Support for online configurator tools by customer communities

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Abstract: The main task of mass customization is the integration of individual customers into the manufacturer’s system of value creation. This purpose can be supported by information technology, like for instance configurator tools. With such tools customers are enabled to virtually assemble a product, often facing problems like lack of knowledge or uncertainties about proper configuration. The idea of this contribution is to overcome such problems by enhancing configurator tools with community functionalities. The paper discusses how communities can influence and support customers and it draws a first framework for a collaborative configurator tool, which enables customers to help each other.
1. Introduction

For business-to-business relationships collaborative work has become more and more usual. Supported by computer systems different enterprises can interactively work together for fulfilling a common project and for achieving an agreed goal. Even for the purpose of developing and designing products, computer systems can bring together members of different enterprises in a virtual collaborative workspace. In this paper I will concentrate on the computer supported collaboration for designing and developing physical products (Mishra et al., 1997; Reich et al., 1999). But in difference to the usual approaches I want to go a step further and integrate into the process of product development not only different enterprises but also the community of customers.

This effort is motivated by the fact, that in mass customization manufacturers have to take care of individual product wishes and desires (Pine, 1993; Piller, 2001). Even for commodity products of daily use, manufacturers try to find ways, of how to adapt them to a single customer. In doing so one faces some obvious problems: In addition to the challenges in manufacturing, another fundamental issue is how to integrate the customer into the design and development phase of the product. The customer has to become aware of the product’s properties and functionalities, which can be directly modified by the customer, and she needs some methods and tools to finally adapt the product. First technical approaches for this purpose are online configurator tools (Sabin/Weigel, 1998; Felfernig et al., 2001), which can be found, for instance, on the homepages of the large automakers. In some respects, with the configurator tool the customer gets the possibility to virtually assemble a car that is adapted to her individual needs and preferences.

For real individualization of products, configurator tools have to provide more design possibilities for the customer. This means that, at least theoretically, even the smallest subcomponent of a product should be customizable by the customer (Leckner/Lacher, 2003). However, the result of many «degrees of freedom» is great uncertainty for the customer, due to her limited knowledge and experience in developing and customizing products. In fact, too many choices could confuse the customer (Helander/Jiao, 2002). Also we expect that most customers will get overstrained by designing a product completely on their own, even if they are supported by some kind of «intelligent» configurator tool (Inakoshi et al., 2001; Ardissono et al., 2002). Our approach to meet this challenge is to support collaborative product configuration, where customers can interact with other customers or even with professional product designers to help them during the design process.

Against this background, the paper first will discuss the motivation for customers to individualize a product and to use a configurator tool for this purpose (Chapter 2). After this it will be shown, how virtual communities can influence and support the customer during product configuration (Chapter 3), leading into a first approach of a framework for collaborative configurator tools (Chapter 4). In this context both the functionality and the draft for system architecture will be roughly described. Finally the main differences to existing approaches will be addressed (Chapter 6), whereas especially the specific mechanism for agreeing upon common goals will be examined (Chapter 5).
2. Product individualization supported by configurator tools

2.1. Every customer is an individual with specific needs and preferences

Persons are different from one another and differences range from measurable issues like body height or weight to immeasurable issues like interests, hobbies or taste. Also every person has very own desires and needs, depending on personal preferences and in most cases depending on the circumstances in which someone currently lives, too. Some of these differences can be clearly described and expressed others can not. In the following I will concentrate on differences between customers:

a) **Measurable physical aspects**: First of all customers can differ in measurable, physical aspects, like body height or place of residence. Such differences can easily be expressed by the customer herself and therefore can be stored and computed by information technology, for example in a customer's user profile. Most of these explicit data can also be gathered by more «sophisticated» methods like body scan or medical diagnostic routines. Also an import from other resources, like for example telephone-books, records in marketing databases etc. is possible. These kinds of data are in most cases independent from the customer's current mood and situation.

b) **Immeasurable but easily descriptive aspects**: Secondly customers can differ in immeasurable but personally well-known and easily descriptive differences, like interests, hobbies or specific product wishes. These differences cannot be measured physically by body scan or the like. Nevertheless the customer herself usually is quite aware of them and thus can easily express them, when asked. Again most of these data can already be found in customer profiles of other applications and therefore can be imported from there. Additionally some of these issues can also be gathered by implicit methods like the analysis of the customer’s habits or the usage behavior with a software system. Also the analysis of the customer’s social relationships within a computer system can provide interesting results about interests and hobbies.

c) **Immeasurable and «vague» aspects**: Finally customers can also differ in immeasurable and «vague» aspects like experience, preference and taste. In concerns of a product wish, such «vague» aspects are assumed to correlate with the customer’s unarticulated needs: “Sometimes customers don't know what they want, until they see it” (Wind et al., 2002). Therefore this information can hardly be measured and normally the customer herself is also not able to clearly express them. All of this knowledge is implicit and cannot be made explicit in an easy way. And also normally this kind of information is influenced by temporal moods and circumstances. Because of this sometimes customers cannot coherently explain, why they like one product more, than another one. In most cases also experience is such a «vague» aspect of a person, which influences decision making, even though it is absolutely not clear, what experience sways the customer most in a certain situation and why.
Individual attributes of a customer

After all, evidently every person is unique and individual, leading to the idea, that actually individual customers also need individual products. The only problem is that tailor-made goods usually are much more expensive to produce, than standardized goods. Therefore in the research area of mass customization it all is about the mass production of individually customized goods and services for nearly the same prize as standardized products of today (cp. Piller, 2001).

2.2. Customer driven adaptation of individual goods

As a result of the customer’s individual peculiarities, the customer’s voice becomes more and more important during product design. In mass customization enterprises want to be able, to take care of individual product wishes and customers make use of this offer, to get more exactly the products, they actually want. For enterprises this strategy offers interesting perspectives, especially in times of Internet, where business rivals are only one mouse click away. Here mass customization can provide a possibility to gain more customer satisfaction and therefore more customer loyalty. Also for customers the individualization of products provides novel possibilities. Customers must no longer try to find appropriate products in the unmanageable variety of available standardized products. Instead they are enabled to formulate their product wish and afterwards get exactly the product they want. – Even more: In mass customization customers can also place very unusual product wishes, that «normal» products off the shelf could never fulfill.

Summarized mass customization empowers customers to adapt a product’s form, fit and function to the individual preferences and needs. Additionally also certain modalities like place of manufacture, time of delivery etc. can be more actively influenced by the customer. Therefore the main reasons for mass customization from the customer’s point of view are:

a) Adaptation of form: First of all mass customization provides the adaptation of the product’s form and design. In the result the customer can get a product, for instance, which optimally fits to the products already bought, to the furnishing in the customer’s flat or whatever. Another reason for customizing the product’s form and design might be that the customer wants to express her individual style and taste by the product. This is not only relevant for fashion, hair-style or jewelry, but also for trendy technical accessories, like wrist-watches, cellular
phones or designer notebooks. In the end all products with a certain kind of «style» can eventually help to express the customer's personality.

b) **Adaptation of fit:** Another reason for individualizing a product, which is much less motivated by esthetical thoughts, is the customization of the product's fit. Here practical reasons are most important, like the adaptation of a product to the individual physical structure and body measure. Also an interesting application would be, to adapt a product to the individual conditions of a handicapped person. The same principle, which has been well-known for centuries from the fashion industry, can be applied to nearly all other kinds of products. For example the small buttons on a cellular phone are indeed not the same appropriate for someone with large hands, like for another one with rather airy fingers.

c) **Adaptation of function:** An additional motivation for individualizing products has to do with the customization of the product's functionality. Many customers are known to the dilemma of modern products, which in most cases have way too much functionality, which in a great measure will never be used by a single customer. Especially technical products are getting more and more complex and in the consequence it becomes harder and harder for the customer, to handle and operate such products intuitively. The reason for this dilemma is that different customers often expect quite different functionalities from a product. And therefore manufactures integrate the whole variety of expected functionalities to satisfy a lot of different customers. Besides manufactures also tend to produce more and more «multifunction devices», which actually should simplify the customer's life by providing only one product for a various kind of functions. But also these products do normally not really simplify anything, because they are difficult to «understand» and too complex to handle. Thus, more and more customers begin to long for products, that have exactly those functionalities, they want them to have and nothing else.

d) **Adaptation of modalities:** Finally the customer might also want to determine certain requirements for the manufacturing process and the provision of deliveries and services. For example the customer might want to choose by herself, which person should perform a specific service and which (for example energy-saving or environmentally sound) manufacturing method should be used. Also the delivery time and place can be influenced by the customer.

After all the possibility to have more influence in the products properties and to be enabled to interactively adapt a product according to the individual needs and preferences, is one of the fundamental motivations for customers to accept the expected extra efforts for configuring and customizing a product. Thus, customers expect some kind of added value from individualized products. This could mean, that the product fulfills the individual desires more exactly, or it is a completely new product, which the customer otherwise could not buy. The communication of the value added and the interactive character of configuration and customization will be important for a successful mass customization strategy.
2.3. The customer process of individualizing a product

2.3.1 Individualization supported by human consultants

For adapting a product customers usually claim professional product consultants, like for example during the configuration of a family house. Of course a house is highly individualized, even though the customer alone is not able to configure it appropriate to her individual needs and preferences. Reasons for this dilemma are lack of knowledge according to architecture and/or legal conditions. Additionally customers might have uncertainties, because they cannot make informed choices in every detail. Such uncertainties result from lack of knowledge and experience. In difference to products off the shelf, customers do not know exactly what they get, when purchasing an individualized product (Wind et al., 2002). Therefore customers will be interested in recommendations from experts (in the example: professional architects) or at least in opinions from other experienced customers. Without the contact to human consultants, the planning for a family house would be much more complicated for the customer. After all the access to the other's know-how becomes the more important, the higher the risk resulting from wrong decisions. In the case of the family house, customers make an investment for decades. Therefore they want to assure, that the house is stable, homelike and worth the money and efforts. In the result customers benefit from the interaction with others and especially with professional human consultants. The human experts can help in making informed choices and can support the customer by giving comprehensive recommendations even for highly individualized products.

2.3.2 Product individualization supported by toolkits

In most cases in the area of mass customization private face-to-face advisory services are no longer possible. After all in mass customization it is not about tailor-made solutions with a rather high prize. Instead, in mass customization manufacturers aim to produce individually customized goods and services for a prize similar to the prize of standardized products. With the example of an individualized ball-pen it becomes evident, that time-consuming face-to-face consultation is no longer feasible; the prize for one single pen is simply too low. Therefore the customer needs alternative mechanisms to communicate her product wish and to overcome lack of knowledge and uncertainties. Examples for such alternative mechanisms are «adaptive interviews» (Stolze/Ströbel, 2001) and «construction kits», by which customers can build a physical model of their product. Obviously IT-systems provide the most appropriate way of support to the customer. By using such software tools the customer can get an overview about the available degrees of freedom. Also the customer can use such tools to describe her individual product wish. In the ideal, the customer's final product wish is entered directly into the company's system of information management. The product wish then can be translated automatically into a concrete product description and later on into the necessary data for initiating the manufacturing process.

Summarized the software-tool takes over the role of a human consultant, meaning that it supports the customer and helps to compensate the existing lack of know-how. Ideally the software-tool provides all product-related knowledge to the customer (cp. Tiilinen et al., 1998). For this purpose the software-tool must contain some representation of product-related knowledge, namely the so-called product model, which describes the physical and the logical structure of the product. Additionally it defines degrees of freedom, which are those elements of the product model that can be directly modified by the customer. Examples are the product's attributes and alternative/optional components. Every degree of freedom can have a range of valid
values, a default setting and also certain restrictions and interdependencies between different degrees of freedom are possible (Männistö et al., 2001). Picture 1 shows an example of a simple hierarchical product model:

![Hierarchical Product Model Diagram]

In the ideal case the product model contains all the concrete «knowledge» about the product of a human consultation expert. Based on this, the software tool can support the customer and also can generate recommendations for the customer.

For the purpose of recommendations, the software tool needs additional information about the customer, which usually is stored in a customer profile. All the explicit knowledge about the customer can be stored there (see Section 2.1.). Problematical in this context are the rather «vague» kinds information about a customers, like style and taste. It was described earlier in this paper, that this kind of information can neither be measured, nor can it be easily specified by the customer, making it quite difficult to make it explicit and analyzable for the system.

Another problem is that automatic recommender systems are assumed to be inadequate to completely overcome the customer’s uncertainties. During making their decisions, customers are likely to not only rely on the system’s advice. After all customers are not used to a software system’s advice during purchasing a product. Also there arise problems of trust and understandability, because customers often might not understand, how the recommendation was created. Trust in a human expert, who performs the interaction with the customer, usually is supposed to be higher, compared to trust in the «unfeeling» and impersonal computer system.
Both a method for accessing «vague» information and a possibility for explicitly including other people’s knowledge can be realized and supported by customer communities, like described in the following chapters.

3. Virtual communities during individualizing a product

3.1. Influence of communities during individualizing a product

At first glance it may surprise, that individualization and communities have something in common. While individualization takes care of the customer’s individual peculiarities (like described above) and offers possibilities to express one’s very own product wishes and desires, the aim of communities is to help finding same-minded persons or at least persons, to share certain interests with. Therefore it seems that individualization actually is quite the opposite philosophy towards community.

But as mentioned in the previous Chapter, customers are likely to take into account other customer’s opinions during configuring a product. Social studies, like for example reported in (EuroShoe Project 2002), show that the taste of a single person often is influenced by peers and the taste of a community. Maybe this is also the reason, why usually a single person cannot easily express and specify her very individual taste. Further on it means that even if unconscious, a customer normally wants to get a product, which also is liked by persons of her social network. Also for «normal» products off the shelf customers usually take into account, what others might think about the product. After all some products and services have to fit in with the crowd (Wind et al., 2002). One reason for this behavior is, that it will become harder to resell or repair a product, the more specialized it is. Another reason is that especially attitudes towards style and beauty are not defined by a single person alone. It always has something to do with modern «mainstream» and the attitudes of the community. Therefore, for instance, when a customer wants to by a «beautiful dress», she has to consider the community’s attitude towards beautiful dresses. Otherwise the dress would not be named beautiful, also if it perfectly corresponds to the very individual taste of the specific customer.

The consideration of what others think gets even more important, when the product is likely to express a customer’s individual character. In this case the customer identifies herself with the product and offers others the chance to use the product to get an idea about the customer’s personality. All products with a certain «style» and especially innovative and vanguard products like notebooks, cellular phone etc. are supposed to likely express a person’s individual identity.

The conclusion is, that especially the customer’s «vague» peculiarities are often related to the social environment of the customer. For this reason a virtual customer community can support the customer, by offering a technical representation of her social environment. Customers have the chance, to get an idea about what others think and they are enabled to explicitly ask others about their opinions and attitudes. In this way the community acts as an additional source for more significant information for the customer’s user profile. Additionally the customer community supports knowledge transfer between customers (Ishida, 1998) by providing the single customer access to the knowledge and experience of others. Also customers can provide direct advice to other customers (Wind et al., 2002). This may help customers to overcome uncertainties, which are likely to occur while customizing a product with many degrees of freedom, like described earlier in this paper and in (Huffman/Kahn, 1998).
Further on the integration of a community also corresponds to product customization in real world, because in most cases the customer will not use a product alone, but she will share it with others. An example for this idea again is the planning of a new family house, which of course is a highly individualized product, even though it should not only fit to the preferences and needs of a single person, but to a group of persons. In this example all the members of the family (and maybe even neighbors) have to be convinced by the planning, before the new house can be built. Therefore one vision of communities in the area of mass customization is to establish a support system for customer-driven collaborative product configuration. The aim is to provide a computer-based «shared workspace» (cp. Miles et al., 1993) to customers, which enables them to collaboratively design and develop individualized products. In this scenario communities can also play a critical role in new product development (Wind et al., 2002)

Thus, despite taking care of individual peculiarities and the customer's very individual product wishes, also the community of customers provides benefits during adapting a product to the customer's needs and preferences. Additionally the community of customers has influence on the decision making of a single customer and therefore should be accessible for the individual customer during the whole decision phase of individualizing a product.

3.2. Characteristics of virtual communities

For the founder of the expression «virtual community», namely Howard Rheingold, the most important criteria for virtual communities is support to establish relationships and to carry about them: “Virtual communities are social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace” (Rheingold, 1998). Besides, (Hagel/Armstrong, 1997) identified additional characteristics of virtual communities, which are described in more detail in the following:

a) Communication: First of all communities should support different ways of synchronous and/or asynchronous communication between the community-members. In difference to shopping-malls or «normal» web pages all communicants are just members of the community, having equal rights. Each community member has a unique identity within the system, offering also the possibly to create and maintain user profiles. Also communication is an important base for customer collaboration within the community.

b) Content: Additionally the community should motivate its members to actively create own content for the community. The content of the community determines the common topic of interest for its members and it gives to community members a sense of ownership and involvement. The more such contents are created by community members (and not by the community’s operator), the more customers will get interested and the more they are willing to benefit from it and to publish own new content. Examples for usual customer created content are reports based on experience, comments, ratings, etc.

c) Relationships: Rheingold already emphasized the importance of a possibility for community-member to establish and take care of relationships towards other members of the community. Dialogue and feedback are necessary for this task same to some sort of awareness and access to common memories. In this way relationships help customers to experience the feeling of social affiliation to the community. Besides relationships are an important fundament for trust and reputation within virtual communities. Whenever a person has relationships,
there also occur opinions and comments about the person. In the result the person is no longer the unknown stranger, but achieves a real virtual identity.

d) **Loyalty**: Finally Hagel/Armstrong proclaimed, that an important goal of every virtual community are loyal community members. Obviously this statement is motivated by economical reasons, like customer loyalty, lock-in markets etc. Besides in the result loyalty means, that there is ongoing interaction between community members, which is necessary to build up relationships and to form useful communities.

The various characteristics of virtual communities can be realized by different community functionalities like online-chat, ratings, awareness-tools, reputation-systems, etc.

Summarized virtual communities provide an easy way to (synchronously and/or asynchronously) communication with others and to take into account their opinions and experiences for the individual decision. By doing so, on the one hand the customer can ensure, that her product also will be liked by others. On the other hand the customer can receive more confidence for the correctness and usefulness of her individual selections and adaptations (Piller et al., 2003).

4. **A framework for community-supported product customization**

4.1. **Communities and configurator tools**

Like described earlier in this paper, the main tasks of a configurator tool are:

- … to enhance awareness about available degrees of freedom and
- … to enable customers to interactively adapt the virtual product model in accordance to the customer’s individual needs and preferences.

Especially the experience of interactively assembling the product can support the customer by creating an immediate idea about what influence the adaptation of a single degree of freedom will have towards the whole product, for instance referred to the product’s prize, delivery time or appearance. Additionally, configurator tools are often seen as a possible way to entitle customers to create new kinds of products and therefore to foster customer-driven product innovation (Von Hippel, 2001).

In the following more detailed tasks of configurator tools will be enumerated, each of which can be supported by certain community functionalities:

a) **Representing configuration models and degrees of freedom**: In a collaborative shared workspace the configuration model must not only be represented to a single customer, but can be represented synchronously to a group of customers, that configure a product together. For synchronous configuration also awareness functionalities (cp. Schlichter et al., 1998) are necessary to inform the customer, which other customers currently are online and can/want participate in the collaborative configuration process. In this task the customer also can be informed, which parts of the product actually are modified by others.

b) **Create a review on preconfigured products and components with catalogues**: The creation of a review on preconfigured products and
components can be supported by «participatory catalogues» (cp. Schubert, 2000). Such catalogues are enriched with ratings and/or comments and additionally its elements can be filtered and arranged in special orders, like for instance by name of its authors, by the average rating of certain groups etc.

c) **Manual assignment of degrees of freedom:** In contrast to single-user configurator tools the collaborative assignment of degrees of freedom can be supported by a «shared workspace» (cp. Miles et al., 1993) and by access to the opinions and experiences of other community members. Such experiences can be stored for instance in specific «restricted product models» (Leckner/Lacher, 2003), which are especially modified by customers and also can contain certain comments of customers about specific degrees of freedom.

d) **Checking the correctness of a configuration by automatic methods in accordance to the product model:** During collaborative product configuration also other customers can take on the pre-validation of those degrees of freedoms, they adapt manually to a specific value. Thus, the community of customers can manually improve the automatic model-checking procedures.

e) **«Explanations» in regard to product structure and product logic via the product model:** Additionally to automatic explanations in regards to the product model, in a collaborative configurator also access is possible to specific product models, modified and enriched with comments and ratings of other customers. Therefore customers can asynchronously «explain» an especially designed product model and its interdependencies to each other. Further on also a product newsgroup or other synchronous and asynchronous communication methods (e-mail, chat etc.) can provide explanations, given by customers.

f) **Recommendations for degrees-of-freedom generated by personalization techniques:** To simplify the configuration process, recommendations can be given to the customer in form of specialized product models or by specific default values. Some concepts of recommendation in the area of product configuration are explained in (Stegmann et al., 2003; Leckner/Lacher, 2003; Ardissono et al., 2001). In a collaborative configurator tool, the generation of such recommendations can be enhanced by interactive collaborative filtering methods (Koch et al., 2002). Here the customer herself can determine, whose opinions and ratings will be taken into account for the generation of a recommendation for a specific degree of freedom. Also direct customer initiated recommendations are possible, where customers can directly ask («pull») others for help or where customers can actively suggest («push») assignments for certain degrees of freedom to others (cp. Terveen/ Hill, 2001; Schafer et al., 2000).

The previous section showed a first approach for the link between community functionalities and online configurator tools. Additionally the product model, which provides the technical representation of the available «knowledge» of the referred product, is an essential common basis both for the configurator tool and for community functionalities.
4.2 The product model as a basis for community functionalities

In difference to existing B2B-systems, the success of a shared workspace for customers extremely depends on an intuitive user interface, because most customers will not use the system regularly. Additionally the shared workspace must provide extensive knowledge about the product, since the customers will most probably not have adequate experiences to develop and design products from scratch, like professionals. Also marginal conditions, like rules, laws and permissions have to be taken into account for the configuration of a product. Therefore the collaborative configurator tool will be based on a comprehensive product model, which includes all the necessary knowledge about the product.

In addition to the pure configuration task, the product model also provides an important backbone of community functionalities, since customers can give comments, ratings etc. to parts of the product model. All customer created «knowledge» about the product must somehow be related to the product model and specific parts of it. Thus, whenever customers use the community to share knowledge about the product or the product’s degrees of freedom, they must be enabled to refer to the respective product model (e.g. in chat, e-mail, etc.).

When bringing together the product model, the community and the individual product wish, one can conclude, that the main task of individualization is to find a compromise between the «individual dreams», the taste of the community and the marginal conditions. Our approach for helping the customer to find this compromise is a collaborative configurator tool, which is based on a complex product model. In my opinion this computer-based tool can form a realistic representative of individualization in real world, as shown earlier in this paper for the example of planning a new family house.

4.3 Draft for an application architecture

Like for nearly all software systems the application architecture of the collaborative configurator tool roughly can be divided into three mayor layers, namely the data layer, the logic layer and the presentation layer (cp. Denert, 1991; Powel, 2001):

- The **data layer** handles the access to data stored, usually in relational databases. One the one hand there is database for all product-related data, like product models, component models, attribute models and their instances, respectively the configurations of purchased products. On the other hand there are user profiles, in which not only personal data and information about relationships can be stored but also information about ratings and comments to products, components and attributes (with reference to the according data sets in the database of product-related data). Furthermore it can be recorded in the user profile, which products, components and attributes were designed by a customer (alone or together with others). Also the user profile contains references to specific restricted product models and product constraints, which were defined by the customer herself as some sort of product related «knowledge». Finally the user profile also stores information about which products the customer has already bought (as a reference to the according data set in the in the database of product-related data).

- The **logic layer** constitutes the bulk of the task-specific logic of the application, which connects the data layer with the presentation layer. An example in the area of configurator systems is a module for constraint checking. The main task
of this module is to control, if a given product configuration is valid within its underlying product model. Another important task is the match making module, which can find a set of customers, who are similar to a given customer or who have certain properties, which were manually selected by the customer herself. Additionally, various filtering methods are necessary to generate personalized recommendations for product models, products, components etc. Besides also system modules for communication tasks within the community are necessary same to specialized modules for processing various tasks of the configurator tool, like a locking-mechanism to «synchronize» (cp. e.g. Greenberg/Roseman, 1997) the collaborative configuration of a group of customers.

- Finally the presentation layer provides a personalized user interface for all system functionalities. Different views onto the system can be distinguished, like admin-view, manufacturer-view and customer-view (Leckner et al., 2003). Parts of the user-interface in the customer-view are the personalized portal page, the profile editor, the product catalogue, a component catalogue, the configurator (maybe again with different views for initiating and for cooperating customers), an editor for browsing and changing relationships to other users (cp. Leckner, 2001), the customer forum, a front-end for synchronous communication and so forth. A fundamental criterion for a successful user interface is its «usability» (cp. Krug, 2002), so that even new and untrained customers can easily understand and use the system. Besides it will be necessary, to evaluate the user interface by empirical user studies. Also it should paid attention to the fact, that customers enjoy using the system, so that they become loyal customers and return to the system for configuring additional products or for helping others to do that.

After all the distinction between three different layers allows a platform and technology independent development of the whole system. Different functionalities for community support cooperate with different functionalities for product configuration. With the product model as the fundamental backbone, the community functionalities can enable customers to share knowledge and experience within the topic of the current product. By providing a comprehensive product model customers can reference to parts of the product and existing components. References to all available degrees of freedom are possible. This mechanism allows a knowledge transfer in a much broader extent, than in «normal» customer-communities. Also restricted product models, edited by customers and enriched with comments and special constraints (see above), can be seen as a novel way of knowledge transfer between customers.
5. Mechanism for agreeing upon common goals

In difference to usual communities members of the collaborative configurator tool can spontaneously form up a group, to collaboratively design a virtual product. The formation of such a group must be supported by the software system in an appropriate way. Actually to each other unknown persons must be provided computer-supported mechanisms to agree upon a common goal, together strike for that goal and after a successful achievement of objectives disband that coalition. The whole process of collaboration can be roughly divided into four phases (cp. Leckner, 2001):

![Picture 2: Phases of collaboration](image)

a) During the **phase of initiation** the main task for the initiating person is to recognize and identify proper persons for collaboration. For recognizing persons in general, awareness tools play an important role (Schlichter et al., 1998). Supported by such tools, a person can get informed about other persons in the system and also about what these people currently do. Thus, awareness tools can help to find «available» persons for collaboration. The next step is to identify appropriate persons as potential partners for collaboration. Primarily trust into the other's competence and person are the most important aspects in this phase. Therefore mechanisms for supporting the generation of trust are necessary (e.g. Link, 2001), especially for the case, that one does not know the potential partner personally, which might be the normal case in a computer-supported virtual community. Possible criteria for selecting an appropriate partner have to do with «reputation» (Koch et al., 2000), like ratings about the person, proof of successful projects in the past, direct recommendations from other persons of trust etc. A series of own positive experience with the respective person is the most significant criteria for trust in the potential partner (cp. Leckner, 2001).

b) After recognizing and selecting appropriate partners, the main task of the **phase of agreement** is to agree upon common goals and to safeguard such goals by certain methods. Written contracts will not be practicable in the scenario of collaborative configuration. Instead other mechanisms are necessary for awarding successful projects and for penalizing the bad ones. Examples for awards are positive ratings or positive entries in a customer's public usage history file. Also other rewards like credit-points or monetary gifts are possible. In the same way unilateral breakups can be penalized by bad reputation or loss of credits points. In the phase of agreement potential partners have to negotiate all the impacts of positive and negative collaboration. Besides also the common goal has to be negotiated and clearly defined. In the scenario of product configuration the common goal is the concrete product. Additionally in the phase of agreement partners could agree upon who shall modify which parts of the product. Besides the common goal also determines the end of the collaboration. For instance potential partners could agree, that the common goal is reached, as soon as the initiating person orders and buys the product.
Alternatively, and with less power for the initiating person, potential partners could agree, that the common goal is reached if more than 75% of the participation persons are in agreement, that the goal is successfully reached. Also other common goals are imaginable, like collaboration for a predefined number of minutes etc.

c) In the **phase of execution and collaboration** the actual collaborative product configuration takes place. This means, that the group of persons synchronously or asynchronously tries to configure the product, due to the previously made agreements. Synchronous collaboration could be realized by a shared workspace, where participating persons really experience the collaboration process. Asynchronous collaboration could mean, that the initiating person takes into account other people’s opinions, which are stored in the system as ratings, comments and user defined product models. Also it could mean, that a group of persons configures the product with time delays. For example *customer_A* could start the configuration and modify the product model in accordance to her preferences. Afterwards *customer_A* stores the modified product model and sends a message to *customer_B*, who can continue to configure the product in the following and so forth. Also different customers could work parallel but not synchronized on the product, especially if every participating person is entitled to only modify specific parts or only certain aspects of the product. The end of the collaboration was defined in the phase of agreement and is not necessarily equal to the end of the whole configuration process. It also might be possible to agree, that only certain parts of the product are configured collaboratively.

d) Finally in the **phase of control and termination** the collaboration finds its end and the participants can evaluate the achieved goals and the quality of collaboration. For this purpose possible awards and penalties have been constituted in the phase of agreement. After all the collaborative process ends and all participating persons continue to go their own way and maybe cooperate with complete other people in new collaboration projects.

The described phases of collaboration are an important backbone of collaborative product configuration. Therefore the collaborative configurator tool has to support all phases of collaboration in an appropriate way, whereas especially the phase of computer supported agreement between customers is something novel. Up to now there only exist systems for computer supported agreement of dispersed teams, for example in software engineering (e.g. Harris, 1999). In difference to such systems, members of a community usually cannot be seen as teams. In a collaborative configurator the essential issue of the initiation and agreement phases is to form a temporal team of customers. For this purpose customers might need additional methods for computer supported argumentation, which are based on the product model in this scenario. An overview about computer supported argumentation and especially the visualization of the line of argument is given in (Kirschner et al., 2003).
6. Differences towards other systems

Obviously the collaborative configurator tool has some similarities to existing configurator system, to groupware and to pure communities. It combines different functionalities of each of these systems and it additional offers extra-functionality:

![Diagram](Picture 3: The collaborative configuration task)

Compared to pure **configurator tools** the main difference is the support for collaborative functionalities. As far as I know, no existing configurators do provide such functionalities to the customer. Usually the customer is completely alone during the process of virtually assembling a product according to her individual needs and preferences. The main tasks of usual configurator tools are the representation and managing of configuration models and the assistance in configuring a product on the basis of the configuration model (Tiihonen/Soininen, 1997). Therefore in the area of configurator tools, most research concentrates on methods for visualizing product configurations, on product modeling and on model checking techniques. In my approach a focus is set to the collaborative process of product configuration, where customers can be supported by others during virtually assembling the product. Different kinds of collaborative support are possible, beginning with participatory catalogues and interactive collaborative filtering up to a shared workspace for synchronous configuration of products.

Especially the shared workspace obviously has similarities to existing **groupware** applications, which for instance support professional designer teams in the B2B-area already (e.g. Sevy et al., 2000). But in difference to these tools, the users of a collaborative product configurator tool normally do not know each other personally and they are typically not familiar in using the system. Therefore more attention has to be turned on an intuitive user interface that can be handled by non-experts and unfamiliar people. And even more important, compared to the scenario of most groupware systems, the community of customers does not have agreed to an institutional secured goal. This is the fact inherently in the usage of normal groupware systems, which are used by people working in the same company or at least having some contracts of how to collaborate in teams. Also users of groupware systems usually are personally known to each other. In difference to this, the collaborative product configurator supports the cooperation of actually unknown customers. Therefore methods for agreeing upon common goals are necessary, same to methods for safeguarding these goals. After all,
also such methods for negotiating upon common goals can be provided on the basis of the product model.

This product model is also one the most important difference towards usual communities. Normally communities represent a loose group of persons, with some common interests. In the scenario of collaborative product configuration, the product model is an important backbone of the community, enabling new functionalities and providing more comprehensive forms of (model-based) knowledge transfer. Another important difference to pure communities is, that in collaborative configurator tools customers are supported to ad-hoc agree upon a common project, at least temporarily. Therefore the collaborative product configurator tool must also support mechanisms for negotiating and agreeing upon common goals, like described earlier in this paper.

7. Conclusion

In this paper I have discussed the role of virtual communities for the individualization of products. It was shown, that on the basis of a product model, communities can become a valuable source of knowledge for a customer during her process of virtually configuring a product. Additionally a concept for a framework for computer-based configuration of products supported by customer-communities was introduced. In this context also it was discussed, how different community functionalities can help the customer during the interactive process of customization. Finally I have compared the framework to existing approaches and explained the importance of a computer supported mechanism for agreeing upon common goals.

At the moment, the introduced community-framework is only a proposal, which needs to be empirically investigated. Therefore in the context of an interdisciplinary research project (in the Web: http://www.sfb582.de) at the Technical University of Munich we are currently implementing a model-based online configurator tool, which will be enriched by community support functionalities. The effectiveness of customer-driven collaborative configuration has to be tested in empirical user studies in future work.

Also I want to point out, that the collaborative product configurator is just one possible way of how to support customers in the context of mass customization. In my opinion collaborative product configurator tools can support the customer in a more comprehensive way, than tools of today’s use. Additionally the usage of a product model opens up new vistas in the context of virtual communities and knowledge management.

Finally the customer herself will have to decide, what kind of interaction with the company she prefers. Most probably there always will be people, who prefer products off the shelf or face-to-face consultation with real persons during individualizing a product. Therefore an important task of future e-business applications is to support the hybrid «centaur» customer, who is not strictly cyber consumer, but always “remains a human being, with human characteristics that make her resistant to change” (Wind et al., 2002). Nevertheless in the age of information technology and internet also there are a lot of people, who would virtually assemble their products, if only they would have comprehensive and entertaining tools for doing it. Same is true for the purpose of collaboration in product customization. At first glance one may assume that customers might not be interested in virtually helping each other. But when one looks at how and why communities arise and how dynamically and spontaneously they aggregate in so-called «smart mobs» (Rheingold, 2002), one can be sure that nothing is impossible.
References


