12 Linking User Innovation to Other Phenomena and Fields

This final chapter is devoted to describing links between user-centered innovation and other phenomena and literatures. Of course, innovation writ large is related to anything and everything, so the phenomena and the literatures I will discuss here are only those hanging closest on the intellectual tree. My goal is to enable interested readers to migrate to further branches as they wish, assisted by the provision of a few important references. With respect to phenomena, I will first point out the relationship of user innovation to *information* communities—of which user innovation communities are a subset. With respect to related fields, I begin by linking user-centric innovation phenomena explored in this book to the literature on the economics of knowledge, and to the competitive advantage of nations. Next I link it to research on the sociology of technology. Finally, I point out how findings regarding user innovation could—but do not yet—link to and complement the way that product development is taught to managers.

Information Communities

Many of the considerations I have discussed with respect to user innovation communities apply to *information* communities as well—a much more general category of which user innovation communities are a subset. I define information communities as communities or networks of individuals and/or organizations that rendezvous around an information commons, a collection of information that is open to all on equal terms.

In close analogy to our discussions of innovation communities, I propose that commons-based information communities or networks will form when the following conditions hold: (1) Some have information that is not generally known. (2) Some are willing to freely reveal what they know. (3) Some beyond the information source have uses for what is revealed. On an intuitive basis, one can immediately see that these conditions are often met. Of course, people and firms know different things. Of course there are many things that one would not be averse to freely revealing; and of course others would often be interested in what is freely revealed. After all, as individuals we all regularly freely reveal information not generally known to people who ask, and presumably these people value at least some of the information we provide.

The economics of information communities can be much simpler than that of the user innovation communities discussed earlier, because valuable proprietary information is often not at center stage. When the service provided by information communities is to offer non-proprietary "content" in a more convenient and accessible form, one need consider only the costs and benefits associated with information diffusion. One need not also consider potential losses associated with the free revealing of proprietary innovation-related information.

It is likely that information communities are getting steadily more pervasive for the same reasons that user innovation communities are: the costs of diffusing information are getting steadily lower as computing and communication technologies improve. As a result, information communities may have a rapidly increasing impact on the economy and on the landscape of industry. They are and will be especially empowering to fragmented groups, whose members may for the first time gain low-cost access to a great deal of rich and fresh information of mutual interest. As is the case for user innovation networks, information networks can actually store content that participants freely reveal and make it available for free downloading. (Wikipedia is an example of this.) And/or, information networks can function to *link* information seekers and information holders rather than actually storing information. In the latter case, participants post to the network, hoping that someone with the requested information will spot their request and provide an answer (Lakhani and von Hippel 2003). Prominent examples can be found in the medical field in the form of specialized websites where patients with relatively rare conditions can for the first time find each other and also find specialists in those conditions. Patients and specialists who participate in these groups can both provide and get access to information that previously was scattered and for most practical purposes inaccessible.

Just as is the case in user innovation groups, open information communities are developing rapidly, and the behaviors and infrastructure needed for success are being increasingly learned and codified. These communities are by no means restricted to user-participants. Thus, both patients and doctors frequently participate in medical information communities. Also, information communities can be run by profit-making firms and/or on a non-profit basis for and by information providers and users themselves—just as we earlier saw was the case with innovation communities. Firms and users are developing many versions of open information communities and testing them in the market. As an example of a commercially supported information commons, consider e-Bay, where information is freely revealed by many under a structure provided by a commercial firm. The commercial firm then extracts a profit from commissions on transactions consummated between information providers and information seekers. As an example of an information community supported by users themselves, again consider Internet sites specializing in specific diseases—for example, childrenfacingillness.com.

Information communities can have major effects on established ways of doing business. For example, markets become more efficient as the information provided to transaction participants improves. Thus, product and service manufacturers benefit from good information on the perceptions and preferences of potential buyers. Similarly, product and service purchasers benefit from good information on the characteristics of the various offerings in the market. Traditionally, firms have collected information on users' needs and on products' characteristics by means of face-to-face interviewing and (in the case of mass markets) questionnaires. Similar information of high quality now can be collected nearly without cost and can be posted on special Internet sites by users themselves and/or by for-profit enterprises. Dellarocas, Awad, and Zhang (2004) show that volunteered online movie reviews provide information that is just as accurate as that collected by surveys of representative samples of respondents. This emerging new approach to data aggregation will clearly affect the established business models of firms specializing in information collection, with websites like www.ciao.co.uk illustrating new possibilities. If the quality of information available to transaction participants goes up and the information price is low, transaction quality should go up. With the aid of online product-evaluation sites, it is likely that consumers will be able to apply much better information even to small buying decisions, such as the choice of a restaurant for tonight's dinner.

What Paul David and colleagues call "open science" is a type of information community that is closely related to the innovation communities discussed earlier (David 1992; Dasgupta and David 1994; David 1998). Free revealing of findings is, of course, a characteristic of modern science. Academic scientists publish regularly and so freely reveal information that may have high proprietary value. This raises the same question explored in the case of innovation communities: Why, in view of the potential of free ridership, do scientists freely reveal the information they have developed at private cost? The answer overlaps with but also differs from the answers provided in the case of free revealing of proprietary innovations by innovation users. With respect to similarities, sociologists of science have found that reputation among peers is important to scientists, and that priority in the discovery of new knowledge is a major component of reputation. Because of the importance of priority, scientists generally rush their research projects to completion and then rush to freely reveal their new findings. This dynamic creates a great advantage from the point of view of social welfare (Merton 1973).

With respect to major differences, it is public policy in many countries to subsidize research with public funds. These policies are based on the assumption that only inadequate amounts of scientific research can be drawn forth by reputational inducements alone. Recall that, in contrast, innovations developed and freely revealed by innovation users are not subsidized from any source. Users, unlike "scientists," by definition have a personal or corporate use for the innovation-related knowledge they generate. This additional source of private reward may explain why user innovation communities can flourish without subsidy.

The Economics of Knowledge

In this field, Foray (2004) provides a rich road map regarding the economics of knowledge and the central role played by users. Foray argues that the radical changes in information and communication technologies (ICT) are creating major changes in the economics of knowledge production and distribution. Economists have traditionally reduced knowledge production to the function of research and development, defined as the activity specifically devoted to invention and innovation. Starting with Machlup (1962), economists also have identified the knowledge-based economy as consisting of specialized sectors focused on activities related to communication, education, the media, and computing and information-related services. Foray argues that these simplifications, although providing a rationale for a way to measure knowledge-generation activities, were never appropriate and now are totally misleading.

Knowledge generation, Foray says, is now a major activity across all industrial sectors and is by no means restricted to R&D laboratories: we are in the age of the knowledge economy. He makes a central distinction between R&D that is conducted in laboratories remote from doing, and learning by doing at the site of production. He argues that both are important, and have complementary advantages and drawbacks. Laboratory research can ignore some of the complexities involved in production in search of basic understanding. Learning by doing has the contrasting advantage of being in the full fidelity of the real production process. The drawback to learning by doing, however, is that one is attempting to do two things at once—producing and learning—and this can force compromises onto both.

Foray positions users at the heart of knowledge production. He says that one major challenge for management is to capture the knowledge being generated by users "on line" during the process of doing and producing, and to integrate it with knowledge created "off line" in laboratories. He discusses implications of the distributed nature of knowledge production among users and others, and notes that the increased capabilities of information and communication technologies tend to reduce innovators' ability to control the knowledge they create. He proposes that the most effective knowledge-management policies and practices will be biased toward knowledge sharing.

Weber (2004, pp. 72–73) explores similar ideas in the specific context of open source software. "The conventional language of industrial-era economics," he notes, "identifies producers and consumers, supply and demand. The open source process scrambles these categories. Open source software users are not consumers in the conventional sense. . . . Users integrate into the production process itself in a profound way." Weber's central thesis is that the open source process is a new way of organizing production:

> One solution is the familiar economy that depends upon a blend of exclusive property rights, divisions of labor, reduction of transaction costs, and the management of principal-agent problems. The success of open source demonstrates the importance

of a fundamentally different solution, built on top of an unconventional understanding of property rights configured around distribution. . . . And it relies on a set of organizational structures to coordinate behavior around the problem of managing distributed innovation, which is different from the division of labor. (ibid., p. 224)

Weber details the property-rights regime used by open source projects, and also the nature of open source innovation communities and incentives acting on participants. He then argues that this new mode of production can extend beyond the development of open source software, to an extent and a degree that are not yet understood:

One important direction in which the open source experiment points is toward moving beyond the discussion of transaction as a key determinant of institutional design. . . . The elegant analytics of transaction cost economics do very interesting work in explaining how divisions of labor evolve through outsourcing of particular functions (the decision to buy rather than make something). But the open source process adds another element. The notion of open-sourcing as a strategic organizational decision can be seen as an efficiency choice around distributed innovation, just as outsourcing was an efficiency choice around transactions costs. . . . As information about what users want and need to do becomes more fine-grained, more individually differentiated, and harder to communicate, the incentives grow to shift the locus of innovation closer to them by empowering them with freely modifiable tools. (ibid., pp. 265–267)

National Competitive Advantage

Understanding national innovation systems and the competitive advantage of a nation's firms is an important matter for national policy makers (Nelson 1993). Can what we have learned in this book shed any light on their concerns? Porter (1991), assessing national competitive advantage through the intellectual lens of competitive strategy, concludes that one of four major factors determining the competitive advantage of nations is demand conditions. "A nation's firms," he argues, "gain competitive advantage if domestic buyers are, or are among, the world's most sophisticated and demanding buyers for the product or service. Such buyers provide a window into the most advanced buyer needs. . . . Buyers are demanding where home product needs are especially stringent or challenging because of local circumstances." For example: "The continental United States has been intensely drilled, and wells are being drilled in increasingly difficult and marginal fields. The pressure has been unusually great for American oil field equipment suppliers to perfect techniques that minimize the cost of difficult drilling and ensure full recovery from each field. This has pushed them to advance the state of the art and sustain strong international positions." (ibid., pp. 89–90)

Porter also argues that *early* domestic demand is also important: "Provided it anticipates buyer needs in other nations, early local demand for a product or service in a nation helps local firms to move sooner than foreign rivals to become established in an industry. They get the jump in building large-scale facilities and accumulating experience. . . . Only if home demand is anticipatory of international need will home demand contribute to advantage." (ibid., p. 95)

From my perspective, Porter is making the case for the value of a nation's domestic lead users to national competitive advantage. However, he is also assuming that it is *manufacturers* that innovate in response to advanced or stringent user demand. On the basis of the findings reported on in this book, I would modify this assumption by noting that, often, domestic manufacturers' links to *innovating lead users* have the impacts on national competitive advantage that he describes—but that the lead users' input to favored domestic firms would include innovations as well as needs.

Domestic lead users make a difference to national competitive advantage, Porter argues, because "local firms often enjoy some natural advantages in serving their home market compared to foreign firms, a result of proximity as well as language, regulation, and cultural affinities (even, frequently, if foreign firms are staffed with local nationals)." Porter continues: "Preferred access to a large domestic customer base can be a spur to investment by local firms. Home demand may be perceived as more certain and easier to forecast, while foreign demand is seen as uncertain even if firms think they have the ability to fill it." (ibid., p. 93)

What new insights and research questions can the work of this book contribute to this analysis of national competitive advantage? On the one hand, I certainly see the pattern Porter describes in some studies of lead user innovation. For example, early in the history of the US semiconductor industry, AT&T, the inventor of the transistor and an early innovator, developed a number of novel types of production equipment as a user organization. AT&T engineers went to local machine shops to have these machines produced in volume to meet AT&T's in-house production needs. A side effect of this procurement strategy was to put many of these previously undistinguished firms into the business of producing advanced semiconductor equipment to the world (von Hippel 1977, 1988).

On the other hand, the findings of this book suggest that the "natural advantages" Porter proposes that domestic manufacturers will have with respect to filling the needs of local lead users may be eroding in the Internet age. As has been seen in the case of open source software, and by extension in the cases of other information-based products, users are capable of developing complex products in a coordinated way without geographic proximity. Participants in a particular open source project, for example, may come from a number of countries and may never meet face to face. In the case of physical products, the emergence of a pattern of user-based design followed by "foundry-style" production may also reduce the importance of propinquity between innovating lead users and manufacturers. As in the cases of integrated circuits and kitesurfing discussed earlier in this book, users can transmit CAD product-design information files from anywhere to any suitably equipped manufacturer for production. Probably only in the case of physical products where the interaction between product and production methods are not clear will geography continue to matter deeply in the age of the Internet. Nations may be able to create comparative advantages for domestic manufacturers with respect to profiting from innovation by lead users; however, they cannot assume that such advantages will continue to exist simply because of propinquity.

The Sociology of Technical Communities

Relevant elements of this field include studies in the sociology of technology in general and studies of the sociology of open source software communities in particular. Historical accounts of the evolution of a technology have often taken a linear view of their subject. In the linear view, a technology such as aerodynamics and related technological artifacts such as the airplane start at point A and then naturally evolve to end point B. In other words, it is implicitly assumed that the airplane will evolve from the artifact of wood and fabric and wire developed by the Wright brothers to the characteristics we associate with aircraft today. Nothing much to explain about that.

In the Social Construction of Technology (SCOT) model of technological evolution (Pinch and Bijker 1987), the direction in which an artifact (a product, for example) evolves depends very much on the meanings that different "groups with a problem" construct for it. These meanings, in turn, affect which of the many possible variations of a product are developed, how they evolve, and whether and how they eventually die. Groups that construct the meanings of a product centrally include, but are not restricted to, product users. For example, in the case of the bicycle, some relevant groups were users of various types—people who wanted to travel from place to place via bicycle, people who wanted to race bicycles, etc. Relevant non-user groups included "anticyclists," who had a negative view of the bicycle in its early days and wanted it to fail (Bijker 1995).

When one takes the views of all relevant groups into account, one gets a much richer view of the "socially constructed" evolution of a technology. As a relatively recent example, consider the supersonic transport plane (SST) planned in the United States during the 1970s. Airlines, and potential passengers were "groups with a problem" who presumably wanted the technology for different reasons. Other relevant groups with a problem included people who expected to be negatively affected by the sonic boom the SST would cause, people who were concerned about the pollution its engines would cause in the stratosphere, and people who had other reasons for opposing or supporting the SST. Proposed designs evolved in an attempt to satisfy the various contending interest groups. Eventually it became clear that the SST designers could not arrive at a generally acceptable compromise solution and so the project failed (Horwich 1982).

Pinch and Kline (1996, pp. 774–775) elaborated on the original SCOT model by pointing out that the way a product is interpreted is not restricted to the design stage of a technology, but also can continue during the product's use. They illustrated with the case of the automobile:

> . . . although [automobile] manufacturers may have ascribed a particular meaning to the artifact they were not able to control how that artifact was used once it got into the hands of the users. Users precisely as users can embed new meanings into the technology. This happened with the adaptation of the car into rural life. As early as 1903, farm families started to define the car as more than a transportation device. In particular, they saw it as a general source of power. George Schmidt, a Kansas farmer, advised readers of the *Rural New Yorker* in 1903 to "block up the hind axle and run a belt over the one wheel of the automobile and around the wheel on a [corn] sheller, grinder, saw, pump, or any other machine that the engine is capable of running, and see how the farmer can save money and be in style with any city man." T. A. Pottinger, an Illinois farm man, wrote in *Wallace's Farmer* in 1909 that "the ideal farm car should have a detachable backseat, which could turn the vehicle into a small truck."

Of course, user innovations and modifications are involved in these cases along with users' reinterpretation of product uses. Kline and Pinch report that manufacturers adopted some of the rural users' innovations, generally after a lag. For example, a car that could also serve as a small truck was eventually offered as a commercial product.

Research on communities of practice offers another link between studies of user innovation and sociology (Brown and Duguid 1991; Wenger 1998). The focus of this research is on the functioning of specialist communities. Researchers find that experts in a field spontaneously form interest groups that communicate to exchange their views and learnings on how to carry out and improve the practices of their profession. Members of communities of practice exchange help in informal ways that seem similar to the practices described above as characteristic of open source software projects and communities of sports innovators.

Research on brand communities is still another related research thread (Muniz and O'Guinn 2001). Brand communities form around commercial brands and products (e.g., Lego construction toys) and even around products discontinued by their manufacturers e.g., Apple's Newton personal digital assistant). Brand communities can be intensely meaningful to participants and can involve user innovation. In Newton groups, for example, users develop new applications and exchange information about how to repair aging equipment (Muniz and Schau 2004). In Lego communities, lead users develop new products, new building techniques, and new offline and online multiplayer building projects that later prove to be of interest to the manufacturer (Antorini 2005).

The Management of Product Development

Finally, I turn to links between user-centered innovation and teaching on the management of product development. Information on lead users as a source of new product ideas now appears in most marketing textbooks. There also should be a link to other elements of user-centered innovation processes in the literature on product-development management—but there really isn't much of one yet. Although much of the research on user innovation cited in this book is going on in schools of management and business economics, little of this information has moved into teaching related to the product-development process as of yet.

Clearly, it would be useful to provide managers of both user firms and manufacturing firms with a better understanding of the management of user-centered innovation. It is a curious fact that even managers of firms that have built major product lines upon user-developed innovations may hold the manufacturer-centric view that "*we* developed that." For example, an early study of innovation in scientific instruments documented that nearly 80 percent of the major improvements commercialized by instrument manufacturers had been developed by users (von Hippel 1976). When I later discussed this finding with managers in instrument firms, most of them were astonished. They insisted that all the innovations in the study sample had been developed within manufacturing firms. They could be convinced otherwise only when supplied with actual publications by user-scientists describing user-built prototypes of those instrument improvements—prototypes developed from 5 to 7 years before any instrument firm had sold a functionally equivalent commercial product.

My inquiries into why managers in this field and others held—and largely still hold—such contrary-to-fact beliefs identified several contributing factors. First, manufacturers seldom track where the major new products and product improvements they sell actually came from. Managers see no need to set up a tracking system, because the conventional wisdom is clear: "Everyone knows new products are developed by manufacturers such as ourselves based on user needs identified by market research." Further, the manufacturing firms have market-research and product-development departments in place, and innovations are somehow being produced. Thus, it is easy to conclude that the manufacturers' innovation processes must be working as expected.

In fact, however, important, functionally novel innovations are often brought into manufacturers by informal channels. Product-development engineers may attend conferences and learn about important user innovations, salesmen and technical service personnel discover user-modified equipment on field visits, and so on. Once the basic innovation-related information is in house, the operating principles of a user's prototype will often be adopted, but the detailed design of the device will be changed and improved for production. After a while, the user's prototype, if remembered at all, will begin to look quite primitive to the firm's engineers relative to the much better product they have designed. Finally, when sales begin, the firm's advertising will urge customers to buy "*our* wonderful new product."

The net result is understandable: the user roots of many new commercial products, never widely known in manufacturing firms, are forgotten. And when it is time to develop the next innovation, management again turns to the conventional methods that "worked so well for us last time." Eventually, information about new user innovations will again arrive by pathways unnoticed and unmanaged—and with an unnecessary lag.

To improve matters, managers must learn when it is appropriate to follow user-centered and manufacturer-centered innovation process paradigms and how user-centered innovation can best be managed when it is the method of choice. Managers in user firms and in manufacturing firms need tools with which to understand the innovate-or-buy decisions they face—to understand which product needs or which service needs users (rather than manufacturers) should invest in developing. Managers in user firms also need to learn how their firms can best carry out development work in their low-cost innovation niches: how they can best deploy their information-related advantages of being actual users and residing in the context of use to cheaply learn by doing. Managers in manufacturing firms will want to learn how they can best play a profitable role in user-centered innovation patterns when these play a role in the markets they serve.

Innovating users may also want to learn whether and how to diffuse their innovations by becoming manufacturers. This may be a fairly common practice in some fields. Shah (2000) found that users of sports equipment sometimes became manufacturers by a very natural process. The users would demonstrate the performance and value of their innovations as they used them in public sporting events. Some of the participants in the meets would then ask "Can you make one of those for me too?" Informal hobby-level production would then sometimes become the basis of a major company. Lettl, Herstatt, and Gemunden (2004) report on case histories in which user-innovators became heavily involved in promoting the commercialization of important innovations in surgical equipment. These innovations tended to be developed by surgeons, who then often made major efforts to induce manufacturers to commercialize them. Hienerth (2004) documents how user-innovators in "rodeo kayaking" build their own boats, discover that kayak manufacturers (even those established by a previous generation of user-innovators) are unwilling to manufacture what they want, and so are driven to become manufacturers themselves.

Managers must learn that no single locus of innovation is the “right” one for either user firms or manufacturer firms. The locus of innovation varies between user firms and manufacturing firms according to market-related and information-related conditions. These conditions may well vary predictably over product life cycles. Utterback and Abernathy (1975) proposed that innovation by users is likely to be more important in the early stages of such cycles. Early in the life of a new product, there is a “fluid” stage in which the nature and the use of a product are unclear. Here, Utterback and Abernathy say, users play a big part in sorting the matter out, in part through innovation. Later, a dominant product design will emerge—a shared sense of exactly what a particular product is, what features and components it should include, and how it should function. (We all know, for example, that a car has four wheels and moves along the ground in directions determined by a steering wheel.) After that time, if the market for the product grows, innovation will shift from product to process as firms shift from the problem of what to produce to the problem of how to produce a well-understood product in ever greater volumes. From a lead user innovation perspective, of course, both functionally novel products and functionally novel processes are likely to be developed by users—in the first case users of the product, and in the second by manufacturing firms that use the process.

In Conclusion

In this book I have explored how and why users, individually and in firms and in communities, develop and freely reveal innovations. I have also argued that there is a general trend toward a open and distributed innovation process driven by steadily better and cheaper computing and communications. The net result is an ongoing shift toward the democratization of innovation. This welfare-enhancing shift is forcing major changes in user and manufacturer innovation practices, and is creating the need for change in government policies. It also, as I noted at the start of the book, presents major new opportunities for us all.