

# The Phenomenological Boundary in Open Innovation

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*Abstract and Introduction*

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## **Abstract**

Distributed and open innovation models have gained increasing visibility in the recent years. One important driver for this interest has been the success of open source software projects that have highlighted the possibilities of digital communication and emergent forms of coordination, control, and division of labor.

The present paper introduces theory that shows that the effectiveness of distributed and open innovation models depends on the type of innovation objects. Some innovations belong to domains that can be modeled with high fidelity as syntactic systems, and they are therefore easy to model using digital representations. Other innovation domains, in turn, have characteristics that make social distribution of innovation processes easy. Some of the most successful open source projects have focused on innovation domains where both digital representation and social distribution is easy.

Different types of artifacts create different constraints for innovation processes. This paper introduces and develops the concept of *phenomenological boundary*, and shows how it leads to different innovation dynamics in open source software and open source hardware projects. The presented theory leads to a rewriting of earlier theories on boundary objects, communities of practice, and open and distributed innovation. To illustrate the developed concepts, the paper presents an exploratory empirical study that focuses on differences between logic design hardware projects, close-to-hardware software projects, and social software projects.

The phenomenological boundary restricts the possibilities for using digital technologies to facilitate innovation. The results, therefore, have consequences on how to organize and support innovation processes in distributed networks.

## ***Introduction***

During the last two decades, innovation researchers have become increasingly aware of the socially and organizationally distributed nature of innovation processes. Although innovation is still often studied from an organizational and product development point of view, it is now well understood that the traditional manufacturer-centric view on innovation does not accurately describe innovation processes (Von Hippel 1976; 1988). Innovations are developed in organizational and social networks (Powell and Grodal 2004), where social learning is important (Schön 1983; Brown and Duguid 1991; 2001; Engeström 1987; 1999; Lave and Wenger 1991; Sawhney and Prandelli 2000; Wenger, McDermott, and Snyder 2002), where the characteristics of innovation are articulated among multiple stakeholders and across heterogeneous groups (Teece 1986; Henderson and Clark 1990; F. Kodama 1995; Kogut and Zander 1997; Leonard-Barton 1995; Boland and Tenkasi 1995; Carlile 2004; M. Kodama 2007; Yoo, Lyytinen, and Boland 2008), and where innovations can be co-constructed in spaces of interaction and meaning creation (Nonaka, Toyama, and Hirata 2008). Studies on social shaping and domestication of technological innovations have also dislocated innovation from its traditional organizational locus, extensively documenting the point that users are often key drivers in the innovation process (Oudshoorn and Pinch 2003). Researchers in the actor-network paradigm (Law and Hassard 1999; Latour and Woolgar 1986), distributed and situated cognition (Hutchins 1995; Suchman 1987), socio-cultural cognition (Luria and Vygotsky 1992; Scribner 1997; Cole 1986; Cole, Engeström, and Vasquez 1997) as well as research on boundary objects and boundary infrastructures (Bowker and Star 1999; Bowker 2005; Star and Griesemer 1989) have shown how human and non-human actors often play complementary and dynamically changing roles in the innovation and problem-solving process, thus implicitly redefining the traditional “artifact centric” model of innovation and illustrating the socio-technically networked nature of innovation processes. Research on agricultural innovation (Engel 1997) and internet-related innovations (Tuomi 2002) has emphasized the importance of parallel creative processes in multiple stakeholder groups in the realization of latent innovative opportunities, essentially distributing the focus of innovation to a field of mutually evolving social practices.

In the multifocal innovation model of Tuomi (2002), the interdependences, interests, and tensions among social activity systems and related communities of practice define constraints and drivers for the articulation of the meaning of technological opportunities. When a new technological opportunity emerges, people engaged in different social practices try and figure out how the latent opportunity could meaningfully be integrated into the social practices of the community. The potential users construct the meaning of the latent opportunity using the local system of meanings as a starting point. If the users are successful in “reinventing” the technical opportunity, i.e., what its pragmatic meaning is in the context of the present social practice, the latent innovation becomes real. This step of “reinventing,” therefore, is the step that actually “produces” the innovation, in a form that can subsequently be registered in historical and economic accounts of innovations and technical progress.

The multifocal model dislocates the conventional organization-centric model of innovation, puts the locus of innovation to “downstream,” and describes the evolution of innovative artifacts as structural drift in a field of diversified social practices and their heterogeneous stocks of knowledge. It starts from the historical observation that socially and economically important innovations are often invented several times before they eventually start to have real impact. In addition, the model starts from the assumption that parallel discovery dominates in socio-economically important innovations. This implies a rather radical redefinition of the traditional firm-focused view on innovation. In essence, as a first approximation, the multifocal model reverses the linear model of innovation claiming that the bottlenecks of innovation can rarely be found from inside an organization, and that a critical task for innovation management is about managing and facilitating social learning, knowledge creation, and change processes in “downstream” activity systems and communities. As key innovation processes do not occur inside organizational boundaries, the adoption of the multifocal model also leads to new models of coordination, control, and division of labor, thus requiring that we rewrite some basic concepts of organization and management theory.

In the multifocal model, innovations become real when they change social practice and when they become embedded in the activities of the community in question. The “same” innovative technological artifact can simultaneously be used in many different social practices and it can have multiple different user groups (Tuomi

2002, chap. 2). For example, the user groups of a medical diagnostic system could include hospital administrators, physicians, nurses, maintenance engineers, patients, equipment manufacturers and distributors, insurance firms, and educators. In the multifocal model, “users” become redefined as socially embedded practitioners in a complex system of social division of labor, and they cannot anymore be represented simply as the “consumers” of manufacturer-developed innovations. Manufacturers, in turn, become interpreted as only one special case of “innovation users” among the various stakeholder groups. Consumption, itself, becomes reinterpreted as active productive use of outputs and products created in other social practices. In economic terms, consumption becomes reinterpreted as intermediate production and circulation in a continuously evolving system of technology-mediated practices (Tuomi 1999).

The multifocal model implies that technology trajectories are generated in a field of social interests. In some special cases, when one dominant user group defines the present uses of the “product,” this complex field of interactions can be reduced into a simple bipolar network of “producers” and “consumers.” This dyadic model characterizes many mass-produced “consumer goods” that are used in common cultural practices, where the “user” may relatively easily be represented as a generalized category with relatively homogeneous characteristics. In general, however, many different user groups exist simultaneously, and the evolution of the innovation is shaped in a potentially complex field of social forces, driven by different groups at different times.

The multifocal model means that the capabilities of “downstream” communities are critical for the realization of latent innovation opportunities. It also means that technology development trajectories are formed in an essentially political process, where different stakeholders try and define how the latent opportunity could be made real within their own horizon of meaning, and where the co-evolution of multiple potentially incompatible interpretations of the practical meaning are negotiated. One conceptual implication of this is that innovations can be categorized based on the social characteristics of these negotiation processes. Some innovations, for example, are “low conflict” innovations, that allow incompatible interpretations to be easily negotiated, thus facilitating rapid development. The different stakeholders may also be able to construct boundary objects and interfaces that effectively isolate the developmental dynamics of the different stakeholder

groups, thus reducing conflict (Star 1992). Other innovations, in contrast, may involve heavy power struggles and complex negotiation processes, potentially bringing the evolution of the innovation to a halt, as documented in different theoretical contexts by, for example, Dougherty (1992), Carlile (2004) , Latour (1996), and Hughes (1983).

The multifocal model of innovation has emphasized the importance of intra-community social constraints and inter-community negotiation in the evolution and realization of innovations. These constraints exist at the social level, and their root cause can be understood as the heterogeneity of systems of meaning. In general, local systems of meaning generate what will be called *phenomenological boundaries* below. Although the characteristics and dynamics of phenomenological boundaries have rarely been discussed in organization theory, the existence of boundaries and heterogeneity within and across organizations is well known, and underlies much of the research on organizational cognition, the knowledge-based view of the firm, and knowledge management. The multifocal model, however, also implies the existence of another variation of the phenomenological boundary, which has not been studied before. This boundary exists between the object world and its possible meaningful reconstructions. The characteristics of this boundary vary depending on the object domain, and lead to different innovation dynamics in different domains of innovation.

As representations—including digital representations of events, processes and objects—are abstractions, they never completely characterize the represented reality. An important exception, however, is the domain of software. Given a technical infrastructure, software can be both a description of a system and the functional system itself. Some software development projects that focus on hardware-related software can therefore relatively easily overcome the phenomenological boundary. In general, however, the possibilities to support innovation processes with digital technologies will be limited by the phenomenological boundary.

The present study will ask the question how different types of innovations facilitate and constrain innovation dynamics and digital innovation. I shall argue that software-based innovations form a special class of innovative artifacts that can exceptionally well be developed in distributed innovation processes. Although

software development can efficiently be distributed partly because digitized artifacts can now easily and cheaply be moved across global communication networks, the claim is that the fundamental enablers for distributed software innovation are not economic but ontological.

Furthermore, there exist different types of software-based innovations. Software is sometimes used to reorganize relations among social practices, as happens, for example, in typical organizational information systems. Sometimes, however, software is used to create computer operating systems, hardware device drivers, and embedded information processing devices where the software system is interacting with natural systems and other technical artifacts. When the innovation object can be modeled as a syntactical system, it can easily be processed algorithmically, and it easily crosses the phenomenological boundary. Both types of software innovation benefit from the easy digitalization of the objects under construction; they, however, lead to very different social conflict and negotiation models. These negotiations occur across a specific type of phenomenological boundary, which will be called the *political boundary* below. The phenomenological boundary between formal and natural systems, as defined below, will, in turn, be called the *syntactic boundary*. The characteristics of the syntactic boundary, therefore, will have important consequences on the possibility to create digital representations of innovative artifacts.

The paper is organized as follows. First we develop the theoretical basis for understanding the phenomenological boundary. The following section then uses the developed concepts to discuss the specific characteristics of computer programs as innovation objects, and it also shows that close-to-hardware software forms a special class of computer programs. The next section then discusses the impact of innovation domains on innovation dynamics. After this theoretical and conceptual background, the following section introduces an exploratory empirical study that illustrates the different innovation dynamics in three closely related innovation domains: open source logic hardware design, close-to-hardware open source software, and open source social software. We describe the research approach, describe the data and study method, and report the main results. The paper ends with discussion.