

# ANALYSIS OF A PROJECT COURSE AT A BASIC LEVEL FOR THE ENGINEERING PROGRAM AT UNIVERSITY OF CHILE

**Ximena Vargas**

Civil Engineering Department, University of Chile

## ABSTRACT

In year 2007 the new plan for engineering studies at the Faculty of Physical and Mathematical Sciences of University of Chile begun. The plan is based on CDIO standards and considers the entire professional careers as well as scientific programs imparted by the School of Engineering. One of the main changes were the incorporation of Introduction to Engineering course in the first year (standard 4) and the transformation of a design course in the second year to a project course in order to have experiences of design and implementation (standard 5) with emphasis on products construction and process implementations under real contexts at a basic level. The project course is demanded by almost 700 students in the fall semester and we have decided that each class should have a limit of thirty students so we need almost forty teachers to fulfill this requirement. Since 2008, six versions of the course have been carried out and this article shows the evolution of the areas covered by the different classes. Also the process of evaluation of students is presented and the final activity where one group of each section communicates its project through a poster presentation and presents the constructed prototype is remarked.

**KEYWORDS** project course, evaluation, prototypes, generic abilities, Standards: 1, 4, 5, 6

## INTRODUCTION

Nowadays the lack of the combination of professional knowledge and pronounced transversal skills is recognized by engineering recruiting companies as an essential deficit in qualifications of applicants (Annus, 2004). These skills are related with creativity, ability to cooperate, to work in teams, to communicate and continuous learning. Young students with a low level of these competences need to become skilled by opening learning opportunities and through good interpersonal skills, all developed by a combination of formal and non-formal work-based and situational learning. As this disadvantage affects mostly young students, to close the gap it is necessary to intervene at an early stage and this is one of the goals of the CDIO initiative that in Standard 4 promotes students engagement in the practice of engineering through problem solving and simple design exercises, individually and in teams in the course Introduction to Engineering. The course also includes personal and interpersonal knowledge, skills, and attitudes that are essential at the start of a program to prepare students for more advanced product and system building experiences. Since year 2007, University of Chile adopted this standard and two courses of introduction to engineering were initiated and offered to the freshmen students. The number of students in these courses is large (around 100 students) and teachers propose specific projects to be solved in a creative way by the students working on teams of 5 persons. The students undertake oral and written presentations and the evaluation of the generic competences are initiated through the development of Design-Implementation experiences.

At the third semester the opportunity to conceive, design, implement, and operate products and systems at a basic level (Standard 5) is included in a compulsory course, EI2001 Workshop Engineering Projects, where students must choose one of the sections among the 30 to 40 projects available offered by different professors from diverse departments (civil engineering, electrical engineering, mining engineering, computers sciences, etc.). In this case the enrollment in each section of the course is limited to roughly 30 students and they work in teams of 3 to 5. The article deals with evolution of the areas covered by professors in this course, workspaces used and the performance of the students throughout 6 years of application of the new program based on CDIO standards.

## **PROGRAM OF THE COURSE EI2001**

The general objective is to engage the student in the processes of conceiving, designing, implementing and operating engineering projects, giving an innovative response to a real need in a specific area of application.

The specific objectives are related to:

- Give students an opportunity to apply their knowledge of science and technology, and encourage the acquisition of new knowledge in these areas.
- Continue to develop creative skills.
- Develop the skills to build models that help to reason about design alternatives. This includes such estimates, preliminary designs, spreadsheets, mathematical models, simulations and models.
- Develop skills and prototype implementation of models of high quality.
- Learn to work in large teams on a project that requires teamwork to be successful.
- Continue to improve communication skills through a variety of means.
- Understand and develop enthusiasm for engineering activities involved in project development.

## **EVOLUTION OF THE COURSE**

The number of students taking the course EI1101 Introduction to Engineering in first semester at the School of Engineering of the University of Chile since year 2007 and the number of students in EI2001 course, starting on fall semester of year 2008, has varied as indicated in Table 1. Considering that year 2008 was part of the transition period between the old and the new plan because in addition to the 751 students on the Fall semester 120 students took the course EI2001 during the spring semester, number disproportionate different from the average of 20 students on the following years, we can say that the last five years the retention is near 94% at the second year. This can not only be explained by the inclusion of the Introduction to Engineering courses in the first year but is a consequence of the change in a whole, that involves modification of yearly to semester courses on the first year and use of new teaching methodologies.

At the School of Engineering we offer nine careers in civil engineering (mechanical, mathematical, industrial, electrical, computational, biotechnology, mining, chemistry and civil), three licentiate programs (astronomy, physics and geophysics) and geology. As shown in table 2, only geology is missing as an area of interest of instructors that offer one of the

sections of EI2001 course but also math has not being a real area because the instructor of that Department offered a project related to environmental issues on fall semester 2013.

Table 1: Number of Students in the Engineering Program at University of Chile

Course	Fall Semester of Year						
	2007	2008	2009	2010	2011	2012	2013
EI1101	638	645	671	780	791	765	779
EI2001	-	751	586	631	685	703	707

In figure 1 the number of students enrolled in the different areas of the projects for each year is shown. We can see that each year most of students are enrolled in civil engineering projects due to the larger offer in this area and that only in years 2011 and 2013 almost all the areas are covered. From table 2 we obtain that the total number of instructors involved in this course during the period 2008-2013 is 245 and the evolution of instructor's participation shown in figure 2 indicates almost a constant number of instructors, around 40, for each year after 2008. The number of sections offered each year is presented in table 3, indicating that some sections have more than one instructor but also some of them participate in more than one section. Another important remark is that there are 13 professors that have participated permanently in the course being eight of them full professors. Also, as seen in figure 3, the maximum number of students enrolled in each section has decreased due to the increase of sections and the limitation of the enrollment on them.

Table 2: Total number of students and instructors by area of instructor in fall semester EI2001 course. Period 2008-2013

Area of Instructor	Number of students	Number of instructors
Mechanical Engineering (ME)	35	2
Mathematical Engineering (MA)	17	1
Industrial Engineering (IN)	631	37
Electrical Engineering (EL)	637	26
Computational Sciences Engineering (CS)	726	39
Biotechnology and Chemical Engineering (BT-C)	457	32
Mining (MI)	291	15
Civil (CI)	937	70
Astronomy (AS)	126	9
Physics (PH)	68	5
Geophysics (GP)	138	9

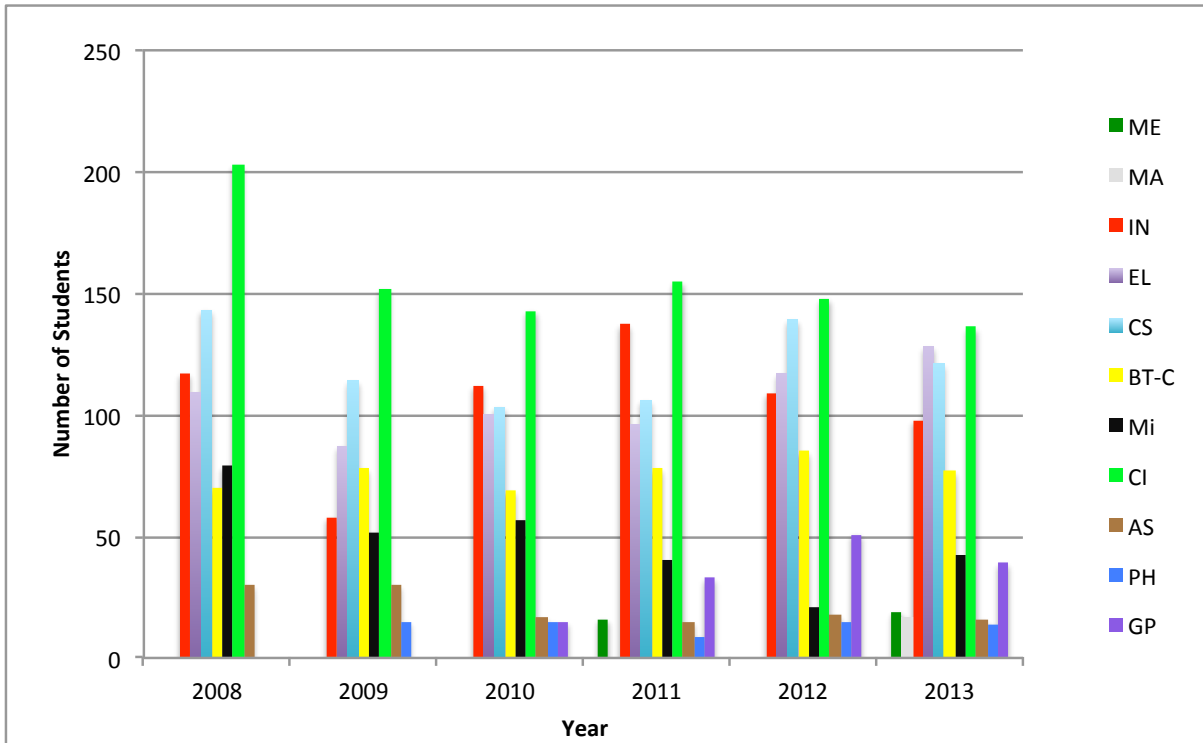


Figure 1: Students enrolled in each area of projects

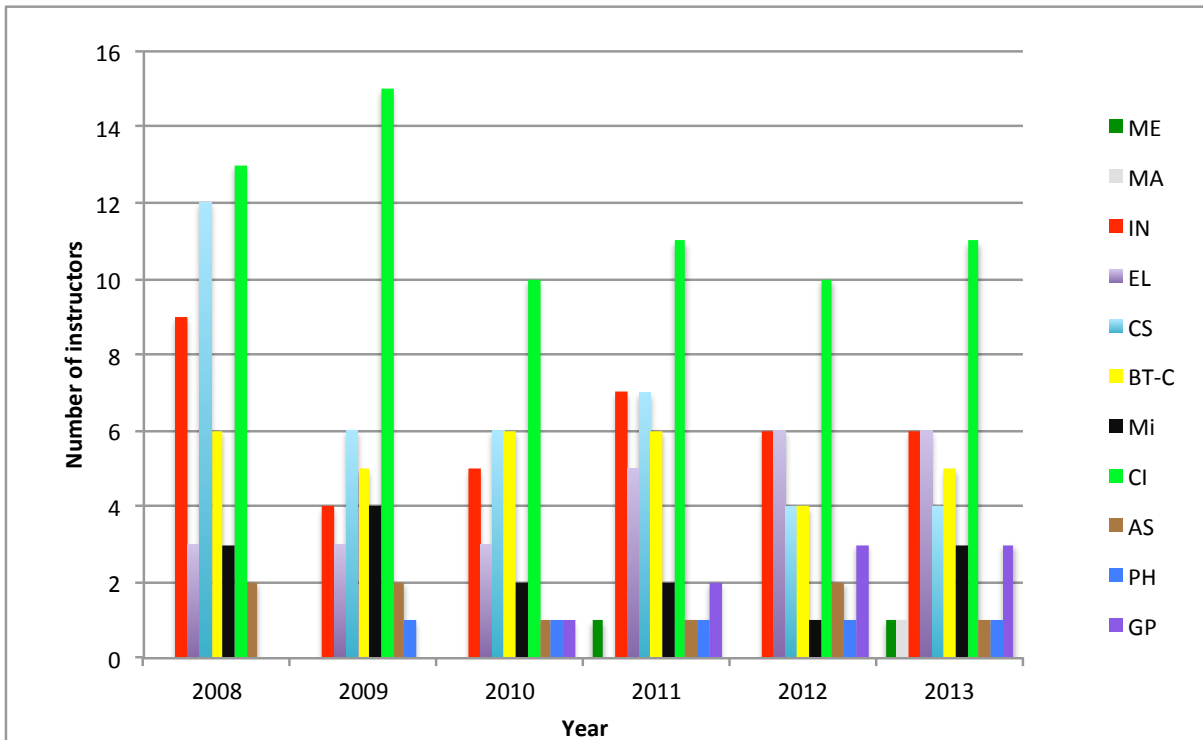


Figure 2: Instructors involved in the course EI2001

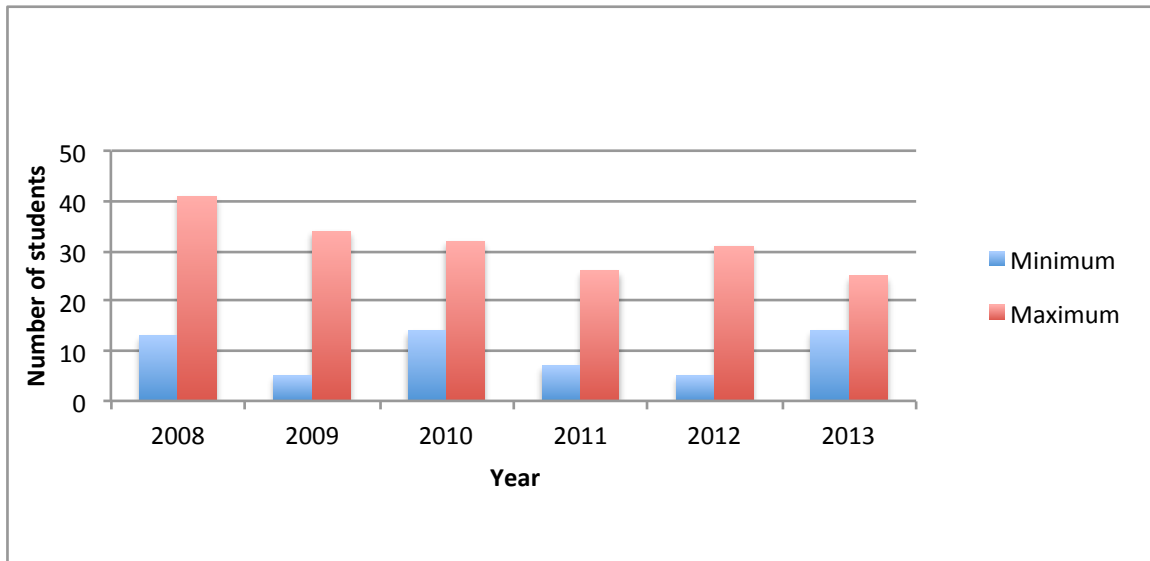


Figure 3: Maximum and minimum number of students enrolled in one section.

## EVALUATION OF THE COURSE

During the semester students are evaluated through oral and written presentations concerning their project and at the end of the semester the functioning of the prototype as well as their performance as a team is the matter of evaluation (see figure 4). The grades obtained by the students range from approved (4) to excellent (7); as seen in figures 5 and 6 the average grade is around 5.8 with a mean standard deviation of 0.54 in all the period, however, every semester, as shown in figure 7 for year 2011, there is a great variability from one section to another. Occasionally students are reprovred in this course and we can find 68 students reprovred in all the period, most of them during Fall 2008 (21 students) and Fall 2012 (21 students); the reasons are attributed to the change of the course from design to implementation projects for the former and to demotivation due to a student's strike occurred during the latter semester. In both cases the reprovred students were from only eight sections.



Figure 4: Mid semester oral presentations and final exams presentations

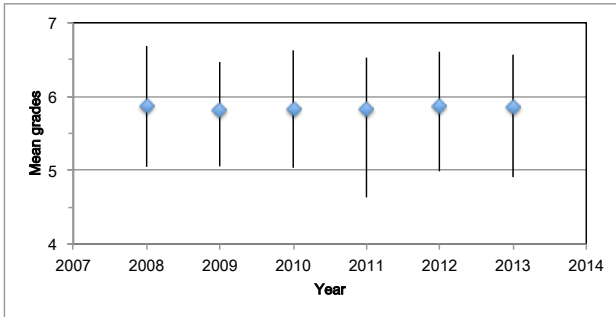


Figure 5: Average grades obtained by students in EI2001, maximum and minimum mean for sections

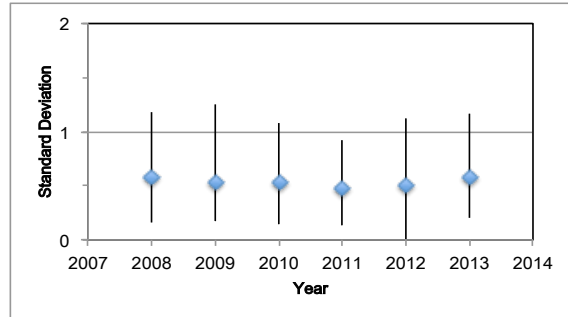


Figure 6: Average standard deviation of grades obtained by students in EI2001, maximum and minimum standard deviation for sections

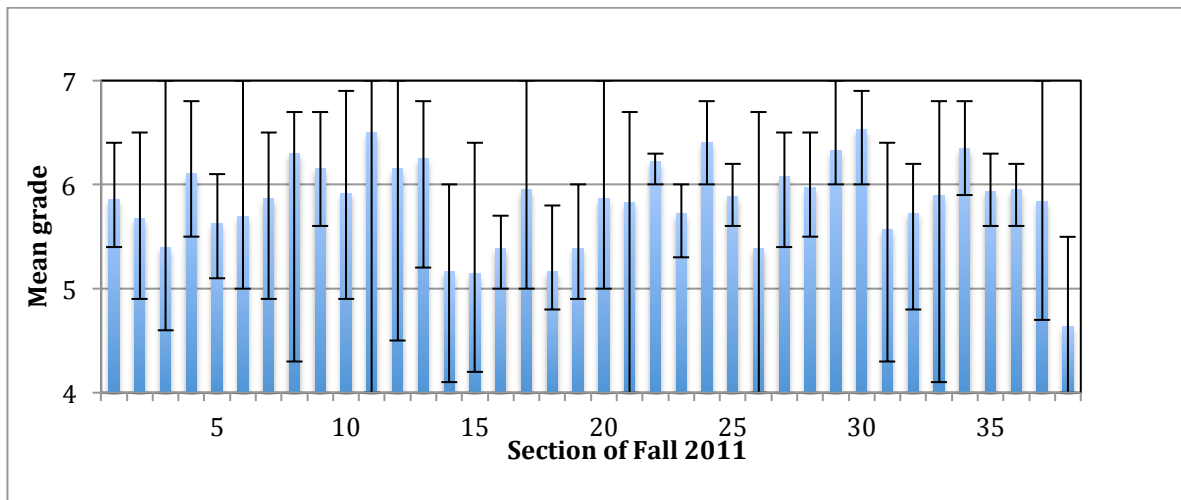


Figure 7: Mean, maximum and minimum of student's grades on sections of Fall 2011

At the end of the semester a project is selected by students or instructors of each section to be presented in a exposition where they present a poster and their prototype. The event is organised in the second or third week of the Spring semester and one of the projects is selected as the best one and also the best poster is chosen by the judges. In figure 8 we can see the a view of one of these events and figure 9 shows the quality of some of the poster presented.



Figure 8: Participants on the exposition of EI2001 course



Figure 9: Examples of posters presented in exhibition of EI2001 course

Workspaces used by students have been evolving from the traditional labs, one laser cutter or their own tools at home to 3D printers and a FabLab where students can fabricate the prototypes they conceived and designed.



Figure 10: Traditional Labs and Modern installations

Students evaluate the course and the professors. In general the opinion about the professors is good about their knowledge but sometimes they feel that the professors are not really involved with the course. The most common claim is that they needed to spend more time than the formal dedication to finish their projects.

## CONCLUSION

The main objectives of the course have been achieved. At the end of the course the student is able to conceive, design and implement, at a functional prototype level, an engineering project of moderate complexity. Students are capable of communicating the data acquisition process, theory involved, construction and performance of the team project, through oral and written presentations; nevertheless rubrics for communication skill should be applied consistently in every section and continuously evaluated in posterior courses. Ethical and social dimensions are not fully taken into account in the projects so these aspects have to be improved.

In summary, the EI2001 course is progressing.

## REFERENCES

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## BIOGRAPHICAL INFORMATION

**Ximena Vargas**, is Associate Professor in the Civil Engineering Department at University of Chile, Santiago, Chile. Her current research focuses on water resources and climate change. She collaborates regularly with the School of Engineering on topics related to curriculum design and the improvement of teaching.

### ***Corresponding author***

Ximena Vargas  
Civil Engineering Department  
Universidad de Chile  
Blanco Encalada 2002, Santiago, Chile  
56-2-29874398  
[xvargas@ing.uchile.cl](mailto:xvargas@ing.uchile.cl)



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