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The Future of America's Research-Intensive Industries

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August 1995

Report R-97

This report was prepared by the Institute for the Future

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Deborah Erickson is a Deputy Director of the Institute for the Future. She is a former member of the board of editors for *Scientific American*. She graduated from Baruch College with a B.S. degree in business journalism.

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Stephanie Bardin, Jeff Charles, Nancy Ozawa, Andrea Saveri, and Jennifer Wayne also made important research contributions. Charles Grosel edited the report. Janet Chambers prepared the graphics, and Kimberley Lawrence was responsible for the entire production process.

Sponsored by the following research-based companies:

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PREFACE

Research-intensive industries are critical to the future health of the United States economy. Yet they are under increasing threat as the public policy framework of support built up during the Cold War unravels and as a competitive global economy forces our nation's largest industries to reorganize their operations into new organizational and operational patterns.

"The Future of America's Research-Intensive Industries" reflects a growing concern about the role of America's research-intensive industries in the decades to come and about the public policy framework that will help them flourish. It identifies the need for a new perceptual paradigm concerning public and private R&D investment; calls for forging a new system of support for R&D; advocates for increased (and smartly focused) R&D spending; and makes specific recommendations for adjustments in incentives in various policy areas.

This report was prepared by the Institute for the Future. We worked closely with a panel of senior executives from many of America's leading research-intensive industries. We talked and met with these executives over the course of the project and used their help and guidance in identifying the critical issues and exploring the changing policy framework. While we are greatly in debt to our task force members, the report itself is fully the responsibility of the Institute for the Future.

TASK FORCE MEMBERS

Apple Computer, Inc., Randy Rettberg, Distinguished Scientist

Applied Materials, R. Wayne Sayer, Senior Consultant, Public Policy

AT&T, E. R. Kerkesleger, Vice President, Technology and Infrastructure

Bell Communications Research, Daniel J. Collins, Executive Director Regulation and Public Policy

Bristol-Myers Squibb Company, Andrew G. Bodnar, M.D., J.D., President, Oncology/Immunology and Worldwide Strategic Business Development

Designtech International, Inc., Mark Gottlieb, Executive Vice President

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Microsoft Corp., Kimberly Ellwanger, Director, Corporate Affairs

Raychem, John Midgley, Vice President, U.S. Corporate Technology

SmithKline Beecham Pharmaceuticals, George Poste, Ph.D., Chairman, Research and Development

Texas Instruments, Calvin C. Coolidge, Vice President, Washington Operations and U.S. Marketing

Varian, Derrel DePasse, Vice President, Worldwide Government Relations

EXECUTIVE SUMMARY

INTRODUCTION

Though we seldom stop to think about it, much of what makes our lives as Americans safer, longer, easier and more productive and enjoyable is the direct result of scientific and technical research. Research conducted by the computer and semiconductor industries, for instance, has transformed telecommunications, retail sales, and banking—bringing consumers faster service and better choices. The "information revolution" continues to increase our ability to quickly process data and communicate with others, while health care R&D yields innovative pharmaceuticals that save lives, reduce suffering, and enhance quality of life. Aerospace research continues to support the commercial airlines that arose from it—improving machines that have transformed worldwide distribution systems. From transportation to entertainment, consumer electronics to home appliances, the benefits of research are embedded in countless aspects of our daily lives.

So accustomed are we to the "inevitable" march of progress enabled by research that rarely do we stop to acknowledge who's helping lead that march—namely, America's research-intensive industries. Eight industrial sectors are responsible for almost all of the new and improved products and services we rely on: Aerospace, chemicals, communications equipment, computers and office equipment, pharmaceuticals, scientific instruments, semiconductors and electronic components, and software. These are the most research-intensive industries in America. Together, they pay for 70% of the industrial R&D conducted in this country, yet their combined sales account for only 33% of total net U.S. manufacturing sales. On average, the companies that populate these industries channel almost 8% of their domestic net sales toward R&D each year. Together, America's research-intensive industries provide a net trade surplus of over $50 billion.

An increasingly turbulent global economy and mounting domestic demands on government now threaten the ability of research-intensive industries to continue advancing the nation's standard of living. Unless direct public policy actions are taken, the United States risks setting itself up for serious, long-term underperformance. The pace of improvement we have come to expect as a nation is severely threatened. The magnitude of the danger, as well as the belief that the nation can improve its course, spurred the Institute for the Future to conduct this examination.

We determined to examine the contributions of these eight research-intensive industries to American life, the impending threats to a continued flow of contributions, and the policy steps that are essential to

ensuring our future. As a key part of this study, "The Future of America's Research-Intensive Industries," the Institute for the Future convened a task force representative of the eight industry sectors to look at what government's role has been, and what it should be now in light of the shifting economic conditions that threaten all eight industries. The reason for gathering the group was to get a high-level perspective across industries, in the belief that there are fundamental solutions to the complex challenges facing these disparate industries. The policy recommendations the group has come up with are intended to help government provide the contextual support that would preserve our nation's leadership role in innovation.

INVESTMENT GOALS FOR R&D IN AMERICA

> *The United States must increase its public and private investment in R&D to ensure continued global competitiveness. The government should provide the support and context necessary to increase our total R&D investment from 2.6% of GDP to 3%, at least matching the level of our main international trading rivals Japan and Germany.*

Both President Clinton and the Republican Congressional majority support higher levels of investment in new technologies. President Clinton outlined his support for increasing total R&D investment to 3% of GDP in "Science in the National Interest," released by the Office of Science and Technology Policy in August 1994. The new Republican House majority supports an increase in productive investment in their "Contract with America" released in September 1994. This report on "The Future of America's Research-Intensive Industries" is consistent with the goals of both leadership documents; it recommends a specific action agenda that will provide the needed context of support that is necessary to raise public and private spending on R&D from its current level of 2.6% of GDP to 3%.

The complementary investments of government and industry provide goods and services that transform America's quality of life and personal health. This synergy is fueled by just a small fraction of our national expenditures—total U.S. R&D spending is only 2.6% of our gross domestic product (GDP), or approximately $160 billion. Federal spending accounts for about 42%, or $68 billion, of this national R&D effort. Currently, only a quarter of the government's share is directed toward basic research that eventually brings widespread benefit to the nation; the rest is devoted to defense-related and other applied R&D and has been since the beginning of the Cold War. Industry provides the bulk of the U.S. R&D effort—about $84 billion or 53% of the total. Universities and nonprofits account for the other 5%.

In principle, the federal government has a dual responsibility for ensuring the appropriate mix and level of R&D. First, it must maintain its role as a major contributor towards basic research and scientific training. Second, it should create incentives to stimulate greater levels of private-sector investment in applied research and development. Because many of the benefits of research become available rapidly to others who had no role in funding it, the economy tends to underinvest unless incentives are provided.

This report provides an action agenda that outlines the steps necessary to achieve the goal of increasing total R&D spending to 3% of GDP. There are five major tasks:

- *Government spending on basic research must be maintained.* The end of the Cold War is an opportunity to equalize federal spending for defense-related R&D and fundamental basic research. The goal should be to maintain federal funding of R&D at its current level of 1% of GDP—$68 billion in 1993. Currently, approximately 60% of government R&D spending is directly for defense; we envision that this share will fall to 50% and the remainder of funds will be freed to move into other areas of basic and applied research. Changes in the global economy make adequate funding of basic research by the private sector nearly impossible. State-of-the-art research laboratories and scientific instrumentation are essential to America's future competitiveness, but many of our research institutions, especially universities, have not kept pace. Government investment in basic research creates the intellectual foundation that America's research-intensive industries require to develop new goods, services, and technological processes.

- *The government must increase tax incentives that encourage higher levels of private investment in longer-term R&D.* Government has an important role to play in adjusting incentives. Government should make the R&D tax credit permanent and substantial, lower the capital gains tax rate, and strengthen the inducements for institutional investors to take a larger role in long-term investments.

- *Government must consciously act to create a regulatory environment that reduces government-generated risk associated with innovation by increasing the use of market forces.* There are three big areas where government actions can make a difference. The government should push for tort reform that establishes national standards for product liability that will reduce the risk of litigation for firms that have deep pockets and are innovative. The government should also, where appropriate, utilize cost-benefit analysis and regulations that set industry or regional outcome goals or targets so that efficient market forces can play the key role in

enforcing the regulations. Finally, the government should use anti-trust policies that encourage cooperative R&D ventures and global competition.

- *Intellectual property rights should be expanded to help industries receive adequate return on their R&D investments.* The new General Agreement on Tariffs and Trade (GATT) accord provides a framework for international enforcement for intellectual property rights in the rapidly growing developing countries. The government should support enforcement efforts and legislation that promote these goals. Government should also act to ensure that laws take account of the digital revolution, to protect inventors' ideas in the electronic forms in which they are increasingly developed and stored. Enabling the evolution of encryption technologies is one promising way the government can open a particularly attractive global market, prevent piracy of intellectual property, and increase commercial utilization of the information highway.

- *A healthy environment for cooperative R&D must be created.* The government should play a role in encouraging the use of ideas developed in the universities and federal labs through cooperative research programs that call for equal private funds and that give companies the right to patent results. In addition, the government should continue to provide support for infrastructure and adapt antitrust laws to encourage productive collaborative R&D ventures such as research consortia, ventures, and partnerships that cut across institutional and/or international boundaries and accelerate development rather than serve political purposes.

POTENTIAL CONTRIBUTIONS IF INVESTMENT GOALS ARE MET

If the United States achieves the goals highlighted above—maintaining the overall level of federal support while increasing the share going to basic research slightly and increasing private R&D investment to 2% of GDP—then research-intensive industries will produce remarkable improvements in the way our current and future generations live and function in the world. For example, advances in the eight principal sectors will help transform the way we work—the computer, communications, and software industries will change the basic organization of industries, firms, and work teams and change the way consumers shop; aerospace will bring the European and American markets closer to Asian manufacturers; the pharmaceutical industry will help the elderly maintain a healthy, active lifestyle longer and decrease national expenditures on health. The report examines the many ways that R&D will enhance education, medical care, entertainment, communications, world agriculture, and even the functions and efficiencies of local government.

Increasingly, R&D advances by one industry will be used to further advantage by other research-intensive industries. One example considered in the report describes the enhancement of results from the medical field as they capitalize on new information technology. Interactive videos will help patients decide when to seek treatment and educate them about options. Computer databases will help to customize medical care, by analyzing patients' medical profiles before matching them with treatments best suited to their individual needs. Semiconductor chips coated with DNA will enable genetic screening and inform about the choice of therapies for diseases diagnosed this way. Software will help to design and improve pharmaceuticals, track clinical trials, automatically re-order hospital inventories, and record patients' experiences. Many other promising types of synergy are discussed in the report.

WHAT WILL BE LOST IF INVESTMENT GOALS ARE NOT MET

Significant economic and social improvements will not materialize if the nation does not reach its R&D investment goals. The specific losses will be difficult to quantify. We'll never really know what we've missed—what new ways electronics could have simplified and enriched our work and personal lives, what nonpolluting forms of energy and transportation could have been ours, what cures might have been developed for diseases such as Alzheimer's, coronary heart disease, arthritis, and osteoporosis. If we fail to invest sufficiently in R&D, the next wave of career opportunities and employment gains may never arrive. We may never glimpse the new technological vistas described by freshly coined words such as "interactive TV," "wireless," and "biotechnology"; our relative standard of living will decline if our research-intensive industries slip behind those of other nations.

THREATS TO PUBLIC INVESTMENT IN R&D

Traditionally, federal expenditures for R&D have been driven by fears of the military might of the Soviet Union; our national commitment to be the world's superpower in defense also included plans for strategic space stations. Consequently, over the last 50 years, 60% of the federal research budget has gone to defense spending, another 10% to aerospace. But the R&D investments we made for strategic purposes did more than ensure national security—they enabled the transformation of the American economy and way of life.

Aerospace provided the means for the transportation revolution while defense contractors made fundamental contributions to computers, semiconductors, communications, and energy industries; these industries were direct beneficiaries of federal research dollars and specialized procurement. Defense spending enabled these industries to build vast new infrastructures and create new products and processes broadly useful in society. Defense investments in basic science sup-

ported the career development of many of the leading research scientists who helped America gain its technological—and therefore geopolitical—edge on the Soviet Union and other nations.

The end of the Cold War takes with it the most compelling reason America has ever had to invest federal dollars in R&D. At the same time, fierce global competition is forcing many firms to cut costs to stay competitive. The rates of R&D spending in four of our eight research-intensive industries—aerospace, chemicals, electronic components, and scientific instruments—have fallen over the last five years. In just the last year, six of the ten largest R&D spending firms in the United States cut real spending on R&D.

We as a society need to articulate the need for R&D in a world with a closely integrated global market in which new ideas embodied in products will determine the wealth of nations. If the nation is going to continue to lead the world in bringing innovative products to market, government officials must find the means to stimulate basic and applied research across a broad range of research-intensive industries in the United States. They must also convince a wider public of the benefits that only R&D can cause to flow through a myriad of products that benefit daily lives and welfare.

Finding the political will to invest more in basic research will be increasingly difficult, as other interests vie for a larger share of the federal budget. Two key trends foreshadow the coming struggle. Entitlement spending has already risen from 30% to 55% of the federal budget and will approach 70% by the year 2000 under current trends. At the same time, interest payments on the national debt, now taking about 13% of the overall budget, will grow further if the deficit is not reduced. Not only will available discretionary funds diminish, there will be ever more interest groups lining up with new petitions. Those demanding federal financial support to improve their immediate conditions will prove potent competitors to those who understand the need for long-term national investments in research.

POLICY RESPONSES TO ENSURE PUBLIC INVESTMENT

> *The federal government must make a strong commitment to support basic research by refocusing investments once devoted to defense R&D toward fundamental inquiries that offer more widespread rewards.*

Voters must support public officials with the vision to recognize that making greater investments in basic research is an irrevocable responsibility—one that once met helps to keep the nation economically strong by addressing the long-term needs of the many rather than the immediate needs of the few. If America is to remain a world leader,

its citizens must elect officials who do not shirk their duty to enhance basic research, but rather support it as the nation's springboard for economic growth. To underinvest would invite long-term economic and social deterioration.

THREATS TO PRIVATE INVESTMENT IN R&D

Both Germany and Japan spend more than a full percentage point more on total private sector R&D than the United States. In the United States, the share of private investment in total R&D is growing and now accounts for 58% of total national research spending, up from 40% over the last two decades. Still, the United States lags well behind its major trading rivals. The overall level of private investment in R&D depends on the amount of capital investors are willing to commit, and industry's ability to devote internally generated resources to this purpose. There is trouble on both fronts.

The business climate for America's research-intensive industries is undergoing fundamental changes that threaten the ability of these sectors to maintain their current levels of R&D investment, let alone increase them. In many regards, these threats are side effects of past R&D successes. One such threat results from the information revolution: The increased speed of data transfer has also increased the speed with which an inventor's discoveries can be copied or stolen. Such double-edged effects force reconsideration of public policy approaches, ranging from those meant to protect intellectual property and patentable products to those meant to enable a fair return on investment.

Past research successes have raised the bar on what will be considered "breakthroughs" in the future; the complexities and costs of achieving major advances are steadily increasing. Public policies seeking to increase private investment in R&D must address the high costs and financial risks incurred by innovator industries by enabling the formation of new collaborative structures, such as research consortia, that will allow groups of firms to pool expenditures and risks.

Other new federal policies must reverse the recent trend toward falling confidence levels in societal leadership and in our economic future. There has been an associated increase in regulation and litigation, which has daunted R&D investment in recent years. Fear of bearing the unknown costs of new regulation and lawsuits continues to discourage experimentation and innovation among research-intensive industries. One marker of the current level of business concern is this: "Fear of product liability" is cited as the number-one threat to future growth by member firms of the National Association of Manufacturers.

Specific trends threatening to undercut private investment in research include the following:

- *The returns from R&D are diminishing.* Many large firms, especially those involved in high-tech global markets, are experiencing a decline in margins. A number of factors are behind this commoditization of product: Global competition is squeezing price levels; the rapidity of new-product innovation is reducing product life cycles, and the information revolution has eroded the edge once provided by patent and copyright protection.

- *The costs of research are climbing.* Research and development costs are rising, for reasons that range from the expense of changing over to new technologies, to the costs of complying with a web of new regulations, to more expensive product testing, to the increasing cost of venture capital. The difficulty of going it alone is giving rise to consortia-like relationships intended to spread both costs and risks.

- *U.S. rates of personal and corporate savings are lowest of any nation.* Compared to citizens of other industrial nations such as Britain and Germany, Americans save and invest far too little. Current tax policy is riddled with disincentives to greater savings that is equivalent in the national account to investment. Double taxation on income and again on savings is one undermining factor. Another is the uncertain nature of the corporate R&D tax credit, which—because it is only a short-term credit that government can revoke at will—seldom stimulates long-term investment.

- *An aggressive regulatory climate will diminish investor interest in research-intensive industries.* Government's continuous encroachment on competition through regulatory controls that distort market forces is undermining investor confidence. Cases in the report examine how regulations on specific types of emissions from discrete facilities (rather than activities over a broad area) penalize innovation; policies promoting single solutions for problems like air pollution (electric cars) preempt competition among new technologies; policies that grant local monopolies provide protective barriers (local phone service and banks) and discourage service improvements; policies that distort prices (cable TV rates, pharmaceuticals purchased by Medicaid) discourage competition and innovation.

- *Public policy should help build an environment where collaboration can flourish.* The ability of a single firm to bear the full burden of R&D costs is disappearing as the central research facilities are pared in many large firms and the costs associated with devel-

oping research ideas, winning market approval, and bringing them to market rise.

CONCLUSIONS

Research discoveries enable vast improvements in the quality of life in America, and in our country's world standing. Investments we make now—through both public and private sectors—will spur growth for many years. Research, and the industries dedicated to turning ideas into goods and services, have great power to positively influence not only how we fare in the future, but how our children and grandchildren will fare as well. But the basic assumptions on which we have based our R&D decisions for the last 50 years are in a state of transition, threatened by changes in international politics, the force of current technological change, and the fierce pressures of global competition.

The goal of both public- and private-sector policy must be to encourage research. To do this does not require massive changes in roles or spending levels but rather shifts in marginal societywide incentives that will encourage changes in spending priorities and organizational adjustments. Our public policies must encourage research. Overall federal investment must continue at a rate of 1% of GDP, with greater emphasis on basic research; federal policies must actively encourage private investment to increase to 2.0% of GDP, from the current rate of 1.6%. Historically we have done more; we can now afford to do no less. Our past decisions to support research were made easy by the strong economic growth we enjoyed after World War II, and by the Soviet threat that spurred us on. The standard of living we have today is only possible because America made the investments it did 20 and 30 years ago. It's our turn to invest—knowing that we, and the generations that follow us, will reap untold benefits.

The decades ahead will challenge our ability to be mindful of the long-term value of investing in research. The call to increase public monies for basic research comes as economic growth has slowed, and at a time when a smaller federal purse is asked to solve ever more immediate problems. Private investment is threatened by global competitive factors, diminishing the profitability that enabled R&D investments in the past.

Our public policies toward research investment must now take their motivation not from fear, but from recognition of responsibility to our own future and future generations. Aware of the benefits we have received from our previous investments, America must act out of optimism for what can be accomplished through research. Together as a nation, we must make a conscious commitment to be true to our future—and enact public policies that encourage research and development.

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Industrial Research Institute, Inc.

June 30, 1995

To: Federal Science and Technology Committee

Subject: **FST COMMITTEE ACTIVITIES & INFORMATION**

IRI will convene a special policy roundtable meeting on Wednesday, August 23 from 9:00 am to 3:30 pm, at IRI headquarters in Washington, DC. The focus of this session will be to review pending and planned changes in funding of government science and technology programs in DOC, DOE, DOD, NASA, NSF, and other agencies, to discuss the implications of these changes on research in university and government labs, and to examine their impact on the long-range needs of industry in promoting technological innovation. You recently received a memo (and registration form) from Chuck Larson outlining the program. We urge you to send a representative if you are unable to participate.

Please take a few minutes to look over the enclosed materials:

1. A copy of the 1995 Annual report of the FST Committee.

2. A copy of the FST Committee's Summary of Recent Accomplishments.

3. Chuck Larson's June 30 memo with the FST Committee Charge and Roster.

For your calendar, The FST Committee will meet on the following specific dates over the next year:

Thursday, November 2, 1995, Coronado, CA, 8:30-11:30 a.m.,
Thursday, May 23, 1996, Colorado Springs, CO, 8:30-11:30 a.m.

In addition, there will be a two-day FST Summit/Committee meeting in Washington, DC during January 1996; we will notify you as soon as specific dates are confirmed. Please send any suggestions you have for agenda items to Dave Knowlen, FST Committee Chair, or me. Dave also wanted me to mention that the FST Committee is sponsoring a Special Interest Session at the Fall meeting in Coronado on Saturday morning (11/4) on the "Los Alamos Industrial Fellows Program." We look forward to your participation in FST Committee activities during the coming year.

Margaret

Margaret R. Grucza
IRI Liaison
FST Committee

MRG:krr
Enclosures
cc: D. Knowlen
G. McGraw

FEDERAL SCIENCE & TECHNOLOGY COMMITTEE
1995 Annual Report

Federal Science & Technology (FST) Committee serves as the primary liaison between IRI and the Federal Government on policies and programs of national interest. To accomplish this, the committee:

- Makes available to Federal Agencies the advice and counsel of IRI in the field of industrial research and development.
- Maintains an effective flow of information to and from IRI members on the activities of federal agencies, especially by means of interactions with the key members of the Federal Government Liaison Council.
- Initiates, from time, to time, IRI position Statements, Advisory Letters and Questionnaires regarding government policies and programs that affect the conduct and application of various aspects of research and development.

Peter Boer of W. R. Grace was Committee Chair in 1994-5, and Dave Knowlen of Boeing served as Vice-Chair. Significant activities during the past year are outlined below:

Federal Government Liaison Council (FGLC)

The dominant event of the past year was the change in control of the Congress. This brought into question not only the funding that would be available to Federal agencies to undertake R&D, but the very mission of the agencies and the philosophies guiding their relationship with IRI member firms. These developments should heighten the importance of realistic commercial value in priority setting for Federal laboratories, and increase the voice of industry in Federal R&D decisions.

A second important congressional initiative, introduced before the November election, focussed on the concept of "strategic research" - in essence a recognition that the justification of future R&D budgets must be based on their relationship to national priorities.

The FGLC membership is:

Mary L. Good, Under Secretary for Technology, Department of Commerce

Siegfried S. Hecker, Director, Los Alamos National Laboratory

Lionel S. Johns, Associate Director for Technology, White House Office of Science & Technology Policy

Anita K. Jones, Director of Defense Research and Engineering, Department of Defense

Martha A. Krebs, Director, Office of Energy Research, Department of Energy

Neal F. Lane, Director, National Science Foundation

William Madia, Director, Pacific Northwest Laboratory

Arati Prabhakar, Director, National Institute of Standards & Technology

Gregory M. Reck, Acting Associate Administrator, Office of Advanced Concepts
Technology, National Aeronautics & Space Administration

Presentations by FGLC members and other interested parties at the January 1995 FST Committee meeting were extremely valuable in defining IRI members' interests in the new order in Washington, DC.

Key FST-Sponsored Activities

1. FST Chair, Peter Boer, wrote an Advisory Letter to the member companies highlighting the potential implications of the change in congressional control to ongoing and proposed programs involving IRI member companies with the Federal government, and urging timely input to the Congress regarding their own views and interests.
2. The Los Alamos Industry Fellowship Program has started very successfully. Thirty-five companies expressed interest in the program as did forty professionals within LANL. Six organizations are serving as hosts - the Delco Division of General Motors; The Dow Chemical Company, Lockheed/Martin Marietta; Allied-Signal, Eaton, and the Association of American Railroads. Initial reports from Peter Lyons indicate significant evidence of improved interaction with the national laboratories, and high interest in expanding the program.
3. The IRI staff updated and distributed a membership survey regarding the effectiveness of various Federal programs aimed at commercializing R&D from the Federal sector. This study, based on an IRI questionnaire had its origins in workshops conducted at the Annual Meeting in Palm Desert, CA in 1994. It has been circulated extensively to policy-oriented groups within and external to the Federal government.
4. The Department of Defense has proposed a Technology-for-Technology program to create access to technology from Japanese companies. This proposal was the subject of a meeting held at IRI headquarters in late April 1995.

Highlights of 1994-1995 FST Meetings

At the IRI Fall Meeting in Williamsburg, Skip Johns, OSTP, described the Administration's achievements in reducing and consolidating federal laboratories. He also gave an update on White House initiatives including: high-performance computing, the establishment of a national space transportation policy, and education and training programs. Finally, the role of the Critical Technologies Institute was discussed.

Bill Madia, Pacific Northwest Laboratory, reviewed the unique relationship of PNL with the Battelle Institute, which has its own laboratory co-located with PNL that is set up to facilitate cooperation with industry. DOE allows industry access to the laboratory through an existing "use permit agreement".

Graham Mitchell, Commerce, reported on the use of Federal resources to undertake R&D with the private sector, and indicated that today, the pressures of international competitiveness require the coordination of trade, economic and technology policies, with the health of the private sector being a measure of success and the views of the customer, i.e., American industry, absolutely critical to the effort. Another important need is to develop a government-industry partnership that goes beyond R&D itself, dealing with important areas such as regulations, capital formation, and tort reform.

Martha Krebs, Department of Energy, gave an update on the Galvin Committee regarding the national laboratories and the Administration's new National Science & Technology Council. She described the four "core" business lines of the DOE as *industrial competitiveness, national security, energy resources, and environmental quality*. She also reported that DOE has already far exceeded its goal of issuing 1000 CRADAs by fiscal year 1995. DOE has halved the time necessary to complete agreements with industry and the focus in CRADAs is now shifting to consortia, both horizontal and vertical.

Anne Petersen represented NSF Director, Neal Lane. She saw NSF as a catalyst in fostering strategic links between education, industry and other groups and regards universities as NSF's primary customers. There was a lively discussion of funding for academic infrastructure, and all agreed policy changes in this area should be cautious because the research universities are a great national asset.

Ed Brown gave an update on the Army Research Laboratory. It has seen some significant shrinkage in its budgets and staff levels. ARL seeking more "dual-use" technologies in its portfolio and is increasingly relying on out-sourcing of R&D. Ed described an innovative Army concept, the "Digital Battlefield, and the "Federated Laboratory" Concept which will leverage the private sector to be an intellectual crossroads for the Army.

At the January Meeting in Washington, George Vermont, OSTP, solicited suggestions for streamlining the regulatory process for industry. Input was requested as to which regulations should be amended, eliminated, and/or sustained. He also discussed the need for assistance in developing government metrics to measure federally-sponsored research.

Anita Jones, Defense Research & Engineering, defined the new global DOD mission in the post-Cold War era. She cited several new demands, including competition from the global arms market, the need to maintain military technological superiority with reduced budget, the demands of peacekeeping and counterproliferation, economic challenges, and the need to apply technology to achieve affordability. DOD is focused on affordability, dual use, rapid transition of technology to the warfighter, and an integrated technology plan, all the while emphasizing basic research, quality assurance, and superiority of technology.

Arati Prabhakar distributed a NIST status report indicating that Advanced Technology Program is focused on 11 programs suggested by industry. Early results indicate that companies with ATP-co-funded projects are doing R&D they would not otherwise have tackled and as a result, have identified new market opportunities. Early results on the Manufacturing Partnerships program indicate that the initial federal investment led to a seven-fold return as client firms modernized their operations.

Skip Johns noted that the President's budget will include funding for a major research and technology agenda from the private sector. Noting that Republicans will push for a $198 billion spending reductions, he said industry should worry about what's needed for long-term competitiveness. He noting that spending would be drastically reduced in the event of passage of a balanced budget amendment.

FEDERAL SCIENCE & TECHNOLOGY COMMITTEE OF THE INDUSTRIAL RESEARCH INSTITUTE

Summary of Recent Accomplishments

Founded under the auspices of the National Research Council, IRI's third Purpose is "To afford a means for industry to cooperate effectively with the Federal government on matters related to research." This cooperation was strengthened by IRI's relocation from New York City to Washington, DC in 1989. That move has allowed the Institute, through its Federal Science & Technology Committee and the IRI staff, to become an even more effective resource to government. IRI interactions with the Federal government since 1989 are outlined below.

1989

- **Aug.** Rep/Alts asked to prioritize five Federal R&D megaprojects and to provide comments on their technical feasibility, commercial potential, and cost-benefit. The overall rankings were (1) Human Genome Project, (2) National Aerospace Plane, (3) Space Station, (4) Strategic Defense Initiative, and (5) Superconducting Super-collider. Results sent to Rep/Alts and circulated widely in Congress and the Administration.

1990

- **Mar.** IRI issues a Position Statement on "Establishment of a Federal Research Institute." Copies sent to Rep/Alts, the Administration, Members of Congress, other associations, and the media.

- **May** Exhibits illustrating the facilities and expertise available at selected Federal laboratories and consortia at IRI Annual Meeting.

- **May** Special Interest Session on "The Advanced Technology Program: A New Role for the Federal Government in Civilian Technology Development" at IRI Annual Meeting.

- **June** IRI Rep/Alts invited to offer opinions to the National Science Board (NSB) on the "Potential Causes for the Erosion in U.S. Technology Leadership." Responses formed the basis for NSB's report, "The Competitive Strength of U.S. Industrial Science and Technology," issued August 12, 1992.

- **July** IRI officers hosted the President's Council of Advisors on Science & Technology (PCAST) for informal reception and dinner.

- **Sept.** IRI Past President Jules Blake began his 18 months' service as IRI Fellow in the Office of Science & Technology Policy. He was the seventh IRI Fellow to serve in OSTP over an eight-year period. His predecessors were Joe Morone (GE), Ora Smith (Rockwell), Lee Rivers (Allied-Signal), Fred Leavitt (Dow), Bill Owczarski (United Technologies), and Bob Schaefer (Amoco).

- **Nov.** Exhibits illustrating the facilities and expertise available at selected Federal laboratories and consortia at IRI Fall Meeting.

- **Nov.** Special Interest Session on "Opportunities for Technology Transfer with the DOE National Laboratories" at IRI Fall Meeting.

1991

- **May** Two Special Interest Sessions conducted in cooperation with the Department of Commerce, on "Financing of Technology" and "Vertically Linked Industrial Teams," at IRI Annual Meeting.

- **June** Created a 10-person liaison group of Federal laboratory directors and senior government executives responsible for science and technology policies (originally designated as the Federal Advisory Council, now Federal Government Liaison Council). Meets with FST Committee four times each year and provides focal point for closer interaction between industry and government on matters related to science and technology.

- **July** Conducted survey for Department of Defense on member company recommendations for future directions in manufacturing R&D.

- **Aug.** Rep/Alts invited to comment on the report of the National Critical Technologies Panel. Responses provided to OSTP and DOC.

- **Sept.** Selected Rep/Alts invited by Treasury Department to comment on staff analysis of "Foreign Investment in the United States: Unencumbered Access."

- **Oct.** Visits to Argonne National Laboratory and Fermi Lab during IRI Fall Meeting.

- **Dec.** IRI Emeriti provide proposal review from a business perspective for NIST's first awards in its Advanced Technology Program.

- **Dec.** Survey conducted for the U.S. Patent Office on the use of patent information by industry. Results provided to the Patent Office and the IRI membership.

1992

- **Jan.** IRI's Program Committee hosted a dinner with NSF Director Walter Massey. Subsequent meetings were arranged with industry R&D representatives in New York City (September 1992) and Pittsburgh (October 1992).

- **Feb.** IRI officers hosted the President's Council of Advisors on Science & Technology (PCAST) for informal reception and dinner.

- **Mar.** IRI co-sponsored, with CORETECH, a "Presidential Candidates' Forum on Research & Technology Policy " in Washington, DC.

- **June** Conducted survey for Department of Energy on member company interaction with Federal laboratories, for comparison with a similar survey conducted four years earlier. Results presented in Congressional testimony, at an IRI late-afternoon symposium, at the 1993 AAAS Annual Meeting, and in several publications.

- **July** "IRI Day" held at the National Institute for Standards and Technology and co-hosted reception for President's National Technology Institute meeting held at NIST the following day.

- **July** Survey conducted for OSTP to identify member companies interacting with the Former Soviet Union in science and technology, and to list barriers being encountered in this interaction.

- **July** IRI Position Statement on "United States Economic and Technology Policy--A Message to the Presidential Candidates" sent to President Bush, Governor Clinton, and Mr. Perot, as well as to Members of Congress, the Administration, campaign advisors, Rep/Alts, the media, and other associations.

- **July** Four representatives of IRI participated in the Naval War College's Global '92 program.

- **Aug.** Roundtable meeting to provide industry input on GATT R&D issues held in conjunction with OSTP, DOC, DOE, and USTR.

- **Sept.** Rep/Alts invited to offer suggestions on future directions of National Science Foundation (NSF), in response to a request from the Commission to Study the Future of NSF. Each reply and a summary of the responses were submitted to the Commission in October 1992. These responses also provided the basis for Testimony by IRI President Brian Rushton on future science policy in the U.S. before the House Subcommittee on Science and Technology in March 1993, and a subsequent IRI Position Statement on "Strengthening Industry-University Interactions," issued July 1993.

- **Sept.** Co-sponsored, with AEA, AIAA, AIA, COC, and other organizations, "Washington Conference on America's Industrial Manufacturing Base" in Washington, DC.

- **Oct.** Special Interest Session on "Federal Centers of Excellence" at IRI Fall Meeting.

- **Oct.** IRI representatives participate in a Symposium on "Targeting R&D for Competitive Advantage" at Department of State.

1993

- **Feb.** IRI participates in AAAS Seminar on industrial innovation and technology policy for new Congressional staffers.

- **Feb.** Rep/Alts invited to suggest names of appropriately qualified younger members of their research staffs for consideration as future members of NRC Committees.

- **March** IRI President Rushton testifies on U.S. science policy and the role of NSF before the House Subcommittee on Science.

- **April** IRI representatives participate in a Symposium on "New Directions in Technology Policy" at Department of Commerce.

- **May** Exhibits illustrating the facilities and expertise available at selected Federal laboratories and consortia at IRI Annual Meeting.

- **July** IRI Position Statement on "Strengthening Industry-University Interactions" sent to senior members of the Administration, Members of Congress, agency officials, University Presidents and Deans, media, and other associations.

- **Sept.** IRI sponsors Spotlight on Advanced Materials and Manufacturing Technology at Los Alamos and Sandia National Laboratories.

- **Oct.** IRI Director MacLachlan testifies on S. 1537, "The Technology Commercialization Act of 1993," before the Senate Commerce Subcommittee on Science, Technology, and Space.

- **Nov.** Special Interest Session on "Technology Transfer from National Labs: Learning from Industry's Needs and Experience" at IRI Fall Meeting.

- **Nov.** Rep/Alts invited to comment on Department of Commerce's "Advanced Civilian Technology Strategy," which references IRI's 1992 Position Statement on "U.S. Economic and Technology Policy."

- **Nov.** IRI appeals to U.S. Trade Representative about possible adverse effects of GATT R&D issues.

1994

- **Jan.** IRI co-sponsors, with NSF, Engineering Foundation, and NJIT, 20th Anniversary Conference on "New Directions for Multimember Research Collaborations: The Best Path for Industrial Research?" in Washington, DC.

- **Jan.** IRI conducts Seminar on "R&D Portfolio Selection and Evaluation" for DOE laboratory directors in Washington, DC.

- **Feb.** IRI co-sponsors, with OSTP, AAU, NAE, NAS, IOM, NIA, AAAS, and other organizations, a "Forum on Science in the National Interest: World Leadership in Basic Science, Mathematics and Engineering," in Washington, DC.

- **Feb.** Late-Afternoon Symposium held in cooperation with George Mason University on "GATT R&D Subsidies--Revisited."

- **March** IRI Representative Bush testifies before the Senate Labor and Human Resources Committee on the reauthorization of the National Science Foundation.

- **April** IRI Representative Kravitz testifies before the House Subcommittee on Science and Technology on GATT R&D Subsidies.

- **May** IRI Representatives participate in industry-specific workshops at Annual Meeting, in cooperation with the Department of Commerce, to prioritize recommendations in 1992 IRI Position Statement, to identify and assess critical technologies, and to assess the value of government programs that can benefit commercial technology.

- **July** Workshop summaries sent to all Rep/Alts with a request for additional assessment on the types of government R&D programs that can benefit commercial technology and for comments on the DOC document, "Listening to Industry: Business Views on Technology Policy."

- **Oct.** Special Interest Session on "How Industry Can Interact More Effectively with Government" at the IRI Fall Meeting. IRI updated Position Statement on "U.S. Economic and Technology Policy sent to Rep/Alts, to the President and key members of his Administration, and to Members of Congress.

- **Nov.** "Industrial Fellows" from Los Alamos National Laboratory begin a one-year visit to six IRI member companies.

1995

- **Jan.** FST Committee advisory issued on precipitous changes being called for in funding of federal science and technology programs.

CFL:pt
6/28/95
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Industrial Research Institute, Inc.

June 30, 1995

To: Federal Science & Technology Committee

Subject: **COMMITTEE CHARGE AND ROSTER**

Each year IRI welcomes newcomers to its committees, and again thanks those members who continue to serve.

One of our responsibilities is to make sure that you have the "Charge" of your committee as it is spelled out in IRI's By-Laws. This "Charge" is included in the enclosed committee procedures. "Guidelines for Committee Chairpersons" are also enclosed for your information.

Keep in mind that the Board representative to your committee is the official link between it and the Board. Any committee recommendations needing Board approval should be sent to your Board representative and to me at least two weeks before the Board meets, or earlier if possible. The Board is scheduled to meet on July 20, on November 3 in conjunction with our Fall Meeting in Coronado, on January 26, and again on May 22, before our Annual Meeting in Colorado Springs.

Also enclosed for each of you is the current roster of your committee. We've used the titles, addresses, and telephone numbers that we have on file. You will note a space for your Fax number and e-mail address. Please fill in either, if it is not already shown, make any corrections in your address or phone number, and return the roster to me by July 17. We will then reissue the roster with up-to-date information.

Please contact Pat Tiede if you would like a supply of the new IRI letterhead.

Charles F. Larson
Executive Director

CFL:pt
Enclosures: Committee Procedures, Guidelines, and Roster

GUIDELINES FOR COMMITTEE CHAIRPERSONS

The IRI's Purposes are accomplished principally through the efforts of the various committees. The committees are established by the Board of Directors, and the functions and plans of each committee are approved by the Board.

A Board Representative is appointed to each committee as the official link between the committee and the Board. The Board Representative is accountable to the Board for ensuring that the charge and functions of the committee are realized and that the committee operates in a manner consistent with the policies and practices established by the Board.

Committee chairpersons are responsible for the effective operation of their committees and for the achievement of their functions and plans. They are accountable to the Board through the designated Board Representative.

As a general rule, committee chairpersons are authorized to take whatever steps are necessary and appropriate to achieve the charge and functions of the committee. This includes committing their committee to a project or task, provided the committee concurs and the decision does not involve a real or potential, unauthorized financial obligation for the institute and does not involve establishing and starting an implied position of IRI. In the case where committee activity could involve a financial, moral, or voluntary commitment of the Institute as a whole is to be promulgated, the chairperson is obligated to confer with the Board Representative who shall bring the matter promptly to the attention of the President.

Committee chairpersons should note that copies of all committee correspondence, meeting notices, minutes, etc., should be sent to the President and to the Executive Director, who are ex-officio members of each committee, and to the Board Representative. The Board Representative is responsible for informing the President and Executive Director (or IRI staff liaison) of any additional items committee activities will be presented by the Board or when judged desirable by the committee chairperson and the Board Representative.

This procedure is intended to facilitate understanding in regard to responsibility and authority of committee chairpersons and Board Representatives pertaining to business within the Institute or to interaction with outside organizations.

FEDERAL SCIENCE AND TECHNOLOGY COMMITTEE

Reference:

By-Laws, Article III.

Committee Composition:

There shall be at least 6 appointive members, including the chairperson, who shall be a Past President when feasible. Two members shall be appointed each year for a 3-year term, and, recognizing the special requirements for continuity and experience, any of its members may be reappointed to an additional 3-year term without a lapse of 1 year. Appointive members of the committee must be employees of member companies, but not be current Representatives or Alternates; appointment of such persons must receive approval of the members of IRI's Executive Committee.

Committee Functions:

The Federal Science and Technology Committee shall:

A. Make available to appropriate Federal bodies and the National Academies the advice and counsel of IRI in the field of industrial research;

B. Maintain an effective flow of information to IRI members on activities of Federal bodies in fields of interest; and

C. Cooperate with the government in matters related to research.

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February 1, 1995

To: FST Meeting Attendees

Enclosed are the materials discussed during the recent FST Meeting. A copy of Peter Boer's memo to the IRI Membership is also enclosed.

Margaret

Margaret R. Grucza
Director, Research Services

FEDERAL SCIENCE & TECHNOLOGY COMMITTEE MEETING

INDUSTRIAL RESEARCH INSTITUTE
1550 M Street, NW, Washington, DC
First Floor Conference Room
January 12, 1995

AGENDA

8:30 - 9:00 a.m.	Peter Boer, FST Chair Introductions, Announcements, Future Issues
* 9:00 - 9:30 a.m.	Anita Jones Department of Defense
* 9:30 - 10:15 a.m.	Skip Johns OSTP
10:15 - 10:30 a.m.	Break
* 10:30 - 11:00 a.m.	David Goldston Council on Competitiveness
* 11:00 - 11:45 a.m.	Arati Prabhakar NIST
* 11:45 - 12:15 p.m.	Darius Sankey RAND/CTI Activities
12:15 - 12:45 p.m.	WORKING LUNCH Pat Windham, Senate Commerce Committee Discussion on Congressional Issues
* 12:45 - 1:30 p.m.	Anne Petersen (for Neal Lane) NSF
1:30 - 2:00 p.m.	David Nelson (for Martha Krebs) DOE
2:00 - 3:00 p.m. *	Federal Lab Discussion Topics: Industrial Fellows Program Update (P. Lyons) NTTC Initiatives (L. Rivers) FST/FGLC roles concerning industrial interactions with Fed labs (ALL)
3:00 - 3:30 p.m.	Meeting wrap-up; Adjourn

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Industrial Research Institute, Inc.

January 20, 1995

To: IRI Representatives and Alternates

Subject: FEDERAL SCIENCE AND TECHNOLOGY (FST) COMMITTEE ADVISORY

The implications for change in government/industrial policies on the fast-changing Washington scene are large. Many of you may have significant stakes in the outcome. As FST Chair, I am writing this advisory to alert you to this situation and the importance of expressing your concerns via your corporate contacts on Capitol Hill.

The January 12 meeting of FST was attended by senior officials from DOD, DOE, NIST, NSF and OSTP, in addition to congressional staffers. They were uniformly concerned about precipitous changes in direction on jointly developed federal-industrial programs which many of us feel have been a giant step in the right direction--building a partnership between government and industry in areas that foster economic growth and industrial innovation. At stake, among other programs, are Commerce's Advanced Technology Program (ATP), the CRADAs (now numbering 1,300) at the DOE's national laboratories, and the Technology Reinvestment Project (TRP). IRI companies have received over 100 awards under ATP and TRP alone.

There is a lack of understanding of the objectives and potential benefits of these programs within the Congress, and an undue emphasis on dollars versus recognition of what industrial-government cooperation can do to bring a sense of economic reality to the invaluable technology assets of the government sector, and so enhance the competitive power of American industry. The face-to-face contacts of scientists, engineers, and managers that are underway today are far more important to the U.S. in the long term than the potential savings from the programs that stimulated them.

The FST Committee developed a consensus on what should be done--direct discussions or correspondence with your representatives on the Hill in your own words with regard to your own concerns. Timing is critically important as Congress is ready to take action.

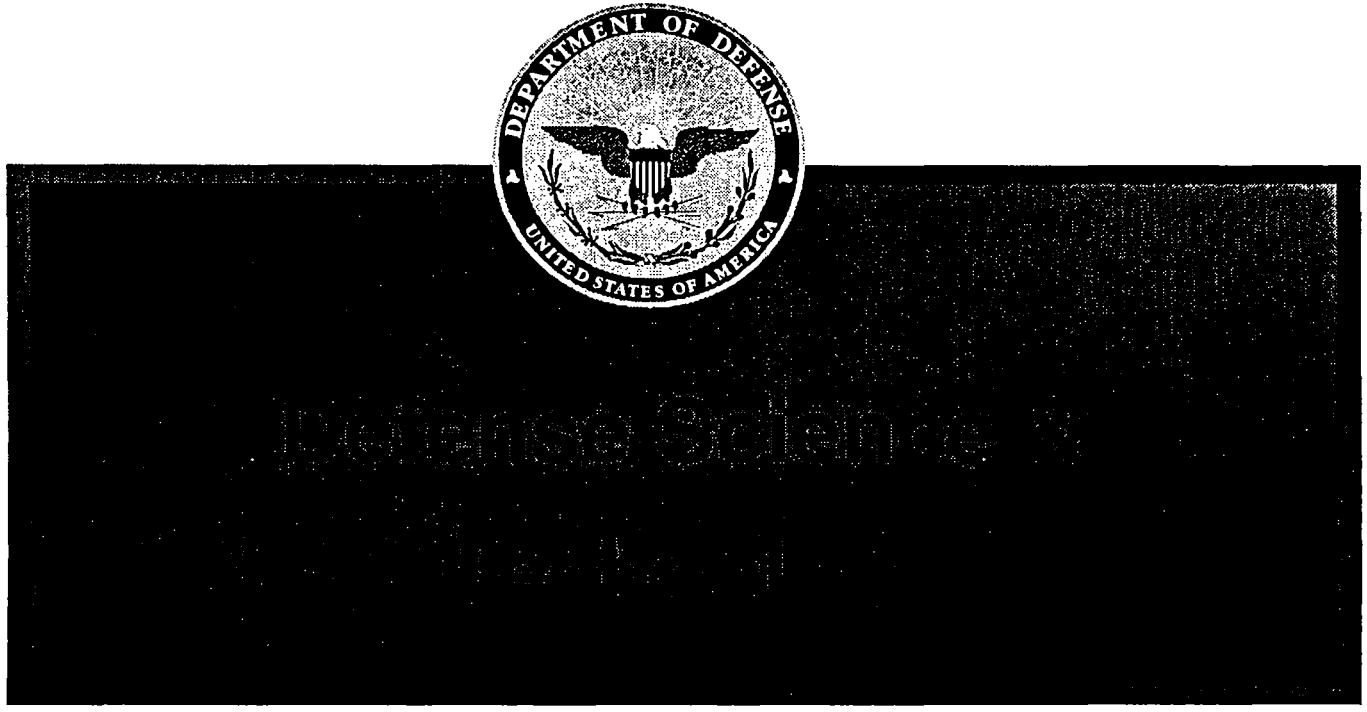
Recall that a top priority in IRI's recent Position Statement on United States Economic and Technology Policy was to:

> **"Increase private sector involvement in deliberations that establish policies affecting innovation, and that determine major government R&D investments."**

If you agree that we have made great strides in this direction during the past two Administrations and don't want to see the momentum lost, get involved now!

F. Peter Boer

F. Peter Boer, Chair
Federal Science & Technology Committee
Past President, IRI



Dr. Anita K. Jones

Director, Defense Research & Engineering

Post Cold War: New Demands of a New Era

- Today's Competitor is the Global Arms Market
- Must Maintain Military Technological Superiority with Reduced Budget
- Broader Military Demands: Peacekeeping & Counterproliferation
- The U.S. is Challenged Economically
- Apply Technology to Achieve Affordability -- Acqusition, Insertion, Ownership, and Force Levels

Joint Staff Future Joint Warfighting Capabilities

- To Maintain Near Perfect Real-Time Knowledge of the Enemy and Communicate that to all Forces in Near-Real-Time
- To Engage Regional Forces Promptly in Decisive Combat on a Global Basis
- To Employ a Range of Capabilities More Suitable to Actions at the Lower End of the Full Range of Military Operations which allow Achievement of Military Objectives with Minimum Casualties and Collateral Damage
- To Control the Use of Space
- To Counter the Threat of Weapons of Mass Destruction and Future Ballistic and Cruise Missiles to the CONUS and Deployed Forces

DoD Science & Technology Program

- **Basic Research**
  - Produce Knowledge that is Militarily Relevant
  - Invest for the Long-Term
- **Exploratory & Advanced Development**
  - Advance Technological State-of-the-Art
  - Build Laboratory Experiments
  - Demonstrate Military Applications

Strategy: How to Proceed

New

- Affordability: Reduce Cost of Systems
- Dual Use: Strengthen the Integrated Commercial-Military Industrial Base
- Transition Technology Rapidly to the Warfighter
- Integrated Technology Plan

Emphasize

- Promote Basic Research
- Assure Quality & Superiority of Technology

Reduce Cost

- Use Best Commercial Products, Practices, and Capabilities
- Invest in Manufacturing S&T and Improve Manufacturing Processes
- Exploit Advanced Distributed Simulation
- Insert Technology into Long Lived Systems

Commercial-Military Cooperation

Integrated High Performance Turbine Engine Technology

Team
- **Air Force, Navy, Army, NASA, Allied Signal, Allison, General Electric, Pratt & Whitney, Textron Lycoming, Teledyne Ryan, Williams**

Funding
- **1994 DoD: $132M NASA: 17M Industry: $94M**

Objectives
- **Turbofan/Turbojet Thrust/Weight Ratio:**
  - +30% by 1991, +60% by 1997, and +100% by 2003; -25% Cost by 1997
- **Turboshaft/Turboprop Specific Fuel Consumption:**
  - -20% by 1991, -30% by 1997, and -40% by 2003

Commercial-Military Cooperation

Integrated High Payoff Rocket Propulsion Technology

Team • **Army, Navy, Air Force, NASA, Aerojet, Atlantic Research, Hercules, Kaiser Marquardt, Rocketdyne, Rocket Research, Thiokol, TRW, United Technologies**

Funding • **1995 - DoD: $50M Industry: $30M (est)**

Objectives • **Boost/Orbit Transfer:**

- 2000: +5 sec Isp; +30% Thrust/Weight; -25% Failure Rate
- 2010: +20 sec Isp; +100% Thrust/Weight; -75% Failure Rate

Commercial-Military Cooperation

Advanced Synthesis and Processing of High Performance Composites

Team • Naval Air Warfare Center, ARPA, Los Alamos, NASA Lewis, GE Aircraft Engines, Pratt & Whitney, McDonnell-Douglas, Hexcell Corp, Univ of Virginia

Funding • ARPA: $4.5M Industry: $4.8M (24 Months)

Objectives • Develop Low Cost Manufacturing Process and Specifications for High Performance (High Strength at High Temperature) Metal & Ceramic Composite Tape Materials for Aerospace Structures.

Commercial-Military Cooperation

Sematech

Team
- DoD/ARPA, Advanced Micro Devices, Motorola, National Semiconductor, AT&T, Digital, IBM, NCR, Hewlett Packard, Rockwell International, Intel, Texas Instruments

Funding
- 1994- DoD: $90M Industry: $90M

Objectives
- Solve the Technical Challenges Required to keep the U.S. Number One in the Global Semiconductor Industry

Defense Driven Applications

Transmit / Receive (T/R) Modules

Team
- Air Force/ARPA/Navy, Texas Instruments, Westinghouse, Hughes Aircraft

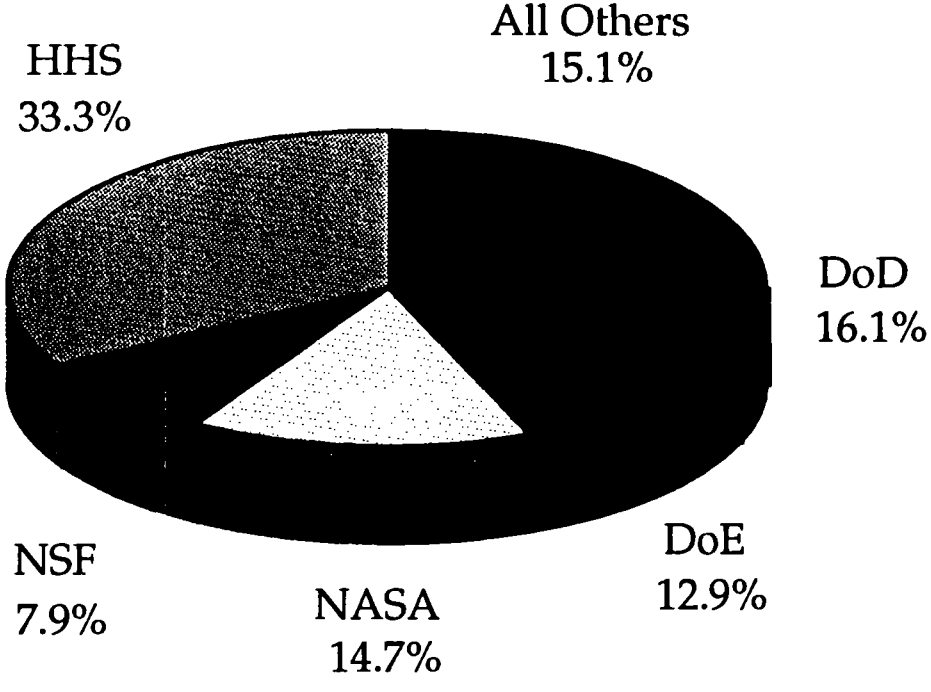
Funding
- 1989-1994 DoD (S&T): $21M 1995 Out: F-22 Integrates

Objectives
- Establish and Demonstrate a Low Cost Manufacturing Capability for Large Quantities of Complex T/R Modules for Inclusion into Advanced Active Array Radar Systems

Results
- Part Count Reduced by 75% (130 to 35)
- Test Time Reduced by 75% (6 to 2 Hrs)
- Interconnects Reduced by over 60% (800 to 300)
- On Track for Cost In Production of $400 Per Module

1993 Federal Research
(6.1+6.2 Funding)

Federal Breakout



Comparisons

HHS - Health ($9.3B)

NSF - General Science ($2.2B)

NASA - Space ($4.1B)

DOE - Energy ($3.6B)

DoD - Defense ($4.5B)

All Others ($4.2B)

1993 Total Federal Research: $27.9B

Source: Federal Funds for R&D NSF Report #93-323

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE & TECHNOLOGY POLICY
TECHNOLOGY DIVISION

To: CHUCK LARSON

From: SKIP JOHNS **Fax#:** 872-6356

Pages + cover: 3 **Date:** 1/12/95 12:30

Special Instructions:

URGENT

"Your members seemed interested..."

Old Executive Office Building • Washington DC 20500 • Room 423
TELEPHONE 202 456•6046 FAX 202 456•6023

1994: "THE BEST YEAR OF JOB GROWTH IN A DECADE"

• ***THE BEST YEAR OF OVERALL JOB GROWTH IN A DECADE** -- ALMOST 3.5 MILLION JOBS WERE ADDED TO THE ECONOMY IN 1994. MORE THAN TWICE AS MANY JOBS HAVE BEEN CREATED DURING THE CLINTON ADMINISTRATION THAN DURING THE PREVIOUS 4 YEARS -- IN LESS THAN HALF THE TIME.*

• ***THE BEST YEAR OF PRIVATE SECTOR JOB GROWTH IN A DECADE** -- OVER 3.2 MILLION PRIVATE SECTOR JOBS WERE ADDED TO THE ECONOMY IN 1994. PRIVATE SECTOR JOB GROWTH DURING THE CLINTON ADMINISTRATION IS 8 TIMES THAT OF THE PREVIOUS ADMINISTRATION.*

• ***THE HIGHEST PERCENTAGE OF NEW JOBS IN THE PRIVATE SECTOR IN OVER A DECADE** -- 93% OF ALL JOB GROWTH IN 1994 WAS IN THE PRIVATE SECTOR. DURING THE CLINTON ADMINISTRATION, 92% OF ALL JOB GROWTH HAS BEEN IN THE PRIVATE SECTOR, COMPARED TO 54% DURING THE PREVIOUS ADMINISTRATION.*

• ***THE MISERY INDEX** -- THE COMBINED MEASURE OF UNEMPLOYMENT AND INFLATION -- **IS AT ITS LOWEST LEVEL SINCE 1972.***

• ***1994 IS THE FIRST YEAR THAT MANUFACTURING JOBS INCREASED EVERY MONTH SINCE 1978** -- AFTER LOSING OVER 2 MILLION MANUFACTURING JOBS OVER THE PREVIOUS 12 YEARS, 292,000 MANUFACTURING JOBS WERE ADDED IN 1994.*

• ***AUTO EMPLOYMENT IS AT THE HIGHEST LEVEL SINCE 1979** -- AUTO JOBS INCREASED BY 69,000 DURING THE CLINTON ADMINISTRATION -- AFTER DECLINING BY 44,000 DURING THE PREVIOUS 4 YEARS.*

• *MORE JOBS WERE CREATED IN HIGH-WAGE INDUSTRIES IN 1994 THAN IN THE PREVIOUS FIVE YEARS COMBINED.*

• *The December employment report showed that employment grew by 256,000 jobs in December (with all growth in the private sector), pushing the total number of jobs created during the first 23 months of the Clinton Administration to 5.60 million and the total created in 1994 to 3.48 million. Preliminary estimates indicate that the benchmark revision will raise employment by another 760,000 jobs. That would bring job growth to over 6 million in less than 2 years.*

• *The unemployment rate is at 5.4%, down from over 7% at the start of the Administration.*

• *92% of the new jobs -- 5.2 million -- have been in the private sector.*

• *Since the economic plan passed on August 6, 1993, the economy has created 4.4 million jobs -- over 270,000 per month -- and over 92% in the private sector.*

• *Manufacturing jobs have gone up almost 300,000 jobs this year -- and rose every month during the year for the first time since 1978. Construction employment is up 522,000 since the President took office and more construction jobs have been added this year than in the previous 9 years.*

... of the economic plan and are at their

5.6 MILLION JOBS ADDED DURING CLINTON ADMINISTRATION:

• ***5.60 Million Jobs Added in First 23 Months:*** The total number of jobs created during the first 23 months of the Clinton Administration is now 5.60 million -- 92% in the private sector. Since the President's economic plan was passed in August, 1993, employment has expanded by almost 4.4 million jobs, 92% in the private sector. In 1994, 3.48 million jobs were added.

• ***Five Times More Jobs Per Month than Were Created in the Previous Four Years***: Since the President was inaugurated, the economy has created 244,000 jobs per month, nearly 5 times more jobs per month than were created under the previous Administration (50,000).

• ***Twice as Many Jobs in 23 Months as During Previous Four Years***: The economy has now created over twice as many new jobs -- 2.77 million more -- in 23 months than were created in the previous four years combined (2.44 million).

ON PACE TO CREATE 6 MILLION JOBS IN TWO YEARS:

• Preliminary estimates indicate that the benchmark revision will raise employment by another 760,000 jobs, putting the economy on a pace to create over 6 million jobs during the first two years of the Clinton Administration.

UNEMPLOYMENT IS DOWN:

• ***Unemployment is Down:*** The unemployment rate declined *from over 7% in January 1993 and from 6.7% in August 1993 to 5.4% for December 1994.*

STRONG PRIVATE SECTOR JOB GROWTH:

• ***92% of Job Creation -- Over 5 Million Jobs -- Was in the Private Sector***: Of the 5.60 million jobs created, 92%, or 5.16 million, were created in the private sector economy.

• ***Eight Times More Jobs Per Month than Were Created in the Previous Four Years***: Since the President was inaugurated, the private sector has created 225,000 private sector jobs per month, over 8 times more jobs per month than were created under the previous Administration (27,300).

• ***Over Twice As Many Private Sector Jobs Per Month as During the Last 12 Years:*** Compared to the private job creation over the last 12 years, the last 23 months have still seen private sector job creation at over twice the pace (224,000 vs. 111,000) as seen during the past two Administrations.

QUALITY JOB CREATION:

• ***Job Growth in High-Wage Industries:*** In 1994, there were more new jobs created in high-wage industries than during the previous five years combined.

• ***Manufacturing Jobs Are Up Every Month This Year for the First Time Since 1978:*** Manufacturing employment increased every month during 1994 -- making a year of continuous increases for the first time since 1978. After losing 2.2 million manufacturing jobs during the 12 years prior to the Administration, the nation has added 292,000 manufacturing jobs in 1994.

• ***Construction Employment Up 522,000:*** After declining by 664,000 jobs during the Bush Administration, construction jobs are up 522,000 jobs since January 1993. This year alone has more new construction jobs than during the previous 9 years combi .

• ***Auto Jobs Are Highest Level Si e 1979:*** Auto employn t has increased 6,000 since the

FAX TRANSMITTAL

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★ ★ ★

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NO. OF PAGES: 8 (including cover page)
RE:

STATEMENT ON R&D Policy & Competitiveness

STATEMENT ON R&D POLICY AND COMPETITIVENESS

As the 104th Congress begins its historic work, efforts to promote research and development (R&D) should be high on the agenda.

In fashioning R&D policy, the Congress should keep in mind three fundamental principles.

First, science and technology are key to the nation's economic growth. Economists attribute the unprecedented productivity growth of the United States during the post-World War II period to its strength in research and development -- a conclusion borne out by the continuing global competitiveness of such American industries as telecommunications, computers, financial services, pharmaceuticals, chemicals, textiles, aerospace and agriculture. No program to improve the standard of living and quality of life of the American people can succeed without ensuring the nation's continued leadership in science and technology.

Second, the government has a central role to play in ensuring that the United States maintains that leadership. This principle has long been a subject of bipartisan agreement. The federal government has contributed to the nation's success in science and technology in numerous ways since World War II. It has financed about half the nation's research, supporting work in universities, corporations and government laboratories. It has promoted science education, university facilities and advanced telecommunications, putting in place the

groundwork for a thriving R&D enterprise. And it has spearheaded work to accomplish national missions, such as exploring space, improving health and maintaining national security, that, in turn, have sparked industrial innovation and increased productivity.

Third, government, industry and academia must work together in an active partnership for science and technology to move forward. Merely continuing 50-year-old R&D policies will not be enough to succeed in an era of global competition. In recent years, Republican and Democratic administrations, working with the Congress, have begun to frame a joint R&D policy for the post-Cold War world based on this notion of cooperation. We need to build on that foundation.

To promote cooperation, government must help create a tax and regulatory environment in which R&D can flourish. The new Congress should ensure that tax laws help increase the availability of long-term, patient capital; that regulations stimulate rather than stifle the R&D efforts of industry and universities; and that intellectual property receives adequate protection.

Government must also see that its own R&D dollars are spent in a way that enhances the long-term competitiveness of the United States. At a time when both federal and corporate budgets are under stress, this is more important than ever. The new Congress should support programs that provide incentives for private partners to pool their R&D capital and expertise to invest in long-term and riskier projects.

The private sector must continue to do its part as well. Industry has begun to focus its R&D on improving manufacturing and market performance. Universities are revamping their curricula and research programs to improve the nation's productivity. These efforts must be sustained and strengthened.

The new willingness of government, industry and academia to work together has already born fruit. The 1994 Critical Technologies Update recently published by the Council on Competitiveness showed that the United States has begun to regain its edge in a wide range of technologies. But a Council survey also found that most American business, labor and academic leaders believe that the nation's greatest competitiveness challenges still lie ahead.

The need to respond to this continuing challenge -- some might say "threat" -- must guide Congressional action in the first 100 days, and beyond. No new agenda, no new program, no new policy will succeed over the long term if it undercuts the ability of the United States to innovate and compete. We urge the Congress to move swiftly to eliminate regulations that unnecessarily encumber R&D and investment in new technology; to enact tax reforms and incentives that stimulate private R&D; and to continue to support federal R&D investment that enhances the nation's competitiveness and encourages cooperation among the government, industry and academia. We stand ready to work with the Congress to develop a comprehensive R&D strategy that includes all three of these elements.

Signatories to Statement on R&D Policy and Competitiveness

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Co-Chairman and Chief Executive Officer
Alza Corporation

John R. Stafford
Chairman, President and
Chief Executive Officer
American Home Product Corporation

Richard C. Notebaert
Chairman and Chief Executive Officer
Ameritech Corporation

Joel Marvil
Chairman and Chief Executive Officer
Ames Rubber Corporation

Ray Stata
Chairman of the Board and Chief
Executive Officer
Analog Devices, Inc.

Jack Sheinkman
President
Amalgamated Clothing and
Textile Workers Union, AFL-CIO, CLC

William Archey
President
American Electronics Association

William V. Muse
President
Auburn University

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John Clendenin
Chairman of the Board
BellSouth Corporation

Charles A. Heimbold, Jr.
President and Chief Executive Officer
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Thomas E. Everhart
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California Institute of Technology

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Convex Computer Corporation

James R. Houghton
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Chief Executive Officer
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Henry B. Schacht
Chairman
Cummins Engine Company, Inc.

Thomas J. Murrin
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George M. C. Fisher
Chairman, CEO and President
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President, Pharmaceutical Division
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SETTING PRIORITIES AND MEASURING RESULTS AT THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

National Institute of Standards and Technology
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FOREWORD

Accelerated development, commercialization, and adoption of technology are key, driving elements of the Clinton Administration's plan to foster long-term economic growth that benefits all U.S. citizens. The Administration's strategy of making direct, purposeful investments to prime industry's wealth- and job-creating pump of innovation and commercialization is moving federal technology policy in new directions and toward new horizons.

A "grand experiment" has begun, one in which industry and government are collaborating as willing partners in responding to unprecedented technological challenges and opportunities. Past federal investments in science and technology helped to bring an end to the Cold War and to make the United States the world leader in science. To repeat this success in the arena of global economic competition, the federal government must tightly couple its technology programs to U.S. industry's goals and priorities, and it must work closely with the private sector to accomplish technological and economic objectives that will pay dividends to the entire nation.

This widely recognized imperative—that of effectively linking the complementary technology activities of government and industry—evokes two key questions that warrant thorough, thoughtful responses. First, how does the federal government select where to invest public resources and, second, how do we measure the results of our investments in technology development and application?

This paper presents how we at the Commerce Department's Technology Administration are addressing these important questions for the National Institute of Standards and Technology (NIST). It describes how NIST's four major programs—the Advanced Technology Program, laboratory R&D, the Manufacturing Extension Partnership, and the Malcolm Baldrige National Quality Award program—set priorities, evaluate performance, and measure economic impact. The issues addressed in this paper cannot be reduced to simple formulas that yield unambiguous, quantitative answers, or fixed coordinates that lock in a course for NIST programs. But, in addressing these questions, we can identify ways to improve how we do our job and to increase the effectiveness of NIST programs.

Judgments are an inherent part of the process of setting priorities and measuring results, but these judgments must be guided by comprehensive qualitative and quantitative information that captures customers' needs and accurately portrays how efficiently and effectively NIST is responding to those needs. Therefore, efforts to develop better processes and metrics are fundamental to accomplishing NIST's objectives of continuously improving and increasing the value of our programs.

This paper, which has benefited from our discussions with many government and industry experts, has been prepared to promote discussion and invite constructive criticism from industry, academia, government agencies, and others with a role in civilian technology. Therefore, we pose a question to our readers: How can NIST improve its processes for setting priorities and measuring results? We'd really like to benefit from your thinking. So, please send us your comments.

Mary Good
Under Secretary for Technology, DOC

Arati Prabhakar
Director, NIST

SETTING PRIORITIES AND MEASURING RESULTS

Growing appreciation of technology's pivotal economic role is leading to changes in federal R&D investment strategies. The Clinton Administration aims to accelerate technology development and application as part of a national effort to foster long-term economic growth that creates new high-quality jobs, builds new industries, and improves the U.S. standard of living. With strong support in Congress and industry, the Administration advocates direct, purposeful investment in commercially relevant technologies. Moreover, the new policy assigns the federal government to the role of partner to industry—as well as to labor and academia—in working to catalyze and facilitate technology development, application, and adoption. An operational aim is to focus and leverage federal expenditures so that relatively small investments yield meaningful economic benefits for the nation.

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Like the post-World War II decisions that successfully aligned federal R&D spending with defense and other national needs, today's policy decisions are reckoning with new circumstances wrought by the end of the Cold War, intensifying global economic competition, the rapid diffusion of discoveries and innovations across international borders, and the increasing technological intensity of modern manufacturing and service industries.

This transition in federal technology policy is occurring during a period of constrained federal budgets, prompting two frequently asked questions: First, how do agencies with technology programs identify and select areas warranting investment of federal resources? Second, how do agencies measure the results of their technology investments and ascertain whether these investments are yielding their anticipated national benefits?

The Mission and Role of NIST

These questions are especially relevant to the National Institute of Standards and Technology, part of the Commerce Department's Technology Administration. The Clinton Administration has assigned NIST to an important role in its plans to help U.S. industry to improve its development, commercialization, and adoption of new technology.

NIST's explicit mission is to promote U.S. economic growth by working with industry to develop and apply technology, measurements, and standards. [See box on next page, NIST in the Context of Federal R&D.]

The agency's portfolio of programs features four approaches to carrying out its mission and serving U.S. industry.

Under this mission, unique among federal agencies, NIST's direct customer is U.S. industry, which, in turn, is the means to accomplishing the agency's ultimate objective of fostering sustained economic growth that benefits U.S. citizens. The agency's portfolio of programs features four approaches to carrying out its mission and serving U.S. industry:

- an Advanced Technology Program (ATP) that invests in cost-shared projects in companies to develop enabling, high-payoff technologies that otherwise would not be pursued because of technical risks and other obstacles that discourage private investment;
- laboratory research programs focused on meeting U.S. industry's infrastructural technology needs, including standards, measurements and measurement technologies, evaluated data, manufacturing process models, product-performance tests, and quality-assurance techniques;
- a Manufacturing Extension Partnership (MEP) that is scaling up to a cost-shared, integrated, nationwide network of over 100 manufacturing extension centers to help small and medium-sized manufacturers to modernize their production capabilities; and
- the Malcolm Baldrige National Quality Award program that provides criteria for assessing quality management and competitiveness and sharing information on successful strategies.

NIST in the Context of Federal R&D

The Clinton Administration has begun to make a clear transition in technology policy. It is moving the government from the four-decade-old R&D policy based on post-World War II priorities to a policy that specifically includes an investment strategy designed to strengthen America's industrial competitiveness. NIST's programs are one important part of this transition.

The federal government is responding to global economic changes by:

- Direct investment in civilian technology for economic growth. NIST is the part of the federal R&D investment that focuses explicitly on this mission.
- Increased emphasis on directing defense R&D toward a dual-use technology base. The Defense Department's Advanced Research Projects Agency has led technology efforts to foster the growth of an integrated industrial base that is economically competitive and able to meet military needs. This approach is now expanding to other parts of the defense investment.

NIST aims to be a strong partner to U.S. industry. Over nine decades of working with U.S. companies, its laboratories have developed a culture of cooperation. Indeed, a recent report by the Council on Competitiveness described the NIST laboratories' process of working cooperatively with industry as "the most streamlined of all and is perhaps the best model for other federal labs to follow. ... NIST is very flexible and able to respond quickly to industry's inquiries without bureaucratic interference."[1] This traditional culture is the base upon which NIST will build to meet its new challenges.

"NIST is very flexible and able to respond quickly to industry's inquiries without bureaucratic interference."

Need-Focused Priorities, Results-Driven Measures

NIST programs are guided by measurement and evaluation systems that the agency uses as it sets priorities, evaluates operational performance, and assesses near- and long-term returns on agency investments and activities. Priorities are set and results are measured on the basis of benefits realized by U.S. industry.

Conferences and workshops regularly convened by NIST are among a variety of tools that the agency uses to identify industry's high-priority technology needs. Industry input helps to set the direction and emphasis of NIST programs, and it encourages industries and individual companies to shape and participate in new initiatives. One result of this process is high levels of industrial participation in NIST programs; another is solid agreement on technical objectives.

- Increased industry access to commercially useful technology developed in government laboratories for other purposes. The Department of Energy and the National Aeronautics and Space Administration, for example, are working to leverage their laboratory investments for economic benefit.
- Maintaining a strong commitment to basic science. A healthy and productive national science base—the world's best—will continue to be a critical source for future technological progress. The National Science Foundation and the National Institutes of Health are key players in this endeavor.

In the context of these new directions in federal technology policy, NIST has an important, tightly focused role to play. As the NIST budget grows, the agency's share of funding will increase but will still remain a small fraction of overall R&D spending: less than two percent of the federal allocation and less than one percent of the nation's total R&D expenditures. Working in partnership with industry and coordinating closely with other federal technology agencies, NIST can contribute significantly to the national effort to accelerate the benefits of technology for economic growth.

NIST seeks and relies on industry input on the direction and content of its program at several levels of organization. For example, the Visiting Committee on Advanced Technology, a nine-member advisory body that traces its origins to the founding of the agency in 1901 and is composed largely of industry representatives, meets quarterly to review the policies, budget, organization, and programs of the Institute. Indicative of the committee's oversight are a 1992 evaluation of NIST's strategic planning process, subsequent reviews of the strategic plans of several laboratories, and a 1993 study of the strategic direction of the Advanced Technology Program. In addition, each of NIST's eight intramural laboratories undergoes annual performance assessments by independent panels of experts from industry and academia, convened by the National Research Council.

Continuous Improvement

Like any organization aspiring to world-class status, NIST must critically evaluate itself and scrutinize its programs through the eyes of its customers. Likewise, systems and mechanisms for setting priorities, evaluating performance, and measuring impacts must be continually strengthened and improved, paving the way for improvements in the quality and content of programs and services.

Scaling Up, Managing Growth

President Clinton's economic plan calls for increasing NIST's total budget from $384 million in FY 1993 to $1.4 billion in FY 1997. While the total NIST investment will still be a small fraction of the federal R&D budget, the growth represents a significant challenge for NIST to scale up rapidly while maintaining the quality of its activities. The agency is meeting the challenge through carefully developed management plans. The strategy is to build on NIST's proven approaches for working with industry and to achieve scale-up with minimum staff growth and bureaucratic overhead.

Two programs will account for more than half of the expected increase in the agency's budget through 1997. The ATP will grow from $68 million in FY 1993 to $750 million in FY 1997. The MEP will increase from seven manufacturing technology centers to a nationwide network of over 100 extension centers. Both programs have been pilot tested, and results attest to their potential to produce important macro- and microeconomic benefits. From their inception, the ATP and MEP have been designed to be national in scope. And, because the funds in each program are for activities performed in the private sector, neither will require large increases in NIST personnel. For FY 1997, each program will operate with a total staff of under 100 staff members.

The strategy is to build on NIST's proven approaches for working with industry and to achieve scale-up with minimum staff growth and bureaucratic overhead.

The focus on methods for setting priorities, evaluating operational performance, and measuring results is especially critical now, as the Administration proceeds with plans to nearly quadruple the NIST budget by 1997 and as public expectations for economic returns on the agency's technology programs increase commensurately. [See box on Scaling Up, Managing Growth.] The ATP and MEP will scale up rapidly, growing from pilot projects to programs of the size necessary to achieve national economic impact.

Each NIST program aims to accomplish objectives that depend significantly on industry's behavior, capabilities, and commitment. Measurements of performance and impact are critical, the basis for improving the effectiveness and extending the reach of NIST programs. Yet, there is little precedent in the federal government—and inconsistent results in industry—when it comes to measuring the results of technology investments.

Each NIST program aims to accomplish objectives that depend significantly on industry's behavior, capabilities, and commitment.

Returns on R&D investments typically do not begin to accrue until several years after research is completed. This lag between expenditures and returns—and diffusion of expected benefits across broad sectors of the economy—makes assessments of the economic impact of most ATP projects and much of NIST's laboratory-based R&D a long-term endeavor. Because economic effects can be projected but never known with certainty in advance, NIST must select priorities

Direct funding of NIST laboratories will roughly double between FY 1993 and FY 1997, to about $400 million. This increase will address a shortfall in national capability that is the result of two trends. First, during the past several decades, NIST's laboratory budget has been flat or eroding while new industries—such as biotechnology and computer networking—have emerged and the technological complexity of established industries has increased. The result has been a widening gap in our national measurement infrastructure. Second, NIST laboratories have been heavily dependent on funding from other government agencies: for example, about 25 percent of the NIST laboratory staff was supported by Department of Defense funding in FY 1993. As direct appropriations for NIST laboratories increase, the agency will be better able to respond to industry needs for infrastructural technologies. The laboratories plan to offset their heavy dependence on other agencies' funding and thus only increase staff by about 10 percent through FY 1997.

The Malcolm Baldrige National Quality Award program already has experienced dramatic scale-up from its establishment in late 1987 by Congress to its first awards the next year to a full-scale program with national and international impact. With pressing needs to move quality management principles into the practices of education and healthcare organizations, NIST is readying pilot efforts leading to full-fledged award programs in 1996.

The need to measure returns on taxpayer investments in federal technology programs is of paramount importance.

carefully and rely on measures of performance and short- and intermediate-term results as it decides where and how to invest its resources.

In addition, methodologies for measuring economic impact are still evolving, and data-collection efforts confront several obstacles: the proprietary nature of certain information, the necessarily qualitative nature of some types of impacts (for example, the adoption of quality strategies or changes in the horizons and composition of corporate research portfolios), the high cost of collecting original data, and the difficulty in clearly defining criteria for quantifying job creation and job retention. Methodological and data-collection issues notwithstanding, the need to measure returns on taxpayer investments in federal technology programs is of paramount importance, and approaches to meeting this need warrant thoughtful—but action-oriented—discussion inside and outside of government.

ADVANCED TECHNOLOGY PROGRAM

One of the most innovative elements of the NIST technology strategy, the ATP invests directly in the nation's economic growth by supporting enabling technologies with strong potential for U.S. economic benefit.

The ATP provides funds for the early phases of technology development through cooperative research agreements to single businesses or industry-led joint ventures and research consortia. There are some legislated limits. Awards to individual companies may not exceed $2 million, and the projects must be completed within three years. Projects by joint ventures may run as long as five years, and the ATP can fund up to 50 percent of the project. Cost sharing is required for all projects.

The ATP relies on substantial input from this diverse industrial base to define and implement its programs.

ATP projects are selected on the basis of a rigorous competition that considers both the technical and business merits of the proposals. One of the unique features of the ATP is this review process, which evaluates the proposal's potential economic impact, the evidence that the proposer is significantly committed to commercializing the results of the project, and other business-related factors affecting the likelihood that successful results will be commercialized.

The nature of the ATP poses unique challenges for effectively setting priorities and evaluating the results of the program:

- The potential ATP client base—effectively all of U.S. industry—is huge and diverse, covering all areas of technology and ranging from small entrepreneurial start-ups to major multinational corporations. The ATP relies on substantial input from this diverse industrial base to define and implement its programs. The challenge is to run a program that responds effectively to the priorities of this heterogeneous community.
- The time line for ATP payoff is relatively long. The ATP does not support product development, but rather the development of key technologies that *enable* innovative new or improved products, services, and industrial processes. While the goal of the ATP is to foster significant economic benefits for the United States, the greatest benefits will flow from products, services, and processes that will be developed *after* an ATP project itself is completed. The challenge is to set up an evaluation strategy that considers both the immediate performance of the program and its effectiveness in the long run.

Setting ATP Priorities

A central tenet of the ATP since its inception in 1990 always has been that its research priorities should be set by industry rather than the government. The purpose of the program is not to impose government's judgment of the best opportunities for commercial success, but rather to enable industry to pursue certain high-risk projects that, if successful, would enable significant economic benefits for the country. U.S. industry invests tens of billions of dollars annually to turn "technology" into products, profits, and jobs. The relatively minor funding from the ATP is meant to extend industry's reach, to foster riskier projects that would not be pursued by private funds alone.

During the pilot phase of the ATP, NIST held general competitions for ATP funding, open to all areas of technology. All project *ideas* come from industry. Candidate projects are not evaluated on the basis of *what* technology is proposed, but on how sound the proposal is within that technology and on the projected economic impact. Specifically, proposals are evaluated on:

- scientific and technical merit;
- the potential broad-based economic benefits;
- plans for eventual commercialization of the research;
- the experience and qualifications of the proposer; and
- evidence of the proposer's level of commitment to the project, and clarity and appropriateness of the proposer's management plan.

As it grows from a pilot program to a full-scale activity, the ATP requires a more sophisticated approach to setting investment priorities. Even at the Administration's proposed funding level of $750 million per year by 1997, the ATP will represent less than one-half of one percent of the nation's R&D budget. To obtain maximum benefit from its investments, the ATP will devote the bulk of its funds to selected, focused *program areas*.

ATP focused programs will have aggressive, well-defined technological and business goals, generally involving the parallel development of a suite of interlocking R&D projects.

ATP focused programs will have aggressive, well-defined technological and business goals, generally involving the parallel development of a suite of interlocking R&D projects. By managing groups of projects that will complement and reinforce each other, the ATP will be able to have the greatest possible impact on technology and the economy.

The key to this plan is a system for selecting program areas that retains the strong industry orientation of the ATP. The approach is analogous to that used in *project* selection: let the ideas come from industry and select on the basis of clear evaluation criteria.

The criteria for selecting focused program areas for ATP investment resemble those used for project selection:

- potential for U.S. economic benefit;
- strength of the technical ideas;
- evidence of strong industry commitment; and
- the opportunity for ATP funds to make a significant difference.

ATP competitions within the focused programs will support specific *projects,* using the same procedures and selection criteria used for general competitions. While most of the ATP's resources in the future will go to specific focused programs, the ATP will continue to hold general project competitions open to any and all areas of technology, holding the door open to promising ideas that don't fit into any current program. (See Reference 2 for a complete description of the process being used to define focused programs and to solicit program ideas.)

ATP Evaluations

From its start, the ATP has emphasized detailed evaluation as critical to an effective, results-oriented program. The evaluation plan for the ATP as a program has five principal elements and stresses *measurable* goals whenever meaningful:

From its start, the ATP has emphasized detailed evaluation as critical to an effective, results-oriented program.

- assessing the ATP's own critical operational activities;
- "portfolio" profiles of applicants, recipients, technologies, and projects;
- evaluation of industry's implementation of both the R&D and business components of ATP projects;
- tracking short-term and intermediate project results; and
- measurement of long-term economic impacts.

There is one important overriding consideration: The ATP does not expect every project or program to be a success. The ATP is supposed to foster *high-risk* projects that would not be undertaken without its support. In fact, too high a technical success rate would suggest that the project selections are overly conservative. Thus, ATP's success must be evaluated from the perspective of portfolio management, for which the key measures are aggregate returns on the full set of ATP-funded technologies.

Performance of critical operational activities is a measure of the ATP as a service organization. To be effective, the ATP must work smoothly with private

industry and, like industry, must be agile and responsive to a rapidly changing technological frontier. Operational activities include:

- soliciting and evaluating proposals;
- promoting a widespread understanding of the ATP and its opportunities;
- providing constructive feedback to proposers whose projects were not selected;
- providing additional support to selected projects, by initiating links to related research programs, for example; and
- monitoring the progress of projects.

The ATP sponsors third-party studies of award recipients to get customer feedback.

Typical questions include: How well known is the ATP in industry? Is industry responsive to ATP solicitations? What steps are taken to ensure high-quality proposals to the ATP? How thorough is the review process? And—very important—how do the program's immediate customers—the companies the ATP works with—view it?

Considering the relatively low levels of funding in its first three years as a pilot program, the ATP has engendered a particularly strong favorable response from industry. In four competitions, the ATP has received nearly 1,000 applications, performed more than 2,000 technical evaluations and more than 700 business evaluations (only the highest-scoring proposals in the technical evaluation go on to a business evaluation), and made awards to nearly 90 projects.

In addition to numerous talks and briefings by ATP personnel around the country, four conferences have been sponsored to help potential applicants with the fine points of the proposal process. Oral "debriefings" have been made available to all unsuccessful applicants.

The ATP sponsors third-party studies of award recipients to get customer feedback. Comments on interactions with the ATP staff have been uniformly positive. For instance, the vice president of a small company stated, "The personnel within the ATP have been the most responsive of any government organization that I have dealt with over the years. This is extremely critical. The commercial markets in technology-related fields move very fast, and a needless delay can kill a promising technology or leave it to be taken over by foreign competition."[3]

Profiles of applicants, recipients, technologies, and projects enable the ATP to assess how well it meets goals of reaching a broad spectrum of technologies and stimulating private R&D. Typical questions include: Can small businesses compete effectively for ATP awards? How does the ATP affect R&D trends in private industry? What technologies tend to receive the most awards? What is the geographic distribution of ATP participants? How do the ATP projects reflect critical national technology goals?

Analyses of the projects funded to date suggest that small businesses in fact do very well in the ATP. More than 60 percent of all successful single applicants are small businesses, and small businesses are playing a critical role in 18 of the 23 ATP joint ventures, including leading six of these projects.

Profiles also suggest that the ATP has led—as desired—to an increase in joint research and development ventures in private industry. In the first four competitions, approximately 125 joint ventures involving over 800 organizations were formed to apply to the ATP.

While the ATP has demonstrated considerable breadth in its pilot phase, with projects from fields such as manufacturing processes, medicine, pollution abatement, transportation, energy conservation, and even agricultural pest control, proposals have been concentrated in certain areas: information technologies (including electronics), advanced materials, manufacturing processes, and biotechnology. ATP projects can be found in every subcategory of the "critical technologies" list prepared by the Office of Science and Technology Policy.

Evaluation of industry's implementation of both the R&D and business components of ATP projects tracks how well businesses follow through on the business and commercialization strategies outlined in their ATP proposals.

Evaluation of industry's implementation of both the R&D and business components of ATP projects tracks how well businesses follow through on the business and commercialization strategies outlined in their ATP proposals. NIST considers this an important element, because financing research for its own sake is *not* a goal of the ATP. It also encourages the award recipient to constantly re-evaluate the commercial opportunities opened up by ATP research in rapidly changing technologies, and allows ATP managers to understand how business strategies change as projects evolve.

ATP project managers collect the information during quarterly, year-end, and end-of-project reviews. The ATP is field testing a new, customizable, questionnaire designed to gather more detailed data than are now available. A key goal is to gather the information in a manner that allows for easy updating and minimizes the reporting burden.

Tracking short-term and intermediate project results provides an indication of the ATP's immediate effect on the companies that participate. A number of measurable short-term effects are expected to provide indicators of long-term economic success. In addition to straightforward tracking of technical milestones, these indicators include:

- increased R&D investment and R&D in new areas leveraged by ATP funds;
- increased industrial collaborations and strategic alliances;
- strengthened technological infrastructure (through the development of new enabling technologies);

- shortened R&D cycles;
- investment in production capacity; and
- productivity improvements.

A variety of tools are used for these analyses, including data gathered by ATP project managers, studies done by participating companies, and third-party reviews and surveys conducted as part of the ATP evaluation program.

After four competitions, the ATP has committed to $247 million, leveraging approximately $268 million in industry investment in R&D. Early results from this pilot phase of the ATP indicate that the program is making an impact.

In addition to the increase in industrial joint R&D ventures noted above, a third-party survey of early ATP award recipients found that the participants cited the ability to pursue promising lines of research that they otherwise could not have followed as the most important effect of the ATP.[3] Forging new relationships between companies, and between companies and government or academic labs, was rated by participants as the second most important effect of the ATP.

A third-party survey of early ATP award recipients found that the participants cited the ability to pursue promising lines of research that they otherwise could not have followed as the most important effect of the ATP.

Another third-party study found that total U.S. R&D work on advanced technologies for printed-wiring boards (PWBs) essential to all modern electronic devices more than quadrupled as a result of the ATP.[4] As a direct result of the ATP, major research consortia have been formed to pursue advanced technologies in mass data storage and flat-panel displays, two technologies considered key to future information technologies. Other consortia have been funded in the areas of biotechnology, automated manufacturing, and advanced materials.

ATP participants also have cited dramatic reductions in development time and significant productivity gains—participants in the PWB project estimated average productivity gains of 30 percent in major program areas.

Long-term economic impact is the bottom line for the ATP, and its measurement is key. Program goals include increased U.S. economic growth, increased industrial competitiveness, and creation of high-value jobs. Measures of the long-run success of the ATP include:

- creation of new industries or new industrial capabilities;
- improvements in manufacturing costs, product quality, and time to market;
- increased worldwide market share;
- job creation; and
- private and social rates of return on investment.

At present, it is too early to measure long-term impacts. Several products incorporating the results of ATP-supported research have been introduced or are near

commercialization. In addition, one company has introduced ATP technology into a manufacturing process on a pilot scale, but in general almost all ATP projects are still in the R&D phase of product development. In most cases, it will take several years before a long-term effects study will be feasible.

The planned approach to these long-term studies is to use microeconomic case studies to estimate specific benefits and costs of new technologies developed under the ATP. This approach is in line with generally accepted economic analysis techniques. Specific projects and programs for detailed study will be selected using statistical sampling techniques.

The measurement of long-term economic impacts of the ATP requires three major efforts:

- development of quantitative measures of the degree of influence or effect that the ATP has on the introduction and diffusion of each new technology it supports;
- development of quantitative and qualitative measures of the influence or effect of each ATP-funded technology on the economy; and
- estimation of private and social aggregate economic benefits and costs from each new technology developed under ATP funds.

The planned approach to these long-term studies is to use microeconomic case studies to estimate specific benefits and costs of new technologies developed under the ATP.

NIST LABORATORY PROGRAMS

NIST's eight laboratories serve all sectors of U.S. industry through tightly focused research programs and services that address industry's needs for measurement and infrastructural technology. Industry traditionally underinvests in the development of these infrastructural technologies because they are used simultaneously by many firms and typically are not embodied in products, making it difficult for individual firms and even industries to recover R&D investments. However, measurement methods, evaluated data, process models, interface standards, and other types of infrastructural technologies are pacing factors in technology development and application, setting the upper limit on what can be accomplished in the laboratory or on the factory floor.

As noted in a recent report by the Office of Technology Assessment, NIST's laboratory program occupies a "unique niche in the nation's infrastructure."

As noted in a recent report by the Office of Technology Assessment, NIST's laboratory program occupies a "unique niche in the nation's infrastructure." The report also characterized the program's core competency and preferred problem-solving approach:

> NIST has earned a worldwide reputation for impartiality and technical excellence. Its competencies in metrology—the science of measurement—span a number of disciplines. The efficiency of solving a measurement problem once at NIST and then disseminating the results throughout the whole industry, rather than each company performing the job independently for itself, provides outstanding leverage for NIST's metrological development.[5]

NIST's evaluations of industry's technology needs indicate widespread demand for enhanced measurement capabilities, and industry's own analyses concur. For example, a 1993 assessment by the Semiconductor Industry Association (SIA) identified unmet measurement needs as impeding the U.S. semiconductor industry's progress toward accomplishing critical technology goals. SIA called on NIST for increased assistance, describing the agency as the "only place in the U.S. where the broad range of measurements needed for semiconductor processing are routinely and systematically developed."[6]

Similarly, the Council on Radiation Measurements, which represents more than 150 U.S. companies, asked NIST to improve the accuracy of measurement standards for optical and infrared radiation by a factor of 10. The request was motivated by the companies' desire to improve quality control in a variety of manufacturing processes. The collaboration has produced a cryogenic radiometer that is possibly the most accurate in the world and is being tested in a number of applications.

Setting Laboratory Priorities

NIST's laboratories set their priorities in consultation with industry in accordance with six guiding criteria:

- the magnitude and immediacy of industrial need;
- the degree of correspondence between a particular industrial need and NIST's mission to develop infrastructural technologies;
- the opportunity for NIST participation to make a major difference;
- the nature and size of the anticipated impact resulting from NIST's participation;
- NIST's capability to respond in a timely fashion with a high-quality solution; and
- the nature of opportunities afforded by recent advances in science and technology.

NIST's laboratories try to anticipate the measurement and other infrastructural technology needs of industry. The ideal is to have solutions available before prospective problems and challenges materialize as actual obstacles in product development, manufacturing, market transactions, or other industrial and business activities. If NIST does not respond early to looming technological hurdles, the effectiveness of its laboratories is diminished. Therefore, failures to anticipate major technology needs also must be taken into account as the laboratories' priority-setting performance is reviewed.

In their strategic planning, the laboratories employ a variety of formal and informal mechanisms for soliciting industry input and gauging its priorities. Formal mechanisms include NIST-convened conferences devoted to eliciting and synthesizing company and industry-wide views on key technical challenges and major goals in important technology areas. In 1993, 40 priority-setting conferences were convened to address topics ranging from "green" manufacturing technologies to technical issues in network security.

In their strategic planning, the laboratories employ a variety of formal and informal mechanisms for soliciting industry input and gauging its priorities.

Over the past two years, a series of conferences focused on measurement needs arising from tightening dimensional tolerances in manufactured products from integrated circuits to aircraft. Responding to the needs voiced by representatives of the $15 billion U.S. gear manufacturing industry, NIST joined with the American Society of Mechanical Engineers and the Department of Energy's Oak Ridge Y-12 plant to create a NIST/DOE Center for Gear Metrology at the Y-12 facility. The unprecedented interagency collaboration is now under way.

Other formal mechanisms for assessing industry priorities include the agency's Visiting Committee on Advanced Technology, an advisory body primarily composed of industry representatives. Industry also is well represented on independent

assessment panels. Organized by the National Research Council, these panels annually review the performance of each NIST laboratory and evaluate its short- and long-term goals.

Each laboratory has cultivated strong working relationships with industrial, trade, and professional organizations in its areas of technology concentration. The program of NIST's Building and Fire Research Laboratory, for example, is guided by a prioritized research agenda developed by volunteer experts from the building and fire communities under the auspices of the National Institute of Building Sciences. NIST personnel also participate actively in industry-organized technology-planning exercises. Recent examples include the Semiconductor Industry Association's initiative to develop a comprehensive technology road map and the 21st Century Manufacturing Enterprise Strategy Project.[7]

Each laboratory has cultivated strong working relationships with industrial, trade, and professional organizations in its areas of technology concentration.

The laboratories also solicit industry input through formal surveys and through reviews of NIST-prepared planning documents and needs assessments. In early 1993, the Electronics and Electrical Engineering Laboratory issued a definitive assessment of measurement needs in nine fields of electronics technology. Developed in consultation with industry, the 448-page document, *Measurements for Competitiveness*, identifies high-impact measurement capabilities that are widely needed by the U.S. electronics industry but are beyond the resources of individual companies to develop.[8] It serves as explicit guidance for setting the laboratory's priorities.

Other means of assessing industry's infrastructural technology needs include:

- visits to companies;
- participation on more than 800 national and international standards committees;
- measurement "round robins," which provide a comparative basis for assessing the current state of measurement practices employed by industry and for identifying key technical problems;
- joint demonstrations and experiments to identify problems and requirements for supporting technology;
- regular researcher-to-researcher interactions; and
- participation in consortia, including the 13 cooperative arrangements organized by NIST and those organized by other groups, such as PDES Inc. and the Semiconductor Research Corp.

NIST has found it necessary to use this complete set of tools to determine industrial needs. Workshops, conferences, and surveys provide valuable information on an industry, but this information usually is not complete or specific enough to be the sole basis for program planning. In turn, company visits,

participation on standards committees, "round robins," researcher-to-researcher interactions, and participation in consortia offer insight into specific company needs, and they afford the additional advantage of directly involving NIST researchers, who provide their peers from industry with a direct link to the agency's programs and projects. Thus, combining information that is specific to firms and information that can be generalized to an industry or even groups of industries is necessary to develop a balanced view of challenges facing the private sector and of the relative importance of each challenge. To assure that the proper balance has been reached, NIST publishes its planning documents for review by outside panels and by industry.

This planning process is continuous, involves most of NIST's professional staff, and provides a wealth of useful information. In developing a new program in magnetic engineering, for example, staff of the Chemical Science and Technology Laboratory solicited the views of experts at more than 50 companies and universities to identify the critical technical obstacles perceived as impeding the development and application of new thin-film magnetic materials.

Another example demonstrates how this approach is used in planning consortia. In 1991, members of the Materials Science and Engineering Laboratory visited aerospace industry companies to acquire first-hand information on problems encountered in the precision casting of metal alloys. Analysis of this information guided planning for a meeting, co-sponsored by the Aerospace Industries Association, to explore the merits of forming a consortium to improve the precision casting process. A subsequent meeting, attended by industry, university, and government representatives, resulted in a detailed technical research plan addressing issues in key processing areas and defining deliverables in forms usable by industry. Subsequently refined, that plan is now being carried out by a NIST-led consortium involving seven manufacturers, seven universities, and three federal laboratories. The effort is a distributed, cooperative undertaking, with NIST and other members performing in-house research to accomplish agreed-upon tasks that will contribute to accomplishing the consortium's four major objectives.

NIST's iterative approach to planning and priority setting enables it to respond quickly to new developments and opportunities. A clear picture of industry's needs also helps laboratory managers to determine when it is appropriate to terminate programs and reallocate scarce resources to address new, higher priority problems that have emerged. For instance, the Physics Laboratory terminated a project to provide reaction-rate data for fusion reactors and reassigned the technical staff to work on plasma-processing issues relevant to semiconductor manufacturing, which led to a productive collaboration with SEMATECH.

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Short- to Medium-Term Measures of Performance

NIST laboratories use a variety of measures to track and evaluate performance, including the value and utility of research deliverables and services. Customer feedback, gathered through a variety of mechanisms, is the laboratories' principal source of evaluative information.

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Although each laboratory has its own procedures for monitoring performance and technical progress—and not all of the laboratories use every available tool—all set goals for individual projects, determined on the basis of perceived customer needs identified during planning and priority setting. Technical milestones are established for individual projects, and progress is evaluated internally on at least a quarterly basis. Customer feedback also is analyzed during project, group, division, and laboratory reviews, not only to assess performance and rates of technical progress but also to identify changes in customer needs that may warrant redirecting laboratory resources. Besides their own internal reviews and those conducted by NIST management, all laboratories undergo annual assessments by external panels convened by the National Research Council. These assessment panels produce written evaluations of performance, missions, and short- and long-term goals—for the laboratory overall and for each division.

NIST gathers information on its primary "products"—measurements, standards, databases, process models, and the other types of deliverables produced by its laboratory program. These deliverables usually take the form of technical information that NIST makes widely available to U.S. industry. Measures of the relevance and value of this information to industry include:

- industry attendance, comments, and level of participation at technical workshops;
- number of inquiries and requests for information;
- attendance at technical training sessions provided by NIST personnel;
- commercialization of products incorporating the results of NIST R&D; and
- application of NIST R&D results to industrial processes.

For federal laboratories, a widely—and, perhaps, overly—reported process metric is the number of cooperative R&D agreements (CRADAs) that laboratories have entered into with U.S. businesses. Because NIST has been working with industry for more than 90 years, the agency was quick to embrace CRADAs as an additional tool for working with industry. Across the federal government, NIST has the highest ratio of CRADAs per number of technical staff and, by far, the shortest average time for processing agreements. According to *Science* magazine, "Only

the National Institute of Standards and Technology, created to work with the private sector, appears to be doing what Congress intended. ...[O]nly NIST appears to have managed to embrace CRADAs without getting smothered."[9]

CRADA tallies, however, are an incomplete measure of performance—just as the numbers of patents received and licenses issued do not capture a technology organization's full technical output and level of innovation. CRADAs represent but one mechanism for working with and addressing the technology needs of U.S. industry—effective for accomplishing some technical objectives, but inappropriate for others. In fact, most forms of NIST-provided technical assistance are nonproprietary (used by many firms) and are best accomplished without the formality of a legal contract.

Other measures and information used to assess industrial relevance, performance, and productivity of laboratory activities include:

- level of industry commitment to NIST projects and consortia (e.g., number of participating companies, number of visiting researchers assigned to NIST, value of resources committed);
- number of guest researchers from industry;
- extent of NIST's contributions to industry's voluntary standards (e.g., number of standards incorporating NIST's work, number of memberships on standards committees);
- number of joint industry-NIST "round-robins"; and
- number of repeat customers.

Measures of Long-Term Impact

In the early 1980s, NIST initiated a series of periodic assessments of the economic impacts of NIST research.[10–13] Conducted by independent researchers under contract to NIST, these third-party assessments have estimated the aggregate rates of return (also referred to as social rates of return) on work addressing infrastructural technology needs of industry. Returns on NIST work in the six technology areas evaluated thus far range from 63 percent to 423 percent, greatly exceeding the average rate of return on private-sector innovations and the rates reported in the few studies of other government research programs. To economists, this disparity implies underinvestment in R&D aimed at developing measurement methods and other infrastructural technologies.

Third-party assessments have estimated the aggregate rates of return on work addressing infrastructural technology needs of industry.

An example is NIST's work supporting the U.S. optical fiber industry.[11] NIST-developed measurement technologies served as the basis for more than 20 industry standards that have helped reduce market transaction costs arising from disagreements between optical fiber manufacturers and their customers. The standards established a solid basis for evaluating the technical performance of

NIST also is placing increased emphasis on tracking how companies and industries use specific services and the results of specific R&D projects.

fibers. The social rate of return was estimated to exceed 400 percent, and one manufacturer has credited the standards with significantly expanding the size of the market for optical fibers.

In addition to the series of case studies of economic impact, which is continuing, NIST also is placing increased emphasis on tracking how companies and industries use specific services and the results of specific R&D projects. For example, the Visiting Committee on Advanced Technology studied the commercialization of NIST innovations that have won "R&D 100 Awards" in the annual competition sponsored by *Research and Development* magazine. Between 1973 and 1990, NIST won 71 R&D 100 Awards; about three-fifths of the innovations (41) achieved commercial impact.[14] NIST also has begun to prepare a series of brief "industrial impact statements" that are intended to capture the nature of the laboratories' assistance to companies or industrial sectors, including resulting improvements in products or services, processes, and market performance, as well as jobs created.

MANUFACTURING EXTENSION PARTNERSHIP

The Manufacturing Extension Partnership, or MEP, is a growing nationwide network of manufacturing extension services that provides small and medium-sized U.S. manufacturers with technical assistance as these firms modernize their operations to increase their competitiveness. Comprising the core of the nation's manufacturing base, the more than 370,000 U.S. manufacturing establishments that employ fewer than 500 people often are, as characterized in a recent National Research Council study, "operating below their potential. Their use of modern manufacturing equipment, methodologies, and management practices is inadequate to ensure that American manufacturing will be globally competitive."[15]

A variety of obstacles hinder small and medium-sized manufacturers' modernization efforts. Those that impede the adoption of appropriate modern technology and organizational methods include lack of resources and in-house technical expertise, limited awareness of changing manufacturing technology and its applications, and difficulty in locating unbiased sources of information and technical assistance. Viewed from a national perspective, currently available public and private sources of assistance—which range from large companies' supplier-improvement programs to small, local industrial outreach programs and private-sector consultants—are fragmented and vary greatly in breadth and depth of services. Collectively, they reach only a small fraction of small and medium-sized manufacturers whose existence is threatened by continued reliance on outdated technology, production techniques, and management practices.

By providing leadership and building a national framework for the *delivery* of manufacturing extension services, NIST's MEP will organize a comprehensive, yet locally responsive, system to help small and medium-sized manufacturers upgrade their equipment, techniques, and operations. From a base of seven regional Manufacturing Technology Centers (MTCs), established between 1989 and 1992, the MEP is planned to grow to over 100 extension centers by 1997. Linked by a coordinating national infrastructure, each center and each partnering organization will be an entry point into an integrated network of technical resources, services, and expertise on topics ranging from computer-aided design and manufacturing to just-in-time inventory methods to workforce training.

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The evolving MEP network has several components:

- regional MTCs, or MTC-like service providers, located in areas of high manufacturing density;

- Manufacturing Outreach Centers, or MOCs, which serve areas of lower manufacturing density, either as free-standing entities or as MTC satellites;
- the State Technology Extension Program, or STEP, which provides funding and technical support for planning, implementation, and regional linkages to strengthen industrial extension efforts in the states; and
- "LINKS," which encompasses the national structure of communications, data systems, evaluation, field-agent training, tool development, and linkages with technology sources.

NIST's MEP staff have played a key role in the review and merit-based selection of winners of deployment awards made under President Clinton's Technology Reinvestment Project (TRP), which is managed by the Defense Department's Advanced Research Projects Agency. NIST is managing 42 of the 70 TRP deployment activities selected to date, and these activities will be incorporated into the manufacturing extension network. Recent TRP award winners include 22 new centers that will enable NIST to accelerate development of the MEP network.

Setting Priorities

Guiding Principles. The design and evolution of the national manufacturing extension network are guided by several basic principles that broadly define the MEP's priorities, operational and organizational philosophies, scope of services and activities, and strategic emphases.

Recipients of MEP funding are selected through merit-based competitions that assess how fully each candidate satisfies the criteria established for each component of the network.

First, all recipients of MEP funding are *selected through merit-based competitions* that assess how fully each candidate satisfies the criteria established for each component of the network.

Second, service providers in the MEP network *tailor assistance and technology solutions to the needs and constraints of client firms,* including budgets and workforce capabilities. The providers are client-driven, not provider-driven.

Third, extension centers and other components of the MEP network are *not supported to perform manufacturing R&D,* concentrating entirely on the diffusion of appropriate technologies to speed industrial modernization.

Fourth, the MEP is *inclusive*, and it *prevents duplication* of effort by emphasizing a network design that takes maximum advantage of the knowledge, experience, and expertise of a broad spectrum of existing organizations.

This principle yields two other, closely related characteristics that are key:

- The network is non-hierarchical. It builds on grassroots proposals motivated by and tailored to the needs of local industry and allows local

flexibility and innovation in addressing those needs, while providing the technical support and resources of a national infrastructure.

- The MEP does not compete with private technical consultants; it recognizes the important role that these consultants play in helping small and medium-sized manufacturers improve their operations. The NIST MTCs have developed constructive relationships with private consultants, who can help the centers extend their reach and broaden the range of technical assistance and expertise accessible through the MTCs. At the same time, in many cases, MTC activities help private consultants expand their reach by qualifying small manufacturers and helping them understand the value of consulting services. To ensure a clear understanding of this relationship and to avoid potential conflicts, MEP staff are now evaluating how private consultants serve small manufacturers and what role the MTCs play in that process.

Selection Criteria. Separate selection criteria have been developed for each MEP component, although there is substantial overlap because of shared objectives. All centers and projects are selected only after undergoing competitive review. The criteria used to evaluate proposals for new centers are representative:

- *Knowledge of target firms:* Comprehensive understanding of an area's manufacturing base, including business size, industry types, product mix, and technology requirements.
- *Technology resources:* Linkages to external sources of technology, including educational institutions, state and regional technology transfer programs, and federal laboratories.
- *Delivery mechanisms:* The staff, resources, and methodology for effectively delivering appropriate manufacturing technologies and techniques to local or regional manufacturers, as well as the ability to form effective partnerships with other organizations offering complementing services or resources.
- *Management and financial plan:* An effective management structure, full-time top management, additional sources of funds, and an effective system of internal evaluation.

MEP builds on grassroots proposals motivated by and tailored to the needs of local industry and allows local flexibility and innovation in addressing those needs, while providing the technical support and resources of a national infrastructure.

Program Evaluation

In preparing for the MEP's expansion, staff members are developing a strategic plan that integrates the functions of each service-delivery component of the network and lays the methodological foundation for evaluating program performance and measuring results. A national, standardized system of data collection

A national, standardized system of data collection and evaluation will enable MEP staff to assess the efficiency and effectiveness of the entire network.

and evaluation will enable MEP staff to assess the efficiency and effectiveness of the entire network, each network component, each type of extension service, and each service provider. The evaluation system will identify the services most valued by small and medium-sized manufacturers; characterize the types of firms and industries that make the greatest use of manufacturing extension services, as well as those that make the least use of services; prevent duplication of effort; and measure economic impact at levels ranging from individual services and centers to the MEP as a whole.

Measures of Organizational Performance. All MEP organizations are required to submit detailed quarterly and annual reports, standardized for each of the four components of the network, and they undergo annual performance reviews by MEP regional managers. At the end of the third year of operation, extension centers undergo rigorous evaluations by outside panels appointed by NIST.

Reported quarterly by each center, the following types of information help MEP management to evaluate overall performance of the MEP organizations and to assess market penetration (i.e., number of client firms relative to the size of the potential client base), the mix of services provided, the breadth and depth of organizational linkages, and the ability of the center to generate revenue to support operations:

- staff composition and percentage of employees working with clients in the field;
- number of establishments served, by size;
- ratio of the number of technical assistance projects proposed to client companies to the number initiated;
- number of activities initiated, by type of activity (e.g., formal assessment, technical assistance project, initial site visit, information referral), technical focus (e.g., control systems; plant layout; computer-aided design, manufacturing, or engineering), and size of firm;
- number of participants and number and types of firms represented at training programs and other events; and
- results of client valuation surveys.

Upon completing technical assistance projects, the centers ask client firms to assign values to the services provided. Clients estimate the impact that the just-concluded project will have on company performance over the next 12 months.

Specifically, firms are asked to estimate the anticipated impact of the project on sales, costs, capital spending, inventory levels, and jobs (number created or saved). Although subjective, these measures provide center management and personnel with the means to ascertain levels of customer satisfaction and to

differentiate among clients' perceptions of the type and magnitude of benefits attributable to center activities.

MEP management fully appreciates the importance of measuring performance, but it also recognizes the need for flexibility in reporting formats, particularly for pilot projects that are testing experimental services and service-delivery mechanisms. Overly rigid process and outcome measures could yield data that provide little meaningful information for evaluations of performance and impact and, at the same time, inhibit experimentation and innovation. Successful "LINKS" and extension enabling TRP projects, for example, may provide services that indirectly affect manufacturers but directly improve the quality and accessibility of information and services provided by extension centers. Measures of performance and results are being developed for these kinds of activities, with the recognition that what gets measured gets emphasized and that not all measures are equally significant for all types of activities and MEP components.

Measures of Economic Impact. In addition to evaluating the performance of each extension center, NIST also measures each center's specific impact on client companies. In contrast to the ATP and NIST's laboratory programs, the MEP is expected to generate economic benefits within a short time span. Indeed, MTC client firms reported substantial benefits, including cost savings, higher productivity, and increased earnings, within the first year of each center's operation.

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Though necessarily small in scope because of the limited scale of manufacturing extension efforts undertaken thus far, the results of analyses—supplemented by case studies and other anecdotal evidence—illustrate the large potential for significant economic and company benefits.[15–18] Cumulatively valued and based on self-reported data from MTC client firms, company-realized benefits from formal MTC technical assistance projects totaled an estimated $320 million between 1989 and 1992, translating into a return of over $7 on each federal dollar invested in the centers. This estimate undervalues the impact of some MTC services, such as seminars and information referrals. Many firms consider these "soft" services to be very beneficial, even though their impact is difficult to quantify.

For the network's individual extension centers, as well as for the MEP as a whole, the fundamental unit of analysis is and will continue to be individual firms. On an annual basis, the MTCs also administer questionnaires to ascertain the progress made by client firms. One year after the completion of a technical assistance project or other substantive interaction with a center, client firms are asked to assess their progress and business health by comparing information in key performance areas one year before and one year after projects have been completed. The before-and-after assessment considers three levels of outcomes, which will be analyzed in relation to a "control" group.

Base-level client outcomes serve as indicators of how successfully centers are assisting firms in adopting appropriate technologies and management practices.

Base-level client outcomes serve as indicators of how successfully centers are assisting firms in adopting appropriate technologies and management practices; making more use of capital, labor, and materials; and improving response time and other key aspects of manufacturing performance. These measures are:

- changes in scrap rate (value of scrap per sales—an indicator of quality and of efficiency of material use);
- changes in computer use (percent of employees using computers or programmable machine controllers at least weekly—an indicator of broadening applications of computers, the essential element of many new manufacturing and business technologies); and
- changes in inventory turns (ratio of sales to inventory—an indicator of increasing throughput, which may be the result of improved lay-out, scheduling, and routing).

Intermediate-level client outcomes are designed to reflect changes that stem from performance improvements at the base level of operations, although these changes may take longer to materialize. These include:

- changes in the ratio of sales per employee—an indicator of increased labor productivity; and
- changes in manufacturing lead time—an indicator of decreased response time to customer orders.

Top-level client outcomes reflect business and employment gains traceable, at least in part, to operational improvements captured by the previous categories of measures. Among the outcomes measured are:

- change in total sales,
- change in export sales,
- change in employment, and
- change in employee income (payroll per employee).

Although these objective outcome measures may not correspond directly to the extension services provided, they are easily tracked by client firms, and they have the virtue of being related, at least indirectly, to the substance and aims of most service activities. As they come on line, all MEP service providers will be required to submit client progress reports based on surveys to ascertain the performance of firms in the years before and after completion of an extension service activity.

The MTCs are currently collecting 1990 and 1992 data from firms that they assisted in 1991. Results of client progress surveys of 28 firms assisted by the Great Lakes MTC in 1991 are illustrative.[16] For example, the firms reduced their

manufacturing lead times by an average of 22 percent and reported average increases of:

- 13 percent in sales,
- 47 percent in value of exports,
- 6 percent in employment,
- 17 percent in total payroll, and
- 46 percent in the use of computers or computer-controlled equipment by employees.

To increase the value of the data gathered in client progress surveys, the MEP is developing a nationwide benchmarking database on the performance of up to 1,000 plants to help companies better understand their competitive position in the marketplace. The database will build on a 300-client database developed by the Midwest MTC in Ann Arbor, Mich., which now contains performance data for five industries. This will enable the Midwest MTC to provide benchmarking service to client firms of other extension services. In addition, the expanded database will be a useful MEP management tool, enabling national-level comparisons of the performance of MEP clients with the performance of "control" firms that have not used extension services.

Because the MEP is promoting measurement and evaluation as powerful learning and management tools, it has asked the Modernization Forum, which draws its membership from the centers, to develop a guide on evaluation and associated training materials for use by project managers and manufacturing extension field agents. Training workshops are now being planned, with the first scheduled for February 1994.

Finally, the MEP will continue to sponsor third-party reviews of the extension network and its components to evaluate their effectiveness and to guide improvements in performance, including evaluation. It already has initiated several efforts to build a common understanding of process and outcome evaluation. For example, it has sponsored studies of evaluation issues and practices in industrial modernization programs, one conducted by the Georgia Institute of Technology and the other by Carnegie Mellon University. It also requested a National Research Council study of barriers and opportunities to improve the manufacturing performance of small and medium-sized manufacturers.[15] Other steps taken to build a national framework for evaluation include the continuing development of taxonomies for classifying types of services, activities, and manufacturing problems and practices as well as efforts to form a national network of evaluators comprising federal, state, local, and academic experts.

The MEP is promoting measurement and evaluation as powerful learning and management tools.

MALCOLM BALDRIGE NATIONAL QUALITY AWARD PROGRAM

The award is having a major effect in encouraging large numbers of U.S. companies to adopt quality improvement strategies.

Government-private sector partnerships are essential as the United States responds to economic challenges. The NIST-managed Malcolm Baldrige National Quality Award program demonstrates just how effective such partnerships can be. Industry pledged more than $10 million to support the program when it was launched, and NIST coordinates the more than 90 percent of program activities that are undertaken by the private sector.

Established to promote quality awareness, to recognize quality achievements of U.S. companies, and to publicize successful quality strategies, the award is having a major effect in encouraging large numbers of U.S. companies to adopt quality improvement strategies—whether or not they ever decide to compete for the award. These corporate strategies are improving the ability of U.S. companies to compete in a more important and larger contest: winning in the global marketplace.

The program recognizes quality management excellence in three categories: manufacturing, service, and small businesses. Up to two awards can be made in each category. In the six years the award has been given, the number of winners has ranged between two and five.

Although the major focus of the award is on results and customer satisfaction, it is not given for specific products or services. To win the award, a company must have a world-class system for managing its processes and its people. The system should ensure continuous improvement. The assessment of individual companies' performance rests with an independent group of quality experts, selected almost entirely from the private sector. The assessment process itself is an iterative one, involving several reviews for each applicant and providing comprehensive feedback to every company that applies.

Setting Priorities

The award's enabling legislation made it clear that the program was to extend beyond the selection of individual companies for recognition; it was expected to raise awareness and to provide information and incentives for U.S. industry to become more competitive in the global marketplace by incorporating proven quality management strategies.

The primary customers for this program were clearly identified as U.S. firms, and NIST's priorities for this program have been designed to ensure that all U.S. companies were targets for involvement and information. Accordingly, NIST has made major efforts to reach out to two categories of companies that seemed to be under-represented in the early years of the award program: service sector and smaller companies.

NIST's first priority was to create a program that was credible to quality experts and business leaders and that built up a new private-sector network to do the bulk of the work in reviewing applications. The program also needed to be financially viable, relying primarily on private-sector contributions of time and funds. NIST also assigned high priority to expanding that private-sector network to involve trade and professional associations and state and local organizations to extend the reach of the Baldrige Award criteria and the impact of lessons learned by companies using quality management techniques.

Now that the award has become established and well known in the business community, NIST is beginning to expand the program into two areas of national importance: health care and education. NIST expects to scale up these initial efforts and to create separate awards in these categories if pilot programs launched in 1995 are successful and develop strong involvement and support.

Now that the award has become established and well known in the business community, NIST is beginning to expand the program into two areas of national importance: health care and education.

In developing criteria for the Baldrige Award, NIST consulted extensively with private-sector quality experts formally through workshops and informally through many meetings and presentations. The criteria are refined after annual improvement meetings involving award judges, examiners, and others from the private sector. For example, the 1994 criteria reflect a much greater emphasis on corporate responsibility and citizenship and on customer-oriented quality results than the criteria used in the initial years of the program. At this same annual meeting, the private-sector examiners also review the application and selection process. Continuous improvement is the aim of these regular reviews of the criteria, much as it is a goal of the entire award program.

Program Evaluation

Just as award applicants are required to measure and show results for their quality management strategies, the award program relies on a variety of tools to evaluate program effectiveness and to measure results.

A formal advisory committee to the Secretary of Commerce reviews the program's progress. This prestigious group of national quality experts from business and academia provides an annual report to NIST and to the Secretary. Other annual reviews are provided to NIST by the Panel of Judges (which makes final recommendations on proposed winners to the NIST Director) and the Foundation for the Malcolm Baldrige National Quality Award—which has a direct interest in en-

suring that NIST manages the program to make the best possible use of the funds provided by the foundation. Moreover, the House Committee on Science, Space and Technology, which introduced the legislation establishing the award, conducts an annual oversight hearing involving winners of the award, NIST, and outside experts to review the program's effectiveness and management issues.

As part of its formal evaluation process, the Panel of Judges has surveyed a sample of quality award applicants to determine their satisfaction and to gain insights into problems that they may have encountered. The NIST Office of Quality Programs reviews the information gathered through these two mechanisms and sets specific goals and actions for improvement. For example, the survey of applicants indicated a desire for more rapid feedback from the examiners on the strengths and areas for improvement in the companies' quality management efforts; after making changes in the evaluation process and a major effort, the turnaround time for feedback reports was reduced substantially from the 1991 competition to the recently completed 1993 cycle. Feedback quality also improved during this period.

Generating greater public awareness of quality management strategies and the opportunity for improvement is a major aim of the award program, and winners of the award are asked to provide detailed feedback to NIST on the conduct of the public information portions of the program. Meetings and surveys are conducted each year, providing information that is used to revise and guide the program's information and outreach efforts.

In addition, meetings are held with past winners to review the award program's overall impact and effectiveness and to solicit ideas for changes. For example, in July of 1993, top-ranking quality officials representing 14 of the 17 companies that had won to date met at NIST to provide that feedback.

The Baldrige criteria serve as the basis for approximately 30 separate state and local level awards for quality.

One especially useful indicator of the program's success is the level of companies' interest in the award criteria. More than 1 million copies of the criteria, which serve as quality improvement guidelines, have been requested and distributed. They are reproduced and used widely by companies and other organizations to drive quality improvement in all sectors of the economy. They serve as the basis for approximately 30 separate state and local level awards for quality, and they now are used as the model for awards in Mexico, Europe, and elsewhere around the globe. Another indicator of interest: more than 20,000 presentations have been made on quality improvement through the Baldrige Award approach—the vast majority by award winners or examiners from the private sector.

Ultimately, the program's effectiveness must be evaluated by the impact on companies' performance. Quality management is just one of numerous factors that determine a company's financial performance, and quality improvement alone is no guarantee of financial success. Still, many companies assert that their adop-

tion of quality management practices based on the Baldrige criteria have placed them in a better financial and competitive position.

Some measures of the program's bottom-line effectiveness to date:

- A 1991 report from the General Accounting Office calls the Malcolm Baldrige National Quality Award criteria "the most widely used accepted formal definition of what constitutes a total quality management company."[19] On the basis of a survey of firms using the criteria, the report concludes that "In nearly all cases, companies that used total quality management practices achieved better employee relations, higher productivity, greater customer satisfaction, increased market share, and improved profitability."
- Solectron Corp., a 1991 award winner, noted, "Since we applied for the Malcolm Baldrige award in 1989, Solectron's sales have increased 316 percent and profit has increased 338 percent in 3 years. ... We attribute our financial performance a great deal to the improvement we made through the rigorous examination and feedback from the Baldrige application process."
- According to a *Business Week* analysis, the three publicly traded, whole company Baldrige winners outperformed the Standard & Poor's 500 from the time they won the award through September 30, 1993, by 8.6 to 1.
- AT&T's Transmission Systems Business Unit reduced time to market by 50 percent in three years.
- Zytec's internal manufacturing process yields improved fivefold from 1988 to 1992, with on-time delivery up from 75 percent to 98 percent from 1989 to 1992.
- Motorola Inc. considers the criteria for the Baldrige Award so important that it has given its suppliers until 1994 to follow the award criteria or risk losing Motorola as a customer for their products.

The overall impact of the program was described in an article in the *Harvard Business Review*:

> In just four years, the Malcolm Baldrige National Quality Award has become the most important catalyst for transforming American business. More than any other initiative, public or private, it has reshaped managers' thinking and behavior. The Baldrige Award not only codifies the principles of quality management in clear and accessible language. It also goes further: it provides companies with a comprehensive framework for assessing their progress toward the new paradigm of management and such commonly acknowledged goals as customer satisfaction and increased employee involvement.[20]

"In just four years, the Malcolm Baldrige National Quality Award has become the most important catalyst for transforming American business."

Comments on this paper are encouraged.

SUMMARY

In the midst of a new imperative to more effectively link government and industry in tackling technology challenges, NIST recognizes the importance of clearly spelling out how the agency sets priorities, evaluates performance, and measures economic impact. This paper provides a snapshot of those processes today for each of the Institute's four major programs. NIST seeks continuous improvement—to build upon the mechanisms already in place, to learn from others, and to more vigorously and comprehensively apply the best of the best evaluation and measurement tools. Always, the end goal must be to maximize the Institute's work with industry to promote technology for economic growth. Comments on this paper are encouraged.

Comments on this paper should be directed to:

Dr. Arati Prabhakar
Director
National Institute of Standards and Technology
Gaithersburg, Md. 20899-0001
fax: (301) 869-8972
email: director@micf.nist.gov

REFERENCES

1. Council on Competitiveness, *Industry as a Customer of the Federal Laboratories*. Washington, D.C., 1992.

2. For a full description of the process for defining ATP program areas, see *Advanced Technology Program: A "How-To" Guide for Submitting Program Ideas*, available from Program Ideas, Advanced Technology Program, NIST, A430 Administration Bldg., Gaithersburg, Md. 20899-0001 (phone: 1-800-ATP-FUND).

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Science and Technology Policy Research

At

RAND

Dr. N. Darius Sankey

Overview

Critical Technologies Institute

Institute on Education and Training

Project Air Force

Flex Fund Project

CTI: Set Up in Response to a Perceived Need

Multiple constituents within the government

- Principal sponsor: President's Science Adviser
  - OSTP Chairs OC, is secretariat for NSTC
- Assists National Science and Technology Council
- Interacts with wider community in industry and academia

CTI's Basic Mission

- Help decisionmakers understand the likely effects of alternatives
- Improve understanding in both the public and private sectors of the ways in which scientific and technological effforts can better serve national goals
- Provide analytical support to the Executive Office of the President through the Office of Science and Technology Policy

A Characterization CTI Research

Provide analyses of S&T policy choices which are:

- objective
- analytic

Three Main Classes of Activity:

- Conduct comprehensive analyses of proposed S&T policies
- Generate knowledge necessary to inform policy Discussions
  - map the policy terrain
  - information syntheses drawing on many fields
- Facilitate communication between government and industry

Two Classes of CTI Activities

I. Develop Tools

- Database of Federal R&D Efforts and Expenditures
- Measurement of Performance for Federal R&D in
  - basic science
  - environmental technology
  - civilian industrial technology
  - education and training

And are in response to requests from different clients

II. Specific Applications and Studies

- Space policy
- Technology in education and training
- P N G V ("Clean Car")
- GPS study
- Machine tools study
- Environmental technology

CTI's R&D Database: A Critical Task for the NSTC

"One of the most critical tasks I expect the NSTC to undertake is an across-the-board review of federal spending on research and development."

-- Statement of the President
November 23, 1993

Institute on Education and Training

- Develop Analytic Tools to Model the Research Universities as a Global System
  - Emphasis on Science and Engineering Research
- Jointly Develop and Test a new Resource Management System for Research Universities

Pro

- Air Force Lab Produc pact Assessment Study
  - What Metrics are used to measure Productivity?
  - How are Resources Managed?
- Management of Satellite System Study
  - Assess future Applications in Commercial Sector
  - Develop Specifications for Future Military Systems

Rand Sponsored Project

The Impact of DOD R&D Budget Cuts on Production of Scientist and Engineers

- **Is a Crisis going to Occur ?**
- **Where are DOD Resources Principally Targeted?**
- **What Percentage of Science and Engineering Graduate Students are funded by DOD dollars?**
- **What is the Demand in the Academic, Government, and Industrial Sectors? (Will there be a Shortage?)**
- **What is the level of Industry Support?**

NSF -- Strategic Areas of Research and Education

8

- High Performance Computing and Communications
- Science, Math, Engineering & Technology Ed.
- Global Change
- Biotechnology
- Civil Infrastructure Systems
- Adv. Manufacturing Technologies
- Environmental Research
- Advanced Materials and Processing

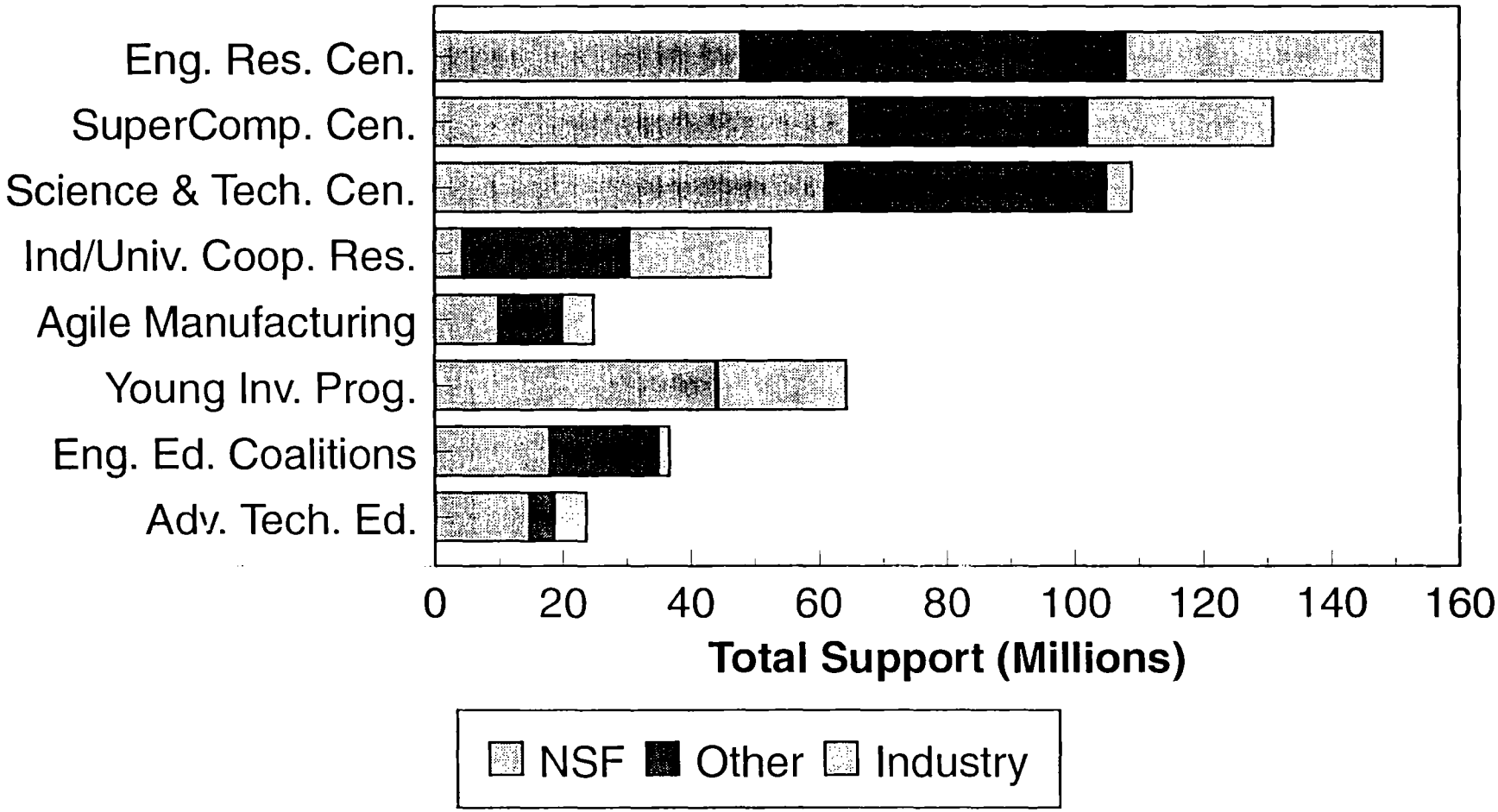
7

NSF: New Program Directions

- GOALI -- New Mechanisms for Industry/University Linkages
- CAREER -- Research/Education Linkages
- Strategic Areas

Cooperative Investments: Selected NSF Programs (FY94)

6



Other Includes: State/Local, Institutional, Other Fed.

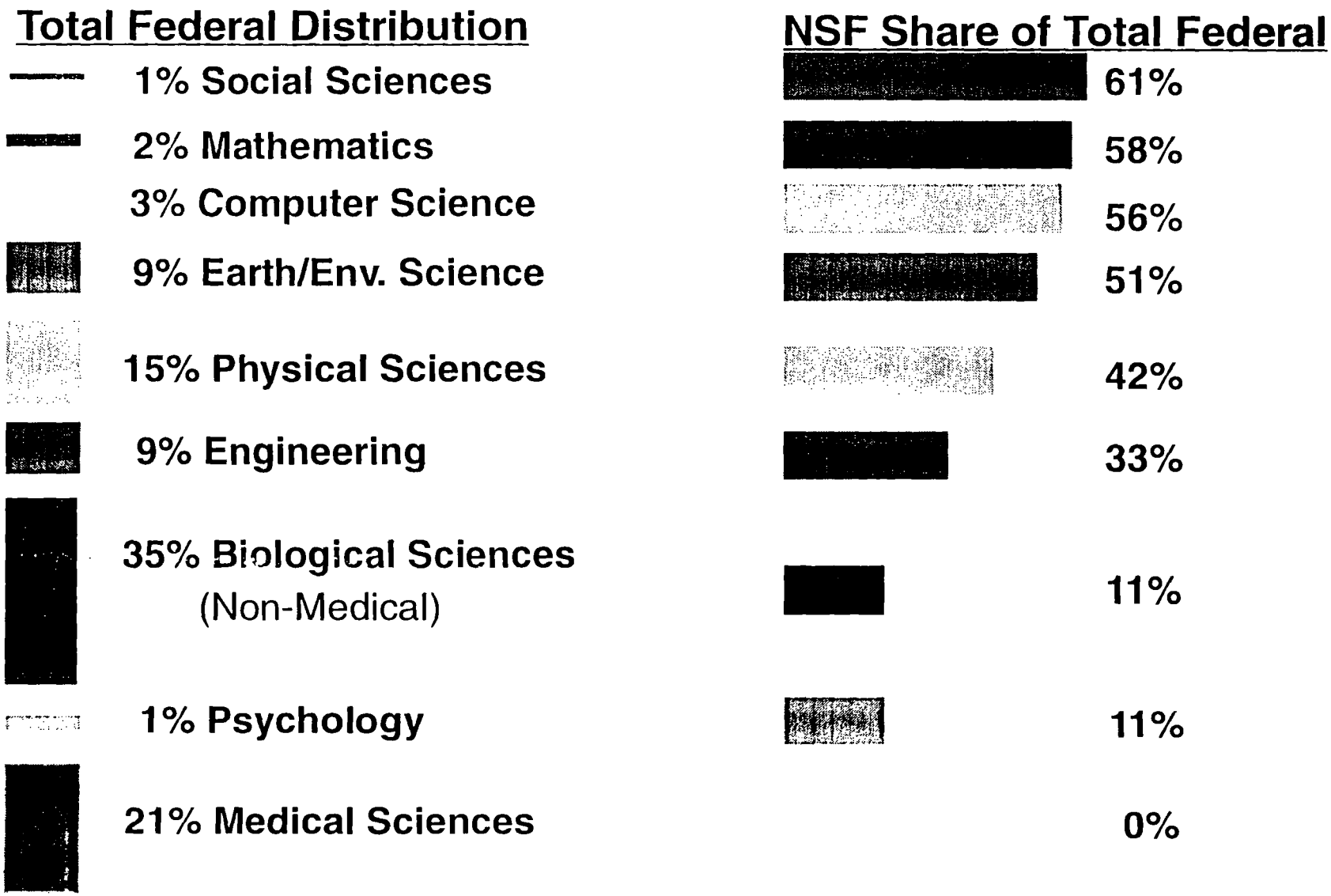
(5)

NSF and Industry: Overview

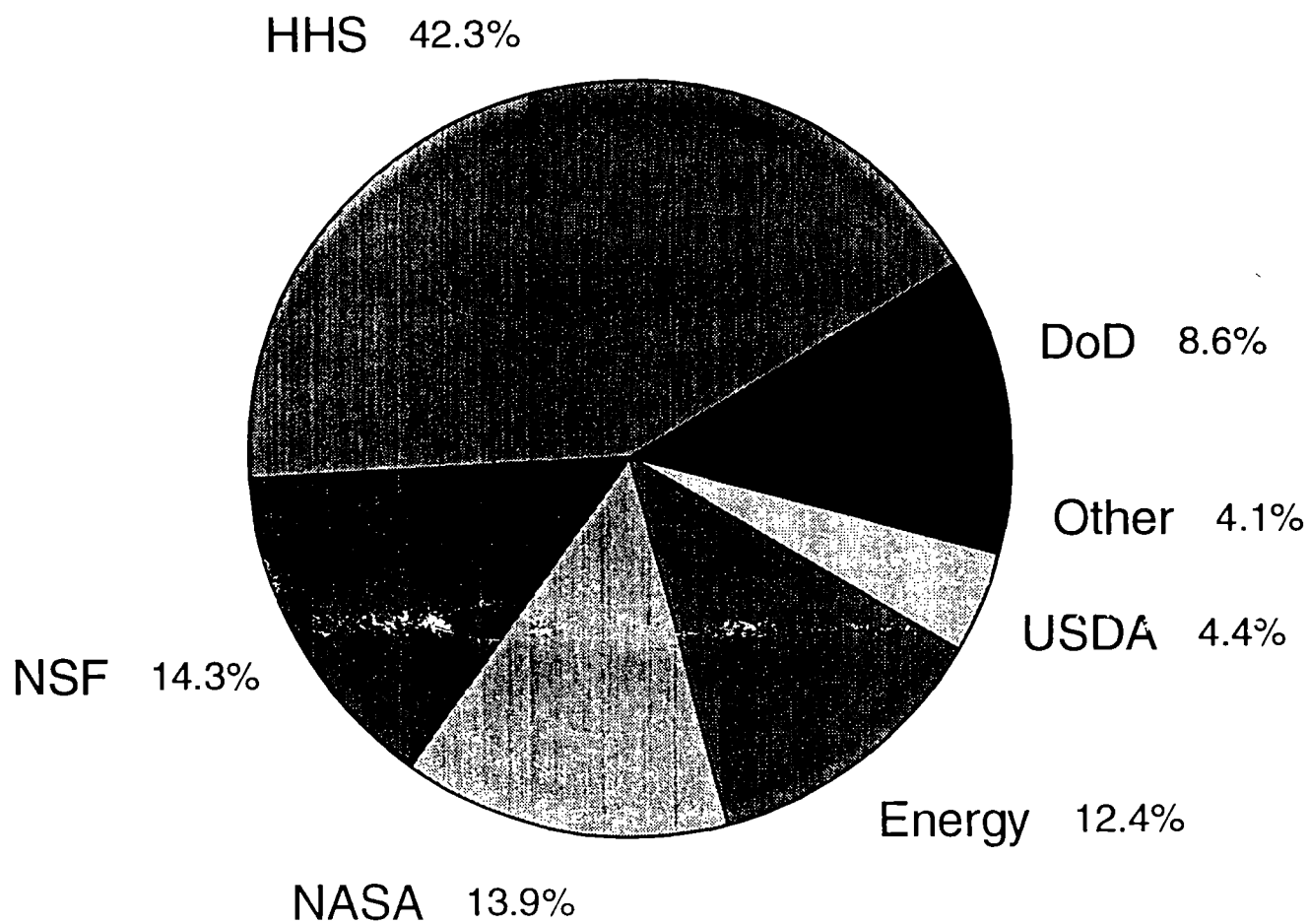
- >50 Programs with Industry Cost Sharing
- >$250 Million Invested by Industry in NSF Programs in FY94
- Need for Industry Input and Guidance
  - Advisory Committees
  - Systemic Reform, Outreach
- Survey Activities
- Strategic Plan: Premised on Partnerships

Federal Obligations for Basic Research at Academic Institutions

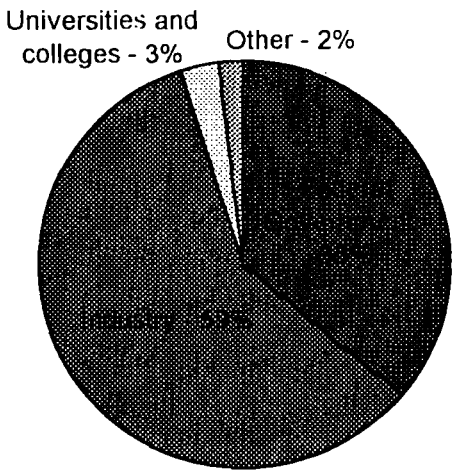
(FY 1994, $7.2 B)



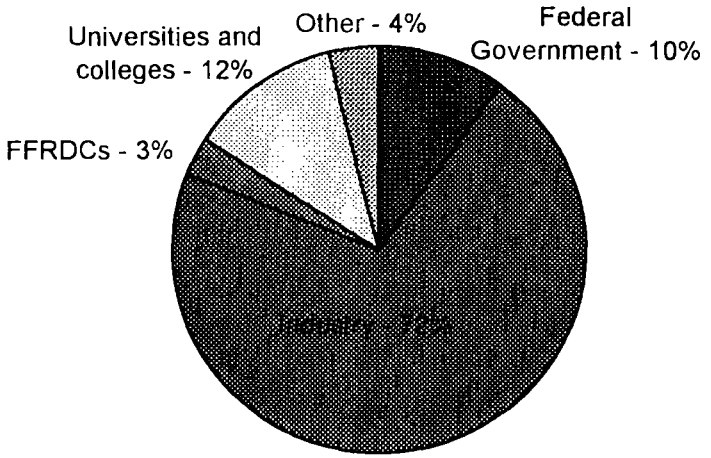
Federally Supported Basic Research By Agency
(1994, $14.3 Billion)



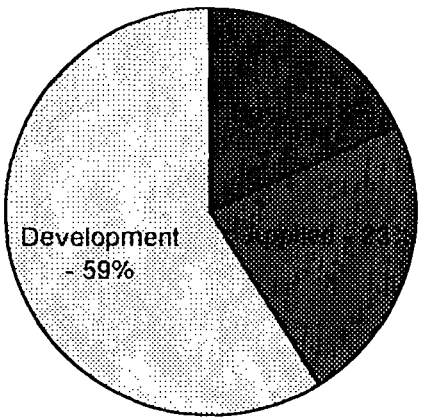
National R&D expenditures: 1994



By source of funds



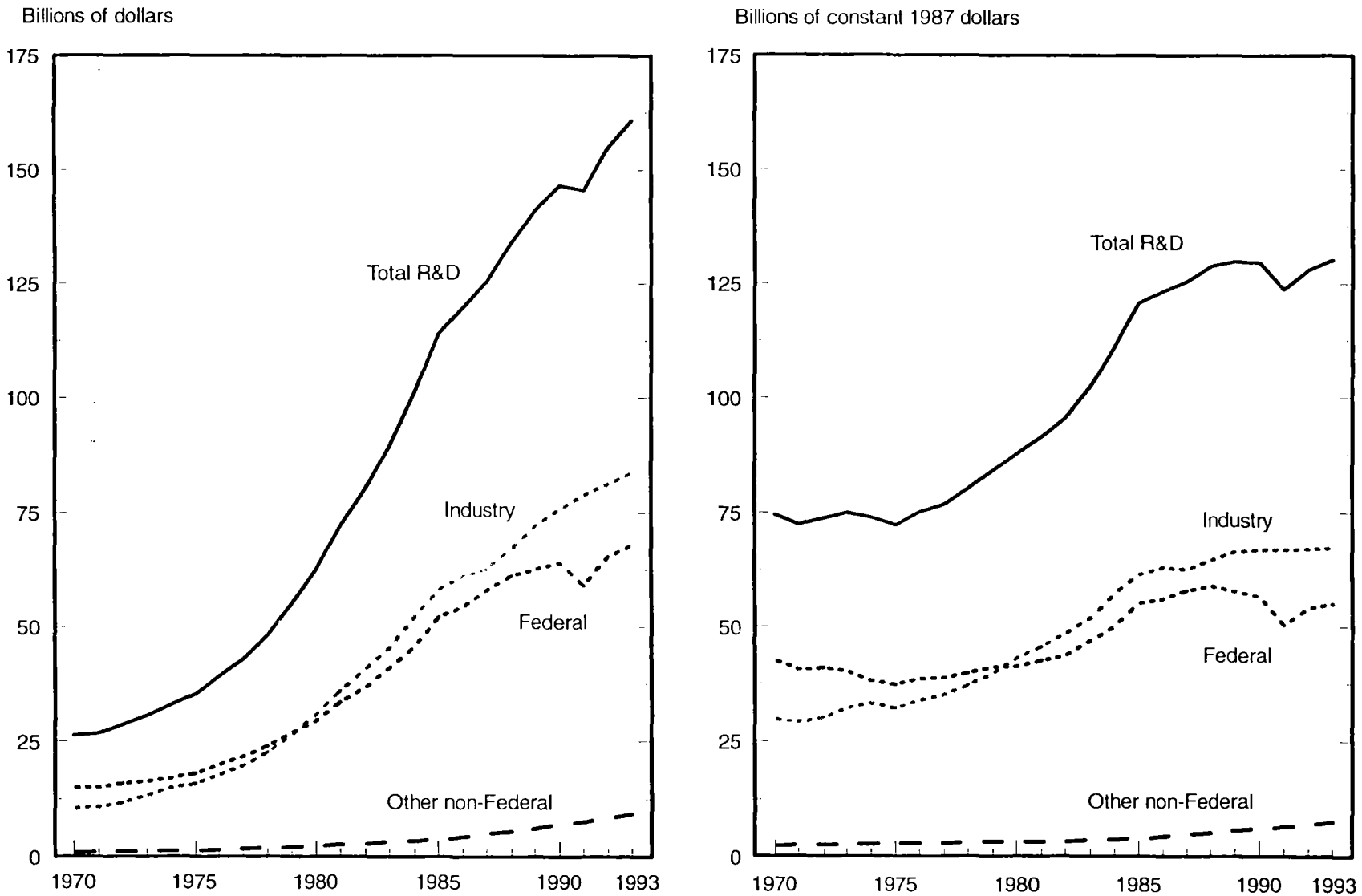
By performing sector



By character of work

Anne Petersen: NSF presentation

National R&D funding, by source



See appendix table 4-4.

Executive Director

NATIONAL
TECHNOLOGY TRANSFER
CENTER

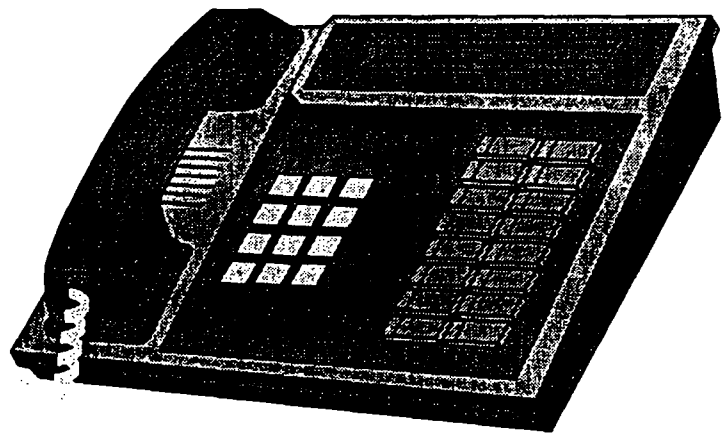
WHEELING *JESUIT* COLLEGE
316 Washington Ave.
Wheeling, West Virginia 26003

(304) 243-2455
FAX (304) 243-2463

National Technology Transfer Center

NTTC Gateway Service

Free *access* to
federally funded
research & expertise



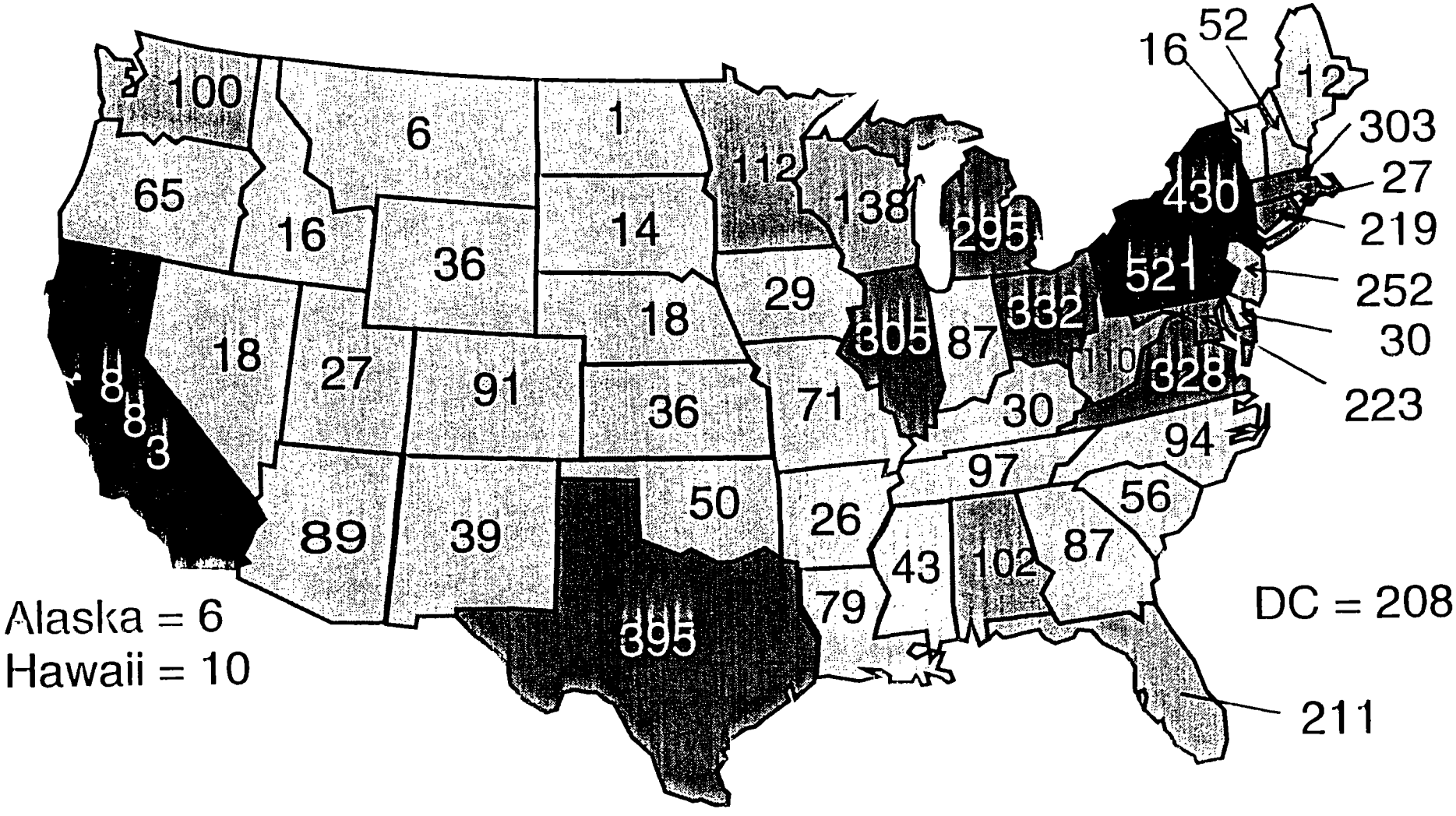
1-800-678-6882

The NTTC Product Line

- Free access to federally funded research through 800 number
- Electronic bulletin board - Business Gold
- Technology transfer training
  - Federal agencies and labs
  - Industrial Extension
  - Private sector
- Strategic partnering conferences
- Technology-based economic alliances
- Washington Operations (BMDO)

NTTC Technical Requests by State

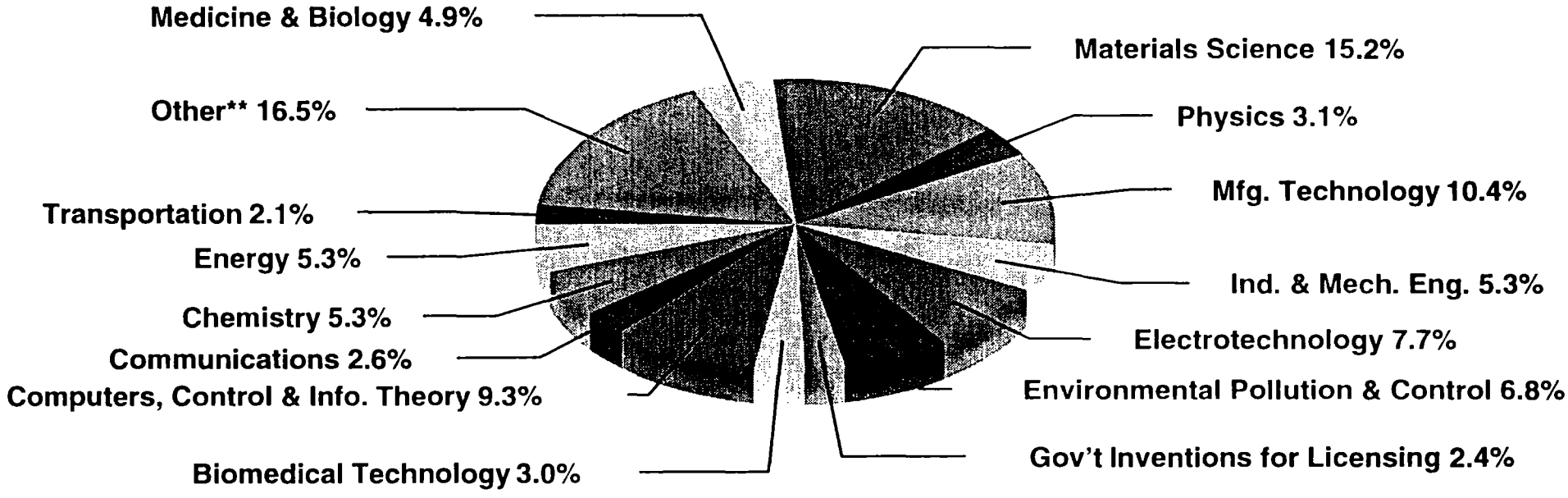
Data through 3rd Quarter 1994



Total Requests = 6825

NTTC Requests By Technology Area*

Data Through 3rd Quarter 1994



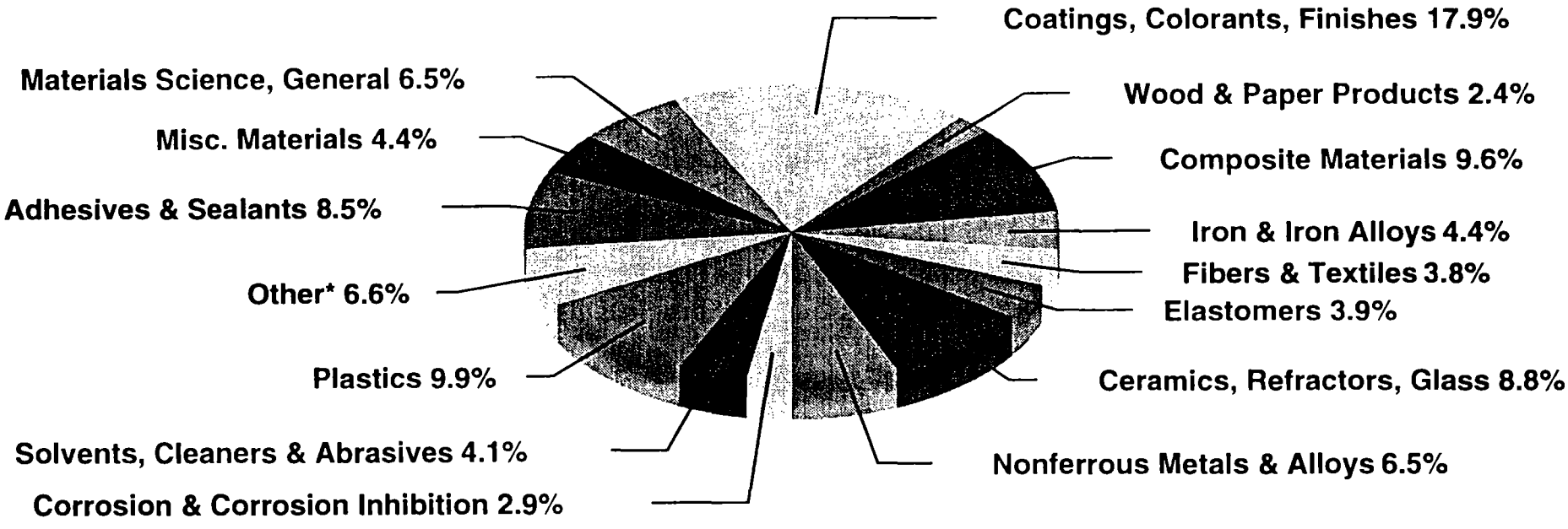
Total Requests=6825

*Major NTIS Classes

**Other includes categories with <2% of total

NTTC Technical Requests in Materials Science

Data through 3rd Quarter 1994

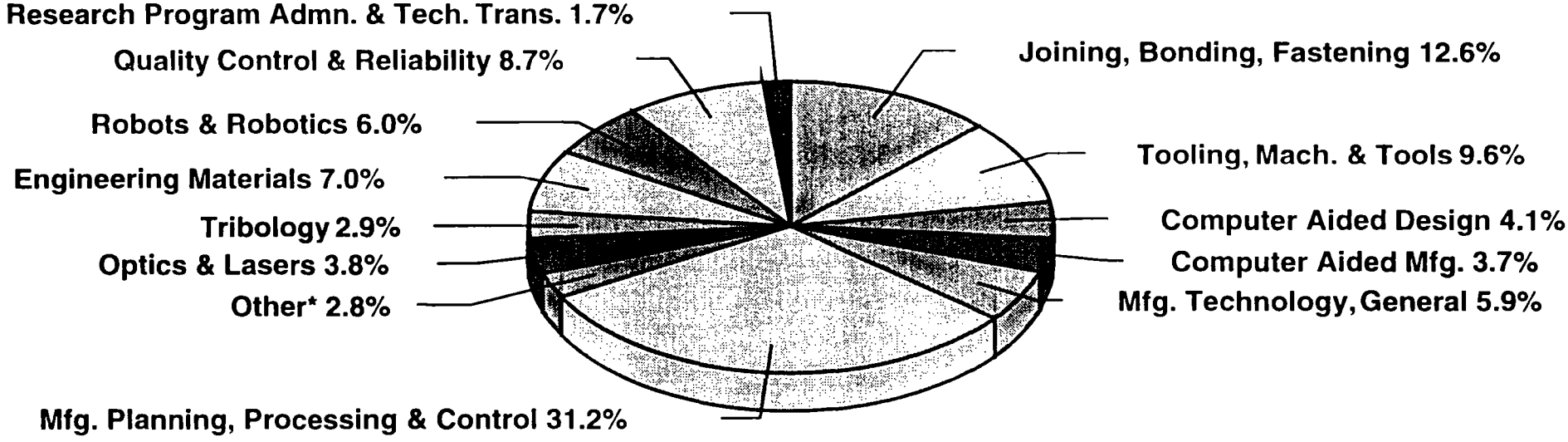


Total Requests=1033

*Other includes categories with <2% of total

NTTC Technical Requests in Manufacturing Technology

Data through 3rd Quarter 1994

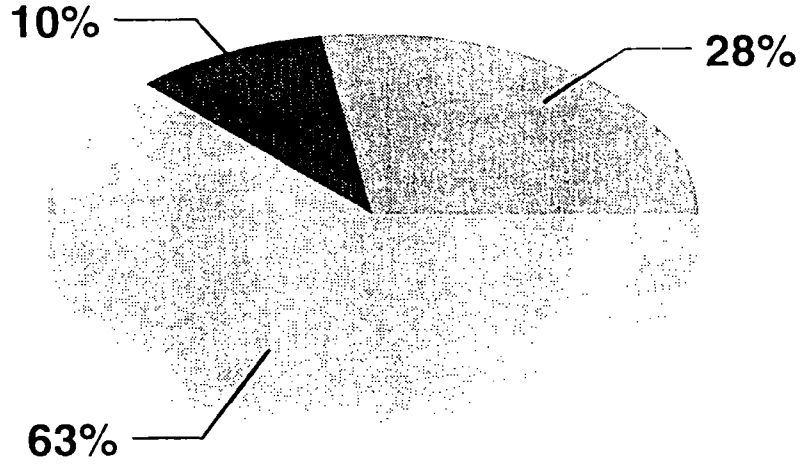


Total Requests=712

***Other includes categories with <1% of total**

NTTC Clients by Number of Employees

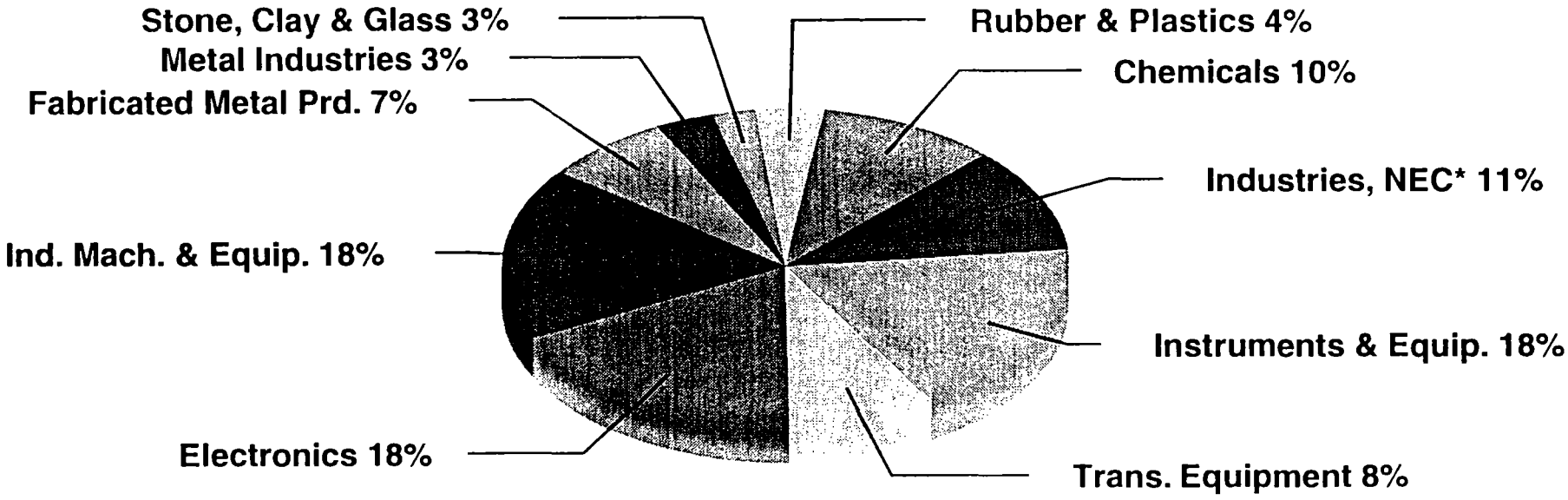
Data through 4th Quarter 1994



Total Clients = 4463

NTTC Clients in Manufacturing Industries

Data through 4th Quarter 1994

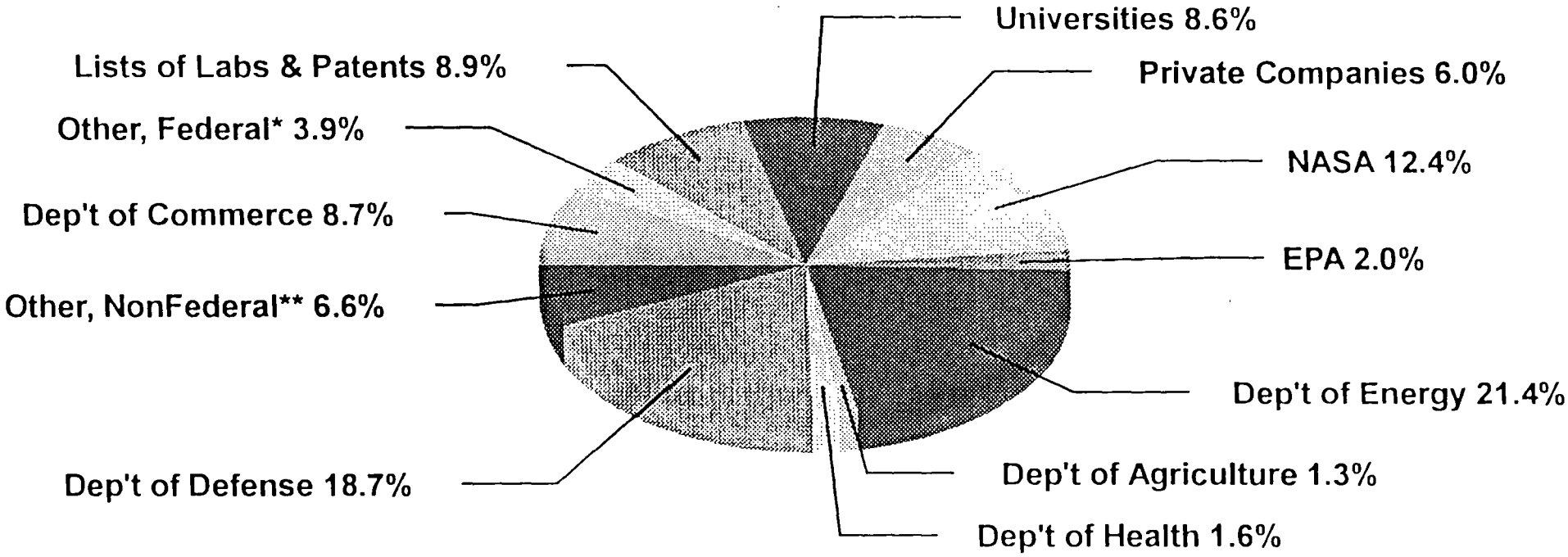


Total Requests=2010

* Not Elsewhere Classified

NTTC Referrals

Data through 3rd Quarter 1994



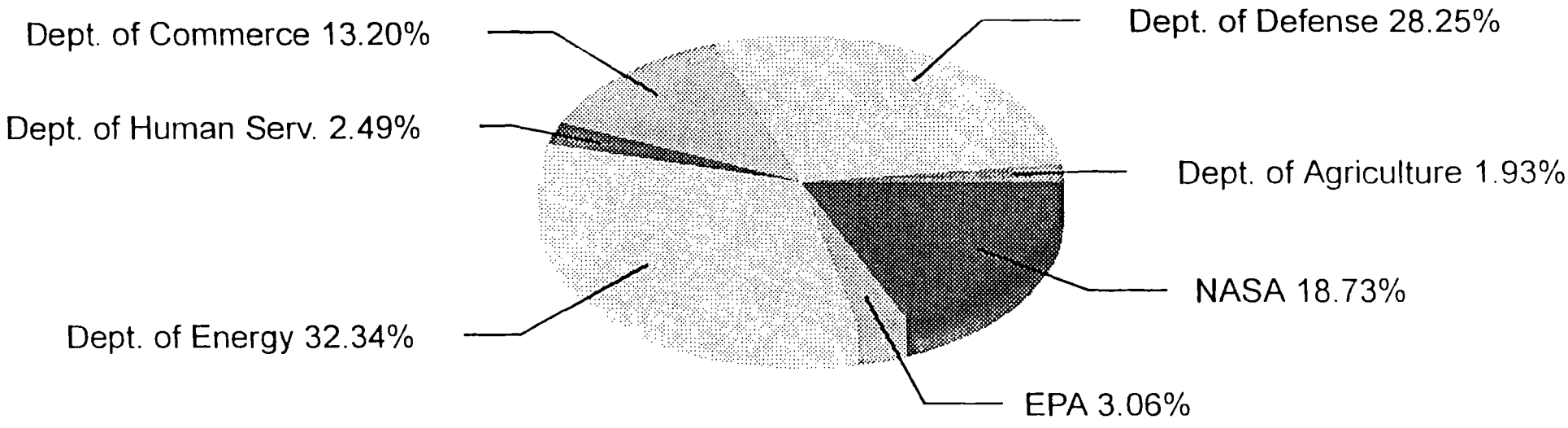
*Categories with less than 1.2% of total referrences

**Categories with less than 1.5% of total referrences

Total Referrals=15,560

NTTC Referrals to Top Seven Federal Agencies

Data through 3rd Quarter 1994



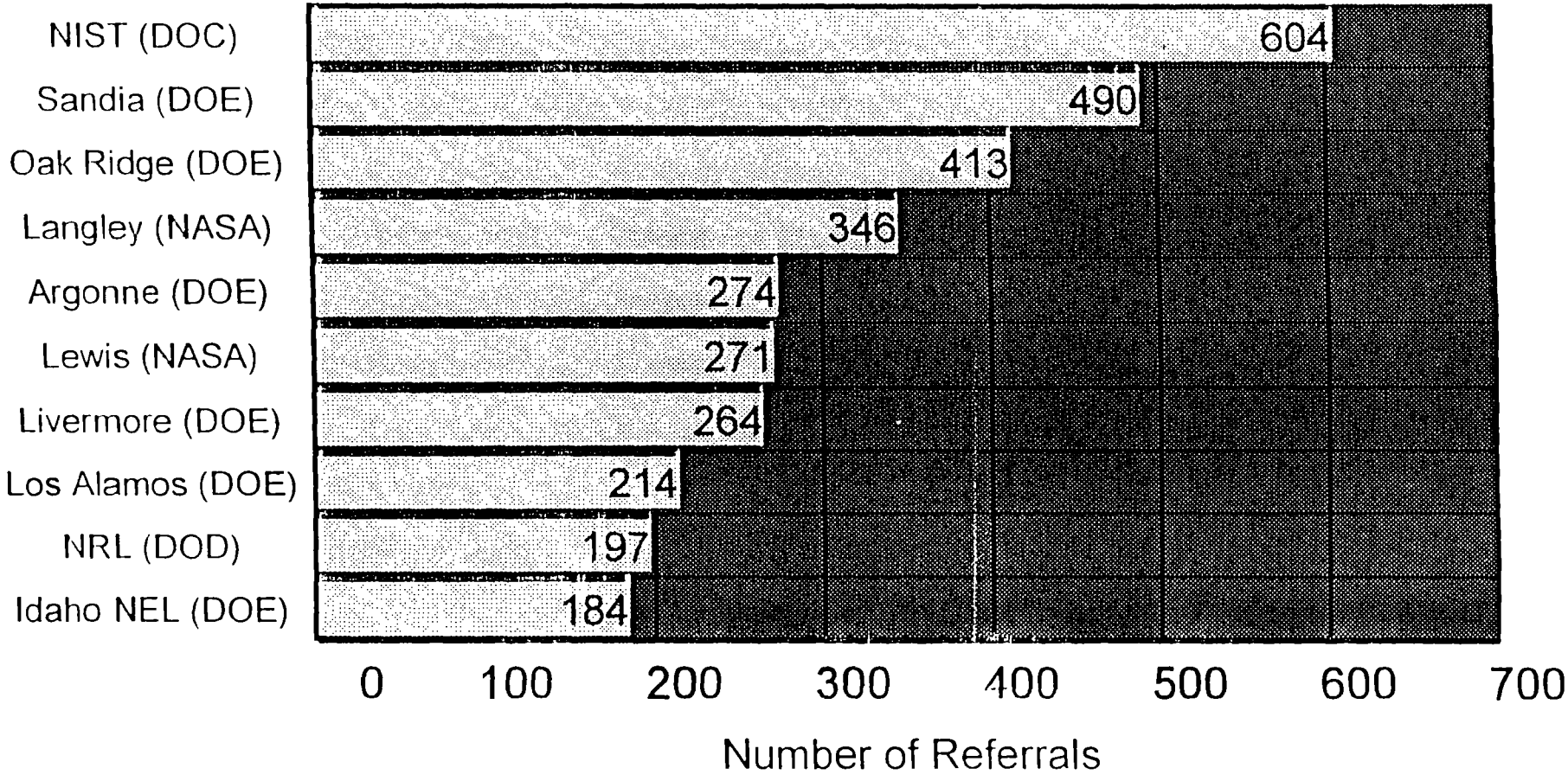
n=10,360

Total Referrals=15,560

Lab 2

NTTC Referrals to Top Ten Laboratories

Data through 3rd Quarter 1994



Industrial
Research
Institute, Inc.
Suite 1100, 1550 M Street, NW
Washington, DC 20005-1708

Date 1/9/95 From: Margaret Grucza
Total Pages 2 Fax: 202-872-6356
Phone: 202-872-6355

To Skip Johns Fax: 395-4155 Phone:

Attached is the agenda for the Thursday, January 12 Federal Science and Technology Committee Meeting. I look forward to seeing you then.

Margaret

Margaret

8:30-12:30
BREAK
1:30-
10:15

FEDERAL SCIENCE & TECHNOLOGY COMMITTEE MEETING

INDUSTRIAL RESEARCH INSTITUTE
1550 M Street, NW, Washington, DC
First Floor Conference Room
January 12, 1995

AGENDA

8:30 - 9:00 a.m.	Peter Boer, FST Chair Introductions, Announcements, Future Issues
9:00 - 9:30 a.m.	Anita Jones Department of Defense
9:30 - 10:15 a.m.	Skip Johns OSTP
10:15 - 10:30 a.m.	Break
10:30 - 11:00 a.m.	David Goldston Council on Competitiveness
11:00 - 11:45 a.m.	Arati Prabhakar NIST
11:45 - 12:15 p.m.	Darius Sankey RAND/CTI Activities
12:15 - 1:00 p.m.	WORKING LUNCH Pat Windham, Senate Commerce Committee Discussion on Congressional Issues
1:00 - 1:45 p.m.	Anne Petersen (for Neal Lane) NSF
1:45 - 2:15 p.m.	David Nelson (for Martha Krebs) DOE
2:15 - 3:15 p.m.	Federal Lab Discussion Topics: Industrial Fellows Program Update (P. Lyons) NTTC Initiatives (L. Rivers) FST/FGLC roles concerning industrial interactions with Fed labs (ALL)
3:15 - 3:30 p.m.	Meeting wrap-up; Adjourn

FEDERAL SCIENCE & TECHNOLOGY COMMITTEE MEETING

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Suite 1100 • 1550 M Street, NW • Washington, DC 20005-1708
Tel. (202) 872-6350 • Fax (202) 872-6356

Industrial Research Institute, Inc.

December 9, 1994

To: Federal Science and Technology Committee Members

Subject: **JANUARY 12, 1995 MEETING**

The FST Committee will meet on Thursday, January 12, 1995 from 8:30 a.m. to 3:30 p.m. at IRI Headquarters in the first floor conference room.

The agenda will include:

• Federal Government Liaison Council Issues/Updates	FGLC members (see enclosed roster)
• Council on Competitiveness Report	Erich Bloch
• Critical Technologies Institute Activities	Darius Sankey (RAND)
• National Technology Transfer Center Update	Lee Rivers
• Informal Lunch Discussion on Congressional Issues	Pat Windham (invited) (Senate Commerce, Science & Transportation Committee)

A more detailed agenda will be sent to you the first week in January. Please return the enclosed fax to Margaret Grucza at IRI before **January 4, 1995**. Feel free to contact me (407-362-1831) if you want to discuss potential agenda items.

Best wishes for the holidays. I look forward to seeing you at our January meeting in Washington.

F. Peter Boer

F. Peter Boer, Chair
Federal Science & Technology Committee

FPB:krr
Enclosures
FGLC Roster
Meeting RSVP Form
Minutes from Williamsburg

Federal Government Liaison Council (FGLC) Members

Dr. Mary L. Good
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U.S. Department of Commerce
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Washington, DC 20230
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Fax: 202-482-6184

Dr. Siegfried S. Hecker (Sig)
Director
Los Alamos National Laboratories
M/S. A100
Los Alamos, NM 87545
Tel: 505-667-5101
Fax: 505-667-2997

Dr. Lionel S. Johns (Skip)
Associate Director for Technology
Office of Science & Technology Policy
Executive Office of the President
Washington, DC 20500
Tel: 202-395-6175
Fax: 202-395-4155

Dr. Anita K. Jones
Director of Defense
Research & Engineering
U.S. Department of Defense
3030 Defense Pentagon
Washington, DC 20301-3030
Tel: 703-697-5776
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Dr. Martha A. Krebs
Director, Office of Energy Research
Department of Energy
1000 Independence Ave.
Room 7B2222
Washington, DC 20585
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Fax: 202-586-9520

KRR
12/07/94

Dr. Neal F. Lane
Director
National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230
Tel: 703-306-1000
Fax :703-306-0109

Dr. William J. Madia
Director
Pacific Northwest Laboratory
Battelle Blvd., P.O. Box 999
Richland, WA 99352
Tel: 509-375-6600
Fax: 509-375-6844

Dr. Arati Prabhakar
Director
National Institute of Standards and Technology
Admin. A1134
Gaithersburg, MD 20899
Tel: 301-869-8972
Fax: 301-975-2300

Mr. Gregory M. Reck
Acting Associate Administrator
Office of Advanced Concepts & Technology
NASA Headquarters
Code C
Washington, DC 20546
Tel: 202-358-0701
Fax: 202-358-3084

Invited:

Dr. Robert J. Huggett
Assistant Administrator for R&D
EPA
401 M Street, SW
Washington, DC 20460

FAX SIGN UP SHEET: Please return to IRI before **JANUARY 4, 1995**

TO MARGARET GRUCZA at IRI FAX NO: 202-872-6356

PHONE NO: 202-872-6355

NAME:_____ COMPANY:_____

FAX NO:_____

FEDERAL SCIENCE & TECHNOLOGY COMMITTEE MEETING

IRI Headquarters
Washington, DC
January 12, 1995
8:30 a.m. - 3:30 p.m.

_____ I plan to attend.

_____ Sorry, I cannot attend.

_____ The following person from our company will attend:_____

Topics I would like the Committee and/or FGLC members to address:

_____

_____

_____

_____

_____

To: Committee Members
IRI Executive Committee Attendees

MINUTES
FEDERAL SCIENCE AND TECHNOLOGY COMMITTEE MEETING
OCTOBER 23, 1994
WILLIAMSBURG, VIRGINIA

Attendees: List attached

1. Federal Lab Issues

A. Los Alamos Industry Fellowship Program

Peter Lyons gave an update on the Los Alamos Industry Fellowship Program which is starting very successfully. Thirty-five companies expressed interest in the program as did forty professionals within Los Alamos National Laboratories. Six organizations are serving as hosts: the Delco Division of General Motors; Dow Chemical; Lockheed/Martin Marietta; the Association of American Railroads; Allied-Signal and Eaton. It is too early to evaluate actual results from the program, but Peter Lyons will be visiting these companies for follow up and is planning regular discussions with the IRI to update us on its progress.

B. Future Spotlight Proposals

Margaret Grucza gave a brief description of the reasons why the spotlight proposal to visit Lawrence Livermore National Laboratory (with a focus on parallel processing computing at all three weapons labs) did not draw sufficient interest, resulting in cancellation of the program. Nonetheless, there appeared to be interest among some members in other spotlight proposals, such as an environmentally oriented meeting at Oak Ridge National Laboratory. It was agreed that the IRI should do more "market research" internally to determine the actual level of interest among the representatives and alternates before engaging one of the laboratories in developing a new spotlight program and publicize it thoroughly within IRI. It was also suggested that future visits could be an excellent opportunity to provide industry feedback to the labs, i.e., to use IRI as an ad hoc "visiting" committee.

C. Pacific Northwest Laboratory (PNL)

Bill Madia, recently appointed director of the laboratory, reviewed the unique relationship of PNL with the Battelle Institute, which has invested over $70 million in its own laboratory co-located with the Pacific Northwest Laboratory and which is set up to facilitate cooperation with industry. The Department of Energy allows industry access to the laboratory through an existing "use permit agreement." Approximately one-third of the industrial interactions of PNL are through Battelle and the other two-thirds are direct.

D. Federal Laboratory Consortium (FLC)

Beverly Berger gave an update on the FLC, which was chartered by Congress in 1986 and which now constitutes a group of some 600 federal laboratories. The group was established to help the labs help each other. FLC has created extensive descriptive information, which Beverly made available to the FST members. Copies may be obtained from FLC.

2. Federal Government Liaison Council (FGLC)

A. Office of Science and Technology Policy (OSTP)

Skip Johns of OSTP described the administration's achievements in reducing the number of federal laboratories and a major initiative to consolidate the federal laboratory organizations. He also updated us on communication and information infrastructure planning and told us that federal information is now available via the Internet. Other White House initiatives include high-performance computing, which will get investments upwards of $1 billion, and the establishment of a national space transportation policy, including the utilization of excess missile assets and an inventory of national aeronautical resources. A fourth subject included education and training programs emphasizing a small R&D effort to use high technology to improve the productivity of education. The latter programs are sponsored by the Department of Energy and the National Science Foundation. Finally, Skip reminded us of the Critical Technologies studies that have been performed under the committee chaired by John Young.

B. The Department of Commerce (DOC)

Graham Mitchell reported on the use of Federal resources to undertake R&D with the private sector, and indicated that in the past there were three fairly independent approaches involving trade policies, economic policies, and technology policies. But today the pressures of international competitiveness require the coordination of all three of these policy areas, with the health of the private sector being a measure of success and the views of the customer, i.e. American industry, absolutely critical to the effort.

Another important need is to develop a government-industry partnership that goes beyond R&D itself, dealing with important areas such as regulations, capital formation, and tort reform. Graham discussed the TRP and ATP programs which have been oversubscribed by a ratio of about ten to one. The numbers imply that DOC needs to perform some reexamination, because the costs of preparation of proposals may be approaching the value of the grants. Graham was very enthusiastic about the ATP because it creates a forum for new ideas and new combinations of players.

C. Department of Energy (DOE)

Martha Krebs gave us an update on the Galvin Committee regarding the national laboratories and the new National Science & Technology Council functioning within the Administration. She noted ironically that while there were many committees in the group, none of them dealt with Energy. She reemphasized that there was need both to build a strong economy and to protect the environment, and that both goals would be mediated by technology. She also addressed the equity concept, particularly in regard to rich and poor countries and the impacts and programs to control greenhouse gas emissions. She described the four "core" business lines of the DOE as industrial competitiveness, national security, energy resources, and environmental quality. She also reported on the fact that the DOE has far exceeded its goal of issuing 1000 CRADAs by fiscal year 1995 and has already surpassed this number. DOE has halved the time necessary to complete agreements with industry.

The Office of Energy Research's CRADAs represent $216 million of the nearly $2.1 billion in DOE CRADAs. The focus in CRADAs is now moving to consortia, both horizontal and vertical. Martha noted that David Roessner has

been asked to help analyze the data base for CRADAs and other interactions within DOE.

D. The National Science Foundation (NSF)

Anne Petersen represented NSF Director, Neal Lane. She saw NSF as a catalyst in fostering strategic links between education, industry and other groups. She regards universities as NSF's primary customers. Anne also acts as a "Chief Operating Officer-COO" in terms of government accountability initiatives.

Examples of industrial partnerships include co-sponsorship of the Forum on Science in the National Interest and the use of research centers as catalysts for industrial/university interactions. She noted an initiative on precompetitive research for reducing pollution at its source, sponsored by the Council for Chemical Research and involving some 20 grants. CCR helps the linkups to occur. She also described the "Agile Manufacturing" initiative sponsored by NSF and ARPA, funded to the extent of some $18 million. These are programs to assist manufacturing to adjust more rapidly to customer needs.

There was a lively discussion of the 14% increase being devoted to the academic infrastructure, with concern expressed by some of the IRI representatives that too many research universities might be competing for what is fundamentally limited funding. It was felt that many professors do not understand the degree to which the world is changing with regard to the availability of funds for them via the Congress. All agreed we need to move with caution in this area because the research universities are a great national asset.

E. The Army Research Laboratory (ARL)

Ed Brown gave an update on this new organization. It has seen some significant shrinkage in its budgets, which have declined from $750 million to $410 million while people are decreasing from 4300 to a (planned) level of 2600. ARL is seeking more "dual-use" technologies in its portfolio and is increasingly relying on out-sourcing of R&D.

An important and innovative Army concept is the "Digital Battlefield." Battlefield communications are now the key to military success

and there will be greater emphasis on them at all levels, including the use of sensors, the distribution of information, and the analysis of that information. Ed noted that the real technological power in these areas actually exists in the commercial sector and hence some 60-80% of the Digital Battlefield will be outsourced through "cooperative agreements." Cooperative agreements were described as being something between a contract and a grant with a 5-10 year duration.

Ed also described the "Federated Laboratory" Concept which will leverage the private sector to be an intellectual crossroads for the Army. Finally, he noted that ARL is a pilot study under the Government Performance and Results Act, which is an attempt to bring metrics into the measurement of government research performance, an area in which all IRI members have great interest.

3. The report from the Council on Competitiveness to be delivered by Eric Bloch was cancelled because he was unable to attend the meeting.

4. Our next meeting will occur on January 12, 1995 at the IRI Headquarters in Washington, from 8:30 a.m. to 3:30 p.m.

FPB/mlg 11174FB1

October 23, 1994
FST Committee Meeting Attendance
Dr. F. Peter Boer, Chair

Appleton, Bill	Martin Marietta/Oak Ridge National Lab
Berger, Beverly	FLC
Blair, John	Emeritus/Raytheon Company
Boer, Peter (Chair)	W.R. Grace
Brown, Edward	Army Research Laboratory
Brown, Stanley	Engelhard
Garfinkel, Marvin	GE
Grucza, Margaret	IRI
Hanneman, Rod	Reynolds Metals
Jackson, Auzville	Emeritus/Robertshaw Controls Co.
Johns, Lionel (Skip)	OSTP
Johnson, Ted	Boeing
Kettler, Dave	BellSouth
Krebs, Martha	DOE
Larson, Chuck	IRI
Leavitt, Fred	Emeritus/Dow
Lyons, Pete	Los Alamos
Madia, Bill	Battelle
Mitchell, Graham	DOC
Nemeth, Ed	Aristech
Petersen, Anne	NSF
Pettifor, Andrew	Rockwell International
Quicksall, Carl	Mallinckrodt Chemical
Redmond, John	GTE
Scheuing, Dick	Emertius/Grumman
Vermont, George	OSTP-Emeritus/Mallinckrodt
Via, Francis	Akzo-Nobel
Werber, Frank	Emeritus/USDA