

Preface

In 2001 in a literature review article on mass customization (MC) published in the *International Journal of Production Economics*¹, the two editors of this book and Denis Borenstein proposed future research directions envisioned as promising in the subject. Most of them were related to engineering aspects of MC which, at that point, were yet to be explored in the literature. We had hit an emerging topic, and the article has received hundreds of citations since then. MC was a promising production strategy in industry, catching the attention of researchers and practitioners.

To date the subject is still receiving great attention in the operations management and industrial engineering literature. The focus, however, has shifted from strategic to operational, and topics such as product development for MC and the scheduling of customized production jobs have been explored. Gradually the research directions we enlisted in the 2001 paper have been addressed through different propositions in the specialized literature.

This book is a compendium of recent engineering and management research on MC. We invited renowned researchers to give contributions on the subject, and the result is a state-of-the-art collection of technical chapters on different, relevant aspects of MC. It covers MC in the context of global industrial economics and operations. The book is divided into four parts, moving from broad strategic issues to operational decisions and case illustrations; 17 contributed chapters are included in the book.

Part I, entitled *Concepts and Definitions*, is comprised of three chapters. Chapter 1, by Roberto Lu and Richard Storch, presents an approach to the analysis of the design, planning, and operation of global MC production systems. To model such systems, the authors use discrete event simulation, statistical modeling, and real option analysis techniques. A literature review covers the state of the art of the use of such tools in MC analysis, and the propositions are illustrated through a case study from the aircraft manufacturing industry.

¹ da Silveira, G, Borenstein, D, Fogliatto, FS (2001) Mass customization: Literature review and research directions. *International J of Production Economics* 72: 1–13.

Chapter 2, authored by Rebecca Duray, offers an update on Hayes and Wheelwright's product-process Matrix² in order to accommodate MC as a competitive possibility. After providing an overview of the matrix variations proposed in the literature, the author expands the traditional bi-dimensional matrix with product and process structures in the axes to include a third dimension named process variation. The result is a model that incorporates standard process types as well as mass customization. The chapter closes with future research directions of the proposed model.

In Chapter 3, Ian McCarthy, Leyland Pitt, and Pierre Berthon shift the focus from the manufacturing to the services industry and propose a dramaturgy-based strategy to mass customize services. The authors present a typology with four configurations for achieving service customization. Such configurations are obtained by combining levels of two variables: time pressure to customize and level of customization required. Dramaturgy concepts of performance, scripts, and improvisation are analyzed in the light of the four configurations, and ideal settings for each type of service customization are proposed. The chapter closes with a discussion section in which research opportunities on the subject of service customization are identified.

Parts II and III are fully devoted to the engineering of MC and were divided, following the emphases of the contributions, into product and process related analyses of MC in industry. Part II, entitled *Engineering of Mass Customized Products*, is comprised of six chapters. Chapter 4, by Nizar Abdelkafi and Margherita Pero, presents a framework for aligning product development activities and the management of supply chains. The proposed alignment framework explores the relationships between two sets of variables: those related to the product, which are variety, modularity, and innovativeness, and those related to the supply chain, which are configuration, collaboration, and coordination complexities. The framework development was motivated by a case study, which is also presented in the chapter.

Chapter 5 was written by Adrian Mondragon and Christian Mondragon, and is a natural follow-up to the developments in the previous chapter. The authors explore the relationships between MC, modularity, technological innovations and the supply chain. More specifically they discuss the management of technological innovations using modularity to provide customized products. Their propositions are founded on empirical observations of well-succeeded MC cases in the automotive industry.

David Ben-Arieh contributed Chapter 6, discussing the platform based design and production strategy, a recurrent research problem in the MC product design literature. Ben-Arieh presents a linear programming approach to the problem in which the objective is to identify a platform that allows production of a family of products at a minimum cost. Three methodological propositions of the problem are presented, and the developments are illustrated using a simulated example.

² Hayes, R, Wheelwright, SC (1979) Link manufacturing process and product life cycles. Harvard Business Review 57: 133–140.

The development of product platforms for MC is also the subject of Chapter 7 by Sagar Chowdhury and Zahed Siddique. The authors are interested in the development of commonality indices that indicate products belonging to a common family. They propose two families of indices for component shape comparison: dimensional-related and positional-related indices. These two sets of indices are combined to generate platform indices aimed at helping designers in platform decision problems. Two case studies illustrate the proposed indices. The first one deals with a platform for cell phone casings; the second case presents a coffee-maker product platform.

The platform problem in the previous two chapters is extended to the services industry in Chapter 8, written by Seung Moon, Timothy Simpson, Jun Shu, and Soundar Kumara. The authors use a quite innovative approach, relying on data mining techniques to identify a service platform to create a family of service variants. More specifically fuzzy clustering is used to partition service processes generating modules used to create a service family. The developments in the chapter are illustrated in a case study from the banking services industry. A future research section closes the chapter.

Chapter 9 closes Part II of the book. In this chapter Shane Xie presents a STEP (standard for the exchange product model data)-compliant on-line digital library for the rapid development of high value-added customized products. The chapter presents a method to create a product digital library for digitizing customized products. Once available the information in the library will be reused in the development of different customized items. A case study illustrates some of the propositions in the chapter.

Part III congregates six chapters under the title *Engineering of Processes for Mass Customization*. It opens with a review of enabling technologies for planning and control of MC processes, written by Mitchell Tseng and Andreas Radke. The chapter reviews the literature to present the state of the art on propositions to address three subjects that constitute challenges in production planning and control of MC environments: demand forecasting, economies of scale, and product development lead times. The authors review over 100 references to accomplish their objective.

Chapter 11, by Neville Lee and James Dai, investigates a technological aspect of MC production systems: the material handling system (MHS). More specifically the authors review the literature on the design and planning of MHSs for MC, and eventually present the design and planning of a flexible MHS based on the use of free-ranging automated guided vehicle with an indoor local positioned system. A case study from the apparel industry closes the chapter.

Geraint Owen, Jason Matthews, Richard McIntosh, and Steve Culley are the authors of Chapter 12; they propose design for changeover (DFC) as a tool to enable flexible manufacturing of MC products. The DFC methodology is based on the concept of determining the correct interfaces between machine elements that different resources (*e.g.*, personnel, hand tools) must act upon. To achieve that DFC, indices and design rules are proposed and illustrated through a game conceived to train industry's practitioners on the methodology.

In Chapter 13 Phil Reeves, Christopher Tuck, and Richard Hague investigate the applicability of additive manufacturing (AM) in MC production environments. AM, also known as rapid manufacturing, is a denomination for different process technologies such as laser sintering and three-dimensional printing. AM produces components additively by adding successive layers of material together, guided by three-dimensional CAD (computer aided design) data. Thus parts or final products are produced directly from digital data, providing the flexibility desired in MC production. The authors investigate the applicability of AM in the manufacturing of customized items derived from computer games in a case example. They close the chapter by discussing the implications of AM adoption in MC businesses and propose some future research directions.

In Chapter 14, Michel Anzanello investigates the problem of variable selection for clustering of product models into families based on their common processing needs. The objective is to increase the efficiency of production programming and resources allocation through proper clustering of models. To attain this it is crucial that relevant clustering variables be identified, and the author proposes a method for variable selection that integrates an elimination procedure with a k -means clustering technique. Some of the clustering variables investigated are related to the worker's learning rate, being modeled through learning curves. Learning is a key element in MC production environments where model changeover is intense and lot sizes are small. The author illustrates his propositions in a case study from the shoe manufacturing industry.

Chapter 15, by Hartanto Wong and Mohamed Naim, closes Part III of the book. The authors analyze the benefits of postponement (also known as delayed product differentiation, a key strategy to attain MC in practice) under a new perspective where the production-inventory and the marketing functions are aligned to maximize profits. They provide mathematical models for manufacturing configurations comprised of different levels of four variables: inventory, lead time, price, and product variety. The authors present the benefits of postponement under each configuration through numerical examples.

Part IV of the book is devoted to contributions in which theoretical propositions are strongly backed by case studies. Two chapters are included in this section of the book. In Chapter 16, Andreas Kaplan introduces the idea of virtual worlds as a means to achieve MC in practice. Virtual worlds encompass Internet-based applications that enable consumers to interact with each other in real time; the virtual social world Second Life, by Linden Research, Inc., is a typical example of such applications. Professor Kaplan states that Second Life offers opportunities for virtual MC and investigates such statement using three case studies in which companies' corporate activities take place in virtual worlds, integrating customers into the production process and thus enabling virtual MC.

Our book closes with Chapter 17, authored by Jason Matthews, Richard McIntosh, and Glen Mullineux, in which the feasibility of MC applications in the food industry is investigated. The authors review the literature on MC applications in industry, list the most prominent techniques used to enable that, and explore their applicability in a series of case studies from the food and beverage industries.

We are grateful to Mateus Dalci who tirelessly helped us to edit this book and to the staff at Springer-London who always provided the assistance to carry out this project. We particularly thank Jaydeep Balakrishnan, Jonas Carvalho, Mohamad Jaber, Elmostafa Qannari, Klaus Schützer, Henrique Rozenfeld, and Cameron Welsh for reviewing initial versions of the book chapters. Finally, we are very grateful to our contributors for giving us such qualified material and for their patient compliance to rules and deadlines throughout the editorial process.

Professor Fogliatto would like to dedicate this book to Prof. Susan L. Albin, with gratefulness and admiration. He would also like to acknowledge the support provided by CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) through research grant 301380/2008-2.

Prof. da Silveira dedicates this edition to his family. He thanks for continuous research support by the Natural Sciences and Engineering Research Council of Canada and by the Warren & Marline Dyer Faculty Fellowship at the Haskayne School of Business.

Good reading!

Porto Alegre, Brazil
August, 2010

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<http://www.springer.com/978-1-84996-488-3>

Mass Customization

Engineering and Managing Global Operations

Fogliatto, F.S.; da Silveira, G.J.C. (Eds.)

2011, XVIII, 378 p., Hardcover

ISBN: 978-1-84996-488-3