Prometheus, 2013
Vol. 31, No. 2, 125–138, http://dx.doi.org/10.1080/08109028.2013.818790

Routledge
Taylor & Francis Group

RESEARCH PAPER

Users as innovators? Exploring the limitations of user-driven innovation

Paul Trott*, Patrick Van Der Duin and Dap Hartmann

Faculty of Technology, Policy & Management, Delft University of Technology, Delft, The Netherlands

Considering users as innovators has gained considerable support over the past 30 years. Eric von Hippel's work in this area forms a significant part of the theoretical underpinning and evidence behind this concept. Many further studies have been undertaken to support it. It has contributed to our understanding of innovation management in general and new product development in particular. Even so, Lüthje and Herstatt emphasise that empirical findings are scarce and that the most radical innovations of the last 35 years were not developed by users. Thus, in this paper we critically review the lead-user theory and focus on three specific areas of weakness of the lead-user concept (conceptual, methodological, empirical), and argue that improvement in these areas would considerably strengthen its standing. We conclude that although lead users can contribute to the innovation process, this contribution should not be overstated, and that insufficient attention has been paid to the limitations of this theory.

Introduction

The theory that users innovate has become established within the mainstream innovation management literature. It has challenged the technology push model of innovation that had dominated science and innovation policy since the 1950s and beyond (Bush, 1945a). Indeed, research exploring the role of users as innovators has been extensive. It covers a diverse group of academic fields adopting a variety of theoretical perspectives, including social exchange theories and economic incentives theories for information sharing. Furthermore, studies on lead-user characteristics apply theoretical work from marketing and psychology (such as motivation and creativity theories) and within innovation management and technology forecasting the lead-user concept has a common currency and it is operationalised into management decision making. In view of this, we refer to this body of work as the lead-user school.

Support for the idea of users as innovators has grown over the past 30 years, However, it has grown without significant critical appraisal. This is surprising since, for instance, a quick glance at the most important innovations of the last 35 years (such as the Internet, the cell phone and the personal computer) shows that user involvement was quite low. We elaborate on this issue. Recently, Schreier and Prügl (2008) have argued for extending the lead-user concept beyond idea generation to

*Corresponding author. Email: paul.trott@port.ac.uk

more general issues in the marketing of new products. Although, Bogers *et al*. (2010) have recently put forward a review and critique of users as innovators, they are merely looking for theoretical holes in order to fill these and thereby strengthen the theory. We offer a wider appraisal in an attempt to address this gap in the literature on lead users.

This paper deals with the question of what the limitations are of the lead-user school. This question has arisen following our recent experiences of working with start-up firms at technical universities in the Netherlands. Many of these start-up firms involved advanced technology applications developed initially at the university. Our views have been informed by our observations of these start-up firms engaging with potential users and customers. We identify three key areas of weakness of users as innovators and suggest that further improvements are needed in the theory. We will argue that although lead users can contribute to the innovation process, this contribution has been overstated and that insufficient attention has been paid to the limitations of this approach. The issues raised in this paper generate clear innovation policy implications for the firm and for government officials involved in developing innovation policies. Both need to ensure that their search for sources of innovation is not overly reliant on users, for curiosity-driven research unfettered by the market will surely continue to provide a rich source of technological innovations.

The following section summarises the literature on lead users. Next, we present three points of criticism on the lead user concept and we end this paper with the implication of our criticism for how companies should deal with users as sources for innovation and for governmental innovation policy.

Users as innovators: an overview

Benoit Godin has written extensively on the intellectual history of innovation. This helps us place users as innovators within the innovation literature. His work provides a detailed account of the development of this category of innovation. In *Innovation Studies: The Development of a Speciality* (Godin, 2010a, 2010b), he explains how two traditions emerged. The first, in the US, was concerned with technological change as the use of inventions in industrial production, and the second, in Europe, was concerned more specifically with commercialised invention. The European tradition, which was developed as late as the 1970s, restricted the previously broader definition of innovation as the introduction of change to a narrower focus on technology and commercialisation. Christopher Freeman is usually credited as responsible for this European tradition, which shifted the focus of studies of innovation from invention to diffusion and the consideration of policy issues, specifically economic growth. The idea of a professionalised R&D system was proposed as having a key role. According to Godin, this is now the position adopted by many public organisations, including the OECD.

Godin argues that Freeman transformed an old meaning of technological innovation (introducing technical change within firms) to commercialising technological invention, and so helped build a new tradition. The European tradition saw invention as part of the innovation process and introduced the function of market uncertainty. This begins to shift the focus to product development and the role of users in the testing of such products. In addition, Godin identified another rationale that Freeman put forward for wanting to include users of the technology: ‘Freeman believed that there is a failure in the market mechanism in relation to technical

change in consumer goods and services' (Godin, 2010b, p.26). Godin concludes by suggesting somewhat mischievously that the two different traditions have emerged on different continents and continue to exist in almost total ignorance of each other. This helps to explain the emergence of different views on how to delineate innovation.

In his seminal and often cited work, Eric von Hippel was first to identify and evidence the role of users as innovators. In this study of medical equipment manufacturers in the 1970s, he claimed that 80% of innovations were developed by users (von Hippel, 1976, 1977a). He argued that users were the major source of innovation. Following this ground-breaking work, other studies have identified different types of user innovations; for example, 'consumer users' and 'intermediate users'. Von Hippel (1988) argues that users in general and 'lead users' in particular are a source of innovation and considers the notion that companies (i.e. product manufacturers) innovate to be a 'basic assumption [which] is often wrong' and which reflects a 'manufacturer-as-innovator bias', but is nevertheless conventional wisdom (p.117). The lead-user school sees a (predictable) distributed innovation process of which the sources vary greatly and in which users play a very important, but overlooked role. There have been several studies that provide strong evidence to support lead users as innovators. Urban and von Hippel (1988) find that 87% of lead users (in contrast to 1% of non-lead users) innovated. 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. In addition, Franke *et al*. (2006) studied kite surfers and found that those users who demonstrated high 'lead-usern-ess' were more likely to develop commercially attractive innovations.

In their review of users as innovators in the *Journal of Management*, Bogers *et al*. (2010, p.859) explain that 'intermediate users are firms that use equipment and components from producers to produce goods and services' whereas 'consumer users – users of consumer goods – are typically individual end consumers'. They further illustrate that intermediate users who develop innovations are in the following industries: semiconductors (von Hippel, 1988), printed circuit CAD software (Urban and von Hippel, 1988) and library information systems (Morrison *et al*., 2000). Consumer users have been found mainly in consumer products and, somewhat surprisingly, in sports-related consumer goods, such as mountain biking (Lüthje *et al*., 2005) and kite surfing (Tietz *et al*., 2005).

When it comes to explaining why users innovate, it is argued that they possess distinctive knowledge and the necessary expertise. For example, the development of kite surfing was possible only because of the expertise gained from years of experience of windsurfing (Franke and Shah, 2003). Indeed, in his more recent research, von Hippel (2005) argues that when one compares innovations from producers with those from users, frequently those from users are distinctive because of the unique tacit knowledge they have gained from extensive use of the products (Bogers *et al*., 2010).

The lead-user school further contends that while many users modify products for their own use (for example, computer hardware and software for industrial processes and high-end sports equipment), these innovations are concentrated among the lead users. The example of surfers is cited as an illustration; they developed an experimental surf board with foot straps that enabled them to leverage the energy of waves to make controlled flights. Lead users are

characterised as ahead of the majority of users with respect to an important market trend, and they expect to gain relatively high benefits from the solution to the needs they have encountered: '… lead users are users whose present strong needs will become general in a marketplace months or years in the future' (von Hippel, 1986, p.791). Further, it is argued that by focusing on working with lead users, companies can increase the probability that they will discover innovative solutions they can leverage and sell to their other customers. For companies seeking to increase their capacity to innovate, the lead-user school argues that it provides a firm foundation for a strategy of innovating with selective customers, and that it is a much more effective basis for an innovation strategy than the more traditional technology-centred approach, where scientific exploration and technology development lead to opportunities for firms to exploit. This approach led to the growth of a whole new sport, 'kite-surfing'. Clearly this had little to do with surfboard manufacturers, who did not discover this innovation; rather it was innovative surfers. The lead-user school recognises users (both consumers and companies) as an essential knowledge source for the innovation process. Hence, it distinguishes between ordinary users and lead users. It argues that ordinary users have difficulties providing fresh and relevant insights into the product development process since their familiarity with existing products 'interferes with their ability to conceive of novel products and uses when invited to do so' (von Hippel, 1988, p.103). This is rooted in their inability to come up with new solutions because they are not creative enough and they have difficulties in evaluating new and (thus) unfamiliar products that fall outside their real world.

The development of commercially successful new products has consistently shown the need for accurate understanding of the needs of the user. Within the marketing literature, this is firmly established (see Kohli and Jaworski, 1990; Deshpande *et al*., 1993). Although von Hippel discusses the limitations of market research in *The Sources of Innovation* (first section of Chapter 8), it is from this premise that he builds his arguments for the role of lead users. According to von Hippel, lead users are familiar with conditions that lie in the future for others; they can serve as a need-forecasting laboratory for marketing research (1988, p.107). Significantly, it is their activities at attempting to fill their needs which von Hippel identifies as providing opportunities for firms wishing to develop new products. Much of the work on users as innovators has centred on how firms should identify lead users and how firms can incorporate their perceptions into new products. This has tended to focus on technology-intensive industries and products. Table 1 offers a summary of the widespread adoption of the lead-user concept, grouped into the themes found in the existing literature. This is not an exhaustive listing, merely an illustration of the prevalence of the lead-user school of thought within the literature. In the next section, we systematically examine the concept in an attempt to illuminate our understanding of the management of innovation at the level of the firm.

The role of lead users within innovation processes: three areas of criticism

In the previous section, we described how users can contribute to innovation processes and how lead users can be a valuable source of innovation. In this section, we review the lead-user school. In short, much of the evidence is based on idiosyncratic case studies and cannot be generalised. Furthermore, the lead-user school

Table 1. A summary of the widespread adoption of the lead-user concept (grouped into the themes found in the literature)

Themes	Selected representative references
Lead-user concept development	Franke *et al*. (2006); Schreier and Prügl (2008); Spann *et al*. (2009); Baldwin *et al*. (2006); Baldwin and von Hippel (2011)
Characteristics of lead-users	Lüthje (2004); Morrison *et al*. (2004); Tronsden (1996)
Users as a source of product ideas	Lilien *et al*. (2002); Herstatt and von Hippel (1992); Urban and von Hippel (1988)
Management of firm innovation processes	Von Hippel *et al*. (1999); von Hippel (1977b); Jeppesen and Molin (2003); Robey and Farrow (1982); Olson and Bakke (2001)
Innovation policy	Riggs and von Hippel (1994); von Hippel (1982); Lettl *et al*. (2006)

is based on an unusual definition of innovation. Empirical research on the sources and patterns of innovation makes clear that users are just one of many different sources of innovation.

Conceptual: invention is not innovation

One major problem with the lead-user school is that even though the word 'innovation' appears 1389 times in *The Sources of Innovation* (1988), von Hippel does not provide the reader with a definition of innovation. More recently, Bogers and West (2012) have also argued for more clarity in terms of defining what can be considered an innovation. The majority of the user innovations that von Hippel presents appear to be merely (small) modifications to existing products. Following on from Godin (2010a, 2010b), surely most researchers would hesitate to call a modification an innovation. Of course, the boundary between a modification and an innovation is quite vague, as is the transition of the point at which a modification becomes an innovation. Von Hippel does not seem to make this distinction. For example, in Table 3-3 (von Hippel, 1988, p.31), he lists a sample of tractor shovel innovations in two categories: 'major improvements' and 'significant special-purpose accessories'. Adding power steering to a tractor shovel can be considered a major improvement, but is it an innovation? Von Hippel does define innovator as 'the individual or firm that first develops an innovation to a useful state, as proven by documented, useful output'. This is rather vague and does not get us any closer to what he means by innovation. Von Hippel claims that in both the process equipment industry and the electronics industry 'the innovators are most often users'.

In general, innovation is understood to mean much more than having an idea that could lead to the development of a new product or service (Garcia and Calantone, 2002). Innovation encompasses the entire process of developing an idea through to a new product or service that is implemented in a market. The process consists of activities such as R&D, technology transfer, knowledge management, market research, futures research, technology intelligence, product development and many more. The lead-user school distinguishes four different stages in this (innovation) process: (1) identify need; (2) research/development; (3) build prototype; and (4) apply, commercialise and diffuse innovation. The user is to carry out the first three and the manufacturer only the last step (von Hippel, 1988, p.25). The

lead-user school does not explain why the first three roles are played only by users and not by manufacturers. This seems to be more an assumption than an empirically established fact. Given that the closer the innovation process is to the market, the more innovation resources (finance, personnel, time) are required (Turner, 1999; Meredith and Mantel, 2006), being the source for an idea (invention) is a relatively small component of the entire innovation process. Consequently, the lead-user school portrays lead users as a source of ideas (which is undoubtedly true), but then overstates their role within the innovation process by underestimating the amount of innovation resources (money, time, risk) other actors (i.e. not users) spend carrying out that part of the innovation process.

The limited role of the user in the innovation process is also clearly illustrated in theories of innovation systems (e.g. Carlsson *et al*., 2002) and open innovation (Chesbrough, 2003). Both views of innovation are based on the notion that nowadays knowledge has become widely distributed and every actor involved in the innovation process should be aware that most of the knowledge required for innovation can be found elsewhere. But there are more sources of innovation than just the user, and modern innovation depends on how these different actors are related to each other and their sharing of information and knowledge. So, sources are less important in innovation than how different sources of innovation together constitute the innovation process (system). Indeed, much empirical research on finding success factors for innovation shows that there can be many different sources of innovation, often depending on the type of industry in which the innovation is being developed (see e.g. Pavitt, 1984; Miller and Blais, 1993). So, we conclude that the lead-user school's emphasis on the large or even dominant role of users in the innovation process is based on an old-fashioned definition of innovation. Because of this, it has understated the activities of the other actors that play such a vital role in the entire innovation process, most notably the firm. As a consequence, what the lead-user school labels as innovations are predominantly inventions.

Methodological: case studies are difficult to generalise

The lead-user school is almost entirely based on case study research methodology. In general, this methodology is applied when no theory is available and the researcher carries out an exploratory study to establish the first cornerstones of a theory that can be tested and validated later on (Yin, 1994). The goal of case study research is not to find results that are representative and/or significantly valid for an entire population. Rather, case studies are meant merely to find a unique empirical phenomenon, which may not be typical of the rest of the (not researched) population. In other words, the external validation of case studies is doubtful and difficult to establish. However, the first priority of a case researcher is not to validate results, but to find the particular instead of the general.

Despite these limitations, the lead-user school has no difficulty extending its case results to other non-researched cases. And although it is possible to do so by applying analytical (or theoretical) generalisation, the lead-user school does not argue why its cases are also valid in other (non-researched) industries. It does not make clear why its cases exhibit the same characteristics as non-researched cases. Furthermore, their cases appear quite exotic. It is difficult to understand why, for example, scientific instruments and surfboards are regarded as everyday businesses providing lessons that can be applied to any other industry. We acknowledge that it

is sometimes necessary to begin the exploration of a new phenomenon by studying extreme cases as a way to show its existence. In many ways, however, this underscores our point about overstatement.

Strictly speaking, one can argue that the lead-user school is not really doing case studies. The case-study method attempts to discover (causal) mechanisms and processes that relate different concepts or empirical phenomena. The case study method is mainly qualitative by nature and holds a process view on the units of analysis under investigation. In the lead-user school, cases are innovations that have been developed either by users or by producers. As such, the lead-user school is merely looking at the outcomes of innovation processes and listing who was the main source of innovation. Its main concern is not to go deep into how these innovations are being developed, but to decide which part of the innovations is developed by users and which part by producers. Description of how users developed innovations is limited.

Furthermore, the difficulties of extending the conclusions of a few cases to other non-researched cases include a methodological problem of a temporal nature. That is, the lead users in one case (i.e. an industry at a certain time) do not necessarily have to be the future lead users in that industry. Lead users might be good predictors of future demand in that industry, but this does not imply that they will also be the right forecasters of the next generation of new products and services in that industry. For instance, because of their special relationship with a new product, they might be more locked-in to that product and have more difficulty switching to new products than non-lead users since they are less (emotionally and functionally)

Table 2. The 25 most important non-medical innovations of the past 35 years

	Innovation
1.	The Internet
2.	Cell phone
3.	Personal computers
4.	Fibre optics
5.	E-mail
6.	Commercialised geographic positioning systems
7.	Portable computers
8.	Memory storage discs
9.	Consumer level digital cameras
10.	Radio frequency identity tags
11.	Micro-electro-mechanical systems
12.	DNA fingerprinting
13.	Air bags
14.	Automatic telling machines
15.	Advanced batteries
16.	Hybrid cars
17.	Organic light-emitting diodes
18.	Display panels
19.	High definition television
20.	The space shuttle
21.	Nanotechnology
22.	Flash memory
23.	Voice mail
24.	Modern hearing aids
25.	Short range, high frequency radio

attached to the former product. So, for companies, listening to former lead users in developing new products and services is certainly not without risks; and from a research perspective it means that the predictive power of case studies should be seriously questioned.

Another methodological weakness is that the lead-user school puts lead users and companies within the same research population while they are two different empirical categories. Users are, in principle, all the inhabitants of a certain geographical area and surely will outnumber companies, which are institutional constructions. Stating that users innovate more than companies is comparing apples with oranges. Because the role of the user and the company are so different in the innovation process, they cannot be considered as one research population.

Empirical: most radical innovation is of technological origin

When we consider some of the most significant technological developments over the past 20 years, such as the World Wide Web, DNA sequencing or the Hubble telescope, it seems these were the result of scientific curiosity, unfettered by the demands of the market. So, if users are the predominant source of innovation, a list of the recently most important (radical) innovations might be expected to contain many innovations based on ideas and developed by users. Such a list was made in 2005 in collaboration with the Lemelson–MIT Program. The list contains '25 non-medical innovations that have become widely used since 1980, are readily recognisable by most Americans, have had a direct and perceptible impact on everyday life and could dramatically affect the future' (CNN, 2005). Table 2 shows that list.

As with any list, the validity of the items in Table 2 and their ranking can be criticised. For example, nanotechnology is a scientific discipline, not an innovation. The results of nanotechnology research can be innovations. Half products, such as carbon nanotubes and nanoparticles, may be used in consumer products ranging from golf balls to foot warmers and from skin care products to military-grade disinfectants. Even without the historical records of who or what can be attributed as the source of each innovation on the list, the items can be ranked in the likelihood that the source is an end user, from 'absolutely inconceivable' (such as the space shuttle and nanotechnology) via 'highly unlikely' (the hybrid car, high definition television and the cell phone) and 'unlikely' (display panels and micro-electro-mechanical systems) to 'possibly' (voicemail and modern hearing aids).

To describe the development of all the innovations on this list is too much for this paper, so let us focus on number 1, the Internet. The Internet is sometimes described as a user innovation. Certainly the precursors of the present Internet (such as ARPANET and NFSNET) were created by the Advanced Research Projects Agency and the National Science Foundation for their own use; but if that makes the Internet a user innovation, then the space shuttle is also a user innovation. A name that frequently comes up in discussions about user innovations and the Internet is Tim Berners-Lee, the inventor of the World Wide Web (www). Berners-Lee is a physicist and computer scientist who developed the hypertext markup language (HTML), a computer implementation of hypertext, an idea first described in a paper by Vannevar Bush in 1945 (Bush, 1945b). Berners-Lee also created the first browser to access documents written in HTML. The purpose of this software project was to create an information system through which researchers could share and update

information (Berners-Lee, 1989). The World Wide Web was born when Berners-Lee joined his hypertext protocol with the Internet: 'I just had to take the hypertext idea and connect it to the Transmission Control Protocol and domain name system ideas and – ta-da! – the World Wide Web' (Berners-Lee, 2011). Does this make the World Wide Web a user innovation? The source of the innovation can be traced back to Vannevar Bush's idea of hypertext. Another inventor inspired by the same paper is Douglas Engelbart, inventor of the computer mouse, the word processor and the hyperlink.

The hypothesis that users are the source of most radical innovation is not substantiated by this list of the most important non-medical innovations from the last 35 years. Indeed, a more in-depth look at the innovations on this list shows that behind every (radical) innovation there is always a person or group of persons, but these persons do not have to be users. On the contrary, these people are in most cases scientists, researchers or entrepreneurs who develop new technologies and put great effort into using these technologies as an input to new product development in the context of the organisation employing them.

Concluding remarks

We would like to make clear that the lead-user school has made a significant positive contribution to our understanding of the management of innovation. Our intention here is to make a critical contribution. In the above sections we have attempted to explore the theory of lead users as innovators, and to examine and critique it. To us it seems that lead-user theorists have been hasty and have reached an inductive generalisation based on insufficient evidence. The lead-user theory has based a broad conclusion upon the statistics of a survey of a small group that fails to represent the whole population. Furthermore, we state that the lead-user school is using a wrong definition of innovation by considering inventions as definitions. Lastly, the empirical basis of the lead-user argument would seem to be limited in that the most important innovations of the last 35 years have not been developed by users.

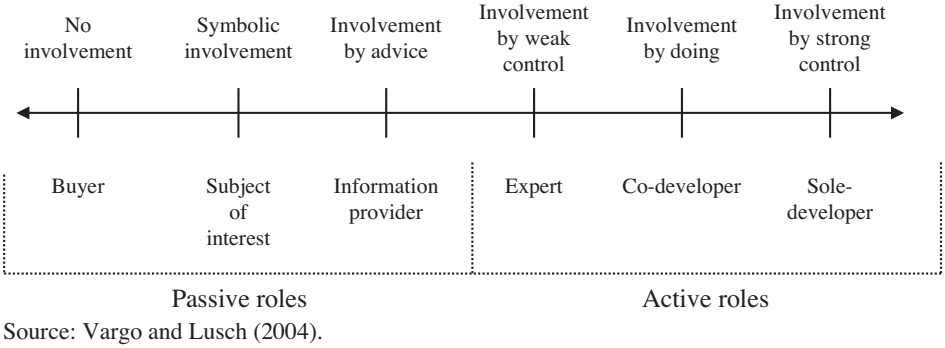
From a rhetorical perspective, we think that the lead-user school uses a straw man argument with the implication that the alternative to a lead-user approach to innovation is a technology push model. This is simply misleading; the arguments surrounding models of innovation and the need for both market and technology inputs are well known and understood (Rothwell, 1992; Berkhout *et al*., 2010). Furthermore, literature on ambidexterity has shown that combining both approaches is quite difficult but can benefit a company significantly (e.g. O'Reilly and Tushman, 2004; Lee *et al*., 2007; Andriopoulos and Lewis, 2010). This linkage between technology push and market pull should be explored more in order to inform companies more specifically how to do this. In this respect, we would like to draw attention to the Cyclic Innovation Model (CIM), an 'innovation system' model that not only structures the different innovation actors involved and emphasises the non-feedback nature of many innovation processes, but also shows how the different 'nodes' of an innovation system can function as different sources of innovation (Berkhout *et al*., 2010). According to the CIM, innovation processes can start either with scientific insights, new technological knowledge, different product requirements or changes in market needs. The essential point of CIM is that although the innovation process starts at one of the four innovation sources,

innovation processes can be successful only if these sources are being related to each other by (cyclical) knowledge flows. The innovation source, even if it is the market need, functions only as a starting point and it is the combination of the different innovation sources (nodes) that forms the core of the innovation system.

The notion of innovation processes having different innovation sources (and more than just user needs) is also in line with the contingency approach that states that there is not just one factor (or set of factors) that explains or describes the success of innovation processes. Indeed, much empirical research on innovation comes close to stating that there is no single (successful) way of innovating, and that there are many different ways of delivering innovative products, of which user-centred innovation is just one (Pavitt, 1984; Miller and Blais, 1993; Ortt and Van Der Duin, 2008). Users and lead users may sometimes be helpful, but not always.

We think the marketing literature can assist the lead-user school in its development by considering the wide variety of roles that consumers and business users can play in the new product development process (Nambisan, 2002). Indeed, within consumer product markets, this type of consumer research has been undertaken for more than 50 years and has delivered a rich source of new product ideas. For instance, within technology-intensive consumer product industries, the role of the consumer is largely that of inactive buyer with a few informed consumers having either a symbolic involvement or being information providers. This inactive role even extends to customers within the supply chain. Clearly, in business-to-business product industries the role of the consumer (user) has been very different. Indeed, here we find many examples of consumers involved in co-developing products. The continuum developed by Vargo and Lusch (2004) for the development of new services illustrates the degree of customer (user) involvement (see Figure 1).

In principle, the marketing context can provide relevant information and knowledge to ensure the development of innovative new products and the acceptance and diffusion of new products. In both cases, it is usually the insights with respect to understanding potential customers that marketing supplies. Uncovering and understanding these insights is where effective marketing is valuable, but despite the potential value of users for the innovation processes of companies, the deep insights necessary for truly innovative products require great skill as much of the information gained from customers for such products needs to be ignored (Veryzer, 2003). Research within marketing has shown for many years that gaining



Source: Vargo and Lusch (2004).

Figure 1. Degree of customer (user) involvement in new product development

valuable insight from consumers about innovative new market offerings, especially discontinuous new products, is extremely difficult and can sometimes be misleading (Tauber, 1974; King, 1985; Hamel and Prahalad, 1994; Martin, 1995; Veryzer, 2003). Users typically just want the same product – only cheaper and better. In addition, students of innovation management may recall Christensen's observation that the main reason for the market leaders, from IBM to Xerox, failing was that they listened too closely to what their customers wanted rather than looking beyond their immediate needs (Christensen, 1997).

Furthermore, the benefits of discontinuous innovations to potential users may be difficult to identify and value. Because there are likely to be few substitute products available, it is difficult for buyers to compare and contrast. Sometimes product developers have to lead buyers/consumers and show them the benefits, even to educate them. This is where some marketing views suggest the process is no longer customer-led or driven by users. They would argue that what is now occurring is a technology push approach to product development. So, it seems there are a number of false dichotomies here (Day, 1999), such as that:

- you must either lead or follow customers;
- you cannot stay close to both current and potential customers; and
- technology push cannot be balanced with market pull.

This is compounded by higher levels of risk for both the customer and the producer. Herein lies the problem: highly innovative products have an inherent high degree of uncertainty about exactly how an emerging technology may be formulated into a usable product and what the final product application will be. Market vision or the ability to look into the future and picture products and services that will be successful is a fundamental requirement for those firms wishing to engage in innovation, but also very problematic (Van Der Duin, 2006). It involves assessing one's own technological capability and present or future market needs, and picturing a market offering that people will want to buy.

Our criticism of the lead-user school has two implications for governmental policy:

- The lead-users school more or less regards invention as innovation. If governments adopt this standpoint, they focus their innovation policy predominantly at the early stages of the innovation process within organisations and thereby neglect the end phases of organisational innovation, which often require considerable support. Regarding inventions as innovations may also give a misleading view of the innovativeness of a country since in many surveys inventions are classified as an input to innovation. This may lead to an overstated picture of the innovativeness of a country.
- Too much emphasis by policy makers on the significance of lead-user theory as a driver of innovation risks too much emphasis being placed on incremental innovations at the cost of fundamental, radical innovation. In the Netherlands, innovation policy is dominated by large companies and industries which decide on which technology areas universities and other research organisations should focus. These companies consider themselves to be 'users' or clients of scientific research and are not eager to finance fundamental scientific research because the technology development remains too uncertain. Hence, emphasis

will be placed on developing scientific knowledge for incremental innovations thereby endangering the long term innovative capacity of the Netherlands.

Further research on the role of users and lead users could focus on the following topics:

- How different types of users relate to different types of innovations. How can we develop research further than the notion that radical innovations have their source in scientific and technological developments whereas incremental innovations start from user needs?
- Whether lead users for a certain type of new product or service can also function as such for other new products and services. What is the predictive power of lead users? Once a lead user always a lead user?

References

Andriopoulos, C. and Lewis, M. (2010) 'Managing innovation paradoxes: ambidexterity lessons from leading product design companies', *Long Range Planning,* 43, pp.104–22.

Baldwin, C., Hienerth, C. and von Hippel, E. (2006) 'How user innovations become commercial products: a theoretical investigation and case study', *Research Policy,* 35, 9, pp.1291–313.

Baldwin, C. and von Hippel, E. (2011) 'Modeling a paradigm shift: from producer innovation to user and open collaborative innovation', *Organization Science,* 22, 6, pp.1399–417.

Berkhout, A., Hartmann, D. and Trott, P. (2010) 'Connecting technical capabilities with market needs using a cyclic innovation model', *R&D Management,* 40, 5, pp.474–90.

Berners-Lee, T. (1989) *Information Management: A Proposal*, available from http://www.w3.org/History/1989/proposal.html [accessed May 2011].

Berners-Lee, T. (2011) *Answers for Young People*, available from http://www.w3.org/People/Berners-Lee/Kids [accessed May 2011].

Bogers, M., Afuah, A. and Bastian, B. (2010) 'Users as innovators: a review, critique, and future research directions', *Journal of Management,* 36, pp.857–75.

Bogers, M. and West, J. (2012) 'Managing distributed innovation: strategic utilization of open and user innovation', *Creativity and Innovation Management,* 21, 1, pp.61–75.

Bush, V. (1945a) *Science: The Endless Frontier*, US Government Printing Office, Washington, DC.

Bush, V. (1945b) 'As we may think', *Atlantic Monthly*, July. Reprinted in *Life Magazine*, 10 September 1945.

Carlsson, B., Jacobsson, S., Holmén, M. and Rickne, A. (2002) 'Innovation systems: analytical and methodological issues', *Research Policy,* 31, pp.233–45.

Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston, MA.

Christensen, C. (1997) *The Innovator's Dilemma*, Harvard Business School Press, Boston, MA.

CNN (2005) Available from http://edition.cnn.com/2005/TECH/01/03/cnn25.top25.innovations/ [accessed May 2011].

Day, G. (1999) *The Market Driven Organization. Understanding, Attracting, and Keeping Valuable Customers*, The Free Press, New York.

Deshpande, R., Farley, J. and Webster, F. (1993) 'Corporate culture, customer orientation, and innovativeness in Japanese firms: a quadrad analysis', *Journal of Marketing,* 57, pp.23–7.

Franke, N. and Shah, S. (2003) 'How communities support innovative activities: an exploration of assistance and sharing among end-users', *Research Policy,* 32, pp.157–78.

Franke, N. and von Hippel, E. (2003) 'Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software', *Research Policy,* 32, 7, pp.1199–215.

Franke, N., von Hippel, E. and Schreier, M. (2006) 'Finding commercially attractive user innovations: a test of lead-user theory', *Journal of Product Innovation Management,* 23, pp.301–15.

Garcia, R. and Calantone, R. (2002) 'A critical look at technological innovation typology and innovativeness terminology: a literature review', *Journal of Product Innovation Management,* 19, pp.110–32.

Godin, B. (2010a) *'Innovation Studies': The Invention of a Speciality (Part I), Project on the Intellectual History of Innovation*, INRS, Montreal.
Godin, B. (2010b) *'Innovation Studies': The Invention of a Speciality (Part II), Project on the Intellectual History of Innovation*, INRS, Montreal.
Hamel, G. and Prahalad, C. (1994) 'Competing for the future', *Harvard Business Review,* 72, 4, pp.122–8.
Herstatt, C. and von Hippel, E. (1992) 'From experience: developing new product concepts via the lead-user method: a case study in a "low-tech" field', *Journal of Product Innovation Management,* 9, 3, pp.213–21.
Jeppesen, L. and Molin, M. (2003) 'Consumers as co-developers: learning and innovation outside the firm', *Technology Analysis & Strategic Management,* 15, 3, pp.363–84.
King, S. (1985) 'Has marketing failed or was it never really tried?', *Journal of Marketing Management,* 1, 1, pp.1–19.
Kohli, A. and Jaworski, B. (1990) 'Market orientation: the construct, research propositions, and managerial implications', *Journal of Marketing,* 54, pp.1–8.
Lee, K., Rho, S., Kim, S. and Ju Jun, G. (2007) 'Creativity-innovation cycle for organisational exploration and exploitation: lessons from Neowiz – a Korean internet company', *Long Range Planning,* 40, pp.505–23.
Lettl, C., Herstatt, C. and Gemuenden, H. (2006) 'Users' contributions to radical innovation: evidence from four cases in the field of medical equipment technology', *R&D Management,* 36, pp.251–72.
Lilien, G., Morrison, P., Searls, K., Sonnack, M. and von Hippel, E. (2002) 'Performance assessment of the lead-user idea-generation process for new product development', *Management Science,* 48, 8, pp.1042–59.
Lüthje, C. (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, C. (2004) 'Characteristics of innovating users in a consumer goods field, An empirical study of sport-related product consumers', *Technovation,* 24, 9, pp.683–95.
Lüthje, C., Herstatt, C. and von Hippel, E. (2005) 'User-innovators and "local" information: the case of mountain biking', *Research Policy,* 34, 6, pp.951–65.
Martin, J. (1995) 'Ignore your customer', *Fortune*, 8, 1 May, pp.121–25.
Meredith, J. and Mantel Jr, S. (2006) *Project Management. A Managerial Approach*, John Wiley & Sons, Delhi.
Miller, R. and Blais, R. (1993) 'Modes of innovation in six industrial sectors', *IEEE Transactions on Engineering Management,* 40, 3, pp.264–73.
Morrison, P., Roberts, J. and Midgley, D. (2004) 'The nature of lead users and measurement of leading edge status', *Research Policy,* 33, 2, pp.351–62.
Morrison, P., Roberts, J. and von Hippel, E. (2000) 'Determinants of user innovation and innovation sharing in a local market', *Management Science,* 46, pp.1513–27.
Nambisan, S. (2002) 'Designing virtual customer environments for new product development: toward a theory', *Academy of Management Review,* 27, 3, pp.392–413.
Olson, E. and Bakke, G. (2001) 'Implementing the lead user method in a high technology firm: a longitudinal study of intentions versus actions', *Journal of Product Innovation Management,* 18, pp.388–95.
O'Reilly, C. and Tushman, M. (2004) 'The ambidextrous organization', *Harvard Business Review*, April, pp.74–81.
Ortt, J. and Van Der Duin, P. (2008) 'The evolution of innovation management towards contextual innovation management', *European Journal of Innovation Management,* 11, 4, pp.522–38.
Pavitt, K. (1984) 'Sectoral patterns of technical change: towards a taxonomy and a theory', *Research Policy,* 13, pp.343–73.
Riggs, W. and von Hippel, E. (1994) 'The impact of scientific and commercial values on the sources of scientific instrument innovation', *Research Policy,* 23, 4, pp.459–69.
Robey, D. and Farrow, D. (1982) 'User involvement in information systems development: a conflict model and empirical test', *Management Science,* 28, 1, pp.73–85.
Rothwell, R. (1992) 'Successful industrial innovation: critical factors for the 1990s', *R&D Management,* 22, 3, pp.64–84.

Schreier, M. and Prügl, R. (2008) 'Extending lead-user theory: antecedents and consequences of consumers' lead-userness', *Journal of Product Innovation Management,* 25, 4, pp.331–46.
Spann, M., Ernst, H., Skiera, B. and Soll, J. (2009) 'Identification of lead users for consumer products via virtual stock markets', *Journal of Product Innovation Management,* 26, 3, pp.322–36.
Tauber, M. (1974) 'Predictive validity in consumer research', *Journal of Advertising Research,* 15, 5, pp.59–64.
Tietz, R., Herstatt, C., Morrison, P. and Lüthje, C. (2005) 'The process of user innovation: A case study in consumer goods setting', *International Journal of Product Development,* 2, 4, pp.321–38.
Tronsden, T. (1996) 'Some characteristics of adopters of a major innovation in the computer field and of potential use in marketing', *Industrial Marketing Management,* 25, 6, pp.567–76.
Turner, R. (1999) *The Handbook of Project-based Management*, McGraw-Hill, London.
Urban, G. and von Hippel, E. (1988) 'Lead user analyses for the development of new industrial products', *Management Science,* 34, 5, pp.569–82.
Van Der Duin, P. (2006) *Qualitative Futures Research for Innovation*, Eburon Academic Publishers, Delft.
Van Der Duin, P., Ortt, J. and Stavleu, H. (2007) 'Mind the gap: concluding remarks to the special issue', *Technological Forecasting & Social Change,* 74, pp.1847–51.
Vargo, S. and Lusch, R. (2004) 'Evolving a new dominant logic for marketing', *Journal of Marketing,* 68, 1, pp.1–17.
Veryzer, R. (2003) 'Marketing and the development of innovative products' in Shavinina, L. (ed) *International Handbook on Innovation*, Pergamon Press, Ottawa, pp.6–17.
Von Hippel, E. (1976) 'The dominant role of users in the scientific instrument innovation process', *Research Policy,* 5, 3, pp.212–39.
Von Hippel, E. (1977a) 'The dominant role of the user in semiconductor and electronic subassembly process innovation', *IEEE Transactions on Engineering Management*, EM-24, 2, pp. 60–71.
Von Hippel, E. (1977b) 'Transferring process equipment innovations from user-innovators to equipment manufacturing firms', *R&D Management,* 8, 1, pp.13–22.
Von Hippel, E. (1982) 'Appropriability of innovation benefit as a predictor of the source of innovation', *Research Policy,* 11, 2, pp.95–115.
Von Hippel, E. (1986) 'Lead-users: a source of novel product theories', *Management Science,* 32, 7, pp.791–805.
Von Hippel, E. (1988) *The Sources of Innovation*, Oxford University Press, New York.
Von Hippel, E. (2005) *Democratizing Innovation*, MIT Press, Cambridge, MA.
Von Hippel, E., Thomke, S. and Sonnack, M. (1999) 'Creating breakthroughs at 3M', *Harvard Business Review,* 77, 5, pp.47–57.
Yin, R. (1994) *Case Study Research*, Design and Methods, Sage, London.