# *PUPR Looks Forward to the 21st Century with a Program of Research and Development*

*Gilberto A. Vélez, BSME, MSNuE*
*Dean, School of Engineering,*
*Science and Land Surveying*
*Polytechnic University of Puerto Rico*
*E-mail: gvelez @pupr.edu*

## *I- INTRODUCTION*

*The New Economic Development model adopted by the Government of Puerto Rico is an effort to provide a diversified and solid foundation for future economic development in view of changes in the global economic context. The policy established the development of Science and Technology and their role in Puerto Rico's economic future as an integral part of the new model.*

*The recognition that Puerto Rico's annual rate of economic growth remained stagnant at about 2.5% from 1976 to 1993, in contrast to a growth rate above 6% in the sixties, was the launching pad for the New Economic Development Model.*

*The importance of science and technology in the new knowledge-based economy is widely recognized. The model establishes a general framework for the positive participation of various components of the science and technology system by developing actions in support of specific objectives.*

*The Government of Puerto Rico, being fully committed to the development of Puerto Rico's capacity to innovate and to understand, produce and harness developments in science and technology, will promote development through alliances with the private sector and academia.*

*One of the objectives is to strengthen and further develop the scientific community. Universities are encouraged to establish and develop collaborative efforts aimed at attracting scientific talent by the pooling of resources and creating joint teaching and research activities. Combined research institutes that provide the underpinning for the establishment of science and technology-based industries are also encouraged. It is also singled out that universities should initiate manufacturing engineering programs at the master's degree level.*

*The Polytechnic University of Puerto Rico (PUPR), conscious of its role in our society, has been actively involved in the articulation of an action plan that will catapult the institution to new levels of competency. This will permit us to significantly contribute to the economic development of Puerto Rico. Several things that have been done already are discussed below.*

## *II- MASTER'S PROGRAMS IN MANUFACTURING*

*The Industrial Engineering Department of the PUPR offers, since August of 1998, two graduate programs in manufacturing. The first program leads to a Master of Science in Manufacturing Competitiveness or to a Master in Manufacturing Competitiveness. The second program leads to a Master in Manufacturing Engineering or a Master of Science in Manufacturing Engineering. The first program seeks to prepare professional engineers, scientists, and business administrators for managerial positions and responsibilities in manufacturing organizations. The program offers the opportunity to specialize in three major manufacturing sectors in Puerto Rico; namely the pharmaceutical, the medical devices and the electronic sectors.*

*The programs of studies will allow graduates to acquire a deep knowledge in current and new manufacturing technologies, regulatory issues affecting manufacturing, decision making tools as well as thorough knowledge in all the aspects regarding the operation and management of high technology*

*industries. Such knowledge will prepare them to assume key positions within manufacturing companies either in Puerto Rico, the USA or abroad.*

*The Master's Program in Manufacturing Engineering seeks to prepare professional engineers for managerial and supervisory positions and responsibilities in manufacturing organizations. The program offers the opportunity to specialize in the Manufacturing Automation field, preparing graduates to serve a large number of manufacturing companies. It also offers the opportunity to specialize in two major manufacturing sectors of Puerto Rico, namely the pharmaceutical and electronic sectors.*

## *III- MASTER'S DEGREE IN CIVIL ENGINEERING*

*The Department of Civil Engineering offers graduate instruction leading to the Master of Science in Civil Engineering (M.S.C.E.) and Master of Engineering in Civil Engineering (M.E.C.E.).*

*Experience and professional practice are essential elements in the formation of an engineer, but an in-depth knowledge of the different Civil Engineering areas, and the development of strong analytical skills based on state of the art knowledge, methodologies, and techniques are also necessary. The latter can be better learned in an academic environment. The professional experience would complement and strengthen the study through applications that are actually implemented, but they cannot substitute the knowledge acquired through an academic graduate level degree.*

*The Civil Engineering graduate program seeks to promote and guide advanced studies and research at the PUPR. Moreover, it seeks to involve graduate students in this process and to instill in them an intense desire for knowledge and for the acquisition of skills and mental attitudes, which are prerequisites for the obtainment of knowledge.*

*Civil engineers are responsible for providing the world's infrastructure facilities, which are basic to the continued existence of modern society. These facilities can be large and complex, thus requiring the civil engineers to be broadly trained and able to deal with the latest technologies. The goals of the Graduate Program in Civil Engineering at PUPR are to provide comprehensive training in the Civil Engineering fields and related areas, to offer instruction in the methods of independent investigation, and to foster the spirit of research scholarship. A graduate program is much more than a continuation of undergraduate work; its true spirit is one of inquiry and of promoting the desire to contribute to human knowledge. Graduate studies should, therefore, be contemplated only by students who have already demonstrated in their undergraduate programs high intellectual achievement and the power of independent thought and investigation.*

## *IV- MASTER OF ENGINEERING MANAGEMENT*

*The Master of Engineering Management (MEM) program is designed to prepare professional engineers for managerial positions and responsibilities in technological and scientific organizations in industry, commerce and public service. The program is designed to assist the student in attaining the knowledge, abilities, and judgement to become a successful manager of a technological or scientific organization, or both. The program is interested in teaching engineers that come from diverse disciplines of specialization the managerial knowledge required to develop the skills, and abilities, without neglecting the emphasis on technological advances in an enterprise, with the idea in mind to become entrepreneurs.*

*The graduate from this program will be amply qualified to perform effectively as a manager of technological and scientific enterprises. This program is especially structured to provide a unique opportunity for the development of managerial skills at the graduate level to the more than 7,500 engineers on our island. It also provides engineers with an opportunity to hold leadership positions in managing business firms with emphasis in Construction, Manufacturing, Public Enterprises, and Environmental Management.*

## *V- MASTER OF BUSINESS ADMINISTRATION*

*The Master of Business Administration (MBA) is designed to provide students from diverse academic backgrounds a solid foundation in business concepts, and a broad management perspective for today's global business environment. Students are introduced to the various business disciplines of Finance, Marketing, Human Resources, Management, Economics and Statistics as tools available to managers in their decision making process.*

*Emphasis is placed on teaching students to fully utilize today's rapidly advancing technology to attain the organization's goals and objectives more quickly and effectively. Managing in a global context requires an understanding of how differences in culture and ways of doing business can dramatically influence the probability of achieving the desired business outcomes.*

### *A- Concentration in Management of Technology*

*Engineering and Management programs have traditionally been kept separate within the same institution following different educational tracks. This results in managers who cannot understand technology, or engineers that do not understand the overall management perspective. The MBA concentration in Management of Technology seeks to change that by producing managers capable of bridging the gap between the managerial and technological disciplines.*

### *B- Concentration in Management of International Enterprises*

*The concentration in Management of International Enterprises teaches students to view organizational management in a global context, and to be aware that marketing strategies must consider the different cultural perspectives. Business operations and legal ramifications must also be carefully analyzed when operating in a multinational environment. Finally, currency exchange rates and other financial considerations must be carefully managed to properly achieve the parent organization's objectives.*

### *C- Concentration in General Business*

*The concentration in General Business allows the students to design their own program to match their personal interests. The four courses (12 credits) of the concentration can be chosen from among the other fields of specialization, such as Engineering Management, International Enterprises, Management of Technology or Environmental Protection Management. Instead of specializing in any one field, selecting courses from several areas will serve to broaden the student's perspective.*

## *VI- ALLIANCE WITH THE UNIVERSITY OF MISSOURI-COLUMBIA (UMC)*

*The Polytechnic University of Puerto Rico entered into an agreement with the University of Missouri-Columbia to facilitate doctoral graduate study at UMC by PUPR faculty with only a master's degree in engineering. The agreement establishes the terms and conditions of the program in order to fulfil the primary goal of faculty development by allowing selected PUPR faculty to obtain a doctoral degree within UMC'S College of Engineering in disciplines of great need for PUPR or Puerto Rico.*

*It is the goal of this program that 50 doctoral students (either faculty members or new students from PUPR) will be selected (See table I) starting in August, 1999 and each fall semester thereafter in a ten year period. This program is perfectly aligned with PUPR's objective of being an active participant in the official science and technology initiative created by the Government of Puerto Rico. The accomplishment of this goal will allow PUPR to transform itself from a mere undergraduate engineering teaching institution to one where applied research and development will contribute to the creation of thousands of new jobs in the island. It is of extreme importance to keep in mind that people with doctoral degrees, particularly those in engineering, are the ones with the capacity to generate new positions in the industrialized environment that prevails in Puerto Rico.*

***Table I:*** *Number of Participants Per Year*

| | Year of the Program | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Group No.** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **Total** | **Man-years** |
| 1 | 5 | 5 | 5 | | | | | | | | 5 | 15 |
| 2 | | 5 | 5 | 5 | | | | | | | 5 | 15 |
| 3 | | | 7 | 7 | 7 | | | | | | 7 | 21 |
| 4 | | | | 7 | 7 | 7 | | | | | 7 | 21 |
| 5 | | | | | 7 | 7 | 7 | | | | 7 | 21 |
| 6 | | | | | | 7 | 7 | 7 | | | 7 | 21 |
| 7 | | | | | | | 7 | 7 | 7 | | 7 | 21 |
| 8 | | | | | | | | 5 | 5 | 5 | 5 | 15 |
| *No. of participants each Year* | *5* | *10* | *17* | *19* | *21* | *21* | *21* | *19* | *12* | *5* | *50* | *150* |

*PUPR and UMC, on a collaborative form, already began developing several important projects that will benefit both institutions and Puerto Rico at large. These projects are the following.*

1- *Plasma Research Center*

*UMC donated PUPR a plasma machine worth about $2,000,000. The machine has been moved from Columbia and installed in the PUPR Campus. Once it is in place and tested, it will be of great help to stimulate research activity in physics as well as in the electrical engineering program.*

2- *Engineering Research Center (ERC)*

*The main objective of this center is to develop fuel cell compact power sources. This project contemplates doing the needed research to develop fuel cells that may be used in land transportation vehicles to replace conventional gasoline engines. Also, they may be used in satellites. New technologies will be integrated into the ERC to help solve key problems in the development of compact power supplies. Research clusters will be formed to deal with hydrogen transport and storage, advanced materials, modeling, industrial processes, and advanced energy conversion.*

3- *Software Development Center*

*The development of a strong information infrastructure for Puerto Rico depends on an effective software development center in San Juan, which is readily accessible to all businesses, government agencies, and industries. Since major computer and communication companies are providing hardware products worldwide, the missing link is the Software Development Center that could bridge computer and communication hardware and software systems to practical users applications of the region, namely Puerto Rico and its neighboring countries. The impact to the economic development of Puerto Rico will be significant, for knowledge based jobs and revenues will be generated and the Puerto Rico Information Infrastructure established. The center will be located at the PUPR campus.*

4- *Antiterrorism Research Laboratory*

*The objective of the proposed work is to develop a portable prototype sensor for identification and detection of explosives (TNT, RDX, HMX, and others). It is proposed to explore different surfaces as sensor materials, investigate and quantify the sensor's response to the presence of target molecules in a mixture, develop a robust electronic system for sensor operation and data analysis, and generate field experience with the prototype over the next three years.*

5- *Distance Learning*

*A strategic program goal is to set up a fast Internet link between PUPR and The University of Missouri-Columbia (UMC). UMC is already working in the areas of distance and computer- based education and integrated curriculum. One course in Health Physics has already been taught off-campus via Smartboard technology and ISDN video. Two additional courses (Radiation Safety and Radiation Detecting) have been formatted for computer instruction. Other courses that are computer-based include the Energy Systems and Nuclear Physics.*

## *VII- ALLIANCE WITH VIRGINIA INSTITUTE OF TECHNOLOGY AND STATE UNIVERSITY*

*Prior to the UMC-PUPR alliance another alliance, at a much smaller scale, was agreed upon with Virginia Tech. The objective of the alliance is to allow PUPR professors to pursue a doctoral degree. While this happens, advanced doctoral students from Virginia Tech come to PUPR to substitute our professor. They teach three sections every quarter. Under this program one professor completed his third year and a second one finished his second year of their doctoral programs. In August, 1999 a third professor moved to Virginia Tech to initiate his doctoral studies.*

## *VIII- OTHER DOCTORAL PROGRAMS*

*Besides those three at Virginia Tech, one professor already obtained his doctoral degree from Worcester Polytechnic Institute in February, 1999 and another finished at UPR-Mayagüez in May, 1999. A third one is in the final stages of his dissertation at the University of Detroit. A fourth professor completed his first year in a doctoral program at the University of Michigan.*

*The aggressive faculty development program put in place will complement the research team already organized at PUPR's campus. During the last two years five professors with doctoral degrees have joined the faculty with the specific idea to organize and initiate a research and development program.*

*The implementation of the research and development program will contribute significantly to the graduate academic programs, the professors, the students, the government of Puerto Rico and our community at large.*