the Learning Network on Sustainability

MODEL FOR THE DEVELOPMENT OF OPEN SOURCE PRODUCTS MOD+RE+CO+DE

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ABSTRACT

The teaching of sustainable strategies for product design should be structured to propose a fast transition to circular production models, more suitable for the optimal management of resources currently available. These models must be articulated from the academy in each of the stages of product design and allow an open collaborative development of the knowledge generated, so that it be appropriated quickly with tools that facilitate the integration of sustainable methods, concepts and objectives. Mod+Re+Co+De is an exercise that unites diverse concepts, seeking that this transition takes place sooner in the academy and that can transcend to the design of circular products.

Key Words: open source design, circular economy, design method.

INTRODUCTION

In industrial design one of the most important methods for the definition of components and structural detail design is the product architecture, used both in the formal configuration and the function of the components, affecting the manufacturing processes and the useful life of these products. The product architecture defines how the different systems will be integrated and how they will make an equipment to work, how they will be used and the user interface.

Different strategies applied to design and focused on developing the sustainability of products from an "eco-pluralist" philosophy Loy, J (2008) can become fundamental in the teaching of sustainability and therefore in the definition of the proposed architecture, thus, design for X[1] or design by components[2], can impact on such architecture, affecting from the productive processes to the selected materials and the product-service system connected to all those activities necessary for the maintenance of the useful life of the product.

On the other hand, it should also be borne in mind that many of the strategies that can be applied in product sustainability and focused on the use of materials and subsequent recovery processes, are not being developed in accordance with the product architecture, but there is evidence of a disconnection between both processes. Components that must be replaceable after a period of time established by wear and tear, consumables necessary for correct operation but with a very short time of use, or elements that have a main function of long duration, must be developed in accordance with the product architecture and sustainable strategies for the maintenance of a useful life according to the function provided.

BACKGROUND

In Colombia, product architecture is a subject that is widely used in the different schools or faculties of design and engineering. This "method" is used for the structuring of the components and systems of a product in the detailed design rather than in sustainable management, although it can be a quite useful tool for this management. Different design faculties in the country base their contents on sustainability in environmental issues and almost all of them are structured around product life cycle analysis, or in the selection of materials and processes of lesser impact, evidencing a lack of variety in strategies that connect the design of products with the sustainable management of projects.

With respect to open source[3] in Colombia, its application predominates the digital world. In this regard, "the country is timidly approaching the development of open source solutions that are widely visible in the world"[4]. Proof of this situation is that in a country of almost 50 million inhabitants, only 89 software projects and open source applications are registered in the Colombian Public Software platform[5]. Despite this progress, in other productive and knowledge areas, open source is practically relegated and little exploited, with a lack of solutions other than software development, which ensure responding to market trends and the needs of a world that sees collaboration as an alternative to the failures of a productive, economic and social model that every day widens the gap between sustainability and inefficient use of resources.

The Open Source revolution gives the possibility not only to individuals but also to communities to be able to have in their own hands the instruments to improve their own life and also that of others, without having to ask permission or without having to have large amounts of money to achieve it. One of the most outstanding examples is Arduino[6] which is the world's leading ecosystem of open source software and hardware. The company offers a range of software tools, hardware platforms and documentation that allow almost anyone to be creative with technology, originally started as a research project at Ivrea's interactive design institute, Turin in 2000. Other example is Casa Jasmina[7], a project in the business space of home electric networks or "Internet of things in the home". Born in 2015 as a two-year pilot project, Casa Jasmina has become a permanent and continuous project. The aim of Casa Jasmina is to integrate traditional Italian skills in furniture and interior design with emerging skills in Italian open source electronics.

In 2016 the OSCED network[8], which seeks to develop an open source model for the circular economy and has been working on it since 2014, joins the Disruptive Innovation Festival[9] developed by the Ellen MacArthur Foundation, an event from which the need to make a transition to production processes more in line with the sustainable use of resources and the free distribution of information is raised, for which more than 30 contributions were requested and proposed based on the development of proposals for a future circular city projected to 2050.

HYPOTHESIS

It is considered that a model for product design based on a modular architecture with clearly defined sustainable specifications may allow a much faster transition to a circular economic model, where greater value is given to the

[1] Watson B., Radcliffe D. (1988), Structuring Design for X Tool Use for Improved Utilization, Journal of Engineering Design.

[2] Bistagnino, L. (2006), The outside shell seen from the inside, Torino, Politecnico di Torino, Document available online.

[3] Term popularized by Eric S. Raymond in the nineties to describe a free access software code not necessarily free pay.

[4] Ana Albir, founder of the Moondropapps company that develop and analise web and mobile products. Recovered from (https://www.eltiempo.com/tecnosfera/novedades-tecnologia/proyectos-en-la-cumbre-digital-colombia-4-0-38253.

[5] https://www.softwarepublicocolombia.gov.co/

[6] https://www.arduino.cc/

[7] http://casajasmina.cc/

[8] Open Source and Circular Economy Days Network.from : https://oscedays.org/

[9] Global event to shift mindsets and inspire action towards a circular economy. From: https://www.thinkdif.co/

components and the recirculation of the resources necessary for the manufacture of products, leaving established from the initial stages of design the useful life time of each component and its final disposition, the functions that the product-service systems must fulfill and project that allow developing an economy of updating, replacement and maintenance of components, focused on the biological and technological cycles[10] of the different components.

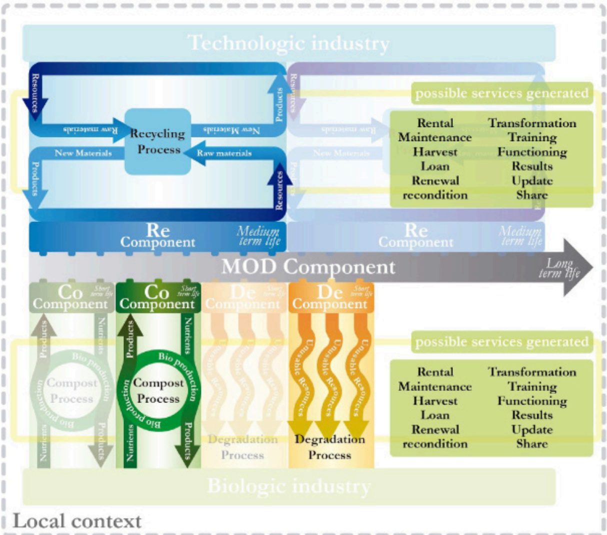
METHOD

For the structuring of this model an inductive method was worked on, proposed as a process of 4 stages (book of methodologies) for the development of products that could be used in the same way in other fields outside the academic. For its development, different work teams of equal number of participants are formed, which must follow specific steps to complete the exercise and be able to evaluate the results of the activity. The exercise is based on a modular product architecture, in which there must be 3 main components (Figure 1):

MOD Component: It is the module that fulfills a primary function in the sectional modular architecture and it is the component to which the others are connected to fulfill the function of the product. Its main characteristic must be to have a long period of useful life, for which its materials must be of high duration and resistance for the function it fulfills.

Re Component: These components fulfill one or several secondary functions, but without which the product cannot meet the performance for which it was intended. These components are designed to have a useful life time that depends on the intensity of use and so that they must be RECYCLED, which implies defining very well materials and processes that manage to close the life cycle of the component. Its exchange can be carried out several times in the total lifetime of the product, allowing the whole product to increase the duration of its use.

Co Component: Are those components that do not fulfill a main function but are facilitators for the proper functioning of the proposed product. These components are periodically replaced and have a very short life of use. Their non-implementation does not imply that the product cannot be used, but they help to maintain it in optimal working conditions. At the end of their use they must be disposed to be composted serving as food for new productive cycles.



[Figure 1]Functioning system of the components MOD+Re+Co+De

CONFIGURATION OF EQUIPMENT AND WORK MODE

The teams begin the work by proposing a product used in a common environment to all participants, seeking to facilitate the understanding of the use and exchange of components between them. For the later configuration of the product they must complete 3 stages that include the generation of functions of the components, the development of detail of each component and the rapid prototyping of these.

[Table 1] Exercise Development Stages

Functions definition	Component detail development	Rapid product prototyping	Group reconfiguration/ testing	Circular productive structuring / Service product system
Originally raised exercise			Exercise Upgrade	
Group definition of the characteristics and base components for all pieces of equipment, individual functions per component.	Detailed development of the components to comply with the established parameters.	Development of conceptual models and volumetric prototypes that allow to understand the configuration of components to carry out verifications.	The teams redefine their components bearing in mind that they must be able to be exchanged and used for other products.	Define the product service systems associated with the development of economic models for the circular production of the necessary resources for the proposed products.

10. Ellen MacArthurFoundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braugart & McDonough, Cradle to Cradle(C2C)

DEVELOPMENT AND REVIEWS

The first moment of verification was during 2 weeks of class in 2016, in which worked following the proposed stages and where the teams were able to configure proposals for use in the context of the Colombian rural home. Since then it has been used in 5 academic semesters with 14 courses of 30 students of sustainable design of the Pontificia Universidad Javeriana de Bogotá, and whose evaluation of the results obtained has allowed to make adjustments to the whole model:

Introducing a Component De: that maintains the characteristics of the module Co, but at the end of its useful life it should be possible to degrade it in the environment without generating greater environmental impact. (Figure 1)

Increasing the duration of the exercise to 4 -6 weeks.

Increasing the use of digital tools.

Modifying the number of stages, including prototype testing and group reconfiguration, which implies that teams must work together to allow reconfiguration and exchange of components, and a stage of analysis and planning of circular production processes / product-service systems sustainable to show the improvements that can be developed at economic level / technical production / service.

In addition to this, all the generated contents are available to the public in the Envienta platform[11] that allows both that the developments can be shared globally, and that they are improved via “cosmo-localization” Ramos, J. (2017).

Parallel to this academic exercise, the process has been applied to the design of interdisciplinary products in the design of a transfemoral prosthesis for the lower limb, following the parameters proposed by the Materialización 3D foundation under the tutelage of Camilo Salamanca from the company IKU[12]. In this project, the objective was to develop a prosthesis that could be made through 3D printing technology, so that its components could be easily manufactured and repaired, using local raw materials and keeping manufacturing costs below 500 US dollars. The final result of the exercise is a prosthesis[13], currently in the last element testing phase and working with a selected user.

[Figure 2] Documentation academic process / first industrial exercise, Transfemoral prosthesis Retrieved from https://community.oscedays.org/t/action-prototype-a-circular-product-mod-re-co/5521/47

ACADEMIC RESULTS

This exercise has generated a dialogue on the technical aspects and characteristics that a product must possess in order to be implemented in a circular economy in an open manner, a subject that is little discussed and known by educational institutions and local companies. A large number of the students who have developed the activity have expressed a quicker understanding of the topics discussed and, above all, the implications that this would have for the industry, both in logistical and productive aspects, as well as in economic issues. Another point that has been identified is that many of the functions proposed for the components are initially very basic and disjointed, which makes it difficult for them to understand the integration processes both between their components and between the products of the various teams.

CONCLUSIONS

So far, the results of 5 academic exercises and 1 practical exercise have shown that this proposed model can be useful to extend the application of sustainable strategies to different areas of product design, allowing us to understand that the sustainable approach is transversal to the different stages of product development.

The quality of the projects presented has progressed positively with the introduction of the updates mentioned in the activity and has been much more valuable for students the integration of equipment for structuring the shared components, in addition to it has served to better understand the product architecture and systems sustainable service product. As expressed by the students who have participated in the activities, the exercise has allowed to understand concepts of circular economy and product-service systems faster and more practical than in master classes.

As a future proposal, is to develop an activity integrating the academic exercise with local companies, which can be developed within their current processes and to test in industrial reality the concepts raised by students.

11. http://platform.envienta.org/

12. http://iku.com.co/nos.html

13. Ellen MacArthurFoundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braugart & McDonough, Cradle to Cradle(C2C)

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