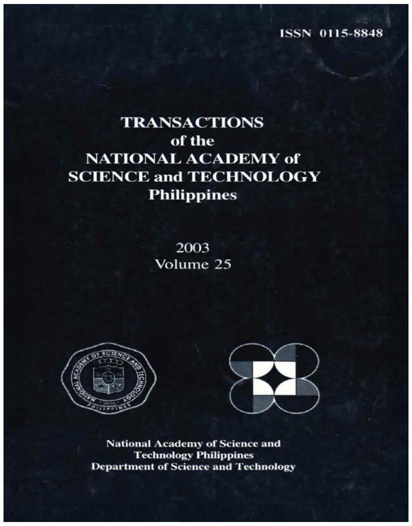
TRANSACTIONS**NASTPHL**

ISSN 0115-8848 (print)
ISSN 2815-2042 (online)

https://transactions.nast.ph
Vol. 25 Issue No. 2 (2003)
doi.org/10.57043/transnastphl.2003.4745

Transactions NAST PHL, is the official journal of the National Academy of Science and Technology Philippines. It has traditionally published papers presented during the Academy's Annual Scientific Meeting since 1979 to promote science-based policy discussions of and recommendations on timely and relevant national issues as part of its functions as a national science academy. Starting in 2021, this journal has been open to contributions from the global scientific community in all fields of science and technology.



Competitiveness in Engineering R&D

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Citation
Sabularse RC. 2003. Competitiveness in engineering R&D. Transactions NAST PHL 25(2): 394-409. doi.org/10.57043/transnastphl.2003.4745

Transactions Natl Acad. Sci. & Tech. Philippines 25 (2): 394-409 (2003)
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Abstract

In today's globalizing economies, both the developed and developing countries acknowledge the importance of investing on education and manpower resources to propel economic growth. The country's state of industrialization and economic growth entails a corollary demand for highly skilled manpower including scientists and researchers to bring about the desired progress.

In line with the need to develop human resource in science and technology, the Department of Science and Technology (DOST), particularly through the Philippine Council for Industry and Energy Research and Development (PCIERD) has been stimulating and supporting research activities in identified priority areas. Linkages among the academe, industry and government agencies have been strengthened to effectively carry out S&T programs and projects.

Key words: competitiveness, engineering education

Introduction

In the 2001 World Competitiveness Yearbook (WCY) rankings published by the Institute for Management Development (IMD) it was reported that the Philippines placed 40th overall out of 49 countries surveyed. The Philippines ranked 32nd in 1998 and apparently, the 2001 rating reflected a big slide. The world competitiveness yearbook ranks countries based on their performance in key areas using surveys and available statistics. Of the four broad categories used to rank countries, Philippines got a near bottom rank of 44th, for its infrastructure and business efficiency where the country was most uncompetitive in both categories. Some of the specific areas which the World Competitive Yearbook lists as our major weaknesses include: inefficient distribution infrastructure (roads, trains, planes, etc.); low expenditures on research and development (R&D); low number of telephone lines; low internet use; poor patent and copyright protection; and protectionism.

The problem with the distribution infrastructure is that infrastructure projects are concentrated in Metro Manila and other major cities and are not spread out to the rest of the country which is a major obstacle for firms with operations in the provinces. There is a small number of fixed telephone lines, which is estimated at 0.046 lines per person though there is a phenomenal growth of cellphones. Our neighboring countries in Asia such as Taiwan and Singapore have 0.588 and 0.472 phone lines per person respectively, which is more than ten times the number of phone lines per person compared to our country. The Philippines ranked near the bottom in terms of computers per person, with only 28 computers per 1000 people, which is far less than in Singapore which has 580 computers per 1000 people or over 20 times that of the Philippines.

As to the country's strength, the World Competitiveness Yearbook listed the Philippines as number one in the world in terms of possessing skilled labor, ranked third for having competent senior managers and excellent finance and IT professionals ranking 4th and 14th places for the finance and IT skills respectively.

In terms of the country's low expenditures on R&D, this is not only a government concern but also of the private sector as well. Although the government can do its part by allocating more of its resources to R&D, the more developed countries finance their R&D primarily through the support of the private sector. Another major problem is the poor patent and copyright protection, particularly with rampant software piracy. This serves as disincentives to our talented programmers.

Challenges to Engineering Education

There have been dramatic changes in the culture of universities from organizations focusing on education and research towards organizations caring about income and economic viability. In addition to the tuition and other fees that are collected from students, the state colleges and universities are now expected to generate income to support their activities.

There is an increasing debate about the efficiency of traditional education philosophy and delivery techniques in the light of the advances in information and communication technology (ICT). ICT has greatly improved and sped up the access to a vast wealth of information available through the Internet which leaves the traditional information delivery techniques obsolete.

Industry is more concerned about the increasing gap between the traditional education programs and industry needs for well-rounded graduates and lifelong learners. Technology advances so fast that industry needed graduates who are able to cope with the fast pace of technology development in order for them to come up with the products in the market on time.

Society is also demanding that current education programs should be able to address broad socio-economic issues such as caring for the environment, sustainability, international terrorism, poverty, biomedical ethics, product liability, among others. As the ultimate recipient of engineering services, society is starting to take active roles in defining the outcomes expected of engineering education programs.

Emerging Strategies

With the ever-increasing global interconnectedness of the world, more and more countries are moving towards cooperation in the mutual recognition of their engineering programs among their counterpart institutions. Learning institutions now think in terms of a global village. They are now open to national and international students to enroll and study regardless of geographical location.

In 1994, the Washington Accord was signed by eight (8) countries for the recognition of equivalency of their accredited engineering education programs leading to the engineering degree. The signatories include the United States, Canada, Australia, United Kingdom, Ireland, New Zealand, Hongkong and South Africa. They exchanged information and examined their respective processes, policies, and procedures for granting accreditation to engineering academic programs and have concluded that these are comparable.

In 1999, the ministers of education of 29 European countries signed an agreement known as The Bologna Declaration. For engineering programs, the FEANI Register and Index would be the articulation of the Bologna Declaration.

Recognizing the need for equivalency of engineering education, other countries started requesting for accreditation from the US. In response to these requests, ABET has operationalized the Engineering Credentials Evaluation International (ECEI), a body to authenticate and evaluate international engineering programs. Before 1997, equivalency was limited only to countries with mutual recognition agreements from the Washington Accord and CEAB. Today, more and more countries are working towards mutual recognition.

Strategies call for programs that are comprehensive and at the same time with the ability to accommodate and cater to the learners' diversity and demand. There is a need for structures that are integrated and are able to provide consistent and coherent paths into and between different programs.

There is a need for flexibility in the delivery and assessment of the programs. Learning approaches have to be more flexible and open, learners need to have more control on how, when, and where to learn. Focus should be on the learners' perspective. There is a need to provide for flexibility in terms of entry and exit points, learning resources, sequence of learning, and modes of assessment.

Today, engineers also need to have a good working knowledge of how the local and international legal systems work and to have an understanding of the approaches to solving legal problems. This provides important understanding of professional engineering life and provides the engineers a basis for developing excellent communication skills both oral and written. It is also important that the legal topics develop lifelong learning attitudes and skills. Some of the legal topics important to engineers are:

a) Contract law (including commercial arbitration)
b) Professional negligence (including criminal negligence)
c) Intellectual Property
d) Product liability
e) Environmental law

On the aspect of global competition, one factor that contributes to the competitiveness of a country is its ability to innovate, to create new products and services. This puts pressure on the universities to hone their research capabilities. In a 1998 survey by Asiaweek, for example, university heads agree that the amount of money that students pay do not really have a great impact on the university's academic excellence. Research programs do.

In the US, externally-funded research in their universities totaled to $4.3 billion in 2001 with almost 65% coming from the federal government. (Figure 1) The business and industry sector contribute a significant 14% to the total research fund. Most of the new money was allotted for weapons development and biomedical research. The increase in federal funding for research in these areas probably has been brought about by the drive against international terrorism.

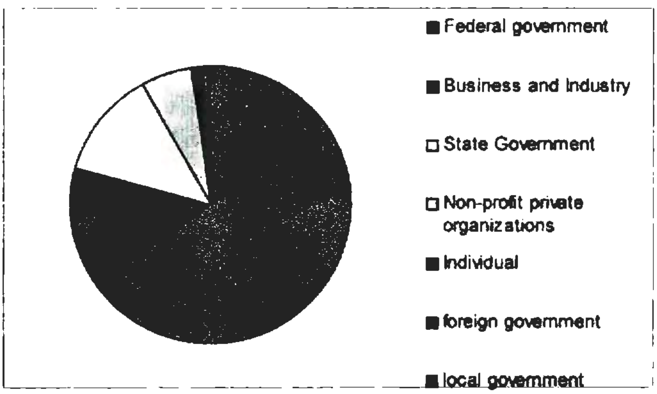

Figure 1. Source of research funds of US engineering schools, 2000-2001
From: ASEE Profiles of Engineering and Engineering Technology Colleges, 2001 Edition

The Philippine Situation

On the average, from 1995 to 2001, the Philippines produced about 40,000 engineering graduates every year. According to statistics, approximately 45% of the graduates pass the licensure examination administered by the Professional Regulations Commission (PRC). With around 160,000 annual enrollees and 4,000 faculty members, student-faculty ratio is around 40:1, one of the highest in this part of the globe. In terms of employment, according to a study by Licuanan in 1994, only 62% of engineering graduates land jobs they were trained for.

Academic Preparation

In terms of the total number of years of academic preparation of an engineer, the Philippines has the shortest as shown by the following comparative table. Primary or elementary education is six (6) years, followed by four (4) years of secondary or high school for a total of ten (10) years prior to entering college. The main difference in the educational system is in high school where most of the other countries have six (6) or seven (7) years. Except for China and Laos which have eleven (11) years of preparatory education, all the other Asian countries have a total of twelve (12) to thirteen (13) years of educational preparation prior to entering college as shown below (Table 1).

Table 1. Comparative Education Statistics of Selected Asian Countries

Country	Entry Age	Years of 1st level	Years of 2nd level	Total
Japan	6	6	6	12
Hongkong	6	6	7	13
Singapore	6	6	7	13
Brunei	6	6	7	13
Korea	6	6	6	12
Malaysia	6	6	7	13
Thailand	6	6	6	12
Indonesia	7	6	6	12
Sri Lanka	5	5	8	13
Philippines	7	6	4	10
China	6	6	5	11
Pakistan	4	5	7	12
Laos	6	5	6	11
Cambodia	6	6	7	13
Vietnam	6	5	7	12
Bangladesh	6	5	7	12
India	6	5	7	12

In 1994, DECS allowed children who have reached age six by the beginning of school year to enroll in Grade 1.

In the report by the Philippine Commission for Educational Reform (PCER) it was cited in a study of the Philippine Education Sector Study (1998) that "...education obtained in a typical Philippine college or university may only be equivalent to a secondary education from typical high schools in Japan or Europe."

CHED's Centers of Excellence/Development (COEs/CODs)

In order to promote excellence among academic institutions, the Commission on Higher Education (CHED) implemented the COE/COD program. In this scheme, colleges/institutions are evaluated according to certain criteria and are given status of Centers of Excellence and Centers of Development. These Centers are given financial assistance by the CHED.

As of February 2001, the CHED has identified 271 COEs/CODs in various disciplines across the country. Information Technology has the most number of CODs with a total of 24 followed by Teacher Education with 21 COEs/CODs, Civil Engineering with 19 CODs, Electrical Engineering with 16. Biology, Mechanical Engineering, and Business have 14 COEs/CODs each. The remaining 37 disciplines have 11 or less COEs/CODs.

Performance in Licensure Examination

Data from the Professional Regulations Commission (PRC) licensure examinations from 1997 to 2001 show that the average passing percentage across 33 professional fields for the past five (5) years is 44.53%. The data show a gradual improvement in the performance of graduates in the licensure examination from 42.15% in 1997 to 47.97% in 2001.

The highest average passing percentage in 2001 was 91% for Geology, followed by Mining Engineering at 87%, Environmental Planning at 76% and Metallurgical Engineering at 70%. In terms of the five-year averages from 1997 to 2001, Geology registered an average passing of 72% followed by Mining Engineering at 68%. Medicine and Pharmacy averaged both at 66.40%.

Taking the average of the five-year averages of the twelve (12) engineering professions (including architecture) gives 43.8% which is below the national average of 44.53% across the 33 professional fields. This is an indication that on the average, less than half of engineering graduates who take the PRC licensure examinations pass. Only three (3) of the twelve (12) engineering fields had averages higher than 50%. These are the Mining, Metallurgical and Agricultural Engineering.

The Engineering and Science Education Project (ESEP) Experience

To examine the quality of education in the Philippines, a World Bank Mission in 1989 studied the country's engineering programs and summarized its findings as follows:

1) Small disperse graduate programs and low research output
2) Inadequate research funding
3) Proliferation of engineering degree education
4) Underfunding of engineering education
5) Weak university-industry linkage
6) Weak science and mathematics preparation
7) Poor career incentives
8) No incentives for higher education

The mission recommended that science and higher engineering education be strengthened. This resulted in the establishemnt of the Engineering and Science Education Project (ESEP) whose main objective is to increase the supply of well-trained Science and Technology (S and T) manpower in support of technology development for industrialization. One of its specific objectives is to strengthen the science and engineering education in priority fields at selected educational institutions. Project components include:

1) Faculty development
2) Acquisition of books and journals, libraries development and networking
3) Acquisition of laboratory equipment
4) Upgrading of research laboratories in public and private universities

Nineteen (19) colleges of engineering participated in the project consisting of five (5) public and fourteen (14) private. Of the 19, three (3) were developed into flagship engineering institutions, the other 16 colleges were developed as lead institutions in selected regions.

In a report by Dr. Milagros Ibe (2000), it was cited that ESEP has attained its targets in the following areas:

1) Faculty development through scholarship grants to selected science and engineering schools. A total 5,891 scholarship slots were filled up, of which 5,151 have graduated.
2) Library upgrading through acquisition of books and training of library staff. Books and journals totaling 72,296 titles and 569 journal titles were delivered to concerned institutions. Eight libraries are now electroni cally linked.
3) Acquisition of laboratory equipment and upgrading of the universities' laboratories. A total of 1,268 items of laboratory equipment have been installed in laboratories all over the country.

4) Installation of computer hardware and development of software.
5) Adoption and adaptation of software for the monitoring of various ESEP components. Six database systems were developed and installed including a) Scholarship Monitoring System (SCOLM); b) Graduate Information System (GIS); c) Staff Appraisal Report System (SARS); d) Financial Management Information System (FMIS); e) Library Materials Procurement System (LIBPC); and f) Bidder's Module (SUM96).
6) Design and development of database system for Science and Technology planning and monitoring

One of the impacts of ESEP is the greater interest and opportunity that it has created for Research and Development and consultancy among the members of the engineering faculties who were granted scholarships for advanced degrees. It also provided the impetus for other faculty members to pursue higher studies. New linkages and wider network were developed. Examples of these are the industry-academe linkages, consortia of universities as well as international linkages.

Although a sequel to ESEP was proposed to further build up the R and D and technology management capabilities of the network of engineering schools, this never came to fruition.

Next Steps

1) Re-engineering the profession

Despite the successful implementation of the ESEP, Filipino engineers are still wanting in terms of being able to create the critical mass to undertake quality research. In one of the Consultative Conferences on Engineering Education in 1997, engineering students were described as showing weaknesses in communication skills, critical thinking, adapting to new situations, ability to work in teams, creativity, customer orientation and decision-making.

With the trade agreements in place, it is just a matter of time when we shall have to deal with the reality that local companies will have to accept foreign engineers to work in the country provided they meet globally-accepted qualification.

It is quite evident that a re-engineering of the local engineering profession is necessary in order to be able to compete with foreign counterparts. Some of the main reasons for re-engineering are:

1) fast changing technology;
2) market competition; and
3) profitability

Due to the fast changing technology, there is a need for the current curriculum to be re-engineered through dialogues with industry needs. In the area of electronics and information technology, for example, the traditional subjects offered may need to be replaced with the more current subject matter. This is to shorten the training that the industry gives the fresh graduates before they become productive engineers in a company.

There is also a need to install a widely accepted accreditation system for engineering. Perhaps, the US ABET accreditation system, which has been successfully implemented in the United States and have been copied by other countries, might be a model that the local universities can start with.

In one of the workshops on "The Philippine Engineering Education System and the Globalization Challenge" (Belino, 1997), the following were identified areas to be addressed in the education of a global engineer:

1) Solid grounding in Science and Mathematics
2) A sophisticated understanding of engineering processes. A hands-on experience is imperative to students in understanding the engineering processes
3) An ability to integrate new computing tools and processes
4) An emphasis on creative thinking
5) Concern for the environment
6) Awareness of ethical issues in engineering
7) Ability to relate engineering to other disciplines

One of the proposals contained in the report of the Philippine Commission for Educational Reform (PCER) is the establishment of a one-year pre-baccalaureate system. This proposal recommends a one-year period between secondary education and tertiary degree program, not only to bring Filipinos at par with other countries but also to ensure readiness of high school graduates for tertiary education, thereby reducing dropouts and expensive repetitions.

It goes without saying that there is a need to continuously upgrade research capability through faculty development and physical facilities upgrade. Of course, this has to be tied-up with a research and development program that the industry is committed to support.

On market competition and profitability, a former Secretary of Education once espoused liberalization of the education sector to allow market forces to work. He asserts that the future cannot be determined with much accuracy. Market is dynamic and assumptions change. For example, the classic 3 – Liberal Arts, Business and Teacher education has now given way to IT, Health Services and Marine Education. Today, people think of jobs abroad rather than local employment. Market therefore must be free to react according to perceptions in what the future will look like.

2) Engineering Ethics

Engineering education must emphasize an understanding of ethical issues in the work life of an engineer. Engineers design not only labor saving devices but also machines that have great impact on peoples' lives. Such devices as bioelectronic implants, for example, will have far-reaching impacts on the environment and to our very own selves. Their moral and social implications require an engineering education that goes well beyond technical or scientific literacy.

A study by Belino (1998) revealed that the existing code of ethics in engineering are traditional and do not address contemporary issues. The professional licensure examinations give limited emphasis to engineering ethics. Students generally receive poor quality instruction in engineering ethics. There is lack of support to promote engineering ethics education from government, schools, and professional engineering societies.

To address the poor quality of instruction in engineering ethics, the following were forwarded by Belino(1998):

1) Schools, professional engineering organizations and associations of engineering schools should include in their continuing professional education program seminars and lectures on engineering ethics;
2) Faculty members currently teaching engineering ethics must update them selves on innovative teaching methodologies and course content;
3) Schools should explore the possibility of team teaching for the course in engineering ethics. The team may be composed of an engineer in part nership with either a theologian, professor in religious studies, philosopher or lawyer;
4) School libraries must be given ample budget to acquire current books, journals, audio-visual materials and other instructional materials on engineering ethics; and
5) Incentives should be given to faculty members engaged in publishing papers or developing instructional materials on engineering ethics.

DOST Initiatives

One of the main objectives of the ESEP was to improve the quality and increase the capacity of research activities in the academe. Today, even after the completion of the ESEP, the DOST continues to work towards that goal.

At the DOST level, a national Science and Technology Human Resource Development Plan (STHRDP) is being drafted. The plan will be used as guide in meeting the perceived S and T requirement of the country in support of the National Science and Technology Plan (NSTP) which is to be pursued in the next two decades. The plan is to develop expertise in 12 area thrusts including the manufacturing and engineering sector. Among the strategies identified to meet the HRD needs of the country are: a) consortia and networking arrangements; b) degree programs via research; c) international recruitment or outsourcing; d) balik-scientist program; e) incentives for graduates and researchers; f) accreditation for program quality; g) innovative scholarship programs;

and h) internal capacity building for DOST.

At the level of the Philippine Council for Industry and Energy Research and Development (PCIERD), for example, one of the strategies being implemented is the strengthening of research networks throughout the country by establishing Industry and Energy Research and Development Consortia (IERDCs). These consortia are composed of academic, government and private institutions in the region whose objective is to support regional development by addressing the research agenda of their respective regions. To date, there are nine (9) IERDCs throughout the country. One important feature of these consortia is the presence of the private sector which is a key element in ensuring that the research agenda being implemented by the consortia is relevant to the industry.

Even with the limited available funds, the PCIERD is continuing to support its Engineering Manpower Development Program (EMDP), which is a graduate scholarship program in the field of engineering particularly in the areas of industry and energy. This is being implemented by the University of the Philippines in Diliman and the De La Salle University in Manila. At present, the scholarship privileges is being reviewed to make it more attractive and competitive with other scholarship programs.

Research and Development Endeavors

Under its mandate the PCIERD is responsible for nine (9) industry sectors namely: Process, Food and Feed, Metals and Engineering, Mining and Minerals, Textile, Energy, Transportation, Construction and Environment. The PCIERD supported a number of R&D projects under its priority sectors, which has resulted into different products and processes.

Industry-related S&T Activities:

- Development of processed food products (ethnic food, milkfish program, convenience food, nata de coco, coconut milk beverages)
- Upgrading the capability of metals and engineering industries to fabricate local equipment for food processing, post harvest, and packaging (bamboo veneer lathe)
- Improving the productivity and export performance of the furniture industry (bleaching and dyeing technology; wood preservative formulation from cashew nut shell liquid)
- Mineral-based products development (Biliran ceramic training R&D center; exploration models to aid discovery of new ore deposits)
- Development and utilization of cost efficient housing materials and components (cement bonded board from wastewater treatment sludge; waste plastic as binder for plywood production)

Energy-related S&T Activities:

- Alternative indigenous fuels (compressed natural gas for transport, coco methyl esters as diesel substitute
- New and renewable energy sources (wind and tidal current resources assessment; micro-hydro and solar water pump)
- Water-to-energy projects (biomass utilization for cogeneration, landfill gas resources assessment and utilization)
- Energy conservation

Environment - related S&T Activities:

- Solid and industrial waste management projects (accelerated bioreactor-based composting, used tires as fuel for cement industry, industrial wastewater treatment)
- Cleaner production technologies

In order to have an effective scheme for the assessment of the developed technologies and to facilitate transfer to potential adoptors, the Council created a Technology Assessment, Utilization and Transfer (TAUT) Team. Specifically, the team is tasked to evaluate and prioritize the technologies that are ready for commercialization; define its mode of transfer; establish and maintain compendium of technologies; and conduct technology matching with potential takers.

To protect and manage the intellectual property of the researchers, the DOST established an Intellectual Property and Technology Mechanism (IPTM) in each agency. The IPTM will address IPR protection issues, transfer and commercialization of technologies/products including technology valuation, negotiation for technology transfer, policy and advocacy, and database management of technologies generated by all agencies of DOST.

Information, Education and Communication (IEC) Campaign

In addition to supporting R&D projects, the Council also conducts IEC campaigns on Science and Technology. In collaboration with the Science Education Institute (SEI), experts are tapped to conduct roving lectures to elementary and high schools. The project allows teachers, students and other participants to gain and enhance their knowledge and hands-on experience in the field of science and technology, thereby upgrading and making teaching and learning more exciting and interesting. The lectures are injected with encouragement for the schoolteachers to search for students who at an early age already exhibit interest in science and technology which they can nurture as potential scientists or engineers.

Search for Outstanding Research in Industry and Energy Competition

One of the strategies adopted to promote and steer the direction of R&D activities in the country is to give awards and recognition to outstanding researches. Every two years, PCIERD gives due recognition to outstanding researches in industry and energy through the conduct of S&T Fora and Competitions. The Search for Outstanding Research in Industry and Energy encourages researchers and technology generators to be responsive to the scientific and technological needs of the industry and energy sectors. It gives recognition to individuals or groups who are able to apply the product of their research in the industry and energy sectors. In 2004 the Council will be holding its 5^{th} S&T Fora and Competition.

Information Dissemination

In disseminating the results of the Council's R&D projects and activities, the use of information and communication technology (ICT), has been a great advantage. An effective and fast medium of information dissemination, results of the R&D projects and activities are posted in the PCIERD website for the information of the general public. The Council also participates in various activities such as fora, exhibits, radio interviews, press conferences and press releases to promote its R&D activities, projects, products and technologies.

Inter-Council Committee

The PCIERD as one of the sectoral council of DOST, is a member of the Inter-Council Committee (ICC) which is a body where matters pertaining to coordination of R&D projects are discussed. One of the subject tackled by this Committee are the projects submitted by State Universities and Colleges (SUCs) to be funded under the General Appropriations of respective SUCs. These projects are evaluated and endorsed by the DOST to the Department of Budget and Management (DBM) for budget allocation. Among the criteria in the evaluation of the ICC proposals are as follows: (a) alignment with the country's S&T and R&D programs; (b) no duplication of projects with other research institutions; and (c) soundness of the technical and financial aspect of the R&D activity. Since 1995, the Council has received and evaluated 1,962 project proposals from various SUCs.

University-Industry-Government Linkage

The university-industry-government linkage has provided opportunities for innovation, growth and leadership. While the universities conduct and seek funding for their researches, the PCIERD anticipates that research proposals involve industry collaboration. PCIERD believes that such policy on industry collaboration in the implementation of R&D activities will facilitate technology commercialization process.

The academic institutions, in enhancing their research capabilities, enter into various forms of linkages with the industry and the government sectors. Some of the most popular forms of linkages/networking are through consultancy services, contract researches, faculty training, student on-the-job training/summer internship program, integrated plant visits/tours, seminars and field trips, joint research, project feasibility study, community outreach, manufacturing linkage program and research collaboration.

In an effort to intensify research capability ties between the private and academic institutions the following should be strengthened:

- *Regular interaction between industry and academe.* This will enable both sectors to exploit regular opportunities for R&D collaboration.
- *Exchange training program of research and industry personnel.* Staff exchanges will help facilitate sharing of information. The scheme, in undertaking research activities, will enable the academic institutions to determine industry needs and requirements.
- *More active promotion of R&D activities and results.* Internet and print media can be used to direct industry's attention on current R&D activities and breakthroughs.
- *Strong industry participation in the research process.* The DOST intensifies its policy on private sector participation in its research activities. This way, technology commercialization process will be readily realized.

Conclusions

The economy has increasingly become global in many aspects including education. With the fast changing technology and the pressure of increasing globalization of markets, there is a need to re-engineer the Filipino engineer in order to be globally competitive.

Among the things that need to be addressed in re-engineering the Filipino engineer are:

1) additional one year pre-baccalaureate
2) an industry-responsive curriculum
3) a widely-accepted accreditation system
4) equivalency with foreign learning institutions
5) a strong research and development program
6) engineering ethics
7) agility to react with market forces

DOST can contribute towards the making of globally-competitive Filipino engineers through its existing scholarships and research and development programs. However, for this to be realized, the concerted effort of all stakeholders must be secured.

References

ASEE Profiles of Engineering and Engineering Technology Colleges, 2001 Ed.

Bauchspies W. 2000. Global engineer as seen from multiple perspectives. International Millenium Conference on Engineering Education. Manila.

Belino M. 1997. Key considerations in re-engineering engineering education for the future" 5th Triennial Conference on Engineering Education, Manila.

Belino M. 2001. Towards a world-class engineering ethics education. Philipp. J. Engineering Edu. 1(2):__-__.

Berreen T. 1997. Teaching legal matters in engineering management courses. 5th Triennial Conference on Engineering Education, Manila.

CHED Statistics. www.ched.gov.ph

Dawood A, Bergmann N. 2000. Global strategies for changing the culture of engineering education" International Millenium Conference on Engineering Education, Manila

Green L. 2000. Educating the global product engineer. International Millenium Conference on Engineering Education, Manila.

Ibe M.2000 An evaluation of the impact of the ESEP on S and T in the Philippines.

Laurito A. 2001. Current thrusts in global accreditation and assessment of engineering programs. Philipp. Engineering Edu, 1(2):__-__.

Licaros A. 2001. Are we ready to re-engineer engineering education in the Philippines? Philipp. Journal of Engineering Edu, 1(2): __-__.

Performance Audit Report, Engineering and Science Education Project (ESEP), World Bank

Philippine Agenda for Educational Reform: The Philippine Commission for Educational Reform (PCER) Report. 2000.

Truxa J. 1998. Second call. ASEE PRISM

Vea R. 2001. Engineering research in the era of globalization. Philipp. Engineering Edu. 1(2)__-__.