

2017

WORLD MASS CUSTOMIZATION & PERSONALIZATION CONFERENCE

Aachen, Germany - November 19-21st 2017

Customization 4.0

Elevating Mass Customization to a New Level



Research Area
Technology,
Innovation, Marketing,
Entrepreneurship

RWTHAACHEN
UNIVERSITY

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DAY 1: 20.11.2017

	BERLIN (Plenar Hall)	K1 (Eurogress)	K2 (Eurogress)	MADRID (Quellenhof)	
08:30 - 10:00		Plenary I: Smart Customization Keynote 1: Frank Piller (RWTH Aachen): Customization 4.0 Keynote 2: B. Joseph Pine II (Strategic Horizon): 25 Years of Mass Customization			10:00 - 10:30
		Coffee Break, Exhibition and Posters			
10:30 - 12:00	Parallel Session 1.1: How Smart Customization Transforms Industries: The Example of the Textile Industry	Parallel Session 1.2: MCP Success Factors and Best Practices (I)	Parallel Session 1.3: Managing Variety, Product Families and Platforms		12:00 - 13:30
		Lunch Break, Exhibition and Posters			
13:30 - 15:00		Plenary II: Digital Manufacturing & Industry 4.0 Keynote 1: Günther Schuh (RWTH Aachen): Complexity Management 4.0 Keynote 2: Reinhart Poprawe (RWTH Aachen): The Future of Individualization by Digital Photonic Production			15:00 - 15:30
		Coffee Break, Exhibition and Posters			
15:30 - 16:55	Parallel Session 2.1: Digital Manufacturing and Digital Business Models for MCP (I)	Parallel Session 2.2: MCP for Apparel & Textiles (I)	Parallel Session 2.3: Smart Customization: Data-Driven Approaches for MCP (I)	Parallel Session 2.4: Choice Navigation: Matching Customer Needs and Preferences (I)	19:30 - 22:30
17:00 - 18:30	Parallel Session 3.1: Digital Manufacturing and Digital Business Models for MCP (II)	Parallel Session 3.2: MCP for Apparel & Textiles (II)	Parallel Session 3.3: Smart Customization: Data-Driven Approaches for MCP (II)	Parallel Session 3.4: Choice Navigation: Matching Customer Needs and Preferences (II)	
		Conference Gala Dinner			

DAY 2: 21.11.2017

	BERLIN (Plenar Hall)	K1 (Eurogress)	K2 (Eurogress)	MADRID (Quellenhof)	
08:30 - 10:00	Plenary III: Sustainability and Mass Customization Keynote 1: Pim van der Jagt (Ford Motor Company): How Can Customization Enhance Future Mobility Keynote 2: Wolfgang Budde (Philips Lighting): Lifecycle Management in the Era of IoT				
10:00 - 11:30	Parallel Session 4.1: Promising Practices and Success Factors for Bridging MCP, Industrie 4.0, and Sustainability	Parallel Session 4.2: MCP Success Factors and Best Practices (II)	Parallel Session 4.3: Platforms, Ecosystems, and Business Models for Digital Manufacturing	Open Space for Mass Customization Discussion I	
	Coffee Break, Exhibition and Posters				11:30 - 12:00
12:00 - 13:30	Parallel Session 5.1: Mass Customization-Driven Industry Development: UNESCO World Heritage Town Røros	Parallel Session 5.2: Environmental and Sustainability Assessment of MCP	Parallel Session 5.3: Digital Manufacturing: Implementation, Usage, and Value Capture	Open Space for Mass Customization Discussion II	
	Lunch Break, Exhibition and Posters				13:30 - 14:30
14:30 - 16:00	Plenary IV: Success Factors & Key Insights by Mass Customization Pioneers Closing Panel with Christoph Berger (adidas), Philip Rooke (Spreadshirt), Sergio Dulio (Atom Lab) & Vladimir Puhacac (Doob Group)				
	Transfer				16:00 - 16:30
16:30 - 18:00	Industry 4.0 Tour: Digital Capability Center Aachen (DCC)	Industry 4.0 Tour: Aachen Center for Additive Manufacturing (ACAM)	Industry 4.0 Tour: RWTH Demo Factory (WZL / FIR)		
	Transfer				19:30 - 21:00
	Farewell Reception				

Sessionsoverview - DAY 1: Monday, 20th Nov 2017

REGISTRATION

Monday 20.11.2017 /// 07:45 – 08:30 /// Hotel Pullman Quellenhof (Chimney Lounge)

Plenary Sessions I: Smart Customization

Monday 20.11.2017 /// 08:30 – 10:00 /// BERLIN (Plenar Hall)

▶ **Keynote 1: Customization 4.0**

Presenter: Frank T. Piller, RWTH Aachen University

Over the past decade, we have studied mass customization in more than 200 different organizations. Our Customization500 study provided the first international benchmarking of more 500 companies in BtoC mass customization. In our research, we found that mass customization is a strategic mechanism that is applicable to most businesses, provided that it is appropriately understood and deployed. Successful mass customization builds on developing a set of strategic capabilities that will, over time, supplement and enrich an existing business. The talk will introduce these capabilities and then reach out to discuss new opportunities for mass customization provided by smart, connected products and flexible manufacturing technology provided by digitalization and connectivity ("Industrie 4.0"). Its objective is to provide an overall strategic framework on how to profit from mass customization and set up a corresponding business model.

▶ **Keynote 2: 25 Years of Mass Customization**

Presenter: B. Joseph Pine II, Strategic Horizons

Celebrate with us 25 Years of Mass customization. On Oct 26th, 1992, B. Joseph Pine's landmark book „Mass Customization“ was published for the first time, making the idea of mass customization popular. The book inspired hundreds of entrepreneurs and managers to utilize mass customization as their business model. At the MCPC 2017, B. Joseph Pine will review with us the past and present of mass customization and discuss what is next.

Parallel Session 1.1: How Smart Customization Transforms Industry: The Example of the Textile Industry

Monday 20.11.2017 /// 10:30 – 12:00 /// BERLIN (Plenar Hall)

Session Chair: Christian Gülpen

▶ **Smart Customization in the Textile Industry [104]**

Presenter: Thomas Gries, RWTH Aachen University

Abstract: The textile industry is not particularly known for its digitalization standard. Due to the still increasing complexity of the global market, high lead times in production and transportation have become particularly critical. Textile manufacturers constantly try to follow customer demands, but traditional manufacturing in Asia is setting boundaries in terms of time to market. The development of automation in the textile industry has offered alternatives to the distress of growing market complexity. Due to the increasing share of intelligent systems within the process chain, textile manufacturers are able to produce closer and faster to key markets, providing individual products with higher margins. Professor Thomas Gries has taken a step into the future of digital textile manufacturing: By founding the Digital Capability Center Aachen he and his team are showing the possibilities of Industry 4.0 by decreasing digital waste and increasing time to market for textile manufacturers. Within acatech – the National Academy of Science and Engineering – and innovative projects like SPEEDFACTORY and STOREFACTORY he is preparing to push the boundaries of the textile industry to new limits, by developing mass customizing production systems back in Europe.

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▶ **adidas SPEEDFACTORY – Innovation for Creators [103]**

Presenter: Jan Hill, adidas

Abstract: With SPEEDFACTORY adidas is developing a manufacturing innovation platform that will enable personal and purpose-built products based on individual athlete needs and desires. It is combining speed in manufacturing with the flexibility to rethink conventional processes. adidas SPEEDFACTORY is heralding a new era in footwear crafting providing greater precision, unique design opportunities and high performance. SPEEDFACTORY allows adidas to co-create with consumers and react quickly to consumer demands as well as staying on top of key trends, ultimately providing consumers with truly tailored product solutions delivered with unprecedented speed.

▶ **Lessons from a New York Fashion Start-Up [101]**

Presenter: Kali Ventresca, Impish Lee

Abstract: Kali Ventresca of Impish Lee reveals what every woman is searching for in the bedroom, intimate apparel that is custom made just for them. With such variety in size, shape and personal style, women are in need of comfortable and supportive under garments that they can personalize. Impish Lee, launched by sister duo, Kali and Noelle Ventresca, in 2015, enables women to design their own intimate apparel online. The New York based start-up seeks to change the way women purchase lingerie. As other intimate apparel brands expand into more personalized shopping experiences such as style profiles, fit guides and personalized subscription services, Impish Lee takes a unique approach, allowing the customer to be the designer. Impish Lee's mass customization business model enables the brand to cater to women of all sizes as the demand for size inclusivity is rapidly increasing. Kali Ventresca discusses the brands start-up journey, mission to transform the intimate apparel industry, and the advantages of personalization in growing niche markets.

Parallel Session 1.2: MCP Success Factors and Best Practices (I)

Monday 20.11.2017 /// 10:30 – 12:00 /// K1 (Eurogress)

Session Chair: Cipriano Forza

▶ **Mass Customization in Food Industries: Case and Literature Study [40]**

Presenter: Sofie Bech, Aalborg Universitet

Co-Authors: Sofie Bech, Anne-Sophie Schou Joedal, Thomas Ditlev Brunoe, Kjeld Nielsen

Abstract: The food industry currently faces demands for more diverse products. This introduces a different competitive environment than the food industry has traditionally experienced. A possible solution to the change in customer demand is to apply the business strategy, mass customization, which enables customized products at prices near that of mass produced products. Although mass customization has been utilized in several different industries, the food industry has not yet seen this business strategy widely adopted. This paper presents a literature review, which only reveals few works within mass customization in the food industry. The limited literature covers food manufacturing processes, product configuration and supply chain. To examine the potentials and challenges of mass customization in the food industry, a case study of a food manufacturer is conducted. It becomes evident that the case company has challenges with mastering the capabilities required to achieve mass customization. The challenges identified in this study are: 1) No product solution space development. 2) Limited knowledge of raw material. 3) Manual equipment adjustment. 4) Dedicated software and hardware solutions. 5) Limited choice navigation. In light of the listed challenges and the limited literature in field, it is clear that more research is imperative in order to enable mass customization in the food industry.

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► **Product Configuration in the ETO and Capital Goods Industry: A Literature Review and Challenges [39]**

Presenter: Bjørn Christensen, Aalborg Universitet

Co-Authors: Bjørn Christensen, Thomas Ditlev Brunoe

Abstract: Product configurators are IT tools often used to enable choice navigation in mass customization environments, with the purpose of giving companies the ability to interact and deliver customized products to the customers. While product configurators have been widely adapted and investigated in the consumer-industry, research on which challenges companies are facing in the ETO and capital goods industry, in regard to product configuration, is less extensive. Therefore, the objective of this paper is to identify challenges in applying product configuration for ETO and capital goods companies, as well as reviewing potential solutions in research, which can be applied to address these challenges. The findings show a gap between the solutions and challenges especially in the area of staging commitments of product characteristics, flexible management of alterations to the configuration design, and connecting decision criteria in product configuration with supply chain processes. The gap analysis lay the foundation for future research.

► **Integrate Customer Order Decoupling Point and Mass Customisation Concepts: A Literature Review [64]**

Presenter: Violetta Giada Cannas, Politecnico di Milano

Co-Authors: Violetta Giada Cannas, Margherita Pero, Tommaso Rossi, Jonathan Gosling

Abstract: The postponement represents the key strategy for companies to achieve mass customisation. It is associated with the customer order decoupling point (CODP) positioning: the backward shifting, from a pure standardised configuration (i.e. make-to-stock, MTS), allows companies to delay some supply chain activities until the customer order arrives, increasing product variety while maintaining efficiency. This concept has been widely analysed in the literature but there is a lack of studies about the means to reach more standardisation starting from a pure customised configuration (i.e. engineer-to-order, ETO). Nevertheless, the movement toward mass customisation benefits also ETO companies, by reducing costs and lead times while assuring flexibility, and represents a need in the high competitive global markets. Therefore, this concept needs to be extended to a wider perspective that includes possible levels of customisation achievable from different configurations. This is possible through a good understanding of the CODP theory. This paper reviews the CODP literature to investigate the different existing perspectives, and classify them in a structured framework. This framework compares the CODP literature with the mass customization one, to understand what the interconnections among them are in the actual state-of-the-art, and what is missing to achieve a more general view of these concepts. This allows the study to open further research highlighting the recent trends and the uncovered topics.

► **The Individualization of Mass Customization: Exploring the Value of Individual Thinking Style through Consumer Neuroscience [68]**

Presenter: Frances Turner, Menlo College

Abstract: Neuromarketing is looked upon by some with suspicion, others with enthusiasm: it is seen either as a dastardly way of getting inside our heads to make us buy what we do not need, or a potentially better means to glean more accurate consumer insights to guide design and production of goods, services and experiences leading to commercial success. Can brain science reveal the nature of individual thinking style to help the consumer collaborate so effectively with the mass customization (MC) provider such that she really gets exactly what she wants or needs? Could deeper knowledge by the consumer of her own neural processes empower her to assist the MC provider in elevating her perception of value of the customer experience? If an individual's thinking style is innately unique and situation or context specific, then studying the individual's perception of the consumer experience via exploration of factors related to her inimitable cognitive processing could help individuals gain, and practitioners and

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scholars provide, further insights into enhancing the relational value of MC. This paper is an initial exploration of how consumer neuroscience might be useful to the consumer and firm to further individualize and enrich the consumer's perception of value of the mass customization experience.

► **Choicla: Intelligent Group Decision Technologies for Business Environments [74*]**

Presenter: Paul Blazek, SelectionArts

Co-Authors: Martin Stettinger, Alexander Felfernig, Paul Blazek, Stefan Reiterer

Abstract: Group decision technologies show increasing commercial interest in different contexts such as software engineering, recommendation of products and services, configuration, scheduling, etc. In these contexts, group decision technologies support groups of users in identifying decisions acceptable for the whole group while taking into account aspects such as decision optimality, consensus, and fairness. In this paper we provide an overview of decision scenarios where group decision technologies can help to improve decision quality with regard to the mentioned aspects (and beyond). In addition, we provide an overview of the Choicla environment that aims to support the above mentioned scenarios and thus provides a major basis for the implementation of group-based decisions in commercial contexts.

Parallel Session 1.3: Managing Variety, Product Families and Platforms

Monday 20.11.2017 /// 10:30 – 12:00 /// K2 (Eurogress)

Session Chair: Kjeld Nielsen

► **Data Driven Product Family Modelling with Feedback [44]**

Presenter: Thomas Ditlev Brunoe, Aalborg Universitet

Co-Authors: Thomas Ditlev Brunoe, Kjeld Nielsen

Abstract: In order to become a successful mass customizer, companies must be in control of their product variety. This is to ensure that the product variety is sufficient in order to satisfy the range of customer demands, but also to ensure that there is no excess variety, which compromises efficiency in business processes and manufacturing processes. This is often addressed by establishing product family models which represents the variety in a specific product family and any constraints there may be. In this paper, we first present a literature review of the currently existing product family modelling methods, in which it is concluded that most current methods are stand alone, document based methods, which largely do not consider integration with other product data systems or feedback from production and products. We then propose a number of new approaches to product family modelling, which utilizes data from other systems such as ERP and PDM, which enables a more fact based modelling process. Furthermore, the proposed approach enables feedback loops into the product family model, which is possible due to advances in connectivity (IOT applications). The new approach will enable better qualification of decisions regarding product variety management once implemented.

► **Production Platform Development through the Four Loops of Concern [45]**

Presenter: Daniel G. H. Sørensen, Aalborg Universitet

Co-Authors: Daniel G. H. Sørensen, Jacob Bossen, Mads Bejlegaard, Thomas Ditlev Brunoe, Kjeld Nielsen

Abstract: Managing product variety is still an issue in the industry, and one that gets a lot of attention. Among several ways to address this issue, is the development of platforms. Platforms, for instance coupled with the use of reconfigurable manufacturing systems, can potentially enable manufacturers to deal with a more dynamic market, an increase in variation and decrease in product lifecycle. The development of these platforms and systems is often difficult to begin, and even more so to finish. This paper presents a method for developing and co-developing product and production system platforms, using concepts from the field of software architecture development. Development and implementation of the method was carried out through case studies in two Danish companies. The method is an iterative approach consisting of four loops

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with four steps each. It facilitates the utilisation of concepts and tools from software architecture development during the platform development process.

► **Managing Customized & Profitable Product Portfolios using Advanced Analytics [58]**

Presenter: Merle-Hendrikje Jank, RWTH Aachen University

Co-Authors: Günther Schuh, Michael Riesener, Merle-Hendrikje Jank

Abstract: Due to heterogeneous and volatile customer requirements as well as a growing demand for individualized products, companies nowadays face a highly uncertain environment. As a consequence, the number of product variants offered has increased drastically in recent years and across all industries. That way, the complexity of the product portfolio increased, too. Due to this complexity, internal costs rise and often outweigh possible sales revenues. Under these circumstances, to satisfy various customer requirements and to keep profitability high, a dynamic optimization of the product portfolio is necessary. Existing literature discusses the topic of configuration management for product portfolios regarding diverse circumstances. While current research focuses on the tracking of costs related to configuration changes either while they occur or retrospectively, no approach succeeds in cost and demand prediction. In this paper, the topics of product portfolio management and advanced analytics are combined to overcome the limitation of retrospective modelling. A concept for a methodology to dynamically optimize the product portfolio during the use phase is suggested. Moreover, the methodology aims at predicting the optimal portfolio configuration using real-time data and advanced analytics. That way, customized and profitable product portfolios are realized efficiently.

► **Product and Service Variety vs. Internal Performance – Towards New Balances [79]**

Presenter: Khaled Medini, École des Mines de Saint-Étienne

Co-Authors: Khaled Medini, Abderrahmane Moujahid, Xavier Boucher, Alain Bernard

Abstract: Increasing customer demands for individualized solutions has a major impact on the manufacturing sector. Companies are confronted with producing high volumes in order to meet market demand while customizing their offering to meet specific customers' requirements. One of the subsequent major challenges of this situation is to cope with the high offering variety while ensuring higher performance within the production system and supply chain of the solution provider. This paper deals with the impact of integrating products and services on the variety-induced complexity. Based on a consistent literature review, a model is proposed to conceptualize the main drivers of variety management of product and service offering. The ultimate objective of the model is to support decision makers in the identification of balances between customer satisfaction and supply chain performance.

► **Which Variety Is Free? Discerning the Impact of Product Variety in the Process Industry [31*]**

Presenter: Alexandria Moseley, Technical University of Denmark

Co-Authors: Alexandria Moseley, Anna Myrodia, Lars Hvam, Zaza Nadja Lee Herbert-Hansen

Abstract: In the pursuit of mass customization, it is a great challenge for companies to maintain mass production efficiencies while producing a wide range of products. This poses an even greater challenge to process industry manufacturing systems which are built for high volume, low variety operations and which are sensitive to changes in process parameters. Many studies have been performed to quantify the impact of product variety on the efficiency of automotive assembly processes, but little work has been done to address process manufacturing systems. This study aims to determine the effects of individual product features on machine productivity at a process industry manufacturer. A lasso regression model is developed and tested using actual product and process level data from a stone wool manufacturer in central Europe. Results show that product features are less correlated to machine efficiency than process parameters, such as planning and crew performance.

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Plenary Session II: Digital Manufacturing & Industry 4.0

Monday 20.11.2017 /// 13:30 – 15:00 /// BERLIN (Plenar Hall)

► **Keynote 3: Complexity Management 4.0 – Product Modularization in the Context of Industrie 4.0**

Presenter: Günther Schuh, RWTH Aachen University and e.Go AG

For manufacturing companies managing complexity implies finding the optimal balance between flexibility and standardization. From a customer perspective that means increasing the external flexibility for targeting the exact needs of markets. While from an internal point of view, the intention is a decrease of development efforts through standardization. However, since the mechanisms of Industrie 4.0 have started to establish, the collection and evaluation of data is getting more attractive. Companies are starting to use existing sources of data as well as collecting additional information of their products and processes within a digital shadow. Those effects will lead towards a new understanding of products in the future. On the one hand, the results of advanced data analytics coming along with Industrie 4.0 support the conception of products during the definition phase. While on the other hand, the influences also extend to the use phase of products. Combining the two different perspectives of complexity management in terms of internal and external view with the conception phase and the use phase of products, there are four fields of action that have to be considered for describing the effects of Industrie 4.0 on product modularization.

► **Keynote 4: The Future of Individualization by Digital Photonic Production in the Context of Industry 4.0**

Presenter: Reinhart Poprawe, RWTH Aachen University

Abstract: Industry 4.0 is drawing increasing attention to production around the world. Examples of future DIGITAL PHOTONIC PRODUCTION systems with focus on Additive Manufacturing will be discussed. In principle, with these characteristics lot size 1 production will become economically feasible. This includes additive manufacturing in Selective Laser Melting SLM, Laser Metal Deposition LMD and controlled deposition of functional layers. Production without tools directly from digital design data, also frequently referred to as 3D-Printing, are envisioned even in series production. The presentation will display the systematic advantages of the technology ultimately leading to economic one piece flow and complexity for free. Build up rates for complex metal parts will increase by a factor of 10 in the next 3 years. New design methods for products will be displayed allowing optimization in terms of product functionalization, characteristics like tensile strength, fatigue behavior and deformation. A next version of DPP is currently developed in a high precision ablation process: ultrafast laser ablation, also referred to as Digital Milling. It allows micrometer precision at macroscopically relevant ablation rates. The perspectives of process scaling will be shown.

Parallel Session 2.1: Digital Manufacturing and Digital Business Models for MCP (I)

Monday 20.11.2017 /// 15:30 – 16:55 /// BERLIN (Plenar Hall)

Session Chair: Sebastian Kortmann

► **The Power of 3D Customization [32]**

Presenter: Martijn Joris, Twikit

Abstract: Digital manufacturing technologies such as 3D printing enable a lot of benefits for your products and your customers. Brands can produce on-demand, use digital flows and offer end-user personalisation. Within the presentation, Twikit will walk you through a variety of cases in different segments such as lifestyle, construction and automotive. The goal is to share hands-on experiences with the audience. Twikit is a Belgian scale-up who offers a 3D customisation software platform.

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► **Yuniku – The First Fully Personalized Eyewear: An Innovation with a Transformative Potential [19]**

Presenter: Alireza Parandian, Materialise

Abstract: To understand how to scale personalization projects with transformative potential, decision makers must understand the impact of digital technology on customer experience, product differentiation, operations and business model. This paper reflects on a blue print for the development of digital supply chains of personalised products. It discusses the development of such a supply-chain in the eyewear industry through a collaboration between two market leaders, Materialise and Hoya. The result is a system called Yuniku enabling the world's first fully personalised eyewear. This system allows for both lenses and frames to be designed and positioned to fit an individual's anatomical features, functional needs, and vision requirements. This presentation concludes with key lessons on managing Co-Creation processes.

► **Mass Customization 4.0 in AEC: Additive Manufacturing for Innovative Building Systems [82]**

Presenter: Ingrid Paoletti, Politecnico di Milano

Abstract: This paper highlights the possibility to realize innovative building systems thanks to Additive Manufacturing opening the way to Mass Customization in AEC. Two examples of building systems realized at ACTLAB, ABC Dept, Politecnico di Milano are described which have been designed employing computational tools and innovative manufacturing techniques. The first one is a functionally graduated lattice structure, the second one a complex mould. Both could be realized with FDM and polymeric materials in a very interesting design to fabrication process. Finally some 'what ifs' are traced for a wide diffusion of AM in AEC.

► **Open Experience and Formlur Make Complex Production Facilities Accessible for Everyone over the Internet [35]**

Presenter: Konstantin Krahtov, Open Experience GmbH

Abstract: If a designer, engineer or individual has an idea for a new product or on how to customize an existing one and thus needs sophisticated production technologies to realize it – he has a problem. As complex product shapes require a laser or water jet cutting equipment. Local manufactures which operate with such equipment struggle with requests by individuals. They don't possess the capability to process such orders efficiently. Modell verification, price calculation, invoicing etc. are optimised only for production in big series which rarely change. These obstacles put off creative people to realise their ideas.

Parallel Session 2.2: MCP for Apparel and Textiles (I)

Monday 20.11.2017 /// 15:30 – 16:55 /// K1 (Eurogress)

Session Chair: Sergio Dulio

► **The Future of Footwear: From Mass Customization to Factory on Demand [25]**

Presenter: Andrey Golub, ELSE Corp

Abstract: This presentation describes a project named "From Mass Customization to Factory on Demand". A pivotal case of open innovation, it was a proof-of-concept integration project between the startup ELSE Corp; Atom Lab, a business unit of ATOM Group – Vigevano; and Shoemaster UK. It introduced a streamlined vision for the future of the footwear industry, based on an innovative approach to the industrial processes related to mass customization in the fashion & footwear industry, called "Virtual Retail" (first introduced in 2014 by the Italian startup ELSE Corp, www.else-corp.com/virtual-retail). By incorporating Virtual Retail into Industry 4.0, the nine-step Factory on Demand seamlessly integrated industrial 3D CAD into the on-demand, hybrid production of mass customized footwear products, including those made-to-measure, through a semi-automated and fully traceable production life-cycle, starting on the Cloud and managed by a flexible industrial workflow. The presentation primarily focuses on the first step in the cycle: ELSE Corp's Virtual 3D Commerce platform.

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▶ **Individual On-Demand Produced Clothing – Ultra Fast Fashion Production System [30]**

Presenter: Daniel Bücher, RWTH Aachen University

Co-Authors: Daniel Bücher, Yves-Simon Gloy, Bernhard Schmenk, Thomas Gries

Abstract: In the textile and clothing industry, global value-added networks are widespread for textile and clothing production. As a result of global networks, the value chain is fragmented and a great deal of effort is required to coordinate the production processes. In addition, the planning effort on the quantity and design of the goods is high and risky. Today the fashion industry is facing an increasing customer demand for individual and customizable products in addition to short delivery times. These challenges are passed down to the textile and clothing industry decreasing batch sizes and production times. Conventional clothing production cannot fulfill those demands especially when combined with more individual designs. Hence new sustainable and economical production concepts have to be developed. Together with the adidas AG, Herzogenaurach a flexible and automated In-Store production concept for knitted customized merino wool sweaters has been developed. With Industrie 4.0 technologies an urban and customer close production system has been developed. The analysis of the economical key performance indicators shows how such a new production system performs against a conventional production in Asia and where potentials are hidden.

▶ **Fashion & Apparel Industry 4.0 and Smart Mass Customization Approach for Clothing Product Design [36]**

Presenter: Jocelyn Bellemare, ESG Uqàm

Abstract: Fashion Apparel Industry 4.0, which created what has been called a smart factory, is now a paradise of real-time efficiency. With its work force and manufacturing ability, it is able to keep pace with fashion trends and work closer to market to achieve a mass customization program. This paper examines the potential of clothing configuration within the personalization and mass customization concept. Within the modular structured smart factories, cyberphysical systems monitor physical processes, creating a virtual copy of the physical world and making decentralized decisions. Even if some manufacturers have managed this approach successfully, others have only poorly grasped it. The increase in purchase returns for personalized and customized clothes both in stores and on the Web creates headaches for retailers because it affects their brand image, customer perception and loyalty intention. The first problem is related to the 4.0 manufacturing aspects with measurements, adaptation of patterns and flexibility in methods and manufacturing deadlines. The second is the lack of knowledge and experience on the part of the manufacturers to properly use the configuration systems. It has become increasingly important to understand how to create an approach for configurator implementation for the clothing personalization and mass customization program. For producers to make the most of this approach, they need to better understand what can be done in terms of clothing personalization and mass customization capabilities. We discuss custom clothing in conjunction with the effects stemming from the evolution of mass production practices. This led us to explore the problems related to the automation of standard sizes and integration of "fits" done in traditional as well as computerized ways from different angles with respect to product adaptation. In this paper, we also analyze the mass customization concept and propose technological and transparent operational approaches aimed at initiating useful discussions to better understand these issues and the new culture that has been created.

▶ **TCBL – Textile and Clothing Business Labs [73]**

Presenter: Dieter Stellmach, Deutsche Institute für Textil + Faserforschung Denkendorf

Abstract: The presentation will demonstrate the establishment of an (online & offline) ecosystem for creation and production of customer-driven textiles and clothing, based on the concept of networking (open innovation) labs and an open community. TCBL is an innovation project funded by Horzion2020 to renew the textile and clothing business. The idea of the project (started in 2015, coordinated by Municipality of Prato, and DITF as the technical manager) is to

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establish new ways to design, make, and work together by inventing new products, processes and business models in order to open up attractive markets focusing on small series of textiles and clothing on demand.

► **Business Model Development Regarding Mass Customization Aspects Based on the New 3D Large Circular Knitting Technology [84*]**

Presenter: Kristina Simonis, RWTH Aachen University

Co-Authors: Kristina Simonis, Lena Roisin Weber, Stephan Hankammer, Thomas Gries

Abstract: At the Institut für Textiltechnik (Institute for Textile Engineering - ITA) RWTH Aachen University, a new technology for mass customized manufacturing of knitted goods has been developed. For the first time ever, 3D structures can now be produced on large circular knitting machines instead of using the nowadays commonly employed flat knitting machines. Since large circular knitting machines operate much faster, this innovation increases the overall productivity of 3D-knits. This opens up a completely new avenue for cost reduction through the application of this technology in sportswear, upholstery, aerospace and automotive industries. Since customized changes regarding a product's geometry, size or mesh structure are designed digitally before sending the information to the machine, no hardware modifications are required and manufacturing accomplishes the efficiency of mass production. The introduction of such a technology into the industry warrants the development of a suitable business model. The poster will present the business model created for this newly developed mass customization textile technology. As a basis, the nine business model canvas modules have been defined with respect to the textile process chain, the critical factors in the process chain as well as four different fields of application.

Parallel Session 2.3: Smart Customization: Data-Driven Approaches for MCP (I)

Monday 20.11.2017 /// 15:30 – 16:55 /// K2 (Eurogress)

Session Chair: Frances Turner

► **Affective Computing and the Rise of Emotionally Intelligent Products [24]**

Presenter: Michael Bartl, HYVE

Co-Authors: Michael Bartl, Marco Maier, Daniel Richter

Abstract: Machine Learning is used to infer various human conditions from raw sensory input. Users can then allow connected devices to take their individual emotional states into consideration, allowing the devices to operate smarter and more personalized than before. The corresponding field of scientific research is called affective computing (AC). Fields of application are identified in various industries and an increasing number of pilot applications are under development: Cars can adapt their driver assistant systems according to the emotional arousal of their passengers to increase safety. Online customization and shopping systems can embed the emotional state of the users in their recommendation logic. Smart home systems choose the right climate, light and security features according to the current mood of the users. Production systems can adapt the workflow when workers are overburdened. Education systems can adapt according to the receptiveness of the participants.

► **User-Centered Service Innovation for Commercial Vehicles: Plugging in the Handyman Market [67]**

Presenter: Nicole Eikelenberg, Ford Motor Company

Co-Authors: Nicole Eikelenberg, Kate Spierings, Froukje Sleswijk-Visser, Dirk Snelders

Abstract: There is no vehicle segment where personalisation is as common, as for Light Commercial Vehicles. These vehicles are used for a large variety of tasks, supported by an ever increasing number of new services. One of the most interesting market segments for Light Commercial Vehicles from the perspective of Service Innovation and product personalisation

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is the handyman market. Handymen have a very strong relationship with their vehicle, highly specific mobility needs depending on their specialisation, and spend a lot of time personalising their vehicle. This paper presents the Plugs concept. The Plugs concept is a new open-source approach to deliver personalised services for Commercial Vehicles to the handyman market. The concept was created based on user research and service innovation done by the TU Delft Design School in collaboration with Ford stakeholders from the Research and Innovation Center in Aachen. To deliver a broad variety of personalised hardware- and software-based services, called Plugs, to small handyman businesses in a cost-efficient way, Ford should build a strong open-source platform strategy around the core Ford Transit product, involving third party developers and handyman lead users in the creation of these Plugs.

► **Consumer's Response to Smart Products for Product Customization in the Usage Stage [33]**

Presenter: Ning Wang, RWTH Aachen University

Co-Authors: Ning Wang, Frank Piller, Kanliang Wang

Abstract: In this paper, we test consumer's attitude towards the new concept for consumers to achieve customized and user-specific products in the smart product age – that is Product Customization in the Usage Stage (PCUS) with Smart Products (SPs). On the contrary to the existing concept of customizing products online during the point of sales, a new class of smart products – Adaptive customizable smart product (ACSP) (enabled by recent digital technologies and Internet of Things) – allows consumers to configure them to achieve personalized product or service via embedded toolkits (e.g. connected apps) according to different usage context. The objective of this study is to investigate consumer's perception of ACSP by comparing two different SPs scenarios for PCUS – SPs with autonomous personalization and SPs with user customization. We imply a scenario based survey, in combination with an experiment to test consumers' perception differences between these two types of smart products.

► **Design for Mass Individualisation: Introducing Networked Innovation Approach [04]**

Presenter: Ravi K. Sikhwal, Imperial College London

Co-Authors: Ravi K. Sikhwal, Peter R. N. Childs

Abstract: This paper outlines a nascent field of product innovation, which we believe will become significantly more relevant in the near future. Product design for Mass Individualisation is a new product design paradigm that comprises an open hardware platform and multiple modules that are integrated within the platform. It gives freedom to end users to integrate different modules into the platform as per their choice. Large manufacturers will produce the platform and some specific modules. Other modules will be invented and produced by smaller companies and by the user. This type of product integration will be engaged with by the all actors involved in the design and aims to help them to be more creative and innovative. Strategic and technological integration of all these actors, which is also the theme of Innovation 4.0, is the main focus of this work to intensify the innovation. Key areas which need to be focused on are identified and presented by an explorative study of existing product design and customization approaches. Based on the explorative literature analysis, an industrial questionnaire survey has been conducted and results are presented for the industrial implication and insights on this approach. The findings clearly show that the end product of product design for Mass Individualisation will be more creative and innovative.

► **Understanding Personalisation: An Academic Perspective [57*]**

Presenter: Iryna Kuksa, Nottingham Trent University

Co-Authors: Iryna Kuksa, Tom Fisher

Abstract: Personalisation is a global phenomenon that has come to affect virtually all aspects of our everyday lives. It is a principle that is now designed into many of the situations where we engage with objects, institutions, services and, indeed, one another. We are offered

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personalised shopping and leisure experiences, we exercise with personal(-ised) smart trainers, plan our daily schedules with personal(-ised) assistants using our smart phones, and watch tailored TV programmes on our smart TV-sets. We are 'stalked' by personalised advertisements while browsing the Internet, our health is monitored by personalised wearable devices and we hope for person-centred medical care and personalized social care provision. Personalisation is indeed ubiquitous. It is an inextricable element of consumption and in all its manifestations, personalisation is deliberately designed. What interesting about personalisation is that it has appeared without us really noticing – it has risen without trace.

Although we increasingly expect to be able to personalise our experiences, it may not be an aspect of life that we think about terribly hard. It is also fair to say that neither the definition of personalisation, nor its boundaries and the drivers for its design, are clearly understood.

Parallel Session 2.4: Choice Navigation: Matching Customer Needs and Preferences for Company Capabilities (I)

Monday 20.11.2017 /// 15:30 – 16:55 /// MADRID (Quellenhof)

Session Chair: Frank Steiner

▶ **User Interface Trends for Mobile Optimized Product Configurators [08]**

Presenter: Klaus Pils, Combeation GmbH; Paul Blazek, Combeation GmbH

Co-Authors: Paul Blazek, Klaus Pils

Abstract: Until now studies and research haven't focused on the importance of mobile optimized product configurators, but it was rather mentioned in articles and blogs. Since millennials, the first truly digital generation of people born between 1980 and 2000, have a rising online purchasing power and prefer mobile phones to desktop devices this topic is relevant for science dealing with mass customization and configurators. 30% of millennials use their mobile phone for shopping, furthermore they are interested in personalized or customized products. 4 in 10 millennials are open to co-create products with companies. So it can be assumed that offering customizable products and services optimized for mobile usage may have a significant relevance. This paper will take a closer look at the status quo of online product configurators regarding mobile optimization in the apparel industry. A quantitative and qualitative research will try to find out if there are any user interface design trends to pave the way for further research.

▶ **The Importance of Choice Navigation in Starting Configurator Projects [41]**

Presenter: Ottar Bakås, SINTEF

Co-Authors: Ottar Bakås, Børge Sjøbakk, Maria Thomassen, Lars Skjelstad, Paul Blazek, Martina Partl

Abstract: Choice navigation can support customers in identifying their own solutions while minimizing complexity and the burden of choice. Product configurators are used as an interactive tool to help customers in this process. For companies aiming to develop a configurator from scratch, there are many hurdles. Particularly for SMEs there are additional challenges, such as shortage of resources, experience and knowledge in developing a viable configurator tool. In this paper, we explore the process of designing choice navigation through a product configurator tool. We review existing methodologies, and propose a new process model. Empirical data come from a case study of three SMEs embarking on the process of establishing a choice navigation tool. The proposed model is developed in the context of the research project CustomR. The new process model is cyclic and customer-driven, and aims to develop need-based configurators (as opposed to a linear, technology-driven and function-based approach). The paper reports on challenges and success factors from an ongoing configurator development project.

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► **Value Co-Creation of Complex, Customized Offerings: Prototyping a B2B Toolkit to Capture Customers' Preferences Upfront [22]**

Presenter: Leontin Karl Grafmüller, HHL Leipzig Graduate School of Management

Abstract: The complexity of customized offerings is constantly increasing. Typically, they are created in personal and time-consuming interactions, since intense explanation is needed. Research suggests a consensus that such offerings are co-created most smoothly in personal interactions. However, it neglects how to capture customers' preferences upfront, which appears promising to focus the subsequent process on. This study reports on prototyping a toolkit with that purpose: a B2B co-creation platform. Questions asked are (1) how can a co-creation platform address complex B2B settings, and (2) what parts of the subsequent value co-creation process can be supported upfront. Based on workshops, a practical adaptive design was developed. It was used for a set of field experiments with four companies of the German textile industry. Semi-structured interviews with both provider and customer followed. Findings describe how the co-creation platform streamlines the overall process. Moreover, we identified a bipolarity of customer types in B2B value co-creation. We conclude by deriving managerial implications also for related industries.

► **Design and Development of the CEM-Dashboard – A Diagnostic Tool to Determine Your Current Position and Improvement Directions in Customer Experience Management [50]**

Presenter: Marcel Weber, Amsterdam Business School - University of Amsterdam

Co-Authors: Marcel Weber, Arend Hofsink

Abstract: Customer experience management is gaining attention from companies in recent years. Companies realize that it is not sufficient anymore to only meet customers' functional demands, but that customers also need to be treated pleasantly, receive personalized attention and communication, experience trouble-free and smooth operations, and feel comfortable when interacting and transacting with companies. We call this total set of positive emotions which customers long for the customer experience. As many researchers and practitioners have stated this customer experience can be managed. For this, academics and practitioners have developed several model-based approaches for customer experience management, but they usually prescribe actions on a high strategic level and omit to close the PDCA-loop with an assessment of the results. Organizations that are looking for specific actions and their effects as they are particularly close to their customers, like customer contact centers, mass customization producers, web-retailers and service providers, therefore feel neglected and surpassed by these models. To fill this gap, we designed and developed a diagnostic and benchmark tool, the CEM-Dashboard, for companies seeking to implement customer experience management in the company and its processes to determine their current position and improvement options.

Parallel Session 3.1: Digital Manufacturing and Digital Business Models for MCP (II)

Monday 20.11.2017 /// 17:00 – 18:00 /// BERLIN (Plenar Hall)

Session Chair: Ingrid Paoletti

► **B2B Mass Customization in High-Tech Industrial Automation [105]**

Presenter: Christian Leaser, FRABA GmbH

Abstract: The story of a typical one-location mid-sized company that developed into a fully digitized and globalized organization. With minimal investments this company created its own cloud-based IT system with automated workflows and fundamentally changed its business system from Technology Crafting to Mass Customization. The results of this new system are 75% manufacturing labor cost productivity improvement, access to high margin Small OEM and MRO market niches & a business model that can be replicated in multiple similar market niches.

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► **MC Supporting Tools Based on MC Strategies [27]**

Presenter: Joao Teixeira Soares, EULA IT GmbH

Abstract: Implementing mass customization is a big challenge for all parties involved. Only the mass use of software can master this complexity. But this, in turn, leads to a complex and high heterogenic system landscape. These required software applications cannot work in isolation. They need to communicate with other applications and react to events generated by other systems and devices. Without a powerful integration platform, the system integration depends on tools that the respective manufacturers makes available. This raises costs, and can make some system integrations unfeasible. EULA IT adopted a mass customization strategy as a basis for the development of its Integration Platform. Thus, our customers can follow a best-of-breed approach and use the applications and devices that best suit their business, without worrying about future system integration.

► **How to Create a Profitable Mass Customization Business [21]**

Presenter: Daniel Rübén, Custom Gateway

Abstract: We at Custom Gateway already started in 2010 to help retailers, brand owners, IP license holders and designers to make the most of the exciting new world of mass customization and on demand fulfilment using our tech, content and fulfiller network. In this presentation we show our learnings and failures – where we think mass customization will be in the future and what is driving this business model.

Parallel Session 3.2: MCP for Apparel and Textiles (II)

Monday 20.11.2017 /// 17:00 – 18:30 /// K1 (Eurogress)

Session Chair: Jocelyn Bellemare

► **myShopNET: Personalized Consumer Goods E-Commerce Platform [02]**

Presenter: Rafael H. Stark, AluGroup

Co-Authors: Rafael H. Stark, Pascual Martínez Ibáñez, Enrique Montiel Parreño

Abstract: myShopNET is an EU COSME research project whose focus is on personalizable, design driven, consumer goods. These products have unique requirements, due to their nature: If there is no physical sample before the good has been manufactured, as it is not manufactured before the customer co-designs it, then there is no possibility to see it or try it on before purchase. To overcome these kinds of problems specific solutions are required, such as fitting and sizing tools, pre-visualization tools, or co-design tools. myShopNET's main result will be a market-ready software platform that allows users to create a complete e-commerce solution specifically addressing the needs and requirements of the commercialization of customizable design driven consumer goods in less than 24 hours, comprising specific modules for three types of products (footwear, shirts and high-end fashion), all while being easily expandable to new ones.

► **Exploring Drivers and Barriers for Sustainable Use of Resources: The Case of High-Tech Mass Customizers in the German Textile Industry [46]**

Presenter: Leontin Karl Grafmüller, HHL Leipzig Graduate School of Management

Co-Authors: Paula Rassmann, Leontin Karl Grafmüller

Abstract: An efficient and sustainable use of resources is a core task for every company to ensure competitiveness and long-term success. Compared to large companies and corporations, SMEs have fewer capacities and knowledge on how to implement resource efficiency. Therefore, we explored the drivers and barriers for SMEs in order to both overcome existing challenges and to address sustainability opportunities. The empirical field is the textile industry in Germany, which is considered particularly interesting due to high competitive pressure, long value chains and its niche-specialization. For this purpose, we conducted 14 interviews with company representatives of textile SME mass customizers in Germany. The results show that there is a wide range of possibilities for a more sustainable use of resources, which help textile companies gain a great

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economic advantage. Findings include three drivers and barriers each, for SMEs to implement sustainability-focused activities. Managerial implications present both recommendations for the textile industry as well as related SMEs in other domains.

► **Attitudes Toward Apparel Mass Customization: Canadian Consumer Segmented by Lifestyle and Demographics [13]**

Presenter: Hala Hawa, Hawahat Inc.

Abstract: The wide spread of Internet and mobile applications among consumers made it possible for them to access markets otherwise inaccessible. Manufacturers became able to reach consumers directly, thus reshaping their shopping experience. Technological advances in apparel manufacturing and e-commerce made apparel mass-customization available to consumers online. Online clothing sales are rising in Canada, and the US, and so is the trend of customizing and personalizing products. However, relevant studies on consumer attitude and adoption, and life style segmentation are very limited in general, and missing the Canadian market. Moreover, none included dress social tendency as segment. This qualitative study is the first to explore the uptake of apparel mass-customization online by Canadian consumers, and identifies its ideal target market using multilayer consumer segmentation. This multilayer segmentation is also the first to apply the dress social tendency theory in conjunction with clothes shopping behaviour and demographic data that includes body mass index (BMI). Data collection methods include an interview and a questionnaire. The sample consists of thirteen (13) participants, age 21-65, 8 females and 5 males, from various cultural backgrounds, all residents of Ottawa, Canada's capital. This study provides Canadian consumer attitudes toward apparel mass-customization, and identifies characteristics of its ideal target market. Its methodology and findings contribute as the basis for a large-scale quantitative study applicable to various global markets including that of Canada. The findings would be of interest to apparel mass-customization management and marketing executives, and user experience researchers and designers.

► **Mass Customization Practices of Malaysian SMEs Apparel Sector: An Exploratory Survey [10]**

Presenter: Rohana Zur, Universiti Teknologi MARA, Malaysia

Co-Authors: Rohana Zur, Syaimak Abdul Shukor

Abstract: Mass Customization (MC) is one of the business methods, which combines the flexibility and custom-made products, associated with mass production. Recently, this business strategy has received vast attention from industries and the academic world, but the approach is still inadequate in Malaysia especially the SMEs apparel sector. The aim of this study is to examine the MC practices in Malaysia's SMEs apparel sector besides to carry out the fundamental overview concerning the factors of MC implementation, in collaboration with the Malaysia SMEs Apparel Sector. The method used was survey (open-ended questionnaire) and involved participation from 343 SMEs. The preliminary analysis demonstrates that the Malaysia SMEs apparel are motivated and have intention to implement MC approach, but the overall competency of MC approach is still missing. However, the overall finding shows that, the knowledge of MC significantly predicted the readiness factors $p < 0.05$. While, the manufacturing process flow become the key indicator to look at for the MC implementation. Besides, respondents also did not see any financial issues as a major barrier for MC implementation. This will give positive prospect to emphasize this method among the entrepreneurs. Briefly, this study provides an overview in understanding the requirement, execution and future challenges for MC implementation. It also discusses the advantages in implementing MC in the Malaysia SMEs apparel sector. Furthermore, the implementation of MC as their business strategy will encourage the companies to become more competitive.

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► **Customizing the Implementation of Mass Customization in the U.S. Textiles and Apparel Industry [53*]**

Presenter: Julie Becker, Eastern Michigan University

Co-Authors: Julie Becker, Alphonso Bellamy

Abstract: This study examined job design and mass customization variables that may impact the effectiveness of a mass customization (MC) implementation program within the textiles and apparel industry with a sample consisting of 91 subjects from U.S. textiles and apparel companies that have implemented an MC strategy. The variables consisted of mass customization approaches, employee job design utilizing the Hackman and Oldham job characteristics model, technology strategy, and two dimensions of organizational climate: risks and standards. This research paper will present the results of the job design score (MPS) and the correlation between the technology strategy variable and MC implementation effectiveness. The results showed that all the organizational factors except job specialization and the standards climate factor, had a positive correlation with MC implementation effectiveness. The overall results of the study provide saliency to the need of organizations to conduct an organization readiness assessment related to deploying a mass customization production approach.

Parallel Session 3.3: Smart Customization: Data-Driven Approaches for MCP (II)

Monday 20.11.2017 /// 17:00 – 18:30 /// K2 (Eurogress)

Session Chair: Luca Canetta

► **Demand Engineering in Mass Customization Using a Data Driven Approach [61]**

Presenter: Rui Xu, Stanford University

Co-Authors: Rui Xu, Shuhui Qu, Ying Liu, Jie Wang

Abstract: This paper proposes a general process framework of demand engineering as a significant platform of connecting requirements specification as one side and smart factory as the other, which can be applied to all industries. Our framework performs a sequential methodology to solve existing and prospective mismatching problems between two sides. This mismatching misperceives requirements of the market and simultaneously induces huge waste of manufacturing resources thus severely hampers the industry transformation into Industry 4.0. Affected by the diversity of industries, the requirements to what degree of transformation also varies. Therefore, different industries must clarify their demand for demand engineering.

► **Adapting Product-Service System Methods for the Digital Era – Requirements for Smart PSS Engineering [56]**

Presenter: Simon Hagen, Universität Osnabrück

Co-Authors: Simon Hagen, Friedemann Kammler, Oliver Thomas

Abstract: In the past a lot of time has been spent on creating and improving methods to develop integrated systems consisting of products and services, named Product-Service systems (PSS). Due to the different disciplines involved in creating and maintaining these systems, e.g. service engineering, product and production engineering or information systems, the interfaces between the stakeholders have to be defined to integrate them and to make them work seamless. However, in recent years the concept of PSS shifted, influenced by the still growing impact of smartness and intelligence in the domain of internet and communication technology (ICT). The rise of smart products and services led to the enhancement of “smart” product-service systems (Smart PSS). This paper identifies, based on recent work and a literature review, methods developed for designing PSS. The main characteristics of the methods found are then analysed with regard to the affects smartness has on them. Knowledge about the smartness aspect is taken from descriptions of Smart PSS. The findings are used to derive evidence about the transferability of PSS to smart PSS development methods.

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► **Datamodels for PSS Development and Configuration: Existing Approaches and Future Research [03]**

Presenter: Daniel Schreiber, Leibniz Universität Hannover

Co-Authors: Daniel Schreiber, Paul Christoph Gembarski, Roland Lachmayer

Abstract: Product-Service Systems (hereinafter referred to as PSS) are a hybrid combination of products and services. They are problem orientated solutions which address the individual needs of customers. To fulfill these individual needs a customer-centric development of PSS is necessary. Therefore, a customizable product is essential, which can be designed with parametric and knowledge based models. One of the biggest advantages of a PSS is at the same time one of the biggest challenges: addressing current requirements of customers during the life-cycle. This results in the need of modification of the product during its use. In view of the existing hardware an arbitrary modification is, in contrast to product development, not possible, which calls for refinement and adaption design. In this paper the idea of a variable product model – parametric during the development and case and rule based during the life-cycle – is discussed, to show the advantages and assign different models to the phases of the life-cycle.

► **A Systems Engineering Framework for Mass-Customisation in Construction [06*]**

Presenter: Tanawan Wee, Imperial College London

Co-Authors: Tanawan Wee, Marco Aurisicchio

Abstract: The construction industry is undergoing further industrialisation with greater emphasis towards off-site construction. The shift towards off-site construction allows to achieve cost efficiency and effectiveness in project delivery as well as to meet the growing demand for customised sustainable high value building products. This research tackles the problem of achieving mass-customisation in the construction industry. It highlights that the use of a product configurator could help address the challenges arising from mass-customisation. A systems engineering framework is proposed to support product planning. The framework implements methods for requirements management and prioritisation to identify product solutions and for modularisation to attain greater product flexibility. A plant-room case study was used to evaluate the framework, with results supporting its operation and applicability. The novelty of the framework lies in the integration of tools to support product planning and achieve mass-customisation in construction.

► **Uncovering the Potential Benefits of Data Analytics for Mass Customization [71*]**

Presenter: Hendrik Wache, TU Chemnitz

Co-Authors: Hendrik Wache, Christoph Kollwitz, Barbara Dinter

Abstract: Nowadays, mass customization (MC) is shaped by the application of digital technologies like computer aided design, computer aided manufacturing and distribution planning. During the MC process, different kinds of data are created, which can be used to obtain knowledge about past and future business activities by means of modern data analytics methods. The paper at hand applies design science research to develop a conceptual framework for identifying potential benefits of data analytics for MC. For this, a generic MC process is derived from previous literature and a systematic analysis is carried out using the work systems method. The conceptual framework offers a differentiated view on customers, products, activities, participants, technologies and information as well as on the information flow within the MC process as a whole. It enables manufacturers to identify valuable opportunities for data analytics and to optimize current MC processes. Furthermore, it can be used to develop a systematic process for the discovery and evaluation of data analytics benefits and novel business models in the future.

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Parallel Session 3.4: Choice Navigation: Matching Customer Needs & Preferences for Company Capabilities (II)

Monday 20.11.2017 /// 17:00 – 18:30 /// MADRID (Quellenhof)

Session Chair: Dominik Walcher

▶ **iART – A C2C Platform Enabling Co-Creation & User Generated Art Content [115]**

Presenter: Michel Byvoet, Bivolino

Abstract: The main objective of the iART project is to bring visual art into bespoke clothing so as to make more valuable apparel products compared to other garments in the market and to support artists to exploit their work. To reach this objective a set of innovative ICT solutions has to be developed first, these will be built upon an existing B2C webshop for bespoke shirts Bivolino.com: 1. Upgrade the configuration toolkit from 2.5D to 2.5D/3D by including shadowing and rotating features without the need of plug-ins and extend the catalog to clothing accessories and nightwear fitting with the shirts. 2. Move to real-time online rendering (fabric draping on 2.5D/3D clothing configurator), so as to speed up and increase the flexibility of the whole process from artist design over fabric creation to customized bespoke shirts and other garments. 3. Build a C2C platform connecting artists and consumers enabling co-creation and user generated art content. Develop an Advanced Artist Interface (AAI) with artist cockpit. Implement an Advanced User Interface to allow easy 2.5D/3D viewing in many other platforms through open API's. The related business model supported by easily accessible advanced ICT tools (through open API's) is sustainable and replicable and so has the potential to create a wide impact. Artist's micro SMEs will acquire extra revenues. The European Fashion and Clothing industry SMEs taking up the innovative supply-chains will generate more revenues through high-margin made-to-order collections which cannot be imported from mass production countries. Finally ICT providers are stimulated to offer innovative tools generating new business and turnover.

▶ **An Evaluation Model for Web-Based 3D Mass Customization Toolkit Design [63]**

Presenter: Huiwen Zhao, Bournemouth University

Co-Authors: Huiwen Zhao, Leigh McLoughlin, Valery Adzhiev, Alexander Pasko

Abstract: The development of geometric modelling technologies and web technologies provide the ability to present a virtual 3D product in a mass customization (MC) toolkit. Compared with 2D graphic toolkits, 3D toolkit design requires better consideration of individual customer needs, consumer and toolkit interaction, and also a means of integrating with the underlying technical infrastructure. However, there is currently no widely-accepted model or criteria to regulate and evaluate 3D MC toolkit design. Given these considerations, in this paper we provide an evaluation model for web-based 3D toolkits and a heuristic evaluation of two representative commercial web-based 3D toolkits. The evaluation results indicate the usefulness and effectiveness of the model as a scale for evaluating 3D toolkits. It also reveals that despite a fair amount of effort that has been devoted to theoretical research, current 3D toolkits are still at an early development stage. We therefore conclude this paper by identifying and encouraging further topics and questions as directions for future research.

▶ **User Interface Modifications in Established Product Configurators [09]**

Presenter: Paul Blazek, cyLEDGE Media

Co-Authors: Paul Blazek, Clarissa Streichsbier, Martina Partl, Lars Skjelstad

Abstract: The evaluation of the gathered data in the Configurator Database, the biggest collection of web-based product configurators, shows dynamic patterns of growth and decline in product configurator offerings in the last years. While configurators of all product groups and industries disappear from the market and others are newly added, there is quite a number of established customizable product offerings. This paper researches how the user interfaces of these products undergo modifications when compared over time.

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► **Front-End/Back-End Integration in Mass Customization: Challenges and Opportunities [47]**

Presenter: Børge Sjøbakk, SINTEF

Co-Authors: Børge Sjøbakk, Maria Thomassen, Lars Skjelstad, Ottar Bakås

Abstract: Many mass customization challenges can be ascribed to insufficient integration of front-end (e.g. customer choice navigation processes, product configuration, user interfaces and customer behavior patterns) and back-end (e.g. order management, purchasing and production planning and control) systems. To succeed as a mass customizer, customer/manufacture integration is critical. This paper provides in-depth insights to integration challenges and opportunities based upon a case study of four manufacturing companies. For solution space and product development, high uncertainty in new idea generation, lack of systematic product and solution space development, and limited knowledge of what is the right solution space are identified as challenges with opportunities for improvement. Regarding choice navigation, many companies have limited direct contact with end customers due to sales through dealers and resellers. Associated inefficient information flows is another challenge. The companies acknowledge opportunities related to advisory support during the sales process, as well as enhanced external collaboration with e.g. complementary actors. With respect to back-end systems, inefficient information flows also occur here. This, in combination with a large number of freestanding ICT systems, results in cumbersome production planning and execution. This is complicated even more by incorrect basic data. Finally, there are major opportunities in automatic visualization and efficient utilization of key information from the entire value chain. In addition to outlining several directions for further research, the paper provides in-depth, company based insights to key integration development areas, which managers may use when developing their own mass customization practices.

► **An Adaptive Reference Model for Product Configurators [72*]**

Presenter: Sarah Hönigsberg, TU Chemnitz

Co-Authors: Sarah Hönigsberg, Christoph Kollwitz, Barbara Dinter

Abstract: The integration of customers into organizational value creation activities is considered as a key factor for business success in the global competition. Mass customization (MC) contributes to this by involving customers in the individualization of product designs for a single purchase order. In order to apply MC in companies, configurators are commonly used as the front end to the customer. However, generic standard solutions can rarely be used due to heterogeneous requirements of MC manufacturers. The paper at hand develops an adaptive reference model at the conceptual level, using a design science research approach. Therefore, an extensive literature review and a subsequent case study for evaluation were carried out. The reference model includes configurative and generic adaptation mechanisms to provide a foundation for a flexible and individual development of product configurators in organizations across industry. Furthermore, the reference model can be used as a starting point for further research on automated configurator development.

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Plenary Session III: Sustainability & Mass Customization

Tuesday 21.11.2017 /// 08:30 – 10:00 /// BERLIN (Plenar Hall)

▶ **Keynote 5: How Can Customization Enhance Future Mobility**

Presenter: Pim van der Jagt, Ford Motor Company

Abstract: Ford has been one of the pioneers in mass production of vehicles. Initially mass production was everything but creating customized products. However, through mass production Ford was able to change the way the world moves for the first time. Nowadays we are facing many challenges, especially in cities: congestion and pollution are one of the biggest concerns. Ford has developed a vision of the cities of tomorrow in which Ford's mobility offering is no longer limited to vehicles in all variants, but extends to new products and services that really meet the changing customer needs.

▶ **Keynote 6: Lifecycle Management in the Era of the IoT – Optimizing for People, Planet and Profit**

Presenter: Wolfgang Budde, Philips Lighting

Abstract: For many products we have been used to „repair and replacement“ as dominant forms of lifecycle management. However, with increasing digitalization, it is no longer physical defects which limit a product's lifetime like e.g. a broken filament in a light bulb. Instead, products such as connected LED lamps have virtually unlimited lifetime, while their software and connectivity features are likely to be outdated long before their physical end of life. Upgradability is the key to solving this dilemma, enabling new business after sales of long-lived products, and saving the environment from huge amounts of waste.

Parallel Session 4.1: Promising Practices and Success Factors for Bridging MCP, Industrie 4.0, and Sustainability

Tuesday 21.11.2017 /// 10:00 – 11:30 /// BERLIN (Plenar Hall)

Session Chair: Robin Kleer

▶ **Mass Customization and Personalization: A Way to Improve Sustainability Beyond a Common Paradox [83]**

Presenter: Claudio R. Boër, SUPSI

Co-Authors: C.R. Boër, C. Redaelli, D. Boër, M. T. Gatti

Abstract: While the entire world is measuring the energy spent in saving the environment, and sustainability is one of the trendiest words, the real meaning of the term and the way of making it more concrete is still not clear. Which is the perception of sustainability among academics, industrials and common people? This perception appears as basis of a generally accepted paradox that brings the market players discussing about recycling and renovating and not measuring real users' needs. The present paper tries to also understand how historically the market has produced the above paradox based on the economic value that dominates the global community. The analysis of the confusion about end-of-life and beginning-of-life of a product among consumers demonstrates the generation of a collective contradiction. The paradox of our society is in fact based on the consciousness of the “end-of-life” of the mass-produced products but with total ignorance of the waste energy for products never sold (beginning-of-life). The paper proposes a change in production paradigm as a possible solution to go beyond the paradox. Where today Mass Production (MP) is still the dominant paradigm, Mass Customization (MC) and personalization is becoming more accepted and feasible also thanks to the technological developments and innovations.

▶ **Digitalization as a Driver for Sustainability? [102]**

Presenter: Dieter Wegener, Siemens

Digitalization has already been changing significantly the B2C-world with Smart Services like

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WhatsApp and Uber. Also in the industrial B2B arena the digitalization becomes a strong driver for productivity improvements in traditional factories as well as enabler for more customized production environments, i.e. “Smart Factories” and “Smart Plants”. There are two technological key enablers: Firstly the “Digital Twin”-approach using simulation technologies and secondly the new digital added value creation by means of big data analysis. The Eco-Care-Matrix is a methodology which supports the development of sustainable products, systems and solutions. Some industrial examples will be shown. The combination of both approaches, i.e. Digitalization and the Eco-Care-Matrix will be supporting the developments of more sustainable and more productive solutions in the industrial B2B-world.

► **Circular Economy by Co-Creation. Preparing Designers and Decision Makers for Upcoming Transformations [26]**

Presenter: Dominik Walcher, Salzburg University of Applied Sciences

Co-Authors: Dominik Walcher, Michael Leube

Abstract: Technological development of a growing world population is omnipresent, intensifies ecological and social frictions and has reached a dimension requiring distinct actions to avoid existential crises (Ellen MacArthur Foundation 2013). Among different approaches to a solution, e.g. sufficiency and degrowth, the transformation of our linear “take-make-waste” economy into a circular economy driven by “eco-intelligent” products and consumption appears most promising due to the fact that people are able to keep their life quality not being forced into frugality (McDonough / Braungart 2002). The European Commission’s 2015 circular economy strategy formulates first steps towards a transformation of the current economic system (www.europa.eu). The objective of this article is to summarize relevant action fields, which fundamentally should be taught to designers and decision makers to establish the base for a successful conversion into a circular economy. Co-creation is seen as central factor of a circular economy both in the production phase (rf. open innovation) as well as the use phase (rf. collaborative consumption) or the circulation phase (rf. multi-sided circulation platforms) (Walcher / Leube 2017).

► **Mass Customization as a Driver for Sustainable Consumption [16]**

Presenter: Stephan Hankammer, RWTH Aachen University

Abstract: In this presentation, we present results of applying Sustainable Mass Customization in the consumer electronics industry. Especially, we shed light on the co-creation phase of mass customization and its yet unexplored potential to contribute to the promotion of sustainable consumption. Following the goal framing theory’s rational that pro-environmental behavior can be encouraged by influencing hedonic, gain and normative goals, we investigate how customers can be navigated successfully towards more sustainable choices in a mass customization setting. We show that default settings play a significant role in promoting sustainable consumption, while the nudging effect of the provision of sustainability information is rather difficult to implement effectively. Moreover, we demonstrate that offering goods with customizable attributes of different sustainability levels gives consumers the ability to customize products reflecting their individual consciousness for sustainable consumption.

Parallel Session 4.2: MCP Success Factors and Best Practices (II)

Tuesday 21.11.2017 /// 10:00 – 11:30 /// K1 (Eurogress)

Session Chair: Thomas Ditlev Brunoe

► **Flexibility in Mass Customization of Houses [37]**

Presenter: Salman Khalili-Araghi, University of Calgary

Co-Authors: Salman Khalili-Araghi, Branko Kolarevic

Abstract: Mass customization as a business strategy serves to provide for product variations while maintaining the efficiency of production. Houses are one-of-a-kind products that reflect social and cultural differences of inhabitants who live in them. True adaptation of mass customization in the housing industry demands for flexibility: that is, stability and responsiveness in producing

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highly customized houses. Achieving that requires smooth flow of information among and effective collaboration between customers, designers, and manufacturers. This paper presents a comprehensive framework in the adaptation of mass customization in the housing industry by delineating fundamentals and technological developments in design, customization, and manufacturing spaces. Difficulties and challenges of such an approach are discussed from both companies' and customers' perspectives.

► **Validation of Metrics for Mass Customization – A Pre Study of Validation Methods [43]**

Presenter: Kjeld Nielsen, Aalborg Universitet

Co-Authors: Kjeld Nielsen, Thomas Ditlev Brunoe

Abstract: Over the last two decades literature presents mass customization metrics, recent research presents these in relation to another recent research; the framework of three fundamental capabilities in mass customization. The metrics presented are all considered metrics usefully in company applications like ERP systems. A firm validation of each metrics are not confirmed in the literature. This research aims to address the lack of method for validation. Firstly, by identify a commonly accepted method or procedure to follow to validate a metric; case study was identified as such commonly accepted method. Secondly, perform a simple analysis following the method proposed to assess the potential; an analysis of repurchase rate metric was performed on a small case data set, and it clarified the potential in the procedure for validation.

► **Teaching Solution Space Development: Experiences from the Hanover Knowledge-Based-Design-Lab [52]**

Presenter: Paul Christoph Gembarski, Leibniz Universität Hannover

Co-Authors: Paul Christoph Gembarski, Roland Lachmayer

Abstract: Although the concept of knowledge based design (KBD) and engineering (KBE) is discussed for more than 20 years, only little application outside of academia is documented. Existing approaches are predominantly limited to niche design activities or to aviation and automotive engineering. This fact does not originate from missing IT support or the lack of KBD functionalities in contemporary computer-aided design (CAD) systems but rather from deficiencies in education. As a study showed, in many curricula in engineering design the setup, structured exploration and management of (geometry-based) design solution spaces for configuration and optimization is yet not present. In the following article we present our experience with the Knowledge-Based-Design-Lab which is held at the Leibniz University of Hanover for five years. Scope of the tutorial is shifting the traditional modeling of mostly rigid geometrical product models to automate routine design tasks and create configurable virtual prototypes.

► **Can the SME Successfully Adopt Mass Customization? [76]**

Presenter: Henrike Boer, Aalborg Universitet

Co-Authors: Henrike Boer, Kjeld Nielsen, Thomas Ditlev Brunø

Abstract: The mass customization (MC) literature has, so far, primarily focused on how large enterprises successfully can achieve mass customization, neglecting the small and medium-sized enterprise (SME). Since SMEs constitute a major part of the global economy, this paper has the purpose to examine whether differences between large enterprises and SMEs influence the appropriateness of MC and manner in which SMEs can implement MC. Based on data from a large international survey, it concludes that the large enterprise and SME largely experience the same environmental conditions, and therefore asserts that both types of firms could utilize MC to attain a competitive edge in their environments and cope with fluctuations. It also finds that SMEs have persistently implemented MC-enabling practices to a lower degree when compared to large enterprises. Given their limited resources, this finding implies that SMEs have to choose amongst an excess of practices if they want to pursue MC. This paper suggest three potential starting points, that is, SMEs could start their MC journey with the standardization of the product

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portfolio, with the investment in and assimilation of advanced manufacturing technologies or through the creation of an organization geared towards continuous improvement.

► **Productivity, Challenges and Applying Mass Customization in the Building and Construction Industry [77]**

Presenter: Kim Nørgaard Jensen, Aalborg Universitet

Co-Authors: Kim Nørgaard Jensen, Kjeld Nielsen, Thomas Ditlev Brunø, Jesper Kranker Larsen

Abstract: The productivity in the Danish construction industry is significantly less compared to other sectors in Denmark. It has only doubled over the last fifty years, and based on this fact, this paper as a starting point look into the productivity of the building and construction industry to investigate trend similarities with other countries. Hereafter a literature study elaborates the challenges within the building and construction industry to understand the conditions that strain the industry in improving productivity.

Mass customization as a strategy has increased productivity and competitiveness in other industries in Denmark, and despite that mass customization has not been explored much in the research field of the building and construction industry, so implementing this strategy might affect the building and construction industry in a positive way. Therefore, this paper also study some indicators that justifying mass customization as a strategy applicable within the building and construction industry, as well as some assumptions and requirements of applying mass customization.

Parallel Session 4.3: Platforms, Ecosystems, and Business Models for Digital Manufacturing

Tuesday 21.11.2017 /// 10:00 – 11:30 /// K2 (Eurogress)

Session Chair: Jessica Menold

► **From Mass Customisation to Mass Entrepreneurship: The Impact of 3D Printing on Entrepreneurship [54]**

Presenter: Thierry Rayna, École Polytechnique

Co-Authors: Thierry Rayna, Ludmila Striukova

Abstract: The aim of this paper is to critically assess the impact of 3D printing technologies on entrepreneurship. While 3D printing technologies (also known as additive manufacturing) have been increasingly considered as highly transformative technologies, they have been so far (and despite over 30 years of existence) confined to niche markets. In fact, it seemed, until recently, that only the largest firms were able to take advantage of these technologies. However, the cost of use of such technologies has sharply decreased over the past couple of years and an increasing number of service companies offer both offline (Fab Labs, makerspaces) and online (3D printing platforms) means that it is possible to 'bridge the gap' and provide access to 3D printing technologies to everyone. This paper shows that the easier access to 3D printing technologies is particularly critical because, while they have played and continue to play an important role for larger companies, this is for smaller businesses and start-ups that they are more likely to be transformational. The reason for that relates to the cost characteristics of these technologies: a near constant average cost with no tooling cost involved that makes manufacturing even the smallest series potentially economically worthwhile. Consequently, this paper demonstrates that the use of 3D printing technologies can help alleviate numerous issues faced by entrepreneurs, start-ups and SMEs.

► **3D Avatar Platforms -Tomorrows Gateways for Digitized Persons into Virtual Worlds [11]**

Presenter: Zoran Anišić, Univerzitet u Novom Sadu

Co-Authors: Dinu Dragan, Zoran Anišić, Srđan Mihić, Vladimir Puhacac

Abstract: 3D avatar platforms are tools for offering customers services for production, distribution, and consumption of 3D avatars as a product. In this way 3D avatar platforms will

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become essentially a virtual home for realistic 3D avatars that can be used to explore virtual worlds that are a part of the platform. Alternatively, they can be used as a “vehicle” for visiting virtual worlds on different platforms. Research on existing 3D avatar platforms is described in the paper, alongside their capabilities, tools, and the virtual worlds they offer. A 3D avatar platform showcase was developed for CeBIT2017 as a proof of concept and it will be used in the future as a gateway for digitizing persons into virtual worlds. The paper conceptualizes the possibilities and features of future 3D avatar platforms.

► **A Marketplace for Smart Production Ecosystems – Managing Variability of Products and Factories [23]**

Presenter: Deepak Dhungana, Siemens

Co-Authors: Deepak Dhungana, Alois Haselböck, Richard Taupe

Abstract: The need for product variability to satisfy the needs of customers means that the process of manufacturing these products must also expose a similar degree of flexibility. In this sense, production facilities (factories) can be seen as product lines of manufacturing services. The focus of this paper is on modeling variability of the products in association with the variability in production requirements – the interplay of which gives birth to a smart production ecosystem. We describe an open marketplace, where product sellers can offer their products with variability, end-customers can configure these for their needs, and factories can offer their services to manufacture these customized products. Typically, the equipment used to build up the factory also offers variability, therefore the ecosystem also encompasses equipment vendors and the variability of this equipment. We attempt to bring together stakeholders of a production ecosystem in a marketplace that exploits product line engineering techniques.

► **A Digital Fabrication Infrastructure Enabling Distributed Design and Production of Custom Furniture [80]**

Presenter: Andrea Francesco Barni, SUSPI

Co-Authors: Andrea Francesco Barni, Donatella Corti, Paolo Pedrazzoli, Diego Rovere

Abstract: Thanks to the implementation of advanced technologies within simple-to-use responsive design interfaces, everyone can now purchase perfect-fit products from home. This is possible in several sectors thanks to the great developments in information and communications technology (ICT) and the wide use of cloud computing. The furniture sector is yet scarcely influenced by this trend, still lacking of systems able to translate parametric design libraries in optimally scheduled, ready to be manufactured projects, correlated by list of operations and specifications for on time customers' order fulfilment. This paper aims at describing an application model of the mass-customization paradigm within the furniture sector, focusing on field level solutions implemented to create a fully operative design to manufacturing in one step process. The integration of several software tools, market ready or specifically developed for the need, paved the way for the design of a seamlessly integrated production system able to manage the complexity of a mass-customization environment. The proposed IT infrastructure is intended to run distributed design and production facilities fulfilling the requirements of a highly variable customer demand both in terms of product requirements and buying experience. The developed system has been tested within the context of a shopping mall where the design area and the manufacturing site have been installed for several days.

► **Facilitating Sustainable Business Model Innovation Through Mass Customization [81*]**

Presenter: Hannah Fabry, RWTH Aachen University

Abstract: With the growing relevance of the Business Model (BM) concept, practitioners as well as researchers have introduced frameworks and tools to systematically develop and enhance the innovation of (sustainable) BMs. However, existing concepts focus on the first phase of BM innovation: ideation and concept generation. Thereby these tools neglect internal factors that

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may hamper the realization of a new BM in the later transformation phase. Changes that are too radical and adjacent to the core values and principles of an established business model can lead to internal resistance and thus have to be taken into consideration in the early phases of the business model innovation process. We therefore propose a concept to align present and future BMs by taking existing routines, cognitions and processes into account. The framework give suggestions which business model patterns may be implemented in the short, medium or long run by estimating the distance between the current and possible future business model patterns. This ought to facilitate both the ideation and transformation process of business model innovation. The results demonstrate that the framework is especially useful for sustainable business model innovation as it helps to reduce internal barriers. The MC pattern has been found to be especially useful to bridge the transformation from a purely economic to a sustainable business model as it shares many linkages with both ideas of a business model. It can thus be used as a means to become more sustainable over time.

Parallel Session 5.1: Mass Customization-Driven Industry Development – World Class Manufacturing in a UNESCO World Heritage Town

Tuesday 21.11.2017 /// 12:00 – 13:30 /// BERLIN (Plenar Hall)

Session Chair: Maria Kollberg Thommasen

In this special session, we invite you to hear about an exciting case of Mass Customization. Røros is a small village in Norway, but attracts over 1 million visitors each year. It is listed on the UNESCO world heritage list and wins international awards for sustainable tourism, cultural events and local foods. Still, the largest employer at Røros is the industry, with 1 of 5 working in manufacturing. Mass customization principles have played an important role for many of the manufacturers at Røros. Being situated in a remote mountain region, the need for establishing unique value propositions and customer solutions has been central to remain competitive. A special bond between multiple mass customization companies has been formed. In companionship with researchers and experts, four companies started the Arena for Mass Customization. They have now taken it one step further, and are jointly exploring how to take further steps in mass customization. We will share this journey with you from four perspectives.

▶ **Knowledge and Motivation [111]**

Presenter: B. Joseph Pine II, Strategic Horizons

Joseph B. Pine has been to Røros four times and shared his knowledge experiences. He has worked with the companies and will share his view on the mass customization initiative in Røros.

▶ **Project Design [112]**

Presenter: Lars Skjelstad, SINTEF

Lars Skjelstad is a senior researcher at SINTEF Technology and Society. He and his team has worked with some of these companies since the 1990s, and will share from his in-depth knowledge of strengths and opportunities of mass customization.

▶ **Industrial Benefits [113]**

Presenter: Tor Lømo-Hansen, Røros Windows and Doors

Tor Lømo-Hansen is CEO of Røros Windows and Doors. He will share the story of the transformation his company has undertaken the last 10 years, and talk about the role of mass customization in practice.

▶ **Customer Interaction [114]**

Presenter: Paul Blazek, cyLEDGE Media

Paul Blazek is CEO of cyLEDGE and partner in Combeeneration (Austria). With his team, he is working together with the companies to design excellent user experiences in online choice navigation and configuration.

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Parallel Session 5.2: Environmental and Sustainability Assessment of MCP

Tuesday 21.11.2017 /// 12:00 – 13:30 /// K1 (Eurogress)

Session Chair: Claudio Boër

► **Effects of Mass Customization on Sustainability - A Literature-based Analysis [60]**

Presenter: Paul Christoph Gembarski, Leibniz Universität Hannover

Co-Authors: Paul Christoph Gembarski, Thorsten Schoormann, Daniel Schreiber, Ralf Knackstedt, Roland Lachmayer

Abstract: Sustainability has become increasingly important to business research and practice. Approaches, which support fundamental changes in behaviour to act economic, ecological and social, are required. A popular concept that contributes to these challenges is Mass Customization (MC). MC—defined as a competitive strategy—allows for producing goods and services for individual needs of customers. In doing so, it, for example, helps towards an increased product-customer relation, efficient production and a high degree of personalized goods, which may have positive effects on society and the environment (e.g., by reducing waste). In order to get an overview of which effects of MC towards sustainability are discussed, our study aims to synthesize prior literature. Therefore, we conduct an extensive literature review in different search engines to ensure a broad view on this topic. As a result, 33 articles that met our research purpose are obtained. These articles are coded by three researchers independently and—a total of 157 codes—are consolidated afterwards to determine effects of MC on sustainability. Our classification indicates that mostly social (~87%) and economic issues are addressed (~84%) while ecological aspects are underrepresented.

► **Mass Customization and Environmental Sustainability: A Large-Scale Empirical Study [55]**

Presenter: Enrico Sandrin, Università di Padova

Co-Authors: Enrico Sandrin, Alessio Trentin, Cipriano Forza

Abstract: A growing number of firms nowadays needs to combine mass customization (MC) with environmental-sustainability management (EM). However, the research on the synergies or trade-offs between MC and EM is still in its infancy. Furthermore, the few findings available in the literature are partly conflicting: some studies suggest that MC and EM may be synergistic, while others raise concerns on the environmental sustainability of MC. This paper contributes to this debate by presenting the results of the first, large-scale, empirical test of some of the synergies suggested by prior research. Our results support the existence of two types of synergies between the MC capability of parts commonalization and the EM capability of product stewardship. One type of synergy is explained by the fact that parts commonalization capability reinforces the positive effect of product stewardship capability on environmental performance (interaction-based synergy). The other type is explained by the fact that both these organization capabilities require the same routines of crossfunctional integration (shared-routine-based synergy). Besides enriching the debate on the relationships between MC and EM, our results also contribute to the broader discussion on the compatibility between economic- and environmental-sustainability dimensions.

► **A Preparatory Approach to Environmental Assessment for Sustainable Mass Customization [42]**

Presenter: Luca Canetta, SUPSI; Alena Zoe Hänsch, e-hoch-3

Co-Authors: Alena Zoe Hänsch, Maike Hora, Alessandro Fontana, Stephan Hankammer, Luca Canetta, Shirin Gomez

Abstract: Mass Customization is a growing trend in industry that fulfils the demand of customers for personalized products and services. Parallel to customization, more regulations and demand on sustainable products and environmental business practices are becoming increasingly important on the agenda of businesses today. However, the knowledge about the implementation

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of Sustainable Mass Customization (SMC) models is still mainly theoretical. The SMC EXCEL project presents an approach for the development of a SMC environmental assessment based on Life Cycle Assessment (LCA) methodology for a Television set. The environmental assessment method denominated SMC Excel Sustainability Approach (SESA) presented in this study aims to provide reliable information of the environmental impacts of a product (television) while serving as an efficient and applicable assessment methodology for mass customization. General requirements for the SESA within mass customization are described and applied to a case study of a Television performed during the SMC-Excel Project. Furthermore, the result of a full-scale LCA of a standard TV model are compared with those impacts obtained by the SESA, which indicated that the variance between both results is nominal and, thus, the SESA can represent a valid approach for environmental assessment methodologies. Additionally, with the test case scenario of a Take-back service where both methods are also compared, the impact disparity is similarly low. Nevertheless, further research and testing is required in order to improve accuracy and methodological procedures of the SESA method.

► **Opportunities and Challenges of Product-Service Systems for Mass Customization – A Case Study on Televisions [48]**

Presenter: Maike Hora, e-hoch-3

Co-Authors: Alena Zoe Hänsch, Julia Mohr, Iris Steinberg, Shirin Gomez, Maike Hora

Abstract: The diversification of products that adapt to specific customer needs has been a growing competitive advantage for many businesses. As customers become more self-aware and demanding in their buying preferences, Mass Customization (MC) is experiencing a considerable growth. In the light of growing trends towards sustainable consumption, MC can become a strong drive for the implementation of sustainable products and services. Product-service Systems (PSS) exhibit attributes that can be harmonized with several features of MC as, for instance, the enhanced communication mechanisms between customer and businesses. Hence, in this paper we explore the potential conjunctions of the PSS and MC business models from a sustainable point of view. More specifically, we describe the opportunities and challenges of a sustainable product-service system (S-PSS) with focus on environmental impacts and how these services can influence the environmental performance of a mass customized product. A case study is presented that describes the assessment approach that is based on the Life Cycle Assessment (LCA) method on three comparative scenarios for sustainable product-service systems for a television. The scenarios selected are: take-back service, extended warranty and changing to a renewable energy provider. Part of the analysis and results of this study are based on the research project SMC-EXCEL, a joint research program supported by ECO-INNOVERA (funded by BAFU (Switzerland), BMBF (Germany), and TUBITAK (Turkey)).

► **The Value of MCP for the Next Practice on Sustainability [38]**

Presenter: Yasuyuki Cho, yckyoto.com

Abstract: According to the latest report, Pulse of the Fashion Industry (Global Fashion Agenda & The Boston Consulting Group, 2017), about 62 million tons of textiles are currently consumed by 7.5 billion people globally, and it's predicted that 122 million tons of textiles are needed in 2030 for then 8.5 billion people. Some practices and business groups started to tackle this sustainability problem, but in most of the cases brand companies led the initiative which often do not have production facilities by themselves, and most middleman are rather concerned about their order situation than about sustainability goals.

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Parallel Session 5.3: Digital Manufacturing: Implementation, Usage, and Value Capture

Tuesday 21.11.2017 /// 12:00 – 13:30 /// K2 (Eurogress)

Session Chair: Khaled Medini

▶ **Next Best Action - A Tool to Uniquely and Efficiently Service Each Customer at Every Touch Point [66]**

Presenter: Erik Kayser, Implement Consulting Group

Co-Authors: Erik Kayser, Jonas Sjögren, Magnus Fransson

Abstract: Next best action is an approach to uniquely identify what each customer is most likely to buy in the current touch point along the customer journey – based on past behavior, experience and current product portfolio. It is a uniquely and customized offer for each individual customer. It is not only a scripted tool that offers a segment specific offer at each touch point. It is truly a unique and individual offer based on the customer's entire journey and its experience throughout that journey. The customization logic includes direct feedback from the customer (collected in touch-points) and behavior (pattern and changes in how the service is used) plus automatically measured service performance and level delivered through sensors and measurements throughout the delivery-chain. Next best action significantly contributes to sustainable solutions as we offer the services a customer is most likely to need and want right now. The biggest waste is an efficiently delivered service no one uses.

▶ **Exploring Barriers towards the Development of Changeable and Reconfigurable Manufacturing Systems for Mass Customized Products: an Industrial Survey [18]**

Presenter: Ann-Louise Andersen, Aalborg Universitet

Co-Authors: Ann-Louise Andersen, Jesper Kranker Larsen, Thomas Ditlev Brunoe, Kjeld Nielsen, Christopher Ketelsen

Abstract: Abstract. Cyber-physical reconfigurable manufacturing systems that are able to efficiently produce customized products in lot sizes of one have the potential to significantly advance mass customization. Necessary enabling technologies are fast developing, however, the fundamental enabling principles of changeability and re-configurability are still far from being reality in industry. Therefore, this paper explores organizational prerequisites and barriers for the development of changeability and re-configurability, as well as significant differences regarding their presence in various industrial settings. The findings indicate that important prerequisites are only rudimentarily developed and that knowledge regarding reconfigurable system design is limited. Additionally, a long-term view on investments in production capacity and a strong coordination between production and product development were identified as prerequisites which existence are contingent on the industrial setting. The findings provide valuable insight into how to support an industrial transition towards changeability, in order to create the foundation for smart mass customization manufacturing.

▶ **Automated Processing of Planning Modules in Factory Planning by Means of Constraint-Solving Using the Example of Production Segmentation [49]**

Presenter: Julian Graefenstein, TU Dortmund; Jan Winkels, TU Dortmund

Co-Authors: Julian Graefenstein, Jan Winkels, David Scholz, Oliver Seifert, Michael Henke, Jakob Rehof

Abstract: Abstract. For the adaption of factories, essential data are required as a basis in factory planning. Often these data are either stored in some form or at some location respectively on some data medium or are not available at all. Preparing these data for the planning process in a planning-appropriate manner can result in high effort. In order to counteract this situation, a data warehouse system can be used in the context of Business Intelligence for initially providing the data in a centralized and consistent form. The advantages of an up-to-date and consistent data base is shown by an example of the production segmentation. With the planning of the factory adaption by means of planning modules, which can be orchestrated individually, it is possible to

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process planning tasks automatically or partly automated. A given example of a vice production, which can be produced in four variants, was used to show the benefits and explain the approach in detail. Constraint solving, the modular planning process and the data available in the data warehouse enable the segmentation to be processed automatically and thus reduce planning time.

► **Impacts of Industry 4.0 on the Specific Case of Mass Customization through Modeling and Simulation Approach [62]**

Presenter: Ali Raza, Politecnico di Milano

Abstract: Since last decades, companies have been increasing product variety, thus forcing manufacturers to create more and more customized products. To manage such contexts, manufacturing companies are adopting mass customization, i.e. a manufacturing strategy that aims to offer customized goods at low cost. Recently, advancements in information system technologies provide new opportunities for the manufacturing sector. In particular, the concept of Industry 4.0, i.e. the application of the concepts of smartness and networking to the manufacturing environment, is providing tools to reduce the complexity of managing production systems. Despite the relevance of both areas, how mass customization can be integrated with Industry 4.0 concept and what are the benefits of such an integration are still open issues. Therefore, this study investigates how to implement industry 4.0 concept for the specific case of mass customization industry, and, by using modeling and simulation, proposes a quantification of the benefits of such implementation. Implementing Industry 4.0 solutions requires high level of investments and there is a great need of research that outlines its quantifiable benefits to justify the investments. To the aim of the research, two conceptual models, one integrating industry 4.0 and mass customization and one featuring only mass customization, have been developed. Afterward, these two models have been simulated in FLEXSIM software in order to measure the performance. The results obtained seem to be extremely favorable for implementation of industry 4.0 solutions on mass customization systems. Significant improvement in product completion rate on time, customer satisfaction rate, utilization of equipment and waiting time in queues has been observed. This study will help mass customization industries to understand the opportunities and criticalities concerned with the implementation of this concept.

► **Social Value Creation through Mass Customization [07*]**

Presenter: Konstantinos Vasiliou, TU Berlin

Co-Authors: Soujanya Mantravadi, Janardhan Vellikad, Konstantinos Vasiliou

Abstract: In spite of adhering to lean approaches, manufacturing industry is still battling with sustainability issues (environmental and social). Humans are now living in a highly unsustainable, unequal and conflict-ridden world, with problems of resource depletion, global warming and inequality. On the other hand, there are growing complexities in the markets, as the consumers are becoming prosumers. For example, the 'freight and logistics' industry (estimated to have a market size of USD 9 trillion in 2016) is pivotal in world economy and acts as a backbone of the traditional manufacturing industry. The study suggests that it accounts for a huge portion of world's energy use and logistics-costs account to 10% of global GDP. Mass customization allows energy efficient manufacturing methods (such as additive manufacturing). Its framework will promote ecologically sustainable local production and consumption, with significant energy and cost savings in the operations. A review of production systems suggests that, historical context and foundational industrial experience has spurred the practice of mass customization. However, it must be embraced in greater measure, in order to drive innovation in Industry 4.0. This is because mass customization has a potential to solve the above-mentioned challenges of 'sustainability' and 'change of consumer behaviour'. It will bring positive impacts on society by providing better quality of goods to consumers, as the markets will be flooded with wide variety of products and its operations will empower local bodies with local manufacturing.

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Plenary Session IV: Learning from Experience: Success Factors & Key Insights by Mass Customization Pioneers

Tuesday 21.11.2017 /// 14:30 – 16:00 /// BERLIN (Plenar Hall)

▶ **Interview: Lessons Learned from a Mass Customization Pioneer. The Case of adidas.**

Interviewee: Christoph Berger, adidas

▶ **Keynote 7: It's Not Easy, But Has to Look Easy: How To Create a Big Profitable Customization Company [12]**

Presenter: Philip Rooke, Spreadshirt

Abstract: Spreadshirt has 15 years of experience selling customization in a continuously growing platform and business structure. We learned for example that our customers do not know or do not care that their products are printed on demand – although they are. CEO Philip Rooke will share best practices and insights into how Spreadshirt succeeded in reducing complexity and making complicated things easy – for customers, partners, and even for employees.

▶ **Technology Snapshot: The Next Dimension: Personalizing your Virtual and Augmented Self [116]**

Presenter: Vladimir Puhac, Doob Group

The CEO of DOOB, a startup in the field of augmented and virtual reality, focusing on high-resolution representations of humans (avatars), will discuss how new technological advancements in virtual reality and high-tech scanning will create new business models and opportunities for mass customization and personalization.

▶ **Interactive Closing Panel Discussion**

Panel: Frank T. Piller, RWTH Aachen University (Moderator); Christoph Berger, adidas; Philip Rooke, Spreadshirt; Sergio Dulio, Atom Lab; Vladimir Puhac, Doob Group

Abstract: In the final panel of the conference, we will critically review what we have learned and discuss where mass customization and personalization will be heading in the next decade. Frank Piller will moderate this group of experienced practitioners which will provide different perspectives on the theme: a global market leader, a start-up champion, a multinational technology provider, and the rising startup in the field of virtual and augmented reality.

Industry 4.0 Tour I: Digital Capability Center (DCC) Aachen

Tuesday 21.11.2017 /// 16:30 – 18:00 /// DCC Aachen by McKinsey & ITA RWTH Aachen

Digital textile manufacturing lay the foundation for this tour. The DCC, co-developed by McKinsey and ITA RWTH Aachen, offers the possibility to help companies realize the concrete added value of digitized production.

Industry 4.0 Tour II: Aachen Center for Additive Manufacturing (ACAM)

Tuesday 21.11.2017 /// 16:30 – 18:00 /// ACAM, RWTH Aachen

This tour provides a journey into the world of additive manufacturing and customization efficiency. In the tour, participants visit two of the clusters for additive manufacturing at the RWTH Campus.

Industry 4.0 Tour III: RWTH Demo Factory for Industrie 4.0

Tuesday 21.11.2017 /// 16:30 – 18:00 /// RWTH Demo Factory Aachen, WZL & FIR

The Demo Factory offers the unique possibility to explore Industry 4.0 in practice. In this tour, the entire value-added chain of adaptable production is presented: from manufacturing to assembly.