Action Plan for the Engineer Formation: Guidelines for Success

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Abstract — The most important factor of engineer formation for this era is the capability to solve problems taking into account the promotion of sustainable development. The awareness of the importance of engineers as the main beam of progress has to be recognized by the educational institutions in order to form the engineer prepared to work for the development of science, technology and society. This work discusses an important issue as the engineer formation under the perspective of the present international paradigm of education. COPEC – Council of Researches in Education and Sciences has a history of action in engineering education, conceiving and implementing projects with success. Although it is not an easy task the implementation of programs with permanent attention to the changes in world scenario concerning the political, economical and social aspects of the country and the globe is the way to assure the future of engineering as well as the development of science and technology. 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 guidelines are the result of researches as well experience designing and implementing engineering programs for many different engineering institutions.

Index Terms - competences, flexible programs, guidelines, international paradigm, sustainable development.

INTRODUCTION

In this challenging world education is becoming more and more important in men’s life once the necessity of knowledge is recognized as essential even for the simplest work. Globalization has modified deeply the world scenario and the future is unpredictable once it is not possible to foresee the big players’ next movement in such huge business game of fighting for markets. Smaller distances and real time information exchange has increased the number of people moving around, interacting with different cultures and habits and at the same time having a kind of influence. Transnational corporations are looking for new talents no matter where they are, which means more opportunities and at the same time means more competitiveness, once professionals are competing with colleagues from various parts of the world. The history shows an enormous amount of companies and engineers working in different places in the world accomplishing huge projects promoting the development of countries and societies. Now more than ever engineers should pay attention to what is going on worldwide to go for international experiences to improve personal skills and get different opportunities because nothing has more impact than personal experience.

The School has become an open space connected to the world, where knowledge and experience are shared with community. The classroom is progressing to be an environment of cooperation, where individualities are respected and all students want to share the knowledge. University has an important mission that goes through the centuries, from past to future, passing through the present. Taking into account the new education style that raised, it becomes necessary to promote changes in the way any professional is educated at the present. There is a need to break up the old paradigm of education that perpetuates the mere technocratic formation. Engineering education has become an important issue lately once engineers are important for the development of science and technology altogether with physicist, mathematician, biologists and so on.

Considering this implications there are some questions that need to be answered by educators and institutions such as: 1. Does this process of change really occur at the level of modern engineering education and training in different countries? 2. Are the engineering students aware of the contemporary skill requirements of engineering experts? 3. Does any program consider how much the new socio-occupational demands affect the professional formation of future engineers? These are very important aspects to take into account when real actions are taking place in education reforms regard to engineering programs. Although a little slowly the changes will have to happen in order to attend the demands of the 21st. Century [1].

ENGINEERING AND EDUCATION INSTITUTIONS

It is not possible the development without social promotion of individuals and society and it has become the constant search of scientists, educators and some politicians worldwide after the globalization phenomenon has started. 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.

Technological power may shift from the west to the east as India and China emerge as big players in the global market. The two countries have the size and weight to transform the 21st global economy. This aspect will certainly have an impact on the education in western world too. Although the reality is that India and China will always have an advantage in their numbers, by the other hand in western world there are the freest markets, the most highly trained workforce, the resources and ability to innovate, and the best universities in the world.

History facts show the innumerous achievements of so many engineers all around the world who have diligently built and transformed the environment to make men’s life better. The number of prominent professionals who have been referenced by their accomplishments is uncountable. Based on this it is possible to say that the formation of engineers is fundamental to keep the level of development of humanity in order to achieve the social development similar to the technological. However the present challenges of engineering education institutions are not limited only to the formation of a professional for a new global work market, but also to defeat the crises of education in which they are inserted. 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. Education must promote the natural ability of the mind to set and to solve problems and by inter-relation to stimulate the full usage of general intelligence [2].

THE UNIVERSITY

In the “Post Industrial Revolution” era that humanity is living, the main characteristics are: the neo liberal policies, no borders, complete new values and different social relations and producing system. All these policies have modified human life drastically, in a non-reversible way, in many parts of the planet. In Education field the huge challenge for the Century XXI is to prepare the new professional for the new work market. People live today in a world of no frontiers, with new complete new values and different social relations. All these aspects promote by the development of science and technology have modified deeply people’s life in all levels of the so-called “Global” society. 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 future and to be a winner.

The contemporary paradigm of education preaches among other requirements the international experience as one of the most important skills in the formation of the new engineer. The environmental consciousness, the willing to work in teams, and etc, it is a long list but the most important aspect of engineering formation is the strong knowledge of basic sciences and basic sciences of engineering because these are the tools that will enable the future engineer to perform successfully and more over it will give them the self confidence necessary to win.

For high education institutions the necessary changes are immediate. New ways and approaches to form the professional have to be implemented because the university is the institution responsible for the final product of the long educational system in any country. With weak or good pupils the mission is to prepare the engineers to work and make the world goes round using new technologies and promote the advancement of sciences.

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 viewing the future.

New World order demands a new kind of professional, capable to think global without loosing the dimension of local peculiarities and vice-versa. It is not easy to form this kind of professional although it is known exactly what is necessary. With the goal to defeat this challenge COPEC has implemented many projects in different Engineering Schools that were very challenging. They were programs that required the full commitment of the school team. Others that required substantial financial investment in new equipments but all of them were accomplished with success [3].

COPEC’S EXPERIENCE IN ENGINEERING EDUCATION

The linked world by internet has been shaping relations and ways of working where information is shared and the competence is more than ever required for any professional. It means that the knowledge is important but the capability of knowing what to do with it is essential. World organizations are the first institutions to recognize that engineers are the ones that make possible the world goes round. New competences are required for engineers and they are driving the changes in engineering education institutions worldwide. Engineering Schools have been implementing more flexible programs in partnership with industries, promoting more exchanges programs and so on. It is the education evolution in order to adequate the formation of engineers of the 21st Century.

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. Along almost 5 years 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 - it was a five years program, which main characteristic is the inclusion of extra classes specially selected as aquiculture and business management.
and the effective work in projects. The work in projects was developed in a fishing community or in fishing caught industry, supervised by a professor.

**Computer Science Engineering** - five years program, totally ministered in a traditional way with the insertion of Digital Systems course taught at distance in a first moment and lately with the introduction of Communication Systems course. They were available in punctual and non-punctual systems with tutors to help to solve doubts and intermediate the student – professor interaction.

**Electrical Engineering** - five years programs that had what was called “free period” that was a time when the students could attend classes in the several areas of human knowledge, in one of any other college department of the university. They could choose as many areas as they wanted along the five years, at least one per two years; at the end of the each period they have to present a report about their development. The report was showed and discussed with a council compounded of a psychologist, a pedagogue, an engineer professor and the coordinator of the program.

**Environmental Engineering** - five years program designed to have modular periods; the “theoretical module” and “research module”. The theoretical basis of the researches that the students developed was given to them during the “theoretical module” and the two modules happened in alternate periods. It is as follows: at the fourth year the class was divided in two groups of students half in “theoretical module” and half in “search module” and they shifted at the following period of four months. At the end of each “search module” the student’s performance was evaluated so that the following module approach could be in according to the necessities of the students [4].

**Biomedical Engineering** - five years program that included the “Challenge Cycle”, which is a period of four months at the end or in the beginning of the last two years. It was a period when the students worked effectively in a hospital or research center. A professor altogether the supervisor of the institution supervised the students’ work in part of a project. They had to accomplish their work so that another student that would replace her/him in the project could perform the next step. At the end of the program the student was a professional with full formation in electrical engineer, with strong knowledge in bioengineering, medical and health.

**Electrical and Civil Engineering** - five years program, the curriculum was elaborated in a way that the experience in “Scientific Introductory” was part of the program as a course. It is a way to form the Engineers in which the students since the first year of the program had to develop projects and to present them at the end of each year for an audience. They had also to develop prototypes of devices and show them working. Their scores were based in the design, the prototype performance and the student presentation. Every year it resulted in proceedings edited and distributed by the university.

**Environmental Engineering II** - five years program with the adoption of new courses to improve the formation of future engineer. The courses were offered along the five years of course distributed as follows: Philosophy in the first and second years; Assisted Training Period since the third year to the last one; Human Resources and Management Strategies in the third and fourth years; Development of Projects in the fifth year. The suggested distribution of the courses was conceived taking into account the considerable number of Basic Science, Basic Science of Engineering and specific courses of specific areas of engineering which were essential.

**Electrical Engineering** - five years program, the curriculum was elaborated in a way that the students had before the beginning of the classes four weeks of intensive courses of calculus (to review and to learn what is necessary to have a good performance during the first year of the program), dissertation (to learn how to write reports) and scientific methodology (to learn how to use the scientific method and propose some hypothesis).

Besides the programs COPEC has implemented some other projects to foster the formation of the new engineering. 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** – It is a partnership of COPEC with Construction Companies of the region to provide proper internships for civil engineering students. It is offered to students of 4th and 5th years of civil engineering programs of any engineering school of the region. The student is hired as assistant and s/he has the opportunity to experiment all the phases of a construction site from the blue prints to the final touches of the building [5].

**Cultural Immersion** 

a) 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 [6];

b) Abroad: It is a project that brings students to USA and Sweden 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.

All the programs and projects of engineering education that were implemented 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.
THE FORMATION OF THE ENGINEER

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.

The formation of the engineer must consider above all the strong basis in basic sciences and basic sciences of engineering and the programs should instigate the students the willing to develop some skills such as showed in the Figure 1.

These capabilities can be instigated in the students by means of new education proposals, exchanging programs, international experiences, double diplomas, internships, technological initiation and other feasible implementation at the engineering programs.

FINAL CONSIDERATIONS

Engineers are among the main agents of promotion of development in the world and the formation of a new kind of engineer is the priority to face the future economical and political market. Nations are recognizing the importance of engineers once they are the ones that make possible the world goes round. Engineering Schools worldwide have implemented more flexible programs, more investments in labs and equipments, promoted more exchanges programs and so on. It is the education evolution in order to adequate the formation of engineers of the 21st. Century. This work discusses an important issue as the engineer formation under the perspective of the great international organizations. COPEC – Council of Researches in Education and Sciences has a history of action in engineering education, conceiving and implementing projects with success. However, more and more it is necessary the permanent attention to the changes in world scenario concerning the political, economical and social aspects of the country and the globe. This awareness helps to develop and implement new programs in order to form the engineer for tomorrow. Although it is not an easy task it is the way to assure the future of engineering as well as the development of science and technology. 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.

Summarizing the formation of engineers should focus on the generalist formation and to stimulate in the students the capability to develop their creativity; to teach them how to use the information to improve their work as well as to commit with environment; and above all to adopt a strong ethics.

REFERENCES


AUTHOR INFORMATION

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