

# FROM COMMUNITIES OF PRACTICE TO MYCORRHIZAE<sup>1</sup>

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## INTRODUCTION

When Jean Lave and Etienne Wenger (1991) introduced the notion of communities of practice in their book *Situated Learning: Legitimate Peripheral Participation*, their ideas had a widespread refreshing impact on studies of learning. Acquisition was replaced by participation as the key metaphor and mechanism of learning. Analysis was extended beyond the skin of the individual, to encompass the entire community involved in a given productive practice. Learning was shown to be an inevitable aspect of all productive practices, not a specific process mainly or exclusively limited to schools and other institutions of formal learning.

Subsequently Wenger's (1998) work brought the notion of communities of practice to the consciousness and vocabulary of management practitioners and organizational scholars. Wenger developed a rich conceptual framework around the concept of community of practice and turned it into a toolkit for organizational design and knowledge management (Wenger, McDermott & Snyder, 2002).

Despite its virtues, the notion of community of practice is a quite ahistorical way to conceptualize work communities. In this chapter, I will first assess some strengths and limitations of this notion. I will then discuss the recent attempt of Paul Adler and Charles Heckscher (2006) to analyze firms as historically evolving communities. After that, I will push the historical view further, to identify some emergent features in human activities that seem to open up a radically new landscape of widely dispersed, fluctuating and weakly bounded community forms. These features are particularly evident in new forms of peer production or social production, most prominently in the Open Source movement of software production, that have emerged along with the evolution of

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the Internet. I will introduce the concept of mycorrhizae to capture the quality of these new forms. I will conclude with a discussion of the potentials of mycorrhizae-like activities to take root and spread in domains such as medicine.

## COMMUNITIES OF PRACTICE: PROMISE AND LIMITS

A key strength of *Situated Learning* (Lave & Wenger, 1991) was its presentation of five case studies of apprenticeship. These examples made the notion of community of practice concrete and grounded in empirical data. They helped learning researchers redirect their gaze to partially forgotten forms of learning-by-participating in apprenticeship arrangements, often surprisingly robust even in advanced industrial economies (e.g., Ainley & Rainbird, 1999).

On the other hand, making apprenticeship the paradigmatic form of situated learning in a community of practice had a heavy cost. It fixed the idea of community of practice to the following historically quite limited and limiting aspects of prototypical apprenticeship:

- (a) A community of practice is a fairly well-bounded local entity which has clear boundaries and membership criteria.
- (b) A community of practice has a single center of supreme skill and authority, typically embodied in the master.
- (c) A community of practice is characterized mainly by centripetal movement from the periphery toward the center, from novice to master, from marginal to fully legitimate participation; opposite centrifugal movement may occur but is not foundational.

The last point (c) was noted by Lave and Wenger at the end of their book (Lave & Wenger, 1991, p. 113-117). However, after recognizing this ‘contradiction between continuity and displacement’, the authors smoothen it by concluding:

“Shared participation is the stage on which the old and the new, the known and the unknown, the established and the hopeful, act out their differences and discover their commonalities, manifest their fear of one another, and come to terms with their need for one another. (...) Conflict is experienced and worked out through a shared everyday practice in which differing viewpoints and common stakes are in interplay.” (Lave & Wenger, 1991, p. 116)

This is more a wishful apology than historically or empirically informed analysis. It overlooks the history of oppression by masters and individual and collective rebellions by apprentices against their masters (see Rorabaugh, 1986). More generally, it glorifies a historically limited form of community as a general model for all times. Putting decisive emphasis on the movement from periphery to the center is a foundationally conservative choice. It marginalizes the creation of novelty by means of rejecting, breaking away from, and expanding the given activity.

In his book *Communities of Practice*, Wenger (1996) distanced himself from the original apprenticeship notion. He realized that communities have increasingly problematic and permeable boundaries, and adopted the complementary notion of ‘constellations of practices’. This refers to multiple communities of practice that are somehow connected to another. The analytical power of this notion is limited by the fact that the structure of a constellation “depends on the perspective one adopts” (p. 127) and “a given constellation may or may not be recognized by participants; it may or may not be named” (p. 128). In other words, it may be practically anything.

In sum, neither Lave and Wenger (1991) nor Wenger (1996) situate their communities of practice in the history of real societies and patterns of organizing work. Wenger (1996, p. 87-89) does take up history, but only as a general and abstract issue of remembering and forgetting, reification and participation. One looks in vain for discussions on the conditions of implementing communities of practice in highly rationalized hierarchical mass production organizations, or in settings driven by financialization, outsourcing and fragmentation of work, or in various networks, partnerships and strategic alliances.

## TOWARDS COLLABORATIVE COMMUNITY?

Within organization studies, Adler and Hecksher’s (2006) recent work puts the notion of community in its historical context. Building on the classic sociological distinction between traditional hierarchical ‘Gemeinschaft’ community and modern market-oriented ‘Gesellschaft’ community, the authors argue that a third historical form is currently emerging, particularly in knowledge-intensive firms. This third historical type of community is called ‘collaborative community’ or ‘collaborative interdependence’.

“Collaborative community in modern industry needs to coordinate interactions that span a wide range of competencies and knowledge bases, and that shift constantly to accommodate the evolving nature of knowledge projects. The challenges it faces cannot be met through ‘teamwork’ in the usual sense of small, homogeneous, and informal groups.” (Adler & Heckscher, 2006, p. 44)

Adler and Heckscher list four challenges that this emerging third type of community must meet (Adler & Heckscher, 2006, p. 44).

- (1) The boundaries of solidary groups must be far less fixed than in traditional communities, far more capable of being bridged and merged.
- (2) It must accommodate a very high level of technical division of labor and diversity of knowledge and skills.
- (3) It must allow for authority based not on status but on knowledge and expertise – that is, ‘value-rationality’ – meaning that people must in many cases be accountable to peers or those below them in the hierarchy, rather than to their formal superiors.
- (4) It must bring values into the realm of public discussion, so that they can become common orienting and motivating elements for all the members of the community.

Interestingly enough, the authors suggest that ‘process management’ in corporations is a key ingredient and enabler of collaborative community. Process management is seen as the avenue to transparent coordination of large, diverse communities and high levels of complexity. Process management has two aspects, namely developing shared purpose across organizational units and divisions, and coordinating work among various skills and competencies along the value chain.

“These new formalisms are sometimes experienced as oppressive, and indeed the language of process management can become a cover for coercive bureaucratic control; but when it is successful, people experience the rules of process management as enabling rather than constraining, as helping to structure new relations rather than limiting them.” (Adler & Heckscher, 2006, p. 44)

I have no problem accepting the progressive potential of process management in many cases. But I do not think it can be the core coordinating mechanism of historically new forms of community at work. Process management is foundationally a linear view of work and production. In its linearity, it follows, albeit in expanded and more sophisticated forms, the same basic logic that was the core of standardized industrial mass production. Mastering and updating this logic may be a necessary precondition for successful introduction of more interactive and flexible forms of production, such as process enhancement, mass customization, and co-configuration (to use the terms of Victor & Boynton, 1998). But as I will try to show shortly,

particularly in conditions of co-configuration and social production, the linear logic of process management is simply not enough.

## FROM CO-CONFIGURATION TO SOCIAL PRODUCTION

Each historical type of work generates and requires a certain type of knowledge and learning. At present, the most demanding and promising developments are associated with the emergence of *co-configuration work*. A critical prerequisite of co-configuration is the creation of customer-intelligent products and services which adapt to the changing needs of the user and evolve in use over long periods of time (Victor & Boynton, 1998, p. 195)

We may provisionally define co-configuration as an emerging historically new type of work that relies on (1) adaptive ‘customer-intelligent’ product-service combinations, (2) continuous relationships of mutual exchange between customers, producers, and the product-service combinations, (3) ongoing configuration and customization of the product-service combination over lengthy periods of time, (4) active customer involvement and input into the configuration, (5) multiple collaborating producers that need to operate in networks within or between organizations, and (6) mutual learning from interactions between the parties involved in the configuration actions.

These characteristics have commonalities with von Hippel’s (2005) notion of ‘user innovations’, as well as with Prahalad and Ramaswamy’s (2004) notion of ‘co-creation of value’. In their different ways, both emphasize the growing role of users in the creation of innovations and in the shaping of products and services.

My research groups have been particularly interested in what we call *negotiated knotworking* as an emerging way of organizing work in settings that strive toward co-configuration (Engeström, Engeström & Vähäaho, 1999, Engeström, 2005, Engeström, in press). In knotworking, collaboration between the partners is of vital importance, yet takes shape without rigid prederminded rules or a fixed central authority.

However, the notion of co-configuration does not capture the profound implications of what is called social production or peer production. Benkler (2006, p. 59) summarizes this phenomenon as follows.

“A new model of production has taken root; one that should not be there, at least according to our most widely held beliefs about economic behavior. It should not, the intuitions of the late-twentieth-century American would say, be the case that thousands of volunteers will come together to collaborate on a complex economic project. It certainly should not be the case that these volunteers will beat the largest and best-financed business enterprises in the world at their own game. And yet, this is precisely what is happening in the software world.”

The Open Source movement in software production (e.g., DiBona, Ockman & Stone, 1999) is usually used as the prime example of new forms of community-based work and knowledge creation that go beyond the limits of bounded firm-based models (Lee & Cole, 2003; see also Weber, 2004, Feller, Fitzgerald, Hissam & Lakhani, 2005). According to Lee and Cole (2003), the key to the ‘knowledge expansion’ witnessed in the Linux kernel development is, besides its openness and non-proprietary nature, the norm of critique.

“In the Linux development community we observe a peer review process as a structured approach to generating criticism of existing versions, evaluating these criticisms, and eliminating ‘error,’ while retaining those solutions that cannot be falsified.” (Lee & Cole, 2003, p. 639)

Lee and Cole (2003, p. 641) report that between 1995 and 2000, they found 2605 people in the Linux community “development team” which adds features and fixes bugs. Over the same period, they found 1562 people on the “bug reporting team” which reports, documents or characterizes bugs. In addition, the authors found that 49% of the “bug reporting team” also performed tasks of the “development team,” while 29% of the “development team” performed tasks of the “bug reporting team”. The sheer size, openness and fluctuation across boundaries of this community makes the use of the term ‘team’ somewhat ludicrous.

Independently of the Open Source movement, authors like Howard Rheingold (2002) have begun to prophesize ‘smart mobs’ as radically new forms of community organization made possible by mobile technologies. Initial conditions of such ‘swarm’ or ‘amoeba’ organizations were nicely captured by Rafael in an essay where he discusses the overthrowing of President Estrada in the Philippines in 2001.

“Bypassing the complex of broadcasting media, cell phone users themselves became broadcasters, receiving and transmitting both news and gossip and often confounding the two. Indeed, one could imagine each user becoming a broadcasting station unto him- or herself, a node in a wider network of communication that the state could not possibly even begin to monitor, much less control. Hence, once the call was made for people to mass at Edsa, cell phone users readily forwarded messages they received, even as they followed what was asked of them. Cell phones then were invested not only with the power to surpass crowded conditions and congested surroundings brought about by the state’s inability to order everyday life. They were also seen to bring a new kind of crowd about, one that was thoroughly conscious of itself as a movement headed towards a common goal.” (Rafael, 2003)

Clearly such a ‘smart mob’ has no single, permanent center. Mobile technologies make it possible that each participant is potentially a momentary center. Rafael’s example underlines the importance of a shared goal. But the emphasis on goal also implies the problem. Since goals are relatively short-lived, also ‘smart mobs’ seem to be very temporary organizational forms.

However, there are amoeba-like collective activities which are not limited to the pursuit of short-term goals. Two quite resilient examples are the activities of birding (e.g., Obmascik, 2004) and skateboarding (e.g., Borden, 2001). These might be also called ‘wildfire activities’ as they have the peculiar capacity to disappear or die in a given location and suddenly reappear and develop vigorously in a quite different location, or in the same location after a lengthy dormant period. While participants in these activities commonly use mobile technologies to communicate with one another and to broadcast information about their objects (rare birds, good skating spots), these activities are much older than mobile phones and the Internet. Birding has a history of several hundred years, and skateboarding dates back at least to the early 1970s. Two additional features need to be mentioned. Both birding and skateboarding are peculiar combinations of leisure, work, sport, and art. And they both have consistently defied attempts at full commercialization, offering ample opportunities for entrepreneurship but not becoming themselves dominated by commercial motives.

## MOVEMENT AND LEARNING IN THE NEW LANDSCAPE

What might be the nature of agency, coordination and learning in social production and amoeba-like wildfire activities? What are the

basic patterns of movement in such a landscape?<sup>1</sup> Table 1 sketches a first answer to these questions by presenting rough historical characterizations of dominant features of craft, mass production, and social production. Co-configuration as described by Victor and Boynton (1998) would appear to be a transitional form between mass production and social production.

Table 1. Framework for conceptualizing social production as a new landscape of learning

	NATURE OF OBJECT	LOCUS OF AGENCY	COORDINATING MECHANISM	LEARNING MOVEMENT
CRAFT	Personal object	Individual actor	Identification and subordination	Peripheral participation, gradual transition toward the center
MASS PRODUCTION	Problematic object	Team	Process management	Focal involvement, linear and vertical improvement
SOCIAL PRODUCTION	Runaway object	Knots in mycorrhizae	Negotiation and peer review	Expansive swarming engagement, multi-directional pulsation

In craft-based organizations, when each individual practitioner is focused on his or her own object or fragment of the object, practitioners are commonly held together by externally imposed or tradition-based identification and subordination. In industrial organizations, teams emerged as units for cooperative solving of problems. Their efforts are typically coordinated by various forms of explicit process management. However, teams run into troubles and find their limits when faced with objects which require constant questioning and reconfiguration of the division of labor, rules, and boundaries of the team and the wider organization – in short, negotiation across horizontal and vertical boundaries of the given process.

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<sup>1</sup> The importance of movement for an activity-theoretical analysis of development was stressed by Davydov and Zinchenko (1981) who put forward the concept of ‘living movement’ as foundational starting point for a developmentally oriented psychology. Space does not allow a thorough discussion of this concept in this paper.

Negotiation is a central coordinating mechanism of the distributed agency required in knotworking within social production. Negotiation is required when the very object of the activity is unstable, resists attempts at control and standardization, and requires rapid integration of expertise from various locations and traditions. On the other hand, as noted above by Lee and Cole, social production such as Open Source software movement is dependent on constant, publicly accessible critical commentary and peer review.

In the first column of Table 1, the notion of ‘runaway object’ requires further elaboration at this point. The notion is related to the concept of ‘runaway world’, coined by Giddens (1991, 2000). Claudio Ciborra (2002, p. 98) characterizes the phenomenon as follows.

“We experience control in the age of globalization as more limited than ever. We are creating new global phenomena (global warming and greenhouse effects, nuclear threats, global production processes, and so on) that we are able to master only in part. Although information infrastructures appear to be important instruments for governing global phenomena, they possess ambiguities which make their eventual outcome difficult to determine. Consequently, they may serve to curb our control capabilities just as much as they enhance them.”

Runaway objects typically have the potential to escalate and expand up to a global scale of influence. They are objects that are poorly under anybody’s control and have far-reaching unexpected side effects. Actor-network theorists (Law, 1991) point out that such objects are often monsters: they seem to have a life of their own that threatens our security and safety in many ways. They are contested objects that generate opposition and controversy. They can also be powerfully emancipatory objects that open up radically new possibilities of development and wellbeing, as exemplified by the Linux operating system.

Contrary to mega-projects (Altshuler & Luberoff, 2003, Flyvbjerg, Bruzelius & Rothengatter, 2003), most runaway objects do not start out as big and risky things. More commonly, they begin as small problems or marginal innovations, which makes their runaway potential difficult to predict and utilize. They often remain dormant, invisible, or unseen for lengthy periods of time, until they break out in the form of acute crises or breakthroughs (e.g., Vickers, 2001).

In the second column of Table 1, the most demanding concept is ‘mycorrhizae’. I use it to some extent in the same general sense in which Deleuze and Guattari (1987) proposed the concept of

‘rhizome’. They wanted to highlight the importance of horizontal and multidirectional connections in human lives, in contrast to the dominant vertical, tree-like images of hierarchy. Originally a biological concept, rhizome refers to a horizontal underground stem, such as found in many ferns, where only the leaves may stick up into the air. As such, I find the implications of ‘rhizome’ too limited.

I am more interested in the invisible organic texture underneath visible fungi. Such a formation is called ‘mycorrhizae’ (see Allen, 1991, Sharma & Johri, 2002). It is a symbiotic association between a fungus and the roots or rhizoids of a plant. Fungi are not able to ingest their food like animals do, nor can they manufacture their own food the way plants do. Instead, fungi feed by absorption of nutrients from the environment around them. They accomplish this by growing through and within the substrate on which they are feeding. This filamentous growth means that the fungus is in intimate contact with its surroundings; it has a very large surface area compared to its volume. Most plants rely on a symbiotic fungus to aid them in acquiring water and nutrients from the soil. The specialized roots which the plants grow and the fungus which inhabits them are together known as mycorrhizae, or ‘fungal roots’. The fungus, with its large surface area, is able to soak up water and nutrients over a large area and provide them to the plant. In return, the plant provides energy-rich sugars manufactured through photosynthesis.

The visible mushrooms are reproductive structures. Even these structures are sometimes quite large, but the invisible body of the fungus, mycorrhizae, can be truly amazing. When molecular techniques were used, one Michigan fungus (*Armillaria bulbosa*) which grew in tree roots and soil and had a body constructed of tubular filaments was found to extend over an area of 37 acres and to have the weight of 110 tons, equivalent to a blue whale. An even larger fungal clone of *Armillaria ostoyae*, reported earlier in the state of Washington, covered over 1500 acres. Each clone began from the germination of a single spore over a thousand years ago. Although they probably have fragmented and are no longer continuous bodies, such organisms give us cause to think about what constitutes an individual.

Mycorrhizae are difficult if not impossible to bound and close, yet not indefinite or elusive. They are very hard to kill, but also vulnerable. They may lie dormant for lengthy periods of drought or cold, then generate again vibrant visible mushrooms when the conditions are

right. They are made up of heterogeneous participants working symbiotically, thriving on mutually beneficial or also exploitative partnerships with plants and other organisms.

As I see it, knotworking eventually requires a mycorrhizae-like formation as its medium or base. Such a formation typically does not have strictly defined criteria of membership. But its members can be identified by their activism. The 2605 ‘development team’ members and 1562 ‘bug reporting team’ members of the Linux mycorrhizae mentioned by Lee and Cole (2003) were identified on the basis of their publicly available contributions to the development and perfection of the object, the Linux operating system. It is very likely that mycorrhizae include quite a variety of members, ranging from grassroots activists or clients or victims to certified professionals, researchers, entrepreneurs, and spokespersons.

A mycorrhizae formation is simultaneously a living, expanding process (or bundle of developing connections) *and* a relatively durable, stabilized structure; both a mental landscape and a material infrastructure. In this, it resembles the ‘cognitive trails’ of Cussins (1992) and the ‘flow architecture’ described by Knorr-Cetina (2003, p. 8) as “a reflexive form of coordination that is flat (non-hierarchical) in character while at the same time being based on a comprehensive summary view of things – the reflected and projected global context and transaction system.”

The model of an activity system (Engeström, 1987, p. 78) is a functioning tool for the analysis of individuals and teams. But does it have any use when we step into the fluid world of mycorrhizae? The answer is that horizontal and invisible mycorrhizae do not eliminate visible, erect, bounded and institutionalized activity systems. As I pointed out above, mycorrhizae depend on plants and generate mushrooms, both visible, vertical, and more or less durable. Knorr-Cetina (2003, p. 18) points out that the mycorrhizae-like formation of global financial markets is crucially dependent on institutionalized, stable ‘bridgehead centers’. Without these relatively stable and well-bounded ‘plants’ and ‘mushrooms’, the knotworking mycorrhizae will not take shape. Careful analyses of the structures and dynamics of the activity systems involved are more important than ever before.

The ‘learning movement’ (the fourth column of Table 1) refers to dominant patterns and directions of physical, discursive and cognitive motion in historically different organizational frameworks

of work. Peripheral participation refers to novices moving gradually toward a perceived competent center of an activity or community of practice (Lave & Wenger, 1991). Focal involvement and linear and vertical improvement refer to intense closure around a shared problematic object, often organizationally channeled into a movement of ascending or progressing along a predetermined linear or vertical pipeline of specialized expertise.

Expansive swarming engagement and multi-directional pulsation refer to star-like patterns of movement where the participants disperse outward to pursue their various trails and to expand the scope of the mycorrhizae, but also return and come together in various ways to contribute to the forging of the runaway object. The notion of swarming is borrowed from the study of distributed collaboration patterns among social insects, such as ants and bees (Bonabeau, Dorigo & Theraulaz, 1999). Models from the insect worlds are simulated to build systems of artificial intelligence. Interestingly enough, mycorrhizae behave in ways somewhat similar to the social insects: when one of the filaments contacts a food supply, the entire fungal colony mobilizes and reallocates resources to exploit the new food. Unfortunately, popular applications of the swarming notion in studies or organizations and innovations (e.g., Gloor, 2006) have thus far added little to the basic idea.

Expansive swarming is not just hectic active movement. It has multiple rhythms of improvisation and persistence that correspond to the dual dynamics of swift situational concerted action and pursuit of a repeatedly reconfigured long-term perspective in knotworking. Improvisation has attracted the attention of organizational researches seeking models for swift trust and weakly scripted but well-focused collaborative problem solving in Jazz and other forms of improvised collective performance. Persistence refers to patient dwelling in the object over long periods of time, alternating between intense action and more detached observation or even partial withdrawal. It includes pausing, backing up, regrouping and finding detours or new openings in the face of obstacles. Interestingly, Whorf's (1956) classic description of 'preparation' in Hopi culture displays some crucial features of persistence.

"A characteristic of Hopi behavior is the emphasis on preparation. This includes announcing and getting ready for events well beforehand, elaborate precautions to insure persistence of desired conditions, and stress on good will as the preparer of right results." (Whorf, 1956, p. 148)

“To the Hopi, for whom time is not motion but a ‘getting later’ of everything that has ever been done, unvarying repetition is not wasted but accumulated. It is storing up an invisible change that holds over into later events.” (Whorf, 1956, p. 151)

The concepts of this framework are far from finished and stabilized. They are first approximations, meant to open up a field for further debate, theoretical work and experimentation in activity fields with complex runaway objects, seeking to build collaboration in knot-like ways, beyond the models of stable and well bounded institutions and teams.

## BREAKING AWAY INTO MYCORRHIZAE ACTIVITIES

The most obvious examples of mycorrhizae-like activities at the moment are the Open Source communities in software development and the Peer-to-Peer (P2P) networks in cultural production and exchange.

“What do music file exchanges like KaZaA and Gnutella, collaborative news networks like Slashdot and Kuro5hin and open source operating systems like Linux have in common? They are all forms of digital culture that are networked in technology, are P2P in organization and are collaborative in principle. Although they may seem to be on the fringes of the digital scene, their impact on existing cultural practices may well turn out to be disproportionate to their apparent position; indeed, their implications for how we define certain practices, including the practice of citizenship, and how we participate in cultural production are potentially transformative. These systems might be seen as part of a larger participatory turn whereby the users generate the content, evident in such diverse activities as fan fiction production, computer gaming and club culture. Although the notion of ‘participatory culture’ is not without its complexities, even at its simplest level of meaning, the concept signals a blurring of the boundaries between the categories of production and consumption and a subversion of established hierarchies of cultural value and authority.” (Uricchio, 2004, p. 86; see also Vaidhyanathan, 2004, Subramanian & Goodman, 2005)

The other important area where mycorrhizae-like organizing has become manifest is grassroots political activism.

“On the one hand, grassroots activists have developed highly advanced forms of computer-mediated alternative and tactical media, including Indymedia, culture jamming, hacktivism, and electronic civil disobedience. These practices have facilitated the emergence of globally coordinated transnational counterpublics while providing creative mechanisms for flexibly intervening within dominant communication circuits. On the other hand, activists have appropriated the Internet

into their everyday routines, largely through e-mail lists and Web sites, favoring the rise of highly flexible and decentralized network forms. At the same time, the network has also emerged as a broader cultural ideal, as digital technologies generate new political values and vocabularies, which are often directly inscribed into organizational and technological network architectures, suggesting a powerful dialectic among technology, norm, and form, mediated by human practice. Finally, activists are building a new digital media culture through the practice of informational utopias, involving experimentation with new technologies and the projection of utopian ideals regarding open participation and horizontal collaboration onto emerging forms of networked space.” (Juris, 2005, p. 204-205; see also Hardt & Negri, 2005)

Alternative utopias have the tendency of evaporating or being integrated into existing forms of production and power. Uricchio (2004, p. 89) points out that “corporations are increasingly aware of the power of participatory culture and are incorporating elements of P2P culture in their own marketing.” Weber (2004, p. 234) adds that “as open source software becomes increasingly mainstream in corporate applications, people have started companies to customize and service the software, and these companies have to make money, follow corporate law, and otherwise interface with conventional economic and legal systems.” This brings up the difficult dilemma of *livelihood*: “it is not at all clear how communities and networks will provide for their members” (Uricchio, 2004, p. 89). The dilemma may take the form: sell out or starve.

Another dilemma in the present literature is the relationship between the new organizational forms and *technology*. The analyses mentioned above tacitly or openly tend to make the emergence and existence of mycorrhizae-like organizational patterns entirely dependent on, even generated by, digital technologies.

Steven Weber’s discussion of possibilities of open source models in primary care medicine is an instructive example of the two dilemmas.

“Consider, for example, the structure of medical knowledge in a common family practice type setting, which is interestingly parallel to the structure of knowledge for in-house software development. My doctor in Berkeley has a hard problem to solve. I present myself to her with an atypical sinus infection, low-grade fever, aching muscles, and a family history of heart disease. The bad news is that I represent to her a highly customized configuration and a finely grained problem. The good news is that there almost certainly is a similarly configured patient presenting somewhere else at the same time. At the very least, other doctors are solving pieces of my problem in other settings.

The second piece of bad news, though, is that she will find it extremely difficult to access that distributed knowledge and thus will most likely have to figure out my

problem without much help. In fact, doctors have very cumbersome means of upgrading the common medical knowledge that they draw on to support their work..." (Weber, 2004, p. 268)

Weber argues that medical doctors would benefit enormously from a capacity to share their solutions online. He asks whether much of what has been considered tacit knowledge in medical practice may actually become representable digitally when bandwidth increases. He concludes that "a positive answer would make certain aspects of medical practice an obvious place to experiment with open source style knowledge production" (Weber, 2004, p. 269).

Weber's example implies that the *livelihood dilemma* may be approached by extending open source models to domains of practice which already have a stable, well institutionalized economic basis, whether in the public or in the private sphere. An obvious prerequisite is that there are pressing contradictions in the existing practices that may be resolved by means of introducing the new models. Weber's example also implies that all this will be possible when the technology allows it – when there is enough bandwidth for smooth digitizing and sharing of previously tacit medical knowledge. This leaves us prisoners of the *technology dilemma*. Over the past two decades, medical practitioners have heard time and again the technological promises of unified and user-friendly information systems that make the sharing and using of medical records a pleasure. Promises of bandwidth revolution just don't cut the ice anymore.

From the point of view of activity theory, Weber's example has a fundamental weakness. It is not based on a careful consideration of the *object* (e.g., Engeström & Blackler, 2005).

In an open source software community such as Linux, the object is a concrete product, an operating system that keeps evolving as the developers and users contribute to its improvement. The object is at the same time distributed and unified: everyone can have it and tinker with it on his or her desktop, but it is also one and the same basic system for all. The object is at the same time a product and a project: it does useful work for users, yet it is unfinished, full of challenges and continuously developed further. And it is truly a runaway object: it is a source of pride in that it is conquering the world by being better and cheaper than its commercial competitors. These features give the object unusual holding power.

What would be the characteristics of the object of shared knowledge production in medicine? Perhaps the best available answer comes from the community called *The Synaptic Leap*

(<http://thesynapticleap.org/?q=>). It is an Open Source biomedical research community that describes its object as follows:

“Diseases found exclusively in tropical regions predominantly afflict poor people in developing countries. The typical profit-driven pharmaceutical economic model fails with these diseases because there is simply no money to be made. However, the very fact that there's no profit incentive to research these diseases makes them perfect candidates for open source style research; there's no profit incentive to keep secrets either. Our pilot research communities focusing on tropical diseases are: Malaria , schistosomiasis, tuberculosis.”

It is too early to judge to what extent *The Synaptic Leap* will actually be able to produce new solutions to tropical diseases. However, as Benkler (2006, p. 121) observes, its success is not dependent on medical researchers' benevolence only.

“The capital cost of effective economic action in the industrial economy shunted sharing to its economic peripheries (...). The emerging restructuring of capital investment in digital networks – in particular, the phenomenon of user-capitalized computation and communications capabilities – are at least partly reversing that effect.”

When this technological and economic opportunity is combined with a powerful runaway object, such as tropical diseases, something radically new may indeed emerge. However, as the metaphor of mycorrhizae reminds us, this is happening in a field of symbiotic forms. Most of the researchers involved in *The Synaptic Leap* will continue working in their traditional research institutions while they simultaneously contribute to the Open Source effort. This opens up an interesting landscape of learning to negotiate and balance multiple parallel loyalties, both mutually enriching and hostile to one another.

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