CHEMICAL ENGINEERING TRANSACTIONS
VOL. 29, 2012
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at: www.aidic.it/cet
Guest Editors: Petar Sabev Varbanov, Hon Loong Lam, Jiří Jaromír Klemeš

ISBN 978-88-95608-20-4; **ISSN** 1974-9791
DOI: 10.3303/CET1229268

Difficulty in Teaching in the Preparation of Design Process for Students of Chemical Engineering: a Case Study at the University of the State of Rio de Janeiro

M. A. G. Figueiredo* . M.G.R.G. Figueiredo

[a]State University of Rio de Janeiro. Center Technology and Sciences - Chemistry Institute, Petroleum and Petrochemicals Laboratory of Engineering and Technology. PPET - Room 414
mgaya@uerj.br

Actually in Brazil, a labor market development is process designs area. The growth of oil exploration activity with the advent of pre-salt associated with the proposed installation of new generating plants, such as the Petrochemical Complex of Rio de Janeiro State (COMPERJ) is requiring in the market, chemical engineers with profile is associated with a development project process.
The Chemical Engineering Courses (CE), in general, requires the trainee, a final course project. This project, in most institutions, it aims to consolidate all the knowledge gained in the implementation of the course, a practical applicability. Some projects address the study of a particular industry segment, as the area of medications, others involve more specific matters that, although linked to the area of Chemical Engineering, does not translate in an objective way, the learner's level of knowledge in different disciplines provided along the course. In terms of training, legislation (Resolution no. 019/06) related to higher education, provides 3600 h of average duration for the Chemical Engineering course, and to meet this requirement, various disciplines have been eliminated or reduced . It is noted also that there is no integration between the various disciplines. Specifically, for the Project Development, the only discipline to perform this function would be Economic Evaluation of Projects involving cost studies associated with a particular technology, in order to demonstrate its economic viability, through the application of Financial Mathematics. The others are fundamental; however, there isn't a specific one that associate all others in the form of a design process.
By joining as a professor at State University of Rio de Janeiro (UERJ) I realized that, in dealing with the teaching of industrial processes, the system adopted was to perform specific procedures without allowing the student to understand the various unit operations that constitute a industrial process. As a professional, coming from research in petroleum and petrochemical industries area and extensive experience in the development process for projects of economic feasibility studies, I sought, to teach this course, students bring the last year of course, the primary care the combination of different unit operations in order to minimize errors during the project preparation process. After being ahead of this discipline for over ten years, I noticed that, among the main difficulties that stand out are:

- Lack of integration between disciplines.
- Lack of a more practical approach (non-use of practical examples in the areas of heat transfer, transport of fluids and other unit operations).
- Lack of awareness by students of how to apply the fundamental concepts in the elaboration of a project.

Please cite this article as: Figueiredo M. A. G. and Figueiredo M. G. R. G., (2012), Difficulty in teaching in the preparation of design process for students of chemical engineering: a case study at the university of the state of rio de janeiro, Chemical Engineering Transactions, 29, 1603-1608

1. Introduction

The search for higher education in the area of Chemical Engineering in Brazil, by virtue of growth in oil production area, has shown strong growth, as shown by Filho (2012) (Figure 1).

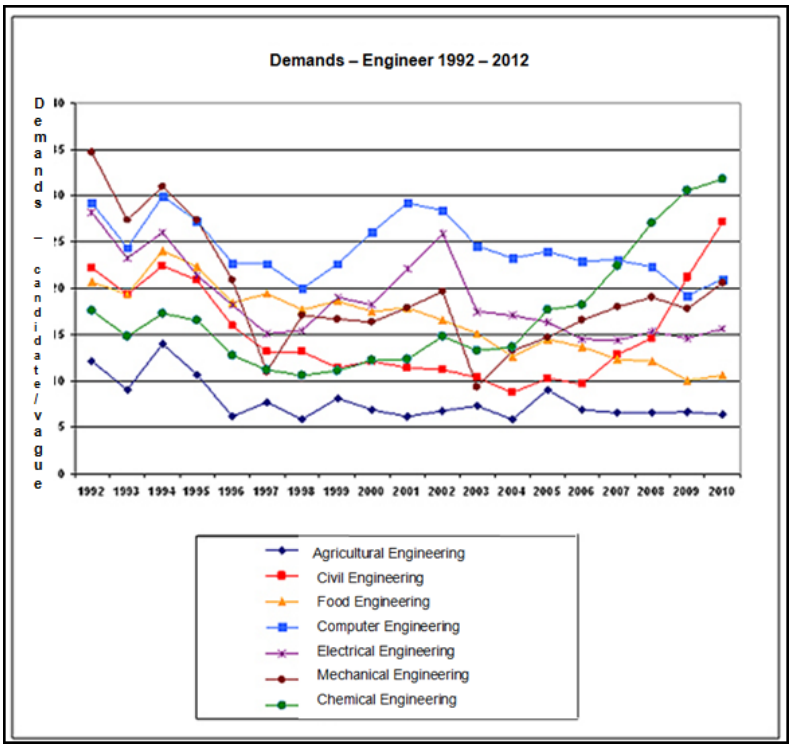

Figure 1. Statistics courses in the pursuit of engineering at UNICAMP (Filho, 2012)

Based on this statistic, it is observed that since 2001, demand increased significantly, reaching a ratio of 35 candidate / opening in 2010. This reflects to some extent, growth in the Chemical / Petrochemical due to increased production in E&P area of Petrobras (discovery of new oil reserves and implementation of new industrial centers such as the Petrochemical Complex of the State of Rio de Janeiro (COMPERJ) and the deployment of new steel company as the Atlantic Steel Company, located in the center of Itaguai in the State of Rio de Janeiro. The questions are: Were the newly formed effectively prepared for entry into the labor market? What challenges must be overcome by universities to meet this demand? A barrier that is still in Brazil is the integration university / industry. Except in the case of search for apprenticeship positions, you do not see an association in terms of training, which allows the inclusion of specific disciplines facing major industries.

The State of Rio de Janeiro is a major oil producer. Given this reality, the universities should have a strategic vision that would allow the inclusion of the newly formed area of Chemical Engineering / Chemistry in the labor market, without the need for this new professional look, specialization courses "Strictu Sensu" called "Master in Business Administration (MBA)" in different segments, such skills are not acquired during their training.

Based on this fact, this work, the fruit of 12 years experience teaching discipline Projects in Process UERJ, at the Chemistry Institute, aims to present the main difficulties encountered in developing an integrative discipline, combining the typical academic disciplines to a more directed to industrial practice. This will show the main challenges encountered, how to face them, the successes and, of course, also the failures.

2. The search for qualified

The issue of qualifications of the individual to take a job in a company is a subject that has been long debated. Since the 70's, the companies are trying different ways to qualify for the newly formed, either through Corporate Universities, as well as through agreements with centers of excellence. Petrobras, since the 70's, held training courses both in Processing Engineering (CENPRO) as in Petrochemical Engineering (CENPEQ), among other specialties to suit the manpower needs. The importance of these universities is presented by Alperstedt, C. (2001) which concluded in his work,

> *"The proposed definition of corporate universities not only favors the formation of strategic development of core competencies to the business, but also, in parallel, the arrest of two key features highlighted: not restricted to employees of educational services, with emphasis on openness to external public in general, and partnerships with institutions of higher education, with emphasis on the validation of claims and the possibility of routed conferral of degrees, diplomas or conferral independently. "*

As regards the question of qualification for the professional serving the needs of the market, although highlighting the importance of corporate universities, Martins, A. and Fuerth, L.R (2012) report that:

> *"Many companies in Brazil are months with job openings for workers unable to find a good level, a ruthless counter-intuitive in a country that has thousands of unemployed" and that "Brazil needs to invest in their professional development and intellectual capital is necessary. It is impossible to achieve any progress in education if there are no investments in this area. "*

As result, this work, following the evolution of production processes and the constant changes in the organizational structures of large companies, effectively justified the need for a realignment by companies via corporate universities, the professional profile tailoring it to their real needs. What, however, should be emphasized is the need for approximation of universities from the companies, enabling it to continually re-evaluated curriculum with the goal of launching a professional job market with better training, even though this is still going to be reclassified the corporate university.

With regard to the importance of bringing knowledge to the university in industrial practice the work done by the University of Wisconsin - Madison College of Engineering, (Smith, K 1995) emphasizes the importance of moving to the student the lessons learned in industrial practice as a way of bringing the engineering course of the industrial reality.

> *"The use of practical examples in the classroom is directed to the following main objectives:*
>
> *(a) Practical examples make the theoretical basis more accessible to students because it helps them understand the new concepts being introduced.*
>
> *(b) To teach students to apply theoretical knowledge in situations that are not directly covered in class. The goal is to show students that what they are learning has practical applications, but more importantly, how to apply the understanding of basic principles to real engineering problems "*

3. The chemical engineering course of the university of the state of Rio de Janeiro

Regulated by the Deliberation No. 019/06 [1], which **redevelop** the full curriculum of chemical engineering course, where he is informed that "The Degree of Chemical Engineer" will be given to the student in a minimum of ten (10) periods and a maximum of sixteen (16) periods, for the day shift, and a minimum of twelve (12) and a maximum of sixteen (16) for the night shift, pay up a minimum total of 3600 (three thousand six hundred) hours and a minimum total of 209 (two hundred and nine) credits. Table 1 shows the distribution of these hours.

Table 1. Distribution of workload over the course of Chemical Engineering UERJ

Core of basic content	1170 (one thousand one hundred seventy) hours, 71 (seventy one) credits.
Disciplines with professional content and specific	1950 (one thousand nine hundred and fifty) hours, 113 (one hundred thirteen) credits
Supervised activities	255 (two hundred and fifty-five) hours / class, ten (10) credits.

3.1 .The evolution of education in chemical engineering

Currently, experience is a reality where new fields are being encouraged, such as New Materials Engineering, Environmental Engineering, Engineering and Supercritical Cryogenic, contributing directly to significant changes in the curriculum. Studies with water reuse, the use of second generation biofuels request of the chemical engineer, increasingly, integrating with other areas such as Mechatronics Engineering, Biology or Medicine. As shown by Zakon and Manhães (2001), in the seventh meeting of Engineering education, the increase in the range of performances of the chemical engineer, led a study to change the curriculum in order to adapt the course to real market needs

> *"The process of curriculum reform that has taken place in the School of Chemistry of Federal University of Rio de Janeiro, (UFRJ) caused the preparation of studies on the professions of engineering and chemistry that resulted in 2000 in the proposition to be created at least twelve new courses (or qualifications) Chemical Engineering to meet the increasing diversification of the labor market "*

3.2 The integrative disciplines

The question of the importance of integration of disciplines in courses EQ is presented by Van Antwerp et al. (2004):

"Integration into the EQ is used to motivate the student. The fusion integrated in a single stroke instead of two individual, for example, fusion of course on the crystal structure of solid metal, with fracture mechanics studies. The concepts of phase diagram are drawn from traditional chemistry, but the emphasis is shifted to solid solutions in order to correlate with the science study of metallic solutions. The acid - base balance is covered by the course of traditional Chemistry and themes are used to build a foundation to look at the potential of corrosion.

In the case of CE UERJ course, is offered as an elective discipline, Introduction to Projects for students in fifth to eighth period. The purpose of this discipline is to present to a group of students, based on a particular product, the development of a preliminary design process where, through patent search process, the group must organize a project consisting of: general description process, graphical representations (block diagrams and flowcharts, process), involving disciplines such as Chemical Process At the end of the course, between the 11-th to 12-th period (if evening course) or between the 9th-10th period (daytime course), students must attend the courses Project I (economics) and II (mechanical aspects). In this case, as a peculiar feature, introduced by me, of CE course UERJ, in project I, the students prepares a standard work on Frond End Loading (FEL1), to have a first view of the attractiveness of the project studied. In Project II, the group reviews the first project in a more detailed level, standard FEL 2, there and then develops a design process, a level of depth that precede the detailed engineering, covering from graphical representations necessary (block diagram, process flowchart, piping and instrumentation flowchart (P&I) and unifilar diagrams) control strategies and risk analysis. In addition, all equipment, control valves and safety must be designed and established to their specification sheets. Based on the information generated in the project FEL2 level, the group should estimate all costs involved and through a financial analysis to evaluate the economic feasibility of the chosen design.

4. The main difficulties encountered in the development of discipline

4.1 The need for pre requirements (obligatory disciplines)

Project final discipline is included in the last period of the course of chemical engineering (CE), but the regulation does not establish UERJ the issue of prerequisite, ie, there is, formally, the need for compulsory subjects that must be routed to enable the student to join this course. The restriction refers to a minimum number of credits (140), the student must have attended and have been approved. This enables you to apply for registration in the discipline of Project final course even if you have attended courses whose contents, concepts and fundamentals are basic and essential to the development of the final project. The department responsible for the discipline of Project II also requires that the student has taken the course of projects I. These two restrictions do not prevent, however, the phase content, which hinders the realization of final design and generates a high number of failures (in the range 30-40 %). Thus, the proposal to adapt the course Project Process to reality, the first test, looks for the

student's level of knowledge in different disciplines that make up the grid of Chemical Engineering and are necessary for the development of the Project. The second test tries to see the degree of involvement of group members in the project developed, i.e., an assessment is "qualitative". As regards the evaluation of the project itself, it is the clarity of the presentation overview of the process: different graphical representations, the proposed control strategy, the depth in the application of a risk analysis tool and filling the specification sheets for various equipment and instruments, which constitute the project.

4.2 Submission of important disciplines for other institutes

Because it is a University who does integration between the different institutes, certain subjects are taught by professors from other institutions, for example, Calculus, Physics and Drawing. This practice actually creates some problems as the association of the programmatic content of the discipline with the needs of the CE course. In this case, the discipline of Project II involves the need for knowledge of graphics and design of industrial equipment. The discipline required in Technical Drawing course CE, the way it is presented, does not address this type of information, only the students are presented aspects related to network wiring or drawing geometric figures, which is not used in CE. The same occurs with the discipline of calculus, which, being taught by professors from the Institute of Mathematics, does not address important concepts to the development of disciplines such as thermodynamics and Processes Unit (mass transfer, heat, etc.), Using a strong base mathematics in their development and are fundamental in the formation of a chemical engineer.

4.3 A practical approach of disciplines that are specific to the group of chemical engineering

Under the time established for complete the CE course about 3600 h, some disciplines such as Control, Instrumentation and Unit Operations, had to be adequate generating little loss of quality and depth and also limitations in the approach a practical viewpoint. The student, for example, when studying the discipline of Fluid Mechanics, has all the necessary information on the calculation of pipes and pumps about sizing, but for lack of time, has a somewhat more practical and not just having the opportunity to study the association of the pump to other equipment. The student is unaware of the major influences that can happen when installing a pump in a tank (or vessel) busy. The same occurs with the process control. In the dynamics of the discipline, the student is given all information necessary for the understanding of Laplace transforms, the calculation of control parameters, and some typical meshes (control cascade / ratio control). In preparing the draft process, the release of the proposed control is compromised, because having only the perspective of the process; the student can not see how the operations interact. Thus, if there is a connection between the bottoms of a distillation column with an extraction tower, the association of the control system becomes compromised. The difficulty is when you combine different unit operations, closing a complete process, involving, for example, distillation and absorption.

5. Measures necessary for a better integration of perception of disciplines

In institutional terms, the main point to be discussed is the inclusion of prerequisite system, i.e., students who lack the discipline necessary to carry out the integrative discipline. Not just in terms of limiting the number of credits routed, but require, for access to the discipline of Project II, the student has passed all courses required for drawing up the final course project.

In the case of courses taught by other institutions, there must be a channel of communication between the institutes, where there is the possibility of discussion and presentation of requirements that meet the specific needs of the subjects in the course of CE. In the case of specific disciplines in the course of the CE "grid discipline" should be reassessed proposing integrative disciplines which are inserted, even as non-compulsory, in order to show the student that the formation of CE and is entwined within a context in which the different information and content of each discipline are integrated. This perception would be instrumental in developing the final design and for professional training. This practice would allow, during the course, students were constantly challenged to understand the associations between the different disciplines allowing a global view of how chemical engineering should act. For example, in the fourth quarter, after completion of the disciplines of organic chemistry, students should be involved, via an intermediate design course on the very subject of organic, in a study on an individual case

anyway without the notion of a structured process, have access to information that would lead him to perceive a process as a whole.
With regard to the specific knowledge of unit operations, the ideal would be that there was a project by integrating university and company, so that programs of technical visits could be established which would help, by far, the perception of different forms of operation of existing equipment in the industry.
As regards the structure of the CE course an important point to be discussed is the participation of large companies in the establishment of goals to be achieved in terms of training. Although the courses are necessarily general, without giving priority productive sectors, it is important to identify with Corporate Universities, in general, which bases priority that should be addressed. In the State of Rio de Janeiro, by virtue of its industrial hub, the universities could consider the basic needs in the oil and petrochemical area in their training courses. This practice would bring an update would help greatly the course of CE, regarding the education of its students, preparing them for the labor market. The University welcomes students, but must, at the end of the course, deliver competent professional society, with a serious and structured view of the relevance and scope of the function of the chemical engineer.

6. Conclusions

Trying to answer the questions posed:

- Are the newly formed effectively prepared for entry into the labor market? What challenges must be overcome by universities to meet this demand? We believe that universities fail in the professional training of Chemical Engineering, appreciating even more the academic than the integration of theory and practice, which makes the insertion of the newly formed labor market. The big challenge is to show how the content can be applied in real engineering.
- The application of a final course project christened in industrial practice, is effective in training the student?

A survey carried out in different courses of CE of the State University of Rio de Janeiro, shows that the use of the subject Project as a way to integrate content and grounds acquired throughout the course, structuring it in a more associated with the practice industry is a plus for students graduates EQ UERJ. The fact apply practical skills associated with academic concepts closer to those of the current labor market in the area of Petroleum and Petrochemicals, developed in the State of Rio de Janeiro

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