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Recent Economic Transformations and Curriculum Adequacy Evaluation in Mechanical and Chemical Engineering at Universidade Estadual de Campinas, based on the Perceptions of Students, Alumni, and Teachers

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ABSTRACT

In this work we discuss the nature of the challenges that the recent economic and industrial transformations associated with so called *post modern* period brought to the engineering profession in general, and in particular to the engineering education in Brazil**.** We present the results of course evaluations conducted in the Mechanical Engineering and Chemical Engineering courses at Universidade Estadual de Campinas (UNICAMP). Starting from a qualitative methodology of assessment, directed to evaluate the educational methodology and content, we examined the course's content, programs, and general approach , incorporating the perception of students, graduate and faculty on several aspects related specifically to the courses and with respect the engineer's profession. In general the results show that Mechanical Engineering course is adequately structured with respect to the performance demanded by the transformations happening in a global scale in the *post modern* period. The Chemical Engineering course although satisfactory with respect to recent challenges was in the process to reformulate the curriculum.

Keywords: Engineering, education, evaluation, curriculum, globalization.

1. INTRODUCTION

The teaching of Engineering, considering its natural and strong relation between engineering and the world of production, presents itself a great challenge, which in the case of Brazil contemplates the question of adequate and somehow independent insertion in a global economic order now undergoing a globalization process, considering that forming adequate human resources is certainly a factor in establishing competitive advantage, and attracting investment.

In this work we consider the major economic transformations underway associated with globalization, and its implications with regards to the teaching of engineering in Brazil, with the objective of responding in our education environment, to the new scientific and technological advances, parallel to emerging and new economic scenario. We present in this study the results of evaluation studies conducted in the Faculdade de Engenharia Mecânica and Faculdade de Engenharia Química of Universidade Estadual de Campinas (UNICAMP), with the objective of analyzing course content and its adequation to the emerging challenges.

2. PRESENTATION

We employ a qualitative methodology of assessment, directed to evaluate the educational process and its content. We examined the programs, also surveying the perception of undergraduate students, alumni, and faculty, on several aspects related specifically to the courses content and approach. This methodology, first implemented at Comvest (Comissão de Vestibulares da UNICAMP) to survey student's profile, and views of interest to the University, is based on relevant developments in the field of evaluation (Bogdan and Biklen, 1994), and was carried out based on two basic points: 1) it apprehend the perceptions of the those involved in the trial teaching/learning process, and 2) provide collaborative interaction between the agents carrying the survey and students, alumni, and faculty. This methodology minimizes the potentially negative effects of an external evaluation, which tends to present an unilateral view, by on the contrary, value the point of view of all those involved in the teaching/learning process. This process make it easier to identify consensual points, as well as points of conflict; permitting the necessity of changes, and to formulate concrete proposals (Bittencourt, 2003). We believe that the essence of this process of evaluation is to guarantee the reflection about the course reality, causing to the maturing of opinions and postures regarding the course, aiming at to the transformation of its reality.

2.1. NEW EDUCATIONAL CHALLENGES

The Engineers, in the last decades of the end of the 20th century, began to come across a new reality, characterised by intense and radical transformations, which changed the political, economic, and social world. Those transformations affected the world of production with respect to: occupational structures; product innovation; labour market; consumption habits, resulting from the transition from the concept of a world based in the set of paradigms brought by the *modernism*, into a new set of values set by the advent of the post-*modern* world. This new world is characterised by the opposition to any rigidity of economical or social nature. This discontinuity set the transition from a regimen of capitalist accumulation known as "*Fordist-Keynesian* ", which prevailed in the post-war expansion period (1945-1973), to the regimen known as of flexible *accumulation* (Harvey, 1988).
Among the main attributes of the *Fordist-Keynesian* period was the accomplishment of only one task per the worker; the high degree of specialisation of tasks; and the little (if none) training in the workplace. The regimen of flexible *accumulation* is characterised as a work model where diversified tasks are distributed to the worker, thus diluting the demarcations between them, and by a much more expressive and intense training in the workplace (Swyngdouw, in Harvey, 1988). With this change of economic model, the economy of scale gave place to a new economy, which introduced a growing demand for rapid product innovation, characterised by the intense use of very dynamic new technologies. Those, and other important and recent transformations, associated with the changes in the economy as it was known, for instance, until 1963, demanded a change in the engineers performance, demanding adaptations in the education model. A new professional profile and a new educational posture was postulated as necessary (B. S. Santos, 1997; Harvey, 1988; Reich, 1993).
The university education requested by the contemporary scenery , demands that the students are given a "solid and wide cultural formation; exposure to generalist theoretical and analytic pictures; a global vision of the world

and of its new values; development of criticality; increasing creativity; readiness for innovation personal ambition; a the positive attitude for intense teamwork, and outstanding negotiating capacity. These qualities were demanded in order to deal with more sophisticated productive processes"(B. S. Santos, 1997, p.198). The professionals who will occupy the central positions and more complex in the productive process - the symbolic analysts, according to Reich (1993)-, need the capacity to give fast , and well justified responses to performance demands; should be able to conceptualize, solve new problems, adapting fast to innovative conditions. It became necessary to teach the students to *learn how " to learn "*; to give them conditions to develop, and improve abstract, and systematic reasoning; developing experimentation capacity, and collaborative interaction. The items above were pointed out as essential for achieving the high competitiveness demanded by the new economic context (Reich, 1993).
The OCDE 1987 report about the different functions that the University, starting from the 60s, demonstrated that the University should privilege a broad education model, thus allowing an adequate performance in a variety of unexpected conditions, set by the dynamic market, in detriment of specialised training for tasks that in period of five or ten years would be obsolete (B. S. Santos, 1997), in the context of the process that promoted the new economic scenario.
The challenge, in the case of engineering education, is how to organize a Curriculum structure capable of creating the potential engineer as a symbolic annalist, in order that society benefits by having workers able to satisfy the needs associated with the evolution of the production with adequate human resources. In this work we investigated the perception on how the Curriculum was related to this objective point, in particular considering a specific modification in the Curriculum introduced Mechanical Engineering

2.2.EVALUATION OF THE MECHANICAL ENGINEERING COURSE -THE CURRICULUM REFORM IN MECHANICAL ENGINEERING

The Mechanical Engineering course at Unicamp had implemented, in 1980, its first curriculum reform with the main objective of establishing a formation based on the so-called *emphasis approach*: energy, projects, and materials and processes. However, the economic transformations that occurred in the world presented a new reality ,that demanded a series of potential changes in the professional's profile, which lead to questioning of the formation directed to specialization, represented by the *emphasis* approach. In 1990, after extensive debating, and discussions, a new curriculum was introduced, which tried to take in consideration the intense economic and technological changes going on. The foundations, which guided that reform, were, basically, the need for the engineer to conduct, and administrate the rapid technological transformations underway then, considering in the process the rupture between the divisions, which separated areas of knowledge. A broader education seemed to be necessary, incorporating solid foundations, with interdisciplinary content, adding subjects to an almost non-existent exposure to humanities.

2.3 EVALUATION OF THE MECHANICAL ENGINEERING COURSE - THE PERCEPTION OF THE STUDENTS

An assessment study conducted with students formed in 1994 and 1995 showed a very positive evaluation of the new curriculum of mechanical engineering. They considered as very positive the education based on the fundamental concepts of the great areas of the engineering, and the adoption of teaching methods which reinforced their independent ability to learn by themselves; the incentive to do autonomous study. According to the students, the offering of disciplines that transmit modern concepts (i.e, in Quality Control , Processes, and Projects); the incentive to the research (named "scientific initiation" in Brazil) ; the good relationship between teacher and student; as well as the individual student effort, propitiated conditions that resulted in a excellent

professional, capable to face the new emerging challenges . The students considered that they had solid foundations plus enough autonomy to acquire new knowledge.

2.4 EVALUATION OF THE MECHANICAL ENGINEERING COURSE - THE PERCEPTION OF ALUMNI

This particular assessment was conducted with 48 mechanical engineers who graduated at UNICAMP in a period previous to the curriculum reform, representing a period of 22 years of professional work, with an interesting diversity of experiences, consisting thus in a very important input for this study.
The majority of the alumni considered that the formation acquired in FEM was only partially compatible with the needs of the profession, mainly due to a certain distancing of the university with respect to the immediate reality of the labor market, and to the tendency of the School to stress a strongly theoretical approach in the disciplines. This fact, that reveals the traditional dichotomy between theory and practice, did not impede, however, that the mechanical engineering graduates from UNICAMP succeeded in their work, even when faced by significant technologic innovation The merit of that success was credited in to personal effort, and mainly attributed to the high quality of their education - in this case to a strongly theoretical, and generalist approach. According to those engineers, the more appropriate approach to face the challenges of a technologically dynamic context should be a generalist one.

2..5 EVALUATION OF THE CHEMICAL ENGINEERING COURSE - THE PERCEPTION OF THE FACULTY

A survey was also conducted in the Chemical Engineering course. According to the view of almost 50% of the Chemical Engineering faculty (Bittencourt and Honório, 2000) the Chemical Engineering course should form professionals capable to evaluate , and efficiently solve the emerging problems related to the area. A profile of the *versatile professional* was established as him being capable of adapting to the different, and more challenging situations posed by today's dynamic market. This profile should be associated with in a rigorous technical-scientific formation, with a solid mastering of the foundations, and basic principles of Chemical Engineering. Other talents are necessary, according to the faculty, such as: critical sense; constant improvement and technological and scientific actualisation; capacity to work in groups; good interpersonal relationship; proficiency in the English language; creativity, and capacity to conduct investigation. According to the survey , to graduate an engineer with this profile, the large majority of the faculty considered necessary an approach that would lead to a generalist formation, in order to increase their performance , and versatility in the labour market. Although some faculty still regard as important emphasis in specific areas, they believe, however, that the specialization should be part of continuing education, to be implemented later on, during the exercising of the profession.
In order to update the curriculum without resorting to specialization, the faculty is in favor of creating a group of disciplines able to transmit knowledge in specific areas considered important. The faculty suggests the introduction of electives, or even the inclusion or adequation of contents in those disciplines already existent, as more efficient solution, to respond to the demands resulting from the new profile of the engineer.
Most of the faculty considered that the number of credits (a little over 3600 hours of class hours) of the course is excessive, and therefore should be reduced. They suggested that the time in class room should be reduced, and substituted by more independent activities such as: study extra-class; work as trainee and more intense case study activity, arguing that this reducing the number of hours in class would not cause any loss in quality. It was pointed out that the introduction of new teaching technologies to increase the effectiveness of the time of class. In the opinion of some, those changes would only be effective if accompanied by a generalized consensus of teachers and students, supporting as a common objective, the changes proposed.

3. CONCLUSION

The proposed educational attitude, in view of the economic conditions which developed within the *post modern* period, as defended by different authors (B. Sousa Santos, Harvey, Reich), and the results of the study conducted with students, alumni, and faculty, lead us to positively evaluate as successful the curriculum reform conducted in Mechanical Engineering at UNICAMP, and to consider it compatible with the current tendencies of the Engineering education. The discussions that the Faculty of the course of Chemical Engineering conducted to better adapt the course, are also compatible with these tendencies.

We verified that the curriculum reform in Mechanical Engineering Course started from a correct interpretation by the faculty of the key relevant aspects of the present economic, and social configurations with respect to the proposed solutions resulting from the interrelationship between education and work. It is clear, particularly, the impossibility of settling down a sequential and stable correspondence between education, work marketplace, and performance. The faculty stressed that in a notoriously dynamic economy, an approach, which relied on solely in specialization, would never be dynamic enough to the point of accompanying the dynamic process itself.

The assessment conducted with the alumni who graduate between 1994 and 1995 showed that they agreed that the curriculum reform was implanted with success, considering that according to their experience, the basic principles adopted in the reform were supported by the their successful performance in their work.

The assessment conducted with Mechanical Engineers who graduated before the reform, suggested some changes they judged necessary**,** when analysing the new curriculum under the light of their working experience, making clear that a rigorous formation in the core areas of Mechanical Engineering was sufficient to enable the engineer to face new technological challenges. We should point out that most of them worked in the private sector of the economy - in the metallurgy and mechanical sectors, dealing with new and dynamic technologies, in companies which used updated and modern management techniques; and which are considered leading companies. Many of them held very high positions in the organizational scale. The specialized knowledge, according to them, can be adequately acquired after graduation, by training within industry, by taking continuing education courses, complemented in a more rigorous manner by the alternative of graduate training .

The assessment conducted in the Chemical Engineering course seem to agree, in general, with the philosophy that guided the curriculum changes introduced in Mechanical Engineering.

We also verified that there is a demand, in both courses, to unite the engineering disciplines with the humanistic ones in a way that will allow an integrated reflection on the interrelationship between science, technology and society. The students feel that disciplines taken in humanities tend to be reduced to a limited instrumental dimension. Alternatively, the disciplines of their interest in humanities should be presented in the way that will allow the acquisition of a global view of world and of its transformations, seeking the development of a critical spirit.

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