

## **AC 2010-1090: ENGINEERING EDUCATION IN BRAZIL: SOME CONSIDERATIONS**

### **Claudio Brito, Council of Researches in Education and Sciences**

Dr. Claudio da Rocha Brito is Professor of Electrical and Computer Engineering; President of Council of Researches in Education and Sciences (COPEC), President of Fishing Museum Friends Society (AAMP), President of (Brazilian) National Monitoring Committee of "Internationale Gesellschaft für Ingenieurpädagogik" (IGIP) and Vice-President of Réseau Carthagène d'Ingénierie (Cartagena Network of Engineering) and Organization of Researches in Environment, Health and Safety (OPASS). He is Chairman of Working Group "Ingenieurpädagogik im Internationalen Kontext" and Member of International Monitoring Committee in IGIP, Council Member of "International Council for Engineering and Technology Education" (INTERTECH), Board Member of "Global Council on Manufacturing and Management" (GCM) and Director of Brazilian Network of Engineering (RBE/SP). He was President of Brazilian Chapter of Education Society of the Institute of Electrical and Electronics Engineers, Inc (IEEE-EdSoc), Member of Administrative Committee of Education Society of the Institute of Electrical and Electronics Engineers, Inc (IEEE-EdSoc) in USA, Secretary of Santos region of SBPC - Brazilian Association for the Advancement of Science, Adviser for International Subjects of the Presidency of Brazilian Society for Engineering Education (ABENGE), Dean of International Relations of SENAC School of Engineering and Technology, Member of Executive Committee of Asociación Iberoamericana de Instituciones de Enseñanza de la Ingeniería – ASIBEI (Iberian-American Association of Engineering Education Institutions), Councilor of Urban Development City Council (CMDU) and Councilor of Economics Development City Council (CDES). He is Member of IGIP (International Society for Engineering Education), SEFI (European Society for Engineering Education), ASEE (American Society for Engineering Education), INTERTECH (International Council for Engineering and Technology Education) and RCI (Cartagena Network of Engineering). Dr. Claudio da Rocha Brito has received a B.S. degree in Electrical Engineering, B.S. degree in Mathematics, B.S. degree in Physics, M.S. and Ph.D. in Electrical Engineering all from the University of São Paulo. He is listed in "Who's Who in the World", "Who's Who in America", "Who's Who in Science and Engineering", "Five Thousand Personalities of the World", "Dictionary of International Biography", "Men of Achievement" and others similar publications.

### **Melany Ciampi, Organization of Researches in Environment, Health and Safety**

Dr. Melany M. Ciampi is Professor of Electrical and Computer Engineering; President of Organization of Researches in Environment, Health and Safety (OPASS), Vice-President of Council of Researches in Education and Sciences (COPEC), Vice-President of Fishing Museum Friends Society (AAMP) and Vice-President of (Brazilian) National Monitoring Committee of "Internationale Gesellschaft für Ingenieurpädagogik" (IGIP). She is Vice Chair of Working Group "Ingenieurpädagogik im Internationalen Kontext" in "Internationale Gesellschaft für Ingenieurpädagogik" (IGIP), Member of Administrative Committee of Education Society of the Institute of Electrical and Electronics Engineers, Inc (IEEE-EdSoc) in USA and Council Member of "International Council for Engineering and Technology Education" (INTERTECH). She was President of Brazilian Chapter of Education Society of the Institute of Electrical and Electronics Engineers, Inc (IEEE-EdSoc), State Councilor of SBPC - Brazilian Association for the Advancement of Science and Manager of International Relations of SENAC School of Engineering and Technology. She is Member of IGIP (International Society for Engineering Education), SEFI (European Society for Engineering Education), ASEE (American Society for Engineering Education), INTERTECH (International Council for Engineering and Technology Education) and RCI (Cartagena Network of Engineering). She was the first American woman who has received the title "International Engineering Educator" of IGIP.

# Engineering Education in Brazil: Some Considerations

Claudio da Rocha Brito<sup>1</sup>, Melany M. Ciampi<sup>2</sup>

<sup>1</sup> President of Council of Researches in Education and Sciences

<sup>2</sup> President of Organization of Researches in Environment, Health and Safety

## Abstract

Lately a lot of research has been done about education in Brazil and in all of areas of the human knowledge. Brazil traditionally invests modestly in the education in all levels. However thanks to the educators' efforts this has been moving forward so that even with all of the problems it has been facing along history it is still possible to form good professionals. Discussing the education particularly in engineering in Brazil, the discussion permeates the engineer formation: as professional who will enter in the job market as well as the researcher that it develops the science of the engineering and more recently the educator engineer. With roots in Portugal, the engineering education in Brazil has a long history of success. The formation of engineers follows the old French formation model and the engineers formed both the engineer of conception and the engineer of application has been successful. Although there are many critics regarding the model it has showed to be still efficient and appropriate once it gives to the recent formed engineer not only a diploma, but also the professional qualification. This work has as objective to show and to discuss about the most important points of the engineering education in Brazil: the beginning, the development, its current state, the impact of the globalization and the perspectives for the future.

**Keywords:** Global thinking; local awareness; contemporary paradigm; sciences advancement; generalist formation; strong ethics.

## 1. Introduction

Unpredictable is the future of globalization process once it is not possible to foreseen the big players' next movement in such huge business game of fighting for markets. The world has been change in such a speedy that the distances are smaller and so we have a larger number of people moving around, interacting with different cultures and habits and at the same time having a kind of influence. Enterprises are looking for new talents no matter where they are and so more opportunities and the reverse side of the same coin more competitiveness. 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 [01].

It is necessary to promote changes in the way engineers are educated at the present. There is a need to break up the old paradigm of education that perpetuates the mere technocratic formation. Following these thoughts there are some questions to be considered: 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 [02].

## **2. COPEC- Council of Researches in Education and Sciences**

The Council of Researches in Education and Sciences is 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.

The history of COPEC has started with an idea shared by some scientists of creating an organization to foster the research mainly in education and sciences. 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. Through its activities COPEC maintains relations between universities, institutions of education, enterprises and the society of the several countries for the discussion of education, technology and sciences directions. It works to stimulate and to foster the efforts to bring an international perspective in education [03].

Constitute powers of the institution:

- General Assembly;
- Deliberative Council;
- Board of Directors;
- Fiscal Council.

## **3. Present Engineering in focus in Brazil**

Sustainable development with social promotion of individuals and society has been 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 innumerable 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 [04].

#### **4. University at present world**

People live today in a world of no frontiers, with new complete new values and different social relations. All these aspects promoted 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.

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 losing 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.

#### **5. 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.

With the colonization of Brazil and the insurance Aspect of Portugal, the royal government recognized the necessity of forming the national engineer and so becoming it of crucial importance. It was made always attending the evolution of French Schools of Engineering and so in 1641 in Lisbon born the Artillery and Square Classes becoming in 1647 the Special Class of Fortification and Architecture. The Portuguese engineer Luiz Serrão Pimentel (1579-1613) managed the school and it is considered the starting point of Lusitanian-Brazilian engineering.

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.

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.

Since the Fortification Classes and Military Architecture founded in Bahia, in 1699 until the more than 200 engineering schools, engineering education has had a history of success full of many conquests and accomplishments.

## **6. One step to keep up the conquests**

There is a consciousness of seeking the best ways to keep up the conquests of education in Brazil despite the several efforts of some governments to do the contrary.

With the creation of Public Universities in the many states of the country, which have worked very well for many years, the country has achieved and has built a solid reputation even abroad also creating generations of Brazilian scientists and educators [05]. These people fortunately have refused to accept the ominous and narrow-minded neo-liberal policies for education having started a fighting to keep up the achievements already gotten and actions that help to maintain and to enhance the researches in every field of science and technology [06].

Many discussions at national level during conferences, all communication medias like radio, TV, etc took place for many years and still take place may seem to be lonely fight once economical speculations seems to be more powerful with more sharp actions world wide.

Anyway, professionals and educators of every field of science and technology have been discussing the destiny of education in the country taking into account the historical moment of the world. Certainly some of these discussions have generated some practical actions at governmental level as a response to the society that see itself as the most interested part in the issue. In Brazil in engineering and technological fields the situation is very delicate. Although the proliferation of private universities all over the country expanding the number of 3rd grade students it does not assure the increase of students in engineering and technology areas. However it is an issue for further discussions.

## **7. Distance Learning Experience – A History of more than 50 years.**

Brazilian Distance Learning Experience dates back from the 40's when two initiatives have to be mentioned as pioneer projects on distance education in the world: Brazilian government started the "Universidade do Ar" (The University of Air), which was the transmission by radio of first grade program. The target was to provide basic education for workers and people of remote places of the country. The other initiative is the one of "Instituto Universal Brasileiro" another institute that has done a very good work teaching by distance, more specifically by post. These Projects have put Brazil as one of the pioneers in Distance Learning.

During the 60's, in Brazil, emerged the "Telecurso 1º Grau" and "Telecurso 2º Grau", which consisted of classes of all courses of first and second grade, by television (Cultura TV Channel) and radio (every radio station). People could follow the content in details in the low price brochures they could buy at any bookstore.

These historical aspects of distance learning in Brazil have generated a kind of prejudice. The idea is that it cannot be good once it was dimensioned to provide education for illiterates and people with basic education although it is a good way for the dissemination of knowledge [07].

Until today many initiatives have taken place offering different types of courses trying to provide education even basic one. Many endeavors keep going not only providing TV courses but also by the internet. Many universities have created and have been offering many different programs in many levels and it seems that the prejudice caused by the past has been overcome due to the necessities of modern life style and the need for constant updating the career. Anyway, many have are opting for distance learning as a way to guarantee a specific knowledge for professional improvement.

## **8. Present Engineering in focus in Brazil**

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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.

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## **9. Engineering Education Projects 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. 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.

**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 the 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 II** – 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.

**The Engineering Educator Graduation Program** – The PEE Program offers two graduate degrees: the Master of Science and the Doctor of Philosophy. It is a very dynamic and rich program, developed in modules, following the trend of global formation of professionals, mainly to attend the need of a prepared engineering educator to act in the several different cultural environments, which mobility has imposed as a fact of life for researchers and teachers at graduation level. Not to mention the necessary new competencies of educators such as: evaluation management; development competencies; communication skills; teamwork; ethics and intercultural competencies. So this program has been designed to fulfill this lack of engineering educators.

**The Port Engineering Program** – The most recent one developed and implemented by COPEC's team, which is a program designed and implemented at Master of Science and the Doctor of Philosophy level very proper for the time and geographical region once there is the largest seaport of Latin America [09].

## 10. 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 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.

All the programs are customized and the students receive a diploma with hours that can be used as ECTS in their University of origin [10].

## 11. The Formation of the 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 [11].

- 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 bellow:

**Basic Sciences**  
+  
**Basic Sciences of Engineering**  
+

- 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, technological initiation and other feasible implementation at the engineering programs.

## **12. Final Considerations**

The mission of Education is most of all, to 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. This general intelligence is the human capability to deal with problems viewing the global aspects that surround it. So it is the global and the complexity that are now more than ever evident in our lives. The educational institutions are redefining its rule in present society and so it became necessary the adoption of new approaches. New programs have been conceived, new laboratories and so on.

Education comprehend the process of teaching/learning that happens not only inside a classroom but in any opportunity when the knowledge (whatever it is), is transmitted from one source to a

receptor. Real learning happens when the mind is capable to situate any information in a particular context and if possible, in the universe that it is inserted. The fragmentation of the complex world in separated pieces, breaks up the problems restraining the multi dimensional aspects and it has as result the decrease of the possibilities of comprehension and reflection, eliminating the opportunities of real learning. The science has developed itself in this kind of knowledge fragmentation, generating the super specialties, divorced from the global context that they are part, atrophying the ability of integrating and evaluating the issue in its context. There is a loss of long-term prognoses, which has a straight incidence in the decisions and choices, when they are necessary. The New World order demands a new kind of professional, capable to think global without loosing the dimension of local and vice-versa. It is not easy to form this kind of professional although it is known exactly what is needed.

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.

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.

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