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STATEMENT OF

OSMUND T. FUNDINGSLAND,
ASSOCIATE DIRECTOR, SCIENCE AND TECHNOLOGY
RESOURCES, COMMUNITY AND ECONOMIC DEVELOPMENT DIVISION

BEFORE THE
SCIENCE, TECHNOLOGY, AND SPACE
SUBCOMMITTEE OF THE SENATE COMMITTEE

ON

COMMERCE, SCIENCE, AND TRANSPORTATION

AT

HUNTSVILLE, ALABAMA

Mr Chairman, this statement is based on GAO's report entitled "The Federal Role in Fostering University-Industry Cooperation" (GAO/PAD-83-22).

We undertook our review to develop information and guidelines which would help policymakers assess whether new or revised federal initiatives were needed and how they could enhance cooperation between universities and industry. The Chairmen and ranking minority members of the House Committee on Science and Technology and the Senate Committee on Commerce, Science, and Transportation expressed special interest in this study and requested a GAO report.

There is evidence of growing interest in various forms of university-industry cooperation. We have received many responses to our report, including requests from individuals and institutions planning new cooperative arrangements or reviewing existing ones. There also have been announcements in the press and contacts with federal officials concerning initiatives contemplated

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by a number of universities with endorsement from state Government officials to establish research parks or cooperative research centers in partnership with industry.

We selected the following three types of university-industry arrangements for study: research parks, cooperative research centers, and industrial extension programs. Research parks are composed of clusters of high technology firms or their research centers that are located on or near the campus of a research university. Cooperative research centers involve a number of companies in a formal agreement to sponsor research programs at a university-based center. Extension services transfer technology from a university to potential industrial users through designated exchange agents.

We conducted four in-depth case studies of existing collaborative arrangememts and followed these with briefer examinations of twelve additional arrangements.

The case studies

The four case studies included: the relationship between Stanford University and the Stanford Industrial Park; the cooperative research centers established at the Massachusetts Institute of Technology (the Polymer Processing Program) and at North Carolina State University (the Furniture R&D Applications Institute); and the efforts of the Georgia Institute of Technology (Georgia Tech) to use the extension approach to assist firms in non-agricultural industries.

We chose Stanford because it was the first university-related research park established in the United States and is widely considered the most successful. We selected MIT's Polymer Processing Program because it was one of the first cooperative research centers to be funded by a National Science Foundation (NSF) program, the Industry/University Cooperative Research Center Program (IUCRC), which has served as a prototype for current government efforts to support the creation of centers for industrial technology since 1973. We chose the Furniture Institute at North Carolina State University because it was regarded as a less

successful experiment and because it provided valuable information about the factors which may lead to failure in cooperative centers even when there is government support. Georgia Tech's industrial extension program was chosen because it includes a variety of extension activities directed at non-agricultural clients. In performing the case studies, we conducted 85 interviews with university administrators, faculty, students, and key representatives from industry management and participating industrial research staff.

The twelve additional arrangements we reviewed included briefer studies of two research parks, seven cooperative research centers and three industrial extension services. These are listed in Attachment I.

FINDINGS

The characteristics of each type of collaboration we examined are summarized in Attachment II. Our findings include their results, their conditions for success, and government roles in fostering them. In this study, we found substantial evidence that deliberately planned long-term institutional cooperation between universities and industry can enhance technological innovation. Each arrangement (the research park, the cooperative research center, and the industrial extension) may be more or less suited to achieving particular policy objectives. However, the successful creation and continuing strength of each arrangement depend upon certain critical factors, some which are general and others specific to each type of institutional arrangement. The federal government has been involved in a variety of ways in fostering cooperative arrangements between the two sectors. We also developed conclusions germane to any new or revised federal initiatives for fostering university-industry collaboration.

Results of University-Industry Collaboration

It is generally recognized that university-industry cooperative arrangements increase communication between scientists and engineers in the two sectors. We found that the nature and degree of communication vary greatly among the different

cooperative arrangements, ranging from mutual intellectual stimulation of scientists and engineers in both sectors to more service-oriented technological assistance by university transfer agents for fragmented low-technology industries. We also found that university-industry cooperation may contribute to industrial innovation by

--facilitating early recognition of significant breakthroughs in basic research which make new products and processes possible;

--increasing the rate at which scientific and technical knowledge is adapted by industry;

--increasing the availability of sophisticated facilities, equipment, and expertise to scientists and engineers in industry and universities;

--orienting university research more toward industrial needs and opportunities (e.g., interdisciplinary research);

--increasing the quality of graduate training of industrial scientists and engineers;

--increasing the rate of founding new businesses that exploit science and technological developments, as well as improving their capacity to survive; and

--increasing the capacity of backward and/or financially constrained businesses or industries to take advantage of scientific and technical developments.

Of the three types of collaboration we considered, the most dramatic contribution to innovation appears to be made by research parks, which enhance university-industry interaction at the frontiers of science and the leading edge of industrial technology. Interaction between the two sectors is enhanced through providing industrial employment of faculty consultants, adjunct faculty appointments for industrial research specialists, shared laboratory facilities, part-time employment of graduate students, special graduate courses for industrial employees, and joint research projects and seminars.

The most dynamic interaction we observed occurred at the Stanford Research Park, where we found that the philosophy of industrial collaboration has been fully integrated into the academic mission of the university. A major consequence is that communication and rapport between academic and industrial sectors have reached a higher level than in any other research park we reviewed. This interaction increases the flow of information affecting the research agendas of both sectors; it also increases academic sensitivity to the possible commercial utility of emerging ideas and research findings. Another measure of success of the Stanford Research Park is its effect on regional economic development. Many large and small technology-intensive firms have been attracted to the Silicon Valley region surrounding the park to take advantage of the university's research park and the industrial cooperative education program.

The Stanford success can be attributed to extremely favorable circumstances prevailing for more than two decades during the creation and early development of the research park. Stanford owned many acres of undeveloped land which were available for long-term leases but could not be sold; the federal government was rapidly expanding its funding of basic and applied research at universities; and Stanford had a leader, Dr. Frederick Terman, Dean of Engineering and Provost of the University, who was greatly respected by academic, industrial, and government sectors, and dedicated to the research park concept. Although it is unlikely that such an ideal situation will emerge again, we believe that, if all of the critical factors summarized on the next two pages are realized, then other research parks may emulate Stanford's success.

Cooperative research centers bring universities and industry together in jointly planned research aimed at accelerating the advance and commercial application of technology. The research agenda of a center is usually designed to fill gaps in science, related to technology, which no company would be likely to support alone in its own laboratories, e.g., to improve scientific understanding of empirically developed processes and techniques.

Although both basic and applied research may be included, the research tends to be more interdisciplinary and application-oriented than research performed in academic departments concerned with individual scientific disciplines. Faculty and students participating in the cooperative research centers gain awareness of industrial perspectives that affect the orientation of academic programs. Universities involved in such centers also make substantial contributions to improving the initial and continuing education of industrial scientists and engineers.

Industrial extension provides assistance to new, low-technology, and fragmented industries. Industrial extension services may attract new businesses to a region, create an information resource about the local economy which may be used by local development organizations, and contribute to the productivity and economic viability of existing local businesses and industries. In most cases, industrial extension has not had much effect on university research agendas.

Conditions that foster successful collaborative arrangements

We found that two types of issues are associated with implementing long-term institutional arrangements--those that are generic to any form of university-industry collaboration and those specific to a particular type of collaboration. Generic issues include the need to reconcile the different objectives, values, attitudes, reward structures, and research agendas of the two sectors; and locate a source of continuing financial support. Critical factors essential to resolve the generic issues for successful collaborative arrangements of any type include

--commitment by both faculty and administrators at a university to orient some portion of university-research and expertise toward industrial needs and opportunities;

--commitment by participating firms to explore and use the strengths of the university while simultaneously honoring university objectives;

--flexibility in the university to allow policies and organizational developments for interaction with industry that respond to industrial objectives but do not compromise the academic mission of the university;

--a strong leader highly respected by both the academic and industrial communities to establish and maintain the partnership;

--matching the physical and human resources, needs, and interests of both university and industrial partners; and

--sustained sources of funding.

An example of a specific issue is the requirement that university and industry participants in a cooperative research center must agree upon a mutually acceptable research agenda.

Each specific collaborative arrangement draws upon different strengths and resources of university and industrial participants and is not likely to succeed unless universities and firms possessing particularly relevant strengths and mutual interests are involved.

Research parks work best at first-tier research universities where a significant portion of administrators and faculty favor interaction with industry. Industrial participants most likely to benefit from this arrangement are high-technology firms which continue to depend strongly on technological innovation for their success. Cooperative research centers require a university with strong departments in areas relevant to the focus of a center. Industrial participation is most successful with medium to largesized firms which have their own research and development capacities adequate to translate the research results into commercial technological applications. Industrial extension services are best performed by a university with a strong commitment to community service and a technology focus to assist local, fragmented industrial clients.

Government roles in University-Industry Collaboration

Federal and state governments have played both direct and indirect roles in creating and sustaining different university-industry arrangements. The federal government has played a significant role in creating and sustaining each type of institutional arrangement by providing

--support of basic and applied research in universities to build excellence in fields of science at the frontiers of emerging industrial technology,

--contract support for R&D at new spin-off high technology firms,

--seed money for cooperative R&D centers as well as continuing project support through grants and contracts, and

--both seed money and continued funding of extension services.

CONCLUSIONS

Financial support alone will not assure success of any of the forms of institutional cooperation. Both the generic and specific critical factors for each type of arrangement must be addressed to assure

--well-defined objectives and expected outcomes of the collaboration;

--the matching of resources, needs, and interests of both university and industrial partners; and

--institutional commitments and leadership capable of reconciling the generic differences between universities and industrial partners without incursions on the independence of either.

Federal policy initiatives intended to foster closer links between universities and industry should

--relate policy objectives to expected outcomes,

--use the most appropriate type of collaborative arrangement, and

--make financial support contingent upon the willingness and ability of all partners to address the critical factors and reconcile their basic institutional differences.

Mr. Chairman, this concludes my statement.

Attachment 1

Case Studies Which We Examined Briefly

Research Parks	Cooperative Research Centers	Industrial Extension Services
Research Triangle Park of North Carolina	California Institute of Technology's Silicon Structures Project	Industrial Extension Service of North Carolina State University
University of Utah Research Park	Rensselaer Polytechnic Institute's (RPI) Center for Manufacturing, Productivity and Technology Transfer	Pennsylvania Technical Assistance Program (PENNTAP)
	University-Industry Cooperative Research Program in Computer Graphics and CAD/CAM [a] at RPI	Texas Engineering Extension Service, The Texas A&M University System
	Center of University of Massachusetts/Industry Research on Polymers [b]	
	University of Delaware's Center for Catalytic Science and Technology	
	Ohio State University's Center for Welding Research [b]	
	Empire State Paper Research Institute	

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[a] Computer-aided design and computer-aided manufacturing.

[b] These were the only two arrangements we did not visit. We interviewed program directors at a conference sponsored by NSF.

Attachment II. Characteristics of Three Types of University-Industry Arrangements

Type of Arrangement	Modes of Interaction	Major Outcome	Critical Factors	Federal Involvement
Research Parks	Research cooperation on frontiers of science and technology Informal interaction Increased sharing of research facilities and participation in consulting, seminars, and continuing education	Increased communication and intellectual stimulation of both sectors Early recognition of commercializable research and acceleration of innovation process Improved training of industrial scientists and engineers Enhanced regional and local economic growth	University commitment to industrial interaction Good fit between university and industrial strengths and research orientations Reconciliation of research objectives, values, and reward structures Strong leadership in academic institution	Funding of university research Contract support for spin-off firms
Cooperative Research Centers	Joint research planning and execution Faculty and student participation in research centers	Improved coordination of university and industrial research Research outcomes oriented to industrial needs and unlikely to be done otherwise Improved education and training for students preparing for industrial careers	Research focus conducive to multiple firm involvement Research expertise and equipment at the university Strong leadership and commitment of all participants Sophisticated R&D in participating firms Active participation by both sectors	Planning grants and seed funding Project and instrumentation support Legislative authorization of Federal assistance for new centers
Industrial Extension Services	Information transfer and consulting by university transfer agents Workshops, classes	Increased access to technology by fragmented industry Increased relevance of university to community Enhanced regional economic development	University commitment to extension External funding Technological focus	Sporadic project support Cost-sharing with State governments

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