Industrial Innovation and Public Policy Options: Report of a Colloquium (1980)

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Report of a Colloquium

National Academy of Engineering

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FOREWORD

Over the last several years discussions of science and technology policy have gained momentum, fueled in part, by an increasing concern over the state of U.S. industrial innovation and the economy. Major studies have been undertaken and completed; initiatives for policy changes have been set underway. In the midst of this activity, the National Academy of Engineering has played a role through its Committee on Technology and International Trade and Economic Issues. The Committee sponsored a number of workshops, seminars, and colloquia, and issued a series of reports on the relationships of industrial innovation to international trade and the effects of direct and indirect government policies on the innovation process. This report summarizes the Colloquium on Industrial Innovation and Public Policy Options, which was held December 5-6, 1979. The Colloquium reviewed a number of major government and private studies of government policy and industrial innovation in an attempt to assist public policymakers identify and understand the recommendations on which there was agreement as well as lack of agreement.

The NAE continues to assess major policy issues as well as to assist in establishing alternative approaches to solving the economic and technological problems facing the nation. Early this year a report of our Task Force on Engineering Education was published. In September we conducted an informal roundtable on issues involved in a proposed National Technology Foundation. The October Annual Meeting will include a Symposium on Academe/Industry/Government Interaction in Engineering Education. Each of these has a direct bearing on innovation.

The tide of events is moving quickly, with national activity continuing on a number of fronts. A brief summary of representative examples is included as an Appendix. It seems likely that important decisions will be made and we hope that new programs or projects will be initiated in the foreseeable future.

COURTLAND D. PERKINS
President
National Academy of Engineering

PREFACE

Technological innovation and the revitalization of American industry have attracted an increasingly high level of attention as critical elements in sustaining international competitiveness and the long-range health of our economy. Numerous studies and policy advisory statements were developed by various private groups; in 1978-79, the Administration conducted a Domestic Policy Review of Industrial Innovation. As a result of all this work, policymakers were to be faced with literally hundreds of recommendations, many of them saying the same things but in different ways and with varying or unclear priorities.

The National Academy of Engineering saw an opportunity to enhance the value of this vast amount of effort by assembling and analyzing the recommendations. The objective was to highlight those areas where there was greatest agreement and to attempt to interpret priorities for action.

The approach included three steps. First an expert in each policy issue area was commissioned to prepare an analytical paper reviewing the conclusions and recommendations of the major reports. These papers illuminated central themes running through the reports and provided some assessment of apparent priorities. They then became the background for a series of panel discussions around which a two-day colloquium was structured. The panels consisted of representatives of each of the reviewed studies plus additional authorities from government and the private sector. This colloquium report summarizes the work of the analysts and the panels, and attempts to describe it in the light of events which led up to the colloquium.

The extent of involvement of representatives of both private and public organizations in the work reported by this document was extraordinary. Hundreds of people from industry -- chief executive officers, R&D and financial managers, legal and patent counsels -- from virtually every type of innovation-oriented business have participated. Their views concerning government policies which affect their decisions to innovate are summarized as are the comments by labor organizations, public interest groups, academic and government experts.

The year 1980 has seen continued growth in awareness and consensus that action is needed to improve the environment for industrial innovation. A number of encouraging policy initiatives have been taken in the Congress as well as in the Executive Branch and we are hopeful that important legislative proposals will be enacted in economic, regulatory, and other arenas in the near future.

There are many who would counsel that policy research has not yet provided an adequate basis for action. In my view, however, we are unavoidably forced to make decisions by the course of events. For example, the combination of inflation with our system of taxation has created a de facto change in the relative tax incentives for savings, investment, and consumption. By failing to adjust tax measures we have made the passive decisions to shift the balance of incentives away from savings and longer-term, innovation-oriented investment. The active alternatives of creating a change in the system structure to restore the earlier balance of incentives is an option which inherently requires no greater knowledge base than did the establishment of the original measures. I believe the lack of satisfying research data, in this case, may be counterbalanced by the strong mandate for action from those who carry out the innovation process in our economy.

I am indebted to my colleagues on the Steering Committee and to Boyd J. McKelvain for guidance in developing the design of the Colloquium and especially to Mary Ellen Mogee for assuming the most difficult task of rapporteur. I am also grateful to the analysts and panel chairmen who provided a unique set of valuable review papers which will be published as an appendix to this report. And finally, I wish to thank Kerstin Pollack, Hugh Miller and Boyd McKelvain whose organizing and administrative talents were critical to the success of the entire effort.

Arthur M. Bueche
Colloquium Chairman

STEERING COMMITTEE

Arthur M. Bueche, CHAIRMAN, Senior Vice President, Corporate Technology, General Electric Company

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Mary Ellen Mogee, Analyst in Science and Technology, Congressional Research Service, Library of Congress

Courtland D. Perkins, President, National Academy of Engineering

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Boyd J. McKelvain
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Panelists: Sherman R. Abrahamson, Special Assistant to the Chief Executive Officer, Control Data Corporation
Robert C. Holland, President, Committee for Economic Development
Ralph Landau, Chairman of the Board, Halcon International Inc.
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Chairman: Edward E. David, Jr., President, Exxon Research and Engineering Company

Analyst: Sumiye Okubo, Policy Analyst, Scientific, Technological and International Affairs, National Science Foundation

Panelists: Ruth M. Davis, Assistant Secretary of Energy for Resource Application, U.S. Department of Energy
Eugene G. Kovach, Deputy Director, Office of Advanced Technology, U.S. Department of State
Stephen Merrill, Professional Staff Member, Subcommittee on Science, Technology and Space, U.S. Senate
Benjamin Sharman, International Trade Representative, International Association of Machinists and Aerospace Workers
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ANTITRUST PANEL

Chairman: William J. Casey, Counsel, Rogers & Wells

Analyst: Douglas H. Ginsburg, Harvard Law School, Harvard University

Panelists: Ky P. Ewing, Jr., Deputy Assistant Attorney General, Antitrust, U.S. Department of Justice
Douglas H. Ginsburg
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Chairman: W. L. Keefauver, General Legal and Patent Counsel, Bell Telephone Laboratories

Analyst: W. K. Lowry, Bell Telephone Laboratories (retired)
Robert H. Rines, President, Franklin Pierce Law Center

Panelists: Joseph P. Allen, Professional Staff Member, Committee on the Judiciary, U.S. Senate
Henry L. Bachman, Vice President, Hazeltine Corporation
Donald W. Banner, Former Commissioner of Patents and Trademarks, U.S. Department of Commerce
Robert B. Benson, Counsel and Director, Patent Law Department, Allis-Chalmers Corporation
The Honorable Allen E. Ertel, Member, Committee on Science and Technology, U.S. House of Representatives
Harry Manbeck, General Patent Counsel, General Electric Company
Philip M. Smith, Associate Director, Natural Resources and Commercial Services, Office of Science and Technology Policy, Executive Office of the President
Richard C. Witte, Chief Patent Counsel, Procter & Gamble Company

PANEL ON FEDERAL R&D SUPPORT

Chairman: Robert A. Charpie, President, Cabot Corporation

Analyst: Willis H. Shapley, Consultant, Office of Public Sector Program, American Association for the Advancement of Science

Panelists: Sidney W. Hess, Vice President, ICI Americas, Inc.
Ronald Konkel, Branch Chief, Science and Space Policy Branch, Office of Management and Budget, Executive Office of the President
Edwin S. Mills, Chairman, Department of Economics, Princeton University
Albert Murray, Subcommittee on Science, Research and Technology, U.S. House of Representatives
Philip M. Smith, Associate Director, Natural Resources and Commercial Services, Office of Science and Technology Policy, Executive Office of the President
Beno Sternlicht, Technical Director and Board Chairman, Mechanical Technology Incorporated

CURRENT LEGISLATIVE INITIATIVES

John D. Holmfeld, Science Policy Staff, Subcommittee on Science, Research and Technology, U.S. House of Representatives

SUMMARY AND CONCLUSIONS

SUMMARY

On December 5 and 6, 1979, an NAE-sponsored Colloquium on Industrial Innovation and Public Policy Options was held to review the recommendations of several recent major studies of government policy and industrial innovation, as well as President Carter's initiatives in his Message to Congress of October 31, 1979. The studies, conducted by a variety of public and private organization, involved representatives from different sectors, including industry, universities, government, labor organizations, and public interest groups. The colloquium was intended to help public policymakers identify and understand the recommendations on which there was substantial agreement.

There was broad agreement on a number of general points. It was generally agreed that steady economic growth is an important national goal, that U.S. economic performance and technological capability are less than desired, and that there is an urgent need for federal action to correct disincentives to industrial innovation.

There was also broad agreement that changes are needed in a variety of public policies. No single policy change was seen as a panacea. Among the major studies there was agreement that policy changes in the following areas are needed to stimulate industrial innovation: tax and economic policy, international transactions, federal R&D support, regulation, patent and information policy, and antitrust policy.

The colloquium reviewed the recommendations made by the following major reports:

- The draft reports of the subcommittee of the Domestic Policy Review (DPR) Advisory Committee on Industrial Innovation

- The Committee for Economic Development report, Stimulating Technological Progress

- The Commerce Technical Advisory Board report, Recommendations for Creating Jobs Through the Success of Small, Innovative Businesses and

- Four reports of the NAE Committee on Technology and International Economic and Trade Issues: Technology, Trade and the

U.S. Economy; The Impact of Tax and Financial Regulatory Policies on Industrial Innovation; Antitrust, Uncertainty and Technological Innovation; and The Impact of Regulation on Industrial Innovation.

While arrangements for the colloquium were in process, President Carter announced a series of policy initiatives to stimulate innovation. The colloquium also reviewed these initiatives.

Most of the major studies agreed that one of government's key roles is maintaining a climate that encourages innovation in all sectors of the economy by providing general incentives or removing unnecessary disincentives. According to this view, the federal government should not select specific types of commercial technologies or specific industrial sectors to stimulate. The allocation of resources for commercial technology development should instead be left to the market.

There was broad consensus that improving capital formation is fundamentally important to stimulating industrial innovation. Studies that reviewed a variety of policy options for stimulating innovation tended to place top priority on policies (especially tax policies) designed to increase investment and savings. Increased investment in plant and equipment tends to spur the diffusion of new technology and to stimulate the development of new technology to meet the increased demand for capital equipment. Tax incentives directed specifically at investment in R&D or innovation were given lower priority, in the belief that without a higher level of investment in plant and equipment there is little chance of new technology being incorporated into the production process.

The CED report, the NAE report on tax policy, the DPR industry report on economic and trade policy, and the CTAB report recommended changes in economic and tax policies. They agreed that such policies should be designed to encourage capital spending, R&D, and the formation of small, innovative firms. There was some disagreement on the relative importance of specific measures, however. The CED report and the NAE report on tax policy concluded that government's primary role should be providing general incentives to investment. Accelerated depreciation of plant and equipment was favored for large firms and reduction of the capital gains tax for small firms. There was agreement, however, that such provisions should be made on a nondiscriminatory basis.

The four studies agreed that additional tax incentives for R&D should be considered, but they differed in the strength of their support for such measures. All four considered tax policies that would encourage the formation and aid the profitability of small innovative firms. They emphasized the roles of the personal income tax and government regulation of financial markets. They did not propose new corporate tax incentives, but favored the expansion of existing tax incentives so that small firms may more readily take advantage of them. The President's message on industrial innovation mentioned possible changes in tax policy to stimulate innovation, but deferred considering specific measures until general fiscal policy would be taken up.

The DPR industry report on economic and trade policy, the DPR report on small business, the CED report, the NAE report on trade, and the CTAB report all made recommendations on the subject of international transactions. (The President's message contained no initiatives in this area.) The five reports recommended changes in trade policies, tax policies, and government regulations. The DPR, CED, and NAE reports favored less control of exports and imports on the grounds that controls are incapable of solving domestic problems of innovation and investment and that trading partners might retaliate. The DPR reports favored more tax incentives for international trade. The DPR and CTAB reports favored liberalizing antitrust policy as it affects international trade.

The DPR industry reports on direct federal support of R&D and on federal procurement policy, the DPR report on small business, the CED report, and the CTAB report all made recommendations on federal support of R&D. The President's message also included several initiatives bearing on this matter. The principal recommendations fell into five main categories: federal support of R&D on commercial technology, federal support of R&D in small business, federal support of R&D at universities, federal support of technology transfer, and support of R&D through federal procurement.

The reports diverged on the question of whether the government should directly fund R&D on commercial technology. Consistent with their position that government should provide only general incentives for innovation and should not attempt to select specific technologies or industries for stimulation, the CED and NAE reports opposed federal support of R&D for commercial technology. Other reports, however, supported federal funding and suggested changes that would enhance its role in industrial innovation. Most studies agreed that such support should be carried out without involving the government in selecting specific R&D projects. President Carter proposed the establishment of generic technology centers where government and industry cooperatively would fund R&D on basic technologies underlying a number of industries. Aside from the above divergence, broad consensus existed on the need to increase privately funded R&D in both large and small businesses, the need for more industry-oriented research at universities, the need to transfer federal technology to the private sector, and the need to encourage innovation through federal procurement.

The DPR industry reports on environmental, health, and safety regulations and on regulation of industry structure and competition, the DPR report on small business, the NAE report on regulation, the CED report, and the CTAB report all recommended changes in government regulatory policy. The President's message also included several initiatives in this and referred to previous regulatory reforms by the Administration. All the studies accepted the basic objectives of regulation--protecting health, safety, and the environment--as well as the need for some degree of government intervention to achieve these objectives. Several studies, however, proposed changes in the scope of government regulation. The three DPR reports, for example, supported increased use of voluntary industrial standards. The NAE

and CED reports recommended experimentation with economic incentives to achieve regulatory objectives. There was strong support for recent Administration actions to improve the regulatory process, including the formation of the Regulatory Council, the Calendar of Federal Regulations, the increased use of cost-benefit analysis in regulatory decisionmaking, the increased use of performance standards, 5-year forecasts of regulations, and the "bubble" concept in environmental regulation. There was agreement that more long-term research should be done on the causes and effects of safety and health hazards. The two DPR industry reports, however, argued that regulations should be confined within the bounds of existing knowledge and technology. Many of the studies were concerned with the problems of small businesses in complying with environmental, health, and safety regulations.

The DPR industry report on patent policy, the CED report, and the NAE report on antitrust regulation recommended changes in patent policy. The President's message also included initiatives in this area. The two most significant problems were uncertainty of patent validity and government patent policies. The studies recommended several measures to increase confidence in the patent system, including improving the Patent and Trademark Office (PTO) examination process by providing more funding, authorizing PTO reexamination of patents, creating a single court of patent appeals, and legalizing the use of arbitration for patent dispute resolution. The DPR report supported giving contractors title to patents for inventions made on federal R&D contracts and making exclusive licenses available for patents on government-made inventions. President Carter's initiative, on the other hand, would give title to contractor-made inventions to the government and would grant an exclusive license to the contractor in fields it chooses to commercialize.

Only the DPR industry report on information policy and the President's message recommended changes in information policy. Both agreed on the desirability of easing public access to patents as sources of information, improving the availability of foreign market and technical information to U.S. industry, and improving the dissemination of government-created information to the private sector. The DPR industry study also recommended assistance to information users, relief from regulatory impediments to information transfer (including the Freedom of Information Act), and better protection of intellectual property in data bases and software.

The NAE report on antitrust regulation and the DPR industry report on regulation of industrial structure and competition both recommended changes in antitrust policy. The President's message contained policy initiatives in this area. It is possible that policies meant to keep the U.S. economy competitive sometimes tend to stifle innovation. The DPR industry report urged the Department of Justice to give more weight to the innovativeness of R&D ventures when joint ventures are proposed. The NAE study recommended only that the department clarify its position on joint R&D ventures; the latter was also included in the President's message as an initiative. Similarly, the DPR industry report urged the Department to give further weight to innovation issues in small business acquisitions, while the NAE recommended that

the Department clarify its policy by issuing further guidelines. Both studies opposed deconcentration legislation on the grounds that it may deter firms from engaging in technological innovation for fear that they will obtain thereby too large a share of a particular market. Both reports agreed that the effects of antitrust policy, including deconcentration legislation, on U.S. foreign trade should be studied. The DPR industry report suggested that if study showed that foreign firms possess competitive advantages by virtue of disregarding antitrust principles, then the nation would have the alternatives of accepting the competitive disadvantage, enacting protectionist legislation, or weakening antitrust enforcement.

The DPR Public Interest and Labor Subcommittees produced reports that commented on the policy recommendations by the DPR industrial subcommittees and made recommendations of their own as well. Their views were often at variance with those of the other reports. These subcommittees were concerned with the social benefits and costs of industrial innovation and the distribution of those costs and benefits, especially among workers, consumers, and the general public. The two subcommittees did not agree with the other studies that there is a serious problem in the rate or level of U.S. industrial innovation. The Public Interest report argued that there isinstead a problem with the goals toward which U.S. industrial innovation is directed. The two subcommittees agreed with the other studies on such economic goals as adequate income and high employment, but also stressed such other social values as health and safety and a clean environment.

The Public Interest and Labor reports opposed general tax incentives for investment because they did not believe that such incentives were necessary or that they would effectively stimulate innovation. These reports also opposed what they perceived as "weakening" of health, safety, and environmental regulations to stimulate innovation, asserting that regulation does not inhibit innovation. They supported government efforts to deconcentrate and control big businesses in the belief that industrial concentration stifles innovation. The DPR Labor report called for additional control of technology imports and exports, arguing that these activities are injurious to U.S. workers and the U.S. economy.

The differences between the points of view of the Labor and Public Interest reports and those of the other reports stem in part from differences in their objective interests, but also from differences in their interpretations of trends in U.S. innovation and the relationships among innovation, international trade, domestic economic welfare, and public policy. Continued research and communication in these areas may reduce some of the differences.

Concerns about limitations in the knowledge base underlying proposed policy change were expressed by some of the reports and panelists during the NAE colloquium. Several reports acknowledged the absence of scientifically acceptable evidence on the effects of government policy on industrial innovation. Two of the NAE reports and the DPR Public Interest report expressed reservations about the evidence on trends in U.S. industrial innovation. The DPR public

Interest Subcommittee was unconvinced that innovation in fact is a problem in the U.S. economy. In the discussions, panelists expressed additional concern about the state of knowledge of the relationship between R&D and innovation on the one hand and economic welfare on the other. The general concern (except for that expressed in the Public Interest report), however, was not that policy changes should be postponed until better information can be obtained, but rather that public policymakers should have realistic perspectives on the state of knowledge in this area. In fact, there seemed to be agreement that, despite limitations in knowledge, the types of policy changes proposed in the studies reviewed by the colloquium could be expected to stimulate innovation.

CONCLUSIONS

The major recent studies of public policies to stimulate industrial innovation agree generally that changes should be made in economic and tax policy; international trade policy; federal R&D support; safety, health, and environmental regulation; patent and information policy; and antitrust policy. The studies state that one of the primary roles of the government is to maintain a climate in which private-sector innovation can flourish, by providing general incentives and removing unnecessary disincentives. Several studies that review a wide range of policy options argue that inadequate capital formation is the key problem in the apparent slowing of technological advance in the United States. They agree that the top priority should be accorded the removal of disincentives for investment and savings.

President Carter's innovation initiatives covered a wide range of subjects, including federal R&D support for commercial technologies, patent policy, information policy, regulation, antitrust policy, small business, and federal procurement. Nonetheless, the President characterized his initiatives as a "first step" toward correcting disincentives to industrial innovation. The most notable gap in the presidential initiatives was the failure to address the problem of inadequate capital formation and tax incentives for investment and savings. The President mentioned the potential of tax incentives to stimulate industrial innovation but deferred considering them until general fiscal policy would be considered. Many other recommendations made in the major studies were not included among the President's initiatives. Given the widely perceived deteriorating position of U.S. technological capability, it appears that all the recommendations on which there was substantial agreement among the major studies warrant further consideration by public policymakers.

PROBLEM STATEMENT

Industrial innovation--the process by which industry develops and uses new products and production processes--has in recent years been recognized increasingly as a key element of national economic policy. U.S. economic problems and a perceived decline in industrial innovation hae combined to broaden this recognition.

During the past decade in the United States, the growths of economic output and productivity have slowed, the rate of investment in new plant and equipment has fallen, unemployment and the rate of inflation have both risen, the balance of trade has declined along with the U.S. share of world trade, and the vigor of innovation has flagged. These economic problems are complexly interrelated and difficult to resolve.

Industrial innovation is obviously an important means of achieving a healthy economy by increasing efficiency and providing completely new ways of filling society's needs. The recent presidential domestic policy review (DPR) on industrial innovation was based on the premise that

> an increase in industrial innovation will contribute significantly to the reduction of inflation, the creation of jobs, the improvement of the country's balance of trade position, and the ability of the nation to conserve natural resources and reduce reliance on non-renewable energy resources.

A recent report of the Commerce Technical Advisory Board (CTAB) stated that more innovation

> means more skilled jobs for an increasingly educated population, an improved export performance, a higher rate of productivity improvement, and at least a partial solution to stagflation, e.g., further, we desperately need more innovation to cope with both new problems and widely accepted national goals--better central cities, safer and more satisfying work, a cleaner environment, and less dependence upon autocratically controlled overseas sources of energy supplies.

Research has shown that research and development expenditures (a surrogate measure of innovation) are closely related to economic growth and productivity. The summary of a 1971 National Science Foundation (NSF) report, still valid, states the issue as follows:

> Although what we know about the relationship between R&D and economic growth/productivity is limited, all available evidence indicates that R&D is an important contributor to economic growth and productivity. Research to date seeking to measure this relationship (at the level of the firm, the industry, and the whole economy) points in a single direction--the contribution of R&D to economic growth/productivity is positive, significant and high.[1]

Edward Denison has estimated that about 50 percent of measurable U.S. economic growth between 1948 and 1969 derived from "advances in knowledge."[2] Research has also shown that R&D-intensity and trade performances are correlated.[3]

A number of disturbing trends have been noted. The White House memorandum establishing the DPR made the following observations, which, it stated, underscored the need for increased federal concern with the industrial innovation process:

- Indications that industry underinvests in innovation in terms of the ultimate benefits to the firm and to society.

- Increased private-sector R&D emphasis in recent years on low-risk, short-term projects directed at incremental product changes, and decreased emphasis on the longer-term research that could lead to new products and processes.

- Declining international competitiveness of some segments of U.S. industry as reflected in: a growth rate for productivity in manufacturing industries that is lagging behind that of some nations; the increasing penetration of domestic markets by producers of intermediate technology and basic industrial goods; and a level of production technology in certain important industries (for example, coal mining and steel production) that lags behind that in other countries.

- Difficulties that small, high-technology firms encounter in obtaining venture capital.

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[1] U.S. National Science Foundation. Research and Development and Economic Growth/Productivity. Papers and Proceedings of a Colloquium. Washington, U.S. Govt. Print. Off., 1972 (NSF72-303. p. 3.

[2] Denison, Edward F. Accounting for United States Economic Growth, 1929-1969. Washington, The Brookings Institution, 1974. p. 128

[3] U.S. National Science Foundation. The Effects of International Technology Transfers on U.S. Economy. Washington, U.S. Govt. Print. Off., 1974. (NSF74-21). p. 3.

• The changed direction of industrial innovation in recent time resulting from the diversion of corporate effort from developing new products to meeting other social goals.

A recent major report by the Committee for Economic Development (CED) stated:

> Three decades ago, the United States was the world's undisputed technological leader, and until the last decade, the U.S. economy was characterized by a rapid rate of innovation. Gradually, however, other industrialized countries have improved their technological performances while U.S. technological progress has faltered.

A recent National Academy of Engineering (NAE) report on tax policy and innovation described the problem in the following way:

> Many informed participants in the innovation process agree that innovative activity has recently declined, on the whole, in the United States. In addition, these observers have expressed concern about what they perceive to be corporate preferences for short-term, low-risk investment in marginal product improvements, rather than long-term, high-risk investment in major technological innovations.

A recent review of a broad range of indicators concluded that trends in a number of both input and output indicators may be interpreted to mean that U.S. innovation is declining relative both to past levels and to levels in the economies of foreign competitors, notably West Germany and Japan. Further, industrial R&D in the United States seems to be shifting toward shorter term, less risky projects.[4]

The decline in U.S. economic performance has prompted a variety of governmental and private agencies to study public policies aimed at reinvigorating industrial innovation. Since industrial innovation includes not only R&D but also the spread of new products and processes among industrial firms, it is affected by a wide variety of government policies--including economic and tax policy, regulation, antitrust policy, patent practices, and R&D funding. The studies have made many recommendations for changes in federal policies that would improve the climate for innovation and revitalize the economy.

U.S. Congress. House Committee on Ways and Means. Subcommittee on Trade. Technology and Trade: Some Indicators of the State of U.S. Industrial Innovation (by Mary Ellen Mogee). 96th Congress, 2d Session. Washington, U.S. Govt. Print. Off., 1980. (Committee Print)

THE NAE COLLOQUIUM ON INDUSTRIAL INNOVATION AND PUBLIC POLICY OPTIONS

In light of the urgency of the problems and the need to expedite decisive action, the National Academy of Engineering (NAE) sponsored a Colloquium on Industrial Innovation and Public Policy Options. The colloquium, which was held on December 5 and 6, 1979, was intended to help public policymakers identify and understand those recommendations on which there is substantial consensus.

The colloquium reviewed the recommendations made by the following major reports:

- The draft reports of the subcommittees of the DPR Advisory Committee on Industrial Innovation

- The Committee for Economic Development report, Stimulating Technological Progress

- The Commerce Technical Advisory Board report, Recommendations for Creating Jobs Through the Success of Small, Innovative Businesses

- Four reports of the NAE Committee on Technology and International Economic and Trade Issues: Technology, Trade and the U.S. Economy; The Impact of Tax and Financial Regulatory Policies on Industrial Innovation, Antitrust, Uncertainty and Technological Innovation, and The Impact of Regulation on Industrial Innovation.

While arrangements for the colloquium were in process, President Carter announced a series of initiatives to stimulate industrial innovation. The colloquium also reviewed these initiatives.

The NAE review and colloquium were structured around six policy areas: economic and tax policies, international transactions, federal R&D support, government regulations, patents and information policy, and antitrust laws. In each of these areas an expert analyst reported on the areas of agreement and disagreement among the major recommendations. These reports provided that basis for discussion at the colloquium by panels that included members representing the President and the major studies.

THE PRESIDENT'S MESSAGE ON INDUSTRIAL INNOVATION

The President's October 31, 1979, message to the Congress proposed initiatives intended to help ensure the Nation's "continued role as

the world leader in industrial innovation." The initiatives fell into nine categories:

- Enhancing the transfer of technical information
- Increasing technical information
- Improving the patent system
- Clarifying antitrust policy
- Fostering the development of smaller innovative firms
- Improving federal procurement
- Improving the regulatory system
- Facilitating labor/management adjustment to innovation
- Maintaining a supportive attitude toward innovations.

DRAFT REPORTS OF THE SUBCOMMITTEES OF THE DOMESTIC POLICY REVIEW ADVISORY COMMITTEE ON INDUSTRIAL INNOVATION

The President's innovation initiatives were drawn from a large number of recommendations generated in a domestic policy review (DPR) of industrial innovation. The DPR was established by President Carter in May 1978 to conduct a comprehensive review of issues and problems related to industrial innovation. The study was to develop a set of policy options for the President. The DPR was especially concerned with federal policies that affect innovation.

As part of the DPR, an Advisory Committee on Industrial Innovation was established. Executives from more than 100 industrial firms participated in subcommittees of this committee, producing draft reports on economic and international trade policy; environmental, health, and safety regulation; regulation of industry structure and competition; patents; information; federal support of R&D; and federal procurement. A subcommittee of organized labor representatives and a subcommittee of public interest group representatives were also established. Each of these subcommittees produced reports describing its views and commenting on the reports of the industrial subcommittees. An ad hoc group of small business participants also prepared a report. All 10 reports were published as the Final Report of the Advisory Committee on Industrial Innovation. The individual reports are cited here as "the DPR report on patents" and so forth.

COMMITTEE FOR ECONOMIC DEVELOPMENT

The Committee for Economic Development (CED) is a nonprofit educational organization of 200 corporate executives and university presidents. In early 1978, the CED established a subcommittee of 25 top business executives and 5 university presidents to consider technological progress in the U.S. economy and related public policy issues. The resulting report, Stimulating Technological Progress,

addressed tax policy, regulatory policy, patent policy, international technology transfer, and federal support of R&D.

NATIONAL ACADEMY OF ENGINEERING/NATIONAL RESEARCH COUNCIL (NAE/NRC)

In 1978 and 1979 the NAE/NRC completed a series of monographs based on studies of its Committee on Technology and International Economic and Trade Issues. The Committee is composed of recognized authorities from industry and universities; representatives of federal agencies also participate actively. The NAE/NRC reports reviewed for the colloquium are Technology, Trade and the U.S. Economy; The Impact of Tax and Financial Regulatory Policies on Industrial Innovation; Antitrust, Uncertainty and Technological Innovation; and The Impact of Regulation on Industrial Innovation. For simplicity, these reports will be referred to as the NAE reports on trade, tax, antitrust, and regulation, respectively.

COMMERCE TECHNICAL ADVISORY BOARD (CTAB)

In 1978 the CTAB, which is an advisory body to the Secretary of Commerce, created a committee of 13 industry and university representatives. In its report Recommendations for Creating Jobs Through the Success of Small, Innovative Businesses, the Committee made 12 recommendations aimed at helping small enterprises regain their economic vitality. The recommendations fell into the following categories: increasing availability of capital and management expertise, reducing regulatory burden, stimulating technology diffusion and application, increasing small business R&D, and stimulating small business exports.

RECOMMENDATIONS OF THE STUDIES REVIEWED BY THIS COLLOQUIUM

The major recommendations and initiatives on which there was broad consensus are summarized here. The full analytical papers will be made available separately.

GENERAL

The President's analysis and the other studies all recognized the close interrelationships between industrial innovation and economic welfare. Not only does industrial innovation contribute to economic growth and improved productivity, but steady economic growth stimulates innovation. In the reports that included overall discussion's of policy options to stimulate innovation, there appeared to be consensus that improved economic policy should be given priority.

A key issue in innovation policy has been whether government policies should be general in scope or specifically aimed at particular types of innovations or industrial sectors. There seemed to be agreement at the NAE colloquium on the importance of the federal role in maintaining a climate that is favorable to innovation in all sectors of the economy. Speaking for the CED report, panelist McKelvain said:

> The principal role is in the area of creating the best possible environment for innovation through the avoidance of unnecessary disincentives and barriers to innovation. The view is that industry is in the best position to make decisions with respect to the allocation of resources related to industrial development. Thus the CED recommendations are really limited to more general incentives and initiatives which are nondiscriminating, relying on the inherent efficiencies of market systems for the allocation of resources.

Panelist Hannay, speaking for the NAE reports, stated:

> Our committee would advocate a lower government role, rather than an enhanced government role and further interventions. We would look for a reduction of disincentives, rather than an active program of searching out new incentives and stimulants. And, we would advocate that we take advantage of the workings of the free market, rather than interfere with them.

The CTAB report took a similar approach. It stated:

> Our recommendations are to reshape certain existing policies to make them less of a handicap to business, rather than to expand the government into new areas.

Panelist Eads noted with approval the emphasis on broad incentives, remarking that past experience has shown that only modest results can be expected from the government's attempting to "pick the winners" in technologies for commercial markets.

The problem of lagging capital formation was paramount in the studies that addressed economic policy. The CED report concluded that inadequate capital investment has held back the rate of innovation in the United States. For the past two decades, it stated, U.S. capital investment as a proportion of output has been about one-third that of Japan and one-half that of Germany. The CED committee believed that the main reason for lagging innovation in the United States was that some current public policies discourage new capital investment--especially tax policies and regulatory activities. It asserted that increased spending on plant and equipment would result in the diffusion of newly developed technology and the creation of increased demand for private R&D and innovation.

The NAE committee also put high priority on policies, particularly tax policies, designed to increase savings or investment. Panelists Hannay and Landau both described this concern of the NAE committee. Landau stated, "[Inadequate] capital formation, . . . is seen as the major block to more risk-taking and innovative progress." The DPR report on economic and trade policy argued that today's economic problems are primarily problems of inadequate supply of savings or investment. Restructuring the tax code to eliminate disincentives to savings and investment is the best available means to correct the problem, it argued. In a similar vein, the CTAB report stated, "Changes in capital gains taxation are probably more responsible than any other factor for the deterioration in technical entrepreneurship that has occurred in the United States during the last decade."

ECONOMIC AND TAX POLICY

The DPR industry report on economic and trade policy, the CTAB report, the NAE report on tax and financial regulatory policies, and the CED report recommended changes in economic and tax policy. The President's message on industrial innovation recognized tax policy as a possible incentive for innovation, but deferred considering possible changes until overall tax policy has been reviewed.

All four studies attached considerable importance to changes in tax policy. Among the reports making recommendations there was a broad consensus about the appropriate focus of tax and financial regulatory policies toward innovation. It was agreed that such policies should encourage general capital spending, R&D, and the formation of small innovative firms.

Remarks by some of the panelists shed additional light on the relative priority of policy recommendations. Panelist Holland noted

that the CED report, which made recommendations in several policy areas, gave top priority to faster capital recovery allowances for plant and equipment. Selective tax changes such as incentives for the conduct of R&D and for investment R&D plant and equipment, the CED argued, would be useful but not significant as a stimulus to industrial innovation.

Panelist Landau noted that the NAE tax report concluded that capital gains tax changes were most relevant for small firms, while more rapid depreciation would provide the most encouragement for innovation. Additional tax incentives for R&D were given lower priority than general tax incentives for savings and investment.

Panelist Stanhope stated that the DPR industry report was basically in agreement with the other reports, although it regarded several additional tax policies as useful and did not attempt to establish priorities among its tax recommendations.

Panelist Abrahamson noted that the CTAB report, which focused on small business, made recommendations in five areas, but gave top priority to improving the availability of capital and management expertise to small businesses.

The DPR industry report, the NAE tax report, and the CED report agreed that removing tax disincentives for capital spending should be considered seriously. Increasing capital spending tends to stimulate innovation in capital goods industries and to speed the rate at which advanced technology spreads through the economy. Under inflationary conditions, the existing method of allowing businesses to recover capital costs on the basis of original cost rather than replacement cost creates a disincentive to investment in plant and equipment. The three reports agreed on the necessity of removing this disincentive effect of inflation on depreciation allowances. The DPR industry and CED reports recommended shortening the depreciable asset lives, while the NAE report recommended indexing depreciation allowances for replacement costs.

Since organized R&D activities are an important part of the process of industrial innovation, policies to reduce the cost of R&D may encourage industrial innovation. Currently Internal Revenue Code Section 174 allows some R&D expenditures to be deducted in the year in which they are incurred, even though the R&D may yield intangible assets with a useful life of more than 1 year. Excluded, however, are the acquisition of patents, models, or processes, and R&D structures and equipment. The DPR industry report, the NAE tax report, and the CED report agreed that additional tax incentives for R&D should be considered, but differed in the strength of their support for this idea. The CED and DPR industry reports generally agreed on several measures: expanding I.R.C. Section 174 to include R&D plant and equipment; allowing double tax credits for R&D plant and equipment; shortening the useful life governing depreciation of patents to a maximum of 10 years; and giving corporations tax credits for contributions to university research. The NAE report was least enthusiastic, arguing that R&D incentives are likely to stimulate industrial innovation only in industries where R&D costs are a significant share of total innovation costs. It also reasoned that

R&D incentives will not help where lagging innovation is due to pessimistic expectations about future profits. Therefore, the NAE report did not endorse any specific R&D tax incentive measures and gave them lower priority than other changes in corporate or personal tax policy.

Treasury Regulation 1.861-8 requires U.S. multinational firms to allocate some domestic R&D expenditures against foreign source income. This may lead to double taxation and a tax incentive to move R&D activities overseas. The DPR industry report, the NAE tax report, and the CED report expressed concern about this potential problem, although they gave it lower priority than tax incentives for capital spending and R&D. The reports made three different recommendations. The NAE tax report recommended studying the desirability of repealing Regulation 1.861-8. The DPR industry report simply recommended repealing the regulation. The CED report urged that the regulation be revised to cover only R&D expenditures directly traceable to foreign earnings.

Small technology-based firms are considered to play a vital role in the development of innovations. The DPR industry report, the NAE tax report, the CED report, and the CTAB report all considered policies to encourage the formation and profitability of small, innovative firms. All emphasized the roles of the personal income tax and government regulation of financial markets. None favored new corporate tax incentives for small businesses, recommending instead that existing tax incentives be expanded or steps taken to ensure that small businesses are able to take full advantage of existing tax incentives.

Ensuring adequate tax deductibility of losses may encourage investor participation in new technology ventures. The DPR industry and CED reports proposed expansion of I.R.C. Subchapter S, which allows treatment of corporations with 15 or fewer shareholders as partners for tax purposes. Loss offsets, depreciation deductions, and investment credits, however, are not of immediate value to new firms that are initially unprofitable and have no corporate tax liability. The CED and CTAB reports recommended that the carry-forward period for unused operating losses be extended.

Personal income tax indirectly affects the amount and composition of private investment. The DPR industry, CED, and CTAB reports all agreed on the need to enact further reduction in capital gains taxes.

Another set of recommendations concerned government regulation of pension funds and of securities markets. The NAE tax report, the DPR industry report, and the CTAB report all recommended that the Employment Retirement Security Act of 1974 (ERISA) criteria for "prudent" investor behavior be defined in terms of portfolio risk rather than the risk of specific investments, to reduce the disincentive to risky, innovative ventures. Subsequent changes in ERISA moved in this direction, but it remains unclear whether these changes are sufficient. The NAE and DPR reports expressed concern that Securities and Exchange Commission (SEC) Regulation A, Rules 144 and 146, intended to lower the costs to small firms of complying with

SEC regulations, may unnecessarily restrict the liquidity of unregistered securities.

INTERNATIONAL TRANSACTIONS

Prominent among the problems motivating the new concern for U.S. industrial innovation are those in international economic transactions, including exports and imports, foreign direct investment, and licensing. The DPR industry report on economic and trade policy, the DPR report on small business, the CED report, the NAE trade report, and the CTAB report all made recommendations in this area. The President's message on industrial innovation contained no initiatives dealing with these problems.

The main international transactions problems discussed by members of the panel were the declining international competitiveness of some segments of U.S. industry, increasing penetration of domestic markets by overseas producers of intermediate technology and basic industrial goods, and lagging introduction of new production technology in certain important industries. There was special concern for the poor export performance of U.S. industry, reflected in large trade deficits and in declining shares of many world markets. This was mentioned by a number of speakers, including panelists Bueche, Eads, Hahn, David, Kovach, and Vargo.

Most of the recommendations in the studies focused on expanding overseas market opportunities for American products, not on stimulating domestic industrial innovation per se. Recommendations on trade policies, tax policies, and government regulations were made.

There was agreement in all the studies making recommendations in this area that the United States must do more business abroad, to provide additional markets and help maintain U.S. prosperity. The DPR industry and CED reports urged little or no control of exports except on grounds of national security. They contended that it may be difficult to enforce controls because of the availability of foreign substitutes for U.S. technology. Moreover, they argued that controls would hurt U.S. employment and growth, would not likely solve domestic problems of industrial innovation and investment, and would invite the retaliation of our trading partners.

The DPR industry report, the NAE trade report, and the CED report also urged little or no control of imports, citing higher costs to American consumers, reduction of competition and innovation in the long term (although jobs may be saved in the short term), and retaliation from trading partners. The NAE trade report suggested that, as an alternative to import controls, the trade adjustment assistance program under the Trade Act of 1974 should be expanded and modified.

The DPR small business report and the NAE trade report both made recommendations about trade with developing countries, but with different concerns. The DPR report recommended federal assistance in organizing small firms to cooperate with the governments of such nations in creating joint ventures. It also recommended a tax-free

exchange of investments (machinery for equity) in developing countries. The NAE trade report focused instead on the demands of developing countries to increase their share of world income through the accelerated transfer of technology from industrial nations. This report made three recommendations. First, the U.S. policy implications of these demands should be analyzed. Second, mechanisms for transferring nonproprietary technologies to developing countries should be created. Third, the United States should support regional institutions in developing countries and provide financial assistance to develop and apply technologies appropriate to local conditions. The President made recommendations in this area before his innovation message, proposing the establishment of the Institute for Scientific and Technological Cooperation (ISTC) to strengthen the scientific and technological capacities of developing countries. This program has yet to begin.

The DPR small business and industry reports favored more tax incentives for international trade. The small business report recommended double deduction of the costs of exporting activity and favorable treatment of income and capital depreciation. As noted in the previous section, the DPR industry report also recommended liberalizing or repealing of Treasury Regulation 1.861-8, which requires firms to allocate a portion of R&D expenditures incurred in the United States among foreign sources of income.

Policy recommendations concerning government regulations dealt mainly with antitrust policy. The DPR industry and small business reports and the CTAB report favored liberalizing antitrust policy as it affects international trade. The DPR industry report recommended, in particular, clarification of the application of antitrust policy to joint ventures with overseas firms. The DPR small business report urged that small businesses be allowed exclusive grant back rights to patentable improvements made by foreign licensees and partners, exclusive marketing rights in the United States, and exclusive sourcing rights of materials and components. The DPR small business and CTAB reports argued that the government should help small businesses market their products abroad by establishing a Small Business Export Council (DPR) or a Small Business Export Trade Corporation (CTAB).

The discussion of the Panel on International Transactions ranged more broadly than the analytical report and brought up some issues not covered there.

A controversy concerning foreign direct investment arose during the panel discussion. Panel chairman David noted that manufacturing abroad is a proven method of capturing foreign markets. Labor representative Sharman, on the other hand, criticized the foreign operations of U.S. firms on the grounds that they often export technology and jobs. According to reports covered by the analytical report, however, foreign direct investment by American firms tends to enhance U.S. exports and reduce exports from other countries, with positive effects on U.S. employment. These reports also indicate that direct foreign investment by American firms makes only a small contribution to the technological capacity of the recipient country.

Panelist Kovach pointed out that U.S. policies to stimulate domestic industrial innovation also influence international transactions. In a related point, panelist Vargo argued that the best way to enhance the international competitiveness of U.S. firms was apparently simply to let natural domestic strengths such as innovation come forth. Panelist Kovach also stressed that policies enacted by other countries to stimulate innovation influence this country, and that U.S. policies affect them. There is worldwide interest in the relation of technology to trade, and many countries have recently undertaken innovation studies similar to the U.S. Domestic Policy Review. Panelist Kovach expressed the belief that there is much room for international cooperation in attempting to understand the factors promoting innovation, and in promoting the multinational environment for innovation.

Panelist Steele made several points aimed at correcting what he termed "misperceptions" concerning technology and international trade. First, he said, there is a growing need to create exports to finance the necessary imports for continued economic growth. Second, he asserted, the past American preeminence in many technical fields cannot be sustained. Third, he claimed, U.S. sellers of technology are getting better at obtaining the full value of technology sold. Fourth, Steele stressed that the value of technology is optimized in relation to local factor costs, so that much technology exported from the United States may be of little value to the receiving country unless it is modified to meet local conditions. Finally, Panelist Steele argued that the presumed past advantage of U.S. technology has been overstated and the present situation is not as unfavorable as many people believe.

With respect to proposed changes in antitrust policy as it affects international trade, the analytical report pointed out that it is unclear whether American firms are facing cartels or cartel-like behavior in foreign markets, and, if so, what the losses and gains might be. It also noted that there is a question of the extent to which trade associations promote exports of U.S. high-technology products. (One study indicates that trade associations do not promote exports significantly.) Moreover, there is the question of the extent to which trade associations would undermine domestic antitrust objectives.

FEDERAL R&D SUPPORT

The direct support of R&D has been a traditional role of government in industrial innovation. As enumerated by Panel Chairman Charpie, four key questions must be answered in developing a consistent policy for federal R&D support related to industrial innovation:

- Should the federal government be responsible for enhancing the support of R&D directed at industrial innnovation and, if so, is

the best method by direct support of R&D or by indirect encouragement of private R&D?

- What changes should be made in the current federal support systems and patterns of R&D?

- What impact on the rate, scale, and success of innovation can reasonably be expected from various changes in federal support of R&D?

- How do we sort out the priorities for action?

The DPR industry reports on direct federal support of R&D and on federal procurement policy, the DPR report on small business, the CED report, and the CTAB report all made recommendations on federal R&D support. The President's message on industrial innovation also made several proposals on this subject. The principal recommendations fell into five main categories: (1) federal support of R&D on commercial technology, (2) federal support of R&D in small business, (3) federal support of R&D at universities, (4) federal support of technology transfer, and (5) support of R&D through federal procurement.

There was general agreement that the federal government should improve its support for R&D directed at industrial innovation. The CED and NAE positions proposed only indirect support measures. The DPR reports and the CTAB report advocated or accepted the need for some form of direct federal funding of commercial technology development. There was general agreement, however, that such support should not involve government in "picking winners" among R&D projects. Panelist Edwin Mills noted that most people agree that market incentives do not provide an adequate amount of R&D, even for new commercial products and processes. It is also widely agreed that decisions on R&D directed at commercial applications should be made by those who will commercialize the new product or process. Based on these two points, stated Mills, the CED report drew two conclusions: (1) the government should stimulate R&D for new commercial products and processes, but (2) it should do so indirectly (e.g., through tax incentives), leaving R&D decisions to the private sector. The exceptions to this rule are federal support of basic research generally, R&D where the federal government is the primary user, and R&D in selected cases like health, environment, and energy where special circumstances may justify direct federal support.

Prior to the President's message on industrial innovation, the position of the Carter and Ford Administrations on the role of the federal government in the support of R&D was similar to that of the CED report. The federal government was held to have legitimate roles in the support of basic research generally and of applied research and development to meet federal mission responsibilities, but the private sector was relied on for support of applied research and development for general industrial and economic development. Recommendations for direct support of R&D--although limited in size and scope--formed a major part of President Carter's message, however. This seeming

divergence raises the question of whether the President's announcement represented a significant policy change.

It appears from the panel discussion that the President's initiatives do not represent a conscious policy change at this time. Panelist Smith, of the Office of Science and Technology Policy, concurred generally with the CED report's rationale and position. He said the case for federal support of basic research generally is clear, but it is less clear how far the government should go in applied research or in stimulating industrial innovation generally. Smith asserted that the government should not do product development or marketing. He indicated that the Administration is taking a limited and experimental approach and does not believe it appropriate to go much further. In this area, he said, tax incentives, loans or loan guarantees, and special arrangements for small business are preferable policy mechanisms. Panelist Konkel, then of the Office of Management and Budget, concurred with Smith's statements and added that the future expansion of the experiment with generic technology centers (for government-industry cooperation in funding R&D on basic technologies spanning) will depend largely on the degree and quality of response from industry. Konkel pointed to examples in defense and space R&D of federal government getting involved in the whole spectrum of R&D activities.

The various analyses displayed a broad consensus on R&D in small business, industry research at universities, transfer of federal technology to the private sector, and the encouragement of innovative R&D through federal procurement.

With respect to federal support of R&D on commercial technology, the President proposed the establishment of generic technology centers, following the recommendations of the DPR industry report on federal R&D support. Such action was opposed by the CED report, as noted above, and by the DPR small business report, which favored cutting applied research in universities and federal laboratories in favor of small business. All the reports making R&D recommendations favored enhancement of small business participation in federal R&D and some form of preferential support of R&D in small business, except the CED report and the DPR industry report on federal procurement policy. A wide variety of specific recommendations was made, but there was broad support only for expanding of existing National Science Foundation programs for small business, which the President recommended. The President also recommended federal assistance to small business for the development of technology to comply with regulations and the establishment of regional Corporations for Innovation Development.

The DPR industry reports on federal procurement policy and support of R&D, along with the President's message, agreed that university research for industry should be increased. The two DPR industry reports recommended tax credits to industry to support basic research in universities. The CED report supported this position implicitly. The DPR industry report of federal R&D support, recognizing the difficulty of passing tax legislation, proposed a transitional system of matching grants for this purpose. The President recommended that

the National Science Foundation program of university-industry cooperative research be expanded. The DPR small business report recommended that federal support of applied research at universities be redirected to small businesses.

The desirability of transferring federal technology to the private sector was agreed on, and a variety of specific proposals were made, including the establishment of federal-state extension systems (DPR industry report on federal R&D support) and use of the proposed generic technology centers to transfer technology (the President's message and the DPR industry report on federal R&D support). In addition, the President recommended establishing new centers for the use of federal technology at the National Technical Information Service (NTIS).

All reports making recommendations on R&D supported the use of federal procurements to encourage industrial innovation. The President's message, the CED report, and the DPR industry report on federal procurement policy specifically encouraged federal procurement of innovative items.

REGULATION

Environmental, health, and safety regulations are widely perceived as presenting undue barriers to industrial innovation. Studies making recommendations for changes in the area of regulation included the DPR industry report on environmental, health, and safety regulations; the DPR industry report on regulation of industry structure and competition; the DPR report on small business; the NAE report, The Impact of Regulation on Industrial Innovation; the CED report; and the CTAB report. The President's message on innovation included several initiatives in this area also, in addition to a variety of regulatory reforms initiated previously.

In the last 15 years the federal government has enacted and implemented a large number of health, safety, and environmental regulations. Despite a certain amount of controversy, all of the studies accepted the basic objectives of government regulation in these areas--improving the environment and protecting health and safety--and the need for government intervention to achieve these objectives. As panel chairman Throdahl stated in his opening remarks, it is justifiable to set rules to prevent harm. However, he said:

> Sometimes those rules are handled inconsistently or become very complex and almost impossible to manage. . . . This morning we are going to be discussing public policy options which minimize the adverse effects of health and safety and environmental regulation on the innovation process, and thereby on productivity, and hopefully on the balance of trade and living standards.

Within the consensus on the need for regulations, however, there remain issues on the proper boundaries of government regulation. The DPR industry reports on environmental, health, and safety regulation

and on regulation of industry structure and competition, and the DPR report on small business, supported private voluntary standards and private insurance-product liability systems. The analytical paper noted that the Consumer Product Safety Commission (CPSC) has been moving toward the private establishment of standards, augmented by public participation, in areas where long-run health hazards are not at issue.

In another issue related to the boundaries of government regulation, there appeared to be consensus among government and academic representatives on the panel that it is desirable to experiment with economic incentives, as distinguished from to direct government regulation, to achieve environmental, health, and safety objectives. Increased use of economic incentives was the primary recommendation of the NAE report and was included among the CED recommendations. Incentives such as effluent fees or tax incentives are almost universally advocated by economists. Among the benefits claimed for economic incentives are the elimination of inefficiencies and uncertainties and provision of strong incentives for the development and installation of new pollution-reducing equipment. Economic incentives would apply primarily in cases where the release of small amounts of the pollutant in question would not be critical.

There was disagreement on the extent to which costs and benefits should be balanced in decisions to undertake particular regulatory actions. In recent years efforts to ensure that regulatory agencies consider the economic and other costs of regulatory actions before undertaking them have intensified. President Ford instituted the requirement for the preparation of Inflation Impact Statements, and President Carter issued Executive Order 12044, which requires the preparation of regulatory analyses for major decisions. Regulatory reform legislation now being considered by the Congress would give this requirement statutory authority. The DPR industry reports on environmental, health, and safety regulation and regulation of industry structure and competition, the DPR report on small business, the CED report, and the NAE report supported the use of cost/benefit analysis in regulatory decisionmaking. In the panel discussion there appeared to be consensus on the value of cost/benefit analysis in regulatory decisionmaking, but concern over how the results of such analyses should be quantified and weighed in decision, given the uncertainties and conceptual problems. Panel members argued that regulations that prescribe "zero risk" should be avoided. Each of these, except for the NAE report, agreed that there should be congressional review and sunset requirements for regulatory programs, based on cost/benefit analysis.

The analytical paper and panel discussion revealed widespread criticism of regulatory procedures. In fact, the strongest consensus was found in this area. The reports and the panel strongly supported recent Administration actions to improve the regulatory process, including the formation of the Regulatory Council, the Calendar of Federal Regulations, the use of performance standards, 5-year forecasts of regulations, and the "bubble" concept in environmental regulation. It was agreed that progress is being made toward

consistency and reduced uncertainty in regulation and toward improved communication and coordination among agencies.

Historically, there has been disagreement on how regulation should proceed in the face of imperfect knowledge. Current regulation takes a "technology-forcing" approach--to force regulated firms to develop technology that will achieve the health objectives of the standards. The two DPR industry reports on regulation, however, recommended that regulation be confined within the bounds of existing knowledge. They argued that attempts to force technology development can impose unrealistically short deadlines or excessively high requirements, which are likely to be high in cost and counter-productive in terms of meeting regulatory objectives.

Many of the reports dealt with the special problems of small businesses in complying with environmental, health, and safety regulations. These regulations are believed to place especially large burdens on small businesses because of their inadequate staffs and resources for handling compliance. This is of concern to those interested in the level of industrial innovation in the United States because a number of studies have found that small businesses have made disproportionately large contributions to innovation in this country. A wide range of suggestions was made, from exempting small businesses from Occupational Safety and Health Administration (OSHA) regulation (DPR small business report) to reducing paper work requirements for small businesses (DPR industry report on the regulation of industry structure and competition). The recommendation with the broadest support (both DPR industry reports on regulation) was to give grants and technical assistance to small businesses in cases where an undue burden is determined to exist. Panelist Bergman noted that a number of actions in this area have already been taken. The panel chairman, supported by a majority of the panel, recommended that the NAE sponsor a workshop on small business and regulation.

There was agreement in the studies and on the panel that more long-term research should be done on the causes and effects of safety and health hazards. The President also called for more research in his message. It was pointed out by a government member of the panel that regulatory decisionmaking is only as good as the scientific and technical knowledge on which it rests. Better scientific and technical knowledge would help reduce some of the current regulatory uncertainties.

The studies displayed less consensus on compensatory policies for offsetting regulatory disincentives to innovation. Some of the compensatory policies suggested included changes in patent policy to lengthen the period of protection (EHSR, NAE), tax incentives or subsidies (EHSR), and import protection and export enhancement (EHSR).

During the panel discussion some members of the panel and the audience argued for public funding of retrofitting existing plants to achieve compliance. The analytical report, however, noted that such a policy might have negative side effects in distorting allocation of investment in new industrial plant and equipment.

On the panel, industry and government representatives stressed the desirability of interaction between industry and government early in

the regulatory process. This could save time in the long run, by reducing the amount of litigation and the number of challenges to promulgated regulations. Parties on both parts expressed a desire to make the regulatory process less adversarial in nature. Panelist Jellinek of the Environmental Protection Agency, however, noted that the legal system almost forces the relationship to be adversarial, at least at certain stages of the decisionmaking process.

PATENTS AND INFORMATION POLICY

Patents and information policy were treated together because the recommendations in these areas were closely related.

Patent Policy

Patents have at least three important functions in the innovation process, according to panel chairman Keefauver. First, they provide the legal basis for the temporary property right in an invention. Second, they are a consideration in attracting risk capital to finance a new venture. Third, they play a role in technology transfer, through licensing.

The DPR report on patent policy, the CED study, and the NAE report Antitrust, Uncertainty, and Technological Innovation made recommendations on of patent policy, as did the President's message. The two problems that seemed to be the most significant were uncertainty about patent validity and government patent policies.

The degree to which one may rely upon patent protection directly affects the incentive to invent and the availability of risk capital. The high cost and the length of time necessary to resolve patent validity disputes through litigation, and the inhospitable attitude of many courts to patents, significantly decrease the attractiveness of innovation as a business investment. Panel members and studies agreed on the need for reliable, enforceable patents. In addition to panel chairman Keefauver, panel members Witte, Benson, Manbeck, and Banner spoke to this point.

The studies made the following recommendation to improve patent validity. The DPR report on patent policy recommended that the Patent and Trademark Office (PTO) should be upgraded with adequate examination staff and modern research tools. The President's message also proposed to upgrade the PTO by improving its filing and classification system. Panel member Smith indicated that PTO fees may need adjustment; other panelists argued that excessive cost would be a disincentive to patent.

The DPR patent policy report recommended reexamination of patents by PTO, as did the President. By empowering PTO to reexamine issued patents in controversy in light of prior art not previously considered by PTO, litigation can be simplified, expedited, and made more uniform.

The DPR patent policy report and the CED report both recommended a single national court of patent appeals. This proposal was also

supported by the President. A single court of patent appeals would make judicial tests of validity more uniform, reduce "forum shopping," and help make the outcome of litigation more predictable.

The CED report recommended voluntary arbitration be legalized for patent dispute resolution, to reduce the amount of litigation in this area. The NAE report on antitrust policy and innovation recommended that the antitrust laws should not be administered or construed to conflict with the patent system's purpose of fostering innovation by granting temporary monopolies.

In the panel discussion, there seemed to be broad consensus on upgrading PTO, reexamination, a single court of patent appeals, and voluntary arbitration.

Government agencies have different policies on (1) the rights of private contractors to inventions made while performing R&D contracts with federal funding, and (2) the available rights to inventions made by government employees. Government patent policy has been debated for nearly 30 years. More than one panel member expressed the opinion that the subject has consumed more time and effort than it warrants, relative to improvements in the overall patent system. There are two schools of thought on the subject. With respect to inventions made by federal contractors, one side has traditionally urged that title to inventions should go to the government; others would leave title with the contractor and give the government a license to use. With respect to government inventions, one side has urged that nonexclusive rights be granted to private-sector users, while others argued that exclusive rights are necessary to justify investment of risk capital.

The DPR patent policy report strongly supported a policy that would leave title to inventions made under R&D contracts to the contractor and make exclusive license available, for a limited time, under government patents. President Carter's initiative, however, would put title to contractor-made inventions in the government and grant exclusive licenses to the contractors in fields they choose to commercialize. Panelists Ertel and Smith stated that a policy vesting title to contractor-made inventions in the contractor, regardless of size, would be preferable. Smith stated that the Administration did not believe it politically feasible at this time, however.

Information Policy

The innovation process requires the generation and use of relevant, accurate information about technologies and markets. Recommendations for changes in information policy were made only in the DPR industry report on information policy and in the President's message. Panel member Bachman described the major recommendations of the DPR report and compared them to the President's initiatives. According to panelist Bachman, the DPR subcommittee on information policy believed that the problem is not lack of scientific and technical information, but its communication, accessibility, and feedback.

The major recommendations made by the DPR patent policy report fell into the following categories: patents as sources of information, foreign market and technical information, assistance to users, regulatory impediments (including the Freedom of Information Act), protection of data bases and software, and government as a creator and distributor of information.

The DPR patent policy report made a number of recommendations with respect to patents as sources of information for innovation. First, it recommended that greater ease of public access to the patent files be provided through computer-based search and retrieval systems. Second, it recommended that a variety of classification and indexing schemes be developed for the patent searching system. Third, it stated that the PTO should expand its depository system and install automated search systems at other locations in the United States. The President's message directed the PTO to undertake efforts to make public access to and use of patent files easier.

The DPR patent policy report recommended further that the government improve the availability to industry of foreign market and technical information. The collection and dissemination of foreign patent information was one proposal; another was the provision of foreign standards and product approval requirement information. The President's message on innovation directed the National Technical Information Service (NTIS) to collect and translate foreign technical literature more extensively. It also directed the Departments of State and Commerce to interview volunteer U.S. citizens returning from overseas about observed foreign technological developments. The President's message did not, however, address the issue of improved foreign market information.

The DPR patent policy report also recommended that, except for confidential or classified material, all information produced or collected by the government be made conveniently accessible to the private sector at incremental cost. The report recommended in addition that government competition with industry in the information area should be avoided except in cases of clear public need. The President announced that he would take action to improve the flow of information from federal laboratories.

The DPR patent policy report also made a number of recommendations that were not included among the President's intiatives. To improve assistance to users, the report recommended (1) the development of a service for users to provide better knowledge of and access to existing information services, and (2) a review of the experience of the innovation centers sponsored by the National Science Foundation.

To decrease regulatory impediments, the report recommended clarification of federal communications policy with respect to information dissemination through computer and telecommunication networks. It also recommended that the U.S. data rights policy under federal contracts be revised to provide greater protection to U.S. firms and that the Freedom of Information Act be amended to provide greater protection to proprietary information submitted to the government.

The DPR report endorsed, as a means of gaining added protection for data bases and software, the recommendations of the National Commission on New Technological Uses of Copyright Works (CONTU), which called for amendments to the Copyright Law of 1976. The report also recommended that the PTO should establish guidelines for software patent requirements.

ANTITRUST REGULATION

Antitrust laws are intended to keep the economy competitive; competition, in turn, stimulates innovation. There are concerns, however, that antitrust laws under some conditions may impede innovation. The NAE report Antitrust, Uncertainty, and Technological Innovation and the DPR industry report on regulation of industrial structure and competition addressed these antitrust issues. The President's message also included initiatives in this area.

As stated by panel chairman Casey, the problems in the area of antitrust and innovation are marginal. That is, the purpose of antitrust laws is to keep the U.S. economy competitive, which should in turn act to keep industrial innovation healthy. Panelist Ewing of the Department of Justice agreed: "I think we are all in agreement that workably competitive markets foster innovation." Panelist Shapiro also agreed with this statement, but raised the issue of whether "the fragility of the innovation process is inadequately understood in antitrust parlance . . . and whether there are unintended side effects of generally pro-competitive policies which adversely impact innovation."

Chairman Casey also made it clear that the antitrust discussion was not concerned merely with innovation as research, creation, or invention, but also with commercialization. "We are not only concerned with innovation, as such," he said, "but also with capturing and holding the benefits of innovation for our national economy, as we, in turn, make innovative products and services available around the world." Thus, much of the panel discussion dealt with the international trade context of the issues, especially foreign acquisitions.

The recommendations and initiatives fell into six categories: further research needs, joint R&D ventures, monopolization policy, horizontal mergers, foreign competition, and better communication.

The NAE report and the DPR industry report on the regulation of industry structure and competition agreed on the need for better measures of industrial innovation and improved understanding of the relationship of market structure and firm size to industrial innovation. Panelist Shapiro criticized antitrust policy for its use of structural criteria in the face of our limited understanding of the effects of antitrust policy on economic behavior, especially innovative behavior, which is intrinsically difficult to measure and ill-understood.

The two reports agreed that joint R&D ventures may make possible innovations that would not be possible through the separate efforts of

individual firms. They also agreed that in some cases joint R&D ventures may be put to anticompetitive uses; thus, the Department of Justice has legitimate concerns with the antitrust implications of particular joint ventures and their modes of operation. Further, the reports agreed that the crucial decision is the weighing of factors in each individual decision to approve a joint R&D venture. Moreover, there was agreement that the criteria used in making these decisions are basically sound, but that they are insufficient by themselves to resolve particular cases in such a manner as to foster innovation.

The NAE report recommended that the Department of Justice clarify its guidelines for industry with respect to joint R&D ventures. The President's innovation policy initiatives also contained this recommendation. The NAE recommendation was based on the conclusion that the Department of Justice provides little guidance that can be applied to particular joint R&D ventures being considered by firms. The report suggested that the uncertainty inherent in the lack of such guidelines and the burdensomeness of the procedure of obtaining a ruling on a specific proposal may inhibit firms from making proposals for joint R&D ventures.

The DPR industry report on regulation of industry structure and competition went further than the NAE report in its recommendation. It urged the Department of Justice to give heavier weight to the innovativeness of ventures being proposed. However, the analytical report and the panel discussion raised the question of whether the Department of Justice is able to assess the innovativeness of proposed ventures and whether, indeed, it is the appropriate institution for doing so. The DPR report also criticized a perceived tendency on the part of the Department to overestimate the capability or willingness of an individual firm to undertake proposed R&D work by itself. It also recommended that compulsory licensing of resulting patents not be required of joint R&D ventures.

Attempts are under way to extend antitrust law to penalize firms that achieve a dominant or monopoly market position by offering lower prices or superior products, without engaging in exclusionary or unfair trade practices. A case prosecuted by the Federal Trade Commission (FTC) staff against E. I. duPont De Nemours in connection with that firm's production of titanium dioxide and proposals for deconcentration legislation in the Congress are indicative of possible trends in this direction. The NAE and DPR reports both opposed deconcentration legislation on the grounds that it may deter firms from making technical innovations for fear that they will thereby obtain too large shares of a particular markets. The DPR report stated that the FTC case against duPont is being interpreted in the business community as a warning that the acquisition of market share by passing through the cost advantages of process innovations and building capacity to support that share is hazardous. At this writing, an administrative law judge had struck down the case, but it was being appealed by the FTC staff to the full Commission.

The NAE report argued against the proposal that large firms in concentrated markets be required to show that they have been sufficiently technologically innovative to explain their success if

they are to avoid dismemberment. The report argued that the burden of mounting such a defense would be sufficient to deter moderate-sized firms in concentrated markets from innovating. Both reports agreed that the effect of such changes in antitrust policy would likely increase profits, decrease price competition, and deter technological innovation, with few benefits to the American consumer.

The subject of mergers between firms in competition evoked the strongest disagreement between government and private sector representatives on the panel. Department of Justice merger guidelines severely limit mergers between competing firms except under certain circumstances, including significant R&D advances that outweigh any competitive losses. The NAE and DPR reports were both concerned that antitrust policy might inhibit innovation-fostering mergers. The basic argument appears to be that, although small businesses often come up with superior innovative ideas, introducing and marketing innovations require large amounts of capital. These reports acknowledge that it would be preferable for the innovating small firm to grow as an independent competitor. It is often necessary, however, for the small firm to sell out to another firm to acquire the necessary capital. In cases where the acquiring firm is a competitor, antitrust policy may prevent acquisition and thus prevent the commercialization of the innovation. Further, antitrust constraints on acquistion may have a general deterrent effect on small business innovation since the prospect of acquisition is an incentive to entrepreneurs.

Despite similar assessments of the problem, the NAE and DPR reports arrived at different recommendations. The NAE report recommended that the Department of Justice clarify its policy by issuing further guidelines respecting mergers that would further innovation. The DPR report urged that Department to give further weight to innovation issues in small business acquisitions on a case-by-case basis. The analytical report pointed out that the DPR position differs only in degree from currently stated Justice policy, but that it implicitly conflicts with the NAE proposal which recommends general guidelines. During the panel discussion, panelist Ewing indicated that the potential for innovation will be given special attention in consideration of merger cases. Panelist Shapiro, however, voiced his concern that the Department of Justice may not have the ability to make the necessary technical assessments and that this expertise should be sought elsewhere in the government.

Both the NAE and DPR reports addressed the question of whether U.S. antitrust policy puts U.S. firms at a competitive disadvantage in international markets. The DPR report stated that many American business executives believe that foreign firms are able to disregard the fundamental principles of the Sherman Act. The report agreed that the effects of antitrust policy, including deconcentration legislation, on U.S. foreign trade should be studied. The DPR report suggested that if such a study shows that foreign firms possess competitive advantages by virtue of disregarding fundamental antitrust principles, then policy alternatives would include enacting

protectionist legislation (with its disadvantages), weakenening antitrust enforcement, and accepting the competitive disadvantage.

As pointed out in the analytical report, the concern behind the DPR report's recommendations appears to be not with technological innovation per se, but rather with long-term shifts in the international competitive balance, which may endanger the U.S. economy. During the panel discussion, members of the audience suggested that cooperation and mergers by foreign firms constituted unfair competition and justified protection of U.S. firms or relaxation of U.S. antitrust laws. This was explicitly rejected by panel member Ginsburg. The analytic report suggested that such concerns would be better addressed on their own merits, rather than as industrial innovation issues. During the panel discussion, members of the panel and audience expressed concern with the protectionist thrust of some of the DPR report's proposals, citing the danger of retaliatory measures by the governments of other countries.

Panel discussion also revealed disagreement on the issue of whether foreign firms have an advantage over U.S. firms in the acquisition of U.S. firms. The DPR report argued that current policies under Section 7 of the Clayton Act, which focus entirely on the U.S. marketplace and do not purport to assess the international competitive significance of American acquisitions, give foreign firms an advantage because the acquisition of American firms by a foreign firm that is not a competitor in the U.S. market does not further concentrate the U.S. market, but acquisition by a U.S. competitor does. The DPR report recommended that the worldwide competitive position of the firm should be considered, not just its U.S. market position. This point was argued by panel member Shapiro. Panelist Ewing, on the other hand, objected to the idea that foreign companies have an unfair advantage in acquiring U.S. firms. He stated that firms attempting to acquire competitors are given very close examination regardless of national origin.

One of the President's initiatives dealt with the need for improved communications between industry and government on antitrust matters. He directed the Department of Justice and the Federal Trade Commission to begin discussions with industry on innovation and antitrust issues. The purpose is to dispel the perception that antitrust policy inhibits innovation. The NAE and DPR reports did not make this recommendation, but the panel members seemed to agree that it could be useful.

As noted in the analytical report, the papers reviewed did not join issue at the broad philosophical level. Although panel chairman Casey noted early in the discussion that he perceived agreement that antitrust policy plays a positive role in industrial innovation, he later commented that perhaps there is a latent disagreement on the value of antitrust. Most attention, however, focused on administrative matters, attitudes, and the weighing of factors in decisions. There seemed to be agreement that the further study and attention were needed. The panel also seemed to agree on the utility

of the President's actions in the antitrust area, although some reservations were expressed.

THE PUBLIC INTEREST AND LABOR CRITIQUES

One of the purposes of the Domestic Policy Review on Industrial Innovation was to involve all parties affected by industrial innovation in a discussion of the issues. The Public Interest and Labor Subcommittess of the DPR produced reports commenting on the policy recommendations of the industrial subcommittees to stimulate industrial innovation and made their own recommendations, as well. The positions taken by labor and public interest groups on industrial innovation proposals may significantly affect the outcome of those proposals. The views of the Labor and Public Interest Subcommittees, which were in many respects at variance with those of the other groups making recommendations, are summarized here.

The basic concern of the Labor and Public Interest Subcommittees was that any government policy for industrial innovation should have social benefits above and beyond the benefits accruing to the innovating firms. These subcommittees were also concerned that the balance of costs and benefits of industrial innovation not be shifted to damage the interests of workers, consumers, and the general public. The Public Interest Subcommittee articulated its view of the federal role with respect to industrial innovation in the following manner:

> If the government is to take any role in promoting innovation in society, it is proper for it to do so only after first answering the questions: Innovation to what end? How does the type of innovation which is being promoted relate to various government objectives? Does the innovation being promoted improve the quality of life? How is that improvement distributed among the various groups in society?

Panelist Sharman, of the International Association of Machinists and Aerospace Workers, said that the government should be involved in innovation and helping to produce technology only if the public would benefit from that technology.

The concern for social benefits and costs of industrial innovation underlies much of the public policy debate. However, the benefits and costs are difficult to measure and understanding is limited. Improved understanding may reduce some of the differences between the positions of the Labor and Public Interest Subcommittees and those of other groups.

The Labor and Public Interest reports placed more emphasis than the other studies on social values. The Public Interest report stated that economic growth is not an end in itself and that "From the public interest perspective, the rate of innovation is subservient to the question of the direction of innovation." It listed a number of social goals that it believed should determine the direction of

industrial innovation and the ends to which government efforts to promote innovation should be directed. These goals included health and safety, employment, adequate income, equitable income distribution, adequate housing and nutrition, a clean environment, equal opportunity, and a democratic society.

The Public Interest report did not agree with the industry reports that lessening the regulatory burden or general tax disincentives was necessary to stimulating innovation. The Public Interest Subcommittee did not accept the proposition that regulation impedes innovation. Rather, it felt that regulations provide an incentive to innovation to meet health and safety goals. It opposed the recommendation for broader use of voluntary industrial standards, reacting in part to the perceived deficiencies of previous private systems. The Public Interest report also expressed the concern that general tax incentives might prove costly to taxpayers and yet not meet the basic needs and priorities of society. It also supported government efforts to maintain a competitive industrial structure, in the belief that business concentration is inimical to innovation.

Although the Public Interest study criticized certain aspects of industrial innovation and proposed policy changes, it noted that innovation can result in important social and economic benefits. The Public Interest Subcommittee accordingly made recommendations for stimulating innovation in a number of areas where it felt that important social values could be achieved. These areas include policy and coordination at the federal level, an exemplary role for the federal government (e.g., procurement and testing), reform and voluntary standards-setting process, reform of the patent system, small business and competition, alternative forms of enterprise, alternative technology, consumer participation, defense spending and conversion, and the effects of innovation on workers. On the other hand, the subcommittee stated that it may be in the public interest to slow types of innovation that might have deleterious social effects; it mentioned toxic substances were mentioned as a possible example.

The primary values expressed in the Labor Subcommittee's report focused on the welfare of the U.S. worker. The Labor Subcommittee agreed with the other studies that industrial innovation is essential to healthy economic growth, rising productivity, and higher living standards. However, it expressed the belief that the best stimulus for innovation would be full employment, which would make possible expanding mass markets.

The Labor Subcommittee also stressed the negative effects that innovation can sometimes have on workers and their jobs. Labor-saving innovations may displace existing jobs; new jobs created by innovation may have different job contents, skill requirements, and pay rates. Innovation may cause changes in industry location and require worker relocation or adjustment. The Labor Subcommittee argued that these effects must be foreseen and accommodated.

In its recommendations, the Labor Subcommittee put top priority on an expanding economy with full employment. It also stressed involving workers through collective bargaining in decisions involving new industrial technology. The Labor report opposed tax incentives to

stimulate innovation. It also opposed what it regarded as the "weakening" of regulations to facilitate innovation.

In the trade area, the Labor report called for control of technology exports and imports and elimination of incentives for U.S. direct investment overseas, arguing that these activities are injurious to U.S. workers and the U.S. economy. It also called for congressional investigation of the effects of industrial market structure on innovation and for more controls on business generally.

The Labor and Public Interest critiques raised the question of whether there really is an innovation problem and whether the proposed policy changes would be effective in stimulating industrial innovation. The Public Interest Subcommittee wrote that the available evidence, which it characterized as "indirect and insufficient," had not convinced it "that there is a problem with the rate of innovation sufficiently serious to merit expensive government intervention." In a similar vein, panelist Sharman said that labor cannot accept the notion that American business lacks the ability to innovate.

The labor and Public Interest reports criticized many of the recommendations made by the other groups on the grounds that evidence is insufficient to show without doubt that they would be effective in stimulating innovation.

DATA AND THEORY LIMITATIONS

Concerns about limitations in the knowledge base underlying proposed policy changes were expressed by some of the reports and panelists during the NAE colloquium. The concern generally was not that policy changes should be postponed until better information can be obtained, but rather that public policymakers should have realistic perspectives on the state of knowledge in this area. There seemed to be agreement that, despite knowledge limitations, the types of policy changes proposed in the studies would be effective in stimulating innovation. The desire for improved knowledge concerns fell into three categories: trends in U.S. industrial innovation, the relationship between R&D and innovation on the one hand and economic welfare on the other, and the effects of government policy on industrial innovation.

One of the major motivations for the proposed policy changes is a widespread belief that U.S. industrial innovation is not as vigorous as it could be. It is difficult to measure innovation, however, and current analysis relies primarily on indirect indicators. Any single indicator is inadequate as a measure of innovation; it is only by reading across a large number of such indicators that is is possible to get a balanced picture of the state of innovation. Similar views on the limits to measurement of industrial innovation were expressed in the NAE reports The Impact of Regulation on Industrial Innovation and Antitrust, Uncertainty, and Technological Innovation. Some of the panelists also expressed reservations about the evidence on trends in U.S. industrial innovation. Panel chairman David, for instance, noted that the indicators may exaggerate the problem of U.S. innovation lag. Panelist Steele pointed out that the earlier U.S. advantage in

technology was never as sweeping as some asserted. Moreover, he said, the fact that the United States no longer has preeminence in so many fields should not be taken as an indication that it is falling behind in all fields.

Concern for the state of U.S. industrial innovation stems in large part from the belief that innovation contributes significantly to economic growth, productivity improvement, and international trade competitiveness. As noted in the introduction to this report, many studies agree that the contribution of R&D to economic growth and productivity is positive, significant, and high. It has been estimated that about half of measurable U.S. economic growth between 1948 and 1969 was derived from advances in knowledge. There are shortcomings in the methods used in these studies, however, that introduce some uncertainty into the relationships. These shortcomings stem from problems in measuring technological change, economic output, and productivity and in isolating the effects of innovation on the economy.

Some panelists expressed concern at the limits of knowledge about the relationship between innovation and economic welfare. Panelist Holmfeld stated that Congress is ambivalent about industrial innovation, partly because of weakness in data and understanding. He called for better analysis and firmer establishment of cause-and-effect relationships. Panelist Eads noted that while there is general agreement that low productivity is a major problem in stagflation, there is no general agreement on the role innovation rates play in producing that low productivity. Similarly, he observed, while there is general agreement that export performance is lower than we would like, there is no such agreement on how more rapid technological change would affect exports.

Another area of knowledge limitations is the effects of government policy on industrial innovation. A number of the studies reviewed by the NAE colloquium acknowledged difficulties in predicting the effects of proposed policy changes on innovation. The DPR industry Subcommittee on Environmental, Health, and Safety Regulations noted in its report, "There is not a clear consensus on the impact of regulation, safety in particular, on innovation. . . . To a certain extent this difficulty stems from measurement problems. . . . Evidence is largely anecdotal."

Although the subcommittee acknowledged the lack of scientifically acceptable evidence on the effects of regulation on innovation, based on the experience of its members it argued that regulation currently handicaps innovation and that policy changes are needed. Similarly, the DPR industry report on patent policy stated:

> While the subcommittee can cite no rigorous evidence which establishes that changes in the patent system could have a major impact on the rate of R&D there is a consensus among the members of the subcommittee that the availability of reliable patents has an impact on the focus of R&D and on decisions to invest in the commercialization of patented products.

The NAE reports on regulation and antitrust also expressed concern about knowledge limits in this area.

Several panelists at the NAE colloquium also commented on the weakness of our understanding of how to stimulate innovation effectively though government policy. Panelist Averch cautioned that:

> Our evidentiary base about the marginal impact of policies with respect to innovation is quite weak. If you look at the research literature, it does not tightly link any of the policy options we will talk about with unambiguous outcomes with respect to innovation.

Panelist Cordes warned that "when one is considering enacting any new incentive, one ought to think long and hard about whether in fact, those incentives will have the type of effect you want, vis-a-vis innovative investment." On the international panel, chairman David pointed out that even if it is agreed that it is desirable to control technology exports, the question of whether it is administratively feasible remains. Panelist Shapiro commented that "Probably the single most important fact about the impact of antitrust policy on economic behavior generally is that we don't know very much about it." This is, he said, especially true with respect to innovation, which is difficult to measure and ill-understood.

Dr. Bueche summarized the consensus of the studies and the panelists on the issue of knowledge limitations in his closing remarks. He said, "There is a lot we don't know about stimulating innovation." However, "There seemed to be agreement, based presumably more on faith than mathematical models, that doing certain things would increase the rate of innovation."

LIST OF ABBREVIATIONS

CED	Committee for Economic Development
CONTU	National Commission on New Technological Uses of Copyright Works
CPSC	Consumer Product Safety Commission
CTAB	Commerce Technical Advisory Board
DPR	Domestic Policy Review
EHSR	Environmental, Health, and Safety Regulations
ERISA	Employment Retirement Income Security Act of 1974
FTC	Federal Trade Commission
IRC	Internal Revenue Code
NAE	National Academy of Engineering
NRC	National Research Council
NSF	National Science Foundation
NTIS	National Technical Information Service
OSHA	Occupational Safety and Health Administration
PTO	Patent and Trademark Office
SEC	Securities and Exchange Commission

APPENDIX

CONTINUING NATIONAL ACTIVITIES

This section summarizes some of the considerable national activities that are directly pertinent to the subject addressed by the Colloquium, and are representative of continuing attention to this vital matter.

Activity has continued on a number of fronts since the colloquium was held. Progress has been made by the Administration in implementing some of the President's "innovation initiatives", announced on October 31, 1979. The President's fiscal year 1981 budget included increases for selected programs such as the National Science Foundation's Small Business Innovation Research program and the Department of Commerce's National Technical Information Service. Although subsequent events reduced the increases for these programs, the increases will probably still be substantial. The Department of Commerce announced in September that it would sponsor three cooperative research centers with industry to conduct research in areas of technology underlying a broad range of industry. The centers will conduct research in welding and joining, lubrication and wear, and power-metal processing. The Commerce Department also announced its intention to sponsor one Corporation for Industrial Development, a regional organization to provide venture capital. The Department of Justice is expected soon to issue antitrust guidelines to facilitate cooperative industrial research. The Administration's patent bill, to establish a uniform Federal patent policy and voluntary reexamination, is being considered by the Congress along with other patent reform legislation. President Cater has also submitted a legislative request for a single Patent Court of Appeals.

President Carter's message on economic revitalization of August 28 also had implications for industrial innovation. Among the more important of these were two proposed tax measures: accelerated tax depreciation and a refundable investment tax credit. The President also proposed an additional $600 million in fiscal years 1981 and 1982 for Federal research and development (R and D) support, much of it for basic research.

The Congress is considering a number of bills related to industrial innovation in addition to those requested by the Administration. In the tax area, some of the major general tax bills are the Jones-Conable bill

that establishes uniform 10-5-3 depreciation and the Kemp-Roth bill that cuts taxes for individuals. Hearings have been held on the Vanik bill, H.R. 6632, that gives firms tax credits for grants for basic research to universities. According to informed observers, passage of some type of tax package seems likely within the next several months.

The Congress has been considering patent legislation actively. The Senate has passed bills on uniform Federal patent policy (S. 414) and reexamination (S. 2446). The Administration bill, H.R. 6933, was reported out of the House Committee on Government Operations and the House Committee on the Judiciary in September. The Bailsback amendment to make the Patent and Trademark Office an independent agency was deleted. The Committee on the Judiciary included the text of H.R. 6934, the "Computer Software Copyright Act of 1980", as an amendment to H.R. 6933. The House reported another bill on uniform Federal patent policy (H.R. 5715) and began mark-up on another (H.R. 2414). On September 15, the House passed H.R. 3806, which establishes a single court of patent appeals.

The Stevenson-Wydler Technology Innovation Act of 1980 (S. 1250), a bill to establish cooperative industry-university centers for industrial technology and to create in the Department of Commerce an Office of Industrial Technology, has passed both houses and gone to conference. Differences between the House and Senate versions have been resolved in committee and the bill has been sent to the President for signature

Hearings were held on H.R. 6910, a bill to establish a National Technology Foundation, in September. The bill reportedly was introduced for discussion purposes but may be reintroduced in the ninety-seventh Congress in a revised form.

A number of bills related to small business and innovation are being considered. P.L. 96-302, the "Small Business Development Center Act of 1980", became law on July 1, 1980. Title II authorizes funding for the small business development center program in the Small Business Administration, which provides management and technical assistance to small business. Other bills, such as the Small Business Innovation Research Act (S. 1074), would establish R and D set-asides for small businesses in all Federal agencies with R and D budgets over a certain size. The Senate has passed S. 2718 which authorizes funds to facilitate the formation of U.S. export trading companies to expand export participation by small businesses.

Some of the major regulatory reform bills being considered in the Congress include S. 262, which provides for regulatory analysis of proposed rules and existing rules; S. 445, which proposes the "sunset" concept for regulatory agencies; and S. 755, which is designed to make regulations more cost effective; to insure periodic review of old rules; to improve regulatory planning and management; to eliminate needless legal formality and delay; and to enhance public participation in the regulatory process. The House counterpart to S. 755 is H.R. 3263, which was ordered reported as amended on September 18.