

## **Research as integrated part of an Engineering Curriculum**

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### Abstract

This work is the description of Engineering subject that has been named “Scientific and Technological Training Program” as integrated part of the Engineering Curriculum. This is a scheme of Education, which the students have a group of subjects that will give them knowledge and skills to be not only good Engineers but also to be good researchers. This subject is the master line of the Program because it is around this one that the other subject gravitates. This is the main goal of this Project to form not only Engineers but also good researchers. This is extremely important to the advancement of Science and Technology. During the program the students have to develop projects of Engineering since first year. The projects must be conceived, developed and applied individually. The students can also have a Professor/advisor to help them. They present their works in a Congress that takes place every end of school year. The development of projects added by lab works provide them at least five projects of experience that means a good skill as researchers too. To increment the course the coordinating team decided to create the “Preliminary week ” to the beginners. The course occurs before the classes start. It takes around fifteen days classes that give the students a better basis of some subjects that will help them to have a better performance during the Engineering course. The experience acquired in this Project has given more information about what needs to be changed in the several courses for the future years.

### I. Introduction

Lately there is an incessant demand of new technologies and work methodologies. In this sense education becomes the main point of qualification. This society of information, knowledge is the propelling machine of development and the change of paradigm. Qualify people for this new producing process leads to the education quiz. It is a fact that education system is selective and expensive in some Countries including Brazil. Even though in underdeveloped countries that obsolete practices of domination and the use of routine disconnected work are very deep-rooted, the new purpose of work organization points out to the necessity of wide and integrating knowledge, which is possible to get only with a good qualification. This is the main characteristic of this intense process of competition all world wide that changes the formation of enterprising and autonomous people, distinguished of environment where a vast unqualified labor was an strategic advantage<sup>1</sup>.

For the new mutating work market of next century the new professional has to have some extra abilities to be able to compete in the era of global economy. Taking it into account the SENAC School of Engineering and Technology has developed a scheme of education that the students have to develop projects since first year of the course. The projects must be conceived, developed and applied individually and they are showed in a Congress that happens every year around November. This is a new kind of education that has been named “Scientific and Technological Training Project”. The projects added by Lab works provide to students at least five projects of experience that means more research skills, self confidence and leadership habits.

As described above the Project has as the main goal to overcome the challenge of forming professionals of engineering and technology to get a good performance and also to contribute for the development of research in Brazil. Besides the experience acquired in this Project is going to give more information about what needs to be changed in the future programs of technological fields.

## II. History of the Electrical Engineering in Brazil

The first practical applications of electricity were telegraphy, telephony and lighting. Since then, the use of electricity has multiplied quickly and electrical engineering has unfolded in many specialization areas. Besides the traditional areas there are those, which have originated from electrical engineering, like computing, process control, automation in general and many others of modern engineering.

The first installations of telegraphy in Brazil occurred in 1852. The first telephone line was installed in 1878. The first cities installed public lighting with incandescent lights were Campos - Rio de Janeiro State, in 1883 and Juiz de Fora – Minas Gerais State, in 1889.

Electrification in Brazil started in fact in Juiz de Fora, in 1889 with the first Hydroelectric Mill of Brazil and South America, the Mill of Marmelos. Eleven years after that, in São Paulo State was installed the Mill of Parnamba and so it started to count with a permanent public service of a hydroelectric mill. The São Paulo Light Co. as it was known has begun a new phase in this history. Between 1905 and 1908, in Rio de Janeiro, the Rio de Janeiro Tramway, Light and Power Co Ltd. Has built the Mill of Ribeirão das Lages. These facts and the Mill of Cubatão – São Paulo State mark the beginning of electrification in Brazil.

An analysis of electrical energy conquests that were realized in USA and Europe shows that the insertion of electrical energy in Brazil happened in the same historical moment of industrial expansion and development of developed countries. And in parallel, electrical engineering in Brazil has emerged and developed. The Mill of Parnamba had the capability of 2.000 kW, amplified later to 16.000 kW transmitted to São Paulo from a distance of 33 Km, under the tension of 24.000 V that were later raised to 40.000 V.

As Brazil has become in one of the biggest market not only of equipment for generation, transmission and distribution of electrical energy, of electrical equipment for industries, but also

the lighting and the use in buildings and residences so a powerful industrial park was installed to supply the sector. Once more Brazilian electrical engineering was involved and has found new opportunities to improve.

In the last 40/50 years, Brazil designed and built, essentially with its own engineering, some of the biggest energy generation systems, ever built in the world, like hydroelectric complex of “Ilha Solteira”, “Itaipu” and “Tucurum”.

So the education institutions in the main cities of the country has started to offer electrical engineering programs. Some of them have adapted the German model of Polytechnic School of Zurich. And most of them still follow this model.

The relevance of the History of Electrical Engineering in Brazil resides in the fact that it is also the History of Engineering Education in Brazil <sup>2</sup>.

### III. SENAC São Paulo

SENAC São Paulo has the main motivation the improvement of knowledge, experience and education technology.

SENAC São Paulo is one of the best-equipped and complete private educational centers in the country. Founded in 1946, the organization is, nowadays, reference in the field of knowledge in the Commerce and Services industry, the experience gathered over the years allows to offer a wide variety of products and services <sup>3</sup>.

It offers a busy agenda of programs and services through its more than 50 Educational Centers spread throughout the state which was complemented 1992, by the inauguration of the SENAC São Paulo Publishing House and in 1996, by the SENAC Television Network.

Being a dynamic and modern Organization with its mind set on the future, SENAC São Paulo has established renowned National and International partnerships in its quest to generate up-to-date knowledge and information in Commerce and Services for the 21<sup>st</sup> Century.

### IV. The Engineering and Technology Program

The goal of this kind of education is to make the curriculum structure adequate and suitable to assure the students a good professional performance and the ability to face the challenges of future world.

A high level of education is a consequence of a good faculty, researchers, technicians as well as the high level students who are rigorously selected. Besides the good material conditions which includes Libraries very well equipped as well as the Labs and Internet access, the Professors can also count with all sort of extra equipment they eventually need for classes.

Good quality courses are the main reason why the SENAC School of Engineering and Technology is one of the best in the city.

#### V. Scientific and Technological Training Project

This Project consists of the union of a high academic process with a strong emphasis to the activities of "Scientific and Technological Training Project" offered to the students in the Labs of the SENAC School of Engineering and Technology. This will provide considerable benefits not only to the students but also to the engineering and technology national scenery and the enterprises, which are the main clients of the institutions of education <sup>4</sup>.

As mentioned before every project developed by the students during the year are presented in a public section and to three Professors, specialists who evaluate the works. The section is presided by the Coordinator/Professor and the approval of the work is necessary condition to the approval of the student for next year, for this course. The projects are also included in Proceedings of the Congress which are distributed to the students and faculty and some segments of the Academic Community <sup>5</sup>.

The students are stimulated to assume more responsibilities and so they have to work hard to ensure the good score for their works.

Besides the project of "Scientific and Technological Training Project" the students also have the other works of the other courses to do.

The Project or the introducing of this new method was planned considering the following aspects:

- The Global Economy which has an incidence straight in Education, with the fall of the boundaries and the exchange of ideas, technologies and culture;
- the new work market that is emerging because of the advanced technological achievement;
- the technological transformations principally in transport and communications that are approaching the distances;
- the changes in the entire Producing System;
- the consequent changes in the work relations;
- as well as the consequent social transformations that have been promoting deep and strong changes in human relationship;
- the Educational Policy of the Country;
- the historical and political moment of the Country and the fact that we are a "developing country";
- the geographical situation of the region São Paulo the capital city of São Paulo State, the most industrialized State of Brazil;
- the material and human resources available in the SENAC School of Engineering and Technology, which includes the good Labs and a very good staff of Professors and Technicians, and of course the students.

The students are selected by the "Vestibular", a selective exam to get into technological fields.

## VI. The Congress and the Preliminary Week

This is a process of integration of theory with the practice because since early, in fact since the first year, the students have to concept projects. They have to propose, to develop and to get the conclusions in according to the proposition. The projects are presented in a Congress that happens every year and some invited Professors evaluate together with the professors of the program all the works <sup>6</sup>.

The curriculum was elaborated in a way that the experience in what is called "Scientific and Technological Training Project" is part of the program as a course. The main objective is to decrease the conflicts between the academic learning and the use of knowledge.

This course provides the students the theoretic and practical knowledge qualifying them to incorporate the knowledge of the areas of engineering and technology in the process of creation of project <sup>7</sup>.

This new scheme of Education mobilizes the whole Institution and so it was created a "Scientific and Technological Training Project" Congress for all students of engineering and technology to show their projects to the Academic / Scientific and Industrial Community <sup>8</sup>.

For the first year of the program of technological fields an extra curriculum week was included. It was named Preliminary Courses. It happens during the weeks before classes start and the students have some courses that will help them to have a better performance during next five years.

The courses were chosen considering the necessity to provide the students a stronger basis to assure a better performance during the program.

To get this goal the following courses were chosen:

- Creativity;
- Engineering and Technology History;
- Calculus Introductory;
- Human Resources;
- Scientific Methodology.

The respective specialists have elaborated the contents of the courses in according to the proposition. The classes are as much as possible more practical than theoretical. The group makes an evaluation of the contents as well as a self-evaluation that are part of the objective of developing their critical spirit.

## VII. A Flexible Curriculum

A flexible and more dynamic curriculum was conceived, just to accompany the quickness of the changes in the several areas of science. So a new strategy of organization of the program was adopted because of the growth necessity of constant reorganization of the curriculum <sup>9</sup>.

To get this goal the curriculum was created so that it is possible the constant adaptation to the necessities of the economy, industry and the society <sup>10</sup>. Then some concerns have come up and the items are listed below:

- attention to the changes of professional practices;
- the courses tend to a generalist organization so that it is possible to face the quick mutations of knowledge;
- logical coherence between the contents of basic disciplines and the specific necessities of engineering and technology program;
- and above all the radical renewal of unnecessary repetitions.

Another preoccupation has been the didactic adequacy of scholar practices and the conditions in which the process develops.

This adequacy was tempted by means of:

- the student has to feel himself a student of technological field since the beginning introducing technical courses since first year of the course;
- permanent attention to the students;
- appropriate locals for studies;
- Library.

Added to this, every student has an advisor who supervises his Scientific / Technological Training Project until the presentation at the Congress.

### VIII. Some Results

In Brazil there are presently 160 Engineering Education Institutions and around 9% of students that finish University every year are engineers <sup>11</sup>.

Although Engineering is a very respectable profession it is not one of the favorites because it is also the most difficult program. Besides students prefer medicine and law, which are still the most attractive professions in terms of social status and achievement of money. And there are also those ones that are up to date like Management and Marketing.

The following numbers refer only to the first class, which started this new kind of engineering education. The goal is only to give an idea of how it is to have a special program at least when it begins. As it is a new program with a special approach, it is not possible yet to have a statistical based in ten or more years of classes.

Around 60 students have started the engineering program and 9 were women.

For second year there were 23 students and 4 were women.

For third year there were 7 students and 2 were women. This number has been the same until last year of the program.

It is a very small number of students but they are the best ones in a way that all of them have already received good purposes of big companies.

## IX. Conclusion

Although it is not easy to picture the future, it is a general asset that the new professional have to be prepared to be more and more enterprising once jobs are decreasing and competitiveness is increasing quicker than ever.

Attempted to that the SENAC School of Engineering and Technology provides the future professional a wide formation involving the several areas of technological knowledge. This achievement is due to a new process of learning where the student is absolutely involved and committed with the conception, manufacturing and appliance of projects along the program.

At the end of the program S/He becomes a highly specialized professional, who is used to leadership situations, with administration and management skills besides the reasonable experience in the development of projects achieved during the course.

The success of this project was so good that it has inspired the coordinating team to develop another special kind of education following the same philosophy for a new program that will be working in a near future. Besides this project has been contributing to the discussions and development of engineering education in Brazil, once it has become a model of education suggested by ABENGE – Brazilian Society for Engineering Education.

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