

# Approaches to Graduate World Class Engineers and to Meet the Needs of Next Decades in Colombia

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**ABSTRACT:** *At the beginning of the new millennium, the global context of the industrialized world compels and threats to increase productivity levels required to improve economic competitiveness of the enterprises. This and also the social pressures to decrease existing levels of poverty are all coexisting factors in Colombia, a country with outstanding amount of natural and human resources. These factors have led educational authorities of Process Engineering Department of Universidad EAFIT in Colombia to create and trig the innovation of its undergraduate educational program. In this paper, a new and systematic approach for Process Engineering learning is presented. It is structured on a Systemic Curriculum and covers transversally Engineering, Management and Human subjects. It is expected that this new approach will produce a new kind of professional, one with more holistic, integrated knowledge, prepared to be aware of his role in the efficient usage of materials, energy and Information in the industrial processes.*

## 1 INTRODUCTION

Last month of May of 2003, the educational authorities in Colombia have approved, for the first time in Colombia, the academic program in the field of the engineering known as Process Engineering. This approach was proposed by a group of chemical and mechanical engineers, of University EAFIT, as an innovative answer to existing and future requirements of local manufacturing industries.

The University EAFIT, which is located in Medellín, Colombia, has nearly 8000 students (some of them from foreign countries). It has been the second University that received Institutional Accreditation in Colombia. The university authorities decided, several years ago, to work with the open and global philosophy, resumed in its slogan "*open to the world*".

Due to this fact, Process Engineering program, since its foundation, was born supported in a systemic vision, which leads to a continuous focusing of mainly two fields: one external and other internal. Focusing on external areas, means to be aware of new trends observed by international academic community, particularly in European and North American universities. At the same time, this also claims for a search of the new profile required for the new engineers that will work in the strongly competitive scenario created by the existing global economy.

Focusing on internal areas has been interpreted as a continuous feedback of external requirements as a driving force that empowers the internal changes on the Curriculum and Syllabus. This internal and systemic approach also represents a continuous and increased communication between the professors of the different courses that compose the process engineering program, in order to reinforce the most critical subjects and to implement common cases that may be used in different courses, improving synergetically the learning processes of the students.

## 2 BACKGROUND

For the next decades, the *process* engineering education in developing countries represents a great opportunity to comply with the challenge that requires to educate a new kind of engineer, quite different of the existing and already known profile for chemical engineers, and other similar disciplines. It means those that have in their scope the study, improvement and control of the manufacturing processes. Traditionally, the engineer in charge of processes has been mainly a technical administrator of these processes, all these obviously created without his active participation and, as an unavoidable consequence

of this fact, he has derived a weak influence on upgrading and optimization of above mentioned processes.

### 3 EDUCATIONAL APPROACHES IN PROCESS ENGINEERING

The University EAFIT had faced the challenge to promote the overcoming of the described existing situation, through a new educational approach presented by its Process Engineering Department. It is expected that this new approach will educate a new kind of professional, one with more holistic, integrated knowledge and specially prepared to be aware of the protagonic role of energy in the industrial processes.

In order to achieve the above mentioned goals, this project has already established and accomplished several *specific tasks* as follows:

- To improve teaching and learning processes, including the review of Macro-curricula and all course syllabuses in order to include and to implement, in various courses, similar Study Cases.
- To include a Course of Systemic Thinking, and in addition, to emphasize in all the other courses the importance of managing processes like interaction among different systems.  
This systemic approach teaches and supports interdisciplinary learning.  
In this course, the student is trained with the usage of software like “I think” developed in MIT (Massachusetts Institute of Technology).
- To use Process Simulators since early courses like Thermodynamics, Physical Chemistry and Unit Operations, as proposed by Seider and others, in universities such as University of Pennsylvania, University of Utah and Israel Institute of Technology.
- To implement the wide use of Multimedia programs, i.e. the ones, created by University of Michigan, which allows the student to comprehend, in the laboratory, about the dynamic performance of most of the Unit Operations equipment.
- The University has implemented a Local Area Network (LAN). On the network, based on a special platform, the different professors may establish, continuous communication with the students of each course, including academic chat. This system allows access to academic documents, forum, and professor and students news in relation to the different topics of the course, internet links, and continuous course assessment made by the students.
- Establish Cooperation Agreements and information exchange with European and other Universities around the world, focusing on those with strong emphasis in Process Design and Biotechnology areas. Such is the case of existing institutional Cooperation with Delf University (Holland), and University of Applied Sciences in Bremmerhaven (Germany), Universidad del Rosario (Argentina), and Universidad de la Havana (Cuba). On these agreements, several students and professors have had opportunity to interchange knowledge, research projects and academic experiences.
- To build the new Laboratories for Unit Operations, Biotechnology and Process Design; based on a change in procedures of implementation. Instead of buying the required equipment, they were designed “in-house” by a teamwork composed of senior and junior engineers, which besides representing economic savings, offers one outstanding opportunity for reinforcing learning through equipment design and development of remaining construction steps. This updated Laboratory also includes the state of the art in Process Simulation Software and different kinds of engineering software tools. Among them, it is possible to specially mention the process simulators: Aspen Plus, Chemcad and Hysys.
- To empower the learning of Process Control and Automation. This includes the usage of most recent books in this area like Marlin, *Process Control*, 2003, and the usage of the Process Design Laboratory. A breakthrough in Process Design teaching and learning was also achieved, due to the fact that a complete and fully automated Batch Reaction System, has been designed, installed and used as a support for the different courses, including Process Control & Automation Course.
- To lead planning and accomplishment of International events. It is the case of the First International Congress on Process Design held in Medellín, Colombia in October 2002 with more than 400 international participants coming from Mexico, Germany, Cuba, and Venezuela.

- To promote participation of Eafit University professors in important International events like International Conference on Engineering Education
- This new approach includes also the flexibilization in 3 emphasis areas: Process Design, Biotechnology, and Polymer Plastics.
- Although Process Design permeates all the curriculum of process engineering teaching and learning, the emphasis in Process Design includes the study of four courses: Engineering of Chemical Reactions, Process Simulation, Process Optimization and Design Project.  
These Courses are supported by the most updated books in the area of Process Design like Turton et al, *Analysis, Synthesis and design of chemical processes*, Walas, S.M, *Chemical process equipment, selection and design*. Seider, W.D. et al. *Process Design Principles*, Ulrich, J.D. *A guide to Chemical Process Design and Economics*.  
Important philosophy applied to teaching and learning processes in process design, includes a balance between heuristics and algorithmic approaches. The former is based on experience acquisition from others engineers and the last refers to mathematic sequence required to get optimal designs.
- Special consideration is placed in teaching and learning of Process Synthesis. This is a critical link of the technological chain that should be constructed step by step in order to allow that new generations of Process Engineers may develop, by themselves, the flow sheets and all the steps that includes the conversion of the strategic raw materials in final products with higher added value.
- Special efforts are made through the teaching and learning processes, in order to develop in the students skills and competences, including communication skills (writing and oral), foreign languages, entrepreneurship, usage of mathematical tools for optimization such as Gams, Matlab, C++.

#### 4 CONCLUSIONS

- This approach includes a reviewed Syllabus, strongly based on Systemic Thinking, Process Design Methodologies, and Process Control.
- Great emphasis is placed in development of skills and Competences relying on fundamentals.
- The international cooperation with other foreign universities is strongly and continuously enhanced. This had already included interchange of students and professors.
- It is outstanding the placement of some of the graduated process engineers in well known and important International companies of Germany and USA, which also is validating the results of existing educational orientation of Process Engineering.
- University EAFIT is leading, at least in a wide extension of the geographic area in central and South America, the promotion of Process Design, Process Control, and Systemic Thinking as a basic structure in learning of Process Engineering.
- In conclusion, this project intends to show the right direction toward a global and interdisciplinary focus in engineering education; and represents an innovative proposal of a systemic approach in opposition to the classical and unconnected way of teaching and learning Science and Engineering courses.

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