User innovation and everyday practices: micro-innovation in sports industry development

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This paper focuses on an underemphasized issue in research on user innovation, namely users' adaptations and micro-innovations and their impact on industry development in user-innovation-intensive industries. It complements previous analyses of rodeo and freestyle-kayaking that explore the role of user innovators in industry development, by focusing on different aspects of micro-innovation: (1) changes in the composition of user base and preferred equipment (2) evolution of everyday practice (3) changes in the settings of these practices and (4) the range of modes of user involvement. Through micro-innovation, users, on the whole, are likely to have more impact on industry development than predicted, and yet the position of lead-users and user–manufacturers may be less powerful relative to outside manufacturers.

1. Introduction

Take a randomly chosen free-style kayaker. What recent user innovations do you expect to find in his kayak these days? If you proceed by surveying the modifications done to it, or interviewing its designers, the answer is likely to be 'none'. His kayak is in all likelihood a variation of the dominant design of 'centre buoyant planing hull' (Baldwin et al., 2006), and the one invention that kayaker might mention is forming personalized foot-rests for greater comfort. But probably he would not think this worth mentioning because it is what most kayakers always modify. The highly inventive stuff, in line with expectations from user-innovation theory, appears to be done by a relatively small number of lead-users who are at the top of the sport (see von Hippel, 1988, 2005).

The answer changes, however, if you go and join the kayaker for a series of evening trips to nearby rapids and on longer excursions. You might need to get out in the backwash personally to appreciate the rather sticky information about holes, waves, moves, technique, hazards, excitement, gear, rapids and so on. But armed with such experience, you would soon notice various *micro-adaptations* and *micro-innovations* (such as self-made thrusters, ways to resist contaminated water, www-forums and www-discharge meters), and begin to notice that people paddle in places they did not used to, that the paddler community has subtly changed, and so have their modes of engagement with the manufacturers of their gear.

Such observations translate into a question regarding R&D management, open innovation and user-innovation research: *are there ways in which these micro-adaptations and micro-innovations feature in and complement our present understanding of user innovation and its impact on industry development?* This conceptual paper aims to show that there are indeed such ways, and that the theme is important in open innovation more generally.

Open innovation has generated increasing interest as a new paradigm for organizing how firms manage R&D (Chesbrough, 2003). It has been argued, and to some extent shown, that instead of relying solely on their own R&D, firms would benefit from 'systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels.' (Cohen and Levinthal, 1990; West and Gallagher, 2006). Innovations by users form an important aspect of open innovation and in some respects the most radical part of it.[1] In striking contrast to the assumptions in the closed model of innovation, 19–36% of users of industrial products (von Hippel, 1988; Herstatt and von Hippel, 1992; Morrison et al., 2000; von Hippel, 2005) and 10–38% of users of consumer products (Franke and Shah, 2003; Lüthje, 2004; Lüthje et al., 2005) develop or significantly modify products.

User innovation is not a new phenomenon (von Hippel, 1976; Rosenberg, 1979; Pavitt, 1984), and its systematic enquiry has progressed for some time (e.g. von Hippel, 2005; IJIM 12/3, 2008). The pioneering line of research led by Eric von Hippel and others has focused on verifying the extent of invention by users, identifying the users that are likely to innovate, why and where users innovate and the composition of user-innovation communities. Researchers have also examined information asymmetries between developers and users and the effects of sticky information in interchange and learning between manufacturers and users (Tyre and von Hippel, 1997; Lüthje and Herstatt, 2004; von Hippel, 2005; Lettl et al., 2006). In so doing, the research has moved beyond inventions by users (von Hippel and Tyre, 1995; Lüthje et al., 2005; West and Gallagher, 2006), and, most recently, inquired into the ways in which user innovations are transformed into commercial products, and the effects user innovations have on industry development in the long run (Baldwin et al., 2006; Hienerth, 2006).

These last two topics offer an interesting insight for R&D management in fields where user innovation plays a role, particularly in situations when user innovators and non-user manufacturers challenge each other. Yet once we move to the pathways of innovation, industry development and considerations of design space, a focus on *lead-users and widely recognized inventions* may only address part of users' relevant innovativeness. As stated in the above research question, this paper aims to provide a complementary insight by elaborating *user micro-innovation and micro-adaptation* in (1) changes in the composition of user base and preferred equipment, (2) evolution of everyday practice, (3) changes in the settings of these practices and (4) the range of modes of user involvement. The paper also formulates tentative hypotheses for how micro-innovation in each of these areas is likely to affect industry development.

Making micro-mechanisms of innovation and learning visible means attending everyday practice at hand (von Hippel and Tyre, 1995), that is, conveying some in-depth ethnographic and/or participant *emic* understanding of that practice (Chaiklin and Lave, 1993; Hutchins, 1995; Wenger, 1998). For this reason, the paper focuses on a particular industry development and practice – that of rodeo and freestyle kayaking[2] – even though the issues about micro-innovation and adaptation have general relevance beyond the particularities of this sport and industry.

In doing so the paper triangulates insight from three sources: (A) Hienert's (2006) and Baldwin et al. (2006) analyses on the industry development related to rodeo kayaking, and closely related research on user innovation in other sports industries; (B) research that complements user-innovation research in sociology of technology (e.g. Williams and Sørensen, 2002; Rohracher, 2005), technology domestication literature (Silverstone and Hirsch, 1992; Berger et al., 2006), workplace studies and information systems research (McLaughlin et al., 1999; Orlikowski, 2000; Sorensen and Williams, 2002), and participatory design (e.g. Preece et al., 2002; Bødker et al., 2004); and (C) the author's 8-year involvement in rodeo/free-style kayaking for exemplifying how key themes in literature B feature in literature A in this particular practice and industry.

2. Development of rodeo-kayaking and its industry: lead-user low-capital vs. high-capital manufacturing

Baldwin et al. (2006) trace the emergence of rodeo kayaking to the turn of the 1970s and outline its growth from a few thousand people's folly into around four million people's hobby and $100 m annual business with, for instance, approximately 50,000 kayaks purchased in 2002. Early river kayaks used for rodeo were made by users from fibre-glass by hand lay-up techniques. Some of these users began to make kayaks for others, and their work evolved into user–manufacturer businesses. Plastic rodeo kayaks emerged in the mid 1970s when two outside plastic manufacturers turned fibre-glass user designs into plastic boats. These more durable models led the initial market expansion, but the cradle of development remained in the few thousand near-sinking 'squirt-boats' (for expert use) that continued to be built by hand lay-up techniques. Dominant design began to take shape in the late 1980s when user innovators invented the 'centre-buoyant planing hull' that surfed on a wave due to its flat bottom, had enough cavity to be safe in white water, and yet could be pushed under water when initiating moves due to low buoyancy at the ends of the kayak. New plastic manufacturers – at first solely of lead-user origin – emerged and the development intensified with introductions of (bi-) annual new models instead of earlier 4–5-year release intervals. After the year 2000, a series of radical innovations gave away to incremental improvements and variations. During these nearly four decades, 100% of innovations in technique came from users, and users also dominated innovation in hardware (62% of major and 83% of minor innovations) over user–manufacturers (2% major and 13% minor innovations) and other manufacturers (25% of major and 15% of minor innovations).

Baldwin et al. (2006) explain the development as follows: User innovators and user–manufacturers hold advantages over other manufacturers (in mainstream kayaks and in other related fields) as long as the expected time between each successful new design is too short to allow returns from investment in more effective but more capital-intensive production methods.[3] They propose a shared equilibrium model, suggesting that even if a manufacturer did shift into high-capital production, low-capital user–manufacturers would continue to dominate the end with the most advanced performance insofar as there were frequently enough significant differences between models and for as long as the design space did not get exhausted.

3. Focus on user community change in addition to lead-user inventions

As a stylized analysis of *lead-user and user–manufacturer influence* on industry development, the above leaves little to bicker about. The capacity and motivation to create new inventions has been shown to be highly concentrated in a few lead-users (von Hippel, 2005), and indeed, the innovators interviewed in those studies were lead-users who pined for the old days when men were men and built their own kayaks. Yet, the solutions favoured by them appeared for long as too unreliable, raw and/or expensive even for the early majority of users. Hienert (2006), 287:

> 'The once so uncontrollable and rough prototypes had become customer adapted [by the late 1990s]. That point marked a true breakthrough for the commercial success of the rodeo kayak . . . The new kayaks could even be used better for lessons in beginner's skills such as rolling or bracing (techniques in kayaking that are used for river running). By continuing the process with incremental innovations, user manufacturers can now sell slightly new designs and fittings to customers every year . . . radical innovations sparked the emergence of the industry, but incremental innovations were needed for the success of the commercialization process and the enlargement of the market.'

Hypothesis 1: *The move from early radical innovation to market expansion depends on a stream of incremental innovation that depend, in turn, on elaborating and responding to preferences of non-lead-users.*

Complementarity between radical and follow-on inventions is not all that is involved here. Not only were the rodeo-kayaks different but so too were the kayakers who initiated and expanded the user practice and the related industry. It was the *other river kayakers* who in the mid-1990s gave a crucial innovative thrust to the industry's development by directing the lead-users' efforts into creating more usable and safer equipment (Hienert, 2006, 284, 287). Such a phenomenon is by no means limited to kayaking. For instance, in early bicycling it was athletic male users who lead all the development of large front wheel machines, but the bicycle that spread widely was affected strongly by safety considerations (Bijker, 1995). Similarly, the microwave oven was initially a 'brown' techie good targeted at young males for heating pre-cooked meals; it spread widely only after being redesigned as a more usable 'white-good' for a predominantly female audience, and when it was associated with new and adapted recipes, cookbooks, etc (Ormrod, 1994). More theoretically, such a process of 'domestication' of technology (Lie and Sorensen, 1996; Pantzar, 1996) tends to feature several changes in the form of the product and in the composition of its user communities, creating a discontinuous rather than a singular diffusion curve (Rogers, 1995).[4]

In the next section we move to a more detailed examination of why forms of innovativeness that are less visible than inventions by lead-users are crucial for practice and industry development.

4. User micro-innovation and micro-adaptation of equipment and practice

The domestication of wild-rodeo kayaks has been and continues to be closely associated with a range of less tangible adaptive and inventive behaviours by other users that are equally crucial for the industry development – alternative uses, improved uses, non-uses, purposefully diminishing functionality, etc that decisively affect the use of equipment and its future development. The last 20 or so years of research in technology domestication literature (Silverstone and Hirsch, 1992; Sorensen and Williams, 2002; Berger et al., 2006) and workplace studies and information systems research (McLaughlin et al., 1999; Orlikowski, 2000; Sorensen and Williams, 2002) has showed it to be a rule rather than an exception that in order to make any equipment work, people need to adapt an appropriate technology in particular and varying ways, and in so doing, accommodate and domesticate it to the spheres of their work and leisure practices.

A more sophisticated way to say this is that when people enact technology, they also enact other meanings, rules, habits and other technologies and blend these into the way they enact a particular piece of equipment (Lave, 1988; Orlikowski, 2000). These findings underscore how the ability to use is not an inherent capacity of equipment or its users, but is constituted by shaping anew the habits, skills, schemes for making sense of and operating technology, along with divisions of labour, fellow practitioners, other instruments and the purposes for which the equipment is intended.

Free-style kayaking is no exception here. Alongside using their equipment in ways anticipated by the designers of the gear, people make various small alterations to make their kayaks work (better) and alter their practices and patterns of usage to make their activity more enjoyable. These alterations include but are not limited to:

- Creating various sorts of padding inside the boat to make the paddler fit more tightly and comfortably in various moves.
- Fitting various hard and inflatable 'thrusters' to maximize buoyancy when vertical with the kayak. The thrusters used range from commercially available items to an inflatable children's beach ball stuffed under the spray-skirt.
- Fitting places for camera storage, extra ropes, first-aid kit, buoyancy aids (ranging from self-made to manufacturer supplied), etc. without compromising the abilities of the kayak.
- Complementing standard kayaking gear with all sorts of cold water resistors: custom-fitted earplugs, paddles with taped in neoprene gloves, grease on the face, etc.
- Eating pro-biotic products, acid drinks and even antibiotics to better resist contaminated water. This diminishes the effects of playing in flooding creeks and rivers, and opens them up to paddling despite the drawbacks of their water.
- Having the play-range of play-sites configured via web-connected water discharge meters and other devices (to avoid hours of wasted driving to sites).
- Exchanging updates, rides, advice and gear through various discussion forums in the Internet.
- Subtle river-shaping such as leaving in ropes or cutting trees for better upstream return to a playwave, fishing out snags from the current, slightly shifting dangerous rocks downstream of a good play-hole during the dry season, etc.
- Establishing various house-rules and self-made scoring systems to allow competing during a practice session even during the dry season.

Such micro-inventions and adaptations help to keep the practice and equipment functioning well; moreover, free-style kayak equipment – as solid physical products – presents tangible evidence of their importance. It is already well documented that they are important in software applications; it is known that extensive post-adoptive behaviours (learning about, adopting into use, extending the full range of features in use, complementing a given application with other technologies and procedures, ignoring dysfunctional and burdening features, etc.) influence the eventual utility and overall productivity of information systems (e.g. McLaughlin et al., 1999; Jasperson et al., 2005).

Hypothesis 2: *Micro-innovation and micro-adaptation are necessary and significant conditions in the development of practice and related industry. They add to lead-users and user–manufacturers advantages over other manufacturers due to the former having a better absorptive capacity and network connections for detecting and facilitating important changes.*

Furthermore, innovativeness in the evolution of user practice and industry development is not restricted to technique and technology, but also includes market, organizational and environmental dimensions, including cultural values, regulations and ecological factors (Hoogma et al., 2002; Sorensen and Williams, 2002; Lettl et al., 2006). In free-style kayaking, few user–manufacturers have managed to retain lead-user position with regard to kayaking technique, but continue to be lead-users when it comes to equipment innovation (technological dimension). Top paddlers tend to be lead-users in technique development, but only very few of them are lead-users otherwise. Then there are also organizational innovators who renew facilities, transport, training, rules, playable-spots, forums, etc, often mixed with a degree of environmental innovativeness in, for instance, negotiation over the shape of certain river sections. The innovations in these dimensions affect the number and orientation of paddlers and hence more indirectly the stability of different areas of the design space. To illustrate this, one class of micro-innovation in the environmental dimension is next examined: evolution of settings and its relation to evolution of design space. Current theory suggests that this is crucial to the renewal rate and survival of low-capital user-innovation producers.

5. Environmental dimension of micro-innovation: The evolution of practice and design space

In practice, users enact only some of the material and symbolic properties built into technologies. As illustrated by Jean Lave with regard to the supermarket (Lave, 1988, 150–151):

> 'The supermarket, for instance, is in some respects a public and durable entity. It is a physically, economically, politically, and socially organized space-in-time. In this respect it may be called an 'arena' within which activity takes place . . . At the same time, for individual shoppers, the supermarket is a repeatedly experienced, personally ordered and edited *version* of the arena. In this aspect it may be termed a 'setting' for activity. Some aisles do not exist for a given shopper as part of her setting, while other aisles are rich with detailed possibilities.'

In a similar vein, white-water sections of rivers form the arena for rodeo-kayaking. There are different versions (or settings) of this arena so that different paddlers (assisted by differences in equipment) can enact different behaviours: one's sweet spot can drown another. Moreover, the arena, in other words the design space has, on the whole, remained fixed only with regard to water:[5] We need to look not only at the equipment and behaviour in white-water, but also at the mutual evolution of equipment and settings. Free-style kayaking can be regarded as a dynamically stable socio-cultural practice: it has evolved a great deal but within a recognizable pathway. The generic imagination animating the practice has changed little: you take a kayak and perform moves (tricks) on a river in places (such as waves, standing waves or holes) where you can use the hydraulic power of the river in doing so. Yet, if the first paddlers, kayaks and moves are compared with the current ones, there is hardly any similarity. Early rodeo kayaking consisted of putting a sabre-shaped kayak (over 4 m long) sideways into a hole to be thrashed up and down as in rodeo or making it loop vertically (out of) there.[6] In contrast, current free-style kayaks are less than half the length and are thrust into an array of mostly vertical moves that stay in the hole or standing wave, such as cartwheels, flips, back-flips, flips rotated to end in a cartwheel, aerial 360° rolls, etc.[7] While equipment changes have become more incremental since 2000, the co-evolution has expanded the range of settings within which the sport can be performed as well as the range of people who are able to create meaningful versions of it. Play-waves and holes are relatively rare in flat areas where the majority of large cities are positioned, but the shortening of kayaks, combined with the micro-innovations such as active marking of www available water-level sensors, allows paddlers to find more suitable play-sites and time their practices to (the often rare) moments when a particular setting happens to suit them (wave/hole form, driving time, personal agility, injury risk level, etc). Present-day kayaks also allow some moves to be performed, practiced and even competed in on flat water (swimming halls, bays, lakes), as well as by using a tow-boat, in ocean waves and skiing-slopes. These changes in settings affect the shape of explorable design space in affinity to rule changes (which Baldwin et al. (2006) also note): inclusion of standing waves in title competitions significantly changed the shape of kayaks and the array of moves performed. Similarly, the 2005 rule change, awarding points per one sort of move, encouraged more all-round kayaks.

Hypothesis 3: *Incremental and micro-innovations in all dimensions of innovation (exemplified here by settings and norms) change the shape of the searchable design space for equipment manufacturing. This in turn delays the point in time when high-capital manufacturing would supplant low-capital user–manufacturers.*

Changing settings is known to foster the formation of sub-specialities and even branching of practice (Lüthje et al., 2005). Bicycling is an illustration, being split into, for instance, velodrome, road, utility, leisure and off-road variants, and further within these so that in mountain-biking alone downhill, jumping, cross-terrain bikes can no longer be used interchangeably and have hence formed their own market and practitioner niches (Lüthje, 2004; Lüthje et al., 2005). Such practice branching has important effects on the shape of the design space (cf. Baldwin et al., 2006, 1299). It also adds to the advantages user innovators enjoy over outside manufacturers through being more closely connected to user-innovation communities (Franke and Shah, 2003).[8]

6. User contributions to different dimensions of innovation and modes of user engagement with manufacturers

Thus far, we have introduced three kinds of 'micro innovation' where non-lead-users are involved. Elaborating the user needs of the early majority of adopters (by 'crucial users') was suggested to expand the community and change its structure and equipment; micro-innovation and adaptation was noted to contribute to the vitality and evolution of user practice; and co-evolution of practice, equipment and settings was noted to expand/change the shape of the design space. All these facets appear to further favour low-capital user–manufacturers not only because these shape the design space but because user–manufacturers have potentially better network connections and capacity to absorb user innovations. In the words of Hienert:

> 'From 1995 to 2000, established manufacturers began to look for paddlers who performed very well in competitions and also had a sense for upcoming market trends. By doing so, they identified lead users and they also produced a type of subcommunity around them to innovate for the company's purposes (company teams). In parallel, internet communities emerged, and the manufacturers created electronic platforms for their customers to meet and discuss the new innovations. In this way, they integrated different actors within one innovation system and additionally used very direct feedback from the community.'(Hienert, 2006)

Yet, with company teams, networks and platforms, the user-innovation communities around potential non-user–manufacturers may go a similarly long way, creating a porous boundary between user and manufacturer competencies. This is particularly relevant when considering all dimensions of innovation as well as the different roles that different types of users are likely to play within such innovation systems. To make the implications clear, four of the most common forms of user involvement in innovation can be found to some degree in most industries and certainly in free-style kayaking.

6.1. *Testing and evaluating models, prototypes and first versions*

Probably the most widespread mode of user involvement in innovation is that of reporting bugs and minor shortcomings and suggesting improvements. This happens with virtually every product after its market launch (e.g. Gardiner and Rothwell, 1985; Schrage, 2000; Hyysalo and Lehenkari, 2003; Hyysalo, 2006). It is hard and expensive to weed out the bugs in the code by simulation or the like. There are also problems that reveal themselves only in site-specific use because they involve connections with other equipment and specific features of the social and physical environment (von Hippel, Eric and Tyre, 1995). User involvement can also take place earlier with mock-ups and on-site simulations of how the new technology is thought to work (Buur and Bagger, 1999).

6.2. *Acquainting designers to work practices and users' environments*

Giving guided tours, selecting useful literature or training materials or teaching designers about their field are common practices in the development of sports equipment and designing for specialized professions. Recurrent problems, workarounds and latent innovations can surface when going through work and its instrumentation on site (Buur and Bagger, 1999). Such an arrangement also prompts users to spontaneously come up with issues they think designers should know and thus helps counter developers' often substantial tacit ignorance about the activities they are designing for (Beyer and Holtzblatt, 1998; Mattelmäki, 2006).

6.3. Forecasting trends and envisioning new products

People in the user domain are strategically placed to discuss future technological options and routes that may open up. In free-style kayaking the top paddlers in company teams are an obvious resource. Elsewhere *advisory boards* are often used, ranging from corporate level strategic decision making to particular development projects. More focused efforts are various envisioning workshops such as *lead-user workshop* (e.g. Herstatt and von Hippel, 1992), *user seminar* (Miettinen et al., 2003) or a *future workshop* (Jungk and Mullert, 1987; Kensing and Madsen, 1991).

6.4. Users' direct participation in designing

User involvement in design usually means having users participate in the concept design phase as experts of their own work and its instrumentation. Mock-ups and various illustrations such as models of work can be used to facilitate communication between designers and user representatives. While technologically savvy and articulate users are likely to be easier partners, successful participatory design projects have also been run with technically unsophisticated and poorly educated people. Collaborating and consulting such user groups may require higher levels of facilitating skills to be exhibited by designers and more use of visualizations, prototypes and clearer explanations and representations to support the design and imagination process (in comparison with groups of people who are more familiar with complex conceptual activities) (Ehn and Kyng, 1987; Ehn and Kyng, 1991; Säde, 2001; Bødker et al., 2004).

Hypothesis 4: *Company teams and other user involvement in innovation-related activities (joined with adequate facilitation techniques) can compensate, to some extent, for outside manufacturers' lacking competence in user practice.*

These different sides of user involvement and available repertoires for enhancing them require more effort than working with lead-users. For instance, almost by definition, crucial users are less enthusiastic about collaborating with a manufacturer in R&D; thus, gaining advantage from their perspectives can require more effort and more advanced methods and skills. None the less it appears warranted to assert our last hypothesis.

7. Discussion and managerial implications

It is well established that lead-users create a proportionally significant amount of user inventions and modifications to existing products. But when the question is broadened to the role of users in industry development the less dramatic forms of user inventiveness highlighted in the course of this paper become relevant too. Local modifications and adaptations are important for the diffusion of innovation, spreading it more widely to new user groups, forming new lead-users and in producing crossovers from nearby practices. User–manufacturers may have greater access to and sensitivity in recognizing small but inventive enactments of the technology, which adds to their competitive advantage. Moreover, they have more sensitivity to encourage users to try out new things and thus spur trails that could lead to further invention.

However, the division between user innovators, user purchasers, user manufacturers and outside manufacturers appears too stylized in this view. Entities such as manufacturers are not homogenous, nor are they strictly constrained by their organizational boundaries. Company teams and other enthusiasts can compensate to some extent for the manufacturers lacking competence in user practice. Hiring pro-amateur users as designers further blurs the boundary between user–manufacturers and other manufacturers. This may undermine some of the calculations by Baldwin et al on industry dynamics. However, if it does so, it is because the role of users' in industry development is *greater* not lesser, for they also contribute to the competence of the non-user–manufacturers.

Managerial implications here extend those made by Franke and Schreier (2002), who note that a manufacturer trying to integrate users would not want to operate solely as a 'hunter' for leading-edge users and their inventive ideas, but also as a 'planter' who provides innovation toolkits to facilitate further invention among users. The literature has established the benefits of providing users with 'innovation technology' (electric fora, design means, model and prototyping access, etc) (von Hippel and Katz, 2002; von Hippel, 2005) and suggested means to screen users most likely to innovate in given producers' direction and then giving them prizes and special discounts as encouragements to do so (Lüthje et al., 2005, 964–965). While involving users in testing new concepts and products in various stages of development is common practice in R&D management, these actions could in all likelihood be enhanced significantly through evaluating exactly what kinds of users are best to engage with in each of the four types of user collaboration and in different moments of industry development. Lead-users vs. normal users is likely to be an unhelpfully crude way to segment users. Dimensions of innovativeness and position with regard to the diffusion and phase of the practice and industry development can be hypothesized to open a more analytic view to whose input is likely to be most valuable and to what sort of support mechanisms may be apt to tease out that input. These kinds of enhanced planting can also be seen as part of more extensive 'gardening' that can (and in sports equipment already does) reach out well beyond equipment-related innovation. Affecting rule changes, competition venue requirements, introduction of series, encouraging new variations of the sport or equipment (or conversely trying to homogenize the sport) as well as making design decisions affecting the second-hand market (keeping it up or trying to cut it down depending on one's interest) are among such measures. In freestyle-kayaking company teams and white-water classes provide manufacturers with indications of what makes the everyday practice grow and develop, including early signs of any branching in the user base, changing motives or ways of conducting the sport. Such 'participation in the gardening' of the sport can be validly read as 'manipulating the design-space', yet with an important difference: few communities of practice are happy about manipulation that they feel is not of service to that community. As Franke and Shah (2003, 174) note: 'a strong community 'voice' may affect the actions of commercializing entities acting against the spirit of these communities'.

In terms of further research, the micro-innovations and micro-adaptations stress the questions about the methodological repertoires in studies of user innovation. Interviewing the equipment lead-users and focusing on the economic rationale in these behaviours (von Hippel, 2005) can be complemented with studies that engage more in depth with practices and community dynamics of users (e.g. Chaiklin and Lave, 1993; Hutchins, 1995) in deepening our understanding of how user and manufacturer as well as private and collective modes of innovation interlink. Should we want to phrase this in terms of 'democratizing innovation' (von Hippel, 2005), lead-users are like citizens of the ancient polis of Athens: a competent, willing and visible elite who are easily seen to constitute the relevant sphere of action. But analogous to Athens' democracy, without the means to pay sufficient attention to the majority of its inhabitants – peasants, women, slaves and foreign merchants – our view of user innovation would miss important issues if the, less grandiose, inventive inputs of other-than-lead-users were neglected.

While the importance of micro-innovation can be highlighted in a conceptual paper such as this, systematic research on the subject faces several methodological challenges. Detecting, comparing and assessing the significance of different micro-innovations can be tricky because of their often elusive and highly situated nature. In particular, adaptations to be found in the actions, settings and identities of practitioner are likely to be more difficult to handle than the more tangible shaping of equipment and arenas. Further significant methodological, empirical and conceptual work is needed to integrate understanding of micro-innovation with the established bodies of user-innovation research.

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Notes

1. Many other facets of open innovation such as alliances, spin-offs and spin-outs, cooption, pooled R&D and many other forms of collaboration between R&D firms have formed an established part of R&D management repertoires for some time (Lüthje and Herstatt, 2004; Lettl et al., 2006; West and Gallagher, 2006). While some user involvement in testing is common practice in new product development, the more far going forms of user innovation and producer–user collaboration remain less so much because of the changes these require from, for instance, organizing of R&D, control of projects, intellectual property regimes and secrecy (Grudin, 1993; Williams et al., 2005; Voss et al., 2009). Indeed, in-depth studies on R&D practices systematically show strong discrepancies between R&D realities and the espoused image of user-involvement portrayed in corporate rhetoric and R&D management handbooks (for detailed studies, see, e.g.

Miettinen et al., 2003; Oudshoorn et al., 2004; Williams et al., 2005; Voss et al., 2009).

2. Rodeo and Freestyle kayaking are used interchangeably throughout this paper. The sport was known as rodeo-kayaking until the late 1990s and then was relabelled as freestyle kayaking. Section 5 recounts the key changes in the sport that led to the relabelling.
3. User-manufacturers have already paid their design costs through their own experimenting; they are already in the user community, which allows word-of-mouth (and credibility) advantages in marketing as well as in design through having absorptive capacity to tap into ideas and modifications that are being discussed among users; and finally they have already set up their prototyping facilities, while entrants must first invest in these (Baldwin et al., 2006).
4. The role of other river kayakers resembles closely what we called *crucial users* in a study of database software for diabetes treatment (Hyysalo and Lehenkari, 2003, 2005). In terms of diffusion theory (Rogers, 1995), crucial users can be located after the edge of the 'chasm' between early adopters and early majority. (Moore, 2002)
   - These are users who must be enrolled in order for the user base to grow to a point where some economies of scale in production and delivery can bring the price of the technology down and allow other positive network externalities.
   - These users do not receive extraordinary benefits from the technology. Their relative lack of enthusiasm makes them require clear value and a smooth and relatively carefree operation from the innovation before they adopt it.
   - These users are not only burdened by the technology in question so that they do adopt innovation if it has benefits (vs. Laggards and late majority in diffusion theory). Thus, if these people do not adapt the innovation, there are some clear barriers to adoption or continuation of usage for most users.
   - These users are not intimidated by technology, and are likely to file reasoned complaints or simply balk at the novelty if it is not easy enough to install and use, too expensive or suit poorly their ecology of tasks. This means they are articulate enough for a manufacturer to be useful.
5. Strictly speaking, even rivers do not stay the same. Building and abandoning hydro power plants, changes in the amount and timing of rainfall, sequencing water discharge in different sections of (dammed) rivers as well as fishermen's petitions for adding more stones to rivers and nature's work in moving boulders and eroding banks all shape rivers significantly. This variation further spurs some of the micro-innovation and adaptation in kayaking but for the sake of clarity here we can mostly bracket it together.
6. As phrased by Hienert (2006, 279): 'Actually, rodeos in those days were won by paddlers who were able to perform some kind of show on the river (e.g. Shawn Baker juggled three stones in the middle of a class IV river without using his hands to paddle in 1990; in 1991, Jan Kellner pulled a banana out of his spray skirt and started eating the fruit on the rapids).'
7. It is equally important to understand that major outside influence features prominently in most of these innovations. Most tricks are adapted from gymnastics and other extreme sports, while few of the materials and means originate in kayaking (carbon, Kevlar, buoyancy materials, advanced plastics, and moulding techniques, hydrodynamic models, CAD-programs, disinfectants, etc). Yet, none of the outside influences makes a difference as such: user-innovators seem to be adopter-adapters *par excellence* who manage to convert techniques and materials into inventive design due to their domain knowledge (cf. von Hippel, 1994; Franke and Shah, 2003) To gain a sense of the development we encourage visiting Baldwin, Hienert and von Hippel's list of rodeo-kayaking inventions http://designresearch.jot.com/RodeoKayakInnovations. To see a range of modern moves in action visit for example, youtube, e.g. http://www.youtube.com/watch?v=w-sy3uR7mds&mode=related&search
8. For these advantages see end-note iii. While white-water kayaking is equally witness to branching to boater-cross, down-river, creek, slalom and freestyle kayaks, paddles and other gear, free-style kayaking itself has not breached into for instance expert and novice gear or big-water, small-water, still-water gear. (Mostly such differences are handled by choosing a different cavity of boat relative to paddler weight or through having two differently shaped boats for the same paddler). Yet, here too an important dynamic regarding low and high capital production emerges as exactly this allows the second-hand market to fend off high-capital entry. Designing very different, light and fragile or radical models for top paddlers could help user-manufacturers to keep the innovation rate fast enough to fend off lower price high-capital manufacturing entry, in general. But in doing so, they would risk losing the value of the used kayaks in the second-hand market (used to finance the purchase of new ones) and would be likely to slow the (1–4 years) cycle of paddlers buying new gear (Hienerth, 2006, 281), as well as risk exposing the 'bottom of the pyramid' to lower priced new kayaks as regular kayakers would be over-served by the top-end models (Christensen and Raynor, 2003)

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