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A CONTRIBUTION TO ASSESS THE USEFULNESS OF PRODUCTS

Kristin Paetzold[1]; Bernhard Höfner[2]

[1]Institute of Technical Product Development, University of the Bundeswehr, Munich
[2]TOOL & SCREEN, Frankfurt

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ABSTRACT

Today, the effectiveness of products is mainly influenced by interactions between user and product, which are described by the handling of a product by the human being. Reasons are not only in the increasing functionality of today´s products, but also in the complexity of human-machine-interactions. An extension of the system borders is required to consider a stronger integration of the needs and the capability of the human being in the development. In that respect, the technical system should include the human being (human being-product-system).

In the past, it has turned out that it is not helpful to describe the human being only based on his capacities or, respectively, his performance restrictions. In fact, it is also necessary to consider his specific life situation and the action situation. Such an extended view connected with the integration of the human being in the system's contemplation assumes a holistic reflection of the human being. In addition, it demands novel methods to validate the products in their functionality concerning a holistic view of the human being.

The focus of the paper lies on the last point. A model approach is explained which assess the usefulness of a product, based on a holistic view of the human being, will be explained. This approach is based on a specific interpretation of the concept of "barrier", which combines a product´s point of view with a user's point of view. As a result, a capacity-support-diagram is derived in which products are classified. This kind of representation helps to explain not only the use of a product, but also to implement a support hierarchy for the human being with products. This representation serves the purpose of deriving key aspects for the product development.

1 INTRODUCTION

Products are developed in order to fulfil a systems purpose. The designer has to think ahead the effect of the product which shall support the human beings in the completion of their daily life in a specific situation. The goal of product development must be to support the human being in his ambition for a self-determined and autonomous life. In this spirit the human being becomes the criterion of all activities. In this context the existing approaches in product development are focused on the human being's performance restrictions.

Such a view on the human being as user is not helpful for two reasons. On the one hand such a deficit-oriented view easily leads to stigmatisation, often made by experiences with products especially designed for elderly people in the past. On the other hand such a view neglects that the use of technical systems can not only be explained with pure rational reasons. There are a number of so-called weak factors which play an important role in using products. The definition of the systems purpose, respectively, the description of the goal system for the development process, which is reduced to the goal to compensate performance restrictions, not only neglects the agglomeration of performance restrictions for example in case of multi-morbidity in old age. At the same time man's natural compensation mechanisms are not considered (for example blind persons evolve a very good sense of hearing). Additionally, motivational and psychological aspects which describe the action situation, as

well as sociological aspects which describe the life situation are not considered enough. Such aspects are very important, because they describe the utilisation of the own capabilities in the field of product development. An example: if a technical system that is developed to support walking in order to achieve mobility, the reasons for walking disabilities are not important (age ore diseases). A specification of the walking disability is needed which result from a set of characteristic data from life- and action situation connected with the performance limits.

Two questions result from such a holistic consideration of the use-situation for the product development:

> **The definition of the system of objective:** Sensory, physical and cognitive performance restrictions are captured very well. Mechanisms are available to define technical functions based on these performance restrictions and to concretise the parameters for the function. Approaches to analyse and to describe "weak factors" which result from the life situation and the action situation, to concretise the system of objective and to transfer this into requirements are not available to this day.
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> **Validation of products and product ideas**: Evaluation procedures which are qualified to asses products from the user's point of view are needed. All relevant factors from life- and action situations concerning to the usefulness have to be considered as well. This usefulness can result from both from objective as same as a subjective point of view.

Today both aspects are not satisfactorily solved. There are some approaches which pick up only parts of the aspects. In this paper the focus lay on the assessment of products or product ideas.

2 STATE OF THE ART: VALIDATION OF PRODUCTS AND PRODUCT IDEAS

The validation of products resp. product ideas, thus, the proof that the product fulfils the desired purpose, is essential for the commercial success and accordingly a reduction of the development risk. Accordingly, literature explains a number of approaches not only on product development, but also on acceptance-research which may be helpful for these tasks.

Nowadays methods of user integration are well established in the context of product validation in the product development. The goal of using these methods is, to integrate the user with his specific experiences, to capture his wishes and needs and to derive new products or product-ideas from this [DIN92a]. The challenge is that the user's view and the engineer's view of the product differ considerably. Sarodnik called these phenomena "…mutual symmetric ignorance…" [SaBr06]. The designer's point of view starts with the system purpose for every kind of development activity. The system purpose will be transformed into technical functions and detailed and concretised to the product. The user's point of view starts with the real product. The user has to interpret this product in order to find out, what its purpose is (figure 1). He tries the product and experiences the usefulness in his specific life- and action situation. Hereby he opens up the systems purpose for himself [Steff00].

The methods for user-participation that are used today are explained and summarised for example in Reinicke [Rein04]. With these methods the engineer is not only able to assess the functionality of a product but also to find out new product ideas and to complete the requirements description. Nevertheless it is difficult to separate between the different views of the engineer and the user. One of the reasons is, that the product models that are used for validation are usual for the designer but very difficult to interpret by the user (for example cad-models, parts of product detached from the overall system). Hence it is necessary to explain the product model. With such an explanation the designer also explains the intention of the product and its functionality. Tests often occur in specific environments so the test situation is not comparable to the real life- and action situation in which the user will use a product. In addition the user often tests only parts of a product, exactly the functionalities which help to compensate performance restrictions.

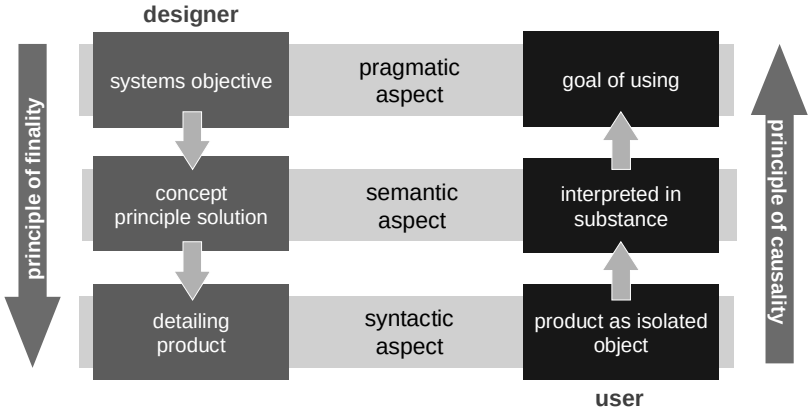

Figure 1: different views of a product by the user and the designer

Methods to validate products are also provided by the field of acceptance research. This is a wide field of research which offers explanation-approaches from behaviour-theory, psychology, but also from economics. Based on the Theory of Reasoned Action by Fishbein/Aizen [FiAj75] the Technology Acceptance Model (TAM) according to Davis [Davi89] and the Unified Theory of Acceptance and Use (UTAUT) according to Venkatesh [VeVi00] are in this context of importance. A number of specific acceptance models use these generic thoughts and approaches. The basic idea of TAM to evaluate a product is to identify conclusions to the "perceived usefulness" and the "perceived simplicity" in the sense of a cost-benefit-ratio. With this thought the assessment of a product focusses more on the typical application context of the user. The life situation and the action situation are integrated in the result of the assessment. UTAUT continues the way of thinking of TAM. However, the approach distinguishes between more separate aspects, which are integrated in an overall conclusion. The weakness of these approaches of acceptance research lay in the point, that the eventually generated acceptance conclusion offers no reference to the product itself. Thereby, no inferences to the design or to the definition of the requirements of the product are possible. The designer gets no indication of what needs to be done to increase the acceptance [Birk14].

In summary, it has to be considered, that methods available today for the product validation at the one hand focus too much on particular aspects, normally coupled with the functionality to compensate performance restrictions and get lost in the life situation and in the action situation. Otherwise, the methods to evaluate products have such a global view on the product, so that conclusions to a specific functionality as well as the life situation and the action situation are not possible anymore. The limited usability of the explained methods are based on the fact that in the product development a holistic description of the human being is not available, but such a description is in terms of reference necessary for a validation.

In the chapter below an attempt is made to describe an approach for a product validation, which tries to compensate the weakness of the explained methods.

3 AN APPROACH FOR THE VALIDATION OF PRODUCTS

The topmost goal of the product development is to support the human beings in their self-determined and autonomous life. To master this challenge it is essential to sensitise as well as to orient the product development on the naturally heterogeneous requirements of the different users and stakeholders. The human being may not be restricted in his individual constitution of life. In fact, by using products the human being shall be enabled to overcome barriers, which hinder a self-determined life. Such barriers result not only from individual performance restrictions, or the life situation and the action situation of the user; they may also be determined by the private or public environment of the user.

Handicaps in the self-determined conduct of life result from two directions: The human being may be hindered either in consequence of performance restrictions or his specific life situation and action situation, or may be hindered in consequence of the product itself. As an example the mobility in the

close proximity of home is considered here. From the first of view point a handicap may result from restrictions in walking due to age or diseases, otherwise the user does not use a product like a walker due to his personal prestige. From the second point of view the product walker can hinder the user in his mobility, for example to overcome altitude differences or in impassable environment. A product like a walker is also not helpful for a powerful human being like an athlete. In this case, the product is not balanced to the individual achievement potential.

Both aspects, the „capability of the user" and the "support by the product" form the axis of the Capability-Support-Diagram (CSD). Both axes may be divided in detail by classifying the axis of abscissae from "no capability" 'till "highest capability". The ordinate classifies between degrees of support, which result from the product to the human being. In the point of origin in the diagram the human being with average capabilities and a product which is neutrally evaluated is pictured (figure 2).

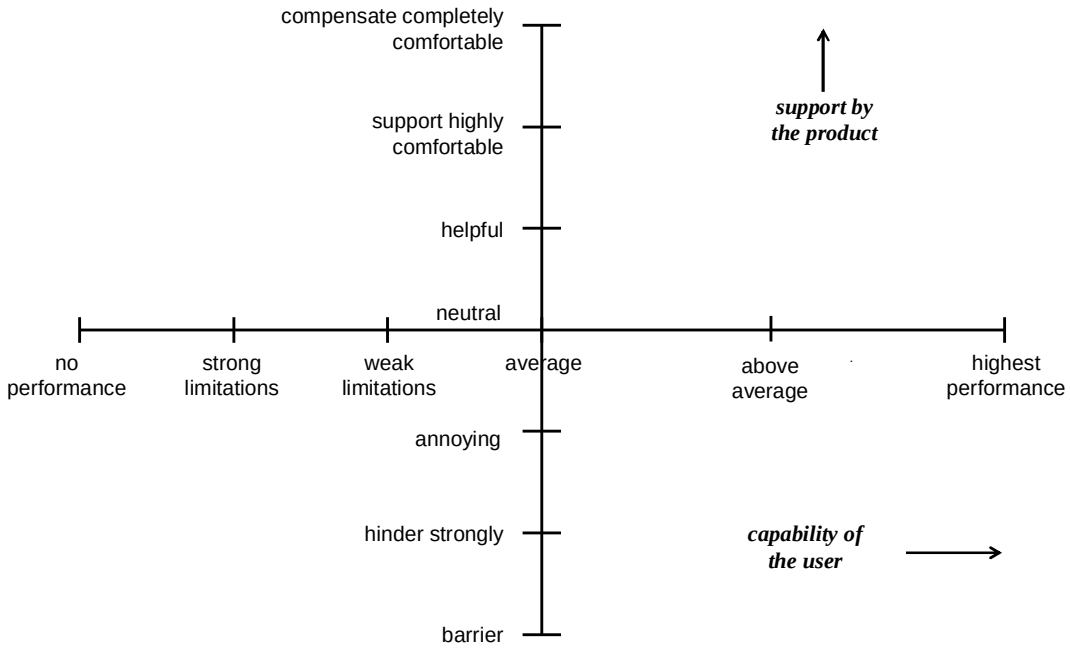

Figure 2: Basic structure of the Capability-Support-Diagram (CSD)

The CSD represents a very genetic approach to describe the relations between the product and the user. The diagram shall help to adapt the functionality of a product ideally to the user. Starting point of the deliberation is the idea that a best possible support for the user is not the pure compensation of performance restrictions by the product, but rather, from the medical point of view, a hierarchy of support has to be used [PaWa12]. This hierarchy is explained in the following:

- Motivation (animation and training): at first the technical system has to activate the user in using to facilitate the daily life. The consolidation of the own capabilities must be the system's purpose.
- Assistance: in the next level the product has to support the user not only by using his available capabilities, but also in specifically difficult situations. The conservation of residual capabilities and the training of compensatory capabilities must be the system's purpose.
- Compensation: Only if the user's existing capabilities are not enough anymore for specific actions in daily life, the capabilities shall be compensated by the product. The system's purpose assures a self-determined lifestyle.

This hierarchy is illustrated in the CSD (figure 3).

Furthermore, in the field of design for elderly people respectively design for all generations two principle development strategies are known, which can be used to optimize the product functionality to the users' wishes and needs:

- The concept of efficiency-adapted product design describes a specific concept which focuses on the specifications in the capability, respectively the performance restrictions of the human being as user, his using behaviour as well as the social contact. This requires an adaption of products in their functionality to fulfil the system's purpose. The strategy focuses on the technical function.
- The universal design describes a generic concept. Technical design, aspects of ergonomic and usability become more important. This aspect has to be considered to ensure the acceptance of the product. In this concept the design orients on the least user, respectively the most demanding user, but not an average user.

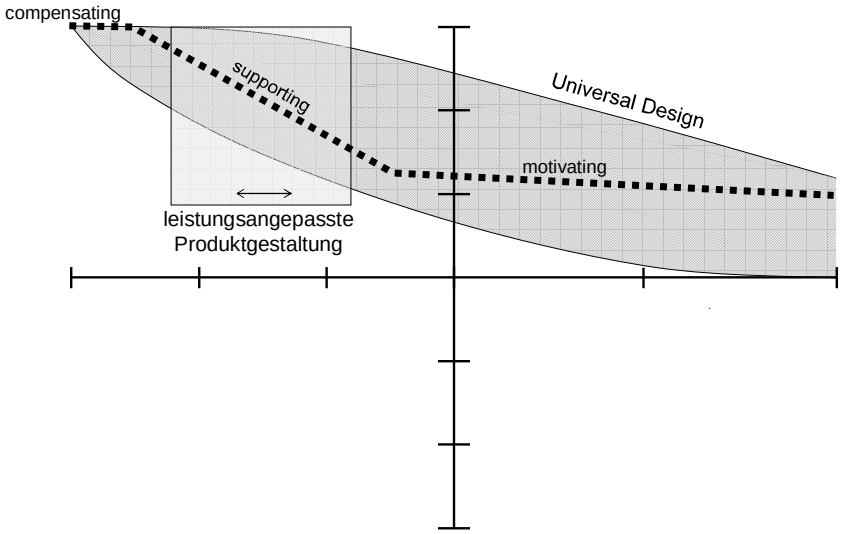

Figure 3: Integration of the support hierarchy and the development strategies in the CSD

With both strategies the use of specific methods in the development process is connected. Figure 3 shows, that these strategies are not mutually exclusive. They complement one another. The efficiency-adapted product design considers already a specific user-group. If the product is used by users outside of this group the product often becomes a barrier. The methods of universal design help to make the product accessible for a broader and more heterogeneous user-group.

4 THE USE OF CSD BASED ON AN EXAMPLE TO SUPPORT MOBILITY

4.1 The Constitution of the CSD

In order to use the CSD to assess technical systems, the generic representation has to be adapted to a specific product and a precise description of the users. This is illustrated with the example of "mobility support near home". "To be mobile" in this context means to cope with activities outside of one's flat, for example shopping, seeing a doctor or meeting friends. Mobility is influenced by the terrain, the state of pavements, goods that have to be transported, the traffic situation, availability of public transport etc. A deeper hierarchical structure is possible and has to be considered for each product.

For the ability "to be mobile" there are sub-activities that are derived from the description of the situation. These sub-activities are for example: to walk, to overcome barriers, to transport goods, to recognise traffic situations, to react to traffic situations and so on. These activities have to be analysed to describe the use-scenario. This includes for example to scrutinize the user's social environment and to consider it in the assessment. A widespread aid to support mobility near home is the Zimmer frame, which is examined below. Based on user polls, users with different capability can be interviewed regarding the support by the product. It doesn't seem sensible to cover the whole spectrum of capabilities by the polls, but to narrow down to the area that represents the defined target group for the product. (The representation in figure 4 is accordingly narrowed down.). For evaluation and visualisation of the results of the user poll the CSD can be used. In application it is necessary to define categories of the restrictions exactly and to distinguish between them properly. The activities that are

mentioned can be displayed in the CSD for different capabilities. For the Zimmer frame as product example, this is showcased in figure 4.

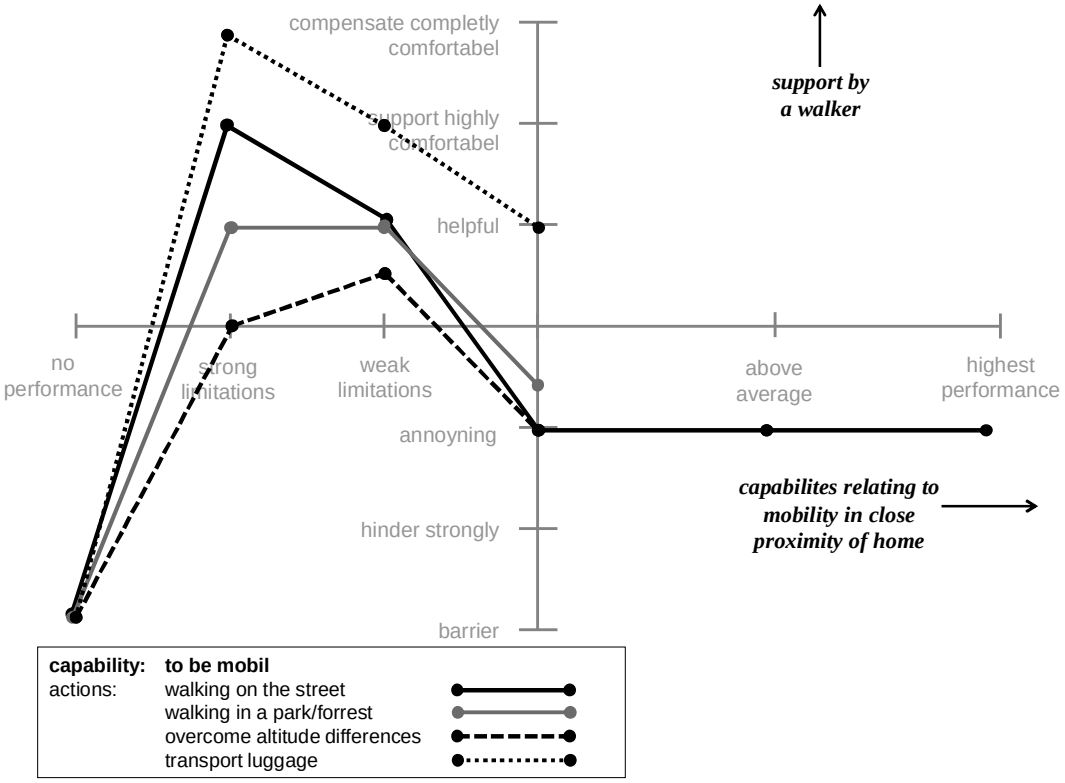

Figure 4: Assessment of single activities based on the example „walker“

Figure 4 shows an array of curves that illustrates for which activity and category of restriction the Zimmer frame provides a benefit. Initially, the spots in the diagram describe the potential of the support for this activity. A specific benefit for a specific user group is related, if these spots are converted in characteristics of the product.

Besides the different activities for one product, different products for one activity can be compared by means of the CSD as well. That means a product comparison is possible.

4.2 Interpretation and conclusions for development

One of the essential statements that can be derived from the CSD at once is the classification of the product properties in one of the quadrants of the CSD. Figure 5 exemplarily shows how this classification is interpreted. The classification provides statements regarding the generally benefit, there are hints where the focus in the development should be or rather which functionalities have to be considered in order to increase the benefit.

Each classification of the potential of support above the axis of abscissae promises a benefit to the user. Each classification beneath disturbs or hinders the user and has hence to be questioned regarding the product functionality critically. The properties or rather functionalities that are meant to support the examined activities have to be questioned. In the use of the Zimmer frame, for example the users feel disturbed by kerb stone edges and to overcome this barrier is very uncomfortable. Possibilities are e.g. to search for better solutions to support those activities or to adjust the basic concept of the product more to the activities.

A classification left of the ordinate characterises a product that supports the user with specific restrictions. The classification on the right hand side of the ordinate reveals a special product as well, but a performance above average is needed to benefit from this product. In both cases the benefit has to be concretised by a pointed description of functions or the definition of parameters for this function.

This requires methods of efficiency-adapted product design. Simultaneously conclusions can be drawn how to broaden the target group easily by using the principles of universal design.

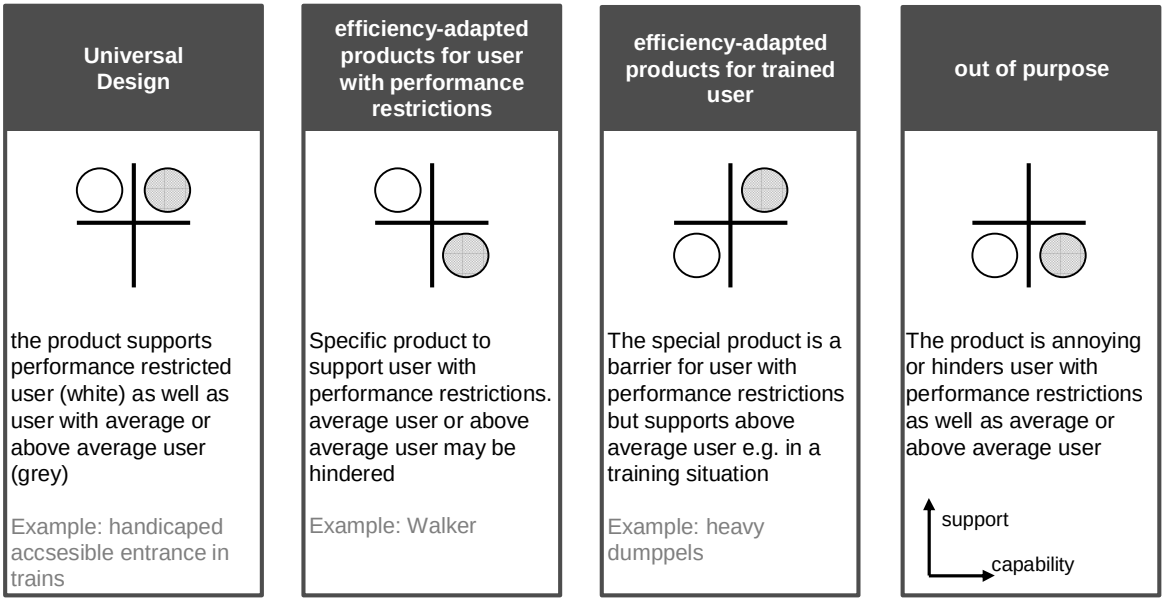

Figure 5: Interpretation of the classification of products in CSD

One of the advantages of the CSD is the possibility to visualise both, different products and different users. Big differences in the judgement of the potential of support for users that seem alike are a hint, that the benefit is more influenced by social or psychological factors than by capability. In the CSD the user is initially judged by his capability. As aforementioned the using behaviour is influenced by the social and psychological factors, which are reflected in the life- and action situation, as well. These "week" factors eventually lead to different user profiles, which share the same capability but conditions of the surroundings are different. These can be drawn as an array of curves in the CSD, which improves the understanding of the impact of the life situation on the use of the product. Is the Zimmer frame refused by one group, but accepted by another group with similar performance restrictions, the cause may lay in the social and psychological factors that characterise this group. Reasons might be stigmatization – one doesn't want to be considered as old – or financial problems. This knowledge helps to adapt product functionality and, furthermore, needs will be addressed better by generating product families.

5 SUMMARY AND OUTLOOK

With the CSD a method for evaluation is provided that helps to visualise and analyse products regarding their benefit for users with different capabilities and even multiple performance restrictions. Initially, only capabilities in the context of the support the product provides are represented. By drawing different curves for one capability-profile, it is possible to include the crucial precision to include the life and action situation. Hence a holistic judgement of the support potential of products is possible. A precondition for drawing the CSD is that users judge the products. Therefore the known methods of questioning or user tests will be applied. The structure of capability and support potential has to be considered in the preparation of the user questioning.

The presentation of the product is not function oriented and hence not from the engineer's point of view. It is focused on the support potential for specific actions. In this way the representation and even the collection of data is carried out from the users' point of view. The challenge of transforming the actions that have to be supported into product functions still remains. The task for the designers is to cooperate with experts from different subjects to fulfil the task of transformation.

To prove applicability and benefit of this method by using examples and to improve it, based on the experience, is part of further research. In addition to that, practical extensions are required, which can adapt the very generic approach to specific product groups and use scenarios.

The CSD is not only valuable for a better fitting of product functionalities and hence an improvement of the benefit of products and product ideas. It is also suitable to derive approaches for modularization of products and the design of product families.

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Contact:
Prof. Dr.-Ing. K. Paetzold
University of the Bundeswehr Munich
Institute of Technical Product Development
Werner-Heisenberg-Weg 39
85577 Neubiberg
Tel.: +49 89 6004-2814
Fax: +49 89 6004-2815
Email: kristin.paetzold@unibw.de
www.unibw.de/lrt3