

## **AN APPROACH TO DISCOVER INNOVATION POTENTIAL BY MEANS OF DELTA APPLICATIONS**

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*“As long as everyone uses your products or services exactly how you think they will you will probably be fine. However, if you watch the early adopters of your new products or services you can sometimes obtain clues about what people will do in the future.”*

Tom Kelley, General Manager of IDEO [ideaCONNECTION 2009]

### **1. Introduction**

Customers can significantly contribute to new product development (NPD) in a vital way due to their specific knowledge and experience. Bringing together the customer and the company provides the basis for a fruitful exchange. The research contribution in this paper is the concept of *delta applications*, which describe out of the ordinary product applications differing from original equipment manufacturer's (OEM) point of view. A methodical procedure allows for systematic identification of delta applications with use of assurances [Maier, et al. 2009]. The procedure aims at discovering innovation potential for new products by integrating the customer in NPD, resulting in the evolution of existing products, and leads to product expansion in new markets.

#### **1.1 Lead User vs. Mass Customization**

Several disciplines focus on the user or special types of users to enrich the design process by their particular experiences and knowledge. Thomke and von Hippel describe two major kinds of knowledge, when reasoning about relations between company and customer: (1) need information and (2) solution information [Thomke and von Hippel 2002]. Basically, need information describes “what the customer wants”, whereas solution information represents “how to satisfy those needs”. The drawback is a lack of skills that accompanies these kinds of knowledge. The major challenge for the companies is to pose the proper questions to the customer to make use of their own specific solution knowledge. The challenge for customers is in communicating their implicit needs summarized in need information. That's where for example marketing research tackles the challenging relation between company and customer selectively.

Two main approaches span the field for integrating customers in NPD: either at the beginning, such as Lead User theory, or late in the process, such as with mass customization. The product definition increases towards the end of the product development process along with a decreased potential to incorporate the needs of the customers and the ability to affect costs (see Figure 1).

Integration of Lead Users supports targeting NPD to needs which can occur, but not always do occur in the mass market. The mass customization approach aims on defining the product as much as

possible in NPD, but to enable the customer to create a unique product by taking decisions at the very last moment. Mass customization focuses on providing a solution space for customizing to the customers. Toolkits guide the customers to choose a solution in mass customization by limiting this solution space. Toolkits also have been developed to support and stimulate Lead Users in early stages in NPD.

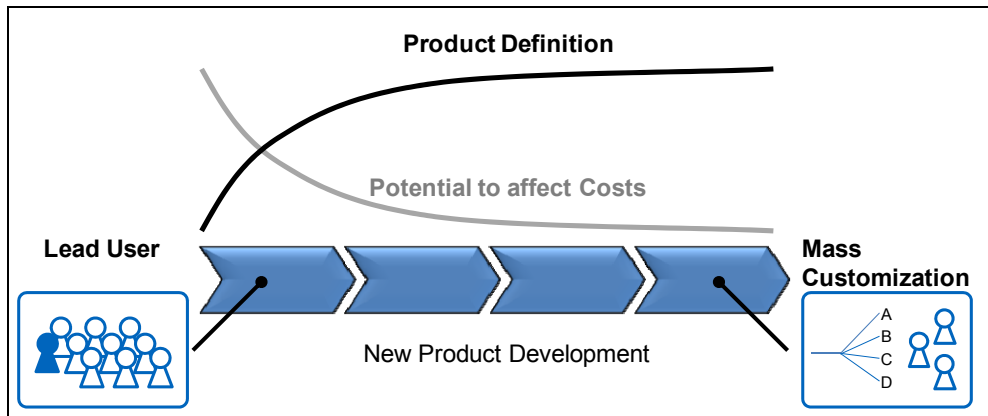


Figure 1. Product Definition in NPD, based on [Ehrlenspiel, et al. 2007]

## 1.2 Adoption of a new product

The adoption of a new product or innovation was firstly described by [Rogers 1962]. Figure 2 illustrates successive groups of consumers, that adopt an innovation or product until the market share reaches saturation. Over time the rate of adoption increases to a maximum and after that decreases again due to that the majority of customers already adopted the product.

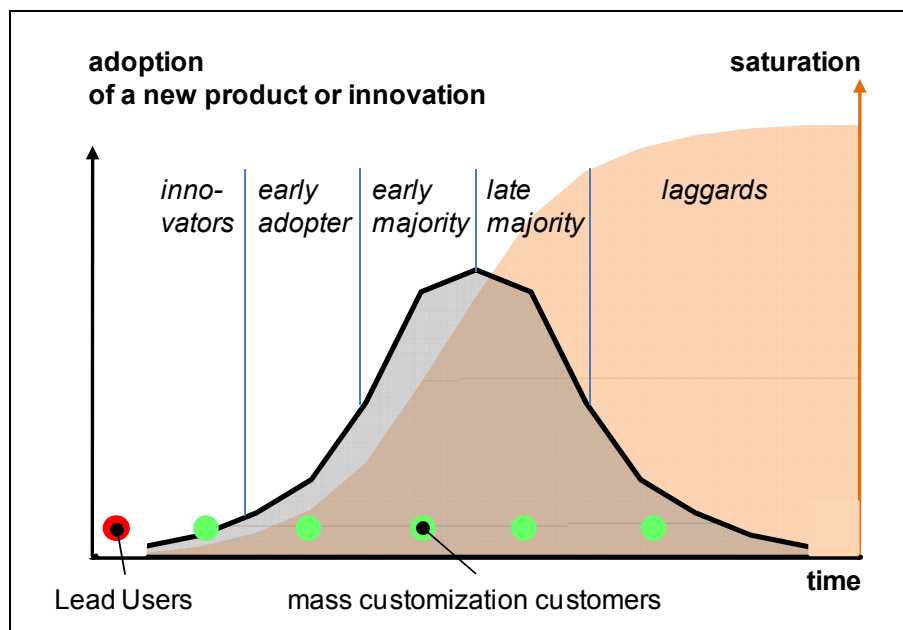


Figure 2. Diffusion of Innovation, based on [Rogers 1962]

When locating Lead Users in this graph, they emerge in the earliest phases; mass customization also reaches first customers in the early phases but additionally all follow on customers as well. This illustrates that the mass customization approach targets a larger group than the Lead User approach, despite the different qualities in needs and abilities of these groups. Lead Users anticipate market needs and possess the abilities to fulfill them on their own, whereas mass customization customers already represent the needs of a mass market.

### **1.3 Customer Integration in industrial small and middle enterprises**

Although several approaches exist to integrate the customer in NPD, industrial small and middle sized enterprises (SME) do not apply these methods comprehensively as revealed by the authors in 34 interviews carried out in Germany. Some of the mentioned reasons already have been reported in literature: difficulties concerning intellectual property rights, the “not invented here syndrome”, identification of the proper customers and lack of resources to name the most popular reasons. Some development departments consider themselves to be the “best customer” for their own products, or assessed that their customers do not know anything about the products they create. This implies that the idea of customer integration has not yet been completely adopted by industrial SME, despite the ample number of approaches described in academic literature.

### **1.4 Hidden Innovation Potential**

Assuming that some customers also apply products in ways that the company did not expect, these so called *delta applications* provide an added potential for further innovation from the company’s perspective. The product bridges the company and the customer providing a common base for exchange. On the one hand the company shapes the product; on the other hand the customer applies the product to fulfill a specific need and becomes experienced in its use. Within this research the authors address the question how classifying several product applications of a specific product provides information to the early phases of product development.

Therefore, the authors propose that the product itself is a means to pool the company and the customer directly to (1) systematically overcome existing barriers in customer integration and (2) explore need information, experiences and knowledge from the customer. This idea gives an impetus to reason about the product itself or even go beyond into new market applications that satisfy a customers’ need.

### **1.5 Paper structure**

Section 2 provides background information and details the Lead User theory, User-Centered Design, Product Affordance, and explains the understanding of an Extended Application Process. Section 3 presents the approach of delta applications to unhide potentials for innovation. Section 4 illustrates the suggested method by presenting several products and some of the applications possible. Section 5 discusses the case study and section 6 concludes the paper and outlooks future work.

## **2. Background**

Literature describes several approaches that directly involve either the user or a specific group of users in NPD. This section provides a short overview of Lead User theory, User-centered Design, Product Affordance, and the term Extended Application Process.

### **2.1 Lead User theory**

When considering the adoption of new products over time as mentioned above, Lead Users as defined by [von Hippel 1988] distinguish themselves by (1) perceiving needs before the mass market, and (2) expect a high benefit by fulfilling their needs. Additionally, Lead Users are (3) able to transform their needs into solutions by their own skills. Lead Users enrich NPD processes significantly by their anticipation of needs and their ability to prototype. A systematic approach supports the identification of Lead Users taking into account requirements and resources of the specific situation. Nevertheless a lot of research focuses on detailing the method in order to ease its use.

### **2.2 User-Centered Design**

Within the domain of design research, [Abramson, et al. 2004] summarize User-Centered Design as comprising design processes in which end-users influence how a design takes shape. Therefore several approaches and methods provide means to engage the users beginning from consultation to collaboration (e.g. background Interviews, questionnaires, sequence of work interviews, focus groups, on-site observation, role play).

### **2.3 Product Affordance**

Maier and Fadel define “*an affordance as a relationship between two subsystems in which a potential behavior can occur that would not be possible with either subsystem in isolation*” [Maier and Fadel 2009]. The concept of functions in design provides a means to deal with complexity within products by a decomposition approach. Maier and Fadel identify fundamental limitations when dealing with open systems, which may be non algorithmic, involve the human explicitly, and embody dynamic and even bidirectional relationships. They push the idea of affordance-based design which stems from psychology. They further emphasize that affordances are form dependent, whereas functions are form independent. Thus affordances describe the product on a precise level of product concretization. Fadel has demonstrated how affordances can be documented using matrix methods and how the satisfaction of affordances propagate hierarchically [Maier, Mocko and Fadel 2009].

### **2.4 Extended Application Process**

Considering the interaction of a product within its environment, the extended application process comprises the appearance and determination of the product application, and process phases beyond product application as discussed in [Kain, et al. 2009]. It contains: (1) the process causing the application, (2) stakeholders including their characteristics, (3) process dependent stakeholder involvement, and (4) additionally technical requirements characterizing the application. The extended application process enables to gather deep understanding of the constraints surrounding the product application.

### **2.5 Need for a new approach**

Section 2 illustrates, that Lead Users can contribute vitally to NPD, but they are hard to identify due to their characteristics. User-Centered Design provides methods to focus NPD to users, additionally product affordances describe and explain user-product relations. Nevertheless a major issue is the identification of the proper customer to be integrated in NPD in a way that the manufacturing company is able to include the customer input to NPD appropriately.

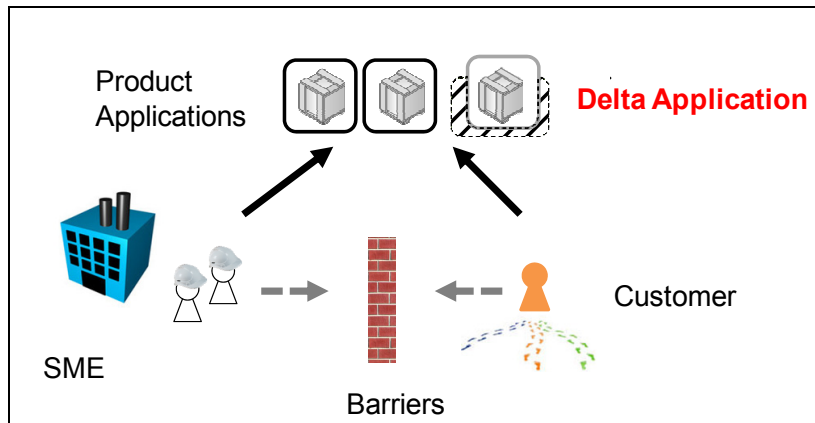
## **3. Systematic Approach**

The authors suggest an approach to overcome the barriers, which constrain the integration of customers in industrial SME. As presented in section 1, the product itself provides a means to pool the company and customer without reservations in product application. The suggested approach discovers potential for innovation by identifying applications that differ from average product application and to analyze these in detail.

### **3.1 Change in Mind-set**

A change of modality is necessary when reasoning about the relation between company and customer to overcome existing barriers. It is not the customer that needs to be integrated into the company anymore, but the product itself is a means to explore product application and thus the customers' needs and experience. Considering the product as an interface between the company – which shapes the product- and the customer – who applies the product and becomes experienced in its use - both meet as equal partners.

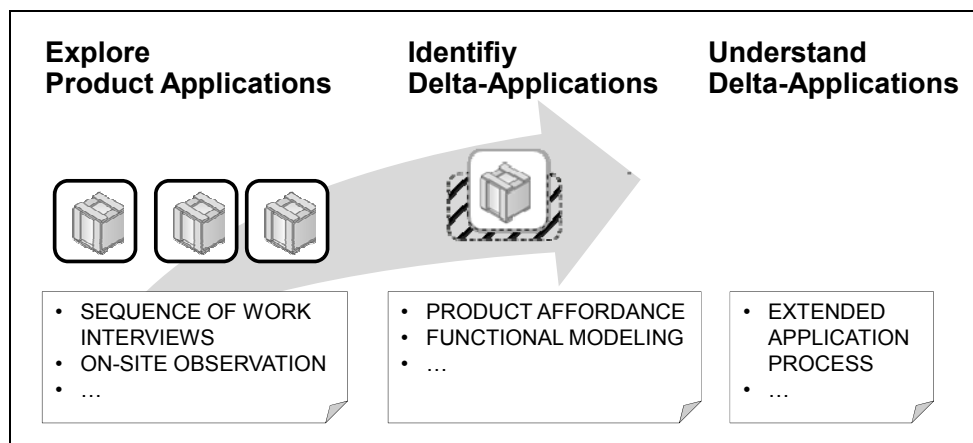
Exchange between the company and the customer becomes reasonable without interfering e.g. intellectual property rights (see Figure 3).



**Figure 3. Product as Interface to pool the company and the customer in product application**

### 3.2 Systematic Procedure

The authors suggest an approach to unhide potential for innovation by identifying product applications that differ from average product applications (see Figure 4). These delta applications represent product use out of the ordinary and give an impetus to reason about the product itself or even beyond. Questioning the reasons causing the delta application finally takes place. Exploring delta applications systematically enriches NPD by representing need information.



**Figure 4. Delta Application Approach**

The suggested approach includes work described in the background section and develops it further to a systematic procedure. Methods, which are already established in user-centered design, support exploring product applications such as the sequence of work interviews or on-site observations. Here the “ordinary” user is the source for collecting differing applications. Product affordances assist to explain the relation between user and product in a specific product application and the extended application process investigates the background of the identified delta applications.

Delta applications have been introduced to discover innovation potential from the company’s point of view based on the customer’s behavior. Engineering documentation already may distinguish between product use cases and product misuse cases. The authors define the term “use case” to represent the companies’ view within NPD, whereas the term “application” takes place at the customer’s end. Product misuse is considered the first hint towards the identification of a delta application. Reasoning about product affordances gives a second hint. Dissatisfied customers may directly complain about products that do not fulfill their needs at the complaint department. Verifying the identified applications with the product affordance model enhances the understanding systematically. Finally exploring the extended application process for a specific delta application fosters a systematic process analysis.

### 3.3 Definition of Delta Application

Affordances and specifications describe the product use case (see Figure 5). Functional modeling on a rather abstract level describes the product itself. The relationship between the product and other products or people emerges on the form dependent level of shape. The affordances comprise user interaction as well as interaction with other products. Technical and organizational aspects specify the background which enables the execution of a task. Technical specifications cover measurable requirements of the application, whereas organizational issues cover e.g. time dependent interactions among other tasks and/ or stakeholders.

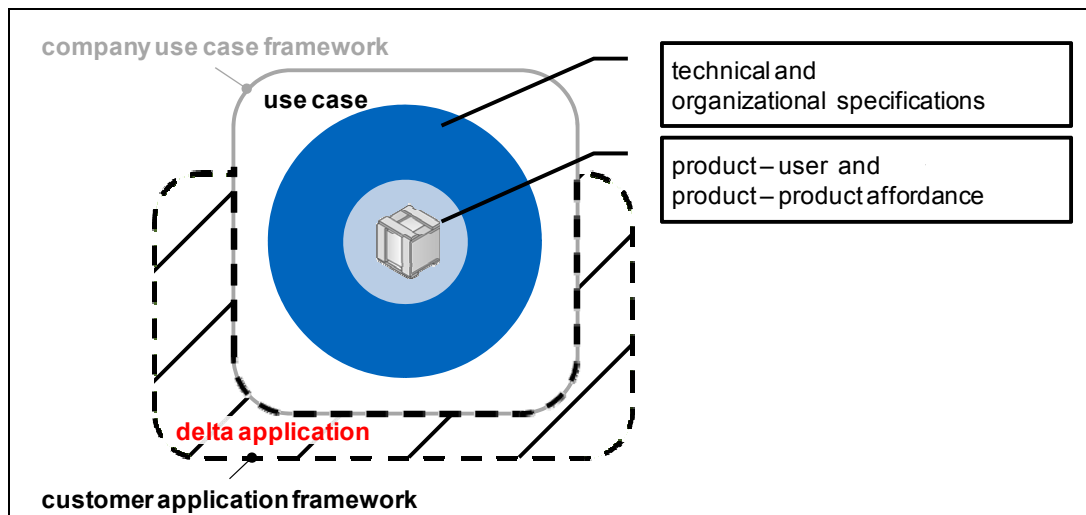


Figure 5. Delta Application can be found at the boundaries of product development

Delta Applications differ in their characteristic attributes from the product use case defined by the company (average product application). Delta applications emerge due to the requirements, experiences, knowledge and skills (either aggregated or missed) of the customer and can be found at the system boundaries of product development.

### 4. Application of the Delta Application Approach

Products mostly fulfill several applications. Becoming aware of differing product applications widens the scope of product use and thus can affect NPD processes. Instead of integrating the customer in NPD the product itself is considered a means to aggregate need information systematically. This section exemplifies the product hair dryer, and some of its applications characterized by types of affordances and specifications.

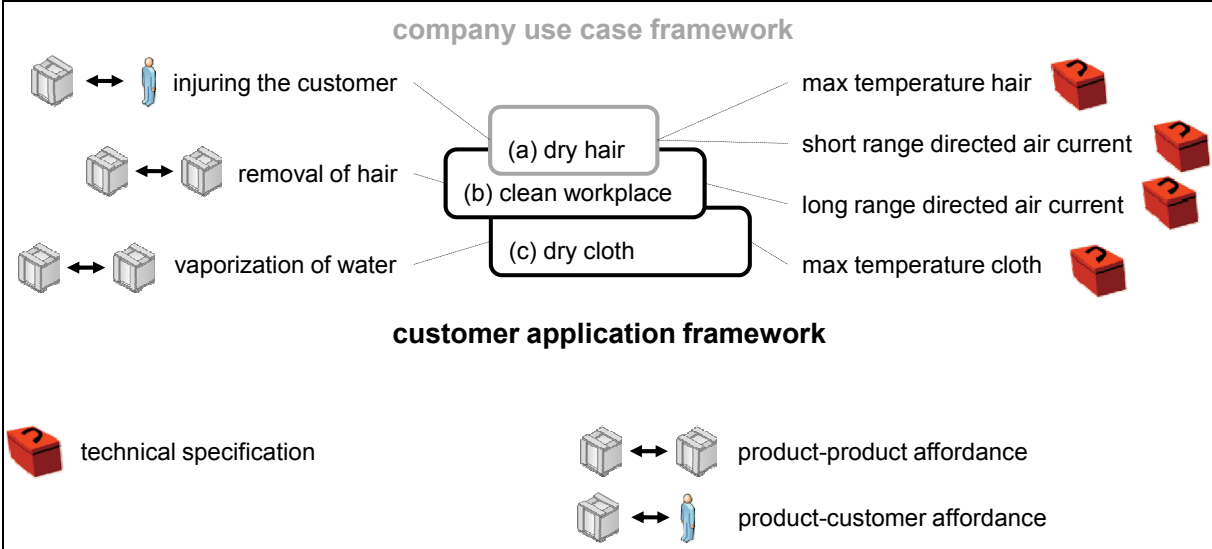
It illustrates the proposed method of identifying differing product applications to enrich the NPD process and overcome barriers in customer integration. (see Figure 6).

Product	Applications	$\Delta$ - Application	Affordances	Specifications
Hair dryer	(a) Assist the hairdresser to dry hair			
	(b) Blow away cut hair to clean the workplace	✓		
	(c) Dry cloth if it got we	✓		
	...			

Figure 6. An example for Delta Applications: hair dryer and its applications

Users apply the hair dryer (a) to dry people’s hair. Some users also apply the hair dryer (b) to blow away cut hair and clean the workplace. It even (c) dries the collar if this got wet when washing hair. The product’s technical capabilities contribute to the application by the user. Application (a) poses an affordance between product and human by treating a human, and technical specifications arise such as the max. temperature not to burn the human. Application (b) comprises the interaction between the hair dryer and the cut hair and demands for technical specifications such as a directed air current. Application (c) describes interaction between the hair dryer and the collar (product-product) and demands for a short range directed air current.

The company use case framework in this example consists of the use case (a) dry hair. Additionally the customer application framework contains (b) clean workplace and (c) dry cloth. Figure 7 depicts specifications and affordances exemplarily.



**Figure 7. A hair dryer and its related applications**

Considering the specifications the applications (a) to (c) differ in the values of the specifications. Drying hair or cloth poses different max. temperatures not to harm hair/people or cloth. This task requires a short range directed air current. When blowing away hair in order to clean the work place, the temperature of the air current is less important than a focus in long range.

**5. Discussion and interpretation**

The customer applies a product in specific applications, which are not necessarily identical to the use case in the company’s use case framework. As demonstrated above, product affordances help to discuss the interplay between user and product within the context provided by an application.

**5.1 Application of the Delta Application Approach**

Considering the product hair dryer the application drying hair seems obviously and designers dimensioned the hair dryer for fulfilling this task. But the second application of blowing away cut hair surely does not represent the main product application. This is considered a delta application due to the fact that a hair dryer is supposed to dry hair (hot and cold air) but not to be a blower for tidying up. One may consult product affordances to explain why hair cutters utilize the hair dryer for cleaning as it works similar to a blower. Key aspects of these applications differ: drying vs. cleaning, which results in technical specifications. Drying the collar poses another different set of specifications due to the short range directed air current, and specific max. air temperature to avoid hurting the human. Abstract functional modeling described the main aspect of several applications. Contrary affordances are form dependent and describe relations among systems. The example of a hair dryer illustrated, that different affordances emerge with different combinations, such as hair, cut hair or the collar. This leads to applications with particular sets of specifications. Thus the user application framework may

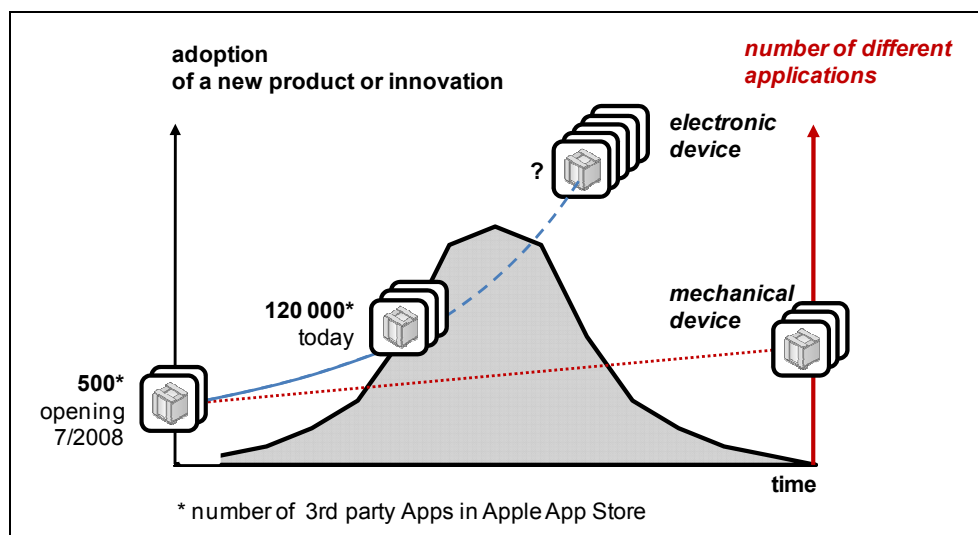
differ from the company use case framework. This difference contains the chance to further develop the existing product in order to fulfill applications, which are required by the user.

These customers may be Lead Users but are not limited to this specific group. A special need may cause the user to apply a product in a special way that does not require special skills to adapt the existing products. Within this need information, the individual customer that anticipates market needs could provide vital input to NPD. In the case of delta applications the product itself provides a starting point for customer integration when considering the adoption cycle of new products.

## 5.2 Emergence of Delta Applications

When considering the curve of adopting a new technology or innovation (depicted in the background section of figure 8), the amount of differing applications equals the number of specific use cases from the company's view at a minimum. This is because in NPD the company focuses at least one use case to a specific product application. Customers may apply the product according to their specific situation, which represents need information. Thus the amount of differing applications will rise relating to the total amount of customers.

However, the amount of product application will not rise enormously like the amount of customers, because this would imply that every new customer applies the product in a different manner.



**Figure 8. Increase of delta applications, based on [Rogers 1962]**

Considering mainly mechanical products the amount of applications may show little increase over time e.g. due to specific trends in lifestyle or to the specific customer situation. The Apple's iPhone is an outstanding example of an electronic device with its applications rising exponentially. Beginning with 500 3<sup>rd</sup> party software apps, the total amount of different applications grew to 120 000 within 18 months [AppShopper 2009]. The iPhone example shows that the market for delta applications can be very lucrative and large in size for software based products. The same principle applies to mechanical devices, however the seamless connection between the company and the user by means of the product must first be established.

## 5.3 Applicability of the approach

On the one hand the big advantage of the suggested approach is that it can be applied nearly independent from the current state of product adoption in the market, because it poses no need to identify a specific group of users. In the other hand, differing applications need to be identified at customers' site, which can be either ensured by customer visits (e.g. sequence of work interviews, on-site observation) or even by web 2.0 communities (digital social networks). In the field of digital consumer goods new possibilities arise to detect product application e.g. due to embedded sensor technologies (multi sensor triangulation) which enable remote monitoring or the internet of goods.



Due to the product based view, different opinions may occur when evaluating product application. Assuming that the company is aware of a specific need the particular product addresses, surprising unexpected applications are considered delta applications. The customer himself applies the product for a specific purpose, and even may not be aware of using the product in an unexpected way from the company's point of view. Thus simply asking the customer, if he fulfills a delta application by the product might not work effectively.

## 6. Conclusion and future work

Customers are able to provide essential input to NPD due to their specific knowledge and experience. Barriers within the company inhibit customer integration to NPD as described in literature and identified by interviews with industrial SME in Germany. This paper contributes to research by suggesting the concept of delta applications, which describe product application by the customer differing from use cases defined by the company during NPD. A systematic procedure integrates customers to discover innovation potential to evolve existing products and claim new markets.

The approach of Delta Applications provides a neutral platform for exchange between customers and the company and overcomes existing barriers (e.g. "not-invented-here-syndrome"). Due to the participation of the company in identifying the delta applications the customer is considered as partner and not as an intruder in the development department. As a result the acceptance of customer integration within the company rises. Delta Applications represent need information by detailing how a customer applies a product and for what specific reasons. The approach presented identifies new innovation potential, supports cross industry innovation and contributes to strategic product planning by structuring information about product application.

The authors continue research and are currently carrying out several case studies to further verify the suggested approach. Weighting and rating the identified delta applications poses a major challenge in order to focus limited resources. The basic idea is to identify criteria which may indicate that a delta application anticipates future market needs.

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