

An Engineering Course for Freshmen: Simulating a Management Company

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Abstract - In ICÉE06, a new experiment involving an Engineering course for freshmen, at PUC-Rio's Technical-Scientific Center (CTC), was presented. This approach handles with a simulation of an engineering company, where different classes of students work in its production or its management departments. The future engineer has the chance of practicing the preliminary steps of his/her profession, in competitive scenes: working as a entrepreneur; creating; innovating; arguing possible solutions of a problem and interacting with multidisciplinary environment. Now, we present how this new idea was applied during last year. The idea of joining production and management activities introduces the student in engineering environments which are simulated, but at the same time, realistic. This project creates a space where different company's departments must interact and shows how actual engineers conduct their jobs. This idea was defined based on high school students' responses to a questionnaire about their choice of future profession. The result of this evaluation showed that 51% of the total number of students (137) wanted to follow a management engineering course, and that they are very sure about their choice. In this paper we also present the questionnaire, its evaluation and argue how our young students choose their future profession.

Index Terms – engineering education, hands-on course, freshman, project management

1. BEING AN ENGINEER: HOW SCHOLAR STUDENTS MAKE THEIR CHOICE

Scholar student's choice for a particular engineering carrier reflects several relevant factors, such as labor market and personal preferences. The student is motivated by internal

elements which attract him/her and give reasons to overcome natural difficulties in order to ingress into the university.

One of these difficulties is related to another choice. Inside the large engineering area he/she must choose only one of several possibilities, such as electrical, mechanics, civil, which in some way must fulfill his/hers most deep wishes and aspirations. And if this option is equivocated, it may cause incertitude, anxiety, sadness and, at least, future drop out of his undergraduate course.

It would be a big mistake think that scholar students come into the university with no idea about his future profession. Great part of high schools has vocational orientation activities created to give them the necessary information and to help in their options for their future professional carrier.

When students ingress the university they are all automatically registered into a hands-on course, named Introduction to Engineering. This is an opportunity to work in engineering projects, and students must behavior like real engineers. And it would be nice if it would be possible to give to students the chance they work just in the engineering topics they wanted to.

So, one of the faculty's worries is to understand and to know about students options for their future carriers, in the very beginning of their course. If these points were well known, it would be easier to handle with initial drop outs, caused chiefly because of equivocated options made by students or what is worst, by the faculty's demands.

1.1 The Questionnaire

In this course, students must develop projects in a particular engineering emphasis and, in general, they are very unhappy if they are instated to work in topics they don't like or, at least, they think they don't like. They insist they are very sure about what they want to do, and in what engineering

emphasis they want to work, when they finish their under graduation program.

During the first term of 2006, in order to understand exactly their feelings, it was prepared a short questionnaire to be submitted to a set of 137 freshmen who were registered in Introduction to Engineering Course, a first term course in engineering under graduation program.

This data collecting was performed to verify if the above assertions were or were not true, and the level of students certitude about their professional options. The questionnaire was composed by seven questions and its results are presented bellow.

1.2 Results related to 137 Introduction to Engineering students' interviews

1. Before you enter the university had you idea about the particular area inside the engineering you would like to follow in the university?

Yes 91.2% **No** 08.8%

2. And what was this area?

TABLE 1
STUDENTS' OPTIONS

Area	Percentage of students
Civil	2.9%
Management	51.1%
Mechanics	5.1%
Computing	5.1%
Chemistry	8.0%
Electrics	5.1%
Environment	3.6%
Naval	0.7%
Oil	2.2%
Mechatronics	2.2%
Automation	5.1%
No answer	8.8%
Total of interviews	100%

3. And now, have you the same opinion?

Yes 88.3% **No** 11.7%

4. Related to your last question's choice, you can assure that:

TABLE 2
PERCENTAGE OF STUDENTS WHO WERE SURE ABOUT THEIR OPTION

Answer	Percentage
I have no doubts; I have already chosen one engineering emphasis	51.1%
I only have doubts between two of them	38%
I only have doubts among three of them	6.6%
I don't know yet which one I will choose to follow; there are so many options	4.4%

Total	100%
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5. When were you sure about your choice?

TABLE 3

WHEN THEY WERE SURE ABOUT THEIR OPTION

Answer	Percentage
In high school	59.0%
During the entrance examination	9.8%
In the beginning of the engineering course (1 st term)	2.5%
I didn't already chosen	10.7%
Other circumstances	18.0%

6. About vocational orientation: (multiple responses)

TABLE 4

HOW DID THEY GET PROFESSIONAL ORIENTATION

Answer	Percentage
I got vocational orientation in my high school	59.8%
I got no vocational orientation in my high school	11.7%
I have made researches in Internet about technical professions	25.5%
I followed the PUC's Introduction to Engineering Course when I was in high school	2.2%

7. About the engineering project topics you have to do

TABLE 5

THE AMOUNT OF ENGINEERING AREAS THEY WOULD LIKE TO KNOW

Answer	Percentage
I would like to choose the topics related exclusively to my professional choice	50.0%
I would like to choose topics related only 2 or 3 different kinds of emphasis in engineering course	46.4%
I would like to experiment topics from several engineering emphasis, because I have no idea of which one I must follow	3.6%

1.3 Comments

The first question shows that students really have an option about his future profession. More than 91% of them said they know exactly what they want to do.

The second question shows the area they selected and it can be observed that more than 50% wants to follow a project management carrier! It is a quite relevant result and shows a change in the scenario of engineering professions in Rio de Janeiro city. Here, the new engineers are directed into the financial market, chiefly banks.

The third question points out that almost all of the students involved in this research didn't change their opinion.

It may be observed, also, the good level of freshmen's professional knowledge and the certitude about their emphasis' choice (question 4). Undecided answers are not representative.

The biggest surprise maybe in question 6, whose answers related to the use of information via Internet showed a very low percentage, about 25%. However, some

hypothesis would be pointed to explain this fact, such as the low capacity in reading long technical texts that can be observed in the greatest part of young students. Information about all the characteristics of engineering professions used by the students comes chiefly through vocational orientation available in high schools.

The process of professional selection is matured slowly in student's mind whose choice would not be changed or influenced in one or two classes, as we can see in question 7. And it is well known that most of them think that this choice would strongly influence his/her professional future.

So freshmen have carefully thought about their carrier and they hope that this fact could be taken in consideration when they enter in the university. It would be wrong to assume that most of freshmen are uninformed and disorientated.

The experience shows that the students final choice is only accomplished after the basic cycle, i.e., after their 3 first terms and, in the most of the cases this final choice just confirms their first selection.

It is also important to stress that, in general, occasional indecisions about the future refer only to 2 or, more rarely, at most 3 emphases. It would be hardly about more than that.

Based upon these results and comments it is possible to point out the idea that students think they do know what they want to their future. So, the most indicated way to assign a student to an engineering project is to assume they are quite sure about their options and to take this fact in consideration.

1.4 "Old fashion" professions

It is opportune to point out to another interesting fact: some professions are, for a short or long period, considered the most attractive and lucrative. Certainly this aspect is always present in students mind and, in a most strong way, also in their parents' mind.

If one or other profession is considered by the community "old fashion" they will hardly be considered in first place. An "old fashion" profession will be preferred only by those students who are strongly focused on that profession.

1.5 Wrong Option

Another important point is related to the disillusion caused by a wrong option. Every year a relevant amount of students get out the university because of incompatibility between students and the course they choose. It is not expressive the number of students who decide to change from Engineering to another course like Administration, Economics, etc, but it is not irrelevant the amount of those who want to change emphasis inside Engineering course. The reason is, in general, due to the difficulties they feel and the efforts they have to proceed.

1.6 The general idea of the engineering professions

Although students say they would to be an engineer, they know that there isn't a general "engineer" profession. They know there exists, or electrical engineering, or mechanical engineering, or management engineering, etc. And this fact is also presents inside all the universities: they have one

separated academic department related to each engineering emphasis.

But the great idea, the most representative points which define the engineering, are almost forgotten. So, when scholar students are asked to choose a particular engineering emphasis before entering the university, they loose this general idea and begin to think in a quite narrow way. And this idea is, certainly, that the project development is the essence of all engineering course's emphasis.

According to these principles, a useful proposal to construct another structure for our course must be take in consideration to give to our students a better professional structure.

It is well accepted that engineers construct, develop, conceive, and execute. They must be prepared to transform "rude material" into services or/and well finished products. They must be able to think and to model. They must to treat with people and teams. These characteristics will be present in their entire professional life.

1.7 An innovator proposal

Examining the ideas involved in last paragraphs it is easy to see that four of them are quite relevant:

- students think they know exactly what must be the special engineering area they want to follow, in their under graduation course;
- more than 50% of our students say that they prefer a management engineering course;
- management engineering has an excellent acceptance in the Rio de Janeiro city
- about 40% of all freshmen indicated they have doubts between only two engineering emphases

It is clear that students will be sure about their professional option later; it will occur only when they will be working in real life. During their course the most they can do is to practice. So, university courses must give them a scene the closest as possible to their future necessities, stimulating creativity, professional responsibility, compromise and competence.

So, thinking of these pointers, a new proposal for the Introduction to Engineering course for freshmen was prepared joining two different areas: electrics and management engineering.

This course is proposed to allow them to have the possibility of making contact with two different engineering areas, what will be useful to understand the essence of each one.

2. A NEW PROJECTS' MANAGEMENT COURSE – AN INTEGRATING PROPOSAL

In the first term of 2006, a new proposal was implemented in the engineering program. This involved 3 classes with thirty students each. They formed 3 different companies conducted by two professors; one of them was the responsible for management – product's specification and quality control, and the other professor was responsible for the development of the new product – research, development and production.

Motivated by “external orders”, the 3 companies should prepare and sell their “new product” in a complete process of industrial fabrication.

This new course was specially designed for freshmen as part of the engineering curriculum. It allows that the essential knowledge for products modeling and management’s projects can be offered to freshmen. Its contents were selected in order to help students to have a good practice in their future professional activities in any engineering emphasis.

2.1 Course Objectives

- Develop a professional conscious allowing a better evaluation of potential products and services;
- Enable to develop scenarios for evaluating products and services;
- Give the capability of products and service modeling;
- Enable to develop engineering projects;
- Habituate the future engineer to budgetary techniques, functional and ergonomics specifications.

2.2 The professional view

Engineers must be impartial related to their emotional feelings: they are not supposed to like everything they must do. So, students must be oriented to work in this way. They must be emotionally and intellectually prepared to consider the real professional life. New paradigms and new concepts are being presented during the course, including the management view.

2.3 Course Definition

This new proposal was implemented during 2006 first academic term, working with 3 different classes of thirty freshmen. Each class represents a different engineering company named Alfa, Beta and Gamma. They must introduce into the market their own version of a new product – a cell telephone based on VoIP.

Each class was divided into 2 parts: the first one worked in company’s production department and the other, in the company’s projects management department. Each of these two departments was directed by a professor, respectively, from Electric Engineering Department and from the Management Engineering Department.

Each company was considered in an independent way but the kind of the future product to be constructed was the same. They have their own proposal and they must act in a competitive way.

Before the beginning of the semester both professors (together) have prepared a kind of “general script” which indicates the way all of the necessary tasks to be performed must interact, in order to allow the complete integration in each company and with all the students.

When students came in their first day in the university, they were informed about their project nature. They were divided into 2 parts and the “course script” was presented by the 2 professors. The 3 companies were, so, initially implanted.

Students who worked in all management departments (from the 3 companies) had initial classes together: they

learned about the fundamental concepts involved in their specific department and about the nature of the new product they had to put in the market. They had specific tasks: fabrication management; sells; industrial control; market; industrial strategies; enterprise management systems.

The same occurred to students who worked in the production department. They had to do: industrial prototypes; physical models; electrical models; functional modeling; the preliminary model development.

How it was showed in [3], this organization can be systematized in figure 1.

2.4 The group’s manager activities

This course was defined through the functional specifications which a new product was supposed to perform. This first and partial version was initially given to the students; it would be worked, increased and completed during the semester. Tasks related to each one of these specifications must be carefully defined. They must be executed sometimes in a parallel way. This fact demands to the student’s teams a special structure, with strong discipline and organization.

The aim of the company was to present to the society a new engineering product. It is a challenge which demands some questions to be presented, discussed, answered, and implemented.

During the process of “constructing” the new product, some tasks must progress, or sequentially or simultaneously, following the projects’ chronogram, such as: its tests, its engineering documentation, its expenses, the kind of this product’s user, the marketing, the necessary technical assistance.

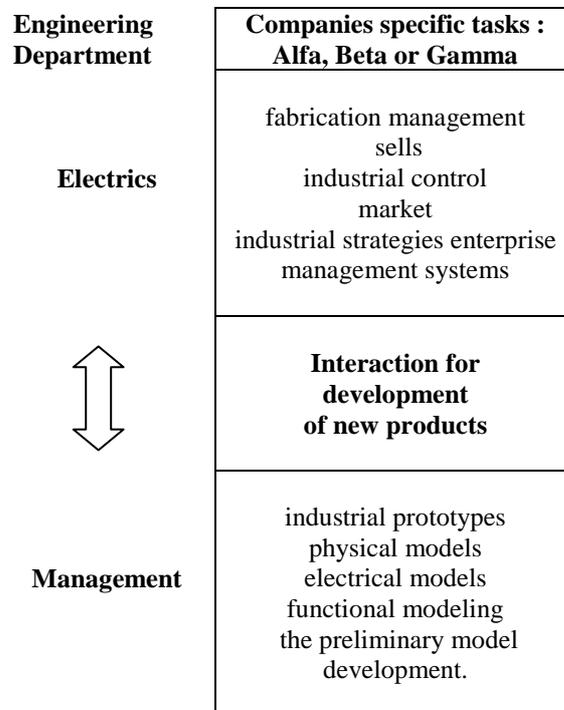


FIGURE 1
COMPANIES ORGANIZATION – SCHEME

2.4 Integration

How it was pointed out in the above, this experiment involved interaction of two different engineering departments; in this particular case, Electrics and Management. This integration was performed through the (virtual) construction of engineering companies, inside of which a new product was created and implemented: students from the electrics department worked in the construction of the new product, whereas students from management department work in this specifications and quality control.

Students was considered the "company's employees". They worked in one of the two departments but they interacted among them and, so they was able to understand how a real company acts.

3. CONCLUSIONS

The experiment's results showed that its goals were fully reached. The 3 "companies" completed their work and "presented to the market" their new products (clearly, in a virtual way). The new proposals of cell telephones were available in Internet, to everyone who wanted "to buy them".

Students said, at the end of the academic term, that they felt just like they were working in real engineering companies and behaved in this way. They fulfill all the formal requirements demanded by the university .

The two groups of freshmen (from electrics and from management departments) successfully performed their tasks, according to their chronogram and all the initial course specifications.

At the end of the semester; an academic meeting was organized in order to present to all students and to PUC-Rio's faculty, the projects developed by freshmen. In this opportunity, all students involved in this experiment have presented their project. They took this presentation the most seriously as possible: they seemed to be happy and comfortable; they were dressed very formally; they spoke loud and clearly; they were quite proud about the work they have done. And they behaved like young entrepreneurial: they look at the audience who was in the meeting room, as they were their "potential costumers".

All of them said to be very enthusiastic with the possibility of becoming true entrepreneurial.

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