

Engineering Education Focusing Improvement on Quality of Life

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Introduction

Engineering education in Brazil has been focusing on technical learning separate from its role in the improvement on quality of life, and human relations.

The development of engineering knowledge has been responsible in great part for the increase in the life expectancy and the health of the population, in the last century. Examples of the role of engineering in the improvement of life are: the activities in the area of sanitary engineering and the design of equipment that permit earlier diagnosis of illness as cancer and others and that permit microsurgery. Presently, if we have the opportunity to watch microsurgery, we have the feeling of being in an industry's control room, except for the fact that the subject under control is a human being and the professional working on it is a doctor and not an engineer.

In the specific case of Brazil, sanitary engineering has an important role with respect to the population's health. Until now, there has been a significant number of poor cities that do not have the use of appropriate sewer systems, drinking water or waste disposal. In these cases, simple engineering projects such landfills can improve people's health as well as the environment. These facts are a result of the difference of income in the country and engineering students are not well prepared for this reality.

As mentioned before, Brazilian engineering curricula do not focus adequately environmental protection and control issues that are linked to the technical subjects learned by the students. A typical example of that are the Civil Engineering Curricula that, usually, has been focused on the structural engineering area. In spite of the importance of this area there is not an adequate balance between this area and others such as hydraulic resources, transportation, environmental, sanitary, etc. [1].

By extension we can report the same behavior in the other graduate engineering courses in Brazil. Even if the curricula have some environmental classes, the contents are presented separated from other technical subjects of the course and, usually, the student is not able to connect,

himself, these concepts. An example of that is observed in the Mining Engineering Course. In this course the students learn about the methods of mining in their seventh semester and only in the last semester (the tenth) will they touch on environmental protection in mining [2]. Another example is the understanding by the electrical engineering students about the pollution caused by telecommunication. It would probably be easy to find a student that knows every thing about this technical subject but very difficult to find one who knows about its impact on environment.

Besides the environmental issues discussed above, the engineering curricula in Brazil do not pay attention to liberal education. This fact does not agree with the reality of the engineer's job. It is known that engineers do not assume positions of leadership early on in the industry or get jobs in business. In both cases, it would be necessary for the engineers to have abilities in human relations and the understanding of the social context of the country.

Due to all the facts previously related, the Engineering School at the Federal University of Minas Gerais State has been working on its engineering curricula in order to respond to the present demand for engineers aware of their social and environmental responsibilities and able to develop better human's relationship. It is what the UFMG has defined as an engineering education focusing the improvement in the quality of life.

The Engineering Curricula: Present and Future Perspectives

The engineering curricula in Brazil are regulated by the Resolution 48/77, from 1977. Only last year, twenty years later, the government has created a new law for education. At this moment, professors from all the areas of knowledge are working developing new guidelines under the law, in order to give superior studies more precise direction.

The main difference between the law from 1977 and the present law is the autonomy given to the Colleges and Universities to develop their own curricula. Only the

independent faculties will necessarily follow the guidelines that are being developed.

The Resolution 48/77, in force until now maintained a relatively modern and concept of curriculum but it has not been very well applied by the engineering faculties. It divided the curriculum in three parts: basic education, general education (both common for all the engineering courses) and professional education, as follows:

- the basic education included disciplines in the areas of mathematics, physics, chemistry, statistic, computer science and some engineering sciences;
- the professional education included: **a)** disciplines that in spite of their professional contents are, even so, considered as general education for engineers, for example: geology for Mining Engineering Course, electrical circuits for Electrical Engineering Course, etc.; **b)** specific disciplines, such as underground mining for the Mining Engineering Course and Civil Construction for the Civil Engineering Course;
- the general education included disciplines in the area of the humanities, social science and environmental science, of interest in this paper.

In spite of the Resolution being presented as flexible, and having caused deep changes in the engineering courses, it established a minimum of 3600 hours for all the engineering curricula and in some cases established a minimum of hours per discipline, now viewed as excessively rigid. This fact was responsible for a homogeneity in the Brazilian curricula because the Resolution did not take into account the differences of the student's profiles or the goals and infra-structure of the individual colleges and universities. As a result of this experience it is possible to observe the difference between the curriculum as it is proposed and how it is implemented in practice.

The Resolution 48/77 did not establish a minimum of hours in the curricula for non-technical disciplines, leaving the decision to each educational institution. The superior educational institutions did not realize the importance of these non-technical subjects in the engineering education and usually have dedicated no more than few credits to these areas. For example, the engineering courses of the UFMG that have 4000 hours on the average (except by the Metallurgical and Electric Engineering Courses) have the maximum of 90 hours (2,3%) of classes in the humanities and social science areas.

The situation in the area of environmental science is better but does not achieve the ideal condition. Using again the UFMG as an example, the engineering students of all the undergraduate courses have the minimum of one course, as established by the Resolution 48/76, of 30 hours in environmental protection. However, with the increase in the

demand for environmental knowledge, some engineering courses are offering elective courses in this area. The problem caused by this situation is the increase in the total number of hours in the curricula and lack of connection to the integration between technical and environmental issues.

Since the discussion about engineering education was motivated by the REENGE Program (Reengineering the Engineering Education Program), at the end of 1995, it became clear to the colleges and universities that the engineering courses in Brazil are very extensive. It has been detected that parts of the curricula are constituted of very specific technical subjects that could become obsolete in a short time and could even be eliminated. Presently, many faculties are working to decrease the number of hours of their curriculum. The minimum of 3600 hours established by the Resolution 48/76 is now part of a discussion involving the Ministry of Education and the Faculties.

In fact, the problem presented to the institutions is: how to increase humanities, social science and environmental sciences in the curricula without any increase in the number of hours of the curricula? It could be expected as a solution to rearrange the technical contents of the curricula, taking off the subjects that could be easily changed with technology's advance and substituted by non-technical disciplines. However, we have observed that, in practice, it is very difficult to convince the engineering professors that their disciplines could be substituted by others, creating an advantage for the engineer's education. As related by the head of the Department of Electrical and Computer Engineering of the Carnegie Mellon University, Professor Robert M. White, in a reporter about the changes in the computer engineering curriculum [6]: "...well-meaning faculty working hard to give students the best, most thorough view of as many topical areas as they could usually with the assumption that this was the only opportunity students would have to see the material".

The UFMG Proposal for a New Engineering Curricula Focusing the engineer's Work on the Improvement of Quality of Life

The REENGE Project of UFMG included three sub-projects that had as a goal to increase, social science and environmental sciences in the engineering education, as will be presented bellow

The increase in social science issues

In the area of social science the project included not only an increase in the number of courses but, principally, to teach the courses in the Faculty of Humanities and Social Science of the UFMG. The project took in account the importance of to expose the engineering students to the environment

experience by students and professors from other areas of knowledge such as philosophy, psychology, law and so on.

The experience with the sociology classes, thought specifically for engineering students at the Engineering School, has shown that the professors designated for these classes are very unmotivated, as their designation had been a kind of disqualification. On the other hand, the engineering students make mistakes thinking that social science and humanities are not important in their education and that the jargon of these areas need to be translated to engineering jargon to be understandable to them. Naturally, the professor who tries to do that has no success and the final result is one more discipline in the curricula that the students do not take advantage of.

The first experience of the REENGE project, with respect to the facts discussed above, will be held this year, with the new curriculum of the Civil Engineering Course. In the new curriculum the number of hours of social science was increased from 30 hours to 90 hours per semester. The Faculty of Humanities and Social Sciences made available some space for engineering students in 19 of its regular courses. The courses are distributed throughout a large number of Departments and the students must choose three of them.

Although the increase in the social science contents in the new curriculum of Civil Engineering did not achieve that recommended by the American Society for Engineering Education in the Grinter Reporter, in 1956, it signified an important change in the engineering education in the UFMG. The faculty's members of the Engineering School have the expectation that in a short period of time engineering students will feel the importance of non-technical subjects in their education and probably will ask for elective disciplines in the Faculty of Humanities and Social Sciences.

Another project incorporated to the new Civil Engineering Course curriculum as part of REENGE, was a different kind of trainee program, involving the social role of engineering and its practice. In this trainee program students from the last year of the course and professors go to poor towns of the Minas Gerais State, helping the local government to improve the quality of life through basic engineering projects and an environmental education program for the poor population. During their first visit to the cities, students and professors confirmed their expectation that the main problems in these cities were located in the areas of sanitary and environmental engineering, as well as small construction with low costs and rebuilding.

In the old curriculum the areas commented upon before were not part of the general education of the civil engineer. They were taught in the end of the course as an elective, with a higher number of class hours. Because of this the student that had not chosen the emphasis in areas such as

environment, had little knowledge in this area. As a consequence of this fact it was necessary to prepare the students for the trainee program. The students had taken additional courses in sanitary engineering, environmental science, low cost construction, etc., as well as classes of the psychology of human relations.

This situation reinforced the previous conclusion of the faculty members that it was necessary to change the Civil Engineering curriculum in order to incorporate all the civil engineering areas as part of the general education. In the new curriculum the student has the opportunity to get a broad knowledge and in a smaller number of hours.

Since August of 1996, the students and professors are assisting 12 towns in the Jequitinhonha region, the poorest in the State, and it has been a successful program. After one year of the program the Engineering School was asked to assist more than 20 other towns.

The opinion of the students that participated in the program is that it gives them the opportunity to see and to solve practical problems of engineering, to develop their creativity, leadership, human's relations and to understand the social role of engineering activities. Besides this the program could detect that there is a lack of engineers in the rural regions. It means new perspectives of jobs for the younger engineers. As an example of this reality one of the students that participated in the program received a proposal to work in the city that he assisted.

The good results obtained in this experience, in the Civil Engineering Course, are motivating the other courses to implement the same project as expected by the Reenge of UFMG. It is important to point out that the new conception of the Civil Engineering Course reaches 200 students per year.

It is interesting to observe that some developed countries are trying to insert into their curricula trainee programs like this, in the sense of developing the ability in human relations and presenting the students social realities that they never had seen before. It is the case of a program called the Human Contact Program that has been developed at the École Polytechnique in France. The program involves four weeks of student work in industries or in poor cities, in other countries such as India or the countries in East Europe.

The increase in the environmental science issues

With respect to the improvement on the environmental science in the engineering curricula the REENGE of UFMG has as a proposal to link the technical subjects of the courses to the environmental protection and impact issues.

The first proposal was to insert the environmental concepts in the contents of some courses, which could be taught by the professor of the discipline or by professors from the Department of Sanitary Engineering and

Environment (DESA). The professors from DESA have different backgrounds, such as in Chemical, Civil, Metallurgical and Electrical Engineering, that permit them to be more comfortable teaching all the engineering courses.

In order to check the acceptance of this proposal and to design a final format of the project, the environmental team of REENGE made an extensive list of questions to be answered by the professors. The form included questions such as the role of environmental issues in the technical context of the course, if the professor teach some environmental aspects related to the subject of the course, if he wants to be prepared to teach the environmental aspects of his course or to share the course with a professor from DESA and if in his opinion it is better to introduce environmental concepts in the existing courses or as independent courses.

The major part of the professors approved the idea to insert environmental aspects into the existing technical disciplines and to add an introductory environmental course. Presently the team from REENGE are finishing the final design of the project with respect to the practical aspects of its implementation.

Final Conclusions

The UFMG project of REENGE has shown that is possible to focus the engineering education on the improvement on the quality of life. The new Engineering Civil Course curriculum is an example of that. The changes in the curriculum to achieve this goal were based on the increase of the liberal education and environmental science issue.

It is a challenge to incorporate the liberal education in the curricula, after more than 20 years of having an engineering education focusing on the technical aspects. It demands, necessarily, a critical analysis of the curricula and an effort to show to the professors that there are many technical subjects in the curricula that can be substituted by the liberal education creating an advantage for the student and as a consequence for engineering enterprises.

The Engineering School at UFMG has the expectation that the engineers graduated by this new curricula will be more conscious about their social and environmental responsibilities and better prepared to assume leadership

positions in order to work for the improvement on the quality of life.

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