

Product Design Education for Circular Economy

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Abstract. Design has continually developed new approaches to find the most appropriate solutions to the growing environmental and social problems. At the same time higher education courses have tried to adapt their curricula accordingly. The most recently proposed model is circular economy. It reinforces the idea of a paradigm shift to a system of closed loops where there is no waste. This article develops a state of the art on the integration of sustainability in product design in higher education and its evolution to embrace circular economy. This analysis includes identifying past experiences, which contents are addressed, what methodologies are used, what type of approach (focused or dispersed) and what are the needs for teaching staff. This paper tries to identify gaps in order to purpose better solution for circular economy integration.

Keywords: Design Education · Product Design · Sustainable Design · Circular Economy · Circular Design

1 Introduction

Humanity is at an historic moment, full of particularities and challenges. Our success as a species has brought us significant benefits, like an exponential demographic growth, but that has been based on a development paradigm fully supported on economic growth. This brings enormous pressure on natural resources and ecosystems, creating environmental problems of various scales and complexities, of which climate change is the most significant. Associated with these problems, but also with many other inefficiencies of contemporary societies, social inequalities continue to increase. On the other hand, we live in a period in which Humanity is more capable than ever to face challenges, in which technology plays an increasing role and where design is assumed, in a multifaceted and growing way, as a discipline with the potential to positively contribute to global development. Design is considered one of the main responsible for the circularity of products [1] and, together with technology, innovation and the responsibility of production and consumption, is seen as one of its main facilitators [2].

But for designers to be able to practice sustainability in an effective way it is necessary that they receive solid training. It is very important for designers learn about

sustainability, social responsibility and the circular economy (CE), namely its key concepts [3] in order to take advantage of this opportunity and make a difference. It is then necessary to know the teaching of product design and know how it has been adapting and creating knowledge to develop a capacity in the area of sustainability. It will be important to identify the relevant and innovative skills and content, but also which pedagogical practices are the most appropriate for this creation of skills.

2 Methodology

The work exposed in this article is based on a methodology of critical review of literature, based on the analysis of articles on product design education for sustainability, in its various stages of development.

3 Circular Economy

The multitude of summits, strategies, declarations and international protocols have contributed positively to promote a solution to the environmental problems but have always fell short of solving it entirely. The most recent strategy presented by the European Commission [4] is CE, which aims to help citizens and companies to make a transition to a stronger and more sustainable economy, proposing to close the production and consumption cycles by increasing the recycling and reuse, extracting the minimum amount of raw materials, promoting energy savings and reducing greenhouse gases [5]. In the European guidelines one can note that design is considered in a direct and relevant way as a tool to support the development of this plan, differently to what happened in the previous plans.

The changes in mentality and the pressures that the business and industrial companies have been suffering due to economic crises, pollution and resource depletion [6] make the concept of CE, which is relatively new, gain attention and traction, as it is seen as a way to continue to increase prosperity while reducing dependence on materials and energy, managing to change the current paradigm of production and consumption of linear economy [7].

CE advocates to close and slow the cycles, that is, tries to replicate nature, where the water and nutrient cycles are abundant. In our daily lives, we have to move away from the linear optics of producing-using-throwing away [8] and thus interpreting this new CE strategy as the new paradigm of sustainable development, while still distinguishing the two concepts [9].

But we must not forget that the third pillar of sustainability has to be addressed. In the production and consumption system, the social function can be worked through corporate social responsibility [10]. Knowing that the activity of organizations generates positive and negative impacts at the economic, social and environmental level and that in a context of globalization, companies are increasingly under the jurisdiction of laws of various States, under the scrutiny of a more demanding public opinion, social responsibility is an instrument through which companies can contribute to a fairer society and a cleaner environment [11].

It is also important to bear in mind that the essential basis for the implementation of sustainability is education. This happens in general training and, more importantly, in education in the area of product design. CE has been very advocated, but it is not yet being widely practiced [12], for this it is necessary to facilitate the education of this theme.

4 Evolution of Product Design Education Towards CE

Higher education institutions have an important role in the promotion of a paradigm shift towards sustainable development. For that to happen they need to go beyond the simple integrations of key ideas in the course contents [13]. And need to overcome the constrain of having curricula that are already packed with other important content [14].

4.1 Ecodesign and Design for Sustainability Education

Looking at the international panorama of product/industrial design education, most of the courses have mandatory or optional curricular units (CU) to integrate sustainability, but there are also several institutions that present 1st cycle degrees totally guided by this theme. The majority of the CU addresses contents in the scope of ecodesign, focusing on life cycle analysis, lower impact materials or recycled/reused material [14]. The development of ecodesign CU, even when based on the same matrix of contents like the PROMISE Ecodesign Manual [15], have to take into account several variables of the local context, like profession background, experience, learning style, local economic developments and cultural context [16]

The ecodesign CU are structured with both theoretical and practical dimensions, with contents ranging from general information regarding sustainable development to specific operative design decisions. The operationalization of this content, similar to the professional context, is made through the use of guides, strategies and tools like “Ecodesign in Higher Education Guide” [17] or other qualitative and quantitative tools. Some programs use student-led seminar to promote the widespread dissemination of the contents throughout the entire class. To enhance the motivation of students in the apprehension of this type of content and development of skills, some universities establish contact with real companies to frame the projects/exercises being created, which proves to be a win-win situation [18].

Most approaches focus on the integration of concepts only related to the environment (ecodesign), but it has been known for a long time that extending the scope of sustainability to integrate social aspects, although a challenge, results in a richer learning process, with greater credibility and acceptance [19].

So that the high number of elements related to sustainability does not cause confusion and dissatisfaction in students during their learning process, the evaluation processes has to be simplified, focusing on the students' ability to identify options for sustainable product concepts and to be able to evaluate these options [19]. Also, since the complexity of sustainability may present added difficulties in conceptualizing solutions, an approach based in systems-thinking, interdisciplinary and anticipatory presents improvement in students' skills [20]. To ease the learning curve of sustainability, literature states that it should be introduced early in the courses, it should

have a bigger importance in the course, that it should be linked with the design studio CU and this contents should be made an expectation rather than an option [21] [22].

The integration of sustainability in product design courses requires a method that links theory with design projects, especially with real-life partnerships with companies, so that students can develop their own case studies in a transdisciplinary way [24].

Several authors indicate that due to the increasing complexity and multidisciplinary of design for sustainability, that integrates criteria from social sciences, renewable energy, corporate social responsibility, social innovation, etc., these contents should not be constrained in a dedicated CU, but should be divided in more than one [20] or dispersed throughout the entire course [24]. Others argue that only through a focused design for sustainability approach throughout the entire program a truly paradigm change can come [25].

The effective transition from ecodesign to design for sustainability pedagogies required comprehensive resources, but also faculty with expertise [23] [24], and this expertise should be connected with professional experience of faculty and fully disseminated among students, since the lack of knowledge in designers is one of the major barriers identified to practicing sustainable design [26]. It should also be noted that the support and autonomy given to faculty may be very important to integrate sustainability in their teaching [21], and this can be a problematic issue, since universities are usually underfunded, and staff is burdened with bureaucratic activities.

The integration of design for sustainability in design practice is still not mainstream, but, nevertheless, students need to be prepared with a range of skills to support and promote a fully sustainable practice, for when that may occur [27].

4.2 Design for Circular Economy Education

Since the affirmation of CE that design for sustainability has started to embrace this approach. It presents a more robust relation between the environmental problem-solution and the economy and, from the design perspective, addresses the problems in a more pragmatic way, base in a clearer and more synthetic model [28].

During the last few year practical guidelines have been developed for design practice [29]. But this new approach presents another challenge related with the possibility of creating new business models, meaning designers should widen their multidisciplinary approach. Also, the perspective of reverse cycles, creates more complexity and depth to the life cycle approach that design for sustainability incorporated from ecodesign.

Also, the new designer archetypes, which are not exclusive product creators, but designers of holistic solutions, have to integrate a wide set of skills to meet the diverse requirements of the CE. Business stakeholders are encouraged to seek the development of such competencies in their product development teams to drive successful implementation of sustainability strategies [6].

Design for CE contents should contribute to understand this new model and its implications for a new economic paradigm. They should promote a multidisciplinary approach, bridging different stakeholders, namely through the development of case studies with companies [30]. Besides some of the contents already referred it is essential that students are fully aware of all design for CE principles and strategies. Regarding the methods, some of the more recent and successful results in the area of design education for CE points to curricular units based on a practical methodology, with a

strong design studio nature [31]. For the implementation of this approach several tools were already developed by Ellen MacArthur Foundation and other have been adapted by other sources.

5 Conclusion

Despite the discussion on whether sustainability should be addressed in a specific CU or across the entire design studios CU, or even throughout the entire course has not yet had a conclusive outcome due to the very different contexts where the courses are taught, it's possible to reason that the best solution would be the development on an entire course with a product design for CE matrix. This would be a solution to the problem of having a sustainability CU packed with contents, and without removing too much hours for the regular contents. However, due to the lack of awareness or training from part of the teaching staff it is still difficult to integrate these skills smoothly. To enable the implementation of design for CE contents in regular product design degrees a pedagogical manual should be developed, structured with the theoretical and practical contents, packed a set of case studies and with a robust set of tools specific for learning design for CE. This manual can be adapted from Design for Sustainability but need to respond to CE specificities.

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