Minimizing Market Risks Through Customer Integration in New Product Development: Learning from Bad Practice

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Customer integration into the innovation process is about to become a best practice. The lead-user approach has proven to be especially valuable when reducing discontinuous innovation's market risk. Since the theory of customer integration still lacks a concept and processes, this article illustrates how companies can be helped from a practice perspective to implement customer integration and maximize market safety. Triggered by the results of an in-depth case study, we adapted Lettl's explorative model of customers' contribution to the new product development (NPD) process, which was originally developed for the medical technology industry, to engineering companies.

Introduction

One of the greatest opportunities for companies wanting to improve their overall innovation capabilities and reduce discontinuous innovations' market risk is to integrate their customers into the innovation process (Cooper, 1980; Kirschmann & Warschburger, 2003; Murphy & Kumar, 1997; Voss, 1985b). The resource dependency theory, relationship marketing and studies on successful new products provide the theoretical and empirical backgrounds that support this assumption (Lüthje & Herstatt, 2004). Customer integration into the NPD process leads to the identification of information on customer needs, disseminates the information throughout the critical functional areas within a company and translates this information into auspicious new products and services (Bruce & Biemans, 1995; Kohli & Jaworski, 1990). Discontinuous innovations pose a greater risk because they also involve more uncertainty in terms of the nature of the product itself, the organization's capacity to effectively and efficiently produce the product, its market acceptance and ultimately, profitability (Deszca, Munro & Noori, 1999).

In terms of forecasting product acceptance and adoption, radical innovation face particular difficulties (Noori et al., 1996). Traditional product-development best practices that are associated with incremental innovation are problematic, as both the product attributes and breakthrough innovations' future environments are not known as yet (Lynn, Morone & Paulson, 1996). By comparison, the results of traditional approaches in forecasting customer needs and market potential, whether they are quantitative techniques or qualitative methods, are merely limited to insights in respect of product improvements (Gassmann, Kobe & Voit, 2001).

However, the development of radical or discontinuous new products or services may contribute significantly to companies' growth and profitability (Kleinschmidt & Cooper, 1991; Ozer, 1999).

There have been some attempts at understanding the characteristics of discontinuous innovation better (Kleinschmidt & Cooper, 1991; O'Connor, 1998; Veryzer, 1998a, 1998b). Customer integration into the innovation process is an increasingly applied method that aims at reducing the risk of failure (Chesbrough, 2003; Gassmann & Enkel, 2004). Companies have, in fact, already started to leverage the advantages of customer integration into their new product development process.

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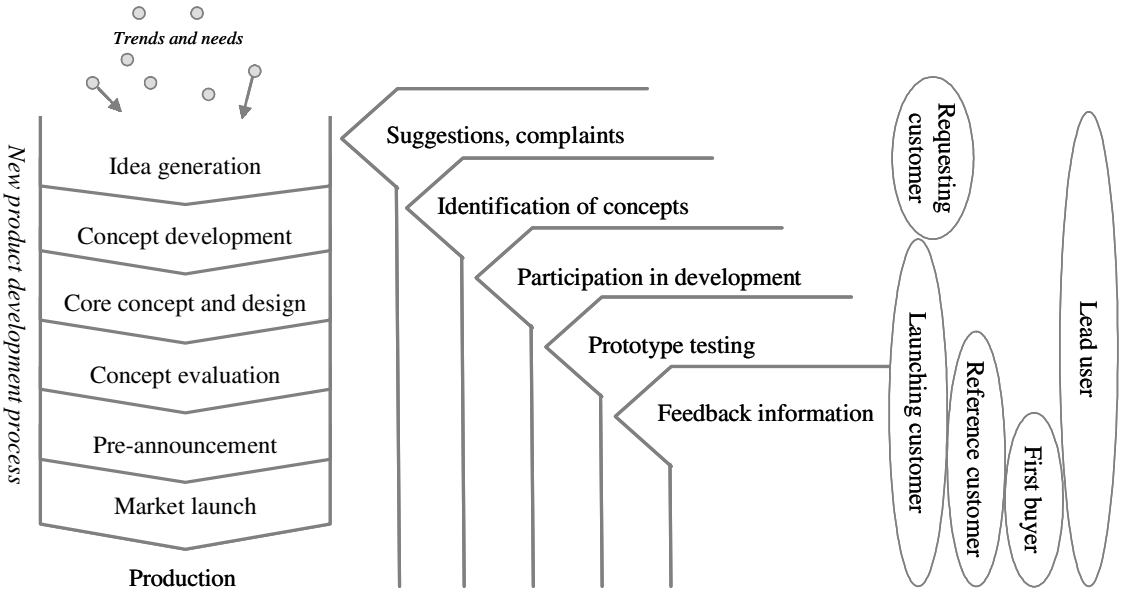


Figure 1. Customer Types and their Contribution to the NPD Process
Note: Adapted from Brockhoff (1998)

Customers' contribution to the reduction of market risks varies according to the innovation process's exact phase (Brockhoff, 1998; Koen et al., 2001; Quinn, 2000). Figure 1 provides a summary of how customer integration can differ in each individual phase of the innovation process, and which customers are best suited to achieve the expected input.

Requesting customers, as they are termed, provide ideas for new products that follow from their needs. A requesting customer's contribution depends on the company's capability to capture customer knowledge, which is often expressed in the form of complaints and suggestions. As complaints are mostly anchored to current product uses and product characteristics, they are a rather limited source of new product information (Brockhoff, 2003). Conversely, the launching customer is integrated right from the development phase to stimulate, design or participate in development activities. The reference customer, on the other hand, supplies application experience. The highly productive role that customers can play in product and prototype testing has been revealed in various empirical studies (Dolan & Matthews, 1993). The first buyer, however, plays a more passive role in development. As described in diffusion models, a precursor that strongly influences market penetration may support market success. Lead users could therefore cover all stages of the NPD process, although the same customer does not necessarily always represent them. The lead user's degree of involvement usually depends on the benefits to be obtained.

In the light of the specified difficulties with conventional market research methods, leading companies such as 3M, Hilti, Johnson&Johnson Medical and Boeing are increasingly working with lead users to develop radical innovation (Condit, 1994; Coyne, 2000; Herstatt & von Hippel, 1992; Lilien et al., 2002; Lüthje & Herstatt, 2004; von Hippel, Thomke & Sonnack, 2000).

Several empirical studies have, first of all, emphasized the novelty of innovation, the expected turnover, the market share and the strategic importance, all of which are significantly higher for innovation projects based on the lead-user method than for those based on traditional methods (Lilien et al., 2002). Second, the lead-user method's multi-stage approach not only aims at generating new, innovative product concepts, but also at improving and enhancing the effectiveness of cross-functional product development teams (Lüthje & Herstatt, 2004). Furthermore, lead users differ from ordinary users. They face new needs significantly earlier than the majority of customers in the market and they profit from innovations that meet those needs (Lüthje & Herstatt, 2004; Urban & von Hippel, 1988; von Hippel, 1986).

Although theory has widely recognized customer integration (see Table 1), the practice still needs help to apply the factors, processes and methods described in theory.

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Table 1. Literature on Customer Integration into the Innovation Process

Attributes of customer integration in NPD	Key issues	Authors
Roles of customer in NPD	Customer integration ranges from lead user to first orderer	(Brockhoff, 2003; Lettl, 2004; von Hippel, 1986; von Hippel, 1988)
Customer contribution to NPD	Activities in • Concept development • Product design • Performance testing and validation	(Kleinschmidt & Cooper, 1991; Lengnick-Hall, 1996; Nambisan, 2002; Ulwick, 2002)
Enhancement of new product success	More new innovation and product success through customer integration	(Gruner & Homburg, 2000; Lilien et al., 2002)
Influence of customer integration on product success	Positive impact of customer integration on innovation process	(Callahan & Lasry, 2004; Gales & Mansour-Cole, 1991; Kleinschmidt & Cooper, 1991; Salomo, Steinhoff & Trommsdorff, 2003; Souder, Sherman & Davies-Cooper, 1998)
Benefits of customer integration	Increase in innovation process's effectiveness and efficiency	(Atuahene-Gima, 1995; Brown & Eisenhardt, 1995; Lengnick-Hall, 1996; Leonard-Barton & Sinha, 1993; Rigby & Zook, 2002)
Customer integration in the case of radical innovation	Characteristics of customer contribution and profile, as well as the interaction and impact's dimension	(Lettl, 2004; Lilien et al., 2002; Lynn, Morone & Paulson, 1996; O'Connor, 1998; Schoormans, Ortt & de Bont, 1995; Urban & von Hippel, 1988; Veryzer, 1998a, 1998b; von Hippel, Thomke & Sonnack, 2000)
Success factors of customer integration	Proposals on team organization, development processes, knowledge generation, culture etc.	(Bruce & Biemans, 1995; Hutt & Stafford, 2000; Littler, Leverick & Bruce, 1995; Maron & VanBremen, 1999; Mohr & Spekman, 1996)
Prerequisites for customer integration	Defining clear roles and objectives and key enabling figures	(Biemans, 1992; Brockhoff, 1998; Bruce et al., 1995; Hauschildt & Kirchmann, 2001; Markham & Griffin, 1998; Riggs & von Hippel, 1994)
Empiric investigations on the importance of customer integration	Users constitute a major source of innovation	(Herstatt & von Hippel, 1992; Lüthje, 2004; Morrison, Roberts & von Hippel, 2000; Slaugther, 1993; Urban & von Hippel, 1988; von Hippel, 1986; Voss, 1985a)
Consumer research methods for opportunity identification in NPD	Methodologies for developing and introducing innovative products to market through customer integration	(Deszca, Munro & Noori, 1999; Kleef, Trijp & Luning, 2005; Leonard-Barton & Sinha, 1993; Lynn, Morone & Paulson, 1996; Noori & Munro, 1999; Ulwick, 2002; Urban, Weinberg & Hauser, 1996)
Negative aspects of customer integration	Illustration of negative side effects and inherent risks of customer involvement	(Becker & Peters, 1998; Camagni, 1993; Enkel, Kausch & Gassmann, 2005; Pisano, 1990; Robertson & Langlois, 1995)

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While customer integration has been extensively analysed, some details on the application of the lead-user method need to be enhanced. The identification of the lead user is a particularly challenging task (Lüthje & Herstatt, 2004), as is his integration into the innovation process's appropriate phase and the adaptation of the whole approach to company specifics.

In order to illustrate this gap in the theory, we provide a real-life example of how an attempt at lead-user integration developed in practice through the use of existing theory. It demonstrates a machine manufacturing company's approach to integrating a lead user into its discontinuous innovation development and its attempts to adapt and use the lead-user approach to minimize market risk.

Research Methodology and Data Sample

The case study is based on data gathered at a Swiss engineering company (called Swiss Eng in this article) over a five-month period from the end of 2004 to the beginning of 2005. A variety of data collection methods was employed, including a series of interviews with the relevant engineers, management and marketing. Project documentation, customer interview transcripts and presentations as well as secondary literature were analysed and evaluated. We observed the customer integration project in a series of seven workshops, and in several bilateral meetings with individual team members who carried out the project. Field visits and interviews at Swiss Eng's R&D centre facilitated the authors' knowledge of the examined innovative project.

As a research strategy, a single case study leads us to understand the dynamics present within a single setting and to examine the phenomenon in its natural environment (Yin, 1994). The case-study method is especially appropriate for research on new topic areas, and can contribute critical insights as well as identify important factors. The case outlined below might be exemplary of customer integration in engineering companies, as this industry has special requirements and challenges: not only does it experience an increasing exigency for a breakthrough product to improve competitiveness and gain market share, it is also caught in the crossfire of ever-increasing requirements in order to offer cost-effective and performance-improved systems. As the development of new machine generations in the machinery industry requires long and costly development times, the pressure to create successful products is exacerbated even further.

Customer Integration into Swiss Eng's Prototype Development

This case illustrates Swiss Eng's attempts to involve one of its customers when it was looking for a method to reduce market uncertainties in respect of the development of a discontinuous innovation. The company operates in a very competitive and seminal market dominated by a competitor with a 70 percent market share. The company itself is ranked second in its industry worldwide, had approximately 4,000 employees and a turnover of €1.1 billion in 2004, doubling the turnover in the previous four years. A range of optimized products and innovative fittings was launched in 2003. The 'Betty' innovation (as the new machine generation was called) was meant to support the company's development and lead to steady growth and increased profitability. A strong demand in the Eastern European, Middle Eastern, and, particularly, in the Asian markets, promised additional business.

At the beginning of the observed customer-integration project, the company's project team worked on the specification of a new machine generation's core concept that promised to be the breakthrough innovation needed to increase the company's market share substantially. The company management saw an acute need to involve additional development partners (like lead users) in the light of increasing doubt whether the concept would meet customer needs. This doubt was rooted in the company's experience with the previous machine generation that had been developed to be a breakthrough product, but had caused enormous losses. Their customers had not accepted it, nor had the design exactly complied with the market requirements. Rather than improving the discontinuous innovation through adaptation to market needs, the management decided to divest. In the end, they could not muster the staying power to persist and learn from the experience, thus modifying the product and basing the exact assessment on that learning, and trying again. The management had furthermore realized that difficulties would occur if the new discontinuous innovation's development were merely accompanied by conventional marketing research methods, as had been the case with the preceding, failed project.

As scheduled first in the lead-user approach, the innovation field identification at the beginning of 'Betty's' innovation was

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solely defined according to general strategic requirements. Although the company was aware of user innovations' conditions for success, no external knowledge source had been integrated as is recommended. In addition, Swiss Eng's representatives had selected a mature product category, characterized by severe performance and price competition, for 'Betty'. They hoped that the production of a next generation machine model in this category would allow the company to surmount its perilous financial situation. The objectives in respect of the innovation process's outcome were defined as a radical degree of innovation and a contribution to company growth and profitability.

A dedicated, interdisciplinary project team consisting of R&D, marketing and sales employees developed ideas by involving technological experts from engineering research institutions (e.g. universities). Finally, after several internal idea assessments, a concept found in a different market was selected as the best fit for the project's needs. Based on observations and separate feasibility studies, an adapted core concept was accepted in combination with brand new upstream and downstream modules that were believed to meet the customers' expectations best.

A few months later, customers were first involved through market research analysis. Internal marketing experts carried out a market feasibility study by surveying international customers. Their focus was to determine if the concept complied with customer needs in terms of performance expectations, system features and technical requirements, and, where applicable, this was refined by means of modifications to the product. The survey was carried out by sales and marketing people, mainly through approximately 50 personal interviews with customers in Europe and Asia. The goal was to prioritize the functions that customers would most prefer in the new product and to abolish those features customers were not willing to pay for. The market research would therefore reduce the costs of the new machine's development and production. However, the customer-attitude evaluation did not shed light on the market needs at all, because it became mired in suggestions and complaints.

The findings therefore did no more than clarify the trends that the company had already detected. The customers selected to provide input data for the market analysis were, furthermore, unlikely to provide insight into new product needs and potential solutions that conflicted with what they knew.

Afterwards, the project team was forced to use the lead-user approach that the management had identified as a tool to reduce market risk, because the latter was still troubled by the market risk, and because the earlier failed project had also initially had positive market research results. The project team, however, did not fully comply with this advice. Their belief that customers could be useful when testing a machine or serving as first buyer, but could never be used as co-developers, was conveyed by the fact that they waited until the last phase of the innovation process (when the prototype had almost been completed) to start integrating customers into the project.

Subsequently, Swiss Eng's project team defined a sub-project for identifying and integrating customers who might support the last phase and reduce the market risks by being the new machine's first buyers or reference customers, and thus employed a small research group experienced in customer integration projects.

Swiss Eng's decision to use the lead-user approach was also based on the management's estimation that this method would be successful because the literature recommends it for dealing with radical innovation. In order to ascertain who the potential lead users of Swiss Eng were, a screening approach was used. The project team, now joined by two doctoral candidates who were experienced in customer integration, decided to search for customers who could judge the value of the new machine from a user's point of view and from a development capability perspective. The screening approach consisted of two major steps. First the number of potential customers within the group of existing key customers needed to be reduced by ranking them according to specific criteria. Second, the research team would interview the small number of customers remaining. Such a preselection provides a more efficient approach to finding appropriate customers as the number of time-intensive interviews is reduced. Figure 2 illustrates the different steps of the selection process, including those of previous efforts.

To select a small number of customers for interviews (between five and eight customers), a cluster analysis, based on lead-user indicators, was carried out (see step 1 in Figure 2). It was important that the customers actually did lead the trends in the product category on which 'Betty' was focused. A second indicator chosen was the customers' dissatisfaction with the existing market offerings at the time and, therefore, the expected benefits from satisfying this need with the new machine. In order to identify customers capable of assisting with the product development and market launch, the project team had to find a subset of users

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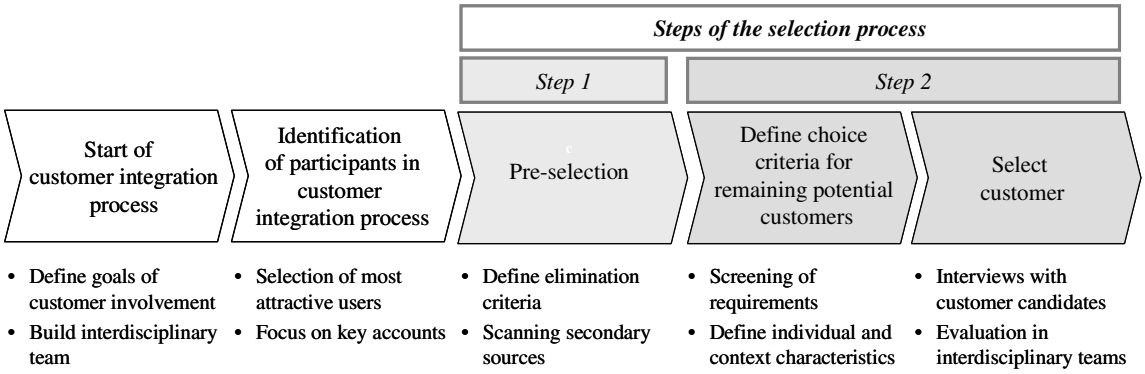


Figure 2. Process of Customer Involvement

who were therefore (1) motivated to innovate (e.g. dissatisfied with existing solutions, high benefits), (2) motivated to cooperate (e.g. cultural and strategic fit, need for the new machine), (3) qualified to innovate (e.g. operational know-how, skilled employees), and last but not least, (4) suitable for cooperation (e.g. confidential co-operation partner, top-performer). Each of the dimensions mentioned consisted of multiple criteria.

In addition, a knockout criterion was defined. The potential lead users had to have at least one location that was exclusively equipped with Swiss Eng machines where prototype testing could take place without having competitors visiting this site.

The research group decided to use secondary literature sources and the internal expertise of the service personnel, key account managers and marketing department to prioritize the list of customers. This was done by designing a matrix that contained the indicators described above as well as the list of customers. The innovation project's marketing and project managers then used the matrix to select five candidates from the 28 customers (see Table 2).

For the rating of the selected customers, a four-point Likert scale was used for each single indicator. The equally-weighted sum of the valuations defined the customers' ranking.

In the second step, one of the five candidates, who fitted the supplier's requirements best and was best suited as a prototype co-developer, had to be selected, which required more detailed information regarding customer demands. A variety of data-collection methods was therefore employed; the primary vehicle was a series of interviews to identify the possible lead user.

As a security measure, the project team decided not to inform the five candidates that the supplier wanted to co-develop a discontinuous innovation, although the interview questions outlined the new product specifications. Only the customer who would be integrated at the end of the selection process would know about the innovation. Another decision was to let the external research group conduct the interviews in order to prevent the customers from simply complaining about their Swiss Eng products instead of answering the questions. Swiss Eng's key account managers selected the interviewees, as he was familiar with the interdisciplinary nature of the questions, knew the customers very well and could also link the interviewers with the customers to be selected. One plant from each identified customer was selected as best suited for the prototype testing and to limit the number of interviews. The interviews focused on this plant's manager, technical managing director and key account manager. This approach limited the data on the customer to only one plant, which was expected to be representative or best suited. Swiss Eng decided to reduce the number of interviewees on the customer's site to prevent his resources from being unnecessarily stretched and to keep him motivated for later co-operation.

The interview questions covered all categories of customer needs and 'Betty's' product specifications, operation and output requirements, cost perspective and operational and development capabilities. The importance of single categories was determined by ranking them in sequence by means of the analytical hierarchy process (Saaty, 1990).

Three of the remaining customers were from Germany and two from Spain. The interviews were held in the customers' native language, once even through the key account manager himself, in order to ease communication with the customers.

The overall proxy used to evaluate the potential lead users consisted of a two-stage approach: (1) Whether the interviewees agreed that advances in the search field that

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Table 2. Matrix used to Evaluate Potential Customers to Co-develop 'Betty'

Criteria (Evaluation of indicators: -1 no (bad); 0 maybe, don't know; 1 yes (good); 2 yes (very good); Weighting of criteria: total: 100%)		Weighting	Customer 1	Customer 2	.....	Customer 28
1. Qualification as pilot customer						
a)	Right machine type	20%	2	2		2
b)	Right machine volume	20%	2	2		2
c)	Top-performer	20%	1	2		1
d)	Confidential cooperation	20%	1	2		0
e)	Independent, self-managed company	20%	1	1		2
	Result	*100%*	*1.4*	*1.8*		*1.4*
2. Motivation to cooperate						
a)	Actual need for new machine	20%	1	1		1
b)	Tangible benefit for customer	20%	1	1		1
c)	Good cooperation through cultural fit	20%	1	1		0
d)	Good cooperation through geographical fit	20%	1	1		1
e)	Good cooperation through strategic fit	20%	2	2		1
	Result	*100%*	*1.2*	*1.2*		*0.8*
3. Motivation to innovate						
a)	Innovative customer, early adaptor of new technologies	25%	1	1		1
b)	Dissatisfied with existing solutions	25%	1	1		1
c)	Engagement in improvements	25%	1	1		1
d)	Tangible benefit from new technology	25%	1	1		1
	Result	*100%*	*1.0*	*1.0*		*1.0*
4. Qualification to innovate						
a)	Professional know-how about operation	20%	2	2		1
b)	Professional know-how about function	20%	2	2		1
c)	Professional market know-how, trend-setter	20%	2	2		2
d)	Sufficiently skilled employees	20%	1	1		1
e)	Feasibility of quality control	20%	1	1		1
	Result	*100%*	*1.6*	*1.6*		*1.2*

had been specified by the internal project team were in fact needed and important, and (2) whether they could describe at least some technically interesting ideas regarding these trends. In sum, a total of 16 interviews were conducted, which included the key account manager's statements. Each interview took approximately two hours and was recorded as well as transliterated.

In this second phase of the identification process (see Figure 2), the interviews and other materials were also analysed on a five-point Likert scale. Because the results gained in this second phase were much more detailed than in the first evaluation phase, the selection criteria were more detailed as well. Each category of the interview questions consisted of different selection criteria. For instance, the category 'development capabilities' contained the criteria: integration in development, support for prototyping and testing, opportunities for quality control and innovativeness. The selection criteria themselves included several questions for the interviewees. The evaluation of each single participant's categories was weighted according to the results of an analytical hierarchy process. The weighted sum of the valuations defined the customers' ranking.

The analysis of the data revealed a surprising fact: none of the interviewed customers prioritized 'Betty's' features as crucial, but demanded functions that were not included. It not only meant that none of the selected customer would be willing to serve as a reference customer or first buyer, but that the new machine's market launch had to be postponed in order to make crucial changes to gain

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market acceptance. At this stage, Swiss Eng terminated its search for a customer able and willing to co-develop the prototype and serve as a reference customer because of the anticipated additional development time the changes would cost. Simultaneously, Swiss Eng also realized that the market search, although conducted appropriately, did not reveal the most important needs of its customers in respect of disruptive innovation.

The company has not yet decided if it wants to integrate one of the interviewed customers in order to redesign the concept and prototype (as a real lead user would be able to do), or if it will continue its search for a launching customer when the future path is defined after the company has adapted the customers' machine concept internally.

Discussion of Customer Integration Approach

Although Swiss Eng followed all the steps that the theory recommends, the project failed. In analysing Swiss Eng customer integration attempt, the case study illustrates that the market research did not embrace Betty's challenges (Deszca, Munro & Noori, 1999; O'Connor, 1998; Urban & von Hippel, 1988; Urban, Weinberg & Hauser, 1996; von Hippel, 1986). The market survey simply confirmed obvious trends in the market place, but did not reveal latent and unarticulated customer needs. This phenomenon is quite common, as specific observations have revealed that traditional market-research studies do not provide valuable input for the creation of promising ideas in respect of discontinuous innovation, because they focus more on future business and market demands (Lüthje & Herstatt, 2004; Noori et al., 1996).

Predicted customer needs are the trigger for many projects. However, at the fuzzy front end, technology is considered the key source of uncertainty. Issues regarding market uncertainty are not prominent in the early phase, but increase as the innovation moves further along in the development process and efforts to capture the customers' voice become crucial (O'Connor, 1998). In the outlined case, similar observations were made. Only the fact that Swiss Eng's management wanted to define the product features and to base specification uncertainties on the customer's needs and requirements in order to not fail again, forced the project team to capture the customers' voice. However, identifying the customers' value is hardly a simple or straightforward process (Thomke & von Hippel, 2002). The value of customer involvement is co-determined by the capability for innovation, the customers' motivation and the degree of involvement (Brockhoff, 2003; von Hippel, 1986).

In the case of Swiss Eng, the customers' innovation capability was not judged as high as that of the company's own engineers, which is why the project team only started thinking of customer integration at a very late stage (when the prototype was already defined). At this stage, customers' input is reduced to mere incremental improvements of the prototype and can no longer be radical ones. Furthermore, by eventually making the marketing division responsible for finding a co-development partner, the success of such a co-development was limited from the very beginning.

Swiss Eng did not truly realize the advantages of integrating lead users in radical innovation projects. Von Hippel (1986) was aware of the characteristics of discontinuous innovation, which is why he developed the frequently cited lead-user approach. Lead users face new, strong needs that will only become general in a marketplace in future and will benefit the company significantly if it can obtain a solution to these needs. Lead users are at the leading edge and are both sufficiently well qualified and motivated to make significant contributions to the development of new products and services (Lilien et al., 2002; Lüthje & Herstatt, 2004; Urban & von Hippel, 1988; von Hippel, 1986). Obviously, the project team's marketing head focused more on involving a reference customer or first buyer, instead of a co-developer like a lead user, because he did not believe that a customer contribution in product development could be valuable.

By analysing the data from the in-depth interviews, we identified three alternative levels of professional participation for the concept development and design phase. An understanding of the specific form in which customer involvement should occur is crucial for the prospects of success, as time and effort spent on coordinating and managing the process involvement vary depending on its intensity. Key influencing factors are the time and intensity of involvement and the form of governance. Customers' technological contributions are likely to increase the project uncertainty, and new mechanisms may be needed to monitor and control the development quality and efficiency (Lengnick-Hall, 1996).

By integrating customers into the NPD process, they participate in or take over activities that constitute manufacturers' classic functions. As the case study supports, users exhibit a profile that at the very least allows a passive

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professional contribution to the NPD process. This is not surprising, as customers also wish for opportunities to compete in times of increasing competitiveness. By obtaining the benefits of new products delivered to them first, the customers may therefore increase the company's value. This effect is even more distinctive if the customer can negotiate a limited exclusive utilization of an innovation.

If customers were to take a step forward and accept a role as active development contributors, they need a challenging context and individual characteristics, such as professional competency, amphibological tolerance, research resources and interdisciplinary know-how to adopt this role (Lettl, 2004). Furthermore, customers' willingness to participate strongly depends on the original inventor of the concept, their professional and technological expertise and the locus of development (Lettl, 2004). Because a prototype had already been defined at Swiss Eng's research department, the integration of technological knowledge was crucial for further development at this stage – but none of the interviewed customers possessed the technological expertise that would allow them to contribute an active role in the concept development's technological domain. Conversely, the lead-user concept definitely implies having the skill to build quasi prototypes (Lüthje & Herstatt, 2004; Urban & von Hippel, 1988; von Hippel, Thomke & Sonnack, 2000).

Obviously, selecting the right collaboration partner is difficult. The prospect of success and, eventually, the reduction of market risks depend on the identification of the right customer. In assessing Swiss Eng's selected customers, it becomes clear that they were not lead users who could contribute to the prototype development. In the company's search for real lead users, it would have been a more productive approach to search for them in analogue markets (von Hippel, 1986). More engineering-focused companies from other industries might have possessed the valuable engineering knowledge that could have helped with 'Betty's' technical details, although this would not have led to identifying the needs of Swiss Eng's customers in order to reduce market risks.

The selected customers could have contributed their current and future needs regarding a new machinery generation of which Swiss Eng was unaware. This very important fact should be highlighted more closely. However, Swiss Eng's intention (perhaps based on their limited knowledge of customer integration approaches) was to find co-developers in terms of customers being able to improve their prototype with the technological knowledge that was required at that stage of the project. 'Betty's' innovation project could have benefited much more from an earlier integration of the customers' requirements and needs (not technological knowledge that they do not possess) and not by being analysed at a stage when the required integration subsequently led to the postponing of the product launch. It all comes back to an erroneous understanding of customers' contribution.

In discussing Swiss Eng's selected customers as reference customers or first buyers and not as lead users, it seems that all the customers were ready to invest in cooperation (testing the prototype) with the supplier. This is not surprising, as the efforts required are closer to their daily work. Three of the five customers pointed out that their activities are limited to operational ones. The analyses of the interview data also showed that these customers did not want to be involved in co-development because of their lack of technological knowledge or engineering personnel.

The higher the innovation-related benefits on the customer's side, the greater the willingness to participate in the development of innovation. Individual customers develop specific expectations concerning the benefits and costs of their innovating activities, and these beliefs drive some to innovate, while others remain passive (Brockhoff, 2003). The innovation's value for the involved user affects the motivation to co-operate significantly. Users may, however, demand executive rights for the usage of the new product for a certain period to ascertain its competitive advantages. Empirical research into the factors that motivate or discourage users from openly revealing their leading-edge information and to participate is, unfortunately, just beginning to evolve (Brockhoff, 2003; Harhoff, Henkel & von Hippel, 2003; Lüthje & Herstatt, 2004).

In the NPD process, the customer is a source of innovation and might participate in product design and development, as well as in product testing and product support (Nambisan, 2002). Given the multi-dimensional nature of new product development, successful customers may contribute insights regarding innovative solutions that are a response to their needs. However, this requires a selective procedure as customers' ability to participate differ (Henard & Szymanski, 2001). The selection in respect of discontinuous innovation, especially if customer involvement is needed in the development and concept phase as well as in the testing phase, can be managed by the multitude of choice criteria. Based on Lettl's (2004) explorative model of customers' contribution to the NPD process, subject to its profile as designed for the medical technology industry

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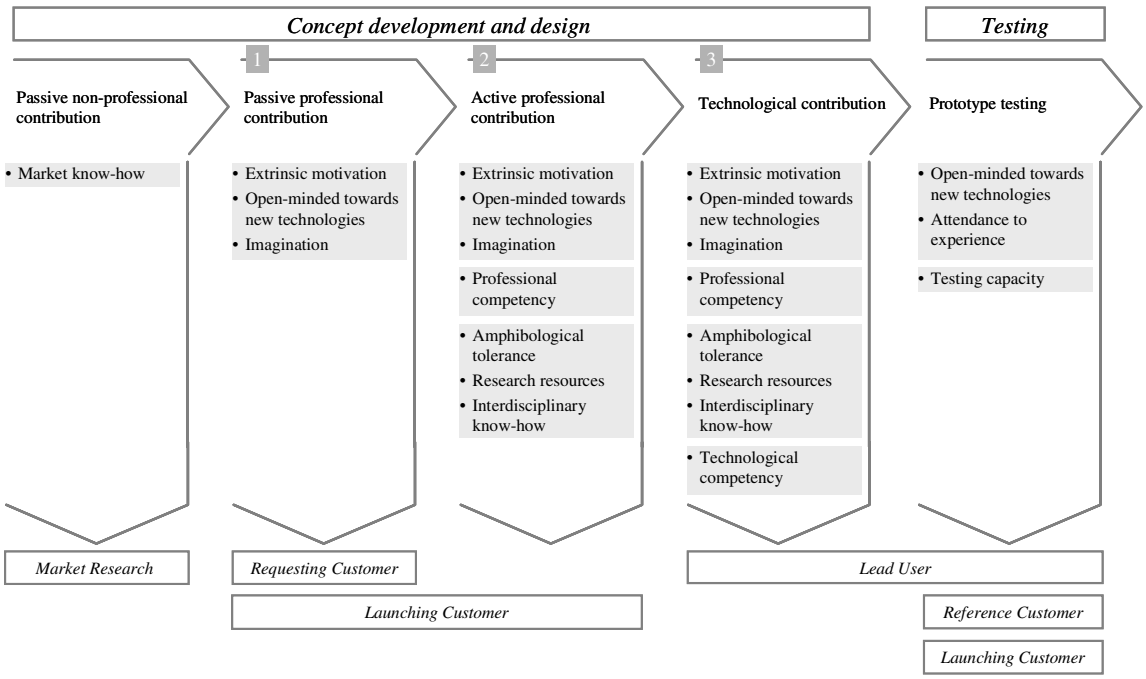


Figure 3. Required Customer Profile for Participation in NPD Process
Note: Adapted from Lettl (2004)

and combined with the knowledge gained from the Swiss Eng case, we have adapted this model for engineering companies. We therefore provide an overview of the customer profile's coherence and customers' contribution to the NPD process (see Figure 3).

Conclusion

As illustrated in this article, customer integration, and specially the integration of lead users in practice, is far from being perfect. This is because companies still do not understand when and how the lead-user approach should be used to reduce radical innovation's market risk. The company's project team did indeed do its best to identify the appropriate customer, but such activities become obsolete when the customer is not given the opportunity to integrate his knowledge. Setting the stage for such integration involves:

- finding the right customer who possesses the knowledge and capabilities necessary for the current stage of the innovation project (in this case, technical knowledge);
- choosing the right customer category in keeping with the expected benefits for the innovation project (in this case, reference customers or first buyers instead of lead users);
- identifying and integrating customer needs in an early phase of the innovation project (much earlier than in prototype development, although market research results are limited in respect of radical innovations); and
- paying attention to both the project team and management's motivation for integrating customers (overcoming 'Betty's' project team's not-invented-here syndrome, or the management's mistaken expectations).

Looking back at the initial goal of Swiss Eng's customer integration project, it is clear that the company wanted to reduce the market risk for its radical innovation by identifying its customers' needs. The results turned out to be very different to what was expected. At the end of the project, the company had reached its goal of knowing more about its customer needs and was able to deduce the functions expected from a new machine from the interview findings, but these functions turned out to be very different from what was offered by the 'Betty' prototype. Swiss Eng's approach had been correct – it was only presented at the wrong moment in the innovation project process as a result of an erroneous understanding of customers' contribution.

The failures described in this case study also illustrate that there is much left to do in respect of research into customer integration. First of

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all, companies need to know what contribution a specific customer can provide. The reference framework (Figure 3) might help to clarify this. Second, companies need much more detailed help in selecting and applying customer integration approaches for their needs – help which science does not as yet provide (e.g. research into selection criteria for lead users or other customer categories, stage descriptions, work on motivating customers to participate etc.). We initiate such help by providing a stage-gate process for the identification of customer (Figure 2 and Table 2) and profile requirements needed for a specific customer contribution to the NPD process (Figure 3).

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