International Journal of Business, Human and Social Sciences
ISSN: 2517-9411
Vol:8, No:4, 2014

From Customer Innovations to Manufactured Products: A Project Outlook

M. Holle, M. Roth, M. R. Gürtler, U. Lindemann

***Abstract*—**This paper gives insights into the research project "InnoCyFer" (in the form of an outlook) which is funded by the German Federal Ministry of Economics and Technology. Enabling the integrated customer individual product design as well as flexible manufacturing of these products are the main objectives of the project. To achieve this, a web-based Open Innovation-Platform containing an integrated Toolkit will be developed. This toolkit enables the active integration of the customer's creativity and potentials of innovation in the product development process. Furthermore, the project will show the chances and possibilities of customer individualized products by building and examining the continuous process from innovation through the customers to the flexible manufacturing of individual products.

***Keywords*—**Customer Individual Product Design, Innovation Networks, Open Innovation, Open Innovation Platform and Toolkit.

I. Introduction

THE continuously increased aspiration level of customers [14] and the growing saturation of the markets which has led to a surplus of goods [23], [1] are the main drivers of the development of customer individual products. Thus, in stagnating markets a strong increase in the number of variants appeared during the last years while the sales remained at the same level as it can be seen in Fig. 1. Only companies who can achieve a successful differentiation from their competitors by expanding their product portfolio are able to succeed in the international markets [20], [16], [18]. For that reason many companies see themselves as a service provider for customers and try to achieve an entire fulfillment of the customers' demands [23]. The consumer respectively the product user shall be able to participate in the product development by direct communication between customer and company via web-based toolkits with broadly extended design flexibility. Thus, his demands and ideas can already be considered within the development of the product. For instance, the adaption of geometry and function can be influenced by the customer. He is able to determine the product design with the maximum possible number of degrees of freedom and he can express his own imaginations and expectations of the product. Simultaneously he is provided with information about the technical feasibility of his design in real time. This is realized by direct feedback from the downstream production planning and scheduling (PPS). This enables a new level of customer individual product design. These products will be henceforth referred to as customer individual products in order to dissociate them from products which are individualized by a combination of pre-defined components (product variants).

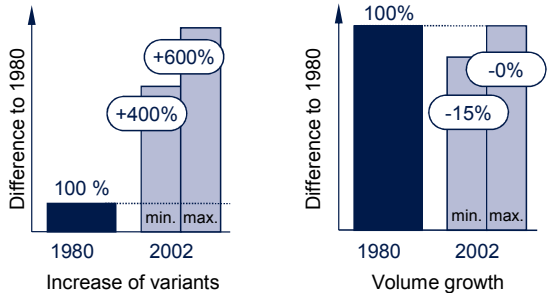

Fig. 1 Development of diversity of variants and of quantities in stagnating markets (according to [24])

The InnoCyFer-project funded by the German Federal Ministry of Economics and Technology has the objective to enable such an integrated design of customer innovated products. To achieve this, a web-based Open Innovation (OI)-Platform with an integrated Toolkit, which enables the active integration of the customer's creativity and potentials of innovation in the product development process will be developed. The OI-Platform shall enable customers to participate in the product development process without having extensive software and design knowledge. Thus, the customer will be enabled to autonomously design highly individualized products. In addition, the OI-Platform will access to the potentials of Crowdsourcing and tap these for improving the company's internal product design. Crowdsourcing in this context is defined as the usage of the collective intelligence of a crowd of volunteers [21].

II. Background / State of the Art

Open Innovation (OI) describes the company's opening up towards its surroundings [3], [4]. Customers, suppliers, other companies, own employees, experts and universities are part of these surroundings. Although in the past different definitions of this term have arisen, this essence remained the same [2]. New innovations will be enabled both, inside and

M. Holle is with the Institute of Product Development/ Technische Universität München, Boltzmannstr.15, 85748 Garching, Germany (phone: +49-89-289-15124; fax: +49-89-289-15144; e-mail: holle@pe.mw.tum.de).
M. Roth is with the Institute of Product Development/ Technische Universität München, Boltzmannstr.15, 85748 Garching, Germany (phone: +49-89-289-15129; fax: +49-89-289-15144; e-mail: roth@pe.mw.tum.de).
M. R. Gürtler is with the Institute of Product Development/ Technische Universität München, Boltzmannstr.15, 85748 Garching, Germany (phone: +49-89-289-15143; fax: +49-89-289-15144; e-mail: guertler@pe.mw.tum.de).
U. Lindemann is with the Institute of Product Development/ Technische Universität München, Boltzmannstr.15, 85748 Garching, Germany (phone: +49-89-289-15130; fax: +49-89-289-15144; e-mail: lindemann@pe.mw.tum.de).

outside the company by the integration of the surroundings into the innovation process [9]. Based on [3] external ideas are seen equal to internal. This provides a number of different advantages for companies, such as common creation of information about needs and solutions or an integration of external input into internal processes based on the ability to interact [19]. Depending on the location of the idea's exploitation respectively of the resulting innovation, "inbound"-innovation (systematic transfer of external knowledge into the company) and "outbound"-innovation (application of internal knowledge to improve external knowledge, e. g. technology-push) can be distinguished [5].

Crowdsourcing is a specific approach which is focused on end customer [21], [13]. This approach enables the integration of a crowd of external customers, respectively participants, who are able to contribute to the tackling and solving of certain problems (e. g. requirement information for new products, solution information for development problems, application information for existing technologies etc.). By this it is possible to systematically transfer former internal research and development tasks to external knowledge carriers. Crowdsourcing uses the existing participant's heterogeneity with their different experience backgrounds, mindsets, skills and knowledge to identify e.g. market needs as well as to develop creative and innovative solutions. According to [10] customer integration causes a positive effect for the company, especially in the following phases: idea generation, product concept development, prototype assessment and selection as well as market launch. A widely spread possibility to integrate this crowd is represented by OI-Platforms. These platforms constitute a web-based virtual interaction environment where different services and applications are provided for the involved protagonists. These services and applications enable a time- and location-independent communication as well as a purposive and targeted exchange of information [12]. Examples for such services are innovation and idea contests [22], broadcast searches [6] and design contests with limited duration [11]. However, there exist also idea contests with indefinite duration which make it possible for e. g. customer to deliver their individual problems with products as well as solutions for given tasks at any time. Examples are the identification of customer problems and solutions on the part of any other customers) or BMW's "Virtual Innovation Agency (VIA)" which tries to contact innovative small and medium-sized companies as potential future suppliers). In this context toolkits are also considered as a long-term service.

Closely connected to crowdsourcing are so called user communities. These represent an informal web-based group of users (in the following also called customers) who exchange knowledge, information, solutions and opinions about different topics. Communities are based on the principle of "learning-by-interacting" [15] where customers collaborate with other customers or manufacturers to create new innovations or potentials of innovation, for example problems, proposed solutions or design drafts [13]. In the scope of a solution search this kind of cooperation has a positive influence on the solution quality by supporting the identification of good and applicable as well as insufficient solutions to be discarded or to be revised. Thus, communities which usually possess the above mentioned customer's heterogeneity supports the creation of innovative new developments and product solutions. However, the usage of Crowdsourcing complicates the development of standard serial products, since they cannot match with all wishes and requirements of each individual customer.

Toolkits for OI-applications are based on the concept of supporting customers to develop their individual product by making the trial and error principle usable in this process. Basically, toolkits describe a development environment which enables the user to transfer their needs iteratively into specific solutions without having personal contact with the respective company. The company just offers an interaction platform (e. g. OI-Platform with toolkit included) where users are able to formulate as well as concretize their needs and to transfer them into ready-made solutions, embedded in an existing solution space, which is mapped by the toolkit. These web-based applications offer new opportunities for the integration of a higher user amount into the different phases of the innovation process. In this context, also different kinds of toolkits exist which offer a virtual customer integration and have the same purpose [7]. Thus, two main goals for these toolkits can be formulated: The first goal is, to outsource a certain part of development activities directly to the customer [17]. Therefore, the innovation activities of users have to be stimulated in order to develop products, which are adapted to the customers' needs. As second goal, the companies seek to minimize the risk and costs of a new product development [8]. This is achieved by accessing implicit knowledge of users, which is provided by these toolkits which support the users to explicitly formulate their implicit wishes and needs.

III. Objective of the Research Project InnoCyFer

The research project InnoCyFer pursues both, the integration of customers in the product development process and the enabling of customer individually designed products. The project will investigate how customers can be integrated in the product development process by the usage of toolkits. It is essential that the toolkit not only provides a high degree of flexibility in design but also offers an intuitive usability to the users. Customers shall be enabled to use the toolkit without any special previous knowledge or trainings. Furthermore a methodology will be developed, which on one hand enables the determination of the general suitability of products for the representation in such a toolkit. On the other hand it will provide support to analyze the demanded degrees of freedom for the individualization by the customers. Based on this, a method to prepare products for the application in toolkits will be developed. These preparations include for example changes of the product structure or the interfaces of the product components.

With the complementary and vivid community, the toolkit users have the opportunity to receive assistance or feedback from other users regarding their problems and questions. Additionally, users can access, adapt or assess existing

product designs of other users. Using these mutual assessments within the community, the companies are able to identify and, if appropriate, develop and offer users' favorite designs as mass products. Therefore it has to be investigated, how customers can specifically be motivated for the utilization of the OI-Platform, the publishing of their designs as well as to provide mutual assistance.

In order to ensure seamless integration of product development and manufacturing, the requirements of the interfaces will be investigated and the specifications will derived accordingly. This mainly includes the interface between the OI-Platform, where Toolkit and community are integrated, and the production planning and scheduling (PPS) (see also Fig. 2). Starting from the user-generated design, the product data has to be transferred to the manufacturing system. Vice versa the feedback about technical feasibility and the estimated price as well as the possible delivery date are transmitted to the toolkit user.

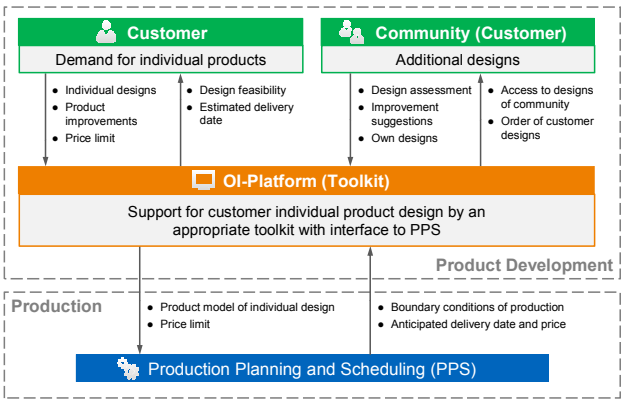

Fig. 2 Basic framework concept of the OI-Platform under consideration of necessary interfaces

IV. Methodology

The objective of work package (WP) 1 is the developed OI-Platform with implemented Toolkit (hereafter termed "functional OI-Platform") which enables a customer individual product design (see also Fig. 3). In this respect, the OI-Platform serves as Information Technology (IT)-Framework for the implementation of the application (Toolkit) and functions (see also Fig. 4). One exemplary function is the link of the Toolkit to a community that enables the exchange and assessment of designs between customers. The Toolkit represents a computer-based development environment wherein the customers create their individual product designs. Thereby, customers can individually adapt pre-defined components (termed as "physical modules" in Fig. 4) regarding their wishes and imaginations by respective operations (scaling, combination, deformation). Furthermore the customers have the opportunity to select main functions and additional functions for certain components and thus determine the functionality of the selected component.

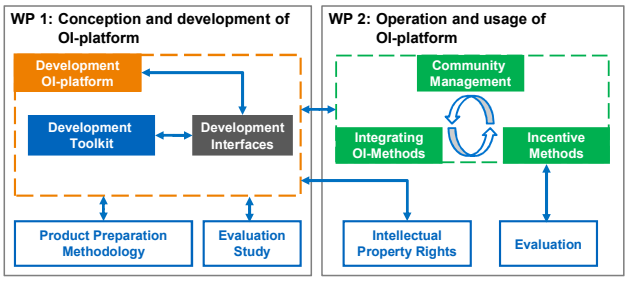

Fig. 3 Overview of related tasks within work package (WP) 1 and 2 as well as their relations

Based on a requirements analysis, a concept for the OI-Platform and the Toolkit will initially be developed. Using given restrictions, these concepts will be tailored to an industrial use case afterwards. In parallel to this, the internal (e. g. between OI-Platform and Toolkit) as well as the external interfaces (e. g. between OI-Platform and PPS) will be conceptualized and developed.

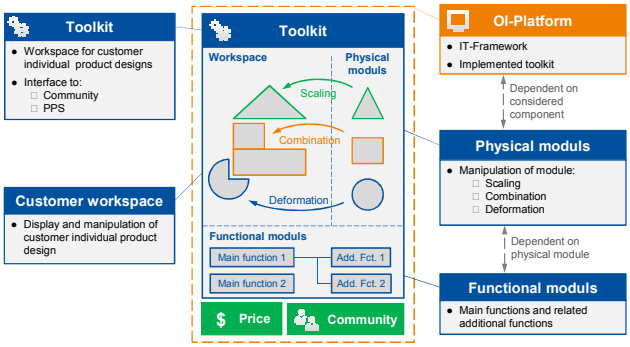

Fig. 4 The basic concept of the OI-Platform and the implemented Toolkit

Additionally, a product preparation methodology will be developed. In the first step, this methodology will enable a structural analysis and assessment of product components regarding their general toolkit suitability. Therefore, suitable assessment criteria have to be defined. Within the next step, the product components which the majority of customers wish to individualize will be identified. This is achieved by web-based customer surveys and product studies. The product components identified in this way will be confronted with the product components that can be individualized by customers from a technical and legal point of view. The intersection of this confrontation represents product components that can be prepared for their usage within the Toolkit afterwards. This preparation of identified product components includes the analysis of necessary modifications of the product architecture in order to ensure certain toolkit suitability. All developed methods will be merged into one integrated methodology.

The WP concludes with a study to evaluate the functional OI-Platform and the consolidated product preparation methodology. Therefore a web-based application of the functional OI-Platform is planned and will be used to host an idea contest. The exemplary product for this evaluation study

represents the second industrial use case which will be selected and prepared according to the methodology before.

The expected results are on one hand a concept for the OI-Platform and the Toolkit for individual product design and on the other hand a technical implementation of these concepts fitted to the use cases. As the third main result, the product preparation methodology represents a guideline to support future applications and the structural preparation of product components for their usage in toolkits.

The objective of WP 2 is smooth operation of the OI-Platform and the integrated Toolkit. Generally, WP 2 is based on the conceptual results of WP 1. The specific OI-Platform configuration and the cross-linking with other OI-methods (e. g. Lead User-Workshops, Broadcast-Search etc.) will be developed and implemented within this WP. Efforts for further OI-activities shall be decreased by the cross-linking with other OI-methods. Therefore, it is conceivable that additional functions, such as a simplified identification of Lead-Users will be integrated during the operation of the OI-Platform (e. g. by interpretation of customer assessments and the allocation of user levels).

Furthermore, incentive measures to motivate community users to participate by creating individual designs and publishing designs as well as by assessing and commenting other user designs will be investigated. In this context the aspects of intellectual property (IP) have to be considered. Therefore concepts to deal with IP and copyrights will be identified in collaboration with patent attorneys and transferred into recommendations for the industrial application.

The following results are expected within WP 2:

- applicable OI-Platform with integrated Toolkit,
- OI-Platform activation (including community management),
- cross-linking of OI-Platform with further OI-methods,
- suitable incentive measures for motivating the OI-Platform users,
- several scenarios in which intelligent property (IP) topics and derived recommendations for companies will be discussed.

V. Results of the Research Project InnoCyFer

A consistent concept for the integration of customers in the development process as well as for the cross-linking of the product development and production are the objectives of the Institute of Product Development (Technische Universität München) in this project. Customers shall be enabled to realize their still unclear product imaginations on their own by using a toolkit without having any special software knowledge. In the field of research activities, a methodology for (1) the determination of the general toolkit suitability of a considered product, (2) the investigation of product individualization, desired by the customers and for (3) the preparation of the product architecture for Toolkit applications are relevant. Customers are supported by other customers in case of arising questions and problems related to their designs through the construction of a community. Additionally, the exchange of individual designs by publishing them on the OI-Platform enables other customers to order or adapt and enhance these designs. Companies also have the possibility to produce the most popular designs of the community separately, e. g. as mass products. In the field of research, incentive measures will be developed in order to motivate customers to utilize the Toolkit, to publish their designs and to provide mutual support. Furthermore, a methodology will be researched that provides an early forecast of estimated product costs. A consistent transfer of the designs from the product development phase to the production phase will be ensured by conception of respective interfaces between the OI-Platform and the PPS.

For the elaboration and iterative evaluation of the project results, a demonstration platform will be built which has the purpose to transfer the results into the practical application. In addition, a “Public Innovation Lab” in form of a trade fair style preparation of the project results will be created. Exposed on trade fairs and congresses its purpose is to share the project results with a broad public and also to involve them in the project progress as well as to integrate their potential ideas into the project in the sense of OI.

VI. Conclusion

The research project InnoCyFer addresses both, the integration of customers in the product development process by the usage of Toolkits and OI-Platforms as well as the PPS and flexible manufacturing of these products. The project will show the chances and possibilities of customer individualized products by building and examining the continuous process from innovation through the customers to the flexible manufacturing of individual products. Thus, it will proof the feasibility of the approach of OI-Platforms and Toolkits as well as the applicability in the industrial context. Moreover methods and possibilities to identify the individual requirements of the customers will be developed and can improve the success of products and derived variants. Companies will be able to support and to optimize their development of customer individual products and hence their market position.

However, the risk remains, how many of the requested degrees of freedom will be achievable. Yet, the methodology to be developed for product preparation can significantly reduce this risk. The participation of the users within the OI-Platform and the community is the second key factor of the project. Additionally, the successful link between the Toolkit and the PPS is essential for the planned flexible manufacturing system. Therefore the respective interface will be specified and implemented with special effort. The developed specification can be used as basis for the link of these two areas in following projects or applications. Due to the fact that the previously mentioned aspect of copyrights and IP aspects are challenging, the project InnoCyFer will also develop scenarios and recommendations to tackle challenges in this context.

The trend to customer individual product design is not

limited to the area of business to customer (B2C) relations. Also in the field of business to business (B2B) relations the need of individualized products is distinctive. The concept of OI-Platforms and Toolkits also offers potentials to improve the products in these markets. It has to be investigated how constraints and objectives vary in comparison to the InnoCyFer project and how findings have to be modified to be applicable in the B2B area.

REFERENCES

[1] Baumberger, G.: *„Methoden zur kundenspezifischen Produktdefinition bei individualisierten Produkten“,* 2007.
[2] Braun A.: *„Open Innovation – Einführung in ein Forschungsparadigma“*, In: Braun, A. et al. (Eds*.):* Open Innovation in Life Sciences, 2012, pp. 3-24.
[3] Chesbrough H. W.: *“Open innovation, the new imperative for creating and profiting from technology”,* 2003.
[4] Chesbrough, H.; Vanhaverbeke, W.; West, J.: *“Open Innovation: Researching a New Paradigm”*, 2006.
[5] Chesbrough, H.; Crowther, A. K.: *“Beyond high tech: early adopters of open innovation in other industries”*, In: *R&D Management 36*, 2006, pp. 229-236.
[6] Diener, K.; Piller, F. T.: *„Methoden und Dienstleister für die OI-Implementation“*, 2010, pp. 85-114.
[7] Franke, N., & Piller, F.: *“Value creation by toolkits for user innovation and design: The case of the watch market”, Journal of product innovation management (2004)*, pp. 401-415
[8] Franke, N., & Shah, S.: *“How communities support innovative activities: an exploration of assistance and sharing among end-users”*, Research policy (2003), pp. 157-178
[9] Gassmann, O.; Enkel, E.: *“Towards a theory of open innovation: three core process archetypes”*, In*: R&D Management Conference (2004)*, pp. 1-18.
[10] Gruner, K.: *„Kundeneinbindung in den Produktinnovationsprozess : Bestandsaufnahme, Determinanten und Erfolgsauswirkungen“* Wiesbaden 1997.
[11] Hilgers, D.; Piller, F.: *„Controlling für Open Innovation - Theoretische Grundlagen und praktische Konsequenzen“*, Controlling 21 (2009), pp. 5-11.
[12] Ihlenburg, D.: *„Interaktionsplattformen und Kundenintegration in Industriegütermärkten: Akzeptanzfaktoren, Wettbewerbsvorteile und Kundennutzen Am Beispiel des Maschinen- und Anlagenbaus“,* Wiesbaden 2011.
[13] Keinz, P.; Hienerth, C.; Lettl, C.: *“Designing the Organization for User Innovation”*, 2012.
[14] Lindemann, U.; Reichwald, R.; Zäh, M. F.: *„Individualisierte Produkte - Komplexität beherrschen in Entwicklung und Produktion“*, Berlin 2006.
[15] Lundvall, B.-Å.: *“Innovation as an Interactive Process - from User-Producer Interaction to the National System of Innovation”*, In: Dosi, G. et al. (Eds.): Technical Change and Economic Theory (1988).
[16] Piller, F. T.; Stotko, C. M.: *„Mass Customization und Kundenintegration: Neue Wege zum innovativen Produkt“*, Düsseldorf 2003.
[17] Piller, F. T., &Walcher, D: *“Toolkits for idea competitions: a novel method to integrate users in new product development”*, R&D Management (2006), pp. 307-318
[18] Porter, M. E.: *„Wettbewerbsstrategien“*, Frankfurt 1999.
[19] Reichwald, R.; Piller, F. T.: *„Interaktive Wertschöpfung“*, Wiesbaden 2009.
[20] Röhrig, M.: *„Variantenbeherrschung mit hochflexiblen Produktionsendstufen“*, Düsseldorf 2002.
[21] Sloane, P.: *“A guide to open innovation and crowdsourcing: expert tips and advice”*, Philadelphia 2011.
[22] Walcher, D.: *„Der Ideenwettbewerb als Methode der aktiven Kundenintergration: Theorie, empirische Analyse und Implikationen“*, Wiesbaden 2007.
[23] Westkämper, E.: *„Einführung in die Organisation der Produktion“*, Berlin 2006.
[24] Wildemann, H.: *„Variantenmanagement: Leitfaden zur Komplexitätsreduzierung, -beherrschung und -vermeidung in Produkt und Prozess“*, München 2009.