IMMERSIVE PRODUCT IMPROVEMENT IPI – FIRST EMPIRICAL RESULTS OF A NEW METHOD

Rafael Kirschner[1], Andreas Kain[1], Alexander Lang[2], Udo Lindemann[1]
[1] Institute of Product Development, Technische Universität München
[2] iman solutions GmbH, Munich

ABSTRACT
Despite the widely accepted and proven benefits of open innovation methods, companies apply them infrequently in their own product development processes. In order to find reasons for this apparently contradiction, we conducted 34 interviews with project directors and a literature study. Thus, we identified ten common obstacles for customer integration. On this basis, we derived a new open innovation method to get over these hurdles. The core idea of the presented crowd sourcing method is a product picture based access to a comment management database by the product user. To illuminate the method, we present an implementation together with its internal data structure for a better understanding. This tool is then validated in an experiment with n=48 users. The results indicate that the picture based approach of the method generates valuable results that can contribute to product development.

Keywords: open innovation; customer integration; product improvement; design method

1 INTRODUCTION
Which are the key factors that affect customer integration in product development, i.e. what factors decide whether external sources contribute to a certain product development project? This is one of the key questions of the research project AKINET – the German acronym for active customer integration in innovation networks. During the time period from 2008 to 2009, we conducted 34 interviews [9] with innovation managers and project directors of different German manufacturing companies in order to identify these key factors. As one result, we found that the majority of the projects took place in absence of external knowledge origins, be it from customers, users or other stakeholders[1], even though most of the managers and directors knew various open innovation methods including their positive effects proven in literature [13]. For this voluntary relinquishment of knowledge and experience, that finally would have the potential to improve the commercial product success, we found different reasons both in literature [8] and the interviews. Some of the managers believed that in their specific cases market research information would substitute open innovation methods. In other cases, the results of past market research activities turned out to be wrong or worthless for the product designers, and, in consequence, these managers rejected external market intelligence for future projects. In addition to these reasons, some of the interviewees claimed that their teams already consisted of the experts in the relevant fields and therefore nobody else could know better about need and especially solution information than they could.
However, most interviewees accepted and understood the need and the benefits of open innovation methods, but combinations of very concrete obstacles restricted their application. They were uncertain about how to…

1. … prevent information loss to competition. [6], [12]
2. … overcome internal resistance in the company (Not Invented Here Syndrome). [17]
3. … structure and distribute the data from external sources without hindering the existing process.
4. … synchronize open innovation activities with (moving) internal project milestones.
5. … identify the „right“ customers to ask. [7]
6. … avoid dependency on customers. [12]
7. … approach customers without disturbing or even annoying them.

[1] For reasons of readability, we will use the term *customer* in the following for all external knowledge carriers. A detailed categorization is given in [12].

8. … motivate customers to participate in product development projects. [14]
9. … design open innovation activities that not only collect ideas but induce the evolution of ideas.
10. … give appropriate feedback to customers in order to generate a bidirectional information flow.

One aim of the research project was the improvement of companies' capabilities to integrate external knowledge into their product development processes by getting over these identified obstacles. The open innovation method presented in this paper copes with all of them and might therefore be an adequate way to promote open innovation benefits in a wide range of companies. It consists of a crowd sourcing approach, i.e. it relies on outsourcing design or creativity tasks (that are traditionally performed by an employee) to a semi-defined group of people through an open call. The core idea of the method consists in a visual representation of the product to improve that can be accessed by such a group in order to post intuitively comments or to collect explicit and implicit requirements on particular product details. On this visual basis, the participants' product use experiences merge with the market intelligence on this very product, thus we denominate the method in the following Immersive Product Improvement (IPI). Different data structuring techniques ensure the practical usability within the product manufacturer's development process.

This contribution focuses on the fundamental questions of the method and, by this, on its general capability to support the generation of market fitting products: Does the picture based approach to customer integration generate better results than conventional approaches, e.g. by text based surveys?

In the next chapter we will first describe the systematic derivation of the method; its validation will be subject of the following chapters.

2 METHODICAL INTEGRATION OF KNOWLEDGE INTO NEW PRODUCT DEVELOPMENT

When it comes to the task of improving products in a new product development process, designers and developers are usually confronted to ill-defined und ill-structured problems [5] with frequently unclear initial conditions and a multitude of possible solutions [13]. The single tasks typically consist in (a) collecting and interpreting existing data emerged from previous products, complaint management, market research activities etc., (b) deriving requirements and needs as goals for the new product to develop, (c) generating various partial solutions that fit these needs, (d) assessing and weighting these solutions, (e) selecting a consistent set of partial solutions and finally (f) detailing the final solution. Each of these tasks requires different knowledge and information, which leads to the existing large number of methods that support the transfer of knowledge in new product development processes. Both internal (from the view of the manufacturing company) and external knowledge is necessary for successful product development.

2.1 Integrating internal knowledge and experience

Even in traditional, „closed“ product development there is a strong need for knowledge transfer between the involved players – disregarding the extreme case of a completely isolated product designer. Various publications give comprehensive views on established and new methods that support this knowledge transfer in product development situations (e.g. [3]).

One exemplary method that supports the design team especially when it comes to the generation of various partial solutions (see step (c) above) is the so called Method 635 or 6-3-5 Brainwriting [1]. Based on the concept of Brainstorming, the aim of this method is to generate a lot of new ideas in a restricted period of time. In a similar way to brainstorming, it is not the quality of ideas that matters but the quantity. The technique involves six participants who sit in a group and are supervised by a moderator. Each participant thinks up three ideas every five minutes and sketches them on a special form. After five minutes, participants pass the form to the neighbor sitting next right to them. Participants are encouraged to draw on others' ideas for inspiration, thus stimulating the creative process. After six rounds in 30 minutes the group has thought up a total of 108 ideas.

The moderator gives the first stimulus in this method, which can be a verbal explanation of the design problem, a visual representation, a short written problem description or even a physical model of a similar product. The following stimuli (after five, ten, etc. minutes) are limited to visual and written inputs from the neighbors. Due to the restrictive method structure, a maximum of six knowledge carriers can be integrated into the creativity process, even though some method variations raise this number to eight or even ten. The effectiveness of the method is proven in numerous industrial applications and widely spread in product development departments. The most important features of this method are:

1. It generates a multitude of solution ideas.
2. Stimulation and influencing effects between participants lead to progressive idea development.
3. It inhibits frictions and conflicts between the participants, thus the dominance of single participants can be prevented.
4. Due to the nonverbal communication, undesirable negative and destructive critique can also be prevented.

As these strengths fit common requirements of companies for idea generation, the method seems to be qualified – after major modifications – to integrate not only six internal knowledge carriers into product development but also external sources.

2.2 Integrating external knowledge and experience

First of all we have to answer the question, why at all external sources should participate at a company's product development process – eventually they add value to the product which in some cases they even pay for after their own integration. Various studies answered this question [14] by identifying motivation factors. These can be separated to internal factors, e.g. intrinsic motivation, altruism, identification with the task, positive mental states (the so called flow) and external factors, e.g. financial compensation, positive reputation or the personal need of an improved product.
Especially one type of external knowledge can be obtained in most companies with minor efforts: ordinary product complaints [11]. It's in the nature of this product feedback that negative user experiences lead to this data. However, even negative experiences are strong motivational factors for users to transmit their complaints to the manufacturing company.
The other types of external knowledge are subject to the fast growing and heterogeneous research field of open innovation [10], customer integration [4], mass customization [8] and lead user [7] approaches. These studies reveal the positive effects of integrating external knowledge in a company's product development process; they suggest different methods and tools for various industries, process phases, product criteria, degrees of confidence etc.
Meanwhile, even negative side effects of customer integration in some cases are subject of studies [12]. The following figure 1 gives a rough overview on some common customer integration methods and their position in an expertise-stakeholder-portfolio.

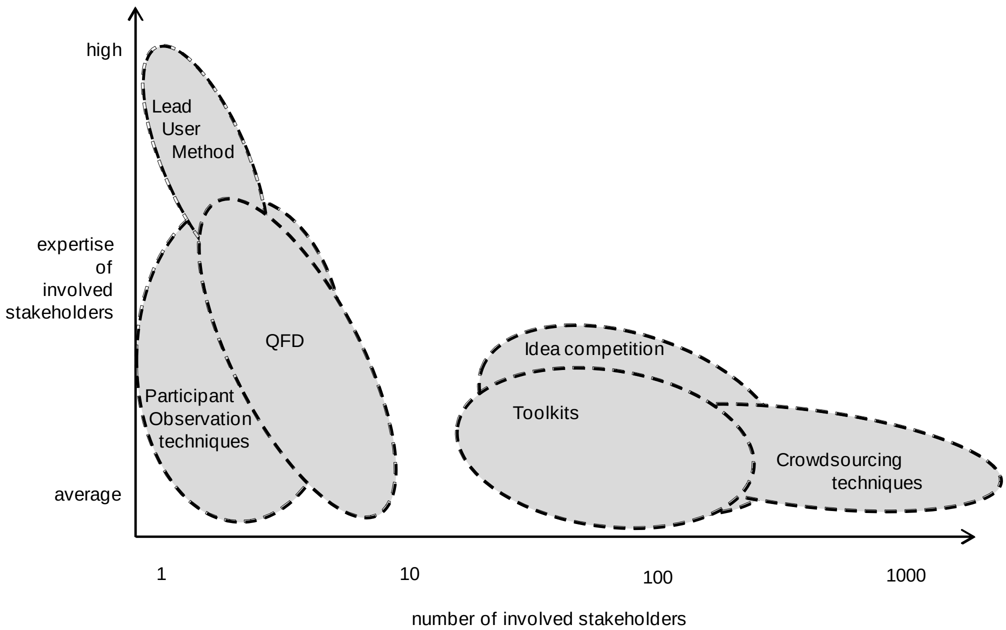

Figure 1: Estimation of some method's necessary expertise and number of involved stakeholders [9]

2.3 Creativity and idea fixation in knowledge transfer processes

One important aspect of creativity based methods is the balancing act between given narrow boundaries and complete independency for the participants. The first extreme allows systematic step-by-step improvements on given ideas with the risk of idea fixation. On the other hand, the second extreme of complete freedom prevents idea fixation for the price of possibly erratic results. According to [2], distinct external encoded sources of information influence designers' creative process during idea generation, but fixation has not been empirically proven as a predominantly negative or positive influence. [2] demonstrated with an experimental setup the occurrence of design fixation when pictorial representations of problems were given, whereas written representations of the same object prevented design fixation.

Thus, it seems reasonable to configure new creativity methods in such way, that they constrain possibilities only where necessary (e.g. in order to ensure result quality) and give freedom where possible (e.g. in order to receive completely new ideas).

3 A NEW METHOD FOR INTEGRATION: IMMERSIVE PRODUCT IMPROVEMENT IPI

The above given research project goals, customer integration obstacles, knowledge transfer approaches and idea fixation risks made it necessary to develop a new customer integration method to get over the hurdles. As we already mentioned in the introduction, this new method bases on a crowd sourcing approach. Our validation experiment was conducted with a software implementation of this method. This implementation allows all participants to examine online different views of a certain product, i.e. pictures of this product from different perspectives. When the participant wants to comment, improve, criticize, or praise a certain functional part of the product, he just has to click on the corresponding area in one of the product pictures. A short dialog box then appears to cluster this comment and to guide him during the commenting process. We call all comments that refer to a single functional part a *thread* in the known sense of email or forum applications.

Before we present the experimental setup and its results, we will give short justifications for the properties of the method IPI in the following.

3.1 Progressive idea development vs. idea fixation

The concept of the 6-3-5 Brainwriting Method serves perfectly for our purposes, as on the one hand a variety of different ideas arises, and on the other hand the most promising ideas can be incrementally optimized by all participants. Nevertheless, idea fixation in a certain extent cannot be prevented, thus every participant has to have the possibility to initialize new threads before he sees and is influenced by the existing ones. As only the first stimulus in IPI is picture based and the following stimuli concerning the concrete ideas are text based, we estimate the danger of idea fixation as relatively low. On the contrary, we hope to provoke even more comments by stimulating with a picture, as every participant connects different individual experiences with the product that will be brought to his mind much better by a picture than by a textual stimulus. Our experimental study will give answer to this hypothesis.

3.2 Motivation for participation

Our method addresses a wide range of different motivational factors, from reputational factors within the product community over personal benefits by an improved follow-up product up to possible monetary incentives. Besides these, without any doubt the strongest motivation will be the negative emotion or even the user frustration that usually leads to complaints to the company (in the good cases) or to calls for boycott (in the bad cases, e.g. via product rating platforms in the internet). The method is one of the few that allows real "active customer" integration in the sense that not the company takes the initiative of integration but the customer himself proactively pushes his improvement comments to the company. This might also increase motivation for participants.

3.3 Facing common open innovation obstacles

All identified open innovation obstacles (as presented in the introduction) seem to be surmountable with the method IPI – at least to a large extent.

1. *Fear of information loss*

   As all data available in the online tool originates from external sources (except the product pictures), information losses of sensitive data to competitors cannot occur. Furthermore, even the systematic collection of the available data by competitors can be hampered by established digital means such as data traffic restrictions.

2. *Not Invented Here syndrome*
The method can be implemented in such way, that only the responsible product part designer has access to the data oh “his” part. This could reduce the negative effects of the Not Invented Here syndrome, as the designer has the possibility to assess the ideas and publish the elaborated or successful ones under his own name, raising his identification with the idea to a maximum.
3. *Data structure*
Through the method IPI, all data is fractionized into small portions that can be clustered by different criteria, e.g. the affected product part, the date of the comment, the activity in threads etc.
4. *Synchronization with milestones*
The easiest way to implement the method IPI is through an online tool. In this case, the cumulative database can also be used in terms of an idea management system. Thus, it gets independent of project milestones, as it can be consulted whenever the company needs external input.
5. *The „right“ customer*
IPI follows an approach that differs from the majority of other customer integration methods that intent to identify the “right” customers of a given population via elaborated approaches. IPI enables every product user to participate the product development process, whenever he wants. We assume that through this way, the “right” customers uncover themselves voluntarily.
6. *Dependency of customers*
All comments can be seen as mere suggestions, i.e. the company or the particular designer has all freedom to reject them.
7. *Disturbing customers*
When a company offers to participate in their product development process, for example by putting a note on the product itself, it demonstrates its esteem for the customer. Nevertheless, the customer can ignore the note and won’t be molested by further contacts.
8. *Motivation of customers:* cf. to chapter 2.4.2 for this topic
9. *Evolution of ideas*: cf. to chapter 2.4.1 for this topic
10. *Feedback to customers*
Giving direct feedback to the customer is easy through an online implementation of IPI. The designer just has to answer to specific comments, thus he gets the possibility to initiate a dialogue with promising customers in order to improve even more the results.

This compilation of surmountable open innovation obstacles leads us to the assumption, that IPI could really improve customer integration in product development. As a next step, we implemented the method in an easy online tool to proof this.

4 METHOD IMPLEMENTATION

4.1 Data structure

In order to define a suitable data structure, we implemented a first and very basic version of IPI for an Apple iPad. We then presented this version on the worldwide largest industrial fair (Hannover Messe in Germany) in April 2010 and collected user feedback and ideas for further development. This version accumulated all comments given in a spreadsheet, enriched only by a time stamp of its posting. The resulting data chaos encouraged us to implement a hierarchical data structure without reducing the ease of use.

Figure 2 depicts the elements of our improved implementation.

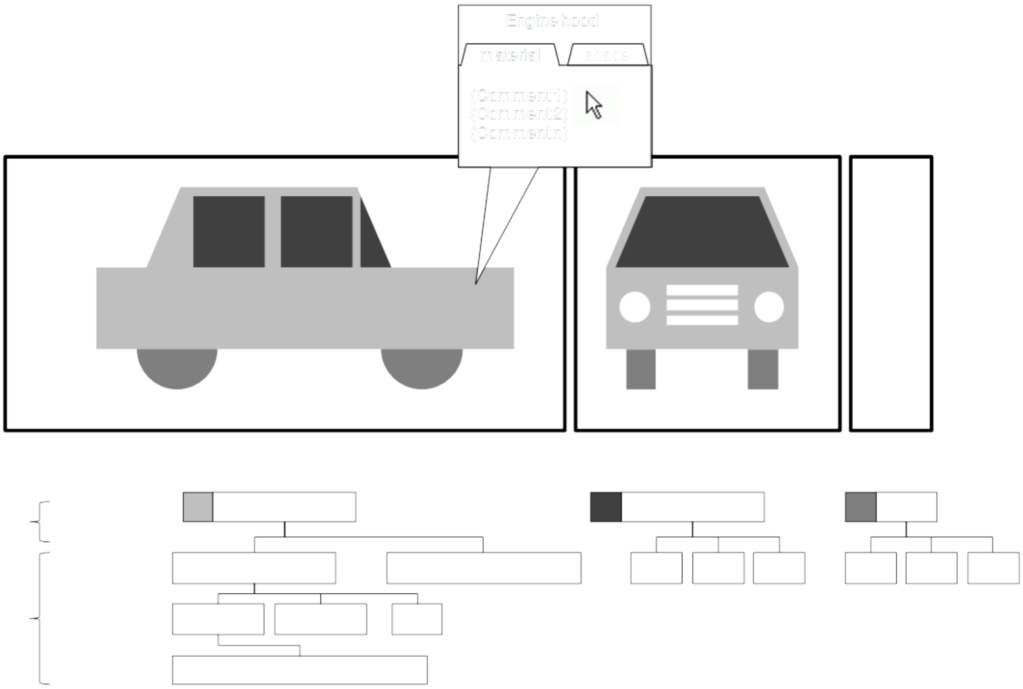

Figure 2: Data structure of our implementation of the IPI method

We first defined “sections” as an internal basis to prevent comments that refer on the same object but are given e.g. in distinct views of the product or with different spelling of the object. Thus, every section contains now only unambiguous objects. So, in the example of figure 2, when the user clicks in the light grey area of the car (defined as section “car body”), a dialog window appears and suggests all existing objects within this section together with the possibility to create a new object. The objects themselves are subdivided into a variable number of categories, each of them including all comments concerning one specific property of the object. Of course, various comments can be given on certain property, forming then a thread.

4.2 Research question emerging from data structure

Apart from an overall evaluation of this second version of IPI implementation, one specific research question triggered the experiment. After having implemented the hierarchical data structure, the question emerged, whether a picture based approach really leads to better results than a structured list based approach – which became possible by the hierarchy. As a follow-up question, we had to define our understanding of the term “better result”, one of the recurrent questions in the whole field of creativity research. For not ending up diversionary questions, we decided to define the “better” in a very pragmatic way, knowing well the danger of misinterpretations: In the limited context of this study we declare these comments as better that provoke more active and passive traffic, i.e. more reading and commenting activities. This simplification finally bases on the so called wisdom of crowds theory [16]. This leads us to the final

Research question: *Does the picture based approach to comment a product generate better comments than a structured list based approach?*

5 EXPERIMENTAL SETUP

Having already implemented the IPI method and defined the research question, we were able to set up the experiment with relatively low efforts. We decided to select a well known and widely spread product for our study: the office telephone *Siemens optiset E standard*. It was important that all participants of the study had more or less the same sound experience with the product to prevent bias effects.

We invited a total of 48 persons to the study, all of them graduated engineers, computer scientist or with an equivalent formation. They were all working in office environments with the Siemens telephone. After having introduced the participants in a short oral presentation to the background of the study and its boundary conditions, they had exactly seven days to access the system whenever and how often they wanted both from their own office or private computers. Every participant received an individual login password, and all their activities within the tool were logged for later analysis. As an additional incentive, we promised a small incentive for the most active participant. After the seven day experiment, we made a cut and isolated the collected data, but we kept the tool online for further research purposes.

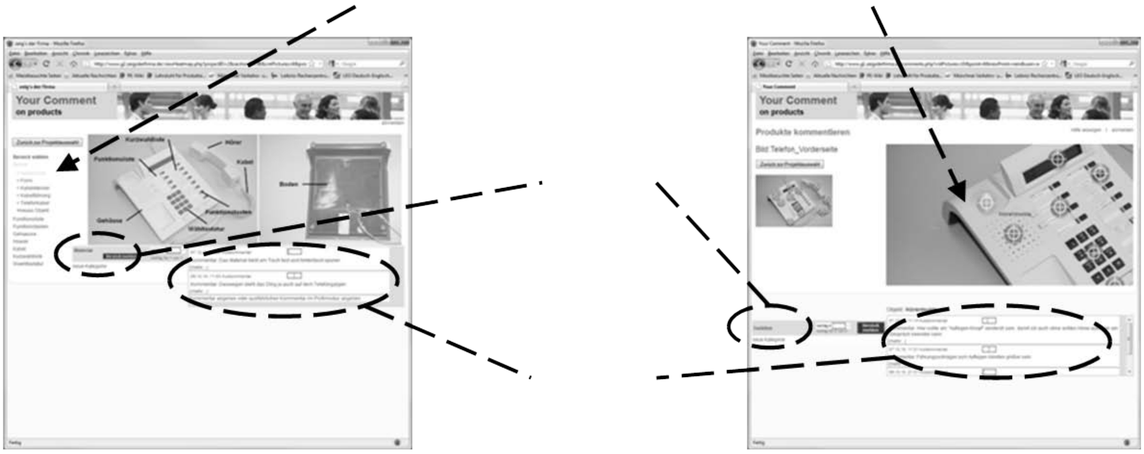

Figure 3: Two variants of the tool: list vs. picture based access to objects and comments

With the arbitrary distribution of the 48 passwords, we divided the group into two subgroups, the participants didn't know of this division. One group of 24 got access to the picture based tool variant, the other 24 got access to the list based approach. Figure 3 shows the most important elements and differences of the two versions.

6 QUANTITATIVE RESULTS

The most obvious difference between the two groups is the traffic. We logged nearly 50% more page views in the picture group in comparison to the list group. The log-in time per visit also differed, but with some 20% in a slighter extent.

	list based group	*picture based group*
page views	1056	1492
mean page visit time	48 seconds	59 seconds
# of objects	18	20
# of threads	23	33
# of comments	33	55

Table 1: Quantitative results of list vs. picture based access (n=48)

Surprisingly, the total number of created objects in both groups is approximately the same, whereas the number of threads on these objects reflects again the around 50%-increase of the page views. When going into detail of the threads (figure 4), we discover both a significant higher number of short 1-comment-threads and two particular long threads in the picture based group. The list based group outperforms in not a single length of threads.

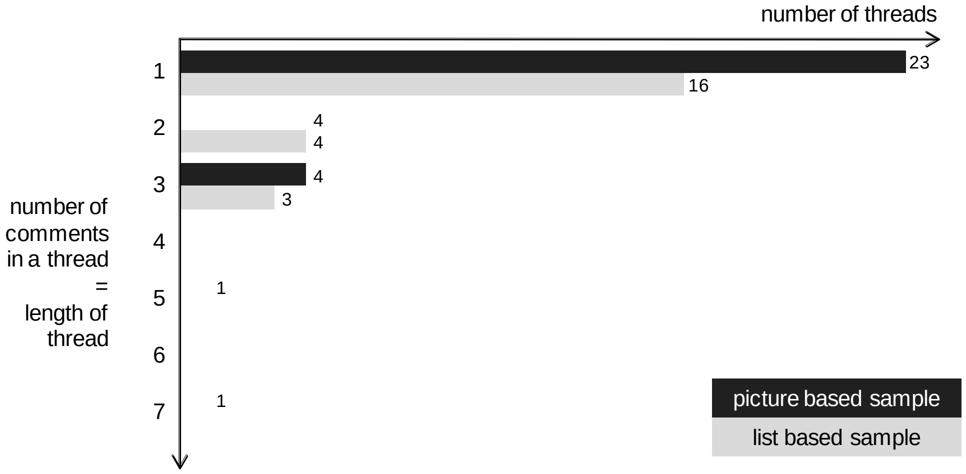

Figure 4: Length distribution of threads in both groups

Apart from this quantitative view on the results, the quality of comments plays of course an important role for the IPI method application. We won't go into detail in this contribution, as we already can answer the research question with the quantitative data. Nevertheless, the quantitative analysis will be subject of further publications [18].

7 INTERPRETATION AND CONCLUSIONS

7.1 Result interpretation and a tentative explanation

As a first result, we can approve the research question. Both the active (comments) and passive (page views) traffic indicate an approximate increase of 50% when changing from the list to the picture based approach. With this, we claim that the picture based approach produces the better results – always under the assumption that quantity correlates to quality of results.

As for the relatively constant number of objects we assume that every product has a certain value of saturation when all objects of the product are already labeled and commented. For the Siemens phone, this number seems to be around 20. The increased number of threads in the picture based sample indicates a broader variety of the results. Furthermore, the traffic decreased sharply after the first day of the experiment, between days six and seven there was only marginal traffic – this fact supports our assumption of saturation.

Although we could answer the research question, we are still interested in the reasons behind the effects. At this point, we can only make tentative assumptions without any scientific rigor. We assume, that the mere additional cognitive effort that is necessary to connect the words in the list with the mental picture of a object is the decisive factor that causes the clear difference between the groups.

7.2 Implications for customer integration and method application

The method IPI generates with relatively low efforts a multitude of real time comments that can be accessed by product designers in a easy way. Thus, the method seems to be beneficial for the development of mechanical products in order to support the systematic improvement process. The results of our experiment also revealed that the method reaches its borders when it comes to intangible product characteristics, e.g. utilization processes or software structures. Besides the methods contribution to product development, we assume a positive effect on the company, as the customer feels appreciated when getting the possibility to participate in product development.

7.3 Further research and outlook:

The next step with the here presented implementation of the method IPI will be a qualitative analysis of the collected comments. We will use different assessment criteria, e.g. the probability of technical realization, the estimated cost of product change, the degree of abstraction, or the degree of innovativeness. Another possible research topic could be the question whether the method allows the identification of special participants with Lead User characteristics according to [7]. These Lead Users then could support the product designers in workshops to generate not only incremental but radical innovation. Finally, we hope to improve different features of the tool itself, e.g. an automatic product recognition via QR-Code or image recognition on smartphone applications.

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Since 2006, **Rafael Kirschner** is Research Associate at the Institute of Product Development in the Department of Mechanical Engineering at the Technische Universität München. He is interested and researches in many aspects of Customer Integration, Open Innovation, Lead User methods and similar approaches with the focus on their industrial application.

Andreas Kain graduated as mechanical engineer at the Technische Universität München in 2007. He now works as a Research Associate at the Institute of Product Development at the Technische Universität München, Germany. His scientific work focuses on methodical support of customer integration in new product development and systematic approaches towards describing product application.

Alexander Lang is consultant and supports industry in open innovation projects. In this field, he attended a wide range of projects beginning from automotive industry to medical engineering.

Udo Lindemann is a full professor at the Technische Universität München, Germany, and has been the head of the Institute of Product Development since 1995, having published several books and

papers on engineering design. He is committed in multiple institutions, among others as Vice President of the Design Society and as an active member of the German Academy of Science and Engineering.

Contact:
Rafael Kirschner
Technische Universität München
Lehrstuhl für Produktentwicklung
85748 Garching
Germany
Tel.: +49 89 289-15155
Fax: +49 89 289-15144
Email: rafael.kirschner@pe.mw.tum.de
URL: www.pe.mw.tum.de