, and international cooperation have all penetrated the agency. Indeed, the EPA has accepted the organizational concept for its national labs that was proposed by the Commission (A-9).

General Information

1. **Joshua Lederberg** and **Jesse Ausubel** continue to work on their volume on science and American democracy, which will address themes and tensions that underlay the Commission's work. Ausubel reports that he is thinking hard about the new populism dominating legislative politics in relation to the kinds of structural recommendations supported by the Commission.

2. We average 400 requests a month for reports through regular channels. In addition, we have received requests for 1495 reports through the catalogue of the New York Academy of Sciences. Report distribution continues to be handled very ably by **Dolores Locascio, Louis Minakakis**, and **Adrian Evertsz**, who assist me at the Madison Avenue Office.

3. CCSTG - The Next Generation. **Robert Aspden**, age 12 (standing at far left in the back row of attached photograph), was the youngest member of the 1994 New Jersey state champion *New York Times* Knowledge Bowl Team. He ascribes his success to the Commission's influence, which is strong in the Aspden household (A-10).

Attachments

A-1	AAAS Press Release
A-2	Gingrich Letter
A-3	Articles about *Reference Manual on Scientific Evidence*
A-4	Judge Schwarzer Letter
A-5	Gil Omenn Article
A-6	Article about State–Federal Symposium
A-7	Review of PCAST Meeting
A-8	Report on International Cooperation in Big Science Projects
A-9	AMS Newsletter
A-10	*NY Times* Knowledge Bowl Champions

N E W S F R O M

AAAS

A-1

American Association for the Advancement of Science, 1333 H Street, N.W., Washington, D.C. 20005

EMBARGOED FOR RELEASE
Sunday, February 12, 6 p.m.

For more information, contact:
Ellen Cooper, 202-326-6431

AAAS ANNOUNCES NEW CENTER FOR SCIENCE, TECHNOLOGY AND CONGRESS

WASHINGTON, DC -- The American Association for the Advancement of Science (AAAS) announced today the formation of the AAAS Center for Science, Technology, and Congress, a nonpartisan source of information on scientific and technological issues for members of Congress and their staffs.

The Center operates under the auspices of a 10-person advisory board co-chaired by former U.S. Representatives John Brademas (D-IN) and Bill Green (R-NY). A complete list of the board members is attached.

"As a former Member of Congress, I know how hard it can be on the Hill to obtain unbiased and timely information about science and technology issues," said Brademas, now president emeritus of New York University. "The Center will be a nongovernmental source to which Senators and Representatives of both political parties can turn."

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"The idea is not to be definitive, but to offer enough information about the pros and cons, and who the important players are, so that members of Congress and their staffs can educate themselves in an informed way," said Green, currently a corporate director in New York City.

The AAAS Center grew out of a two-year grant from the Carnegie Corporation of New York, whose Commission on Science, Technology, and Government launched in 1992 a newsletter called *Science & Technology in Congress.* In 1994, Carnegie transferred the newsletter to AAAS's Directorate for Science and Policy Programs, headed by Albert H. Teich.

"The Center dovetails perfectly with our other policy-related programs here at AAAS," said Teich. "It contributes to our mission to help members of Congress understand, in as objective a way as possible, the increasingly complex scientific and technological issues that come before them for debate." Each year, the AAAS Science and Policy program issues a report analyzing the Administration's proposed budget for R&D spending.

According to Teich, Center activities will include:

▸ ***Science & Technology in Congress***, a bulletin now appearing eight times a year — monthly when Congress is in session. In addition to articles on the status of major legislation and new reports and publications, the bulletin reports on science and technology issues currently before Congress. Presently, 1,700 persons (including 800 congressional staff members) receive the bulletin.

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▸ **Issue updates and special reports.** Updates will be one- to two-page documents covering late-breaking news related to science and technology. The special reports will cover specific topics in more detail than is possible in the bulletin.

▸ **Member and staff briefings.** For many years AAAS has conducted briefings for congressional staff members on such issues as the federal research and development budget and arms control. The Center will build on this tradition of bringing impartial and up-to-date information on scientific and technological issues to Congress.

▸ **Orientation programs.** These "mini-courses" in science policy will help familiarize new congressional staff members with issues in science and technology, and with sources of information. Currently, AAAS organizes a similar, widely acclaimed orientation program for each year's class of AAAS Congressional Science and Engineering Fellows, who work on the Capitol Hill for one year.

▸ **Special projects.** From time to time, the Center might undertake such projects as a seminar for scientists and engineers on the organization and workings of Congress, or the preparation of sourcebooks and other materials to assist congressional staff.

The Center's advisory board consists of the following individuals:

John Brademas (Co-chair), former Democratic House Majority Whip (D-IN) who served from 1959 until 1981. Brademas, president emeritus at New York University, served on the Carnegie Commission on Science, Technology, and Government and chaired its Committee on Congress, which originally recommended creating an institute such as the new AAAS Center.

Bill Green (Co-chair), former Representative (R-NY) who served from 1978 to 1993, including two terms as House chair of the Environmental and Energy Study Conference. While a Representative, Green was a member of the Carnegie Commission's Congressional Advisory Council.

Thomas W. Cole, Jr., the first president of Clark Atlanta University and an organic chemist.

Marye Anne Fox, chemistry professor and vice president for research at the University of Texas, vice chair of the National Science Foundation Board, and chair of the AAAS Section on Chemistry.

Jake Garn, former Senator from Utah and now vice chairman of Huntsman Chemical Corporation.

David A. Hodges, dean of the College of Engineering at the University of California, Berkeley.

Norman Ornstein, resident scholar at the American Enterprise Institute for Public Policy Research and a political contributor to the *MacNeil\Lehrer NewsHour*.

David Z. Robinson, senior counselor to the president at Carnegie Corporation of New York.

Torsten Nils Wiesel, president of The Rockefeller University and chair of the university's department of neurobiology.

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To schedule interviews with John Brademas, call 212-790-1350.
For interviews with Bill Green, call 212-755-6528.

CARNEGIE COMMISSION
ON SCIENCE, TECHNOLOGY, AND GOVERNMENT

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February 24, 1995

The Honorable Newt Gingrich
Office of the Speaker
U.S. House of Representatives
Washington, DC 20515

Dear Speaker Gingrich,

We are aware that Congress is reviewing the role of OTA, the Office of Technology Assessment. The Carnegie Commission on Science, Technology, and Government issued a report on the Congressional support agencies in 1991, and we are attaching a copy of that report in the hope that it will be useful to you and the Committee that is reviewing OTA.

In sum, we believe that as it deals with the challenges facing the country, Congress will confront more and more complex technical issues. Congress will need reliable technical advice to enable it to make the best decisions and to respond to technical initiatives from the Executive Branch. We believe that OTA can perform this valuable function, providing essential support to Congress, and we urge that the Congressional review take account of this and of the strong support that OTA has gathered from the technical and political communities, particularly in the past dozen years of its existence.

We will briefly review the process that produced the report to emphasize the involvement of many thoughtful individuals. We should also mention that one of the signers of this letter, Joshua Lederberg, has served as chair of OTA's Technology Assessment Advisory Council and therefore has had special experience with the agency. The other signer, William T. Golden, was heavily involved in the original decision to establish a science advisor in the Executive Office of the President.

In 1988, the Carnegie Commission established a Committee on Science, Technology, and Congress, chaired by Dr. John Brademas and including former Senators Mathias, Chiles, and Evans, former President Carter, and Dr. Guy Stever, Science Advisor to President Ford. In order to make the Commission reports more effective, Dr. Brademas established an advisory committee of 44 Senators and Representatives who met with him regularly to review reports and advise on issues that the Commission might address. Congress members Boehlert, Morella, and Walker were active members of the group. (The full list of members may be found on pp.7-8 of the report.) The draft report on the support agencies was reviewed by this advisory committee, and was modified as a result, before being brought to the Commission for approval. The Commission reviewed the document further, and with minor changes, endorsed its publication as a Commission report. We believe that this process ensured a constructive bipartisan report.

The Commission found that OTA performs a critical role in the development of science and technology policy, serving an essential analytic and advisory function for Congress. It also serves as an important reservoir of institutional memory for Congress. Nonetheless, the Commission recommended changes in the way that the OTA produces and delivers its reports, to make them more effective and timely. The Commission also recommended that the resources made available to OTA be commensurate with the demand for OTA's products. At that time we foresaw an increase in the demand and called for modest staff increases to meet it. If OTA's budget is to be reduced, we urge that there be ways to reduce the demand, so that the OTA can continue to provide essential high-quality advice to Congress. Even with a constrained budget, we continue to recommend the changes that would make OTA's reports more effective, and we do not believe that these changes should require significant funding increases.

Sincerely yours,

Joshua Lederberg

Joshua Lederberg

William T. Golden

William T. Golden

Enclosure: *Science, Technology, and Congress: Analysis and Advice from the Congressional Support Agencies*

THE WALL STREET JOURNAL

WEDNESDAY, DECEMBER 14, 1994

LEGAL BEAT

New Guide for Judges Tries To Clarify Scientific Issues

By JUNDA WOO
Staff Reporter of THE WALL STREET JOURNAL

Are judges sophisticated enough to handle complex scientific litigation?

The legal community has long debated whether juries made up of ordinary citizens can decipher antitrust, computer and patent law. But judges also increasingly need help with such issues. A new scientific primer, designed just for judges, is drawing attention to the problem.

"Many attorneys and judges are analytical-thinking types who did not do well in math and sciences and do not like it," says Franklin M. Zweig, president of the Einstein Institute for Science, Health & the Courts, a nonprofit think tank in Bethesda, Md. "That's not to disparage them—they'll tell you that themselves."

But it's getting harder for science-phobic judges to do their work. A Supreme Court ruling last year forced federal judges to scrutinize scientific evidence more closely, paying extra attention to methodology.

At the same time, expert witnesses have proliferated, and hard science pops up not only in high-technology and patent cases but even in lawsuits involving, say, alleged injury from environmental pollution.

Now the Federal Judicial Center, a research arm of the federal court system, is trying to come to the rescue with a 600-page primer on DNA testing, epidemiology, toxicology, statistics, surveys and economic damages. The primer, released to the press last week, will be mailed to all federal judges next year.

Without such guidelines, judges who are baffled by scientific evidence sometimes simply pass the buck and let a jury decide, critics say. Such judges also may allow lawyers to offer evidence to juries in ways that can't help but confuse. For instance, juries sometimes are presented with dueling expert witnesses who spout jargon. Without any way to tell who is right, jurors have been known to base decisions on a witness's attire.

Last year the prestigious Carnegie Commission on Science, Technology and Government, a program of the Carnegie Corp. grant-making foundation in New York, concluded that judges generally are successful at keeping so-called junk science out of courtrooms. But the commission recommended some sort of scientific education for judges like the new primer.

Other kinds of solutions have been offered. Court-appointed science specialists who advise judges or even oversee complex cases are being used more often. Such neutral experts have been used in asbestos personal-injury and computer cases. Still, only a minority of judges have ever appointed neutral experts.

Elsewhere, some state courts specialize in handling difficult litigation. Such courts exist in Manhattan and Philadelphia, but the idea isn't catching on. They cost extra money, and besides, some judges enjoy being generalists.

Federal Judge Leonard B. Sand in New York, who lectures on jury comprehension, says judges are quick studies and should be allowed to keep handling all sorts of complex litigation. "Judges have to be aware of and seek help, and the lawyers have to do their share," he adds. He recalls turning to his daughter's chemistry textbook during one case in the 1970s.

The new science primer, which contains several glossaries of scientific terms, lists areas where expert witnesses tend to disagree and explains why. It advises judges to narrow down issues as much as possible early on in a case. When faced with a quarrel between statisticians, for instance, judges should find out whether the experts disagree over calculations or over the basic numbers used to make the calculations. By the time the case goes to trial, evidence and testimony should zero in on the narrowest issues.

The manual also includes a controversial section that explains last year's Supreme Court ruling dealing with scientific evidence. Organizations of plaintiffs lawyers complain that the section puts a prodefendant gloss on the high court's ruling. For example, they are irked by the primer's suggestion that plaintiffs' experts shouldn't be allowed to make analogies between different diseases unless they have investigated the analogy "to the extent feasible." The Judicial Center defends its work.

The primer skips patent and computer issues, which are at the heart of current debates over how courts handle complex evidence. The U.S. Court of Appeals for the Federal Circuit, essentially the last word on patent law in the U.S., last spring asked parties in three separate cases to address whether some patent issues may simply be too complicated for juries. The court has yet to rule on the issue.

The Judicial Center says its manual is only a start, and more sections dealing with other kinds of evidence will be added later.

Meanwhile, some lawyers involved in complex litigation are trying to avoid the courthouse altogether. A small but growing number routinely include clauses in business agreements that require arbitration or mediation of any disagreements.

"Neither judges nor juries are good triers of complex cases," said Jeffrey M. Wiesen, a Boston lawyer who includes such clauses in biotechnology and other high-technology agreements. "You have people spending [illegible]rs becoming Ph.D.s to understand [illegible] things."

Plaintiffs' Bar Loses Bid To Sway Science Manual

Critics say evidentiary guidelines for judges ignore high court's criteria established by Daubert.

BY THOM WEIDLICH
NATIONAL LAW JOURNAL STAFF REPORTER

A JUDGES' MANUAL that was hotly criticized by plaintiffs' lawyers in the preparation stage has just been released, and it does not incorporate its critics' suggestions.

The "Reference Manual on Scientific Evidence," published by the Federal Judicial Center, the federal courts' research arm, seeks to help judges understand complex scientific issues.

But plaintiffs' lawyers, especially those connected with the American Trial Lawyers Association and Trial Lawyers for Public Justice, both based in Washington, D.C., say it is biased against them. [NLJ, Aug. 1.]

The most controversial part of the book is an evidentiary framework chapter written by Brooklyn Law School Prof. Margaret A. Berger. The plaintiffs' attorneys, most prominently Barry J. Nace of Washington, D.C.'s Paulson, Nace, Norwind & Sellinger, the immediate past president of ATLA, protested that Professor Berger's work was tilted toward excluding evidence.

These lawyers contend that Professor Berger downplays the emphasis on methodology that is dictated by the U.S. Supreme Court in its landmark decision, *Daubert v. Merrell Dow Pharmaceuticals Inc.*, 113 S. Ct. 2786 (1993).

Daubert discarded the long-held *Frye* test, which allowed admission of scientific evidence if its conclusions were generally accepted by scientists in that particular field. *Frye v. U.S.*, 293 F. 1013 (D.C. Cir. 1923).

Under *Daubert*, judges must act as "gatekeepers" and examine the methodologies used to determine whether the evidence should be admitted.

In a Nov. 22 letter, Russell R. Wheeler, the deputy director of the FJC, informed ATLA's associate general counsel that the center's board had considered the organization's objections and had voted to reject them. Said Arthur Bryant, executive director of TLPJ, "They corrected the typographical errors we pointed out; they just didn't change the substantive errors."

Several other commentators, including academics and defense lawyers, said that they thought the chapter was generally balanced and that Professor Berger had been unfairly attacked.

"I think, in part, people misconstrued the nature of this project," Professor Berger said. "It's not meant to tell judges how to decide cases. It's to provide judges with a tool to come to grips with some of these issues." NLJ

Adjudicating science

Lee Loevinger

Reference Manual on Scientific Evidence. By William W. Schwarzer *et al.* *Federal Judicial Center, Dolley Madison House, 1520 H Street NW, Washington DC 20005, USA: 1994. Pp. 637. $25 (pbk).*

MEMBERS of a 1907 expedition to the Piñacate desert region of northern Sonora, Mexico, extract water from a cactus. From *Two Eagles/Dos Aguilas*, with photographs by Tupper Ansel Blake and text by Peter Steinhart. For details see page 114.

THE Federal Judicial Center is an agency for policy research and education within the judicial branch of the US government. In 1990, in response to the increasingly complex and esoteric issues coming before federal courts, it decided to prepare a manual to assist judges in managing expert testimony, primarily on issues of science and technology. This volume is the result. As a government publication, the manual is not subject to copyright, and will be made available this month to the principal lawbook publishers, including computer legal networks.

The manual is divided into three parts, the first and third of which each consist of two articles on legal aspects of scientific testimony. The first article discusses the procedural devices by which courts may define and refine technical issues and manage the presentation of expert testimony under the Federal Rules of Civil Procedure. The second article discusses the conditions for admissibility of scientific testimony, which involve both the qualifications of witnesses and the foundation and nature of the testimony. With regard to the latter issue, the decision made in June 1993 by the Supreme Court in the case of Daubert *v.* Merrell Dow Pharmaceuticals established an entirely new set of rules for federal courts, the application of which is still being developed. The discussion of the standards of scientific validity now required for the admissibility of scientific evidence relies largely on cases decided before that date, and so does not add much to the general principles enunciated in the Supreme Court opinion.

The second and principal part of the manual contains seven 'reference guides' detailing the fundamental scope and nature of specific areas of science. The subjects covered are epidemiology, toxicology, survey research, forensic DNA evidence, statistics, multiple regression and the estimation of economic losses in damages awards. Because each article is written by a different author, or set of authors, there is some variation in both style and approach. But the differences are not as great as might be expected in an anthology: each guide has a common framework, with an outline preceding the text, which in turn is divided into sections on issues or subjects peculiarly relevant to the field; substantial cross-referencing; jargon expounded in reasonably comprehensible language; a glossary that defines the technical patois of the field; and a bibliography of additional reference sources.

The seven guides do not, and could not, attempt to make experts out of the reader; but a diligent reader will be educated sufficiently to converse intelligently with an expert in a particular field and to ask questions that would determine the validity of the expert's testimony. Indeed, much of each guide consists of an explanation of the limitations of expertise in the field, and all are strictly expository rather than anecdotal or philosophical.

As might be expected, a common theme is statistics, which are used in most areas of empirical science. Correspondingly, the longest guide is given over to this subject, and is supplemented by a comprehensive glossary of terms and by another article that illustrates and explains in mathematical detail the statistical process of multiple regression. These sections should be useful to anyone interested in any field of science or technology.

The third part of the manual consists of two articles on special procedures that may aid the consideration of scientific evidence by a federal court. One reports the results of a study by the Federal Judicial Center of court-appointed experts acting under rule 706 of the Federal Rules of Evidence. This permits a federal judge to appoint a presumably impartial expert in a case appearing to require such a procedure. This authority has been used infrequently but successfully in a few cases. The last article describes a similar study of the power of federal judges to appoint a special master (or referee) under Federal Rule of Civil Procedure 53 to report on a particular aspect of a complex case. This power, too, is rarely used, although it is potentially useful.

The introductory and concluding articles are specifically oriented toward trials in federal courts under existing rules, and will be of interest primarily to federal judges and trial lawyers. These do not have accompanying glossaries. But the seven substantial guides that deal with areas of science relevant to contemporary legal problems will be of interest to anyone who seeks information about the subjects covered. They do not make for particularly easy reading, but all of them are illuminating; the text and the glossary will help in understanding not only testimony but also other technical treatises in the field.

The manual does not cover all types of scientific data that may be used in legal proceedings. Many subjects, such as physics, chemistry and psychiatry, are not included; but future, and no doubt expanded, editions are planned. The scientific expositions provide more questions than answers. In both science and law, however, the first step toward knowledge is to ask the right questions; and in this respect the manual will provide invaluable assistance. □

Lee Loevinger is at Hogan and Hartson, 555 Thirteenth Street NW, Washington DC 20004, USA.

THE FEDERAL JUDICIAL CENTER
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WILLIAM W SCHWARZER
DIRECTOR

TEL.: 202-273-4160
FAX: 202-273-4019

January 5, 1995

Helene Kaplan, Esq.
Skadden, Arps, Slate, Meagher & Flom
Room 29/72
919 Third Ave.
New York, New York 10022

Dear Helene:

I am happy to be able to send you a copy of the Center's *Reference Manual on Scientific Evidence*, and I hope that you are as pleased with the final product as we are. It seems hard to believe that we began what turned out to be quite a mammoth project only three years ago. It was your idea to create such a manual and your enthusiasm, persistence and material support that made it possible.

As I prepare to turn this office over to my successor and look back on my five years here, the relationship with you and the Carnegie Commission stands out as a high point. Together we accomplished something that should have a lasting impact on the quality of justice not only in the federal courts but in the state courts as well. Several publishers have picked it up and I expect that the manual will receive wide circulation.

With best wishes,

Sincerely,

Bill

Enclosure

Enhancing the Role of the Scientific Expert Witness

Gilbert S. Omenn

School of Public Health and Community Medicine, University of Washington, Seattle, WA 98195 USA

There is growing attention to complex scientific questions in legal cases and the need for scientific expert testimony in these cases, including environmental health issues. This commentary addresses some problems common in expert witness work and recommends ways in which the legal system, the scientist, and our educational institutions can enhance the roles of experts. These recommendations may be particularly relevant for training programs in toxicology, epidemiology, and risk assessment. ***Key words:* *Daubert v. Merrell Dow*, environmental health, expert witness, litigation. *Environ Health Perspect* 102:674–675 (1994)**

Scientists are generally untutored and psychologically unprepared for roles as expert witnesses, until they learn through personal experience. Because science and technology are increasingly important in our everyday world, it is no surprise that complex technical matters may emerge in disputes which lead to litigation and trials. Recently, courts have been asked to rule on use of DNA tests of identification in criminal cases, patentability of living organisms and tagged DNA sequences in intellectual property cases, and a host of toxic tort issues, including silicone gel implants, repetitive motion injury, electric and magnetic field exposures from power lines, and exposures to lead from various sources. In 1993 the U.S. Supreme Court issued a landmark opinion in *Daubert v. Merrell Dow* intended to clarify the criteria for a witness to be granted expert status and for evidence to be considered "scientific" and admissible (*1*). This commentary addresses some of the context of expert witness work and makes recommendations for better preparing interested scientists for such activities.

Positives and Negatives

Judges, juries, and lawyers seem to need expert witnesses in many cases. As noted above, many cases turn on scientific evidence or directly address issues arising from scientific and technical advances. In other situations, scientists can help enlighten the court and the parties about relevant issues. And a whole host of ethical issues leads to legal disputes often requiring medical and scientific input.

Yet, most scientists are loathe to participate in cases for which they clearly have relevant expertise. Why? I think there are five types of reasons:

First, there is a clash of cultures and language. Litigation emphasizes differences, while science seeks consensus. Lawyers/advocates are expected to select the evidence that supports their argument, while scientists are expected normally to reconcile all the relevant evidence. Courtroom proceedings are intimidating to most scientists. The legal construct of "more likely than not" is a far less certain test than the test scientists usually apply in peer review of manuscripts or in debate at meetings. Courtroom jargon is unfamiliar to scientists, just as scientific jargon is unfamiliar to the general legal community.

Second, the legacy of scientific experts is distasteful. It is discomforting to be stacked up against another person who is accepted by the court as an expert, but who may really be a marginal scientist and/or professional testifier, and find the only conclusion the court seems to draw is that "the experts disagree." Then there is the widespread suspicion in both the scientific and legal communities of physicians, scientists, and engineers who do appear regularly in court as expert witnesses; they are often called "hired guns" by the lawyers who oppose them or recruit them, as well as by their colleagues (*2*).

Third, the expert witness may even be confused about her or his role with the hiring lawyer. Scientists may be attracted to the task by an invitation to be a consultant or adviser (the teaching/explaining role), then find they are expected to be willing to testify if needed. Academics are particularly prone to get hooked with the adviser role. As noted by Hollien (*3*), conflicts of ethics arise when an expert is invited to strategy sessions, called upon to help impeach the opposing expert(s), or asked to assist counsel with cross-examinations. Hanley (*4*) and Beall (*5*) warned experts of pitfalls from not learning enough about the case, attempting to testify outside one's real expertise, letting the lawyers control the extent and direction of the expert's investigation and information-gathering, being too careful, or being too aggressive.

Fourth, scientists and physicians lack training for this work, both in the United States and in Britain (*6,7*). As described in the article in this issue by Eaton and Kalman (*8*), it is essential to have specific preparation and, preferably, organized training about the initial request, the deposition phase, and the trial phase. Unless the scientists are veterans, they are unprepared for a personal attack on their credentials and intentions, for questions about their compensation, or for extremely focused questions designed to confuse them or reveal deficiencies in their knowledge of the topic or the case.

Finally, there are serious logistical problems. Seldom can the dates or times of required testimony be predicted, let alone guaranteed. Sometimes the venue is uncertain. The duration of testimony is unpredictable. Extensive preparation may be necessary, yet little of that preparation may be useful. In fact, lawyers or their recruiters may line up experts they have no intention of using, partly to block the opposition from recruiting the same person(s) and partly to intimidate the opposition and, in the end, what may seem to a jury to be high compensation may not really be worth the time to a busy physician, engineer, or scientist.

A New Context for Expert Witnesses

During 1990–93, I served on the Task Force on Judicial and Regulatory Decision-Making of the Carnegie Commission on Science, Technology and Government. The group included prominent federal judges, leading attorneys, and eight people from the scientific community. I was the only active scientist on the task force. There were four main conclusions of our report (*9*): 1) Federal judges have adequate authority under present Federal Rules of Civil Procedure and Rules of Evidence to manage science and technology issues more effectively, as do most state judges under their rules; 2) increased attention to science and technology issues at the pretrial stage, including involvement of experts, could make cases more amenable to disposition by summary judgment, facilitate settlements, or lead to more focused, speedier trials; 3) in the trial stage, judges and jurors may need assistance in handling science and technology information that the parties do not furnish because of insufficient expertise, mismatched resources, or excessive partisanship, which may justify court-appointed experts in highly selected cases; and 4) trial courts need guidance on the legal standards that control science and technology issues.

Our report recommends that judges take a more active role in managing the presentation of science and technology issues in litigation, using new manuals and protocols developed by the Federal Judicial

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Center (*9*); that "modules" about science and technology issues be integrated into judicial education programs; that institutional linkages between the judicial and scientific communities be established, including development of rosters of appropriate experts by various scientific and engineering societies; and that an independent nongovernment Science and Justice Council of lawyers, scientists, and others outside the judiciary be established to monitor, adjudicate, and initiate improvements in the courts' access to an understanding of science and technology information.

The Carnegie Task Force provided an *amicus curiae* brief for the *Daubert v. Merrell Dow* case decided by the U.S. Supreme Court in the 1992–93 term (*1*). The Court made clear that Rules of Evidence rule 702 gives the trial judge the task of ensuring that a purported scientific expert's testimony pertain to "scientific knowledge" tied to scientific methods and procedures and to a body of known facts or ideas accepted as true on good grounds and as relevant to the case. The Court reaffirmed Rule 702's requirement that an expert witness be qualified by knowledge, skill, experience, training, or education.

Recommendations for Enhancing the Role of Scientific Experts

My recommendations for enhancing the role of scientific experts are as follows:

1) Make the expert status more respectable by having judges use criteria for recognition of experts that are tied to their capacity to evaluate evidence admissible in the case under the *Daubert v. Merrell Dow* interpretation.

2) Encourage judges to experiment more with hiring expert witnesses to work for the court, rather than the adversaries. Most scientists would prefer to be responsive to the court, the judge, and the jurors, than be in competition with and perceived as another hired gun. However, judges are wary of choosing someone to be the expert and must have ways of keeping both sides fully informed. The National Conference of Lawyers and Scientists, a joint effort of the American Association for the Advancement of Science, the American Bar Association, and the Federal Judicial Center, co-sponsored a workshop in November 1993 to stimulate practical measures by which scientific societies might assist judges in identifying appropriate scientists in selected fields.

3) Separate the consultant and witness roles. Scientists differ in their talents for explaining and for arguing; there are uses for both. Consultants (including both parties' experts and court-appointed "masters") can be especially helpful in the pretrial stage.

4) Offer training for scientists and physicians in legal procedures, courtroom techniques, and conflicts of interest. Apply what may be called the "light of day" to expert witness work by disclosing such activities to colleagues and one's institutional administrators and by participating in data collection and publishable research about the process and its results. Eaton and Kalman's article (*8*) helps advance this educational mission, based on a special continuing education program co-sponsored by the School of Public Health and the School of Law at the University of Washington in December 1993, involving federal and county judges and plaintiff and defense attorneys, around a case of a hazardous waste site and a community with numerous complaints of ill health. Environmental health is particularly fertile ground for these cooperative efforts to improve the professional interactions of scientists and the legal system.

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States Acquiring Stronger Role In National Science And Technology Policy

■ ***States believe their models of public-private R&D cooperation can provide a basis for more effective national policy***

Wil Lepkowski, C&EN Washington

It's taken three decades and the shock of an election, but the 50 states may have finally reached what could be called a pinnacle in their perceived relevance to national science and technology policy. Time, of course, will determine whether that pinnacle broadens to actual terrain. For the bottom line is more state control of significant amounts of federal research and development money. But change is in the air, the electorate is angry over the distance of government from their problems, and "grass roots" is the ascendant term.

That's what every speaker said at a symposium held on Jan. 26 in Washington, D.C., sponsored jointly by the Carnegie Commission on Science, Technology & Government and the American Society of Mechanical Engineers.

About 250 people gathered to hear the latest developments in "The State-Federal Technology Partnership"—the title of the symposium. Speakers came from Capitol Hill, the executive branch, and the states themselves.

One featured speaker was White House science adviser John H. Gibbons, who said, "The time is ripe to reexamine the national science and technology policy system and to build a stronger role for state and local governments in that process." Gibbons pointed to pronouncements made by one of the country's founding fathers, James Madison, who wrote that in times of war the focus of policy is always on the central government. But in times of peace, Gibbons said of Madison's dictum, "the concentration turns back to local constituencies."

Gibbons, sources say, was always aware of the innovative possibilities of applying localized principles to R&D, but it wasn't until last fall's election, with its more-power-to-the-states mandate, that his attention became more focused.

C&EN staff photos

Gibbons: stronger role for states

The Administration, Gibbons announced, was undertaking a series of steps to bring the states more fully into the national R&D policy picture. As a first step, he said, he would soon be appointing a state-federal task force that would report to the Office of Science & Technology Policy, which he directs. The task force—to be cochaired by Richard L. Thornburgh, former governor of Pennsylvania, and Richard F. Celeste, former governor of Ohio—will study what the Administration needs to do to bring the states more into the flow of policy decisions in Washington. It will report its findings 90 days after it begins its work.

Later in the year, Gibbons will convene a colloquium to build upon the task force findings and to set down an actual policy. An earlier colloquium, in which Gibbons participated, was held in September 1993 (C&EN, Oct. 4, 1993, page 17), and its findings led to the current set of steps Gibbons outlined. In addition, Gibbons announced the establishment of a State Science & Technology Institute, which, he said, "will be a clearinghouse of information on technical problems."

The institute, whose support will come from various sources, will be housed at Battelle Memorial Institute, Columbus, Ohio, and will be cochaired also by Thornburgh and Celeste, both of whom established strong technology programs in their states. Thornburgh presided over the Washington gathering.

The announced occasion for the meeting was the ceremonial release of a 641-page compendium on cooperative science and technology programs. Stuffed with data on technological programs sponsored by each of the 50 states, the compendium was symbolic of what can be seen as the new millennium in national science and technology policy. Called "Partnerships: A Compendium of State and Federal Cooperative Technology Programs," the volume is the first ever collection of such programs.

Some programs are major, such as those of North Carolina, Pennsylvania, and Texas—all $30 million-plus enterprises. Others are barely visible, like those of Rhode Island, West Virginia, and Nevada, which have interest in but no money for such programs. The current thrust, however, is to make better grassroots use of the federal R&D money that flows into every state in various forms.

The compendium also contains perspectives on the technological partnership phenomenon in the states (begun in small ways during the 1960s) and describes the work of federal agencies in their relationship with states and regions. It was edited by Christopher Coburn, director of Great Lakes Industrial

Technology Center, Cleveland, which is funded by the National Aeronautics & Space Administration. Coburn once directed Ohio's overall cooperative technology partnership program—the Thomas Edison Program, one of the major such enterprises in the country. He does almost all of the legwork for Celeste and Thornburgh and is expected to manage the institute that Thornburgh and Celeste will cochair.

Since the mid-1980s, Coburn has shepherded the effort to focus national attention on the important role of states in formulating science and technology policy. That effort has been supported by Battelle—which manages the Great Lakes Industrial Technology Center—and by the Carnegie Commission on Science, Technology & Government. The commission issued an influential report on the subject in 1992 and continues to be a major source of funding for projects pertaining to state science and technology.

Coburn says the Washington meeting was a crucial gathering in the long history of the effort, which began in 1963 with passage of the State Technical Services Act. "Set against the ebb and flow of science and technology policy issues," he says, "this meeting can be seen as day one of a new vector. The compendium is an indispensable information base along with an analysis of the programs. There's now a sense of urgency and a broader mandate about enhancing this relationship."

States spent $385 million on cooperative technology programs in fiscal 1994 . . .

$ Millions		$ Millions	
North Carolina	$37.45	Montana	2.97
Pennsylvania	34.07	Louisiana	2.65
Texas	30.26	Iowa	2.35
Georgia	29.88	Missouri	1.85
Connecticut	27.50	South Carolina	1.80
Ohio	27.48	North Dakota	1.78
New York	22.88	Maine	1.64
New Jersey	20.30	Wisconsin	1.57
Michigan	14.10	Arkansas	1.51
Maryland	12.68	New Mexico	1.26
Florida	12.60	Alabama	1.15
Kansas	11.10	Kentucky	1.12
Virginia	10.40	Idaho	0.73
Nebraska	8.98	New Hampshire	0.65
Alaska	8.50	Illinois	0.60
Oklahoma	6.69	Oregon	0.44
Indiana	5.90	Wyoming	0.35
Minnesota	5.48	Arizona	0.25
California	5.19	Vermont	0.20
Massachusetts	5.05	Tennessee	0.15
Hawaii	4.61	Mississippi	0.08
Utah	4.29	Nevada	0
South Dakota	3.70	Rhode Island	0
Delaware	3.59	West Virginia	0
Colorado	3.41		
Washington	3.35	TOTAL	$384.54

. . . while 10 federal agencies spent $2.7 billion on such programs

$ Millions		$ Millions	
Defense	$1.101.7	Health & Human Services	133.1
Agriculture	450.8	Energy	72.0
Transportation	349.6	Environmental Protection Agency	56.8
Commerce	233.4	Labor	1.6
National Aeronautics & Space Administration	168.6		
National Science Foundation	149.4	TOTAL	$2,717.0

Source: "Partnerships. A Compendium of State & Federal Cooperative Technology Programs"

Being diverse, the cooperative technology effort isn't easy to explain. But the concept is simple enough by itself: States, the federal government, universities, and industry cooperate—by contributing brain power and finance—in the birth and commercialization of technology.

What complicates the effort is the different processes, structures, and financial arrangements that arise out of the particular character and zealousness of each state. The states' actions can take the form of outright grants to firms, expert advice to companies with problems, facilities for entrepreneurs, and involvement of university faculty in state-supported high-tech ventures. The aim is attraction of venture capital and, thus, financial engagement of the private sector—with all the stock-option, intellectual property, and management issues that pertain.

In a fundamental sense, the cooperative technology phenomenon is the high-tech manifestation of what public entitlements are now intended to be: cash incentives for self-sufficiency. The hope is that taxpayer money given to and matched by private firms will abet development of new technology, create jobs, build economies, and invigorate the social condition. Universities are heavily involved in the formula, too, because of their increasing outreach to firms in their regions.

Thornburgh and Celeste have thrown their weight and reputations behind the recent acceleration of interest in state-based science and technology programs. Under Thornburgh's administration beginning in the late 1970s, Pennsylvania established the Ben Franklin Partnership, a network of universities and industries sharing information and facilities and collaborating in R&D to establish new enterprises—and jobs—in Pennsylvania.

Celeste, Ohio's governor during much of the same period, established the Thomas Edison Program, designed along the lines of the Ben Franklin Partnership. A highlight of Ohio's enterprise is "Polymer Valley," located in the Akron-Canton-Cleveland belt. The University of Akron and Case Western Reserve University are working with local industry and federal agencies to transfer technology from the labs to production lines.

Celeste, a Democrat, was unable to attend the Washington meeting. But Thornburgh, a Republican, was upbeat at the meeting, giving what amounted to an ultimatum to the inside-the-Washington-Beltway political culture. "We strongly believe," he said, "that the states—the laboratories of democracy—have the opportunity to bring a new value to this endeavor. If we do not respond to this, it will be to our peril."

Thornburgh: laboratories of democracy

Rep. Constance A. Morella (R-Md.), chairwoman of the House Committee on Science's Subcommittee on Technology, reflected that same mood and outlook in her remarks: "There were clear instructions from the American people to reduce spending and balance the federal budget. We have heard from our governors. They have said give us an opportunity to be the exciting laboratories we know we can be."

Morella then reeled off the various technology-business programs that her state has established over the years. She also mentioned Maryland's 61 federal laboratories [including the National Institutes of Health, National Institute of Standards & Technology (NIST), and Goddard Space Flight Center] and the 130 biotechnology companies in the state. "We have excellent, successful partnership programs," she said. "It demonstrates what can happen with science and technology and a thriving business climate."

Her colleague—and early mentor on the House Science Committee, its former chairman George E. Brown Jr. (D-Calif.)—backed up what she said: "The days of big central government are waning. The momentum will move to the states. We have to be alert to the need to examine the institutional structures we have created. We must see them not as federal or state programs but as national programs."

Vermont Governor Howard Dean, current chairman of the National Governors Association, added a true grassroots note to the meeting. "All this technology will be worth nothing unless we can find a niche for our kids through vocational training in the technological system," he said. "If we don't, we are fighting a losing battle no matter how much time we devote to this." Dean pointed to the relatively low scores U.S. children receive, on a global comparison, in science and math achievement tests.

"The election of 1994 was a good thing," said Dean, a Democrat, in that it brought "new attention to ideas that had previously been rejected. Many Democratic governors agree that a new direction is appropriate in getting government closer to the people. And state governments can do that more effectively than Washington [can]."

What all this means for the future of current federal science and technology programs was not specifically spelled out at the meeting. No one knows what Congress will ultimately do with the many technology programs enhanced or established by the Clinton Administration. It already is known that the Re-

Morella: successful partnerships

publican Congress will attempt to kill or drastically cut back the $357 million Advanced Technology Program at NIST and the $624 million Technology Reinvestment Program at the Defense Department's Advanced Research Projects Agency. Both programs fund research on commercially related technologies, and the funding they provide

Dean: find a niche for kids

is contingent on matching amounts from recipients.

Defenders will try to tie in these programs more closely with existing job-related state technology programs. NIST already has a model for doing that in its Manufacturing Extension Partnership, which aims to establish 100 centers that tie manufacturing know-how in universities and federal facilities to problems businesses actually encounter.

Another federal program that almost all of industry seems to support is cooperative research and development agreements (CRADAs). These agreements involve, again, corporate and federal researchers in work that potentially leads to innovative products.

The major technology link between the federal and state governments will be the institute Gibbons announced. The institute is developing an operating plan and is applying for funding from the Carnegie Corp. and other public and private organizations.

So another stage is set in the continuing evolution of federal-state relations in science and technology. The phenomenon began as a hardly noticed initiative in the 1960s and was kept alive by small programs and funding by NSF during the 1970s until the states themselves began gathering steam in the effort.

The phenomenon itself is fascinating from the political science perspective. It asks federalism's age-old question of proper balance between state and federal power in what, after all, is the same country. If the aim is a strong country, why shouldn't the systems be more coincidental? Why shouldn't DOE's national laboratories be more directly involved in regional and state priorities? Similarly, most universities receive federal R&D funds. Shouldn't they be accountable in more than peripheral ways to state science and technology policies?

But the path will be difficult. As the compendium states, "The promise of state-federal technology partnership has gone unfulfilled for more than a decade. Organizational and cultural differences between the states and the federal government are magnified by the lack of information necessary for potential partners to identify and engage each other." So the thing to watch over the coming months is how well Gibbons pulls off that engagement. □

Coal R&D championed by research council

Early hints are that Congress, the Department of Energy, or both, will cut DOE's budget for fossil energy research and development in fiscal 1996. This move could result in the demise of long-running clean-coal programs.

Begun in the 1970s, the clean-coal programs were a specific response to the oil shocks of that decade—an embargo, shortages, and skyrocketing prices. Coal was touted as the only abundant backup energy source native to the U.S. Oil shortages now seem part of the distant past, but the coal programs persevered. Now, they are on the chopping block.

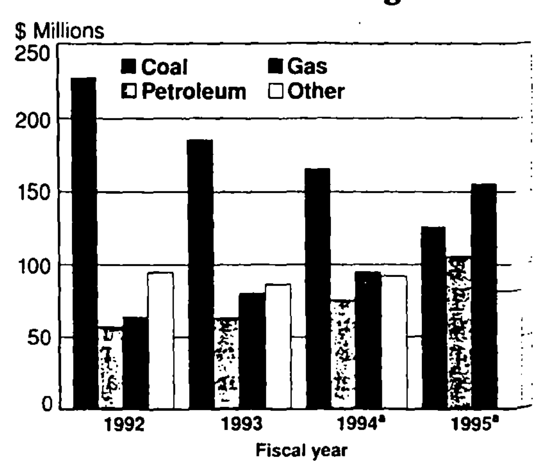
But even as the Administration's fiscal 1996 budget is set to be issued—scheduled for this week—the National Research Council has published a study that finds, "There will be a powerful economic driving force for major and expanded use of coal over the next several decades with concomitant pressures to reduce environmental impacts through improved technology." The study recommends that DOE expand its coal technology programs and that, over time, it place increasing emphasis on production of clean fuels and other carbon-based products.

The study was performed by the NRC Committee on Strategic Assessment of the DOE Coal Program. It assesses DOE's progress toward meeting the requirements of the 1992 Energy Policy Act, which includes provisions for developing environmentally acceptable coal-based technologies for a broad range of applications. The committee is chaired by John P. Longwell, professor emeritus at the department of chemical engineering at Massachusetts Institute of Technology.

The reason for supporting coal research today is essentially the same as it was 20 years ago: Coal is abundant and cheap. Contrary to predictions for petroleum and natural gas, production costs for domestic coal are not expected to increase significantly over the time frame considered by NRC—from the present through 2040. NRC notes that coal production, especially that of low-sulfur coal in the western U.S., is increasing every year, while the price of coal is decreasing. In 1992, the average cost of coal at the mine was about $21 per ton, representing the 10th straight year of lower prices.

U.S. coal production in 1992 reached nearly 1 billion tons, of which 10% was exported, making coal a significant international commodity. Electric power generation is the largest use for coal, accounting for more than 87% of 1992 consumption, even though demand for new coal-fired power plants is expected to remain low for several more years. It is at the middle of NRC's time frame—around 2010—that the report forecasts an ever-increasing demand for coal and

Federal R&D funding declines for coal but rises for oil and gas



a Estimates. **Source:** National Research Council

Rules." Early on, he encountered a firestorm of opposition when he tried to change NASA's charter by shifting a small amount of funds to encourage commercial space ventures. "Not many people know that Brown helped me draft the language to get the bill passed," says Walker. "In a way he's been my mentor."

For Walker, the Science Committee has been "fascinating and exciting." He told us that he was "not a preeminent science student in either high school or college. I've now had 18 years of graduate education. I've not only had the chance to hear some of the best scientists in the country but I've exchanged ideas with them on science policy. I'm ready for the next part of the journey of discovery."

When Gingrich arrived in 1979, Walker was beginning to carve out a floor role for himself as a Republican activist. In 1983 Gingrich, Walker, Connie Mack of Florida, Vin Weber of Minnesota and Trent Lott of Mississippi organized the Conservative Opportunity Society, which promotes views well outside mainstream Republicanism. Walker became one of Gingrich's most loyal allies. In fact, he and Gingrich and several others recruited many of the House's 73 Republican newcomers, now known as "Newtoids."

Walker's vision of the future is remarkably similar to that of Gingrich. Walker's recent reading includes the same futurists on Gingrich's list: Alvin and Heidi Toffler, John Naisbitt and John Diebold. An automobile buff, Walker reads *Car and Driver* and *Motor Trends* and owns a 1991 Corvette, which he calls his "toy." He claims to be the only licensed race-car driver in Congress, racing Formula 2000 rear-engine cars once or twice each year on paved tracks in Pennsylvania. While Walker is an avid sports fan, he has little time to even watch games, unlike his brother, who makes his living as general manager of the Seattle Supersonics basketball team.

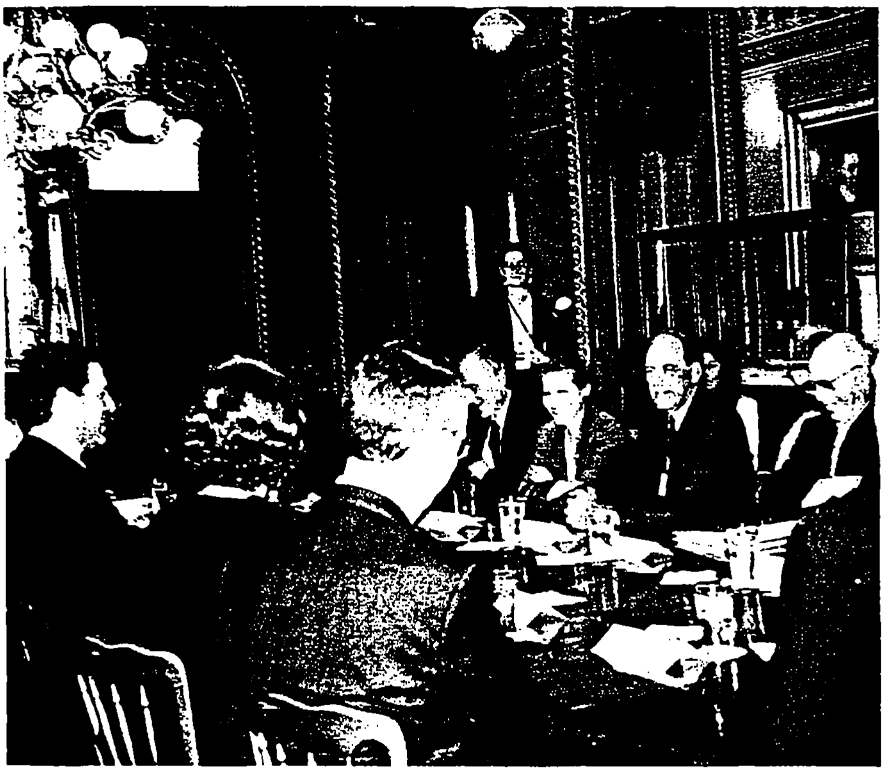
Does he think of himself in his new chairmanship as something of a general manager of science policy? "That would be presumptuous and wrong," says Walker.

▶ IRWIN GOODWIN

Without President to Voice R&D Agenda, PCAST Seeks Relevance and Receptivity

Barely an hour after President Clinton left the White House on the morning of 25 October to bless the Mideast peacemakers at the Israel–Jordan border, the President's Committee of Advisers on Science and Technology assembled for its initial meeting. So instead of hearing firsthand the President's agenda for science and technology, PCAST members spent more than an hour of their one-and-a-half-day session with Vice President Al Gore in his ornate ceremonial office in the Old Executive Office Building, discussing the Administration's R&D programs and plans. The rest of their meeting was also somewhat anticlimactic.

Appointed almost a year after Clinton announced he would form a White House science council similar to those anointed by every president since Eisenhower, PCAST consists of 18 celebrated experts in a variety of specialties (see PHYSICS TODAY, September, page 81). Because their first meeting took place nearly halfway into Clinton's term, most science and technology policies were fully in place without the advice of PCAST. Nonetheless, when John Gibbons, director of the White House Office of Science and Technology Policy and cochair of the committee with John Young, former president and CEO of Hewlett–Packard, invited PCAST members to the meeting, it was implied that they would be asked to suggest any mid-course corrections as well as some new departures. But as the meeting progressed, some members sensed that there was little they could offer, no matter how useful they wanted to be to the President and his aides.



GORE (extreme left) and GIBBONS (extreme right) engage Clinton's science advisers.

On the first day of the meeting, PCAST was briefed by Gibbons and all four OSTP associate directors. Gibbons almost immediately departed from the traditional topics of Presidential advisory committees on science and technology. He proposed that PCAST examine the nation's investment strategies, which involve, among a dizzying array of questions, whether Washington should encourage joint public–private R&D partnerships, stimulate more investment capital for new technological ventures, shift the R&D budget to more utilitarian approaches and support more domestic and global economic "greening" in such areas as sustainable development, biodiversity, desertification, climate change and human health hazards.

This was a perfect segue into the

briefing by M. R. C. Greenwood, OSTP's associate director for science, who launched into a rosy depiction of the economic benefits of investing in "intellectual capital for the future." When Greenwood turned to improving public education and literacy in science, Young interrupted to observe that "the last time I looked at this, some 60 000 high school teachers were unqualified to teach science." Lionel ("Skip") Johns, associate director for technology at OSTP, cautioned PCAST members against suggesting increased funding for the science agencies, because the Administration is committed to reducing both the Federal budget and the fiscal deficit. When PCAST broke for lunch, the members listened to Alice Rivlin, director of the White House Office of Management and Budget, deliver an even grimmer view of the President's spending requests for the science agencies in the fiscal 1996 budget, which will be sent to Congress this month.

Sustaining stability

Jane Wales, OSTP's associate director for national security and international collaboration, spoke of the high priority the Administration is giving to scientific and technological cooperation with six countries "that have the indigenous capacity to produce weapons of mass destruction and the means of their delivery"—namely, Russia, China, India, South Africa, Argentina and Brazil. The countries were selected not only for their nuclear weapons capability, said Wales, but because each possesses scientific and technological capabilities that could attract foreign investment, and each could be a vast market for US products and services. But the best reason for US investment in these countries, she said, is to strengthen and stabilize them. She noted that the scientific and technological communities in these countries were a force for stability and democracy. Peter Raven, director of the Missouri Botanical Garden and home secretary of the National Academy of Sciences, observed that the US has about 5% of the world's population and 20% of the world's wealth. "If we don't do something to sustain nations like Russia, China and India, they will not only be poor markets but they will be strategic risks," said Raven.

Gibbons proposed that PCAST examine and evaluate the Energy Department's defense and nondefense nuclear fusion programs in an effort to comply with a Senate Appropriations Committee report accompanying the 1995 Energy and Water Development Act. The Senate report, directed by J. Bennett Johnston, a Louisiana Democrat, specifically requested that PCAST provide advice "that will help shape the direction of the nation's effort" on magnetic and inertial confinement fusion. Another Senate Appropriations Committee report, this one dictated by Barbara Mikulski, a Democrat of Maryland, called for PCAST to study ways of renewing the academic infrastructure.

During the course of the meeting it became clear that PCAST would meet only three times a year and that there would be little or no staff to provide research or secretarial help. Gibbons noted that the Pentagon's allocation for its Defense Science Board amounted to three times the $150 000 per year available for PCAST. Despite such limitations, Gibbons stated that PCAST's advice would need to be received by April 1995 to have any impact on the fiscal 1997 budget.

Still, said Gibbons, he would like to call on members individually and in small groups to advise his office on some of the Administration's most troubling policy issues. Among those he listed were such unsurprising topics as R&D investments, global conflicts, technology transfers from government laboratories and universities to industry, new roles for the government labs involved with nuclear weapons and military research, health research, and precollege education. Gibbons also said he would welcome PCAST's thoughts on technology and the changing nature of employment, a subject raised by Robert M. White, president of the National Academy of Engineering, in a pessimistic talk at the academy's 1993 annual meeting. In his address White speculated that the creation of new industries may not be adequate to offset jobs lost because of improvements in productivity brought about by computers, telecommunications and robotics. White asked: "Does the current rate of change caused by the introduction of new technology far exceed the political, social and economic capacity for social change?"

Gibbons's shopping list of issues led PCAST members into a discussion on what could be expected of them. Philip Sharp, chairman of MIT's biology department and a Nobel Prize winner in molecular biology, posed the question bluntly: "What output do you want from us?" John Holdren, professor of energy and resources at the University of California, Berkeley, observed that the panel's diversity enabled the participants to look at many matters, but they could not produce a national R&D strategy in the four or five months that Gibbons had given them. In response, Gibbons urged PCAST to develop an agenda of its own. The members decided to restrict their deliberations to five broad issues: education, environment, health, investment in science and technology, and national security and international affairs. In addition they agreed to serve as peer reviewers, in smaller groups of three or four, of the strategy papers that would be prepared by the nine panels of the National Science and Technology Council, the President's Cabinet-level policy group. And there might even be time for PCAST members to comment on three different reviews that are currently being conducted of the national labs supported by the Departments of Energy and Defense and by NASA.

Another Nobel laureate, Murray Gell-Mann, emeritus professor of physics at Caltech who now spends most of his time at the Sante Fe Institute, recalled his service on Nixon's Science Advisory Committee. It had monthly meetings, an ample budget for all contingencies and its own staff, said Gell-Mann, so the group did "deep studies" that often wound up as book-length panel reports.

An intellectual tennis game

Another historical perspective was provided by David Z. Beckler, who served as executive director of every White House science advisory committee from 1957, under Eisenhower, until 1973, when Nixon abolished his science advice. Asked by Gibbons to comment on PCAST's proceedings, Beckler recalled that soon after Eisenhower's first election in 1952, I. I. Rabi, a Columbia University physicist, asked Ike, who had been the university's president, if a group of scientists might help him in making decisions. According to Beckler, Eisenhower told Rabi he would welcome science advice on what technologies would be most useful to meet a military threat. Accordingly, said Beckler, the committee Rabi assembled was assured of Eisenhower's "receptivity." Beckler asserted that the success of any Presidential panel depended on relevance and receptivity. Without these, he warned, the work of such advisory groups was "just an intellectual tennis game."

The warning did not go unnoticed. As Young told members: "If we're a Presidential panel, we should meet with the President." The next chance that PCAST will have for this is its second meeting, scheduled for 27–28 March.

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INTERNATIONAL COOPERATION IN MEGASCIENCE

Carnegie Commission on Science, Technology, and Government

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INTERNATIONAL COOPERATION IN MEGASCIENCE

OVERVIEW

A small number of large, central research facility projects are at the heart of the difficulties in megascience cooperation. The problems are usually political rather than scientific or technical. There are five such "high profile" projects: the Space Station (integrating Russia), US participation in the LHC, ITER and, in the future, internationalization of the Advanced Neutron Source and the next linear collider.

Existing international arrangements for megascience cooperation are adequate for large distributed research programs (e.g., global change research) that draw on the experience of almost forty years of cooperation between governments and the international scientific community. However, future prospects are less certain. More attention should be paid to building stronger institutional relationships between intergovernmental organizations and the international science and engineering communities, and to building the capabilities of developing countries to participate in the planning and implementation of global programs.

Intergovernmental negotiations at ministry/agency level can deal effectively with science and technology issues, but higher-level consultation is needed to address political and financial issues that are not resolved by ministries, including the possibility of cost/benefit trade-offs among a group of megaprojects.

A major stumbling block is the inability to assure long-term funding for megascience projects that depend on annual or biennial appropriations (particularly, but not exclusively, the US). Although long-term funding cannot be guaranteed, international cooperation has been advanced successfully as an argument for budgetary support (space station) and will increasingly become an integral component of appropriations in the U.S. (e.g., ITER. space station, and participation in the LHC). Another hurdle is site selection. Negotiations on the site of ITER and, later, the next linear collider will test scientific diplomacy and national resolve.

Political commitment to megascience cooperation by heads of government and parliamentarians is critical. At best, it should be incorporated in a treaty (difficult to achieve in the US); short of that, in an executive agreement by heads of government. Agreement at the next G-7 Summit plus Russia could be timely and politically opportune.

General principles for megascience cooperation, being drafted by the OECD Megascience Forum for the meeting of Science Ministers in September 1995, can have an important influence in the initiation, implementation, and operation of megascience projects by providing a common foundation for cooperation.

The OECD Megascience Forum has made a significant contribution to megascience cooperation by bringing together government officials and the international scientific community. There is a long tradition of such cooperation in addressing global programs, particularly between the Union members of the International Council of Scientific Unions and the Specialized Agencies of the UN. The international engineering organizations have begun to play a similar role. Nonetheless, the prospect for growing internationalization of government-supported scientific research suggests the need for a more effective international framework and stronger institutional arrangements to enable governments to draw more fully on the international scientific and engineering communities for advice and assessments that cut across the hierarchy of existing intergovernmental organizations.

The Carnegie Group can facilitate megascience cooperation by:

— Exchanging views on future prospects for megascience cooperation at its regular meetings;

— Reviewing governmental positions to be taken at the OECD Megascience Forum in January 1995, and the Science Ministers meeting in September 1995. Issues include a statement of principles for cooperation and the future organization of megascience cooperation in the OECD (including the U.S. proposal to broaden cooperation to cover large science programs that would benefit from closer coordination and consultation on national research plans and programs);

— Consulting on "high profile" megascience projects in exceptional situations where political or economic issues impede negotiations;

— Discussing critical policy issues concerning cooperation among the G-7, EU and Russia.

— Referring other issues for study by the OECD;

In order to preserve the balance of the Carnegie Group agenda, it is suggested that the Group meet as needed in special session for in-depth discussion of critical megascience issues. Depending on the usefulness of these consultations and the need to move toward formal agreements, this could lead to the establishment of an official inter-ministerial group on megascience cooperation.

INTERNATIONAL COOPERATION IN MEGASCIENCE

I. Problem

What can the Carnegie Group do to improve the existing arrangements for international cooperation in megascience?

II. Background

A. International megascience activities are projects and programs that address scientific problems of such significance, scope, and complexity as to require an unusually large-scale collaborative effort involving facilities, instruments, human resources and logistic support (and are unlikely to be carried out without such collaboration). The activities may include large shared facilities, *e.g.*, a space station, or ITER, the International Thermonuclear Experimental Reactor (which we will call Type I programs), or major distributed research programs, *e.g.*, global change research or the human genome project (which we will call Type II programs). Type I projects with substantial near-term commercialization potential raise different problems of collaboration and cost-sharing, and are not addressed in this paper.

B. Megascience programs require hundreds or even thousands of person-years of effort to accomplish them. Decisions to go forward must be based on a clear consensus on the value of the projects, and a recognition that the highest quality technical and managerial skills will be needed if they are to be carried out efficiently and successfully. Arrangements for cooperation must be sensitive to the differences in national priorities and the motivation of scientists and engineers involved, ranging from increased scientific understanding to technological development for societal needs.

C. Usually, international megascience programs have been initiated by specific government agencies or by the science community. International negotiations have normally been among the government agencies responsible for carrying out the projects. Higher levels of government have been involved only rarely, except for intra-European cooperation.

D. There are greater difficulties in negotiating agreements among funding countries for the Type I projects than for Type II programs. In Type I central facility projects, the issues often concern large transfers of funds (relative to the cost of the facility), siting, and equitable sharing of perceived benefits. In Type II programs, the issues usually involve establishing effective mechanisms for coordinating and networking many national research efforts, and fund transfers are not substantial. There have been a few examples of successful cooperation in Type I programs, perhaps the best example being the CERN laboratory. Another example is the European Space Agency.

E. A few particularly expensive and visible Type I projects get major attention from high-level government officials. For these "high-profile" Type I facilities (e.g., space station, Large Hadron Collider, ITER, and in the future, the advanced neutron source and the next linear collider), the major negotiating problems are likely to be political and economic rather than scientific (e.g., difficult issues involving national prestige, site selection, cost sharing, and relative economic benefits).

F. Difficulties in negotiating and sustaining cooperation in high-profile projects have caused uneasiness among the principal funders of megascience projects about the prospects for future international cooperation. This uneasiness led funders to establish the OECD Megascience Forum for intergovernmental consultation as a step toward examination of the underlying issues.

G. For many years, international cooperation in a number of Type II programs has been quite successful, beginning with the International Geophysical Year in 1957 and the subsequent series of global environmental programs. However, future prospects for successful collaboration are uncertain. Linkages between international scientific and engineering groups and governments are ill-defined and tenuous. Non-scientific barriers impede cooperation. For example, the international human genome mapping program has encountered difficulties due to national differences with regard to the protection of intellectual property and disparities in national investments in basic research.

H. Some Type II programs, such as global environmental projects (e.g., biodiversity programs) as well as some Type I projects (e.g., telescopes in the southern hemisphere), require geographically unique resources and also require scientific activity in developing countries. The programs of the Consultative Group on International Agricultural Research are a long-standing example. Better mechanisms and procedures are needed for involving those countries so that they can participate in the planning process prior to funding of research, and advance their scientific capability so that they can effectively contribute to the research programs without distorting their own scientific priorities.

I. There will be increasing pressures for international scientific cooperation, including but not limited to megascience, due to shared scientific objectives and national budgetary constraints. The organization and management of such cooperation will be high on the agenda of senior science policy officials.

III. The Future Role of the Carnegie Group

The Carnegie Group was organized as an informal, unofficial group of high-level government science officials to promote personal relationships and exchange views on S&T issues of common concern, but not to take decisions on behalf of governments. How can the Group give special attention to megascience issues without changing its successful format—off-the-record discussions without staff, and emphasis on mutual understanding rather than advocacy or negotiation? Should it take a greater role as a facilitator and catalyst in the decision-making process? If so, how can it organize to perform this role without impeding lower-level cooperation?

A. The possible activities of the Carnegie Group as now constituted

1. Exchange views on future prospects for international S&T cooperation, including megascience

The Carnegie Group should continue to consider megascience questions as part of its periodic discussions of international S&T cooperation, taking a long-term, global view of megascience involving both old and new institutions, including relationships between intergovernmental and non-governmental S&T organizations.

2. Review national positions to be taken at intergovernmental meetings

Carnegie Group meetings afford an opportunity for the members to review positions that their governments might take in future international negotiations, and through informal discussion, to ease the way for later agreement. For example, the group might consult on national positions to be taken on the issues on the agendas of the next Megascience Forum meeting (January 1995) and the OECD Ministerial meeting (September 1995).

3. Consult on "high profile" megascience project negotiations

Consultation at the level of science ministers may be required in exceptional situations where political, siting, resource-sharing, or economic issues seriously impede negotiations on megascience cooperation. ITER is at this stage, and decisions will also soon be needed on the next step of cooperation on the linear collider. The informal, unofficial nature of the Carnegie Group could facilitate the resolution of sensitive political and budgetary problems.

4. Discuss policy issues concerning G-7 cooperation

The Carnegie Group may wish to consider the preparation of brief issues papers on selected subjects with pros and cons and decision options as an aid to discussion at their regular meetings. The issue papers could draw on the work of the OECD and national governments.

5. Refer megascience issues to the OECD

The members could agree to recommend certain megascience policy issues for OECD study and policy recommendations. A number of suggestions are discussed in Section VI below.

B. A new role: decision-making for G-7 cooperation

While general consultation on megascience issues could be accommodated during the regular meetings of the Carnegie Group, in-depth consultation on specific issues could probably not be dealt with without undesirable changes in the character of the group. As discussed in Section V below, a number of megascience issues concerning large facilities have been proposed for consideration and possible examination by the Carnegie Group. Group members could agree to undertake the requisite studies with a view to achieving later consensus on policy recommendations. Two organizational options seem feasible for in-depth consultation:

1. The Carnegie Group could meet initially in special sessions as necessary to consider specific (non-scientific) obstacles to negotiation or priority megascience issues. Discussions would be based on policy options papers prepared in national capitals. It could seek consensus but could not take decisions on behalf of governments in view of its unofficial status. The Group could later decide on the most effective form of future consultation that could lead to decision.

2. Alternatively, members of the Carnegie Group could agree to recommend to their governments that an official intergovernmental committee on megascience cooperation be established at the level of Science Ministers with authority to deal with unresolved issues in megascience negotiations and to seek agreement on policy questions. It would be supported by a small secretariat and have access to staff and consultants for technical and policy analysis.

IV. The future of megascience cooperation in the OECD

There are two priority issues for consideration by the Carnegie Group that will be on the agenda of the OECD Science Ministerial meeting in September 1995:

A. General principles for megascience cooperation

The Megascience Forum is developing a statement of principles for megascience cooperation for the OECD Science Ministerial meeting in September 1995. The statement will draw on the conclusions of its expert groups and consultant studies. For example, it might stress the need for a strong scientific rationale, building consensus within national scientific communities, early intergovernmental consultation, main reliance on bilateral and multilateral agreements, political commitment at highest level of government, long-term scientific and financial support, access to scientific data and open movement of scientific data and personnel. If approved by the ministers, the statement could gain enhanced political standing if it were endorsed by the OECD Council meeting at ministerial level (Foreign Ministers and Ministers of Finance).

Members of the Carnegie Group could encourage the Megascience Forum to draft a statement of general principles for megascience cooperation for consideration by Science Ministers at their meeting in September 1995, and urge their governments to endorse the agreed statement at the following annual meeting of the OECD Council at ministerial level.

B. The future of the Megascience Forum

The Megascience Forum was created by the OECD Council in June 1992 as a subsidiary body of the Committee for Science and Technology Policy "to ensure the exchange of information and open and substantive discussion on existing and future megascience projects and programs, and to facilitate international cooperation in this area." All but one of 25 member countries participate. Russia, Hungary, and the Czech Republic are observers. The Forum was not conceived as a permanent activity, but was given a 3-5 year life. The Forum has performed a unique function of convening expert groups of scientists and substantive senior government officials in the fields of astronomy, deep ocean and continental drilling, global change research, oceanography, synchrotron radiation and neutron beams, and particle physics. With the help of consultants, the Forum has identified a number of organization, management, and decision-making principles, problems and deficiencies that many cooperative arrangements share in common. The Forum's strengths have mirrored those of the OECD (consultation, policy formulation, assessment, data collection and analysis, and development of methodologies). However, it also shares OECD's lack of action orientation, poor links with UN Specialized Agencies and the international S&T community, and a membership limited to industrialized countries.

Nonetheless, the Forum is generally regarded to be a successful, pioneering effort to catalyze international scientific cooperation in megascience programs. Its accomplishments argue in favor of institutionalizing and broadening its work. In addition to megascience, a successor to the Forum could cover consultation and cooperation on other large science programs and projects and related policy issues that profoundly affect the future course and effectiveness of scientific cooperation, even beyond the confines of the OECD. A decision to expand the Forum's role would give the OECD the opportunity to help build the foundation for a new era of international cooperation and collaboration as we enter the next century. Intra-European cooperation has given substance to a vision of cooperative advance, and encouragement to involving more countries in a network of cooperative scientific relationships.

The U.S. is submitting a proposal on the future of megascience cooperation in the OECD following the termination of the Forum. A central feature of this proposal is to create a mechanism for government program officials to exchange information on research plans and projects in large science programs, discuss relative priorities. and explore prospects for international cooperation. The Forum would be replaced by a Standing Group on Large Science programs. Funding for the proposed mechanism would be separately budgeted as a Part II program of the OECD. Although the proposal does not expressly refer to the examination of generic policy issues affecting cooperation, this function should be included in the terms of reference of the Standing Group.

If the OECD is to perform this role, it will need to develop institutional partnerships with international science and engineering organizations and developing countries. In view of their pivotal roles in bridging governments and the international S&E communities, consideration should be given to according observer status to UNESCO and ICSU in OECD groups planning and executing scientific cooperation.

At its December meeting, the Carnegie Group could explore the possibility of a common position on the future of megascience cooperation in the OECD, including discussion of the following options:

a. *Replace the Forum by a separately budgeted (Part II) program to exchange information and facilitate consultation and coordination on national and international "large-scale" research programs, plans and priorities in areas where that currently does not occur (U.S. proposal), and to identify and resolve specific problems and policy issues affecting cooperation.*
b. *Continue the Forum as presently organized for two or more years to review additional projects and programs and examine generic policy and program issues.*
c. *Terminate the Forum without continuing its functions in the OECD.*

V. Other issues for possible consideration by Carnegie Group

The Carnegie Group could effectively deal with issues related to Type I projects since they raise political and budgetary questions requiring resolution by the principal funding countries. Among them are:

A. <u>A possible Summit declaration</u>

A declaration of support for megascience cooperation agreed by heads of government at a Summit meeting would be the strongest type of political endorsement. There is a precedent. At the initiative of President Mitterand, the Versailles Summit in 1982 issued a declaration on international cooperation in science and technology and agreed to establish an *ad hoc* working group on Technology, Growth, and Employment (Attali Group). Although the Attali Group recommended that the Heads of State continue to include scientific and technological issues at future Summit meetings, this has not been done. However, it might be politically advantageous at this time to demonstrate the common desire of the G-7 countries and Russia to cooperate in large scientific and technological ventures looking toward the 21st century. The declaration could build on the anticipated OECD agreement on principles for cooperation.

Members of the Carnegie Group could agree to recommend to their governments that megascience cooperation (including cooperation with Russia) be included on the agenda of the next Summit meeting.

B. <u>Agreement on negotiating principles</u>

There would be significant advantages if the heads of government could agree on principles and guidelines for negotiations on Type I projects. An agreement would increase confidence in long-term political commitment and facilitate individual negotiations that now rely on *ad hoc* policies and arrangements.

Guidelines for megascience negotiations could cover long-term commitment, sharing of lifetime costs and benefits, in-kind contributions, dealing with cost overruns, intellectual property rights, choice of site, equalization of benefits to host country, control and management responsibility, competitive industrial contracting, number of partners, access and selection of user groups, information sharing and data handling, and the type and basis for financial contributions from small and developing countries.

The type of agreement (treaty, executive agreement, memorandum of understanding, exchange of letters, etc.) will depend on the body concerned (executive, parliament, agency), how detailed the agreement is, and the legal framework.

Agreement by treaty has the highest confidence level (*e.g.*, for a facility such as CERN) since it demonstrates political commitment and the support of parliamentarians as well as the executive. A treaty is used only exceptionally for international cooperation (particularly by the U.S.), but the possibility should be further explored in light of European experience.

Unlike a treaty, an executive agreement is not ratified by Congress in the United States. Nonetheless, it appears to offer substantial advantages for a broad framework agreement on megascience cooperation for central research facilities as well as distributed programs. Executive agreements have worked well for Type II programs which typically include a large number of countries, such as the Inter-American Institute for Global Change Research which established a Conference of the Parties as its principal policy-making organ (considered a treaty under international law).

The Carnegie Group could review the desirability of establishing by treaty or by executive agreement, general guidelines for negotiating megascience collaboration among the principal funding countries.

C. <u>The appropriate level of negotiations</u>

Many current programs seem to be well handled with the responsible agencies/ministries taking the lead. The ocean drilling program, where half the overhead costs of the ship are paid for by the US and the remaining half is divided equally among six other partners is an example. NASA has developed agreements with a number of countries in which those countries supply packages that NASA flies on specific satellites. Experience indicates that, where possible, megascience negotiations should be handled at the agency level, and supported by direct contacts between the corresponding laboratories.

On exceptional occasions international negotiations can better be handled at the science minister level. For example, negotiations may be stalled because of special considerations of foreign policy, domestic politics, national prestige, or disparities in economic benefits. Science ministers or other presidential-level officials may also be involved where there is substantial political sensitivity (*e.g.*, a head of state visit leads to a bilateral agreement, which in turn calls for additional partners, or a project is part of a broader program of cooperation such as the Gore/Chernomyrdin agreements). Of course discussions and negotiations based on a "basket" of projects would need to be conducted at the highest level of government.

The Carnegie Group could discuss circumstances that might warrant referral of unresolved issues in megascience negotiations to higher levels of government for international consultation.

D. 1. Long-term funding

Participating governments would like greater assurance that all of the funding countries will sustain long-term commitments to megascience projects and programs. In some countries of Western Europe and in Japan, governments can make firm funding commitments for 3-5 years, while other countries, like the US. are limited to annual or biennial appropriations. In light of historical experience with megascience cooperation, funding failures are the exception. However, because of failures and uncertainties in funding a small number of high profile megascience projects, the U.S is sometimes viewed as an "unreliable partner" (e.g., although the SSC was not initiated as an international program, its abrupt cancellation after substantial investment has added to these concerns). The U.S. is not alone in this regard, and guaranteed long-term funding is difficult for most governments. For the U.S., it is unlikely that an exception to annual appropriations will be made for megascience cooperation. Although multi-year appropriations have been approved for the National Science Foundation, for example, the fact that the additional funding increases the budget deficit has usually limited the funding to academic projects. Nonetheless, multi-year authorizations for funding coupled with strong presidential backing of international agreements could increase confidence that the U.S. will honor its commitments, particularly with the increasing congressional insistence on securing foreign contributions to megascience projects. The creation of a national "Scientific Investment Budget" for megaprojects was advocated in a report to President Bush by the President's Council of Advisors on Science and Technology (1992). A similar case can be made for international megaprojects and programs.

Early funding guarantees may be needed for many reasons, including to avoid the possible loss of support by a country that loses in the competition for the facility site. The recently opened European Synchrotron Radiation Facility in Grenoble, built on time and on budget, is regarded as a "model for the future". Twelve countries guaranteed funding of $600 million for the first ten years of the project, to 1988. A global budget for a group of megascience projects is another alternative deserving consideration.

Early involvement of parliamentarians could help generate long-term commitment. Exchanges of views with parliamentarians on ways to facilitate such communication could lead to more systematic and sustained communication at national and international levels. On balance, however, this is largely a national problem and solutions will differ according to the political structure of governments and the division of authority between parliament and the executive.

The Carnegie Group could discuss national approaches that could improve the probability of obtaining long-term funding commitments for cooperative projects, including ways of establishing communication with parliamentarians during the process of initiating and agreeing on megascience cooperation.

E. A portfolio or "basket" approach to negotiations

The economic benefits to different partners involved in the siting and construction of large facilities are a well-recognized obstacle to Type I megascience cooperation. Although it might be possible, in principle, to equalize benefits project-by-project (e.g.

the host country pays a higher fraction of the costs, or each country's contributions is made exclusively in kind), this approach is unlikely to be successful for all projects, since, from a political or financial standpoint it may not be possible to develop a "fair" plan. It is superficially attractive to consider trading off benefits through a "basket" of big science projects, where it was generally understood that the location of sites and construction contracts should be considered equitable by the major funders, while the overall goal of scientific excellence is maintained.

This approach is advocated by Congressman George Brown, the chairman of the U.S. House of Representatives Committee on Science, Space, and Technology. It is the view of the Megascience Forum that, although the "basket approach" seems feasible within one given field of science, applying the concept across the borders of disciplines presents numerous problems (including differences in how the field is defined). The conceptual difficulties involved in trade-offs among projects in different areas of science, the fact that individual projects are usually at very different stages of development, and that critical decision points in individual projects therefore occur at very different times, would seem to question the feasibility of formal basket technique. On the other hand, trade-offs could be considered between past, present, and future projects, or it could be decided simultaneously to locate new facilities in several regions over a decade. As the Megascience Forum acknowledges, "governments might be forced to have recourse to this [basket] approach".

The Carnegie Group could review the feasibility of the basket approach, including possible variations.

F. Cost analysis of specific projects and programs

Intergovernmental agreement on megascience cooperation should be based on a common understanding of the actual and projected long-term expenditures for the capital and operating costs and expenditures for research, including support for individual investigators. Accurate estimates of costs and avoidance of cost overruns are essential to gain financial support. It would be useful to have for each project, a detailed analysis that (1) includes the objectives, time frame, and cost of the project; (2) divides the project into phases such as feasibility, design, construction, and utilization—with performance standards and milestones to be met at each phase; and (3) analyzes the economic benefits to the host country and the prospects for burden sharing during each phase.

The task of developing a common budgetary framework, cost accounting methodologies, and standardized reporting for megaprojects could be undertaken under the auspices of the Carnegie Group or the OECD.

G. Organizing for a new era of scientific cooperation

Megascience cooperation is part of a larger fabric of international scientific cooperation. Although there has been a long tradition of communication and interaction among scientists in different countries, national science policies and programs have tended to treat international cooperation and exchange as exceptional. This attitude is changing as scientific needs and opportunities have been squeezed by severe budgetary constraints. Scientists and engineers are increasingly regarded as a global resource, yet the organizational structures and vertical hierarchy of intergovernmental organizations (including the UN Specialized Agencies) severely limits their ability to draw on non-governmental organizations of scientists and engineers to attack problems that cut across jurisdictional lines.

Members of the Carnegie Group could recommend that their governments encourage efforts to mount a comprehensive study to design a more effective multilateral science and engineering system of institutional relationships linked to partnerships with non-governmental science and engineering bodies and the private sector.

VI. Megascience policy issues for the OECD

The Megascience Forum has identified a number of generic policy issues that affect international cooperation. A number of these and other critical issues require detailed analysis and assessment of policy options. The OECD should undertake in-depth policy studies of S&T cooperation in large science programs on a continuing basis.

The Carnegie Group members could agree on key megascience issues which they could recommend to their governments for study and policy recommendations by the OECD, including:

A. <u>Criteria for deciding on megascience priorities</u>

Because of severe resource constraints, government officials would like to have a systematic process for determining priorities among megascience projects and programs, and between them and small scale investments in their respective fields of science. However, there has been no generally accepted methodology and little success in ordering science priorities nationally, let alone at the international level. There are incommensurable differences among and within fields of science and in perceived benefits. While formal methods may not be feasible, there is no doubt that concerns about costs of megascience projects will force more frequent justifications and tradeoffs of various kinds.

The OECD could analyze and recommend criteria for deciding on priorities among international megascience programs, and between investments in megascience and investigator-initiated projects.

B. <u>Choice of operating mechanisms</u>

There are a number of mechanisms for organizing, managing and operating megascience programs.

1. <u>Full partnership</u>

This approach, where the cost and benefits of Type I facilities are shared among the partners has been best developed in Europe (CERN, European Observatory). It requires complex negotiations to deal with cost control, site selection, and perhaps a willingness among the partners to deal with more than one program at a time. Management often reports to an international board.

2. A lead country

One country takes the lead, contributing a disproportionate percentage of the assets into a Type I facility. Other countries contribute, often in kind. Examples include the Ocean Drilling program, the new German accelerator (HERA), many NASA programs. Projects are chosen according to scientific merit. The decisions on experiments are decided primarily on scientific merit. The lead country keeps management responsibility.

3. Harmonized and complementary programs

A large Type II program can be developed by the scientific community, and each country's activities are optimized rather than duplicated. No funds are transferred, but data are shared, and formats for collecting and distributing data are agreed upon. Global Change Research fits this model. Or, complementary national facilities can be interconnected as illustrated in the decision to build three different and complementary synchrotron radiation facilities. Management is decentralized but requires an adequate coordinating staff.

4. User Groups

A full partnership or a lead country institution builds a Type I facility which is capable of accommodating user groups from outside the facility. A peer review mechanism is used to determine which groups do experiments. The users generally bring their own experimental equipment or samples to the facility. Management is controlled by the institution.

The OECD could carry out a review and analysis of operating mechanisms for megascience cooperation in order to develop criteria where each should be used.

C. Cooperation among funding agencies

Cooperation in program and project development in particular megascience areas can be dealt with using a variety of intergovernmental mechanisms. One of the most interesting from the standpoint of broad applicability is the International Group of Funding Agencies for Global Change Research (IGFA). Established in 1990, IGFA is an informal partnership of national agencies that fund global change research programs. It facilitates global change research by including the perspective of national funding agencies in strategic planning and implementation. It is used to exchange information on national programs, discuss approaches to the integration and implementation phases in light of available resources, promote coordination and access to specialized research facilities, and optimize allocation of national contributions to global change research. Another type of cooperation is the informal Donor Forum, organized by a grouping of multilateral institutions (World Bank, UNDP), private foundations, and other non-governmental funders to consider support for the science and engineering contributions to the UNCED and the three environmental conventions.

The OECD could be asked to assess the need for IFGAs and other international groupings of funding organizations in areas where there is no effective international forum, and the extent to which this need could be met by the proposed Standing Group *on Large Science Programs. The possible inclusion of representation from international organizations such as ICSU and Unesco, and from developing countries, should be considered as part of this assessment.*

D. 1. Barriers to international cooperation

There are a number of barriers to effective megascience cooperation of non-scientific character, *e.g.*, disputes in assigning intellectual property rights, issuing visas, taxes, housing for scientists and families, jobs for spouses, language difficulties, among others.

The OECD could be asked to analyze the non-scientific barriers to megascience cooperation and recommend procedures and policies for their reduction or elimination.

E. The impact of new information technologies on megascience cooperation

Inexpensive worldwide communications and information retrieval via E-mail, Internet, and other systems can facilitate and simplify the organization and management of large, distributed Type II megascience programs, and greatly increase capabilities for data acquisition and analysis (e.g., human genome mapping and global change research). Interoperability of data bases and networks is crucial for enhancing collaboration, and it is necessary to work towards appropriate international standards. The U.S. government is developing an electronic data base for government-supported R&D projects to facilitate coordination across agencies in support of national goals, as well as for general use. CORDIS provides similar information on activities of the EU. The development of comparable data bases by OECD member governments could stimulate scientific cooperation at both governmental and individual scientist/engineer levels.

The OECD could examine the ways in which developments in computer-based information systems can transform international scientific cooperation, particularly global mega- science networks, and steps needed to strengthen those systems.

VII. Other mechanisms for megascience cooperation

International institutions other than the OECD are and should be involved in scientific cooperation on large science programs. Assessing the experience of such institutions and ways to strengthen the participation of developing countries and of interntional non-governmental S&T organizations requires study and analysis, probably by the OECD.

A. UN Specialized Agencies

A number of UN Specialized Agencies have mounted successful megascience programs using a variety of institutional arrangements (e.g., the WMO World Climate Program). The series of global research programs that began with the IGY in 1957 have been successful in part because Unions of the International Council of Scientific Unions (ICSU) defined the scientific program and then obtained the endorsement of and worked closely with Unesco, WMO and other UN Specialized Agencies. There is excellent coupling of Unesco programs and ICSU Unions, and Unesco has played a leading role in organizing international megascience cooperation such as the Man and Biosphere Program. Unesco recently convened a new international advisory panel, the Physics Action Panel, to recommend actions to both Unesco and the international physics community on cooperation in physics research, particularly on megaprojects.

The OECD could undertake an assessment of the experience of UN Specialized Agencies in organizing global scientific cooperation in partnership with the international S&T community.

B. Non-governmental organizations

A prerequisite for initiating megascience projects and programs is an international consensus that is based on scientific merit and technical feasibility. Although the valuable role of the international science and engineering community in megascience cooperation is generally recognized by governments, its linkages for communication and mutual interaction and engagement with intergovernmental organizations, the UN Specialized Agencies as well as the OECD, are generally weak and unsystematic (with notable exceptions).

The International Council of Scientific Unions is the prime international scientific organization for generating scientific consensus in both initiating and assessing proposals for megascience cooperation. Global bodies such as the International Committee for Future Accelerators (set up under the auspices of the International Union of Pure and Applied Physics), could play an important role independently of governments in planning future facilities provided they are broadly representative of countries having strong capabilities in the field. Similar bodies could be created in fields where they do not now exist, although it is not clear that all of the relevant ICSU Unions have the capacity (or desire) to assume this role. There is a growing momentum among engineers to participate in megascience programs such as the International Decade of Natural Disaster Reduction. The World Federation of Engineering Organizations and the Union of International Technical Associations have associated to found a Council of Academies of Engineering in part to facilitate cooperation.

The roles of ICSU and the international engineering bodies could be enhanced if they were more strongly supported by governments and had organic connections with intergovernmental bodies involved in megascience cooperation, particularly the OECD, UN Specialized Agencies, and intergovernmental groups in various scientific and technical areas.

Although the international scientific and engineering communities are invaluable sources of scientific advice to governments, direct collaboration between governmental and non-governmental laboratories is the most effective form of S&T cooperation in the design, development, and operation of megascience facilities and should be strongly encouraged.

The national academies of science and other organizations of scientists and engineers also play an important role in international cooperation. As an example, there have been discussions in the U.S. National Research Council of organizing a study to provide guidance by the U.S. scientific community to the federal government for planning and implementing large international facilities for scientific research. Such a non-governmental study, supported and carried out as an international project with the participation of outstanding, experienced scientists from the G-7 countries and Russia, could provide authoritative long-range scientific guidance to national governments.

The OECD could examine ways to strengthen the organizational and financial capabilities of non-governmental organizations to contribute to megascience programs and projects, and to engage them in scientific studies and assessments.

C. Developing countries

Although megascience programs are principally funded by large industrialized countries, their planning and scientific output can be strengthened by involvement of scientists and engineers from all countries on the basis of scientific merit. Indeed, for some Type II distributed megascience programs, geographical considerations often require participation of developing country scientists. However, developing countries may not be able to finance the participation of individual scientists and user groups, and their involvement could interfere with their local priorities. Mechanisms for bringing in developing countries should include programs for capacity building to enable contributions to megascience projects. In the long run, all countries should be involved in international scientific cooperation, and new mechanisms should be developed to include them. In the next decade or so, China, South Korea, India, Brazil and other newly industrializing countries are likely to have strong interests in megascience cooperation, not merely token participation, but as leaders, funders, and contenders for facility sites.

Agreements for megascience cooperation should encourage equitable access and contributions of countries that are not members of the partnership, on the basis of scientific merit, through provisions for user groups and peer reviewed project proposals. For developing countries, questions to be considered include: what contributions they can make given their level of technical and financial capacity and geographical position; what they can gain from participation given their limited resources and priorities; what are their needs for financial assistance and how their participation can best be organized. At present *ad hoc* mechanisms and procedures are used. The U.S. proposal to establish an OECD Standing Group on Large Science Programs contemplates the inclusion of developing countries in particular cooperative projects.

The OECD could be requested to examine problems in, and procedures for, engaging developing counties in megascience projects.

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EPA Realigns Research Organization, Boosts Academic Grants And Training. The Environmental Protection Agency has adopted a new laboratory structure designed to improve its environmental research program, and has upped its ties to academe through a strengthened peer-reviewed grant program and expanded fellowship and traineeship programs.

Among the measures, the Office of Research and Development will dedicate 50 percent of its resources to long-term environmental research, and competitive investigator-initiated research will be expanded.

The agency has also accepted the organizational concept for its national laboratories that was proposed by the Carnegie Commission on Science, Technology, and Government in a 1992 report. It will incorporate in its Office of Research and Development structure a variation of the Carnegie Commission recommendations, reorganizing into four national laboratories dealing, respectively, with health and environmental effects, exposure, environmental assessment, and risk management. Regional and program office laboratories will stay in their current locations.

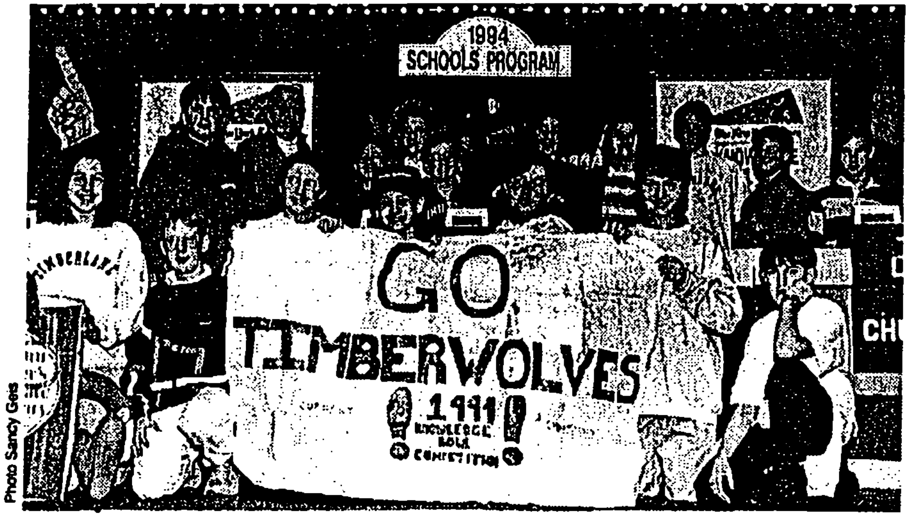
Administrator Carol Browner has deferred decision on any physical consolidations, often a subject of considerable debate and intense Congressional interest, until the next Presidential election year, 1996, when she presumably will have a better idea of which way the political winds are blowing.

Browner said the changes now being made "are a critical step toward our goal of scientific excellence and national environmental leadership. I am convinced that a vigorous and focussed research effort is an absolute requirement for the EPA of the future."

Other actions recommended by an internal steering committee and okayed by Browner include expanding the peer-reviewed investigator-initiated competitive grant program from $20 million to $100 million, and expanding the academic fellowship and traineeship programs. Graduate training will be made available to students through a competitive process.

The steering committee's report said the agency would "significantly increase involvement of the scientific community in its research" through its enhanced peer review process. The process will include on-site review of research laboratories and extramural programs following the approach used by the National Institutes of Health, uniform level of external peer review of research products and publications, and peer reviews of internal research.

The past weakness in EPA's peer review procedures thus appear to have been noticed and acted upon by agency management. Its announcement of the changes preceded the release of President Clinton's *Science in the National Interest* report (see separate story in this issue), which also spoke of the need for a strengthened merit review program for the agency.



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