Extending lead user theory:

Antecedents and consequences of consumers' lead userness

Martin Schreier and Reinhard Prügl

Working Paper

A later version of this paper has been published in the

Journal of Product Innovation Management (25 (4): 331-346, 2008)

Acknowledgements:
The authors are grateful to Michael Biach, Markus Murtinger, Stefan Oberhauser, and Tom Pfneissl for their valuable support throughout this project. We also appreciate the helpful comments on earlier versions of this paper provided by Nikolaus Franke (WU) and Karim Lakhani (MIT Sloan School) and thank the editor as well as the two anonymous reviewers for their important suggestions for improvement. Finally, we would like to thank the many field experts and community webmasters who provided valuable assistance. Naturally, the authors alone are responsible for any remaining errors.

Extending lead user theory:

Antecedents and consequences of consumers' lead userness

Abstract

Lead users have been shown to be a highly promising source of innovation for generating radical new product ideas. According to lead user theory, these users are defined as being ahead of an important market trend and experiencing high benefits from innovating. There is strong empirical support that these users tend to come up with commercially attractive user innovations. Other than that, however, there is hardly any knowledge available which helps to describe and differentiate this "species" of user from more "ordinary" users. The present article aims to fill this gap and extends lead user theory by exploring some antecedents and consequences of consumers' "lead userness". As regards antecedents, it is argued that a consumer's leading-edge status will depend on field-related as well as field-independent variables. First, it is hypothesized that a consumer's basis of knowledge and use experience gained in the underlying field will help explain one's lead userness. Second, it is hypothesized that the two general personality traits of "locus of control" and "innovativeness" will be related to users' leading-edge status in a given domain. As regards consequences, this article develops a link between individuals' lead userness and new product adoption behavior. It is hypothesized that lead users will demonstrate innovative behavior not only by innovating on their own, but also by adopting new products faster and more intensively. These tenets are tested in the course of three studies on extreme sports communities (sailplaners [n=129], technical divers [n=193], and kite surfers [n=139]). Overall, findings are throughout affirmative. First, it is found that the proposed antecedents (both field-related as well as both field-independent variables) are strongly related to consumer's lead userness. These findings have important implications: One major challenge of the lead user method has been the reliable and efficient identification of leading-edge users in the first place. Findings related to antecedents suggest that these variables might be employed to improve the lead user search process – they might be used as a proxy to identify the rare "species" of lead users. Second, also the proposed consequence of being a lead user finds strong empirical support: Lead user tend to adopt new products faster and more intensively than other users. These findings suggest that lead users might be highly valuable to companies beyond the fuzzy front end of generating radically new product ideas. Lead users might also be relevant to more general product development and marketing issues. For example, they might be integrated into new product concept testing methods and "lead userness" might serve as an additional positioning variable for the marketing of new products.

Introduction

Contrary to conventional wisdom, manufacturers are not exclusively responsible for generating ideas for new products. In fact, users have often been found to be the initial developers of what later became commercially important products and processes. The majority of all important innovations in snowboarding, windsurfing, and skateboarding equipment, for example, were originally developed by users (Shah 2000). Other documented first-of-type innovations by users range from computer innovations to petroleum processing and scientific instruments (for an overview, see von Hippel 2002/2005). Furthermore, user innovation is not a rare occurrence. Lüthje (2003), for example, studied surgeons working at university clinics and found that 22% of users surveyed had developed new products for in-house use. Similar percentages were found in the field of printed circuit CAD software (Urban and von Hippel 1988), library information systems (Morrison et al. 2000), mountain biking equipment (Lüthje et al. 2005), and Apache server security software (Franke and von Hippel 2003). The largest share of user innovators in the fields studied to date is 37% in outdoor consumer products (Lüthje 2004), followed by 32% in extreme sporting communities (Franke and Shah 2003).

This has given rise to a growing body of literature which aims to understand and explain the phenomenon of user innovation as well as efforts to reclaim the territory of user innovation for innovation managers. The first important question is whether there are any systematic differences between users who do and do not come up with attractive innovations. One promising answer is provided by lead user theory: Users who are ahead of an important market trend and expect high benefits from innovating ("lead users") will be most likely to develop attractive innovations (von Hippel 1986). The following example from the sport of

windsurfing, as documented by Shah (2000), provides a vivid picture of the mechanism of lead user theory: In the late seventies, when the majority of windsurfers practiced this sport as originally intended (i.e., surfing on the water), some leading-edge windsurfers were trying to push the limits of the sport by developing aerial tricks (i.e., being ahead of trend). They painfully realized the limits of the available commercial equipment as they repeatedly flew off their boards and got injured (which prompted them to expect high benefits from innovating). Instead of quitting, they tackled this consumption problem directly and resolved it by inventing footstraps. Later on, the market trend of performing aerial tricks reached the mass market, and today footstraps are used in almost all windsurfing equipment (commercially attractive user innovation). A number of subsequent studies addressed lead user theory quantitatively and provided strong empirical support. Individuals' or firms' "lead userness" is significantly related to the likelihood of commercially attractive user innovation (e.g., Franke et al. 2006).

Based on lead user theory, it has been suggested that these lead users should be integrated into corporate NPD efforts using the "lead user method" (Urban and von Hippel 1988, von Hippel 1986). Here, companies try to learn from lead users about the needs and solutions they encounter at the leading edge of the market. The ultimate goal is to derive promising new product concepts generated in the course of workshops in which lead users collaborate with company personnel. This type of customer integration is not only being discussed increasingly among innovation management scholars (e.g., Enkel et al. 2005; Hienerth and Pötz 2005; Kaulio 1998, Kristensson et al. 2004; Lüthje and Herstatt 2004; Pitta et al. 1997), the idea is also spreading rapidly in the business world (e.g., Coyne 2000, Dehne 2003, Intrachooto 2004, Economist 2005). This trend is reinforced by several case studies which highlight the commercial promise of lead user integration. Gruner and Homburg (2000), for

example, find that firms collaborating with customers who exhibit lead user characteristics report an increased rate of new product success. In another example, lead user concepts generated at Hilti (a major global manufacturer of construction-related equipment) led to the introduction of a completely new line of pipe hanger products which enjoyed strong commercial success (Herstatt and von Hippel 1992). Furthermore, lead user concepts developed at 3M showed sales potential which was an average of eight times higher than traditionally developed concepts (Lilien et al. 2002).

Despite these encouraging findings, there is generally still a limited understanding of who lead users are and – even more importantly – why they are (or become) leading-edge in a given field. Consequently, one major challenge in applying the lead user method has been the reliable and efficient identification of leading-edge users in the first place (Lilien et al. 2002, Lüthje and Herstatt 2004, Olson and Bakke 2001). This problem seems most severe in consumer goods fields where overall user populations appear to be "unmanageably" large (i.e., several hundred thousand consumers or more). A thorough understanding of what factors impact consumers' leading-edge status and whether lead users can be differentiated from ordinary users by means of certain behavioral patterns might help in this regard. To this end, however, lead user theory has generated only limited advice up to now. In a nutshell, one only knows the definitional characteristics of lead users (being ahead of trend and expecting high benefits from innovating), which in turn explain the likelihood of attractive user innovation.

This article, therefore, aims to extend lead user theory by exploring the antecedents and consequences of being a lead user. It focuses on individual end-users (i.e., consumers) as opposed to user companies (Morrison et al. 2004; von Hippel 2005). As regards antecedents, the link between field-related as well as field-independent variables and individuals' lead

userness is developed and tested empirically. It is proposed that an individual's consumer knowledge and use experience in the underlying field as well as one's personality (in terms of locus of control [the degree to which people believe that desired outcomes are controlled by ones' own actions] and innovativeness [a person's predispostion toward new and uncertain situations]) will impact one's leading-edge status. With regard to consequences, the link between individuals' lead userness and new product adoption behavior is developed and tested empirically. Here it is proposed that lead users will demonstrate innovative behavior not only by innovating on their own, but also by adopting new products faster and more intensively. Given empirical support, the implications of this extension of lead user theory are twofold: First, the antecedents of consumers' lead userness might serve as alternative or additional search variables to identify lead users among larger user populations. Second, if lead users are among the first consumers to adopt new products, there is good reason to integrate them beyond the fuzzy front end of generating radically new product concepts, namely into more general issues in the marketing of new products.

In order to test these hypotheses, data from three extreme sports communities were collected (data collection: May and December 2005). Study 1 (sailplaners) explores the antecedents of consumers' lead userness, Study 2 (tech divers) uncovers the consequences of being a lead user for new product adoption behavior, and Study 3 (kite surfers) attempts to replicate the main findings from Study 1 and 2 in a different field.

In the following, a brief review of theoretical and empirical work on lead user theory is provided. Hypotheses with respect to the antecedents and consequences of being a lead user are then developed. This is followed by a description of the study method, after which the

findings are presented. Finally, this article discusses the implications of the results as well as limitations and possible directions for future research.

Review of lead user theory

Lead user theory

In order to understand what type of users trigger attractive user innovation, von Hippel (1986) developed the "lead user theory", according to which the "nuggets" of user innovation should be concentrated in lead users. These users are defined as being at the leading edge with respect to some dominant market trend (being ahead of trend) and at the same time as anticipating high benefits from solving problems (expecting high benefits from innovating).

The "ahead of trend" component is assumed to explain the commercial attractiveness of user innovation. The rationale behind this idea is that market needs tend to evolve along the lines of certain underlying trends. Users residing at the leading edge of these trends will therefore experience needs today which the majority of the market will not experience until tomorrow. If users who are ahead of trends innovate in response to their own needs, the resulting solutions might subsequently become highly attractive to broader parts of the market. In the field of CAD systems, for example, one dominant market trend is increasing the density with which chips and circuits are placed on a board (Urban and von Hippel 1988). In the field of kite surfing, the general dominant trend is performing more radical aerial tricks (Franke et al. 2006). In both fields, the majority of users are heading in this direction, with certain users *more* and others *less* at the leading edge. Lead user innovations might be commercially attractive if they solve the future problems of the mass market.

The "high expected benefit" component draws on a major stream of literature in the economics of innovation, arguing that an entity's investment in an activity (i.e., innovating) heavily depends on the up-front estimate of its potential benefit (Mansfield 1968). Therefore, a user's innovation likelihood should also depend on the expected benefit dimension. Whereas manufacturers typically benefit indirectly from innovation (by selling new products), the users' benefit is more direct in nature (i.e., using new and better products). The benefit of an innovating surgeon, for example, might be related to solving a serious problem experienced in a specific operation – e.g., by inventing new processes or new medical devices. The high expected benefits of an innovating snowboarder might be related to seeing certain unsolved problems (e.g., poor control of the board when making sharp turns or performing new aerial tricks) and perceiving these problems to be so severe as to justify an investment in solving them.

Evidence of innovation by lead users

Several studies provide strong evidence to support lead user theory empirically (see Table 1). First, Urban and von Hippel (1988) clustered their sample of printed circuit CAD software users into lead users and non-lead users. They find that 87% of lead users (in contrast to only 1% of non-lead users) innovated. With regard to attractiveness, they find that a new PC CAD system which included lead user innovations was significantly preferred over the best commercially available system. Second, Morrison et al. (2000) studied the users of library information systems and operationalized the lead user construct using continuous multi-item scales (as being a lead user or not should not force a dichotomous answer; instead, the degree of lead userness should follow a unimodal distribution; cf. Morrison et al. 2004). They find that respondents' lead userness is significantly related to user innovation likelihood. Furthermore, they report that 70% of user innovations provided commercially important

improvements to existing products. Further evidence of innovation by lead users is provided by Lüthje (2003), who studied surgeons working at university clinics, and by Franke and von Hippel (2003), who studied webmasters using Apache's web server software.

Next, Franke and Shah (2003) analyzed whether this pattern could be also observed among end-users – i.e., consumers (as opposed to user companies like libraries or "professional" users like surgeons or webmasters). Studying four sports communities (canyoning, boardercross, handicapped cycling, and sailplaning), they find that user innovators again demonstrated significantly higher lead userness than non-innovators. In line with previous studies, a certain fraction of user innovations tends to be of high commercial interest (e.g., 15% of innovations were considered to be a completely new product). Similar results are reported for the field of consumer outdoor products (Lüthje 2004).

The most recent and a more rigorous test of lead user theory in a consumer goods setting is provided by Franke et al. (2006). They developed continuous multi-item scales for measuring the two lead user dimensions and surveyed 456 kite surfers. Here, lead users tend to perform more radical jumps in terms of the degree of difficulty, for example (being ahead of trend), and to be more dissatisfied or experience needs which are not covered by commercially available equipment (expecting high benefits from innovating). User innovators (31%) were asked to describe their innovations in detail, which were then evaluated by six experts in terms of commercial attractiveness. The results are affirmative. First, they find that both lead user components significantly explain (a) the general likelihood as well as (b) the likelihood of attractive user innovation (tested by logit regressions based on the entire data set). Second, they find that the "ahead of trend" component significantly explains the attractiveness of user innovation (tested by OLS regressions based on the user innovator sample). In line with lead

user theory, they conclude that if one aims to find the most attractive innovations from a given field of innovative users, one should primarily search for users who are ahead of trend. If, in contrast, one wishes to identify as many user innovations as possible (regardless of their commercial promise) or to identify attractive innovations from an unknown population, then they should search for users who demonstrate high lead userness.

Insert TABLE 1 about here

Antecedents and consequences of consumers' lead userness

The studies summarized in the previous section provide strong support for theory: Lead users tend to come up with attractive user innovation. Other than that, however, there is hardly any knowledge available which helps to describe and differentiate this "species" of user from more "ordinary" users. In the following, this gap is being addressed and hypotheses are developed aiming to link four antecedents with consumers' lead userness and a potentially important consequence is proposed: the link between lead userness and new product adoption behavior.

Antecedents of consumers' lead userness

What factors explain why some consumers tend to challenge the status quo of a given field more heavily than others and thus demonstrate higher lead userness? First, it is argued that a consumer's leading-edge status will depend on field-related variables, namely a consumer's basis of knowledge and use experience gained in the underlying field. Second, it is argued that field-independent variables might also matter. This is in line with the well-known person-situation perspective from psychology, in which a certain behavior is generally influenced by

field-related as well as field-independent factors (Burroughs and Mick 2004, Higgins 1990, Sternberg and Lubart 1996). Following recent work on creative consumer problem-solving (e.g., Burroughs and Mick 2004, Hirschman 1980), the two general personality traits of "locus of control" and "innovativeness" were identified as relevant to this research.[i]

(1) *Consumer knowledge*. Consumer knowledge in a given domain refers to the body of knowledge a consumer can draw on when facing consumption problems like selecting the appropriate product for a specific usage situation (Brucks 1985, Mitchell and Dacin 1996). It is therefore critical to find the proper means (solutions) to one's ends (needs). In this context, expert consumers are frequently described as having more knowledge about performance attributes, different physical components of products, and any attribute-performance relationships (Mitchell and Dacin 1996). With regard to lead user theory, it is argued that high levels of consumer knowledge will be a prerequisite for high lead userness. Before a user can push the limits of a certain domain, s/he needs to have a sound understanding of how to perform ordinary product-related tasks successfully (Alba and Hutchinson 1987). As more and more consumer knowledge is gained, users will develop better schemas, acquire new information more easily, engage in deeper levels of processing, and more thoroughly understand the complex and technical relationships of product-related challenges (e.g., Meeds 2004). This "theoretical" expertise in the field will enable users to move ahead of the trend, to experience leading-edge needs, and to challenge commercially available products. It is thus hypothesized:

Hypothesis 1: The greater one's consumer knowledge of the underlying field becomes, the stronger his/her lead userness will be.

(2) *Use experience.* Whereas consumer knowledge addresses know-how stemming from various sources beyond product usage (e.g., knowledge gained from secondary sources such as magazines), use experience can be understanded as knowledge generated by direct acquaintance (Russell 1948).[ii] Use experience therefore refers to learning from experience and to performance-related knowledge from primary product usage (Alba and Hutchinson 1987, Hoch and Deighton 1989). This aspect of field expertise is generally found to have a strong influence on actual behavior (e.g., Fazio and Zanna 1981). For lead user theory, it is argued that high levels of use experience will be necessary in order to demonstrate high lead userness. Before becoming leading-edge with respect to new needs and before challenging the status quo of equipment, one needs to become familiar with more ordinary product usage situations. As use experience gained in the underlying field increases over time, users will develop better usage skills and be in a better position to perceive and analyze existing usage problems more systematically, to conceive solutions, and to test these solutions in practice (Hoch and Deigthon 1989, Stein 1989, Weisberg 1986). It is therefore hypothesized:

Hypothesis 2: The higher one's level of use experience in the underlying field becomes, the stronger his/her lead userness will be.

Both consumer knowledge and use experience might be referred to as realized inputs or investments that are hypothesized to increase one's lead userness (i.e., output) directly. Note that these input variables might in turn be driven by certain variables such as available time and money or usage accessibility.

(3) *Locus of control (LOC).* Individuals who generally tend to believe that outcomes depend primarily on their own actions are said to have a high internal LOC and are referred to as

"internals" (Rotter 1966). LOC is therefore "an apt descriptor of individual differences in perceived behavior-outcome contingencies" (Leone and Burns 2000, p. 64). In psychology, this trait has long appeared as a key dimension of creativity (London and Exner 1978). Burroughs and Mick (2004), for example, have recently shown that LOC is an important antecedent of consumers' creativity in problem-solving contexts. For lead user theory, it is also proposed that consumers' lead userness will be impacted by their LOC. Internals will be more likely to leave the solid terrain of the ordinary, to cope with new usage situations, and to challenge and appreciate improvements in existing products. This is supported by a broad body of literature which suggests that internals generally tend to be more action-oriented, frequently commit to risky, innovative, and difficult tasks, and put a great deal of effort into mastering new situations. Externals, in contrast, tend to avoid new and difficult situations and believe that they lack the skills necessary to be effective problem-solvers (e.g., Hoffman et al. 2003, Hollenbeck et al. 1989, Howell and Avolio 1993). It is thus hypothesized:

Hypothesis 3: The more internal a consumer's locus of control (LOC) is, the stronger his/her lead userness will be.

(4) *Innovativeness.* Innate consumer innovativeness is "defined as a generalized unobservable predisposition toward innovations […]" (Im et al. 2003, p. 62). Although this trait more generally addresses the "consumption of newness", "willingness to change" (Hurt et al. 1977), "openness of information processing" (Leavitt and Walton 1975), or "consumer novelty seeking" (Hirschmann 1980, Manning et al. 1995), it is mostly reduced and frequently used to explain new product adoption across product domains (e.g., Midgley and Dowling 1978, Roehrich 2004). In psychology, however, innate consumer innovativeness measured as a trait is generally a well-established variable to explain creative achievements which go far beyond

mere adoptive behavior (Amabile 1983, Barron and Harrington 1981, Oldham and Cummings 1996). For lead user theory, it is also suggested that a consumer's lead userness will be influenced by one's innate innovativeness. Consumers characterized by innovative personalities will be more likely to cope with uncertain usage situations at the leading edge of the market, to question current commercial product offers, and to see room for promising improvements. This is supported by Kirton (1976, p. 623), who conceptualized "innovators" as people who break "patterns of accepted modes of thought and action" and who discover both problems and avenues of solution. They also "tend to take control in unstructured situations", are resistant to the customs of the past, and frequently challenge given rules in a risk-taking manner. It is therefore hypothesized:

Hypothesis 4: The more innovative a consumer's personality is, the stronger his/her lead userness will be.

Consequences of consumers' lead userness for new product adoption behavior

New product adoption behavior is defined as the degree to which an individual adopts innovations earlier or more heavily than others (Rogers and Shoemaker 1971). Are consumers with high lead userness different from more ordinary consumers with regard to adoptive behavior?

According to Rogers' (2003) innovation-decision process theory, individuals' readiness to adopt new products never emerges simultaneously for all users, but rather diffuses in a time sequence. First, it is argued that individuals seldom expose themselves to messages about a new solution unless they feel a need for innovation in the first place (with some individuals perceiving this need earlier than others). Second, one's readiness to adopt a particular new

product depends on whether it is perceived to allow new or improved execution of important activities (i.e., offering a significant relative advantage as opposed to competing products). Third, it is the individuals' ability to understand complex technical product attributes and their use implications – as well as the ability to cope with a high degree of uncertainty about innovations – which appear to be critical to the adoption process.

Against this background, it seems plausible that lead users will be among the first to adopt new products in the underlying field, especially because they are at the forefront of dominant market trends, they are the first to experience leading-edge needs, and they expect high benefits from new solutions. Some empirical support for this link between lead user theory and new product adoption is provided by studies on user innovation in user companies. First, Urban and von Hippel (1988) report that the users in their lead user cluster have adopted technologies an average of seven years before users in their non-lead user cluster. Second, Morrison et al. (2004) analyzed Australian libraries and found a strong relationship between the organizations' leading-edge status and their adoptive behavior regarding online database systems. For consumer fields, Lüthje (2004) also suggested that lead userness might be related to new product adoption. Furthermore, Franke and Shah (2003) report that innovating consumers, who also tend to be lead users, significantly benefit from adopting new products early. It is therefore hypothesized:

Hypothesis 5: A consumer's lead userness will positively impact his/her new product adoption behavior in the underlying domain.

Method

Overview

Three studies in consumer sports fields were conducted to test the hypotheses (see Table 2 for an overview). Study 1 analyzes the antecedents of individuals' lead userness in the field of sailplaning (H1 through H4). Study 2 explores the consequences of lead userness for new product adoption behavior in the field of technical diving (H5). Finally, Study 3 tests whether the findings from Studies 1 and 2 can be replicated in a different field. Two of the antecedents (H2, H4) as well as the consequences of lead userness for adoptive behavior (H5) are thus analyzed in the field of kite surfing.[iii] All hypotheses are tested using OLS regression analyses.

In all three domains, consumers tend to pursue the sport as a hobby and need to draw heavily on technical equipment to practice the sport. Furthermore, all three sports tend to evolve along the lines of one dominant market trend, with some users being more and others less leading-edge. This characteristic was a prerequisite for the study in order to enable proper and valid measurement of lead userness. The identification of fields and their dominant trends was strongly guided by secondary data analysis (e.g., magazines and websites) as well as various expert discussions (e.g., with heavy users, community webmasters, and equipment manufacturers).

In the following, this section describes the three research fields studied and reports on data collection, sample characteristics, and measurement. The limitations of the study and accompanying issues of generalizability are addressed in the discussion.

Insert TABLE 2 about here

Description of research fields, data collection, and sample characteristics

(1) *Sailplaners*. The roots of sailplaning (i.e., flying a plane without an engine) can be traced back to the post-WWI period, when flying with engines was prohibited (Wikipedia 2005), and the discipline has since evolved into a highly developed sport. Based on a literature review and expert discussions, it is found that the entire sport and all of its users follow the dominant trend of covering ever-longer distances (e.g., world record: 3,008 km, Wikipedia 2005). This is reflected, for example, in the largest sailplaning competition worldwide, the Online Contest (OLC), in which sailplaners are ranked according to their longest distances covered. The ranking system is highly sophisticated and formalized, with strict guidelines as to what counts and what does not, how to provide evidence of one's performance, and how to account for different models of gliders (cf. http://www2.onlinecontest.org/). Hence, the "consumption" of sailplaning is very much about performing well and improving along the lines of this trend.

Data was collected in May 2005 from "Streckenflug", the most important sailplaning community in the Alpine region, as focusing on a single region eliminates possible extraneous effects (such as thermal lift) on the sailplaners' performance. As nearly every Alpine sailplaner in German-speaking countries frequently visits www.streckenflug.at, the questionnaire was posted online with the support of the community webmaster. The link was online for two weeks, with a reminder thread posted after one week. This yielded a total of 129 valid responses with no missing values, indicating a satisfactory response rate of 25.8% (based on the webmaster's estimate of 500 distinct sailplaners who visited the website during that period).[iv] As a series of t-tests revealed neither systematic nor significant differences between early and late respondents (Armstrong and Overton 1977), there seems to be no concerns related to any non-response bias. Respondents were 35 years old on average (SD =

11.91) and predominantly male (96.90%). They started sailplaning an average of 15 years ago (SD = 10.65) and practice the sport 62 days per year (SD = 58.58).

(2) *Technical divers*. The overall sport of diving can be divided into several submarkets, with each following a different set of trends (e.g., technical diving, recreational scuba diving, surface-supplied diving, or saturation diving). Technical diving, which has been chosen for this study, refers to diving with a "ceiling" which prohibits a direct ascent to the surface. This ceiling can either be a mandatory stop (due to decompression requirements when diving at greater depths) or some type of physical barrier (diving in cave systems or inside shipwrecks; Wikipedia 2006a). Technical dives therefore generally involve significantly longer durations and/or greater depths than average recreational scuba dives, and they require advanced training and specialized equipment. The entire field is evolving along the latent and dominant trend of covering ever-longer periods of time in increasingly complex and difficult environments. This includes, for example, extended dives in unexplored and more sophisticated terrains (e.g., wrecks and caves which are difficult to access), resulting in an increased amount of time necessary to return to the surface. The identification of the field's dominant trend was again strongly guided by a literature review and expert discussions.

Data was collected in May 2005 from Global Underwater Explorers (GUE), the most important international tech diving community worldwide (www.gue.com). The questionnaire was sent via email to all GUE members with the support of GUE founder Jarrod Jablonski (including a reminder e-mail after one week). A total of 193 tech divers completed the questionnaire, indicating a satisfactory response rate of 20.2% (based on the 957 GUE members reached by e-mail). Again, there are no concerns of any non-response bias, which is supported by a series of t-tests (neither systematic nor significant differences between early

and late respondents could be identified). Respondents are 36 years old on average (SD = 8.05), predominantly male (94.3%), and consistently hold some formal tech diving certification. They have logged an average of 48.45 dives (SD = 67.04) over the last twelve months, and their average total number of logged dives comes to 303.27 (SD = 519.07).

(3) *Kite surfers*. Kite surfing refers to using a power kite to pull a small surfboard on the water (Wikipedia 2006b). Kites can be guided with and against the wind, and surfers can use the power of the kite to jump several meters into the air for several seconds at a time. The official take-off of this young sport roots back to the late 1990s, when the first competitions were held and the first kite surfing schools started operations (Kloos and Kappenstein 2004). Estimates for worldwide users range from 100,000 to 250,000, with strong projected growth rates for the coming years (Plastic 2004). As documented by Franke et al. (2006), the major trend in this sport is a continuous increase in performance over time. This performance is reflected by increasingly radical jumps – in terms of height above water, length of time in air, and the degree of difficulty of tricks.

This study revisits the sample collected by Franke et al. (2006), which consisted of several European kite communities. In December 2005, the questionnaire was sent via e-mail to 403 kite surfers, including a reminder e-mail after one week, and received 139 completed responses (corresponding to a response rate of 34.5%). Differences between early, late, and non-respondents do not reveal any significant bias. Once again, the respondents are predominantly male (92.0%) and in this case 30 years old on average (SD = 8.39). The average respondent started kite surfing three years ago (SD = 1.74) and practices the sport 63 days per year (SD = 65.02).

Measurement

Lead userness. Consumers' lead userness is determined by their relative trend position and their expected benefit from innovating. Measurement items were adapted from Franke et al. (2006). In Study 1 (sailplaners), consumers' lead userness is measured by seven items (Cronbach's alpha = .75), in Study 2 (tech divers) by eight items (alpha = .70), and in Study 3 (kite surfers) by nine items (alpha = .79). Sample items are listed in Table 3. In order to assess the predictive validity of these scales, respondents were asked in all three studies whether they had already innovated or not (1 = have innovated, 0 = have not innovated). Logistic regression analyses revealed a positive and highly significant effect of lead userness on innovation likelihood (see Table 3), thus indicating a valid measurement of the lead user construct.

Insert TABLE 3 about here

Consumer knowledge (H1). In Study 1 consumer knowledge was measured on the basis of subjective self-assessment (Park et al. 1994) following an operationalization proposed by Mitchell and Dacin (1996). Three items are used: "How high would you rate your expertise in sailplaning?", "How interested are you in the sport compared to other sailplaners?", and "How clear an idea do you have of which characteristics are important in providing you with maximum usage satisfaction when sailplaning (e.g., related to materials, equipment, and techniques)?" (all measured on 5-point scales where, for example, 1 = very low and 5 = very high; alpha = .70).

Use experience (H2). Use experience (the amount of product-related experience accumulated by the consumer, Alba and Hutchinson 1987) is measured in Studies 1 and 3 by the following

two items: "For how many years have you been sailplaning (kite surfing)?" and "How many days per year do you spend sailplaning (kite surfing)?". As these two indicators are clearly more formative than reflective in nature (Diamantopoulos and Winklhofer 2001), an interaction term is established to cover respondents' overall use experience.

Locus of control (H3). Rotter's locus of control (Study 1) was measured using the established ten-item short form (e.g., "What happens to me is my own doing"; rated on 5-point scales where 1 = strongly disagree and 5 = strongly agree; Valecha 1972, Burroughs and Mick 2004). The initial Cronbach's alpha for the scale was below the recommended .7 threshold (.63) (Nunnally 1978). Four items demonstrated low item-to-total correlations and were thus eliminated from the scale. Cronbach's alpha for the reduced scale was sufficiently high (.70). Correlations between the full and reduced scales revealed no apparent loss of substantial information ($r = .95$, $p<.001$). This is consistent with previous research indicating that personality instruments in general tend to be robust to modifications such as the number of items, measurement scales, or wording (cf. Villani and Wind 1975).

Innovativeness (H4). Kirton's Adaptive versus Innovative Personality Inventory (Kirton 1976) was employed to capture innovativeness (Studies 1 and 3). Like a number of studies (cf. Im et al. 2003), also this study focuses on Kirton's originality subdimension (11 items) to capture the consumers' innovative cognitive style (e.g., "How hard or how easy do you think it would be for you to describe yourself as a person who has fresh perspectives on old problems?"; rated on 5-point scales where 1 = very hard and 5 = very easy). The coefficient alphas for the scale were .83 (Study 1) and .74 (Study 3).

Adoptive behavior (H5). Researchers have used several different measures of adoptive behavior (cf. Im et al. 2003). The most important ones include the number of products owned (e.g., Foxall 1988/1995, Rogers 2003), the ownership of a particular product (e.g., Dickerson and Gentry 1983, LaBay and Kinnear 1981), and the relative time of adoption for a specific product (e.g., Midgley and Dowling 1993, Rogers and Shoemaker 1971).

In Study 2, adoptive behavior is first operationalized as the *number of products* owned from a set of six products (see Table 4 for details). All six products were launched on the global market between six and eighteen months before data collection (apart from the P-Valve, which was introduced four years ago). All products were selected using the criterion that they are generally capable of improving tech diving with regard to convenience, functionality, or safety (with selection strongly guided by expert interviews). Second, adoptive behavior is operationalized as the *time of adoption* of one particular product which has been on the market long enough to generate a reasonably high percentage of diffusion (the P-Valve, see Table 4).

In Study 3, adoptive behavior is first measured as the number of products owned from a set of four products introduced a maximum of one year earlier (see Table 4). As in Study 2, selection was guided by expert interviews, and all four products allow a significant improvement of kite surfing in general (related to performance and safety). Second, two more general proxies for adoptive behavior are employed: (1) annual spending on equipment and (2) replacement rate of main equipment parts (see Table 4).

Insert TABLE 4 about here

In order to control for variables identified in the literature as impacting new product adoption behavior and in order to assess the relative importance of lead userness, also the respondents' domain-specific innovativeness (DSI), age, and income was captured (Im et al. 2003).

DSI is a construct that aims to capture the tendency to adopt innovations within a specific domain of interest (Goldsmith and Hofacker 1991). DSI is measured in Studies 2 and 3 using the established six-item inventory developed by Goldsmith and Hofacker (1991). A sample item is "I like to buy tech diving (kite surfing) equipment before other people do." All six items were rated on a five-point scale (1=strongly disagree and 5=strongly agree). Cronbach's alphas for the scales were short of the .7 threshold (Study 2 = .67; Study 3 = .60). In Study 3, dropping one item (due to low item-to-total correlation) increased the alpha to .63, while the alpha could not be improved in Study 2. Despite these moderate alphas, there are no serious concerns that the measurement of this construct is flawed. First, all item-to-total correlations are sufficiently high (>.30). Second, findings reveal that the predictive validity of the scale is strong: Consistent with literature, the scale has a significant effect on new product adoption (see Table 6 and 7).

Finally, income (per year before taxes) is measured on an 8-point scale (where 1 = up to 10,000 euros and 8 = more than 70,000 euros).

Findings

Findings of Study 1 (sailplaners): Antecedents of lead userness

As described above, in Study 1 (sailplaners) the effects of all four antecedents on individual lead userness are tested (consumer expertise, use experience, locus of control, and

innovativeness). Overall, findings are affirmative (see Table 5). First, it is found that the extent of consumer knowledge in the underlying field demonstrated by sailplaners significantly influences their lead userness (H1: $\beta = .20$; $p < .05$). Second, it is found that a sailplaner's total use experience gained in the field contributes to explaining his/her lead userness (H2: $\beta = .16$; $p < .05$). Third, it is found that the more internal a person's locus of control is (H3: $\beta = .17$; $p < .05$) and the more innovative a person's personality (H4: $\beta = .14$; $p < .05$) is, the stronger his/her demonstrated lead userness will be. Consistent with hypotheses, it is thus found that lead users tend to be different from other users in terms of both field-related and field-independent variables.

Insert TABLE 5 about here

Findings of Study 2 (tech divers): Consequences of lead userness for adoptive behavior

In Study 2 (tech divers), the consequences of being a lead user in terms of new product adoption behavior are analyzed. The results are again affirmative (see Table 6). The lead userness of tech divers is positively and significantly related to adoptive behavior. The higher a consumer's lead userness, (1) the more new products are adopted ($\beta = .16$; $p < .05$) and (2) the faster their time of adoption is ($\beta = .39$; $p < .001$). Consistent with Hypothesis 5, it is thus found that lead users also tend to be more innovative than other users in terms of new product adoption behavior. In line with the literature on product adoption, it is also found that DSI is also closely related to the number of products adopted ($\beta = .26$; $p < .001$). However, the link to the time of adoption ($\beta = .12$; $p = .10$) is markedly weaker than the coefficient of lead userness. Finally, it is found that neither age nor income seems to have affected adoptive behavior in this field.

Insert TABLE 6 about here

Findings of Study 3 (kite surfers): Antecedents and consequences of lead userness

Study 3 (kite surfers), explores whether findings from Studies 1 and 2 can be replicated in a different field. In particular, one of the field-related (use experience) and one of the field-independent antecedents (innovativeness) as well as the consequences (adoptive behavior) of lead userness are re-analyzed. Findings are again in line with hypotheses (see Table 7). First, it is found that consumers' use experience (H2: $\beta = .51$; $p < .001$) as well as their innovative personality (H4: $\beta = .17$; $p < .05$) explains lead userness among kite surfers. Second, it is found that lead userness is strongly and significantly related to adoptive behavior (H5). This holds true for the number of new products adopted ($\beta = .25$; $p < .01$), yearly spending on kite surfing equipment ($\beta = .24$; $p < .01$), and the replacement rate for major equipment ($\beta = .39$; $p < .001$). The effect sizes are similar to those reported for DSI. Again, age and income do not impact adoptive behavior.

Insert TABLE 7 about here

Discussion

The aim of this article was to extend lead user theory by exploring the antecedents and consequences of consumers' lead userness. The results of three studies on extreme sports communities highlight the idea that field-related as well as field-independent variables impact consumers' leading-edge status in a given domain. Lead users tend to possess more consumer knowledge and use experience in the underlying field, demonstrate a high internal locus of control, and can be characterized as having innovative personalities. Furthermore, it is found

that consumers' lead userness is related to new product adoption behavior. Lead users tend to adopt new products in the underlying domain faster and more heavily than ordinary users. However, these findings are not only relevant to the advancement of lead user theory. As discussed in the sections below, they also have important implications for practitioners in innovation management and marketing who are interested in integrating lead users into product development tasks.

Implications for integrating lead users into the design and marketing of new products

Integrating lead users into corporate NPD has been shown to be a highly promising means of developing breakthrough ideas (e.g., Urban and von Hippel 1988, Lilien et al. 2002). Due to the limited understanding of who lead users are, however, one major challenge in applying the lead user method is the identification of leading-edge users in the first place. Olson and Bakke (2001), for example, carried out a longitudinal study on the employment of the lead user method in a high-tech firm. Although it was successful at the start, the lead user method was not made a permanent part of the new product development process. One major reason was the high effort and extra time required to find experts for trend analysis and lead users for concept generation.

The findings of this study suggest that the field-dependent (consumer expertise and use experience) as well as field-independent variables (locus of control and innovativeness) might improve the lead user search process. First, these variables might help to narrow the search field significantly when one needs to screen user markets with several hundred thousand consumers (e.g., by focusing on certain communities of highly experienced users). Second, the variables might also improve the search process if pyramiding (instead of screening) is employed to identify lead users. The pyramid networking technique "relies on the fact that

people with a strong interest in a topic or field tend to know people *more* expert than themselves" (Lilien et al. 2002, p. 1045). Few people are used at the start. A process of recommendation and referral is applied, and several lead users should be identified as a result. Recently, von Hippel et al. (2005) have shown experimentally that the chosen starting points significantly impact the search efficiency of pyramiding. The antecedents of consumers' lead userness might help in identifying the most promising persons to start with.

The finding that leading-edge users tend to adopt new products faster and more heavily than more ordinary users suggests that lead users might be highly valuable to companies beyond the fuzzy front end of generating radically new product concepts. For example, they might be integrated into new product concept testing methods. One common problem here is that ordinary consumers find it difficult to evaluate the potential value of new concepts and products accurately, especially when they are more radical in nature (e.g., Veryzer 1998, Hoeffler 2003). It seems reasonable that the users of today's products and services (in the center of the target market) are poorly positioned to envision the needs or solutions of tomorrow. In contrast, users at the leading edge of the market should be more valuable in this regard: They experience needs today that the mass market will only experience in months or years. If there are individuals who are already living the future of the mainstream, why not integrate them?

Finally, consumers' lead userness might serve as an additional positioning variable for the marketing of new products. If lead users are among the first to adopt, they can subsequently serve as opinion leaders who fuel and accelerate the process of diffusing newly launched products (Morrison et al. 2004, Urban and von Hippel 1988).

Generalizations and future research

As the goal of this research was to test the proposed extension of lead user theory, primarily issues of internal validity had to be stressed (Calder et al. 1981). For example, one key prerequisite here was to identify domains where users evolve along the lines of one dominant market trend (in order to enable valid measurement of lead userness). As a result, there was a need to study highly specialized fields, which generally calls for a discussion of external validity. An initial argument in favor of the external validity of the findings is provided by Study 3, where support for the main propositions could be again found in a different field. At first sight, however, one might argue that all three domains studied appear to be very unique, thus questioning generalizability beyond these extreme sports communities. This seems to be true with regard to the specific intended usage (e.g., flying a plane without an engine) as well as the specific dominant trend (e.g., covering ever-longer distances). However, it is argued that the general underlying mechanism of these fields is very similar to any other consumer field: Consumers start to get interested in an activity, invest physical or mental energy in order to familiarize themselves with ordinary usage patterns, and gain knowledge and experience over time. Users "equipped" with innovative personalities and strong field expertise will be those at the leading edge of the market who will challenge the status quo and shape the needs of the future. In turn, they will be among the first to adopt new products upon market introduction – be they kite surfers, computer gamers, or software users, for example.

In conclusion, future studies are invited to address the external validity of the findings reported in this article by analyzing whether the patterns reported here can be replicated in different consumer domains and whether they can also be transferred to professional user fields (e.g., surgeons or engineers). It might also be valuable to identify further field-related (e.g., involvement) as well as field-independent variables (e.g., need for achievement) which

are likely to help explain individuals' lead userness. Finally, the above-mentioned practical implications of the extension of lead user theory might serve as a basis for further empirical studies. In this way, one might shed more light on the important "species" of lead users and extend the knowledge on how to reclaim the territory of user innovation for innovation management and the marketing of new products.

References

Alba, Joseph W. and Hutchinson, Wesley J. (1987). Dimensions of Consumer Expertise. *Journal of Consumer Research* 13(4):411-54.

Amabile, Teresa M. (1983). *The Social Psychology of Creativity*. New York: Springer.

Armstrong, Scott J. and Overton, Terry S. (1977). Estimating Non response Bias in Mail Surveys. *Journal of Marketing Research* 14(3):396-402.

Barron, Frank and Harrington, David M. (1981). Creativity, Intelligence, and Personality. *Annual Review of Psychology* 32:439-76 (January).

BFN (2005), web: http://www.bfn.de/natursport/test/SportinfoHTML/segelflug.php, accessed on 4 July 2005.

Brucks, Merrie (1985). The Effects of Product Class Knowledge on Information Search Behavior. *Journal of Consumer Research* 12(1):1-16.

Burroughs, James E. and Mick, David G. (2004). Exploring Antecedents and Consequences of Consumer Creativity in a Problem-Solving Context. *Journal of Consumer Research* 31(2):402-11.

Calder, Bobby J., Phillips, Lynn W., and Tybout, Alice M. (1981). Designing Research for Application. *Journal of Consumer Research* 8(2):197-208.

Coyne, William (2000). Lead User: A Conversation with William Coyne. *Health Forum Journal* 43(4):28-9.

Dehne, Tim (2003). The Corporate Culture and Customer-Inspired Innovation. *R&D Magazine* 45(5):11-3.

Deutskens, Elisabeth, de Ruyter, Ko, Wetzels, Martin, and Oosterveld, Paul (2004). Response Rate and Response Quality of Internet-Based Surveys: An Experimental Study. *Marketing Letters* 15(1):21-36.

Diamantopoulos, Adamantios and Winklhofer, Heidi M. (2001). Index Construction with Formative Indicators: An Alternative to Scale Development. *Journal of Marketing Research* 38(2):269-77.

Dickerson, Mary D. and Gentry, James W. (1983). Characteristics of adopters and non-adopters of home computers. *Journal of Consumer Research* 10(2):225-35.

Economist (2005). The Future of Innovation: The Rise of the Creative Consumer. March 12th-18th:61-2.

Enkel, Ellen, Javier, Perez-Freije, and Gassmann, Oliver (2005). Minimizing Market Risks Through Customer Integration in New Product Development: Learning from Bad Practice. *Creativity and Innovation Management* 14(4):425-37.

Fazio, Russel H. and Zanna, Mark P. (1981). Direct Experience and Attitude-Behavior Consistency. In: *Advances in Experimental Social Psychology* (14). Leonard Berkowitz (ed.). New York: Academic Press, 161-202.

Foxall, Gordon R. (1988). Consumer Innovativeness: Novelty Seeking, Creativity and Cognitive Style. In: Research in Consumer Behavior (3).Elisabeth C. Hirschman and Jagdish N. Seth (eds.) Greenwich, CT: JAI, 79-113.

Foxall, Gordon R. (1995). Cognitive styles of consumer initiators. *Technovation* 15(5):269-88.

Franke, Nikolaus and Shah, Sonali (2003). How Communities Support Innovative Activities: An Exploration of Assistance and Sharing Among End-Users. *Research Policy* 32(1):157-78.

Franke, Nikolaus and von Hippel, Eric (2003). Finding commercially attractive user innovation: An exploration and test of "lead user" theory. MIT Sloan School of Management Working Paper (Center for eBusiness) No. 183.

Franke, Nikolaus, von Hippel, Eric, and Schreier, Martin (2006). Finding commercially attractive user innovations: A test of lead user theory. *Journal of Product Innovation Management* forthcoming.

Goldsmith, Ronald E. and Hofacker, Charles F. (1991). Measuring consumer innovativeness. *Journal of the Academy of Marketing Science* 19(3):1004-16.

Gruner, Kjell E. and Homburg, Christian (2000). Does Customer Interaction Enhance New Product Success. *Journal of Business Research* 49(1):1-14.

Herstatt, Cornelius and von Hippel, Eric (1992). Developing New Product Concepts Via the Lead User Method: A Case Study in a "Low-Tech" Field. *Journal of Product Innovation Management* 9(3):213-21.

Hienerth, Christoph and Pötz, Marion (2005). Making the Lead User Idea-Generation Process a Standard Tool for New Product Development. R&D Management Conference, Pisa (Italy), July.

Higgins, Tory E. (1990). Personality, Social Psychology, and Person-Situation Relations: Standards and Knowledge Activation as a Common Language. In: *Handbook of Personality: Theory and Research*. Lawrence A. Pervin (ed.). London: Guilford, 201-38.

Hirschman, Elizabeth C. (1980). Innovativeness, Novelty Seeking, and Consumer Creativity. *Journal of Consumer Research* 7(3):283-95.

Hoch, Stephen J. and Deighton, John (1989). Managing What Consumers Learn from Experience. *Journal of Marketing* 53(2):1-20.

Hoeffler, Steve (2003). Measuring Preferences for Really New Products. *Journal of Marketing Research* 40(4):406-20.

Hoffman, Donna L., Novak, Thomas P., and Schlosser, Ann E. (2003). Locus of Control, Web Use, and Consumer Attitude. *Journal of Public Policy & Marketing* 22(1):41-57.

Hollenbeck, John R., Williams, Charles R., and Klein, Howard J. (1989). An Empirical Examination of the Antecedents of Commitment to Difficult Goals. *Journal of Applied Psychology* 74(1):18-23.

Howell, Jane M. and Avolio, Bruce J. (1993). Transformational Leadership, Transactional Leadership, Locus of Control, and Support for Innovation: Key Predictors of Consolidated-Business-Unit Performance. *Journal of Applied Psychology* 78(6):891-902.

Hurt, Thomas H., Joseph, Katherine, and Cook, Chester D. (1977). Scale for the Measurement of Innovativeness. *Human Communication Research* 4(1):58-65.

Im, Subin, Bayus, Barry L., and Mason, Charlotte H. (2003). An Empirical Study of Innate Consumer Innovativeness, Personal Characteristics, and New-Product Adoption Behavior. *Journal of the Academy of Marketing Science* 31(1):61-72.

Intrachooto, Singh (2004). Lead users concept in building design: Its applicability to member selection in technologically innovative projects. *TQM Magazine* 16(5):359-68.

Kaulio, M.A. (1998). Customer, consumer and user involvement in product development: A framework and a review of selected methods. *Total Quality Management* 9(1):141-49.

Kirton, Michael (1976). Adaptors and Innovators: A Description and Measure. *Journal of Applied Psychology* 61(5):622-29.

Kloos, Gerd and Kappenstein, Jörn (2004). *Kitesurfing New School*. Andechs: Boarder Vision.

Kristensson, Per, Gustafsson, Anders, and Archer, Trevor (2004). Harnessing the Creative Potential among Users. *Journal of Product Innovation Management* 21(1):4-14.

LaBay, Duncan G. and Kinnear, Thomas C. (1981). Exploring the consumer decision process in the adoption of solar energy systems. *Journal of Consumer Research* 8(3):271-78.

Leavitt, Clark and Walton, John (1975). Development of a Scale for Innovativeness. In: *Advances in Consumer Research* (2). Mary Jane Schlinger (ed.). Ann Arbor, MI: Association for Consumer Research, 545-54.

Leone, Christopher and Burns, Joseph (2000). The Measurement of Locus of Control: Assessing More Than Meets the Eyes? *Journal of Psychology* 134(1):63-76.

Lilien, Gary, Morrison, Pamela D., Searls, Kathleen, Sonnack, Mary, and von Hippel, Eric (2002). Performance Assessment of the Lead User Generation Process for New Product Development. *Management Science* 48(8):1042-59.

London, Harvey and Exner, John E. Jr. (1978). *Dimensions of Personality*. New York: Wiley.

Lüthje, Christian (2003). Customers as Co-Inventors: An Empirical Analysis of the Antecedents of Customer-Driven Innovations in the Field of Medical Equipment. Proceedings of the 32nd EMAC Conference, Glasgow.

Lüthje, Christian (2004). Characteristics of Innovating Users in a Consumer Goods Field. An Empirical Study of Sport-related Product Consumers. *Technovation* 24(9):683-95.

Lüthje, Christian and Herstatt, Cornelius (2004). The Lead User method: an outline of empirical findings and issues for future research. *R&D Management* 34(5):553-68.

Lüthje, Christian, Herstatt, Cornelius, and von Hippel, Eric (2005). User-innovators and "Local" Information: The Case of Mountain Biking. *Research Policy* 34(6):951-65.

Manning, Kenneth C., Bearden, William O., and Madden, Thomas J. (1995). Consumer Innovativeness and Adoption Process. *Journal of Consumer Psychology* 4(4):329-45.

Mansfield, Edwin (1968). *Industrial Research and Technological Innovation: An Econometric Analysis*. New York: W.W. Norton.

Meeds, Robert (2004). Cognitive and attitudinal effects of technical advertising copy: the roles of gender, self-assessed and objective consumer knowledge. *International Journal of Advertising* 23(3):309-35.

Midgley, David F. and Dowling, Grahame R. (1978). Innovativeness: The Concept and its Measurement. *Journal of Consumer Research* 4(4):229-42.

Mitchell, Andrew A. and Dacin, Peter A. (1996). The Assessment of Alternative Measures of Consumer Expertise. *Journal of Consumer Research* 23(3):219-39.

Morrison, Pamela D., Roberts, John H., and Midgley, David F. (2004). The Nature of Lead Users and Measurement of Leading Edge Status. *Research Policy* 33(2):351-62.

Morrison, Pamela D., Roberts, John H., and von Hippel, Eric (2000). Determinants of User Innovation and Innovation Sharing in a Local Market. *Management Science* 46(12):1513-27.

Nunnally, Jim (1978). *Psychometric Theory*. New York: McGraw-Hill.

Oldham, Greg R. and Cummings, Anne (1996). Employee Creativity: Personal and Contextual Factors at Work. *Academy of Management Journal* 39(3):607-34.

Olson, Erik L. and Bakke, Geir (2001). Implementing the Lead User Method in a High Technology Firm: A Longitudinal Study of Intentions versus Actions. *Journal of Product Innovation Management* 18(2):388-95.

Park, Whan C., Mothersbaugh, David L., and Feick, Lawrence (1994). Consumer Knowledge Assessment. *Journal of Consumer Research* 21(1):71-82.

Pitta, Dennis, Franzak, Frank, and Pitta, Dennis (1997). Boundary spanning product development in consumer markets: learning organization insights. *Journal of Product and Brand Management* 6(4):235-53.

Plastic (2004), web: http://www.plastic.com/comments.html;sid=04/04/22/03341574;cid=2, accessed 28 January 2006.

Roehrich, Gilles (2004). Consumer Innovativeness. Concepts and Measurement. *Journal of Business Research* 57(6):671-77.

Rogers, Everett M. and Shoemaker, Floyd F. (1971). *Communication of Innovations*. New York: John Wiley & Sons.

Rogers, Everett M. (2003). *Diffusion of Innovation* (5th ed.). New York: The Free Press.

Rotter, Julian B. (1966). Internal-external Control and Reinforcement. *Psychological Monographs* 80(1):Whole No. 609.

Russell, Bertrand (1948). *Human Knowledge: Its Scope and Limits*. London: George Allen & Unwin Ltd.

Shah, Sonali (2000). Sources and Patterns of Innovation in a Consumer Products Field: Innovations in Sporting Equipment. MIT Sloan School of Management Working Paper No. 4105.

Stein, Barry S. (1989). Memory and Creativity. In: *Handbook of Creativity*. J.A. Glover, R.R. Ronning, and C.R. Reynolds (eds.). New York: Plenum Press, 163-76.

Sternberg, Robert J. and Lubart, Todd I. (1996). Investing in Creativity. *American Psychologist* 51(7):677-88.

Urban, Glen and von Hippel, Eric (1988). Lead User Analyses for the Development of New Industrial Products. *Management Science* 34(5):569-82.

Valecha, Gopal K. (1972). Construct Validation of Internal-External Locus of Control as Measured by an Abbreviated 11-Item IE Scale. Unpublished doctoral dissertation, Psychology Department, The Ohio State University, Columbus, 43210.

Veryzer, Robert W. (1998). Key Factors Affecting Customer Evaluation of Discontinuous New Products. *Journal of Product Innovation Management* 15(2):136-50.

Villani, Kathryn E. and Wind, Yoram (1975). On the Usage of "Modified" Personality Trait Measures in Consumer Research. *Journal of Consumer Research* 2(3):223-28.

Von Hippel, Eric (1986). Lead Users: A Source of Novel Product Concepts. *Management Science* 32(7):791-806.

Von Hippel, Eric (2002). Horizontal Innovation Networks – by and for Users. MIT Sloan School of Management Working Paper No. 4366-02.

Von Hippel, Eric (2005). *Democratizing Innovation*. Boston/Cambridge: MIT Press.

Von Hippel, Eric, Franke, Nikolaus, and Prügl, Reinhard (2005). Screening vs Pyramiding: Efficient Identification of Leading-Edge Expertise. Proceedings of the Academy of Management Conference, Honolulu, August.

Weisberg, Robert (1986). *Creativity: Genius and Other Myths*. New York: Freeman.

Wikipedia (2005), web: http://de.wikipedia.org/wiki/Segelfliegen, accessed on 4 July 2005.

Wikipedia (2006a), web: http://de.wikipedia.org/wiki/Technisches_Tauchen, accessed on 20 January 2006.

Wikipedia (2006b), web: http://de.wikipedia.org/wiki/Kite-Surfing, accessed on 25 January 2006.

TABLE 1
Evidence of innovation by lead users

Product field	Method	Key findings (related to lead user theory)	Source
PC-CAD software	• Sample: PC-CAD users (n=136) • Measurement: 7 items for lead userness, including the question of whether users innovated (23%) or not • Analysis: cluster analysis • In addition, 5 lead users jointly developed an improved PC-CAD system, which was then evaluated by 71 PC-CAD users compared to respondents' current systems and the best commercially available systems	• 87% of the lead user cluster had already innovated (as opposed to 1% of the non-lead user cluster) • The concept developed by lead users was significantly preferred over competing PC-CAD systems	Urban/von Hippel 1988
Library information systems	• Sample: Australian libraries (n=102) • Measurement: 7 items for lead userness ("leading-edge status"); user innovators (26%) described their innovations, which were then evaluated by 2 experts using 2 items for commercial attractiveness • Analysis: logit regression	• Lead userness explains likelihood of user innovation • 70% of innovations provided functionality improvements of at least "medium" importance to commercial vendors	Morrison et al. 2000
Surgery at university clinics	• German surgeons (n=262) • Measurement: 6 items for lead userness; user innovators (22%) were asked whether their innovations were or soon would be commercialized • Analysis: logit regression	• Lead userness explains likelihood of user innovation • 48% of innovations were or soon would be marketed by manufacturers of medical equipment	Lüthje 2003

Canyoning, boardercross, handicapped cycling, and sailplaning	• Members of German communities for the respective sports (n=197) • Measurement: 7 items for lead userness; user innovators (32%) described and rated their innovations in terms of newness and market potential and indicated whether their innovations were or soon would be commercialized • Analysis: t-tests	• Innovators demonstrated higher lead userness than non-innovators • 15% of innovations were considered to be a completely new product • 24% of innovations were considered to have high market potential • 23% of innovations were or soon would be produced for sale by manufacturers	Franke/Shah 2003
Web server software	• Sample: Apache webmasters (n=138) • Measurement: 2 items for lead userness; user innovators (23%) described their innovations, which were then evaluated by the users themselves and 2 experts using 2 items for commercial attractiveness • Analysis: logit and OLS regressions	• Lead userness explains likelihood of user innovation (total sample) • Lead userness explains likelihood of attractive user innovation (total sample) • Being ahead of trend explains attractiveness of user innovation (user innovator sample)	Franke/von Hippel 2003
Consumer outdoor products	• Sample: Customers of two outdoor product manufacturers (n=153) • Measurement: 2 items for lead userness ("innovation-related core benefit"); user innovators: 37%	• Lead userness explains likelihood of user innovation	Lüthje 2004
Kite surfing	• Sample: European kite surfers (n=414) • Measurement: 9 items for lead userness; user innovators (31%) described their innovations, which were then evaluated by 6 experts using 6 items for commercial attractiveness • Analysis: logit and OLS regressions	• Lead userness explains likelihood of user innovation (total sample) • Lead userness explains likelihood of attractive user innovation (total sample) • Being ahead of trend explains likelihood of attractive user innovation (user innovator sample) • Being ahead of trend explains attractiveness of user innovation (user innovator sample)	Franke et al. 2006

TABLE 2
Overview of studies

	Study 1: Sailplaners	Study 2: Tech divers	Study 3: Kite surfers
Test of hypotheses	H1, H2, H3, H4	H5	H2, H4, H5
Sample	Alpine gliders (Streckenflug.at)	Global Underwater Explorers (GUE.com)	Multi-sample (Franke et al. 2006)
n (response rate)	129 (25.8%)	193 (20.2%)	139 (34.5%)
Final measurement: Lead userness (α)	7 items (.75)	8 items (.70)	9 items (.79)
H1: Cons. knowledge	3 items (.70)	-	-
H2: Use experience	2 items (interaction)	-	2 items (interaction)
H3: Locus of control	6 items (.70)	-	-
H4: Innovativeness	11 items (.83)	-	11 items (.74)
H5: Adopt. behavior	-	• # of adoptions • time of adoption	• # of adoptions • spending on equipment • equipment replacement rate
Domain-specific innovativeness	-	6 items (.67)	5 items (.63)

TABLE 3
Trend, sample items, and predictive validity of lead userness

	Study 1: Sailplaners	Study 2: Tech divers	Study 3: Kite surfers
Dominant trend	• covering longer distances	• diving in complex and difficult environments	• more radical jumps (height, duration, difficulty of tricks)
Sample items	• "What was your best performance related to the longest distance covered in the 2004 season?" • "I have needs related to sailplaning which are not covered by the equipment currently offered on the market"	• "Compared to most other tech divers I do very long dives with overhead barriers (wrecks/caves)" • "While tech diving, I am often confronted with problems that can not be solved by the tech diving equipment available on the market"	• "How well can you jump when kite surfing?" (Thurstone scale) • "While kite surfing, I am often confronted with problems which can not be solved by the kite surfing equipment available on the market"
Predictive validity	Logit regression (1 = user innovated; 0 = user did not innovate)		
Coefficient (p-value) of lead userness	.918 (.001)	.027 (.000)	1.731 (.000)
R^2 (Nagelkerkes)	.126	.136	.295
- 2 Log likelihood	166.002	229.180	132.418
χ^2 (p-value)	12.760 (.000)	20.046 (.000)	32.906 (.000)

Note: All rating items are measured using 5-point scales where 1 = completely disagree and 5 = completely agree.

TABLE 4
Measurement of adoptive behavior

	Study 2: Tech divers	Study 3: Kite surfers
Number of adoptions	Set of six products (0 = none; 6 = all six adopted) Products: • HALCYON Safety Spool "Cold Water" Defender 100 • HALCYON Wet Notes with Cordura Cover • DUI Dry Suit Explorer Cave Edition • DUI Dry Suit Underwear Lite Loft Thinsulate • HALCYON Balanced P-Valve • HALCYON LED Backup Scout	Set of four products (0 = none; 4 = all four adopted) Products: • New kite with 5th line • New bar system for 5th line or adaptation of 4-line bar for use with 5th line • Unhooked system • Suit/vest with impact protection with or without integrated buoyancy aids or padding
Time of adoption	Year of adoption (reverse coded in Table 6) Product: • HALCYON Balanced P-Valve	-
Equipment	-	"Approximately how much money do you spend on kite surfing equipment per year?" (measured in euros)
Replacement rate	-	"How often do you replace your kite surfing equipment?" Consisting of three scales for kite, bar/safety, and board (6-point scales with 1 = less frequently than every second year; 6 = more often than twice a year)

TABLE 5
Results of Study 1 (sailplaners)

Antecedents of consumers' lead userness		
Independent variables	β estimate	p-value
Field-related variables		
H1: Consumer knowledge	.199	.014
H2: Use experience	.159	.036
Field-independent variables		
H3: Locus of control	.174	.023
H4: Innovativeness	.143	.047

OLS regression (n=129); dependent variable: lead user index; R^2=.117 (F=4.106; p<.01); p-values are one-sided.

TABLE 6

Results of Study 2 (tech divers)

Consequences of consumers' lead userness for adoptive behavior				
	Number of adoptions		Time of adoption	
Independent variables	β estimate	p-value	β estimate	p-value
H5: Lead userness	.161	.011	.387	.000
Domain-specific innovativeness (DSI)	.261	.000	.117	.102
Income	-.072	.167	-.052	.300
Age	.048	.260	.022	.422

OLS regression for number of adoptions (n=193); R^2=.115 (F=6.103; p<.001); and for time of adoption (n=109); R^2=.156 (F=4.788; p<.01); p-values are one-sided.

TABLE 7

Results of Study 3 (kite surfers)

Antecedents of consumers' lead userness		
Independent variables	β estimate	p-value
Field-related variables		
H2: Use experience	.512	.000
Field-independent variables		
H4: Innovativeness	.167	.011

OLS regression (n=139); dependent variable: lead user index; R^2=.311 (F=30.733; p<.001); p-values are one-sided.

Consequences of consumers' lead userness for adoptive behavior						
	Number of adoptions		Equipment		Replacement rate	
Independent variables	β estimate	p-value	β	p	β	p
H5: Lead userness	.254	.002	.242	.003	.388	.000
DSI	.285	.001	.284	.001	.324	.000
Income	-.053	.295	.034	.372	-.109	.130
Age	.005	.478	-.035	.363	-.083	.143

OLS regressions (n=139) for number of adoptions; R^2=.183 (F=7.236; p<.001); spending on equipment; R^2=.182 (F=7.066; p<.001); and for time of adoption; R^2=.327 (F=15.553; p<.001); p-values are one-sided

Endnotes

[i] It is noted, however, that other traits might have served as alternative starting points. Barron and Harrington (1981), for example, review a huge set of personality traits which are relevant to creativity research in general.

[ii] Note that consumer knowledge and use experience are not completely unrelated in theoretical and empirical terms (e.g., Park et al. 1994). Despite possible intersections (i.e., positive correlations), they still address distinct sources of consumer expertise (Alba and Hutchinson 1987). For this study, both aspects are expected to contribute independently to explaining consumers' lead userness. In fact, consumer knowledge and use experience are found to be only moderately correlated (r = .29; Study 1).

[iii] One of the field-related (H2) and one of the field-independent antecedents (H4) were randomly picked to keep the overall questionnaire as parsimonious as possible. This was done in order to ensure a satisfactory response rate, which seems particularly critical for online surveys (e.g., Deutskens et al. 2004).

[iv] This estimate is backed by the fact that an average of 1,000 distinct sailplaners visit the website per month (based on server log file analyses by the webmaster).