Two Way Integration of Engineering Education through a Design Project

FRANCESC GIRALT  
Departament d’Enginyeria Química  
Universitat Rovira i Virgili, Tarragona, Catalunya, Spain

JOAN HERRERO  
Departament d’Enginyeria Química  
Universitat Rovira i Virgili, Tarragona, Catalunya, Spain

FRANCESC XAVIER GRAU  
Departament d’Enginyeria Mecànica  
Universitat Rovira i Virgili, Tarragona, Catalunya, Spain

JOAN RAMON ALABART  
Departament d’Enginyeria Química  
Universitat Rovira i Virgili, Tarragona, Catalunya, Spain

MAGDA MEDIR  
Departament d’Enginyeria Química  
Universitat Rovira i Virgili, Tarragona, Catalunya, Spain

ABSTRACT

Horizontal and vertical integration of engineering education is achieved through an early-design project where students get acquainted with Total Quality Management (TQM) principles and design processes from year-one of their University education. The project is embedded in the undergraduate chemical engineering curriculum as an activity that involves horizontally several first-year subjects and vertically a fourth-year Project Management Practice course and a related Project Management subject. An assessment of the integrated design project indicates that effective teaching and learning spreads through the curriculum, with fourth-year students acting as project managers and experiencing engineering practice. These management and leadership training processes include a shared responsibility in the organization and in the development of the project, which are key factors for the success of the integrated activity. They are also a first step towards the ETSEQ goal of becoming a sustainable student-centered educational system.

I. INTRODUCTION

The School of Chemical Engineering (ETSEQ) of the University Rovira Virgili at Tarragona has offered, since 1993, a five-year undergraduate Chemical Engineering program with emphasis in both the acquisition of knowledge and the development of organizational oriented values and skills. Thus, communication, team work, management by project, quality management and creative thinking are considered and evaluated in the curriculum, and fostered through active learning methodologies. The development of such methodologies has required field testing, over the past fifteen years, different approaches and strategies to attain and maintain the involvement of professors and students in team-oriented, effective teaching activities, such as early-design projects.

The development of early-design mini-projects by groups of students working cooperatively without an external leader has encountered in Tarragona the same difficulties as those reported for the first-year Chemical Engineering group projects carried out at Imperial College of London:

- Roles are not distributed among members and agreement for the election of a leader within the team is seldom reached.
- Groups are not able to organize time properly and prioritize work correctly. Deadlines, if established, are often ignored.
- Lack of planning and late motivation of group members leads to a typical concentration of work during the last two weeks of the semester.
- Queries are to be resolved mostly by the professor, which is not an efficient approach, instead of being thoroughly discussed first by the group.
- Low attendance and lack of punctuality are common in meetings held outside class hours.
- Teamwork often results in duplication of tasks and poor checking of results.
- Friction between group members develops, and solving interpersonal conflicts with external mediation is a difficult task.
- The participation of individuals in group activities is uneven, and communication is ineffective and inefficient.
- Information collected by members is not available when needed by the group.
- Division of labor is often inequitable, and the more gifted students soon become frustrated.
- No clear criteria are established to grade peers.

The above issues and complaints highlight the difference between a group of people put to work together and a team of students learning cooperatively while working together towards a common goal. As a result, several alternatives previously reported for effective engineering education were considered to improve the outcome of early-design projects at ETSEQ and move toward the concept of the global engineer. Examples of those alternatives are the implementation of design projects, the use of Total Quality Management (TQM) concepts and tools to improve teaching and learning, the introduction of the latter in cooperative learning workshops, and the horizontal integration of several subjects of the engineering curriculum. None of these