

## **INDUSTRIAL CHALLENGE ASSIGNMENT IN CURRICULAR CONTEXT**

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### **1. INTRODUCTION**

The integration of societal challenges, coming from real industrial corporations, within higher education teaching and learning is becoming of fundamental importance (Felder, Brent, & Prince, 2011; Nottingham, 2016). By doing so, students learn how the things they learn in the classroom are connected to the real world, and, at the same time, explore career options. Corporations have the possibility to interact with future employees that will have a better comprehension and expectation knowledge of the workplace. Higher education institutions benefit from a generalized improvement of students' motivation and improve the schools' relationship with the community (Gabriel, Valente, Dias-de-Oliveira, Neto, & De Andrade-Campos, 2018; Lester & Costley, 2010). Furthermore, it is a perfect methodology to relate the teaching content, either fundamental and applied knowledge, with society challenges and achieve a good balance between intense fundamental skills and transversal soft skills that are currently demanded by employers (Davide, 2013; Lemanski, Mewis, & Overton, 2011). It is in this context that the curricular unit of Advanced Production Technologies of the University of Aveiro has been promoting assignments to solve real problems presented by regional industrial corporations. Students are requested to analyze technical challenges and seek solutions sustained technically and scientifically, but also considering economical aspects. The challenges presented have addressed issues of production organization, production processes or productive innovation. Commonly, students present some initial resistance to the assignment, probably because it is one of the first times they must deal with industry environment, nevertheless, the final perception is of satisfaction and validation of the methodology adopted. In this presentation, some of the challenges presented in the last years will be highlighted, as well as the evaluation of its application.

### **2. CHARACTERIZATION OF THE CURRICULAR UNIT AND ASSIGNMENT**

#### **2.1 Advanced Production Technologies course**

The curricular unit of Advanced Production Technologies is offered as an optional course to fifth year mechanical engineering students (Integrated Master in Mechanical Engineering of the University of Aveiro, Portugal) and it's a mandatory course of fourth year industrial management and engineering students (Integrated Master in Industrial Management and Engineering). It is also an optional course of the Nanosciences and Nanotechnology PhD Program. It is classified with 6 ECTS credits (European Credit Transfer and Accumulation System) and has 4 hour per week of theoretical and practical contact.

The course scientific area is in Mechanical Engineering and its learning objectives are to promote an entrepreneur mindset in the use of manufacturing technologies, whatever applying conventional processes or making use of the most recent and cutting-edge science breakthroughs. Topics such as product requirements; materials and material properties; processing technologies; additive manufacturing; microtechnology; nanotechnology; design for x; fabrication economical

costs and environmental impacts are covered. Different activities, such as the one described in the present paper, intend also to promote training in transversal skills. The evaluation of students, in discrete evaluation (the main evaluation form) is done by means of two group assignments and a final semester test. The test account 30% of the final grade, the present assignment 30% and the second assignment 40%.

## 2.2 Assignment description

The assignment intends that students analyze a real industrial problem and suggest a solution. Previous to the challenge presentation to students, a regional production company is selected and invited to offer a production problem that can be analyzed within advanced manufacturing technologies.

The assignment must be developed in groups of 3 to 4 students and represents 30% of the final grade of the curricular unit for student in discrete evaluation. Students in final evaluation are not enrolled for this assignment.

Students and other people involved in the assignment must compromise to keep all information accessed confidential. Additionally, students and companies are informed that if the assignment creates truly innovative products or systems that may be object of intellectual property registration, the copyright will be given to the University of Aveiro and to the company. The copyright given to the University of Aveiro will not jeopardize the rights of the students to be designated as creators, inventors or authors of the invention or creation, as well as the teachers and other involved staff.

The assignment has as evaluation criteria: (i) problem identification; (ii) solutions presented (and their technical and scientific accuracy); (iii) investment prediction; (iv) revenue forecast; and, (v) compliance with established rules. Solution proposals that are merely commercial solution will have a penalty of 25% in their score. It is intended with the latter to motivate students to pursuit engineering solution, eventually integrated with solutions available in the market.

The assignment is developed in the first part of the semester, within one and a half month to two months. In the middle of the development period, a follow-up presentation must be done in class. At the end, students must present their proposal in class, with the presence of the contact persons of the company, handover a technical poster of the proposal using a given template and a technical report with a maximum of six A4 pages plus annexes. The presentation time is limited to 6 minutes. Questions and answers to each group is done only after all groups have presented their proposals. Figure 1 illustrates three posters developed within the assignment. The template is provided.

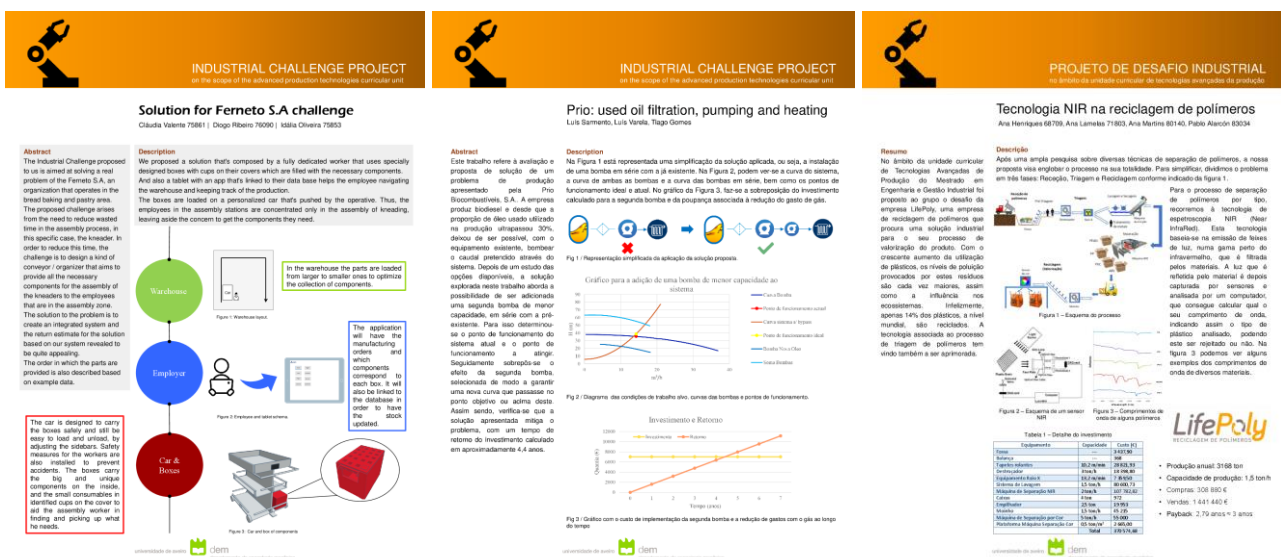


Figure 1. Three examples of posters developed within in the assignment.

### 3. CHALLENGES CASES

The assignment has been proposed since the first semester of the academic year of 2015-2016. The companies and challenges proposed in the assignments from that date until 2017-2018 are presented in Tab 1. The presented challenges involved production organization, production processes or productive innovation.

Table 1. List of companies and challenges proposed in the analyzed time.

Acad. year	Semester	Company	Location	Challenge
2015-2016	1	Autofer	Águeda	Metal profiles cleaning
2015-2016	2	PJF	Aveiro	Reduction of the number of rejected parts from the stamping line
2016-2017	1	Pinha	Águeda	Stainless steel sheet welding
2016-2017	2	Lifepoly	Oliveira do Bairro	Screening and identification of plastic waste
2017-2018	1	Prio	Gafanha da Nazaré	Oil Pumping
2017-2018	2	Ferneto	Vagos	Organization of the manufacturing process

Some of the companies were contacted with the help of RM Consulting, a consulting company working in production organization, such as lean processes.

### 4. RESULTS DISCUSSION

Within the framework proposed by the assignment it is now relevant to analyze the perception and appreciation of the leaning and teaching outcomes by the involved agents – the students; corporations; and teachers. Is the assignment contributing to the goal of integrating societal challenges within students' mindset development? Are students being able to connect the subjects that they learn in the classroom with the challenges of the real world and develop a better comprehension of the workplace? Are students motivated by the assignment? Are companies satisfied by the technical results proposed and with the interaction with students? Is the university-business relationship improved? Are students fundamental and transversal soft skills improved? At the end of each assignment, a small open survey was send to students and companies, to attain inputs to the above mention questions. A resume of the obtain answers are presented in the following sub-sections.

#### 4.1 Students appreciation

Students main appreciation to the assignment were:

- *The problem showed us the difference between an academic assignment and an assignment for a company.*
- *We realized that some concepts cannot be applied linearly in the company.*
- *There should be more initiatives such as this one so that we could understand how companies work.*
- *I loved doing the work. It put us close to the industry and facing real problems. It was one of the few works that gave me joy to do since I entered university.*
- *It would be good to see some of our solutions being implemented by the company, and to have information on how the solutions changed the organization.*

- *This challenge did not add or contribute to a deepening of the topics taught in this curricular unit.*

Globally speaking, students attribute value to the assignment and even encourage that more curricular unit assignments could be developed with interaction with the industrial sector. Nonetheless, not all feedback was positive. Some students didn't attributed significance to the work.

## **4.2 Companies appreciation**

Corporations main comments to the assignment were:

- *The fact that the students have to analyze the investment and the return is very important.*
- *It's a pity we did not have more time to dedicate to you.*
- *Be persistent.*
- *Although the solutions presented may not be directly applicable, they are the source of new ideas.*
- *The challenge is a great way for future professionals to get to know our company.*

Most of the companies, if not all, pointed the importance of merging the technical proposals with the required investment, training of staff and revenue of the investment. This was considered an added value of the assignment and it was recommended that teachers reinforce this point in their classes along the curricula. The openness of companies to receive students and interact with them after the first visit depended very much on their own availability, but company personal always pursuit students to be pro-active and persistent to attain the information needed. Companies also recognize that the assignment is a good source of new ideas and solution proposals, besides considering that it was a good opportunity for them to interact with potential future collaborators.

## **4.3 Teachers appreciation**

Teachers evaluation of the application and results of the assignment were:

- *The challenges contribute significantly to the promotion of student's transversal skills.*
- *Technical skills are also better internalized by students.*
- *In general, both students and companies consider that the challenges have an added value.*
- *The work helps to link classroom teaching with the factory shop floor practice.*
- *Students begin by having a lot of resistance to this kind of assignment.*
- *It is not always easy to come up with challenges that are completely aligned with the programmatic contents of curricular unit.*
- *Logistics of visits is always complex.*

The teacher and other staff involved with the application and management of the assignment consider that it is a good methodology to open students' mindset to the challenges they will face in a near future in the workplace. It promotes competences that were not yet developed within their academic path, such as a direct relationship with companies. Provably because of the originality of the assignment, the number of students reluctant to the assignment is considerable, nevertheless, at the end of the work, it is positively considered by the most. Some students still consider the assignment a waste of time and that it does not contribute to their academic development. The logistics of the assignment is always complex. Not all companies are willing to receive a group of about 50 students and share with them their problems. Then, transportation is required for the first visit and a suitable date for the final presentation, that can suit the class but also companies personal.

## 5. CONCLUSIONS

In conclusion, one can state that the proposed assignment contributes to the goal of integrating societal challenges within students' mindset, while developing their technical and transversal skills. In most of the cases, the challenge creates the condition for a real interaction between students and industrial agents for the first time in their university studies. The assignment also contributes to the integration of the knowledge obtain from different classes to solve a concrete problem and for a better comprehension of the industry.

Although not all students consider the assignment to have a positive impact in their academic studies, most of them value the experience. Companies have expressed their satisfaction with the assignment and it is consider that this type of interaction has a positive impact on the university-business relationship.

## 6. ACKNOWLEDGMENT

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