



Core Capabilities of Sustainable Mass Customization

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Contents

- Three major strategic capabilities of mass customization:
 1. Solution Space Development
 2. Robust Process Design
 3. Choice Navigation



1. Solution Space Development

- Identification of customer needs (what should be offered and what not?)
- Value by customization can be achieved via three design features (options for customization):
 - Fit and comfort (measurements): especially with products directly related to the human body (e.g., inclusion of 3D scanning)
 - Functionality: related to technical attributes of an offering (e.g., speed, power, and memory)
 - Form (style and aesthetic design): visual aspects (e.g., color, style, and flavours)



Methods for Solution Space Definition

- Goal: understanding the needs of the customer
- Approaches:
 - Market research techniques: focus groups, conjoint analysis, customer surveys, analysis of customer complaints
 - Toolkits for user co-creation: easy to use interface with a component library, customer preferences can be analyzed and aggregated into the company's solution space
 - Customer experience intelligence: collecting and analyzing customer data stemming, e.g., from configuration sessions and beyond (e.g., log data, reviews, infeasible requirements)



Methods for Solution Space Definition (Overview)

Table 9.1 Solution space definition approaches.

Name	Description	References
Market research techniques	Selecting and surveying a group of customers to obtain information on needs for new products with the help of conventional market research approaches.	Dahan and Hauser (2002), Griffin and Hauser (1993)
Toolkits for user co-creation	Offering software tools that enable customers to translate their preferences directly into a product design and identifying unsatisfied needs during the process.	Franke and Piller (2004), von Hippel and Katz (2002)
Customer experience intelligence	Continuously collecting data on all transactions, behaviors, or experiences not only from customers but from all users and analyzing that information to determine preferences.	Piller et al. (2004), Rangaswamy and Pal (2003), Squire et al. (2004)



Modular Product Architecture

- Solution space with options has to be represented in a corresponding product architecture.
- No limitless choice, but choice restricted to the options represented in the production system.
- Modularity is an important part of mass customization strategies.

2. Robust Process Design

- Stable processes for delivering high-variety products
- Methods to establish robust processes:
 - Delayed product differentiation (postponement): risk pooling effect (reduce demand uncertainty through aggregation), reduction of inventory stocking costs.
 - Flexible automation: production systems / robots already support a high level of versatility.
 - Process modularity: e.g., individual mobile production cells that can be integrated flexibly in larger production systems.



3. Choice Navigation

- Paradox of Choice: myriad of choices vs. cost of evaluating choice alternatives.
- Danger that customers postpone their purchase decision.
- Need for efficient choice navigation support.



Types of Product Configurators

Table 9.2 Types of product configurators.

Type	Description	Complexity
Select-to-order (STO)	The customer selects all needed components of a product. There are no component dependencies.	low
Pick-to-order (PTO)	The customer picks the components of a product and takes care himself of the dependencies without support of the configurator.	low
Assemble-to-order (ATO)	The configurator matches prefabricated components considering component dependencies.	medium
Configure-to-order (CTO)	The configurator supports the customer in selecting the components that fit to each other based on a modular system.	medium
Make-to-order (MTO)	The configurator allows the customer to define specific parameters based on product rules. Manufacturing takes place after order.	medium–high
Engineer-to-order (ETO)	Very high level of configuration freedom. New components and new rules might be required to satisfy the configuration needs of the customer.	high



Quality criteria for Product Configurators

- Usability (e.g., loading time, support, explanation)
- Visual Realism (how realistic is the visualization of the configured product?)
- Creativity (degree/limitations of creational freedom)
- Enjoyment (fun, delight, pleasure, entertainment, interestingness of the process)
- Choice Options (perceived degree of given choice)
- Symbolic (intrinsic and social) benefits: pride-of-authorship, social network integration,

Future Developments

- Integration of recommender systems (predicting wishes and needs in a pro-active fashion)
- Embedded configuration capabilities (configurator as a standard component of delivered product)
- Intelligent analysis of customer needs depending on different information sources (purchases, interaction logs, product evaluations, discussion forums, etc.)



Exercises

1. Explain the terms “Solution Space Development”, “Robust Process Design”, and “Choice Navigation”.
2. Explain the term “Postponement”.
3. Explain the term “Paradox of Choice”.



Thank You!



References (1)

- (1) Blazek, P., Partl, M., Streichsbier, C., 2013. Configurator Database Report 2013. Technical report, Raleigh, NC. <www.configurator-database.com/report2013>.
- (2) Csíkszentmihályi, M., 1990. Flow: The Psychology of Optimal Experience. Harper & Row, New York.
- (3) Dahan, E., Hauser, J., 2002. The virtual customer. *Journal of Product Innovation Management* 19 (5), 332–353.
- (4) Dellaert, B.G., Dabholkar, P., 2009. Increasing the attractiveness of mass customization: the role of complementary online services and range of options. *International Journal of Electronic Commerce* 13 (3), 43–70.
- (5) Dellaert, B.G.C., Stremersch, S., 2005. Marketing mass customized products: striking the balance between utility and complexity. *Journal of Marketing Research* 42 (2), 219–227.
- (6) Desmeules, R., 2002. The impact of variety on consumer happiness: marketing and the tyranny of freedom. *Academy of Marketing Science Review* 12, 1–18.
- (7) Duray, R., 2002. Mass customization origins: mass or custom manufacturing? *International Journal of Operations & Production Management* 22 (3), 314–328.
- (8) Felfernig, A., 2007. Standardized configuration knowledge representations as technological foundation for mass customization. *IEEE Transactions on Engineering Management* 54 (1), 41–56.
- (9) Franke, N., Piller, F.T., 2003. Key research issues in user interaction with configuration toolkits in a mass customization system. *International Journal of Technology Management* 26, 587–599.



References (2)

- (10) Franke, N., Piller, F.T., 2004. Value creation by toolkits for user innovation and design: the case of the watchmarket. *Journal of Product Innovation Management* 21 (6), 401–415.
- (11) Franke, N., Schreier, M., 2010. Why customers value self-designed products: the importance of process effort and enjoyment. *Journal of Product Innovation Management* 27 (7), 1020–1031.
- (12) Franke, N., Keinz, P., Schreier, M., 2008. Complementing mass customization toolkits with user communities: how peer input improves customer self-design. *Journal of Product Innovation Management* 25 (6), 546–559.
- (13) Franke, N., Keinz, P., Steger, C., 2009. Testing the value of customization: when do customers really prefer products tailored to their preferences? *Journal of Marketing* 73 (5), 103–121.
- (14) Fuchs, C., Schreier, M., Prandelli, E., 2010. The psychological effects of empowerment strategies on consumers' product demand. *Journal of Marketing* 74 (1), 65–79.
- (15) Gilmore, J.H., Pine, B.J., 1997. The four faces of mass customization. *Harvard Business Review* 75 (1), 91–101.
- (16) Griffin, A., Hauser, J., 1993. The voice of the customer. *Marketing Science* 12 (1), 1–27.
- (17) Haug, A., Hvam, L., 2007. The modeling techniques of a documentation system that supports the development and maintenance of product configuration systems. *International Journal of Mass Customization* 2 (1–2), 1–18.
- (18) Huffman, C., Kahn, B., 1998. Variety for sale: mass customization or mass confusion. *Journal of Retailing* 74 (4), 491–513.
- (19) Hvam, L., Mortensen, N., Riis, H., 2008. *Product Customization*. Springer, Heidelberg, Berlin.



References (3)

- (20) Khalid, H., Helander, M., 2003. Web-based do-it-yourself product design. In: Tseng, M., Piller, F.T. (Eds.), *The Customer Centric Enterprise: Advances in Mass Customization and Personalization*. Springer, New York, pp. 247–266.
- (21) Koste, L., Malhotra, M.K., Sharma, S., 2004. Measuring dimensions of manufacturing flexibility. *Journal of Operations Management* 22 (2), 171–196.
- (22) Kotha, S., 1995. Mass customization: implementing the emerging paradigm for competitive advantage. *Strategic Management Journal* 16 (S1), 21–42.
- (23) Kumar, A., 2005. Mass customization: metrics and modularity. *International Journal of Flexible Manufacturing Systems* 16 (4), 287–312.
- (24) Leitner, G., Felfernig, A., Blazek, P., Reinfrank, F., Ninaus, G., 2014. User interfaces for configuration environments. In: Felfernig, A., Hotz, L., Bagley, C., Tiihonen, J. (Eds.), *Knowledge-based Configuration – From Research to Business Cases*. Morgan Kaufmann Publishers, Waltham, MA, pp. 89–106 (Chapter 8).
- (25) Merle, A., Chandon, J., Roux, E., Alizon, F., 2010. Perceived value of the mass–customized product and mass customization experience for individual consumers. *Production & Operations Management* 19 (5), 503–514.
- (26) Novak, T., Hoffmann, D., Yung, Y., 2000. Measuring the customer experience in online environments: a structural modeling approach. *Marketing Science* 19 (1), 22–42.
- (27) Piller, F.T., 2005. Mass customization: reflections on the state of the concept. *International Journal of Flexible Manufacturing Systems* 16 (4), 313–334.
- (28) Piller, F.T., 2008. Mass customization. In: Wankel, C. (Ed.). *21st Century Management: A Reference Handbook*, vol. 1. Sage Publications, pp. 420–430.



References (4)

- (29) Piller, F.T., Möslin, K., Stotko, C., 2004. Does mass customization pay? An economic approach to evaluate customer integration. *Production Planning & Control* 15 (4), 435–444.
- (30) Piller, F.T., Ihl, C., Steiner, F., 2010. Embedded toolkits for user co-design: a technology acceptance study of product adaptability in the usage stage. In: 43th Hawaii International Conference on System Science (HICSS), Honolulu, HI, CD-ROM, p. 10.
- (31) Piller, F.T., Vossen, A., Ihl, C., 2012. From social media to social product development: the impact of social media on co-creation of innovation. *Die Unternehmung* 66 (1), 7–27.
- (32) Pine, B.J., 1995. Challenges to total quality management in manufacturing. In: Cortada, J.W., Woods, J.A. (Eds.), *The Quality Yearbook*. McGraw-Hill, New York, pp. 69–75.
- (33) Pine, B.J., Victor, B., Boynton, A., 1993. Making mass customization work. *Harvard Business Review* 71 (5), 108–119.
- (34) Randall, T., Terwiesch, C., Ulrich, K., 2005. Principles for user design of customized products. *California Management Review* 47 (4), 1–18.
- (35) Rangaswamy, A., Pal, N., 2003. Introduction: gaining business value from personalization technologies. In: Pal, N., Rangaswamy, A. (Eds.), *The Power of One: Gaining Business Value from Personalization Technologies*. Trafford Publishing, Victoria, BC, Canada, pp. 1–9.
- (36) Reichwald, R., Piller, F., 2009. Interactive value creation in the production: individualization and mass customization. *Interactive Value Creation: Open Innovation, Individualization and New Forms of Division of Labour*, second ed. Gabler Verlag, pp. 263–267 (in German: *Interaktive Wertschöpfung in der Produktion: Individualisierung und Mass Customization*).



References (5)

- (37) Rogoll, T., Piller, F.T., 2004. Product configuration from the customer's perspective: a comparison of configuration systems in the apparel industry. In: International Conference on Economic, Technical and Organisational Aspects of Product Configuration Systems (PETO 2004), Lyngby, Copenhagen, Denmark, pp. 179–199.
- (38) Sabin, D., Weigel, R., 1998. Product configuration frameworks - a survey. *IEEE Intelligent Systems* 13 (4), 42–49.
- (39) Salvador, F., 2007. Towards a product modularity construct: literature review and reconceptualization. *IEEE Transactions on Engineering Management* 54 (2), 219–240.
- (40) Salvador, F., Forza, C., 2007. Principles for efficient and effective sales configuration design. *International Journal of Mass Customization* 2 (1–2), 114–127.
- (41) Salvador, F., Rungtusanatham, M., Forza, C., 2004. Supply-chain configurations for mass customization. *Production Planning & Control* 15 (4), 381–397.
- (42) Salvador, F., Rungtusanatham, M., Akpinar, S., Forza, C., 2008. Strategic capabilities for mass customization: theoretical synthesis and empirical evidence. In: *Academy of Management Annual Meeting*, pp. 1–6.
- (43) Salvador, F., de Holan, M., Piller, F.T., 2009. Cracking the code of mass customization. *MIT Sloan Management Review* 50 (3), 70–79.
- (44) Schreier, M., 2006. The value increment of mass-customized products: an empirical assessment. *Journal of Consumer Behavior* 5 (4), 317–327.



References (6)

- (45) Schwartz, B., 2004. *The Paradox of Choice: Why More is Less*. HarperCollins, New York. Squire, B., Readman, J., Brown, S., Bessant, J., 2004. Mass customization: the key to customer value? *Production Planning & Control* 15 (4), 459–471.
- (46) Stumptner, M., 1997. An overview of knowledge-based configuration. *AI Communications* 10 (2), 111–126. Su, J.C.P., Chang, Y.-L., Ferguson, M., 2005. Evaluation of postponement structures to accommodate mass customization. *Journal of Operations Management* 23 (3–4), 305–318.
- (47) Tepper, K., Bearden, W.O., Hunter, G.L., 2001. Consumers' need for uniqueness: scale development and validation. *Journal of Consumer Research* 28 (1), 50–66.
- (48) Tiihonen, J., Felfernig, A., Mandl, M., 2014. Personalized configuration. In: Felfernig, A., Hotz, L., Bagley, C., Tiihonen, J. (Eds.), *Knowledge-based Configuration – From Research to Business Cases*. Morgan Kaufmann Publishers, Waltham, MA, pp. 167–179 (Chapter 13).
- (49) Totz, C., Riemer, K., 2001. The effect of interface quality on success - an integrative approach on mass customization design. In: Tseng, M., Piller, F.T. (Eds.), *Proceedings of the 1st World Congress on Mass Customization and Personalization*, Hong Kong, China, CD ROM.
- (50) Tseng, M., Jiao, J., 2001. Mass customization. In: Salvendy, G. (Ed.), *Handbook of Industrial Engineering*, third ed. Wiley, New York, pp. 684–709 (Chapter 25).
- (51) Tseng, M., Kjellberg, T., Lu, S.C.-Y., 2003. Design in the new e-commerce era. *Annals of the CIRP* 52 (2), 509–519.
- (52) Tu, Q., Vonderembse, M., Ragu-Nathan, T., 2001. The impact of time-based manufacturing practices on mass customization and value to customer. *Journal of Operations Management* 19 (2), 201–217.



References (7)

- (53) Udwadia, F., Kumar, R., 1991. Impact of customer co-construction in product/service markets. *International Journal of Technological Forecasting and Social Change* 40 (3), 261–272.
- (54) Ulrich, P., Anderson-Connell, L., Wu, W., 2003. Consumer co-design of apparel for mass customization. *Journal of Fashion Marketing and Management* 7 (4), 398–412.
- (55) von Hippel, E., 1998. Economics of product development by users: the impact of “sticky” local information. *Management Science* 44 (5), 629–644.
- (56) von Hippel, E., Katz, R., 2002. Shifting innovation to users via toolkits. *Management Science* 48 (7), 821–833.
- (57) Walcher, D., Piller, F.T., 2012. *The Customization 500 –An International Benchmark Study on Mass Customization and Personalization in Consumer E–Commerce*. Tech. rep., Lulu Inc., Raleigh, NC. www.mc-500.com.
- (58) Yang, B., Burns, N.D., 2003. Implications of postponement for the supply chain. *International Journal of Production Research* 41 (9), 2075–2090.
- (59) Yang, B., Burns, N.D., Backhouse, C.J., 2004. Postponement: a review and an integrated framework. *International Journal of Operations & Production Management* 24 (5), 468–487.
- (60) Zhang, M., Tseng, M., 2007. A product and process modeling based approach to study cost implications of product variety in mass customization. *IEEE Transactions on Engineering Management* 54 (1), 130–144.
- (61) Zhang, Q., Vonderembse, M., Lim, J.-S., 2003. Manufacturing flexibility: defining and analyzing relationships among competence, capability, and customer satisfaction. *Journal of Operations Management* 21 (2), 173–191.