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ABSTRACT

This paper presents new principles and basic approaches for the curricula of engineering degree courses. The accentuated evolution of engineering, the fast technological transformations and, still, the impact provoked by government regulations in the field of education in Brazil have called attention to these issues. Following these changes, it was felt that a periodic reconstructing of the curricula for engineering courses at the University of Vale do Paraiba (UNIVAP) was necessary, especially the civil and electrical engineering degree courses. This proposal concerns two important aspects. The first one is the demand for a solid basic formation, and the second is the capacity of the program to remain in a process of permanent modernization without provoking great structural reformulation in its content during the undergraduate portion of the course. The project of restructuring the Civil Engineering Course at UNIVAP faces three important issues that cause problems in the structure of the course: (1) elevated school dropout in the first year of the course due to overcrowding groups of students in the basic cycle subjects of physics and mathematics because of lack of preparation in high school; (2) keeping the subjects and course descriptions that comprise the programs up to date; and (3) the necessity of a solid basic formation to support fast technological transformations. In an attempt to reduce the dropout rate, the new curriculum design introduces fundamental subjects with basic mathematics and physics content in the first year course with the objective of minimizing or even correcting eventual deficiencies originating from the formation of the high school course. A generous increase in the program hour of the subjects that compose the basic cycle of the course, among them mathematics, physics, mechanics, fluid mechanics, and computer initiation, is proposed. With these reformulations it is intended to alter the cycle of basic formation of the course from two to three years, enabling some basic subjects to be extended until the fourth year of the course. On the other side it becomes convenient to introduce some subjects to motivate the students in the course during the first year. These subjects can be highlighted in two parts: (1) Introduction to Engineering and Administration; and (2) Introduction to Construction Engineering. With regard to the subjects of permanent professional modernization, a structure is being proposed towards the end of the course that facilitates the student having a formation composed by modules of subjects with a focus on continuous education, allowing the student to come back to the university for new specialization or extension unit courses in later years. (Author/YDS)

New Principles and Basic Approaches for the Curricula of Engineering Degree Courses

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Abstract- *This paper presents new principles and basic approaches for the curricula of engineering degree courses. The accentuated evolution of engineering, the fast technological transformations and, still, the impact provoked by the government regulations in the field of the Education in Brazil last years have called the attention upon. Following these changes it was felt the necessity of a periodic restructuring of the curricula for engineering courses in the University of Vale do Paraíba, especially the Civil and Electrical Engineering degree courses. Other external demands, as the pressure of the labor market and the need of permanent professional modernization have accelerated the proposal for a new design of the curricula in these courses at UNIVAP. This proposal concerns two important aspects. The first one is the demand for a solid basic formation and the second is the capacity of the program to remain in a process of permanent modernization without provoking great structural reformulation in its content during the education of the undergraduate course. The project of restructuring the curriculum of Civil Engineering course at UNIVAP intends to face three important points causing serious problems in the structure of the course: elevated school drop out in the first year of the course, due to the overcrowded groups of students in the basic cycle subjects such as Physics and Mathematics because of high school unprepared students; keep the subjects and course descriptions that compose the programmes up-to-date and the necessity of a solid basic formation in order to support the fast technological transformations. In the attempt to reduce the drop out, the new curricula design has introduced fundamental subjects with basic mathematics and physics contents in the first year of the course with the objective of minimizing or even correcting eventual deficiencies originating from the formation of the high school course. A generous increase in the program hour of the subjects that compose the basic cycle of the course, among them mathematics, physics, mechanics, fluid mechanics, computer initiation are proposed. With these reformulations it's intended to alter the cycle of basic formation of the course from two to three years, enabling some basic subjects to be extended until the fourth year of the course. On the other side it becomes convenient to introduce some subjects of professional formation in advance to motivate the student of the course in the first year. These subjects can be highlighted in two: Introduction to the Engineering and Administration, and Introduction to the Construction Engineering. Relating to the subjects of the permanent professional modernization it has being proposed a structure in the end of the course, so that it facilitates the student to have a formation composed by modules of subjects with focus on Continuous Education, allowing the student to come back to the university toward new specialization or extension unit courses in the following years.*

Introduction

Considering that every University should look for their own alternatives for improving their undergraduate courses quality, as much through their internal experience as in the experiences of other teaching institutions, UNIVAP - Universidade do Vale do Paraíba specially the Institute of Exact Sciences and Technology has been focusing as one of its main objectives the search for an improvement of the general structure of its undergraduate courses, especially the courses of Civil Engineering, Electrical Engineering and more recently the course of Engineering of Materials. This process started some years ago when searching for an identity of its own in these undergraduate courses besides alternatives that turn them courses with considered excellence teaching quality inside a regional reality and why not to say, national reality.

Besides the internal facts that have been taking the constant improvement of the teaching quality at UNIVAP, there is an extremely important aspect that is the great and fast technological transformation and, it can be added, the impact provoked by government regulations in the field of Education in Brazil last years. Univap as well as other universities is being deeply affected by the employment of these new technologies. Concerning the aspects connected to the teaching, there is an explicit need of knowing these new technologies nowadays besides the need of the students access them in their several undergraduate courses.

In this vision it becomes fundamental the need of a periodic restructuring in the university courses, mainly in those which contain a high correlation index with the technological content as it is in the case of the Engineering courses. The engineering is the great responsible for

producing new goods, processes and services starting from the technological knowledge.

The need of permanent curriculum modernization is still tied up to the need of satisfying the qualifications and longings originating from the professional labor market, besides promoting conditions of permanent modernization and following up the technologies evolution in the production means to the professionals already working in this market, what demands a solid base of scientific knowledge. These restrictions, permanent modernization and solid basic formation were considered during the elaboration of these proposals.

Basic premises for Restructuring the Curriculum of the Undergraduate Courses of Engineering at UNIVAP

The proposal of restructuring the curriculum of the courses of Engineering here presented was still done starting from the following premises and verifications:

a) Reinforcement of the basic cycle of the undergraduate courses in engineering.
b) Take into consideration the Program of Evaluation of the courses of Engineering (Patterns and Approaches of Quality) established by the Commission of Specialists of the Ministry of Education of the Brazilian government.
c) Take into consideration the qualification of the faculty with emphasis in two great areas of the engineering teaching: the **Basic Area** according to approaches of ITCD - Index of Lecturer Qualification, and the **Professional and Technological Areas** according to approaches of ITCD - Index of Lecturer Qualification[1] in relationship to the approaches of ICP - Index of Professional Experience[2], where the lectures' professional experience that teach the subjects of professional and technological characters are considered.
d) To adequate to the present legislation of the minimum curriculum for engineering courses, but at the same time to contemplate a possible new legislation to be established as Curriculum Policies for the graduation courses in Engineering.
e) To increase the program hour of the formative character programmes sensibly, as the basic and technological sciences.
f) Larger emphasis in the programmes in the new curriculum for the courses of engineering at UNIVAP and not in specific subjects for each knowledge area.
g) To reduce the program hour of subjects with informative character.
h) Reduction of the total number of subjects in the normal cycle of the undergraduate courses.
i) To promote a larger relationship among the proposals represented by the contents of the course programmes and subjects.
j) To respect the attributions and the Professional Legislation established by the system of regulation of the profession exercise in Brazil, CREA/CONFEA[3] system.
k) To respect the legislation that establishes a minimum program hour of 3,600 hour-class for the undergraduate courses in engineering.
l) Restructuring of the undergraduate courses in engineering giving special emphasis to the laboratory classes and the experimental practice.
m) Special attention to the use of the computer science as basic tool of the engineering in its different knowledge areas.
n) To respect the characteristics of the students that enter in the undergraduate courses of UNIVAP, say: the insufficient basic formation, night shift undergraduate courses, besides students with short available time for exercising activities out of the normal schedule of the classes, due to the fact that the great majority of them works during the day-light.
o) The great majority of the students accepted in the undergraduate courses at UNIVAP comes from local region.
p) The existent labor market in the area and in the country, is almost exclusively for execution engineers and not for those of conception.
q) The engineer degreed by UNIVAP, in most of the cases doesn't have vocation for theoretical studies that are not strong linked to the development of techniques and tools for the solution of practical interest problems. Thus, it seems reasonable to develop the formation according to an approach of "Concurrent Engineering" in which there is a strong involvement with the applications, being adopted exercises that show their technological usefulness.

In summary, three were the main reasons that focus the current proposal of curriculum reformulation for the engineering courses at UNIVAP: school drop out in the first years of the courses, modernization and the need of a more and more solid basic formation. The reinforcement of the basic cycle is already justified for the experience consecrated in relationship to the difficulties of the students' originating from the selection process and the competition

[1] ITCD – Index of Lecturer Qualification – index that measures the score of the university lecturer qualification.
[2] ICP – Index of Professional Experience – index that measures the score of the university lecturer professional experience in engineering.
[3] CREA/CONFEA – Conselho Regional de Engenharia e Arquitetura and Conselho Federal de Engenharia e Arquitetura – Regional and Federal Councils for Professionals of Engineering and Architecture that control registration and regulate the professional licenses.

formation. This point is important because, when contributing to improve the quality of students' formation in the early stages of the engineering courses,we will be certainly reducing the school drop out.

Still referring to school drop out, was introduced subjects with fundamental contents in Physics and Mathematics in the first series of all the engineering courses with the objective of correcting eventual deficiencies in the formation of the students' medium degree. It is our hope that this change comes to propitiate the student a larger improvement and that he has a larger time to adapt himself to the rhythm demanded by the course. In relation to "the solid and basic formation", the proposal of the new curriculum, besides the subjects of fundamental character already mentioned, it promoted a substantial increase of the program hour in the denominated basic cycle of formation, common to all courses of Engineering, Calculus, Physics, Mechanics, Fluid Mechanics and the Computer Science. The subjects "Introduction to Engineering and Administration" and "Introduction to the Construction Engineering", this last one in the specific case of the Civil Engineering, in the first stage of the course of Engineering, has the purpose of giving the student a vision which comes to be the future engineer's challenge, in the attempt of maintaining the linking, in some way, to the profession already chosen in the beginning of the course.

The programme Computer Science Applied to Engineering, due to its importance for the future engineer as a work tool, was separated in three basic different subjects, "Introduction to the Use of the Computer", "Processing and Analysis of Data" and "Numeric Calculation Applied to Engineering", in such a way that these subjects are support for the use of the computer as work tool in all programme of the undergraduate course.

The problem of the "Permanent Professional Up-to-Dating" was considered, and the solution proposed is that we propitiate the student, guaranteed the necessary basic and general formation for the exercise of the profession already chosen in the last phases of the course, the possibility of chosing one or more specialization areas before going into the last grade. This procedure facilitates the introduction of new areas that come to be of interest, besides contributing for what is denominated "Continuous Education", allowing students already graduated to attend new specialization courses.

The Proposal presented for the Curriculum of the Undergraduate Course of Civil Engineering

The proposed full curriculum is presented below, specially for the course of Civil Engineering at UNIVAP. It points out that the Basic Formation is common to all the existent courses of Engineering at UNIVAP (Civil, Electrical and Materials).

Programmes	Subjects	Total hours	hrs/week
1- Basic Formation **2.080**			
Mathematics 520	Fundamentals of Mathematics	120	3
	Mathematics I (Differential and Integral equations)	120	3
	Mathematics II (Differential and Integral equations)	120	3
	Probability and Statistics for Engineers	80	2
	Matrices and Vectors	80	2
Physics 520	Fundamentals of Physics	120	3
	Physics Theory and Laboratory I	200	5
	Physics Theory and Laboratory II	200	5
Chemistry 200	Chemistry Theory and Laboratory	120	3
	Introduction to Science of Materials	80	2
Mechanics 120	Solid Mechanics	120	3
Computer Science 120	Introduction to the Use of the Computers	40	1
	Processing and Analysis of Data	80	2
	Numeric Calculations Applied to Engineering	120	3
Drawing 160	Technical Drawing	80	2
	Geometric drawing and Descriptive Geometry	80	2
Resistance of Materials 120	Resistance of Materials	120	3
Transport Phenomena 200	Thermodynamics	80	2
	Fluid dynamics, Heat and Mass Transfer	120	3

2- Formation General 160			
Administration, Economy and Social Sciences 160	Introduction to the Engineering and Administration (includes introduction to Environmental Engineering)	80	2
	Introduction to Economy	80	2
	Civil engineering and Environment (optional)	80	2
3- Professional Formation 1.600			
Topography 80	Topographical Engineering	80	2
Geotechnical Engineering 200	Introduction to engineering Geology	80	2
	Geotechnical Engineering and Foundations	120	3
	Foundations and Soils Construction (optional)	80	2
	Design of Foundations for Buildings (optional)	80	2
Hydrology 80	Engineering Hydrology	80	2
Hydraulics 80	Hydraulic Engineering	80	2
Structures 120	Theory of Structures	120	3
Construction Materials 120	Materials for Construction Engineering	120	3
Structures Design 200	Design of Concrete Structures I	120	3
	Design of Concrete Structures II (optional)	80	2
	Prestressed Concrete and Concrete Bridges	80	2
	Metal and Wood Structures	80	2
Transportation 160	Transportation Engineering I	80	2
	Transportation Engineering II	80	2
	Design of Transportation Systems (optional)	80	2
	Urban Transportation (optional)	80	2
Wastewater Engineering 80	Wastewater Treatment Engineering	80	2
	Special Topics of Wastewater Engineering (optional)	80	2
Construction Engineering 320	Introduction to the Construction engineering	80	2
	Construction Engineering	80	2
	Introduction to Construction Management	80	2
	Construction Management (optional)	80	2
	Topics on Construction Engineering	80	2
	Design of Building Utilities (optional)	80	2
4- Complementation 160			
Undergraduate Project Work		160	4
Total Program hour 4.000			

It's important to notice in the proposed curriculum that a program hour destined to the elaboration of a final project work of undergraduate exclusively in Engineering called "Undergraduate Project Work" exists. Guided by a teacher, the student will define an area of performance and a theme on some area of knowledge of the Engineering that he has studied and he will begin the development of a research work on the theme. The student should complete its research work or project on the theme defined, using techniques and knowledge acquired along his formation, under a teacher's orientation, in the elaboration and conclusion of the project or he researches. He should still present this project in form of final report that will be submitted to an examining banking composed by at least three lecturers that, after the student's presentation, will judge the merit of the work followed by formal evaluation.

Conclusions

The engineer should be prepared to dominate and to use technologies that assist the needs of a society turned to the

quality of people's life with compatible costs with the reality and particularities of each area region.

In relation to the formation characteristics, the experience has been showing that what really counts for the engineer's success are three aspects: the capacity of accessing, studying and incorporating new knowledge and techniques in the context of an accelerated technological development; be prepared for managing and leading work teams; and capacity of enterprising and administrating changes, for the role of materialization of new products and business, in face to the technological development opportunities.

Besides the verification that along his professional life the engineer re-does several times " the detailed project of his formation " exists, starting from a " theoretical and technological ", done basic project of formation, mainly in the school banks. It seems that what's more important in our engineers' formation is:

1) Solid formation in theory and basic technologies.
2) Formation in administration of theoretical and human resources, with special value to leadership techniques and management enterprises and changes.
3) Training in the engineering activities, that is, locating, selecting and to using knowledge and techniques for the administration or conception of products and processes, in general of multidisciplinary content, mainly as to the economic viability and socio-environmental impacts.

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