



Innovative flexibility-oriented business models and system configuration approaches: An industrial application



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ABSTRACT

In the current competitive scenario, industrial companies experience frequent unexpected changes in production demand. To cope with this, they often opt for investments in manufacturing technologies which embed extra-flexibility that is rarely utilized and, consequently, affects financial and operational performance. Innovative flexibility-oriented business models based on innovative service value propositions could increase manufacturers competitiveness in turbulent environment and could represent a competitive factor for systems suppliers. Their industrial implementation requires the optimization of manufacturing flexibility over the lifecycle of a system and the quantification of economic performance for customers and suppliers in order to manage risks and to shape sustainable contractual agreements. In this paper, stochastic configuration methods to design focused-flexibility production systems are presented as a promising methodological enabler of new flexibility-oriented business models. An industrial case demonstrating the potential value of these methods is discussed. Future research developments are finally outlined.

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Introduction

The reduction of products lifecycle, due to accelerated technological trends or to very fast market dynamics generated by modern consumption uses, can be the cause of frequent changes in the characteristics of the products and their production volumes. A fundamental key success factor, especially for manufacturers operating in sectors where turbulence is high, is the capacity to rapidly follow unexpected market fluctuations in order to keep customers satisfied and to acquire the reputation of reliable suppliers. However, to reach these goals, they must rely on manufacturing technologies with the right flexibility or re-configurability level to cope with such rapid changes in volumes and features of the produced parts. Thus, the decision on the level of flexibility [3,19] and re-configurability of manufacturing systems is a key decision which can strongly affect company competitiveness. Typically, flexible manufacturing systems – systems that have the embedded potential to adapt to external changes – are expensive and less performing in case of volume productions, while reconfigurable manufacturing systems [9] – systems that have the enablers to be easily modified to adapt to external changes – present a lower initial

investment cost but may require additional cost (and time) to be reconfigured, which could be not compatible with market requests [23,24]. level of manufacturing systems is rather complex, industrial companies often opt for production systems embedding a very high level of flexibility that guarantees the capability to satisfy a wide range of future unexpected requirements. In this way, however, they make a sub-optimal choice, since they pay for something that probably will not be used and experience lower manufacturing performance in the medium term.

To solve the dilemma and increase manufacturing competitiveness, researchers recently proposed new service-oriented value propositions that equipment suppliers can offer with the aim for optimizing the manufacturing flexibility of their customers [4,11]. However, these business models imply a risk shift from the customers to the suppliers, hence, it is essential for suppliers to acquire a better awareness of the manufacturing flexibility embedded in the systems they offer as well as of the production performance and costs under the logic of “Total Cost of Ownership”. In support to this statement, the capability to estimate the economic performance of these business models is outlined in the literature as a critical success factor for their successful implementation [5,12]. In fact, very few methods and tools are available to jointly address the configuration of a production system, the underlying business model and a financial assessment, specifically tailored to the machine tool sector

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[6]. Moreover, the available approaches usually rely on principles and criteria (such as discounted cash flow techniques) that are appropriate for static markets in which uncertainty and turbulence do not play a major role. Thus, methods able to optimize the manufacturing flexibility and estimate the economic impacts in high-uncertainty contexts become fundamental enablers to support the viability of new flexibility-oriented business models.

To cope with uncertainty, stochastic methods for production planning and manufacturing system configuration have been proposed in the last years [20,21]. These latter suggest the type and number of machines to include in the system layout in order to cope with the expected variability optimizing a stochastic cost function, typically the expected value. These methods entail system configurations that are often labeled as “focused-flexibility manufacturing systems”, i.e., systems with the minimal flexibility level needed for the considered production scenarios [17,18]. They were proposed by the manufacturing research community with the purpose of technically configuring production systems, but they were not related until now to the business model research. In this paper we aim at demonstrating that “focused-flexibility” configuration approaches provide a significant support to the use of innovative business models in the machine tool sector and might help to push their adoption.

The outline of the paper is as follows. In second section, innovative flexibility-oriented business models are presented. In third section, stochastic configuration methods are discussed as potential enablers for the presented business models. In fourth section, an industrial case study is elaborated, showing the concrete potential of stochastic configuration methods. Finally, in fifth section, limitations and future research directions are outlined.

Innovative business models for focused-flexibility manufacturing systems

A business model addresses how a company produces value for the market and how it remunerates its stakeholders. It describes the main pillars of a company structure, i.e., the value proposition, the supply chain configuration and the revenue model [2,7]. A business model represents an intermediate approach to substantiate the company's vision and mission into detailed business processes and manufacturing technologies [15].

Recent literature emphasized the role of business model innovation in the machine tool industry with the aim at increasing the competitiveness of both system suppliers and end-users. Different taxonomies and typologies of innovative business models were proposed. In 2002 Molinari et al. [13] presented a categorization of new business models based on different factors: the “Ownership of equipment”, the “Location of production”, the “Responsibility for the operation of the equipment” and the “Responsibility for the maintenance of the equipment”. In 2003, Lay et al. [10] added two additional categorization dimensions for classifying and designing new business models: the “mode of payment” and the “number of customers”. In 2004 Tukker [22] classified the value proposition of service-oriented business models distinguishing between product-oriented Product Service Systems (PSS), use-oriented PSS and result-oriented PSS. In order to define customized and more detailed business models for the machine tool industry, Copani et al. [7] proposed a set of potentially interesting business models: “Build – operate at customer plant – own”, “Full operation concept”, “Equipment supplier turns into a part supplier”, “Supply park concept”, “Own and operate at customer plant with final purchase option”, “Multi-ownership for big and complex investments”. Biege et al. [2] made an effort to summarize new business models for the machine tool sector referring to Tukker's scheme: “Availability guarantee”, “Solving customer qualification

deficits”, “Reconfigurable production systems” and “Lean machine business concepts” under product-oriented PSS; “Leveling irregular and temporary customer capacity requirement” under use-oriented PSS; “Production service” under result-oriented PSS.

Recently, a new type of innovative business models specifically oriented to manufacturing flexibility optimization were presented as a completion to the wide list above discussed and consolidated in literature [4]. They were finalized grounding on a case study analysis investigating both the effective needs and the most relevant opportunities in the machine tool sector. The case study analysis involved a supplier of production systems, (system integrator), a supplier of machine tool components, a service engineering company and a manufacturing end-user in Italy. After the analysis a reduced set of innovative business models were selected and contrasted together with machine tool builders and system suppliers in order to verify their applicability and industrial interest. Finally two innovative business models were selected as the most promising: the “reconfiguration guarantee” and the “capacity guarantee”.

Reconfiguration guarantee business model

In this business model, the system supplier designs the flexibility level of the production system grounding on a set of future scenarios modeling the forecasted customer's needs, without considering the need of extra-flexibility whose future utilization is uncertain. On the contrary, through the use of focused-flexibility design approaches, the system supplier is able to identify possible future reconfiguration actions that might be necessary to cope with the future demand scenarios considered.

Under the frame of the reconfiguration guarantee business model, the contract between the supplier and the end-user covers the supply and installation of the production system as well as the economical conditions that might regulate the possible future reconfigurations taken into consideration, if they will be requested by the customer. Hence, the contractual variables under negotiation are price of the initial production system configuration and the price for a set of possible future reconfigurations.

The role of the customer and the supplier in the frame of this business model, during the whole lifecycle of the system, is represented in Fig. 1 (where DEMAT is the acronym of the FP7 EU Project entitled “Dematerialised Manufacturing Systems: a new way to design, build, use and sell European Machine Tools” and DMS stands for “Dematerialised Manufacturing Systems”).

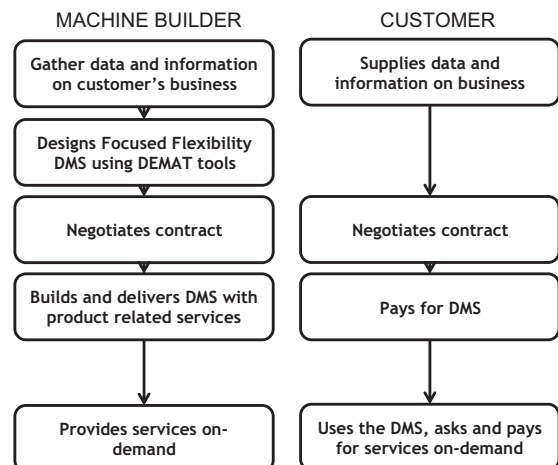


Fig. 1. Role of customer and supplier in “reconfiguration guarantee” business model.

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