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Engineering Education for the Improvement of Practice: Preparing for Labour Market

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Abstract

Technical skill is associated with understanding and proficiency in a particular type of activity, especially those that are involved in methods, processes and procedures. As an example, one can take the training of the engineer, who - mostly - is focused moreover, on calculations, simulations and projects, characterizing it as an individual, above all, objective. Since the human ability can be understood as the ability of individuals to interact with others to form similar one that respects his fellow and nature this individual is aware of his/her own attitudes, opinions and beliefs about others. Realizing the existence of other attitudes, opinions and beliefs different from his/hers, the individual is able to understand them. By becoming aware of the need to combine their technical skills (to run its specific activity) with the human ability (to develop proactive human relationship), this professional develops the conceptual ability, which is directly associated with the coordination and integration of all attitudes and interests of the organization that owns or provides the service. In other words, not technical enough to be good, if not able to understand comprehensively the meaning of the activity that is being exerted, through these three interconnected skills. This aspect is the main one in terms of engineering formation for 21st Century Labor Market for engineers. The goal of this work is to show the engineering programs developed by COPEC with the objective to form engineers ready for the present labor market. The most successful program is the one based on Scientific Research Projects.

Keywords: Labor Market; project based program; information society; social skills; curriculum development.

Introduction

Technological innovation, long a hallmark of academic research, may now be changing the very way that universities teach and students learn. For academic institutions, charged with equipping graduates to compete in today's knowledge economy, the possibilities are great. Faculty members used to teaching in one way may be loath to invest the time to learn new methods, and may lack the budget for needed support [1].

In today's technology-enabled knowledge economy, many universities find themselves facing a new challenge: how not only to equip students with an adequate education in their field of study,

but also to arm them with the skills and knowledge required to leverage technology effectively in the workplace.

Looking for solutions to fit the necessities of present work market COPEC has designed some engineering programs that have been working in different engineering schools in the country.

Education in Global World

Universities and their Schools and Institutes have suffered the impact by globalization that imposes certain needs that are absolutely new and many of them not so necessary. It is no longer a matter of using multimedia equipment in classroom but fundamentally to look for new more appropriate and captivating contents to present to new plugged students [2].

Besides all technical and pedagogical aspects it is necessary to think about psychological aspects of this great and passionate process of teaching [3]. For the good or for the evil, there it is this new socioeconomic and political world of contrasts in which only education can really change for better [4].

University Today

This is a world of no frontiers, with new complete values and different social relations. All these changes are thanks to the development of science and technology that started in the second part of 20th Century. This development has modified deeply people's life in all levels of the current "Information Society" [5].

Immersed in this scenario education institutions are challenged once more, to provide for the society the new citizen, forming the professional prepared to face the unpredictable challenges of the mutant world.

The case is that university has an important mission that goes through the centuries, from past to future, passing through present. This mission is essentially the conservation of cultural inheritance generating ideas, values and knowledge.

This same university has to defeat the challenge of present world serving the contemporary society aiming the accomplishment of its duties which is the primarily reason of its existence [6].

Effectively the present work market demands a new kind of professional, capable to think global without losing the dimension of local peculiarities and vice-versa.

Engineering Formation in Focus

Despite the efforts of so many sectors of society the present status of education in every level in western world is not yet as good as it should be. Education plays an important role in the development of peoples worldwide.

It is the key to combat ignorance and consequently the poverty.

Science and technology alone can not help. It is fundamental the growth investment in education for all. The present challenges of engineering education institutions in western world are not limited only to the formation of a professional for a global work market, but also to defeat the crises of education in which they are inserted [7].

The crucial problem is the necessity of think again the kind of education which has fragmented knowledge that drives people to an inability of articulating its several parts.

The discussions about engineering education in particular shows a lot of innovations in terms of what can be done in the classroom, in the curricula development, in labs, promotion of mobility and etc.

Education policies have become the driven force for educational reforms in national levels as in Europe where Bologna Process is shaping the high education system.

The adequacy in the several countries involved has been very interesting once the differences are very deep in many cases [8].

Similar formation in different countries, recognized diplomas will certainly create a new product - a professional with the right tools and so capable to perform in different environment which is very rich and sooner or later the world will follow the model.

History of Engineering in Brazil

The history of engineering in Brazil has its roots in the XVI Century beginning with the colonization. A Historical analysis shows visibly that it started with the military engineering, which military actions at that time in the country were basically the construction of fortifications and the seek for solutions of defense and attack evolving to what is today the civil engineer [9].

In Brazil the Portuguese style of construction can be seen everywhere and the engineering schools still keeps the European schools style obviously because of the great influence of its countries along the colonization process.

The evolution of engineering in Brazil follows very close the world trends. From the construction of Fortifications through electrical engineer to what is called today Mecatronics Engineering in the country has developed in according to the necessities of promoting its development always seeking for the best applications of sciences achievement to the local resources [10].

Many accomplishments of big proportions can be seen through the time, not only public buildings and houses but also practical applications of electricity like telegraphy, telephony and lighting.

The achievement of Electrical energy in Europe and USA shows that the insertion of electrical energy in Brazil happened in the same historical moment of industrial expansion and development of developed countries [11].

Aspects of Engineering Education in Brazil

Let's show and discuss some of the most important points of engineering education in Brazil: the beginning, the development, its current state, the impact of the globalization and the perspectives for the future. With roots in Portugal, the engineering education in Brazil has a long history of success. Regardless many critics the model has showed to be efficient and appropriate once it gives to the recent formed engineer not only a diploma, but also the professional qualifications in order to enter and to maintain in the job market.

Formation in Engineering in Brazil

Number of People concluded the Engineering Course 1999 - 2008									
Area	1999	2001	2002	2003	2004	2005	2006	2007	2008
Electrical Engineering	16.5%	16.6%	17.0%	16.1%	14.8%	14.4%	13.9%	12.3%	11.7%
Electronics and Automation Engineering	5.2%	6.2%	8.5%	8.8%	11.6%	11.8%	12.7%	11.0%	10.2%
Civil Engineering	29.5%	26.6%	25.5%	24.5%	22.3%	20.3%	18.0%	14.7%	14.9%
General Engineering	18.8%	21.5%	19.6%	21.7%	22.2%	26.8%	29.1%	31.9%	32.4%
Mechanical Engineering	19.8%	19.4%	19.2%	19.3%	16.8%	15.2%	15.3%	14.7%	13.9%
Mining Engineering	0.5%	0.7%	0.6%	0.4%	0.5%	0.5%	1.1%	6.0%	6.4%
Biological Engineering	1.9%	3.0%	3.4%	3.3%	4.8%	4.7%	4.2%	4.2%	4.7%
Chemical Engineering	7.3%	5.5%	5.4%	5.2%	6.2%	5.7%	5.0%	4.7%	4.8%
Others	0.4%	0.4%	0.8%	0.7%	0.7%	0.7%	0.7%	0.5%	1.0%
Total Engineering (Absolute Number)	18,671	25,310	28,024	30,456	33,148	36,918	41,491	47,016	47,098

Source: Ministry of Education of Brazil

The percentage of PhDs in engineering in relation to the total number of doctors in Brazil is 11.8%, similar to the percentage of Chile, Estonia, Portugal, Switzerland and France, but much lower than that of China, the international champion, with 34, 9%, or South Korea, with 24.8%. Data are from a recent study released by the OECD, "Measuring Innovation: a New Perspective".

The Engineering Programs

The engineering programs in Brazil have some characteristics, which are important to understand the formation of engineers, which so far has been successful in terms of forming good engineers.

- 5 years;
- Basic Sciences;
- Basic Sciences of Engineering;
- Specific Subjects;

- So first, basic formation in basic sciences Mathematics, Physics and Chemistry - based on the old system of Great Schools of France in engineering formation;
- Then the Basic sciences of Engineering such as: Transfer of Heating and Mass (Energy), Transport Phenomenon and etc.;
- Finally the specific subjects of Engineering.

The Basic Sciences of Engineering provide the future engineers the general formation of engineering. It is the formation of engineer before to be electrical or mechanical engineer.

At the end the student receives a Diploma that is also a professional title in other words they have also the PEE.

Evaluation System of Programs

The **National Survey of Student Performance (Enade)** evaluates the performance of students in undergraduate courses, entering and graduating in relation to the syllabus of the courses they are enrolled.

The first application occurred in 2004 and the maximum frequency with which each area of knowledge is assessed every three years.

COPEC: Science and Education Research Council

Its History started with an idea shared by some scientists of creating an organization to foster the research mainly in sciences and education. This idea seized proportions and after some meetings the Council became reality. It is a group of scientists, professors and professionals whose vision of future has driven them to start this work.

The main mission of COPEC is to promote the progress of science and technology for the welfare of the humanity.

Through its activities COPEC maintains relations between universities, institutions of education, enterprises and the society of the several countries for the discussion of sciences, technology and education directions.

COPEC - Science and Education Research Council has been very active and has developed many achievements of great importance for the Country.

It is an organization constituted by scientists of the several areas of human knowledge committed with education and the development of science and technology.

Its members believe that education is the main beam in the construction of a better society and that sciences and technology are the big agents in the fostering of progress to promote the welfare of human being.

Engineering Education Programs Developed by Copec

COPEC is an organization that develops many activities on several fields of sciences like environmental, healthy, oceanography, computer sciences and others. The group that is involved with engineering education is very active and counts with a profile of many positive achievements.

The group of engineering education researchers has developed many successful innovative programs that were implemented in different universities. Some of them were in under graduation level such as:

- Fishing Engineering
- Computer Science Engineering
- Electrical Engineering
- Environmental Engineering
- Biomedical Engineering
- Electrical and Civil Engineering

Besides the programs COPEC has implemented some other projects to foster the formation of the new engineer.

They are projects designed to serve engineering students of any engineering school of the region. The objective is to offer opportunities for students to get better experiences and enrich their formation:

- Civil Engineering Internship Project
- The Engineering Educator Graduation Program
- The Port Engineering Program

Study Abroad

In Brazil: It is a project that brings to Brazil students from abroad in a program of 15 days (can be more or less) when they have academic, social and cultural activities. It is very intensive period when the students visit 5 of the 9 cities of Atlantic Forest Region at the sea shore of Sao Paulo state, as well as visit to different industries and universities.

Abroad: It is a project that brings students to USA and Portugal in a program of 15 days (can be more or less) when they have academic, social and cultural activities. It is flexible once it is designed in according to the group needs. It is a way to provide students a good international experience.

The Formation of Engineer seen by Copec

COPEC as an organization that works for the future of education has established some guide lines to be applied on the design of engineering programs.

The guide lines are the result of researches as well experience designing and implementing engineering programs:

- The programs should be flexible;
- Have more practical activities;
- Internships as a way to provide real experience in engineering;
- International Experience.

The formation of the engineer must consider above all:

- the strong basis in basic sciences and basic sciences of engineering
- the programs should also instigate the students the willing to develop some skills such as showed bellow:

Basic Sciences + Basic Sciences of Engineering plus:

- Aptitude to conduct and implement projects
- Responsibilities for actions and results
- Creativity and innovation potential
- Mastering technologies' evolution
- Positive attitudes and behaviors
- The willing to learn all life long
- International experience
- Entrepreneurship mind
- Respect to diversity
- Communication skills
- To work in teams
- Strong ethics.

These capabilities can be instigated in the students by means of:

- new education proposals,
- exchanging programs,
- international experiences,
- double diplomas,
- internships,
- Scientific and technological initiation
- and other feasible implementation at the engineering programs.

Scientific Research Project Program

It is a program of 5 years in which the students have to develop a project in engineering since the very first year. Every year the students have to design one different project.

The main goal of this program is to show the students what it is to be engineer, which in fact is to be a problem solver. The experience of designing a project gives the students the opportunity of learning with the frustration and deal with deadlines besides the management of stress.

The main characteristic of this program is that it is extremely dynamic and appealing.

Details of the Program

- It is an annual engineering program, the disciplines are developed along a year;
- The students are challenged to develop projects since the first year of the program, one different project every year;

- Each year the students have around 9 or 10 disciplines in which one of the scores of the disciplines is given by the examining board that evaluates the project as a whole;
- The evaluation is about the work of engineering of the student, or the development and accomplishment of the project more than exactly if the project works or not; It is the commitment with the methodology of the development of the project

The development of the projects are individual, each student develops one project that is presented at the end of the year

- They have to choose a project and show it to the professor of their choice to be their advisor;
- They have to prepare the paperwork of the project and the prototype (if there is any);
- At the end of the year they have to prepare the presentation about their projects to a large audience and to the examining board constituted by 5 members the Dean the adviser, 2 invited professors being one of them from other institution and some professional from Industry.

The students have some specifications on how to present their project:

To present themselves

- Wearing suits, tie, nice shoes, hair cut, etc;
- They are advised not to show up with any kind of piercing or tattoo and etc;

To present the project

- And the prototype (if there is any) in a way that s/he shows that s/he knows what is doing;
- To speak loud and clear
- The score that they get corresponds to 1/3 of the total score of each course along the year; and it is for the 5 years.
- This program was designed and implemented in the Engineering School of Catholic University in Santos City, Sao Paulo State, in Brazil.
- It has been also implemented in Pittsburg University and American University, in USA

Expected Outcomes of the Program

The main and may be the most valuable result of this program is the quality of professionals that comes out;

In the program designed for an engineering school of a private university it is expected

- 2/3 of students to be immediately employed;
- 1/3 enrolling in academic community getting a PhD degree in different institutions of high quality;
- The students at the end of the program will have already a large experience in presenting their projects as well as speaking for an audience;

It fosters mainly some skills such as:

- -Generate new ideas, new products and new processes;
- -Create original works as a means to personal or group expression;
- -Use models and simulations to explore complex systems and issues; and
- -Identify trends and forecast possibilities-That is, to vision.

It helps indeed the formed engineers to get into the job market as well as to pursue an academic career developing research in prestigious National and International Institutions.

Final Considerations

All the programs and projects of engineering education that were implemented by COPEC team showed that it is possible to innovate and change the formation of engineers and so to provide them the tools that they will use as professional and as researcher.

COPEC understands that the programs should provide the future engineers a generalist formation and to instigate the development some skills such as: communication, knowledge of foreign languages, environmental awareness, and ethics among others in order to be prepared to face the contemporary work market in a world of no borders so extremely competitive and challenging.

Bibliography:

- [01] **World Development Indicators**, 2001.
- [02] Deba Dutta, Professor, Mechanical Engineering Director, InterPro, College of Engineering; <http://www.interpro.engin.umich.edu/>
- [03] **Compete to Win Research Report**, Gilmore & Associates, 1990.
- [04] Elaine O'Reilly, Algonquin College and Diane Alfred, Human Resources Development Canada; <http://makingcareersense.org/>
- [05] **Employability Skills Profile: What Are Employers Looking For?** McLaughlin, 1992.
- [06] Brito, C. da R.; Ciampi, M. M. Engineering and Technology Education Innovating for Growth. In: International Conference on Engineering and Technology Education, 11, Ilhéus, 2010. **Engineering and Technology Education Innovating for Growth**. Ilhéus: INTERTECH 2010.
- [07] Brito, C. da R.; Ciampi, M. M. Technological Development, Sustainability: Discussions about International Aspects of Engineering Education. In: IEEE EDUCON Annual Conference, 01, Madrid, 2010. **The Future of Global Learning in Engineering Education**. Madrid: IEEE, 2010.
- [08] Brito, C. da R.; Ciampi, M. M. Engineering Education in Brazil: Some Considerations. In: American Society for Engineering Education Annual Conference, 117, Louisville, 2010. **Advancing Scholarship in Engineering Education**. Louisville: ASEE, 2010.
- [09] Brito, C. da R.; Ciampi, M. M.; Castro, P. F. e; Harari, J. Converging Towards Sustainability. In: Safety, Health and Environmental World Congress, 10, São Paulo, 2010. **Converging Towards Sustainability**. São Paulo: OPASS, 2010.
- [10] Brito, C. da R.; Ciampi, M. M. Formation of Engineers in Present World: the Case of Brazil. In: International Society of Engineering Education (IGIP) Annual Symposium, 39, Trnava, 2010. **Diversity unifies - Diversity in Engineering Education**. Trnava: IGIP, 2010.
- [11] Brito, C. da R.; Ciampi, M. M. Enhancement of Engineering Education in a Country: Some Considerations. In: ASEE/IEEE Frontiers in Education Annual Conference, 40, Arlington, 2010. **Celebrating 40 Years of Innovation**. Arlington: FIE, 2010.