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A web-based platform for mass customisation and personalisation

Dimitris Mourtzis *, Michael Doukas, Foivos Psarommatis, Christos Giannoulis, George Michalos

Laboratory for Manufacturing Systems and Automation, Department of Mechanical Engineering and Aeronautics, University of Patras, Patras 265 00, Greece

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ABSTRACT

The currently widespread mass customisation paradigm greatly affects the planning and operation of manufacturing networks. The increasing need towards customised products in combination with the volatile product demand calls for efficient ways to design and plan manufacturing network configurations. The work discussed in this paper aims at enabling a mass customisation and personalisation implementation, by engaging the customer in the design of unique products and by enabling the Original Equipment Manufacturers (OEMs) to efficiently plan manufacturing and transportation activities of highly customised products by exploiting an innovative decentralised manufacturing approach. The suggested method, which is implemented into a web-based platform consists of (a) the "User Adaptive Design System" (UADS), focused on providing user-friendly design tools that allow unique product design changes, in a constrained way, (b) the "Decentralised Manufacturing Platform" (DEMAP) that allows the generation, evaluation and selection of manufacturing/transportation network alternatives, and (c) the "Environmental Assessment Module" (EAM) that assesses through simulation the environmental footprint of the alternative network configurations. The applicability of the suggested architecture is validated through its pilot installation to a European automotive manufacturer and a CNC machine building company.

1. Introduction

The market landscape has drastically changed over the last two decades, constituting centralised mass production unsuitable to tackle the emerging production requirements, due to its inherent rigidity. In order to maintain their responsiveness and competitive advantages, manufacturers of traditionally mass produced products such as cars and CNC machines are taking steps towards the adoption of the Mass Customisation (MC) paradigm. MC primarily focuses on serving the customer needs [1]. This customer-oriented environment however, entails characteristics such as short life-cycles, short time-to-market and volatile product demand. In combination with the increased outsourcing trend, these issues generate the evident need to efficiently capture and satisfy customer requirements from the initial product design phase and design and plan manufacturing and transportation activities while satisfying the goals of cost, time, quality and environmental impact. Motivated by these needs, the scope of this research work is threefold: (i) the integration of the customer in the initial product design phase (ii) the provision of support tools to the OEM to identify efficient manufacturing network configuration capable of serving the personalised order demand and (iii) the selection of environmentally friendly configurations.

The literature review in the field of mass customisation is presented in Chapter 2. Chapter 3 contains the description of the components of the proposed web-based platform, namely the UADS, the DEMAP and the EAM. It also includes the description of the workflow that is implemented in a platform. Chapter 5 presents the software architecture and implementation tools and methods, while Chapter 6 demonstrates the validity of the method to a real-life industrial application coming from the automotive and CNC machine building sectors. Finally Chapter 7is dedicated to providing a discussion of the findings and drawing the conclusions.

2. State of the art

A number of enablers fuelled the transition from a mass producing into a Mass Customisation (MC) environment. Among them, the growth of the Internet, the evolution of computation technologies [2], the decrease of the transportation costs for the main intercontinental transport modes, air and sea and finally, the saturation of major markets for mass produced products [3]. However, this transition possess unprecedented problems to Original Equipment Manufacturers (OEMs). The dynamic nature

* Corresponding author. Tel.: +30 2610 997262; fax: +30 2610 997744.
E-mail address: mourtzis@lms.mech.upatras.gr (D. Mourtzis).

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of an MC environment entails demand and supply uncertainties [4] and requires a restructuring of the marketing, production and logistics mechanisms of the company [5,6] as well as of its organisational functions [7]. Difficulties in MC implementation are further compounded considering that the MC paradigm is focused on achieving, apart from economies of scope, economies of scale in order to improve system performance in the dimension of cost, serving a mass market [8] (Fig. 1). Consumers around the globe expressed the need for unique products that combine quality, with short life-cycles, that are also available at low prices, at the right time [9] and are available through online platforms. Market today is shifting towards online purchases, offering to the customers a wide variety of product combinations to select from. This is evidenced by the fact that recent surveys show that 89% of the buyers prefer to shop online over in-store shopping [10]. The significance of the networked world is recognised by firms that exploit the Internet in order to co-create value with customers [11]. Companies are realising that the customer has to be treated as an individual entity and not as a market segment [12]. Nevertheless, the design by non-designers, i.e. customers, can provide valuable information, such as market trends and forecasts to companies [13,14].

Web-based and e-Commerce systems have been implemented and have proven to be very effective in capturing the pulse of the market [12]. The online competition among companies, results in a rapid evolution of web technologies. Web-based toolkits for MC purposes have been deployed, aiming at providing sets of user-friendly design tools for trial-and-error experimentation processes and deliver immediate simulated feedback on the outcome of design ideas. In this web-based decentralised manufacturing framework, in order for the manufacturers to achieve production capacity and costs that can be compared to those of mass production, high coordination and efficient integration must be achieved between the domains of production [53]. The integration and collaboration among different partners of the product development team improved the product quality and reduced the product lead-time, thus providing better global competitiveness for the companies [15].

Nowadays, more and more design and assembly work is conducted as collaborative projects across globally distributed design teams, companies and software modules [6]. Proposed approaches include e-Assembly systems for collaborative assembly representation [16] and web-based collaboration systems [17]. Effective upstream and downstream integration between all partners of the manufacturing network only recently became achievable up to a point, thanks to the web services. Where real-time demand information and inventory visibility were once impossible, web-based technologies offered the tools for supply chain forecasting, planning, scheduling and execution [18]. Currently, though, production planning in a supply network is based on information flow between autonomous enterprises, which is asymmetric and in part uncertain. Mainly this is attributed to the different goals of the stakeholders and their opportunistic stance [19].

Potential solutions in order to achieve MC, including changes in the product design and manufacturing process, have been

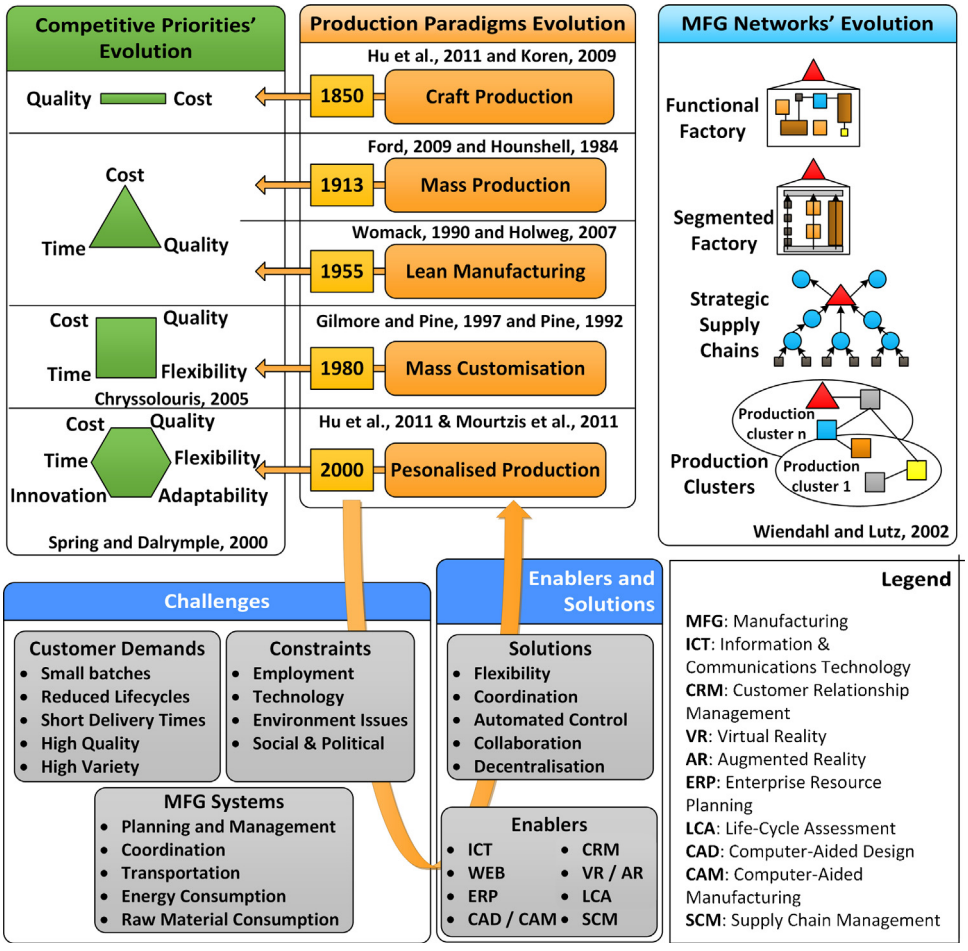

Fig. 1. Evolution of production paradigms, manufacturing networks, and competitive priorities, issues generated and solutions [6,43–52].