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Introducing eco-ideation and creativity techniques to increase and diversify the applications of eco-materials: The case of cork in the building sector

Jorge Sierra-Pérez [a, b, *], Ignacio López-Forniés [c], Jesús Boschmonart-Rives [a, d], Xavier Gabarrell [a, e]

[a] Sostenipra (ICTA – IRTA – Inèdit Innovació SL) 2014 SGR 1412, Institute of Environmental Science and Technology (ICTA), Unidad de excelencia «María de Maeztu» (MDM-2015-0552), Universitat Autònoma de Barcelona (UAB), 08193, Cerdanyola del Vallès, Bellaterra, Barcelona, Spain
[b] Centro Universitario de la Defensa, Ctra. de Huesca s/n, 50.090, Zaragoza, Spain
[c] Department of Design and Manufacturing Engineering, Zaragoza University, Spain
[d] Inèdit Innovació, S.L. Parc de Recerca de la Universitat Autònoma de Barcelona (UAB), 08193, Cerdanyola del Vallès, Bellaterra, Barcelona, Spain
[e] Department of Environmental, Biological and Chemical Engineering (XBR), Universitat Autònoma de Barcelona (UAB), 08193, Cerdanyola del Vallès, Bellaterra, Barcelona, Spain

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ABSTRACT

Cork is an eco-material that has recently been attracting growing interest due to the expanding strategy of sustainable product design, which aims to replace non-renewable materials in the building market. Until now, the cork sector has not taken advantage of the properties of this material and has been fully oriented towards traditional applications such as stoppers for wines and other beverages. The diversification of the cork market, through developing new products with higher added value, is the reason why eco-ideation (using different creativity techniques) can be helpful in creating new products and solutions.

The process of introducing eco-ideation was carried out during two interdisciplinary creative sessions and a product design stage. The results of the process were successful in terms of participation and the quantity and quality of ideas, which were characterised by searching, experimentation, participation and knowledge sharing. The versatility of cork fits perfectly with the creative methods of eco-ideation, as cork's good physical properties allow the diverse generation of new ideas for both applications and markets. The concepts generated in this study are in line with the approach of recognising cork's status as a natural, pure and noble material, taking advantage of the good properties of cork, and giving buildings unique traits due to the singular aesthetic of cork.

1. Introduction

Interest in eco-materials has been growing recently due to the expanding strategy of sustainable product design, which aims to replace non-renewable materials with natural or renewable materials. This strategy aims to decrease the environmental impacts of products during their extraction, manufacturing, use and end-of-life. One eco-material with great application potential is cork (Pereira, 2007). This material is extracted sustainably from cork oak (*Quercus suber* L.) forests, one of the best examples of balanced conservation and development in the world. The cork oak tree is a long-lived species (200–350 years) with high environmental importance due to the key role that it plays in ecological processes such as water retention, soil conservation, and carbon storage (Rives et al., 2013). The extraction of its outer bark, the cork, is a sustainable process because it does not damage the tree, and following extraction, new bark regrows. This process occurs every 9–14 years, depending on the area, until the tree is approximately 180–200 years old (Pereira and Tomé, 2004).

A recent study analysed the production and trade of the Iberian cork sector (Sierra-Pérez et al., 2015). Currently, 85% (161,504 tonnes) of worldwide cork extraction is concentrated in the Iberian Peninsula (Portugal and Spain). However, the production and

* Corresponding author. Centro Universitario de la Defensa, Ctra. de Huesca s/n, 50.090, Zaragoza, Spain.
E-mail address: jsierra@unizar.es (J. Sierra-Pérez).

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trade patterns of these countries are very different. Portugal is a producer and a processor of raw cork into end products; it is a leader in the global market and operates a very powerful industry. Meanwhile, the Spanish cork industry is mainly based on raw material and half-manufactured cork, except for Catalonia, which is the global leader in the champagne stopper market. Currently, the Iberian cork market is highly focused on the wine sector, which accounts for more than 80% of its market; and this makes the cork sector heavily dependent on wine market trends (Sierra-Pérez et al., 2015).

Cork has strong potential for use as a raw material for products with high added value, thanks to its unique properties such as elasticity, impermeability and good thermal insulation, as well as its renewability (Pereira, 2007). However, the current cork market lacks product development strategies (Mestre and Gil, 2011) and is fully oriented towards applications that are conventional and of low economic value, particularly wine stoppers of various types and some construction solutions such as insulating building materials, flooring and walls (Mestre, 2015). Curiously, one of these applications, insulating building materials, constitutes a significant portion of Portuguese exports to the northern European countries. However, this volume of exports is only high in terms of mass and is not reflected in monetary terms (Sierra-Pérez et al., 2015). This shows the emerging potential for improvement and diversification due to the current acceptance of cork in the building sector (Gil, 2015). Moreover, there is a large amount of cork that could generate increased economic value and its potential is currently unrealised. On the one hand, the cork stoppers sector produces a high volume of cork waste (e.g., the final cork stopper uses only 20% of the initial raw cork (Rives et al., 2011)). On the other hand, vast areas of cork oak forest are not fully exploited because they belong to private owners who do not want or cannot make the significant investment required to prepare forests for cork extraction. For example, in Catalonia (Spain) cork oak forests are not fully used at present, and it is estimated that 50% of them are not managed in any way (Tusell and Garcia, 2008). By initiating exploitation of these forests, cork extraction in Catalonia could be doubled (Sierra-Pérez et al., 2015).

Although some environmental studies have been carried out in recent years, most were based on raw materials (Dias et al., 2014; González-García et al., 2013; Rives et al., 2012b); on traditional products such as stoppers (Rives et al., 2012a, 2012c, 2011); on building products such as flooring (Demertzi et al., 2015; Jim Bowyer, 2009; Mahalle, 2011) and on insulation materials (de Brito et al., 2010; Pargana et al., 2014; Sierra-Pérez et al., 2016a). These studies evaluate the sustainability of cork by providing detailed environmental impact assessments of products' life cycles, comparing cork products with the most common non-renewable products used in buildings. One of the most interesting conclusions is that the use of natural insulation materials does not necessarily imply a reduction in environmental impacts. In the case of current cork products, the manufacturing processes require large quantities of energy due to their low technological development. This makes it necessary to improve the sustainability of eco-materials throughout their life cycles, and renewable materials offer great potential for intervention. For example, there are many opportunities for the implementation of eco-innovation strategies to produce more efficient and effective products and improve a product's design, thus helping to increase its market share (Sierra-Pérez et al., 2016a).

Eco-innovation is defined as the production, assimilation or exploitation of a novelty in products, production processes, or services or in management and business methods. Eco-innovation aims, throughout its life cycle, to prevent or substantially reduce environmental risk, pollution and other negative impacts of resource use (OECD, 2009). These innovative actions need to involve a broad network composed of firms, associations, suppliers, product advisors, and clients, while aligning and converging the expectations of these diverse stakeholders (Ceschin, 2013). Eco-innovation takes a similar approach to design processes, which aim to conceptualise and generate new ideas for products (Vallet et al., 2013). These processes include key factors to meet environmental sustainability requirements (Mario Fargnoli, 2006) as efficiently and appropriately as possible throughout the product life cycle of consumer goods (Bocken et al., 2011).

Eco-ideation is defined by Bocken et al. (2011) as the generation of the ideas that reduce environmental impact throughout the product life cycle of consumer goods. The process of eco-ideation for new sustainable products is characterised by searching, experimentation, participation and knowledge sharing. This form of knowledge development is significantly more organic than in traditional science because the knowledge developed by the researcher is combined with practice and informed action, which benefit the participants by allowing them to take control of their situations and circumstances (Swann, 2002). In this regard, the Portuguese cork sector developed a project based on design intervention, which aims to incorporate eco-innovation in the cork sector by exploring the potential uses of cork and creating awareness. The project results in a variety of cork design solution prototypes, which exemplify how the functional and aesthetic properties of cork can be implemented in sustainable product design in different markets, among them transport, furniture, lighting or wall and floor coverings (Mestre and Vogtlander, 2013; Mestre, 2015). This could potentially address the weakness detected in the Spanish sector by catalysing the diversification of its market and developing new products with higher added value.

In this sense, this article describes the methodology used in a project conducted in the Spanish cork sector to increase and diversify the applications of cork in the building sector through the eco-ideation of new product concepts using different creativity tools. In addition, the specific objectives are the following:

- To analyse the potential applications of cork.
- To generate new concepts for cork building products.
- To validate the highest-potential product concepts in the cork industry.

2. Methodology: a creative workshop for eco-ideation

This workshop consists of a creative process that includes two interdisciplinary creative sessions and a product design stage. Moreover, this process is complemented by some preparation and documentation activities to ensure the success of the workshop. This section describes the steps carried out to reach the objectives established above (Fig. 1).

2.1. Background

This workshop is part of a project that aims to diversify the Spanish cork market beyond the wine sector through eco-innovation and eco-design. Previously, the Iberian cork sector has been analysed from a production and trade perspective, which identified the building sector as a potential market (Sierra-Pérez et al., 2015). Due to the intrinsic sustainability of cork, its competitors in the building insulation sector were environmentally assessed from a life cycle perspective (Sierra-Pérez et al., 2016b), as was the main Spanish cork insulation product (Sierra-Pérez et al., 2016a). Next, new concepts for building products made from cork were generated, taking into account the environmental results and