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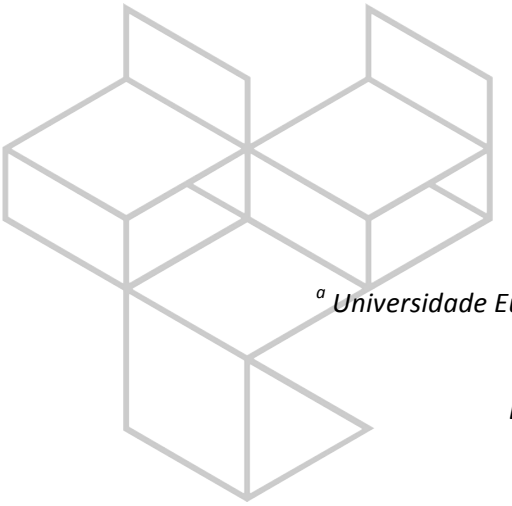

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## ABSTRACT

This paper aims to present the research under development whose main objective is to support an effective and practical transition to a more circular and sustainable economy through design. Currently, circular economy (CE) is gaining attention in Europe and around the world as a potential way for our society to increase prosperity and sustainability by reducing the dependence on primary materials and energy. In this transition towards CE, numerous research projects and activities have and are being developed at distinct levels of society and design has a crucial role, however, there are still several limitations and barriers in its implementation. To implement the model, designers, product developers and companies need to be able to apply the CE principles and criteria in practice in a simple and efficient way. The Ph.D. research project that underlies this paper was designed with the objective of supporting the creation of added value for the design professionals and for the society. Focusing on supporting the transition to the CE, the expected results will strengthen the role of design by providing professionals a strategy supported by effective methods and tools for an innovative and effective design practice.

**Keywords**: Design, Design tools, Design Management, Circular Economy, Sustainability

## INTRODUCTION

The concept of sustainability defined in the Brundtland Report in 1987 as a development model that "responds to the needs of the present without compromising the ability of future generations to meet their own needs" has evolved and has been a widely disseminated and exploited strategy (Brundtland, 1987).

The environmental and social concerns in relation with the design activity had already received attention and, as defended by Victor Papanek in his famous publication "Design for the Real World" (Papanek, 1971) design plays a key role in the definition of the environmental profile of products and services. It is at the design stage that about 70 to 80% of the environmental and social impacts of a product are defined (Sinndesign 2016).

The integration of environmental considerations in product development with the objective of reducing products' impacts throughout their life cycle has been subject of methods development, training and implementation in companies since the 1990's. All products have impacts on the environment, which occur at all stages of their lifecycle, from raw material extraction to manufacturing, distribution, use, and end-of-life.

Today, designers and product developers face a new challenge. The design practice has been recognized as a catalyst to transition from the traditional model of take-make-dispose to achieve a more restorative, regenerative and circular economy. To attend the need for Circular Economy, products need to be designed for closed loops and adapted to generate revenues (Moreno, De los Rios, Rowe, & Charnley, 2016). Design for circular economy, as design in general, has the responsibility of responding to product or service problems,

integrating various criteria and expertise in problem-solving in an innovative way and adjusted to the needs of users. In the circular economy, the designer has the function of translating the strategies and concepts of circularity in the development of products, services, and systems that promote the transition from a linear model to a circular model focused on closing cycles, on the efficiency and sustainability of the system, however, there is a need to provide design practitioners, business stakeholders and product developers recommendations and practices of how to think and apply particular design strategies for different circular business models (Moreno et al., 2016).

The design of a product directly influences the way a value chain will be managed. Building circular, globally sustainable value chains inevitably implies a fundamental change in the practice of design and despite the importance and recognition of the role of design as an engine and promoter of sustainability, there are still numerous barriers to its implementation in practice within companies and businesses (De los Rios & Charnley, 2017; Prendeville et al., 2013).

Numerous research and development activities have been carried all over the world. However, most of the literature is academic or with industrial examples mostly from business-to-business (B2B) level (De los Rios & Charnley, 2017).

Several research projects resulted in tested and validated methodologies and tools for an application in the development of projects in the companies, however, the adoption of sustainability measures is still seen as an accessory element with little commitment from companies and in most cases, its integration is superficial and poorly substantiated. In most of the cases, it is applied having as main objective the use as a marketing tool to promote the product, the company or in some cases, unfortunately as greenwashing (Alves, Ferreira, & da Silva, 2011). There are also numerous examples of research activities and literature developed to support companies to get started and implement sustainability in their process, however, there are very few examples of literature reporting on success cases of the practical application of the methodology and tools (Dekoninck et al., 2016).

The transition to a more sustainable way of design, produce and consume is a crucial objective for the development of our society (Bhamra & Lofthouse, 2007; Braungart & McDonough, 2009; Manzini & Vezzoli, 2010; MARGOLIN, 2014). In 2015 the European Commission adopted an ambitious Circular Economy Package (European Commission, 2015) to help European businesses and consumers to make the transition to a stronger and more Circular Economy where resources are used in a more sustainable way. The proposed actions will contribute to "closing the loop" of product lifecycles through greater recycling and re-use and bring benefits for both the environment and the economy. The plans will extract the maximum value and use of all raw materials, products, and waste, fostering energy savings and reducing Green House Gas emissions. The proposals cover the full lifecycle: from production and consumption to waste management and the market for secondary raw materials.

In December 2017 the National action plan for the circular economy was published by the Portuguese Council of Ministers (PAEC, 2017). The plan is part of the strategy to be followed up to 2020 and aims to redefine the concept of end-of-life of the linear economy, based on the production and elimination of waste, focusing on the concepts of reuse, repair, and renovation of materials and energy.

It is a strategic model of growth and investment based on efficiency and value of resources and minimization of environmental impacts. This is a document aligned with Portugal's international commitments, such as the Paris Agreement, the Sustainable Development Goals, and the European Union.

One of the instruments to support the implementation of circular economy is the design. The plan includes concrete actions to promote the transition to a circular economy and in these the design plays a crucial role. The design community should seize the momentum to promote and add value to its activity.

## Motivation

Changes are taking place worldwide in business strategy and industries face increasing pressures from economic crises, resource scarcity, and pollution (De los Rios & Charnley, 2017). The Circular Economy is gaining attention in Europe and around the world as a potential way for our society to increase prosperity while reducing dependence on primary materials and energy (Ellen MacArthur Foundation, 2015).

Circular Economy is a relatively new concept with a fast development in Europe which is receiving increasing attention worldwide as a way to overcome the current production and consumption models based in so-called “linear economy” or “take, make and dispose model” that depletes natural resources and destroys ecosystems.

In this new transition towards CE, numerous research projects and activities have and are being developed at distinct levels of society and the design has a crucial role, however, there are still various limitations and barriers in its implementation. There is not a systematic approach to its implementation and CE is not already a well-established and mature concept. To implement the model, designers, product developers and companies

need to be able to apply the CE principles and criteria in practice in a simple and efficient way.

In the past, sustainability was widely explored, and despite the perception of practitioners and the society of the need to adopt it in the production and consumption of products and services, in practice, sustainability was seen as a complex subject or as an accessory approach, focused on niche markets with low added value (Ferreira,2003). Despite the potential benefits of ecodesign as a way to implement sustainability in the Design practice, and the existence of several tools and techniques for product design, the actual application of ecodesign has not reached companies worldwide, mainly due to difficulties in ecodesign implementation and management (Pigosso, Rozenfeld, & McAloone, 2013).

## Objectives

The research under development aims to help the transition to a more sustainable and circular economy through design. The design practice has a crucial role in defining the characteristic of the products and services that fulfill the needs of the society and their impacts in the life cycle are defined in the design and development phase. In order to promote design and the practice of design, it is important to assess the maturity of Portuguese companies and designers in the integration of sustainability criteria related to the development process through the analysis of the current design practice applied in the development of sustainable industrial products available in the market. This broad analysis will allow the identification of the current drivers, barriers, and needs faced by practitioners, which will support the development of strategies, methods and effective tools to support designers in the transition to the circular economy.

Circular economy is seen in the current political context as the potential successful path to achieve a sustainable future, a new economic model operating in closed circuits, catalysed by innovation along the entire value chain, is advocated as an alternative solution to minimize material consumption and energy losses (ECO.NOMIA) and designers should have the knowledge and the tools to leverage the process (Vicente, 2012).

The transition to a circular and sustainable economy requires better knowledge about the links between products, their underlying business model and the societal infrastructure and governance determining their life-cycle, which requires fundamental changes to production and consumption systems, going well beyond resource efficiency and waste recycling. Designing products in a smarter and innovative way, extending their useful lives and changing the role of such products within the system will be crucial to the achievement of that transition (European Environment Agency, 2017). Therefore, a new strategy, supported by improved methods and effective tools for designers, is needed.

Within the research under development, the research team aims to identify, explore and develop an effective strategy supported by improved methods and tools which will be easy to apply in practice, in order to promote the transition to circular economy through design.

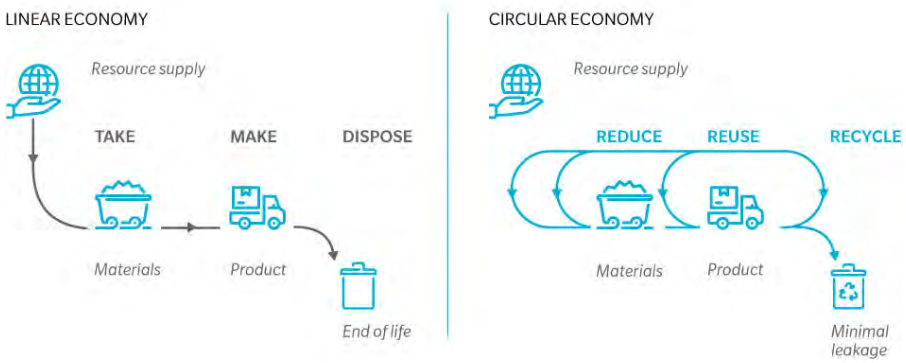


**Figure 1 - Transition from the linear model to circular economy. Source: www.oliverwyman.com**

## Circular Economy and Design

Circular economy is an economic system that is restorative or regenerative by intention and design, which actively promotes the efficient use and productivity of resources. It replaces the end-of-life concept with closing, slowing and narrowing the resource flows in production, distribution and consumption processes, extracting economical value and usefulness of materials, equipment and goods for the longest possible time, in cycles energized by renewable sources, with the aim to accomplish the goals of sustainable development. It is ena-

bled by design, innovation, new business models and responsible production and consumption (Ellen MacArthur Foundation, 2013; Kirchherr, Reike, & Hekkert, 2017; Bocken, de Pauw, Bakker, & van der Grinten, 2016).

Inspired by nature in the mechanisms of natural ecosystems, which manage long-term resources in a continuous process of re-absorption and recycling, the circular economy promotes a reorganized economic model through the coordination of production and consumption systems in closed circuits. It is characterized as a dynamic process that requires technical and economic compatibility but also requires a social and institutional framework (ECO.NOMIA).

The circular economy currently is a focus theme on the international political agenda. The necessary revolution requires concerted and strategic alignment as we live in an age of globalization and value systems on a world scale. This change will require a significant effort from all parties, not only from producers and consumers but also from governments themselves (PAEC, 2017).

The CE goes beyond the scope and strict focus of waste management and recycling actions, aiming at a broader action, from the redesign of processes, products and new business models to the optimization of the use of resources. It thus aims to develop new, economically viable and environmentally efficient products and services based on optimally perpetual cycles of reconversion. It materializes in minimizing resource extraction, maximizing reuse, increasing efficiency and developing new business models through design (ECO.NOMIA).

Under this context, the European Commission is engaged in fostering the transition from the largely current linear model and published in 2015 the roadmap: "Closing the loop – An EU action plan for the Circular Economy" (European Commision, 2015). This communitarian sets out initiatives including ecodesign among others.

Design is responsible, to a large extent, for defining the circularity potential of products: i.e., their reparability, longevity, proportion of recycled and renewable materials, and their suitability for refurbishment and remanufacture (European Environment Agency, 2017). It is also necessary to develop maintenance, repairing, reuse and reverse logistics services; as a matter of fact, new business models and service design are required for dematerialization through sharing, leasing and renting services, as well as services that deliver performance (Bocken et al., 2016). Consequently, the role of designers is to meet people's needs and develop technically and economically feasible products and services (World Design Organization, 2017). Thus, designers are challenged by new environmental, social and economic needs and must adopt a holistic approach to problem-solving (Bocken et al., 2016) taking into account that most of the characteristics of a product entire life cycle are defined in the design stage.

The National Plan for the Circular Economy published by the Portuguese council of ministers in 2017 (PAEC 2017) presents three levels of actions to be introduced and worked over the next three years: national, transversal actions that consolidate some of the actions of several governmental areas for this transition; sectorial agendas, especially for sectors that are more resource-intensive and export-oriented; and regional agendas, which must be adapted to the socio-economic specificities of each region. The Portuguese plan presents instruments to support the implementation of circular economy such as:

- Design: Designing products and services for circularity which requires a systemic view, knowledge, information, and methods.
- Technologies and new business models: technological innovation is of transversal relevance, but the focus has been on strategies of low circularity.
- Reverse cycles (e.g. reverse logistics): a robust, customer-friendly, flexible and efficient reverse logistics to ensure the return of products, components, and materials to the manufacturer for new cycles of use.
- Promotion of favorable context: for an active production in the reduction of impacts, the multiplication of cycles of use, the demand for greater productivity of resources or the valorization of performance (versus the valuation of property) become common, the market will have to have a favorable context.

The plan includes concrete actions to promote the transition to a circular economy and in these the design plays a crucial role. As mentioned before, the design community should seize the momentum to promote and add value to its activity.

## Research questions and hypothesis

The research under development intends to answer the following questions and contribute to the increase of knowledge in the fields of design for sustainability and circular economy:

- How design will support the transition from the linear economy to the new model of circular economy?
- Which tools can designers apply to support an effective design practice for a successful transition to circular economy in the real world?
- How can designers overcome the barriers in the implementation of a design practice that effectively result in more sustainable products and services aligned with the European policies for CE?
- How can the design practice and the role of the design professionals be promoted in circular economy context?

Design has the responsibility of responding to product or service problems, integrating criteria and innovative solutions in problem solving, adjusted to the needs of users and the society as whole, which is a key argument of sustainability resulting from the perception that designers must give a more universal and inclusive response and not only depend on the economic interests of companies or focused in niche markets (Ferreira, A.M., 2008).

In the CE, the designer has the function of translating the strategies and concepts of circularity in the development of products, services, and systems that promote the transition from a linear model to a circular model focused on the closing of cycles, the efficiency and sustainability of the systems**. Design, through its specific methods and tools, is an important factor in an effective transition to a circular and sustainable economy** is the hypothesis that will be verified by the research under development. The aim of the research is to promote design and demonstrate to practitioners and companies the key role design has in this process.

## The anticipated contributions of the study

The authors are convinced that the study will add value to the design practice in the areas of design, sustainability and circular economy at business and educational levels. Firstly, the study will have an innovative approach in mapping the design practice with sustainability concerns in Portugal by identifying relevant products and the process underlying, having as primary sources of information the designers and companies that were responsible for the development and placement of the products in the market. These professionals are the ones who had dealt with the real challenges of the introduction of sustainability in the design process. Secondly, the study aims to establish a new strategy to promote the effective application of the design practice, supported by methods and tools aligned with the needs of designers and other practitioners. Thirdly, guidelines, supporting a robust and effective design practice will be tested and validated by international experts and by the practical application in pilot projects with companies and workshops with companies and designers. Finally, the results of the research will increase the knowledge and contribute to a more sustainable and circular economy, aligned with the needs of the society, today and in the future.

## Research plan and methodology

The methodology presented was designed with the objective of supporting the development of a research plan aiming to the creation of added value for the design professionals and for the society. Focusing on supporting the transition to the CE, the expected results will strengthen the role of design by providing professionals a strategy supported by effective methods and tools for an innovative and effective design practice.

The research plan, established for the next 2 years, is composed of three main methodological moments that correspond to the three main steps in the development process.

In the first methodological moment, which will result in the systematic analysis and identification of the current state of the art by mapping the design and sustainability practices in Portugal and the identification of the main drivers and barriers faced by companies, designers, and practitioners, the plan comprises three main activities:

- Literature Review. A review of the most relevant sources published on the topic;
- Benchmarking of methods and tools. A qualitative analysis of the methods and tools available in the literature, internet, result of international research projects, and other sources. These methods and tools are available, and designers and companies can apply them in the development of new and more sustainable products and services;
- Field research (primary source of information) – Methods and tools applied in practice. At this stage, the research team plans to identify a wide group of products that are produced in Portugal and placed

in the market (national or international) as being more sustainable. The products will be identified through internet, magazines, exhibitions and fairs, by conducting workshops with relevant stakeholder and the creation and management of forums or discussion groups on social media platforms. The collection of products will be gathered in a database of "sustainable" products that will be used to support the research, however, it can be made public, available to all, as a mean to promote sustainability, circular economy, national products, and designers, if perceived useful during the Ph.D. process.

The analysis of the tools and methods applied in product development through contact with the designers and producers of a representative selection of the identified products by questionnaires, phone and face-to-face interviews, workshops and other events will result in the understanding of how sustainable products are developed in Portugal and which tools and methods are applied in practice. This task will also allow the identification of the main drivers, challenges and the needs faced by practitioners.

The effectiveness of the current practice will be assessed by a qualitative evaluation of the sustainability profile of the identified products, based on the information available and using a tool previously developed in an international research project. The tool, following a life cycle approach, is a checklist with a set of questions that allow a fast and simple analysis. This analysis will be useful to perform an overview of the application of sustainability in the products available and how deep the concepts are rooted in the development process and communication of sustainability profiles of products in Portugal.

The identification and characterization of the state-of-the-art will include all the information on how designers are using and applying the methodologies and tools in the development of more sustainable products, which are the motivations and barriers faced in their daily activities and how circular economy is perceived by the practitioners.

The second methodological moment is the phase where the research team, based on the previous analysis will answer the research questions and verify if the hypothesis is valid.

In this step, it is planned to define a new strategy and guidelines to improve the role of design in the transition for a circular and sustainable economy. The strategy for the design practice within CE will be supported by efficient tools and methods that need to be developed, adapted or re-shaped in order to create a toolkit as an experience-based research that can be applied by practitioners in their daily activity to develop innovative and sustainable circular solutions.

An assessment of the proposed Research experiment will be made in workshops with experts from the fields of design, sustainability, and circular economy through the contact with European stakeholders, to discuss, review and validate the results achieved.

In the third methodological moment, related to the test and validation of the previous research work, namely the model of a more sustainable design activity and tools to support it, and in order to guarantee the applicability of the results, it is important to involve the design community and companies from the very beginning of the conception and development phase. The test phase will deliver valuable feedback on meeting the needs and show the practicability, benefits and expected innovation potential of the results.

This activity will be held by the organization of pilot projects in companies and national workshops with designers and companies to discuss, apply and test the result of the research.

The experience gathered from both sides – company representatives and designers – will be transferred into recommendations for further developing.

The interaction with company representatives and designers give an insight on the status and potential for implementing circular economy strategies and should deliver input on how to meet current and future company's needs to support them on the transition towards CE.

Based on the previous moments, the research team will develop the conclusions of the research, which by answering the research questions and validating the hypothesis, will result in an increase of knowledge and contribute to a more sustainable and circular economy, aligned with the needs of designers and companies in Portugal.

## CONCLUSION

This research paper aims to introduce the research work under development by the author within the scope of the doctoral program at IADE and giving continuity to the last 17 years of work in the field of design and sustainability.

The aim of this research is to contribute to society, acting at the level of product design and service design, contributing to the transition to a more circular and sustainable economy.

This research work and the answer to questions such as "How design can effectively contribute to the transition from a traditional and linear economy to a more sustainable and circular model, will result in the definition of a strategy, supported by methods and tools that will support a more efficient design practice aligned with European and national policies and will contribute to a more sustainable future.

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