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By Dr. Juan A. Bonnet, Jr., Director, Center for Energy and Environment Research, University of Puerto Rico.

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Introduction

Universities play two very important roles in technological innovation and economic development. First, they play a key role in training scientists and engineers and expanding the base of scientific and technical knowledge. Second, by transferring talent and information to the business and industrial sectors, they provide a vital nexus for the diffusion of innovation to existing firms and foster the creation of new ones. The growing economic importance of technological innovation has created new opportunities for cooperation between industry and the academic community. Several types of programs can be established to carry out this function.

These roles include:

- Research and Science Parks
- Research and Technical Centers
- University Entrepreneur Training and Assistance Programs

- Industry Research Programs

There are currently working examples of each one of these arrangements. This type of collaboration contributes to industrial innovation and economic development by:

1. Reorienting university research towards the needs and interests of the industry.
2. Increasing the speed at which research results become available to the industry.
3. Allowing wider and more efficient use of university facilities, equipment, and personnel.
4. Improving the quality of training for scientists and engineers.
5. Attracting high-technology firms and encouraging the creation of new businesses.
6. Improving the productivity and competitiveness of existing businesses.

The exact relationship in university and industry cooperation depends on local conditions and needs. Cooperation between the educational and industrial sectors is not a new phenomenon. The Stanford Industrial Park dates from the 1960s and the Research Triangle Park from the 1950s. The Center for Energy and Environment Research, a component of the University of Puerto Rico System, has been active as a catalyst for promoting new industry/university research collaboration in Puerto Rico.

Research and Science Parks

Science parks are generally composed of clusters of research-intensive firms and facilities located on dedicated sites. They are often initiated with state and local assistance and/or tax incentives. They are frequently located close to universities so that each may benefit by the proximity of the other. Examples of successful research parks include Research Triangle Park in North Carolina and SRI International (formerly Stanford Research Institute) in California. The Research Triangle Park was created in the late 1950s by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill. The project was supported by an

The enthusiastic governor received a $500,000 grant from the state. SRI International was created by Stanford University in the late 1940s. There are also examples of research-intensive firms growing up around research universities, which do not constitute research parks per se. The best known of these are Route 126 in Boston and Silicon Valley in California. The world's largest science park, Region 2000 in Israel, is expected to transform Western Galilee into a thriving center of high technology industry. This is an exception to the rule that such centers are located near universities. There are other science parks in Israel located in Haifa, Tel Aviv, and Rehovot. This, in part, allows Israel to export sophisticated products based primarily on local research and development. The value of those exports is more than $1 billion yearly and there are plans to increase the value of exports to more than $5 billion by the year 2000. Clearly, science parks can contribute significantly to the community and the nation. As already mentioned, most science parks are located near universities. There are four basic benefits resulting from this relationship:
1. Increased interaction and easier communication between university and industry researchers, broadening the mutual understanding of problems and needs.
2. Business gains quicker access to new developments through increased information and knowledge transfer.
3. Business also gains access to student workers and faculty consultants, as well as laboratories, computers, libraries, and other resources.
4. Increased interaction opens opportunities for creating new business and university/industry

programs.

The advantages of and the need for a science park are well recognized in Puerto Rico. A commission appointed by the Governor of Puerto Rico in March 1984 recommended that a Center for Science and Technology be established on the island. The commission grew out of a set of recommendations contained in a study.

The text was commissioned by the Center for Energy and Environment Research. The study found it to be "essential, if not imperative, that Puerto Rico develop a science and technology capability of its own." It was found that the proposed center is feasible at this time. It could also play a major role in the development of an indigenous scientific and technological base for Puerto Rico.

The commission considered, among others, nine possible sites for the Center and provided four alternatives: Rio Piedras, Mayaguez, Aguadilla, and Dorado. The Commission's three principal conclusions were: First, that a Science and Technology Center should be established; second, that the University of Puerto Rico should become a “world-class research institution"; and third, that greater emphasis should be placed on assisting the small entrepreneur.

The Commission gave serious consideration to the makeup of the Center. It recommended that the Center be a private, not-for-profit institution. The initial board would be appointed by the Governor, but thereafter it would be self-sustaining. More mainland institutions might enhance the credibility as well as innovating. It suggested that ties with one could bring in expert assistance to the Center.

The Commission also explored financing needs and concluded that for the first three years of operation the government of Puerto Rico should provide funding of between $500,000 and $750,000 per year until the Center could become self-supporting.

The Commission also considered the range of services the Science and Technology Center could and should provide. These fell into four categories: Research, development, and demonstration; Technical assistance; Technology transfer; Concept exchange.

Finally, the Commission recommended that the initial focus.

The focus of the Center is on the pharmaceutical and electronics industries. These two industries are particularly important in Puerto Rico and have an ongoing interest in R&D. As part of the Commission's work, its staff carried out a survey of industry in Puerto Rico to determine what kind of R&D is currently being done on the island. Four hundred questionnaires were distributed, mostly to pharmaceutical and electronics companies. Forty or 35% responded. The survey found that most firms do not perform R&D in Puerto Rico. Respondents gave a variety of reasons for not doing so. As most are branch plants manufacturing for a parent company, R&D is performed largely by the stateside principal. There are many impediments to doing R&D in Puerto Rico, of which lack of know-how was identified as the most important. Another major hindrance perceived by the industry is the inability of the universities to respond adequately to the industry's R&D needs. The survey also explored whether local industry would take advantage of a Science and Technology Center if it existed. Just over half of those responding indicated that they would. Some felt, however, that there should be additional incentives to induce other industries to do R&D in Puerto Rico. Suggestions

included larger and longer tax exemptions and a revision of Puerto Rico's toll gate to include the use of Section 936. Section 936 of the U.S. IRS Code provides special tax incentives under certain conditions to U.S. companies operating in Puerto Rico.

RESEARCH AND TECHNICAL CENTERS

University-based research centers perform applied research in exchange for fees and other support, allowing firms to pool their resources to support long-term research in areas of shared interest. Examples of these research centers include the Microelectronic Center in North Carolina and the Center for Applied Microelectronics at the University of Wisconsin. Some universities permit these centers to provide short-term technical assistance to local industries.

Business services, including patent searches, technical staff, and other research services, can to some extent be viewed as an application of the Agricultural Extension Service model to non-agricultural industries. Examples of these are: (a) the Massachusetts Institute of Technology Industry Affiliates program and (b) the Center for Industrial Cooperation at the State University of New York at Stony Brook.

In some ways, the Resource Center for Science and Engineering established at the Rio Piedras Campus, in cooperation with the University of Puerto Rico, Inter American University, Catholic University, and the Ana G. Méndez Educational Foundation, the proposed Center for Research and Development at the Mayaguez Campus, and the Center for Energy and Environment Research are examples of this type of cooperation. All these centers are seeking and have done contracted work for local industry and government.

UNIVERSITY-INDUSTRY COLLABORATION

Several university/industry research partnerships are currently in operation. Many of these are between a university and a single firm, while others are research consortia involving several companies and/or universities. Some of the most visible of the consortia are Harvard University and Monsanto, Washington University and Mallinckrodt, Harvard Medical School and Seagrams, Massachusetts Institute of Technology and Foxon, and Carnegie Melon and Westinghouse. The research center at Purdue University in Indiana is jointly sponsored by five corporations to develop computer prototypes. Pennsylvania State University has 20 sponsoring industries for a cooperative program in recombinant DNA technology.

The National Science Foundation has a special program to initiate and develop this type of program. The Center for Energy and Environment Research has been active as a catalyst in a concerted effort to develop a collaborative program in Puerto Rico involving the pharmaceutical industry and the university. A planning grant proposal was submitted in September of this year to the...

National Science Foundation is jointly run by CEER and the School of Pharmacy of the Medical Sciences Campus. This proposal was itself a product of a university-industry effort through a joint task force made up of representatives from UPR and local industry. During a 10-month period, the task force held a series of meetings and made several presentations before industrial groups in various areas of the Island. The planning grant proposal reflects the work of the task force and

embodies the essential findings and understandings reached in the process. Most university-industry research centers have a combination of state and federal government, industry, and some university support. Such centers are attracting widespread company support and are addressing areas of research that are interdisciplinary and might prove fundamental to several industries. The most critical factors in developing such centers are support of university administration, industry interest to provide long-term financial assistance, faculty interest in cooperative research with industry, and dynamic leadership with a sense of direction. The changing role of science and technology in society will most likely affect university research subjects and the proportion of basic to applied research conducted at universities. It will also affect sources of funding for university research. There is a continuous spectrum from basic to applied research, and what is one organization's applied research can be another's basic research. Basic research universities and colleges account for about 50% of all basic research in the U.S. Industry conducts about one-third as much basic research as the universities, and government laboratories about 25% less than industry. Industry has many reasons to be interested in establishing research interactions with universities. They could be listed as follows: 1. To gain access to manpower (students and professors) and facilities (labs, instrumentation) 2. To solve a problem or obtain specific information.

Unavailable elsewhere, 3. To gain prestige or enhance the company's image. 4. To make use of an economic resource. 5. To provide general support for technical excellence. Access to high-quality manpower is the prime motivation underlying the industry's desire to establish cooperative research activities with universities. The industry also looks to the university to solve very specific scientific problems in which the university has specific expertise. The industry rarely looks to the university for technological innovation that directly results in new products or processes. Closer relations might lead to expanded research by universities in areas of basic science and engineering that could be built upon by the industry for future growth. Greater rapport between industrial researchers and faculty could presumably increase industry funding for university research. Cooperative programs might strengthen support for graduate students and provide leverage for further grants, thus expanding the level of basic research generally.

There are many reasons universities choose to interact with the industry. These may be summarized as follows:

1. Industry provides new sources of funding. This helps diversify the university's funding base.

2. Industrial money involves less red tape than government money, and the reporting requirements are not as time-consuming.

3. Industrially sponsored research provides student exposure to practical research problems.

4. Industrially sponsored research provides a chance to work on an intellectually challenging research program which may be of immediate importance to society.

5. Government funds are available for research, based upon a joint effort between university and industry.

6. Cooperative research programs provide better training for the increasing number of graduates

going to industry.

A panel on university/industry models for cooperation sponsored by Digital Equipment was convened during the CompuCampus II Conference held at Universidad del Turabo in Caguas last month. It was concluded

The text should read:

Puerto Rico has ideal conditions to establish an advanced manufacturing technologies university-industry program. SEER also carries out a Summer Science Program for high school students exclusively funded by local industries. Among the sponsoring firms are: Banco Popular, Banco de Santander, Caribbean Refreshments, Lifesavers, Merck, Sharp & Dohme, Pfizer Pharmaceuticals, FCA Boring, Queen, Shell Company, SK&F Laboratories, Syntex, Technicon Electronic, Union Carbide, Wang Laboratories and the Westinghouse Education Foundation.

Entrepreneur training and assistance: Universities have also become more active in training entrepreneurs and supporting efforts to create new technology-based enterprises. Some examples are the Chair of Free Enterprise at the University of Texas at Austin and the Institute for Constructive Capitalism funded by Mobil, Shell, Tenneco and other corporations. The Center for Entrepreneurship and Small Business Management at Wichita State University is very successful.

Other examples are the University City Science Center in Philadelphia, and similar centers exist at Rensselaer Polytechnic Institute, Georgia Institute of Technology, Carnegie-Mellon, MIT, and the University of Missouri. The proposed Center for Research and Development at the Mayaguez Campus contemplates this type of training and assistance. The Report of the Governor's Commission on Science and Technology Center for Puerto Rico previously referenced recommends that emphasis be given to small business in Puerto Rico, and that a balanced program and approach is needed. This recommendation is based on the fact that in recent years new employment is being created largely by small business and that the small entrepreneur is the one who will provide a substantial part of tomorrow's new business. In addition, much of the help needed by the small business entrepreneur should be provided at the state and local level.

Concluding Remarks: As discussed in this paper, CEER's special institutional situation involves coordination across different campuses and

Research faculties reporting directly to the President of the University of Puerto Rico has enabled it to foster more direct collaboration internally and with industries. The University System Master Development Plan clearly establishes a 2% commitment to become a first-class research university. Also, the Council on Higher Education recently appointed a Higher Education Committee to foster the establishment of more graduate programs. At present, only eleven Ph.D. programs exist system-wide.

Summing up, we would like to delineate some factors that are essential in setting up more effective and potentially successful cooperative arrangements between University and industry. These factors include:

1. A serious commitment by both faculty and high-level directors at the University of Puerto Rico to

the concept of creating a first-class university research facility.

2. Commitment by local private firms to utilize the strength of the university while at the same time honoring university objectives.

3. Maintaining flexibility in the University to allow policies and organizational development that provide for research and industrial cooperation, without compromising the academic mission of the university.

4. Strong leadership highly respected by the academic and industrial community to establish and maintain this partnership.

5. Matching the needs, interests, and resources, both physical and human, of the university and industrial partners.

6. Commitment by industry to a sustained source of funding.

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