

Eco-design and eco-efficiency competences development in engineering and design students

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Abstract – In this work, the methodology to develop vital competences and a mindset to rethink products, production and business models in engineering and design students is described. These future professionals will play a key role on the development of sustainable products. Within Eco-design and Eco-efficiency curricular unit an assignment was developed that consisted on the development of an eco-design and eco-efficiency study of a given product, provided by a real industrial company. The challenge description and application is reported, as well as the key conclusions.

Keywords - Circular Economy, Eco-design, Eco-efficiency, Life Cycle Assignment.

INTRODUCTION

There is a need to produce goods with lower impact on nature, reducing the use of raw materials, minimizing energy consumption and promoting long and circular product life cycles (Bovea, 2012, Knight, 2012, Pigosso, 2013, Santoyo-Castelazo, 2014). This challenge is integrated in the Eco-design and Eco-efficiency (EDEE) curricular unit at the University of Aveiro (Portugal) where activities are developed to promote an entrepreneur mindset for the creation of sustainable products and processes, in scope with industrial trends of digitalization and circularity.

One of the key activities proposed to students in the academic year of 2018-2019 was the development of an Eco-design and Eco-efficiency project of selected products in their industrial production environment. For the latter, each group selected a product/company of a given pool. This products and companies were arranged by the curricular unit teachers and are presented in table 1.

In this work, the describing of the assignment and its application is reported, as well as the key results obtained.

METHODOLOGY

The assignments were developed in groups 4 to 5 persons. Each group must be composed by students from at least two different courses. The curricular unit is an optional discipline, offered mainly to Mechanical Engineering master students and to Product Engineering and Design master students. The assignment represents 60% of the final grade of the curricular unit, whether students are in discrete or final evaluation.

CASHE

The development of the assignment can be divided in three parts. The first stage is to clearly identify the product and fabrication process (as done by the company); second, students must perform an eco-design analyze of the product and an eco-efficiency evaluation of the production process. This should be developed as a Life Cycle Assessment (LCA) of the product, considering the product from cradle to grave. Finally, proposals to decrease product impact should be projected. In this last stage, students should rethink the product to decrease the resource use intensity, giving priority to the use of renewable materials, including recyclable and/or bio-based materials, and with less hazard and risk (for humans and the environment) and reuse of materials. “Modularization” of the components, allowing easy disassembly, recovery, reuse and end-of-life screening (standard components) may be considered as well as the definition of recycling, reuse and life-cycle extension criteria, considering possible useful applications of by-products and waste. Groups should pursue ways to attain more efficient and cleaner production models, producing more, at lower prices, with fewer resources, less waste and less impact on the environment. Proposals to convert the business model to a circular economy business model are also encouraged.

The assignment must be development respecting the pace of the following milestones, distributed homogeneously throughout the semester:

Milestone 1 | Product and production description (current situation). A 3 minutes video explaining the product and the production process must be delivered.

Milestone 2 | Life cycle assessment of the product (current situation). A 5 minutes video presenting the current LCA of the product and production process must be submitted.

Table 1 - Companies and products studied in the assignment

Company	Location	Product(s)
Composite Solutions	Vagos	“Waterlily”
Levira	Oliveira do Bairro	Office desk and cabinet
Mistolim	Vagos	Detergent Pack
Moldit	Loureiro	Gardening vase
OLI	Aveiro	Toilet flush (bathroom)
PNH	Águeda	Restaurant toaster and fryer
Ramalhos	Águeda	Bakery oven

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Milestone 3 | Eco-design of the product and production processes eco-efficiency. A 5 minutes video explaining the eco-design and eco-efficiency proposals must be handed.

Milestone 4 | Full assignment presentation and discussion, in the company to the company people.

Milestone 5 | Final report delivery. The technical report must have a maximum of six A4 pages complemented with the needed attachments.

Although class materials are all in English, the official language of the curricular unit, the deliverables, presentation and discussion above mentioned, can be either in English or Portuguese. Also, the milestone deliverables can be reformulated at any time until the final exams period.

Because the development of the assignment needs access to production data to properly instruct the inventory stage of the Life Cycle Assessment, students and other people involved in this assignment must compromise to keep all information accessed and deliverables confidential. Complementary, if the assignment creates truly innovative results 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 deliverables were organized by the class teacher in a private webpage.

FINDINGS

Within the framework proposed by the assignment it is relevant to state and analyze the key findings, including if the assignment has contributed to the goal of promoting an entrepreneur mindset for the creation of sustainable products and processes, as well as promoting a better comprehension of the workplace and industry environment.

The working assignment promoted an active and independent interaction of students with local companies. Although some communication difficulties reported by student (“*company contact send us the inventory information very late*”, “*they didn’t send us all requested information*”) and by companies (“*students must be more precise in what information they need us to provide*”), the overall sense is that the assignment created the condition to student to acquire a critical and innovator sense in relation to the way that products are manufactured, being therefore better prepared to develop optimization projects, problem resolution in this technology area and development of entrepreneur project that incorporate eco-design and eco-efficiency philosophy.

Intermediate milestones were very important to promote a working pace. The first three milestones were delivered in short length video format. To the majority of students, this was the first time that they had to produce and edit a video of this type. It was considered a good strategy to also promote

new transversal skills. In future, the third milestone may be requested in poster format instead of video, so that skills in poster production can also be developed and to reduce the number of videos requested. The mandatory blending of students coming from different courses and with different backgrounds were not well accepted at the beginning but were later pointed has a positive point.

CONCLUSIONS

Today’s engineering and design students will be the builders of the tomorrow products. Sustainability is a responsibility of each one of the inhabitants of planet Earth, but engineers and designers play an important role in this. It is therefore of vital importance that they develop competences and a mindset to rethink products, decrease the resource use intensity, pursue ways to attain more efficient and cleaner production models, and to convert linear business model to circular economy business models.

The proposed challenge contributed to the goal of integrating societal challenges within students’ mindset, while developing their technical and transversal skills. The assignment created the condition for a real interaction between students and industrial agents.

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