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## Mini-factories for close-to-customer manufacturing of customized furniture: from concept to real demo

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### Abstract

In this paper a new concept of manufacturing system enabling flexible manufacturing of green personalized furniture close to the customer in terms of features offered, place of fabrication, time to deliver, and price is described. The proposed system encompasses all the technological and organizational requirements enabling to bring design to manufacturing of customized products within shopping malls. The integration of the whole system and relative testing has been carried out within one of the most relevant shopping mall in Milan. During demonstration, customers had the possibility to access the shop, configure their products and see them manufactured in quasi-real time. The promising results of the demonstration activity pave the way for further exploration of the proposed concept.

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*Keywords:* Mass customization; mini-factory; customized furniture; flexible production system; sustainable production.

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### 1. Introduction

The EU furniture market employs around 1 million workers in 130.000 companies generating an annual turnover of around EUR 96 billion [[1]]. As one of the most relevant sector for European manufacturing, recent crisis

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generated a tremendous impact on the related economy, with a constant contraction of the production share that, in 2012, brought to the levels of a decade ago [[2]]. There are several reasons leading to this trend and affecting all the segments of the value chain, these including access to sustainably-sourced raw materials, the cost and complications of harvesting wood in the EU, price reduction driven by competing demand, comparatively higher energy costs in the EU and more complex and demanding environmental policies [[2]]. In order to respond to the abovementioned challenges, European manufacturers have to adopt strategies able to create value in new business areas and with new technologies providing added value in core processes and customer experiences [[3], [4], **Errore. L'origine riferimento non è stata trovata.**]. Furniture customisation has been generally accepted as one of the strategies providing a competitive breakthrough for European furniture industry to remain competitive. Since mass customization generates a high variety of different products, it requires both the manufacturing system and the whole value chain [[7]] to be highly flexible, being able to withstand highly different products without increasing lead time and costs of changing the system [[6]]. Unlike most of the current production systems in the woodwork sector that are economically inefficient, too large and inflexible, disregard to changing consumer behaviour requirements [[8],[9]].

Compact production systems named “mini-factories” have been proposed as manufacturing environments able to meet the challenges faced in current competitive landscape with dynamically evolving requirements of customers [[10]]. The first uses of the term mini-factory in the literature domain refers to a compact system relying on the concept of “manufacturing cell” [[11]] able to manage in an integrated way all the equipment and processes required to manufacture a specific product [[12]]. This type of production systems recently gained momentum as possible enablers of the mass customization paradigm thanks to a structure able to flexibly manage a market-oriented approach, simplifying production and logistic streams [[13], [20]]. Moreover, the introduction of mini-factories in specific contexts showed how the correct tailoring of their behaviour can outperform traditional production configurations in terms of economic, social and environmental impacts [[14]]. The adoption of such manufacturing systems in the woodworking sector is still slowed down by technological and methodological constraints. One of the main obstacles is the widespread anarchy in force amongst woodworkers and product designers in the design phase, and the general ignorance, that designers have, of the production system that will then have to produce the parts. The concept of “*design to manufacturing in one step*”, representing a streamlined approach to the design of furniture products and carried out with methodologies and technologies enabling to let them directly ready to be manufactured, still finds difficult application in the woodwork sector, in particular if speaking about customization, where a deep variability of designs is present.

The elaboration of the discussed concepts brought to the definition of a new business model relying on the concept of mini-factory as a production system able to move the manufacturing industry within urban environments [[15]] and intended to maintain furniture production within Europe, thanks to the creation of sensible added value in the furniture industry. The proposed business model is instantiated within European shopping malls with a twofold aim: on the one hand, innovating the way customized furniture is currently brought to the market benefits producers thanks to the high number of visitors passing by a shopping mall. On the other hand, finding new opportunities for the transformation of the shopping mall buying experience in an immersive activity can reduce the current risk of abandonment of the shopping malls. Recent researches [[16], [17]] indeed showed how shopping malls are keen to be abandoned if they don't keep the peace with modernization, by introducing new attractive activities/experiences for customers coming in.

Aim of this paper is to present a pilot study carried out under the FP7 project *CTC-Close to customer* proposing and testing a new concept of manufacturing system to enable a local flexible manufacturing of green personalized products close to the customer in terms of features offered, place of fabrication, time to deliver, and price. The paper is divided in two main sections, the first describing how the business model proposed by the CTC concept has been designed and developed. The second part is dedicated to the description of the results of implementation within its demonstration context.

## **2. The CTC concept: a compact mini-factory for the design to manufacturing of customized furniture**

The CTC mini-factory is a European innovative production scenario leveraging closeness to customer, customization and sustainability as the main drivers to strengthen the competitive position in the furniture market.

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