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The user dominated technology era: Dynamics of dispersed peer-innovation

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ABSTRACT

Users invent new products and product categories, but the assumption has been that manufacturers will supplant users if their innovation is of value to many. The current paper examines Russian all terrain vehicles "karakats" to discuss a case of an era of extended user dominated technology and the related dynamics of dispersed peer-innovation. Karakat users have invented, modified, diversified and iterated this technology, as well as continued to self-build and self-maintain it. These vehicles are wide spread, have half a century of history and hundreds of design variants. Despite this, manufacturers have captured only a small subsection of the karakat market, albeit they have established new markets based on karakat principles. We find that the combinatory effect of previously known dynamics in user innovation research and science and technology studies offers a plausible explanation for the user dominance and dispersed peer innovation pattern, and manufacturers' failure to conquer the market.

1. Introduction

That users innovate new products and product categories is well known, but it has been assumed that manufacturers will come to dominate production and innovation in user initiated technology domains once they mature (Knight, 1963; Riggs and von Hippel, 1994; Baldwin et al., 2006). In this paper we examine how dispersed users have been able to innovate a new class of complex physical technology, an ecologically sound all terrain vehicle "karakat",[1] and create hundreds of design variants of this technology. After a half a century and two waves of commercialization attempts, users still dominate all aspects of this original technology domain. Manufacturers have built on users work in new heavier vehicle categories and have come to dominate the new markets that have emerged.

This innovation history extends what has been held about users' capacities in innovation.

To date, it has been reasoned that if an innovation by user is of value to many, a manufacturer will enter the market (or emerge among the users) to meet the aggregated demand with its higher manufacturing capabilities (Riggs and von Hippel, 1994; Baldwin and von Hippel, 2011). It has been further suggested that only through digital design and digital sharing users can pool their individual contributions to sufficiently wide scope collective innovation, which manufacturers cannot supplant (Raasch and von Hippel, 2012; Baldwin and von Hippel, 2011). The karakat history indicates, however, that peers do not necessarily need to pool their resources and competences *fully* to serve a wide scope of user needs in a manner that manufacturers cannot outcompete. The case of karakats indicates that dispersed peer innovation and adaptive diffusion presents an alternative pattern by which an extended evolution of complex modern technology can take place.

To make sense of the history of karakats, we draw from user innovation research as well as science and technology studies (S&TS). These two bodies of innovation research have had limited give and take despite their complementarities (Peine and Herrmann, 2012). User innovation research has focused on the

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[1] The design has a variety of names; the formal is 'snegobolotokhod na pnevmatikakh' (a vehicle for snowy and/or swampy terrain on low-pressure tyres). 'Karakat' is the most common naming, however (Nikitin 2009, 'Pozhva Jeeps' 2009, Ksenofontov and Shapiro 2004, MK 1984/1989/1991).

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economic rationale of innovation by users and its diffusion (von Hippel and DeMonaco, 2013; Raasch and von Hippel, 2012). S&TS has examined in qualitative detail the processes that comprise innovation, and user contributions to it, as long-term diachronic and interactive processes (Williams et al., 2005; Rohracher, 2005; Oudshoorn and Pinch, 2003; Pollock and Williams, 2008; Hyysalo, 2010).

We shall next outline research on innovation dynamics that foster distributed innovation by users and simultaneously make it hard for producers to enter a given class of products. We then outline our biography of artifacts and practices research approach, methods, and data. After this we move to empirics; Karakat use, building, and maintenance practices, the evolution of Karakats from the 1960s to 2010s, and their commercial manufacturing since 1990s. In so doing, we connect the case history to previous research to outline the dynamics of dispersed peer innovation. The net outcome of these empirics is discussed in Section 8.3 where we map the dominance of user and manufacturer innovations in the history of karakats. We end by discussion and implications for innovation management and policy.

2. User innovation, producer entry and dispersed peer innovation

Conditions where mass produced goods do not meet the variation in localized needs of users tend to result in what von Hippel calls *user low cost innovation niches*, where users innovate because of their underserved needs (von Hippel, 2005). Such niches have not only resulted in small improvements and single new products, but also spurred entirely *new classes of technology*, such as the mountain bike, the free-style kayak, and the Asca instrument (Rosen, 1993; Luthje et al., 2005; Baldwin et al., 2006; Riggs and von Hippel, 1994).

In such user initiated new technology domains, innovations first proliferate peer-to-peer (Luthje et al., 2005; Franke and Shah, 2003). Should the initial niche grow to a potential market, it is likely to attract manufacturing. Some users may become user entrepreneurs (Rosen, 1993; Shah and Tripsas, 2007) or outside manufacturers enter, often by making a version of a user design by copying it or it being freely revealed to them (von Hippel, 1976; Riggs and von Hippel, 1994). The higher efficiency of mass manufacturing has then be suggested to displace user designs as time goes by, leading to further innovations by manufacturers (Knight, 1963; Riggs and von Hippel, 1994; Baldwin et al., 2006).

To date, this pattern has been researched "full cycle" only in reference to scientific instruments and rodeo kayaks, albeit more evidence of its different phases does exists. Explanations offered have been user disinterest in manufacturing (Riggs and von Hippel, 1994) and superior production efficiency in high-capital production equipment (Baldwin et al., 2006). In digital domains, users may also fend off manufacturers' efficiency, because the distribution and communication costs of design are low enough for users to effectively pool their resources. This allows them to build and benefit from designs that can have significantly broader scope than could be produced by any individual user (Baldwin and von Hippel, 2011), and which hence can address the range of varying needs of different users (von Hippel, 2005). Peer-to-peer diffusion may also result in user contested markets (Raasch and von Hippel, 2012), and short innovation cycles can inhibit returns from capital intensive production methods (Baldwin et al., 2006).

In light of this existing research, we should think that if poorly coordinated users ended up innovating a class of complex modern physical technology with a plausible demand, manufacturers should take it over sooner rather than later. Faced with the case such as that of the karakat, where this has not happened, it then becomes salient to examine what dynamics may have led to such a class of physical technology, which manufacturers fail to serve better than users themselves.

In-depth analyses of innovation in science and technology studies have presented a set of further considerations that add to the above analyses. These researches suggest paying careful attention to the "contents" of both the technology and practices in question – not just their form, origins, amounts or the economics involved – as well as to the interplay of the elements involved instead of a single factor explanation (Williams and Edge, 1996; MacKenzie and Wajcman, 1998). Some of these considerations are explicitly and some implicitly shared by user innovation research, others not.

Both user innovation research and science and technology studies assert that knowledge asymmetries between users and manufacturers are likely to play a role in the emergence of innovations by users as well as in the continued user dominance (von Hippel and Tyre, 1996). Both user domain and manufacturer domain information is tied to equipment, infrastructure, social practices and knowledge base. Science and technology studies show that such situated knowledge (Suchman, 1987; Orr, 1996) is difficult to transfer, and parts of it difficult to explicate (Cambrosio and Keating, 1995; Pollock et al., 2009). The economic effect has been aptly called "sticky information" (von Hippel and Tyre, 1996), information that is costly to detach from its site of origin. In some domains, passing the needed user information to a producer can be relatively straightforward, such as in examining a user design or deploying an in-depth enquiry of user practice (Bødker et al., 2004). In others, such as scientific instruments or new extreme sports, it has been easier for user innovators to adopt design competences (Riggs and von Hippel, 1994; Luthje et al., 2005; Franke and Shah, 2003).

Methods and principles technology design are another issue S&TS directs attention to. Even though blueprints would allow competence pooling to share drawings, a bricolage form of building allows users to take use of whatever skills and parts happen to be available (Büscher et al., 2001). Bricolage may lessen the construction costs for users, as well as add to manufacturer difficulties in deciphering what are accidental and what are necessary characteristics in a design it would potentially wish to copy. The same goes for infrastructural characteristics around the technology. The less systemic, explicit, untangled and uniform the vitally important infrastructural elements are, the harder it is for a producer to glean this context, or to predict and steer the future direction of technology development (Star and Ruhleder, 1996; Pollock et al., 2009; Johnson et al., 2013).

The form of technology is also likely to play an important role. Fleck's (1993, 1988) seminal work on configurational technology makes a distinction between discrete objects (such as kayaks), systems (such as the electricity network), and technological configurations (such as office equipment) that are composed of elements from multiple origins and assembled as local particulars. Star's (1989) work on "plasticity" of objects and De Laet and Mol's (2000) work on "fluid" objects such as the Zimbabwean Bush pump, underscore the further variability that results from varying inclusion of practice and skill components in a configuration. The skill components and their importance are more difficult to trace for a producer than a unified technical form would be, while the resulting high adaptability is apt for serving users' particular needs.

The form of technology further affects the likely proliferation dynamics. Unlike discreet artifacts, such as new crops, medicines or pens (Rogers, 1995), configurational technologies tend to be adjusted in each site of adoption to meet local contingencies (Sorensen, 1996; Williams et al., 2005). This results in a pattern that has been characterized as "innofusion", the fusion of innovation and diffusion as the technology evolves further at each site of use. Such pattern has been shown to feature in early industrial robotics, early new media computing applications in the