Continuing Enginering Education – A Twenty-Year Experiment and New Challenges in Engineering Education in Brazil

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Abstract- *The southeast of Brazil is highly industrialized remarkably São Paulo State, with a high demand for engineer formation and employment. The Escola Politécnica is over 100 years old and belongs to University of São Paulo, one of the three state universities of that State and also one of the best universities in Latin America. Since 1976, Escola Politécnica has offered courses to graduates, in a continuing engineering education environment. These courses have been very successful and, from this success, the increasing offer of similar courses by other institutions, both state and private justify an analysis of this experience. The current text describes its characteristics, organization and operation schemes and its particular context in Brazil. Nowadays, new challenges are turning up in this activity, and some of them are also briefly presented and discussed in this text. One of them is the discussion about which new topics must be introduced in undergraduate courses or must be left to a later specialization – the engineering graduation course role itself, whether it must be basic and generic or it must include specific topics, is in discussion here. Another big challenge is the course quality, the obvious necessity of the incorporation of quality concepts and the possibility of the use of ISO 9000 or similar. A third challenge is the distance learning, a very serious problem in a country with continental dimensions like Brazil, with very different degrees of development and infrastructure in its various regions. Even with these peculiarities, the experiment analysis can be useful to other developing countries in similar conditions.*

Basic Context

Although perhaps better worldwide known by the Amazon forest, carnival and football, Brazil is far more than this. It has 8.544.404 km 2 of territorial area, a population of 161,8 millions inhabitants and a significant economy. As shown in Table 1, Brazil's Gross National Product (GNP) in 1996 was the 7th of the world and, with a 3% estimated growth in 1997, remains in this position. In GNP composition, 13% corresponds to agriculture, 39% to industry and 49% to services, with a profile that approaches those of developed countries. Related to international commercial exchanges, in 1995 the exports reached US$46,500 million and imports US$49,600 million; it is estimated a growing to 1996, with smaller deficit. In this commerce, the MERCOSUL (economic block with Argentina, Brazil, Paraguay and Uruguay) importance is growing, representing now about US$14.000 million, and manufactured products correspond to 60% of the exports (which means the presence of technology / engineering).

São Paulo State, one of the 26 Brazilian states, has an area of 248.809 km 2 and 33,7 million inhabitants. Generates 35,6% of Brazil's GNP, concentrating the most important industrial park of Latin America and the economic, scientific and technological forces of the country. The main campus of University of São Paulo (USP), created in the 1930's, is located in São Paulo City, the state capital, with about 10 million inhabitants.

Table 1 - GROSS NATIONAL PRODUCT
1996
(US$1,000,000.00)

USA	6,648,013
Japan	4,590,971
Germany	2,045,991
France	1,330,381
Italy	1,024,634
United Kingdom	1,024,634
Brazil	555,587

There are approximately 240,000 registered engineers in the State, most of them graduated in schools here established. The engineering courses in Brazil are five years long, with curricula inspired by the European model and structures similar to the north American credits model; as so far, there are significant level differences between different schools. Among the great majority of the engineers, still there is not the habit nor theawareness of the need to continue studying after graduation. Moreover, similarly to what is occurring in developed countries, industry automation and the search for efficiency is nowadays making unemployment growth, also among engineers.

Escola Politécnica, founded in 1893 and integrated to USP at its foundation, constructed its name as the most important engineering school of the country, in undergraduate and graduate (M.Sc. and Ph.D. levels) courses, and one of the best in Latin America, being worldwide recognized. The information presented up to now describes the context in which its activities in Continuing Engineering Education were developed, initiated from 1977

and covering the following main areas: Automation, Chemistry, Civil Construction, Computation, Electricity, Electronics, Hydraulic and Sanitary, Mechanical, Metallurgy and Materials, Mining, Naval, Production, Structures and Foundations, Transportation.

Experiment 1978-1994

Escola Politécnica began its CEE activities in 1976, but the organized course format was established in 1978. Since then, about 1,800 short duration courses (called "professional update courses") have been ministered, involving approximately 338,000 matriculations. These courses are normally offered at night, which is convenient to the engineers that work during the day; at this period, the classrooms and the laboratories are also more available. The classes are ministered at the campus of Escola Politécnica, located 10 km far from downtown. There are a lot of free parking areas, but the access to campus, very easy at first, has been affected by the frequent traffic jams in the city.

Typical courses

- 30-hour course (3 hours/week, 10 weeks)
- 26 students/course
- matriculation fee 300 USD/participant-course
- pro-labore 2,000 USD/teacher-course

Management and bureaucratic procedures

- The CEE courses management was provided by a Steering Committee and its Chairman, with the help of a secretary and some clerks. New courses were suggested by professors, members of the Steering Committee or outside engineers. In some cases, they were requested by Companies or Government Agencies. Suggestions were usually accepted, courses were prepared and announced, but they ran only if they had enough applications. As the costs were low, the break-even point was set to 5 students per course.
- Four set of courses were offered per year and there was a publicizing effort preceding each offer. Brochures were printed and mailed to a 40,000 address mailing list and, until 1990, a half-page paid advertisement was published by the most prestigious São Paulo newspaper.
- Applications were accepted, with no requirements or complicating procedures, by mail, fax or telex. Course were really open, and candidates were only warned of difficulties that they could face if they did not have a minimum level of knowledge or training. Course material, texts, computer hours and use of laboratories were included in the fees. Participants received a conclusion certificate from the University stating if they passed an examination, or how many course hours they attended.

Financing and operation

- The program was 100% financed by fees payment, not requiring any subsidy but, even allowing "pro-labore" payment to teachers, member and the Chairman of the Steering Committee, left some money to be used by the corresponding Department.
- The program was operated by FDTE - Foundation for the Development of Technology and Engineering, to simplify the management of the courses, independently from the heavy activities related to routine academic management.

Present Situation

The program was very successful in the 1980's, reaching almost 3,000 participants-year, but there were only few over 600 participants in 1994. Several factors contributed to this:

- the economic crisis in the country;
- the competition of other institutions, that also began to offer CEE courses;
- poor (or no) marketing, using the same 1980' mailing list without updating the addresses and stopping to publish newspaper advertising;
- decrease of the quantity and quality of the courses, mainly due to the low teacher's and Steering Committee's pro-labore: the very high inflation, reaching 100% a month, transformed the nominal 2,000 USD at the course's start in less than 800 USD at the course's end.

Then, in 1994 PECE - Continuing Engineering Education Program was established, to give a new and strong impulse to these courses. The main changes were of two natures: improve the organizational aspects and turn the program's development strategy to a national and international range.

We already had 2,500 participants in 1997, with high satisfaction level. The main improvements and new challenges are:

Organizational aspects

- Typical courses: The short-duration courses ("updating courses") remain, but the emphasis is given to specialization courses (more than 360 hours), organized by modules, where each module is an updating course. The matriculation fees and teacher's pro-labores are compatible to market levels. Other priority is the organization of "in-company" courses.
- Management and bureaucratic procedures: The management is provided by a General Coordination, helped by an Area Coordination Committee and a clerkship. Marketing and the publicizing are made with the support of specialized companies, paid by the program; it includes publicizing and identification of new interesting courses. All the bureaucracy is kept at the strictly necessary, and there are investments in computer systems to achieve this objective.

Program range

- The courses are better achieving the interest of participants; less courses failing to run because of few applications.
- Courses in some other cities, in São Paulo State, are being organized.
- Two specialization courses ran in Maceió, the capital of Alagoas State, and Manaus, capital of Amazonas State.
- There is a project to develop "Long Distance Courses", using modern technologies.

Quality

The concepts of "client satisfaction" and "total quality" must not be ignored in the courses. We are developing a quality program covering the courses' infrastructure, using ISO 9000 standards. But it is not easy to work with these concepts in an academic environment, where the idea of the relationship "student x professor" is very different from the relationship "client x supplier". We believe that the critical point is to consider the participant as a student, and the key is to see this person as a colleague, a professional working together with the instructor in a professional situation.

Undergraduate x Graduate Courses

A tendency in Brazilian engineering undergraduate courses is to include, in the curriculum, ever-new technological development, in part because the legislation guarantees the graduate the right to professional activity. This is a tendency, but it is clearly impossible to do it successfully and to maintain the course in a reasonable duration and depth level. It is necessary to carefully discuss this point and the present legislation. We believe that an undergraduate engineering course (as already occurs with medicine and law courses) must just provide the basis of engineering sciences, not (or few) specialization. It must allow the person to specialize and update the knowledge and skill after graduation, when her or his professional career is better defined. In this context, the role of continuing education becomes very clear.

It is interesting to observe that courses, which include management topics for engineers, are much more popular that other with technical topics only.

The Future

- Contribute to the discussion on the role of undergraduate and graduate course in engineering.
- Develop the program in a "long distance" context, covering all the country and MERCOSUL (an economic block including Argentina, Brazil, Paraguay and Uruguay). It is very important to focus adequately the problem here, avoiding "technological hysteria" – the question is "which are the more adequate technologies to use in this course" and not "how to organize this course using teleconferences and Internet".
- Organize at least one specialization course in each area covered by the Departments of Escola Politécnica.
- Improve the contact between Escola Politécnica and industrial sectors, catalyzing the collection of more resources and the realization of other activities.
- Contribute to continuously improve the quality of the courses offered.

Final Remarks and Conclusions

- An Engineer in her or his career often shifts from technical activities to more managerial roles, and need to develop corresponding new skills. On the other hand, managers of technical areas needs to know the new technologies related to her or his field. In both cases, CEE courses may be helpful and must see to these needs.
- Fee payment seems not to be a major issue. Many companies pay the fees for their workers. In any case, the "quality" of the course seems to be the most important – it must satisfy the participant, at least.
- The payment of teachers and staff is very important. A special "volunteer" organization may be successful, but a badly paid one certainly not.
- Marketing and publicizing are indispensable; it is not sufficient to be a famous institution.

The experiment here described clearly indicates that a successful CEE program must be competitive, operating with quality and really meeting what the client needs or desires. The "Long Distance" (teacher absent) pedagogic technologies are one important key to growth, as the traditional classroom scheme seriously limits the program action possibilities.