

# ICT Supported Interorganizational Knowledge-creation: Application of Change Laboratory

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Seppo Toikka<sup>1</sup>

<sup>1</sup> University of Helsinki, Department of Psychology, P.O. Box 9 FIN-00014 University of Helsinki  
[seppo.toikka@helsinki.fi](mailto:seppo.toikka@helsinki.fi)

**Abstract.** To answer the challenges of globally distributed organizations facing constant transformation of work, means of ICT supported interorganizational knowledge-creation is needed. First, concept of organizational knowledge-creation is studied and further enriched with concepts of practice and object of activity to conceptualize the social and transforming nature of knowledge. Second, Change Laboratory is introduced as a theory based method of implementing local organizational knowledge-creation. An empirical case of Change Laboratory in a global organization network is presented and the envisioned ICT tools to support the transition from local to networked knowledge-creation are introduced.

**Keywords:** Knowledge-creation, Learning, Organization Networks, Change Laboratory, ICT

## 1 Introduction

The development of working life in the last years, especially due to the developments in information and communication technologies (ICTs), is radically changing the way people and organizations collaborate. Work in organization is increasingly becoming structured in groups supported by technology, characterized by distributed expertise and networked activities. This networked society is bringing new skill and competency requirements [1].

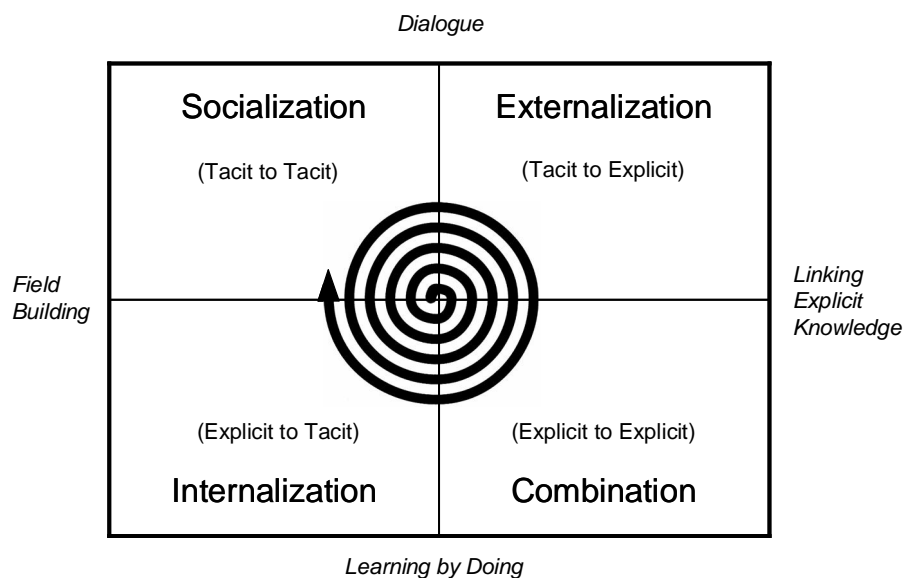
For organizations working in knowledge-intensive domains, ICT has removed the physical constraints of organizations bound to a single location and in the same time facilitates the emergence of global networks. These networks emerge due to organizational partnerships, but also due to a continuing trend for corporations to geographically distribute their units of operation.

In these networks, knowledge is a critical resource for development, and a fundamental challenge is to organize work with knowledge in a way that facilitates continuous knowledge advancement and supports the sharing of intellectual achievements among the members of the community. Therefore, a rising challenge is

to bridge between informal learning strategies of individual experts and formal rules and routines of knowledge work in organizations [2].

## 2 Knowledge in Organizations

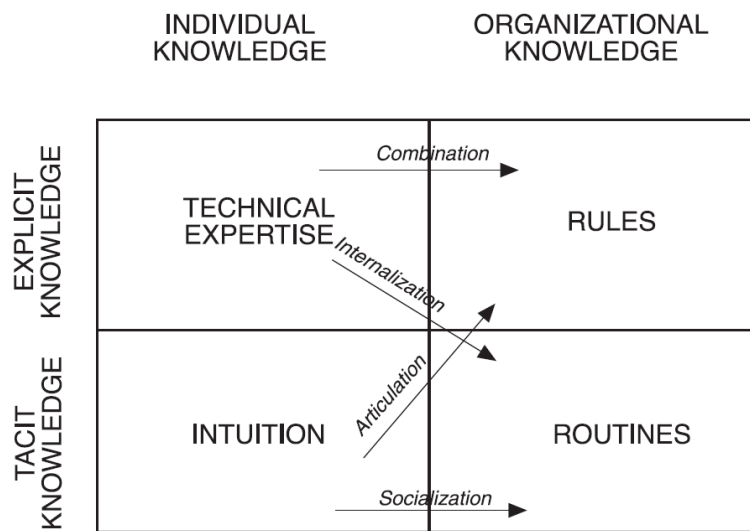
Nonaka and Takeuchi [3] propose a theory of knowledge-creation in organizations. In their model knowledge-creation is seen as interaction between tacit knowledge and explicit knowledge. In their model, the source of organizational knowledge-creation is tacit knowledge held by individuals, that they call the “rich, untapped source of new knowledge”. A “knowledge spiral” (Figure 1) consists of four types of knowledge conversion: from tacit knowledge to tacit knowledge (socialization); from tacit to explicit knowledge (externalization); from explicit to explicit knowledge (combination) and from explicit to tacit knowledge (internalization).



**Fig. 1.** Knowledge-creation Spiral.

Iterative knowledge-creation spiral starts from socialization, phase where a common understanding about the task is created. The next phase, externalization, is the central one in knowledge-creation. In this phase tacit knowledge is explicated and conceptualized in dialogue by means of metaphors, analogies, and concepts. At the combination phase, units of already existing explicit knowledge are combined and exchanged. Finally, explicit knowledge of the organization must be internalized by individuals and transformed into tacit knowledge and into action through “learning by doing.”

Holmqvist [4] points out that while knowledge in organizations is created by individuals, organizational knowledge cannot be reduced to knowledge of individuals. Holmqvist argues that e.g. documents, rules and routines are in fact forms of organizational knowledge. These organizational forms of knowledge are of central importance to organizations for two reasons. First, for individuals to be able to cooperate they need mutual knowledge. Second, mutual knowledge and shared artifacts are important in order to guarantee consistency in the organization, even if some individuals leave the organization. Following Nonaka and Takeuchi, Holmqvist proposes four modes of knowledge conversion in creating organizational knowledge (Figure 2).



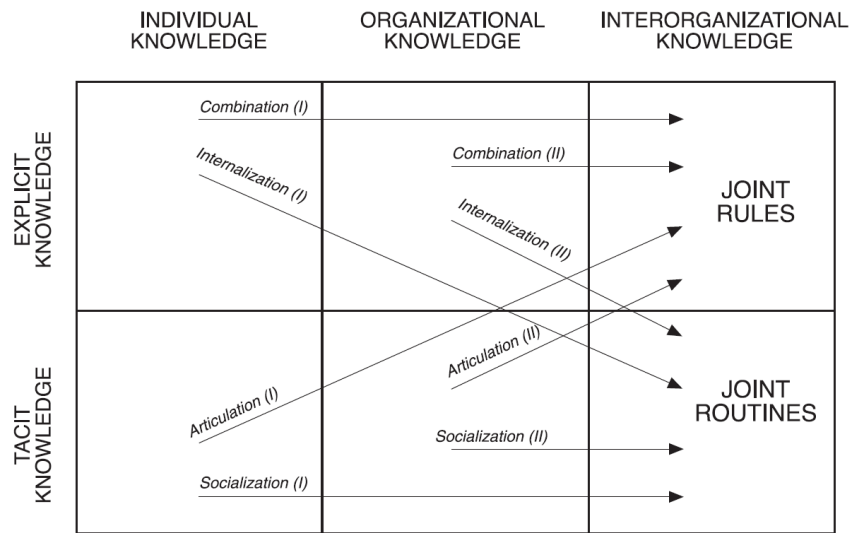
**Fig. 2.** Knowledge-creation in Organizations.

Main distinction to Nonaka and Takeuchi's model is that Holmqvist makes a systematic distinction between individual and organizational knowledge. Organizational knowledge is created from individual knowledge through e.g. joint activities (socialization), collective reflection (articulation), creation of various databases (combination) or corporate bulletins (internalization).

## 2.1 Interorganizational Knowledge-creation

For knowledge-creation in networks of organizations a new dimension of knowledge-creation is needed. Holmqvist [4] further presents an extension to the organizational knowledge-creation model. Holmqvist suggests that in networks of organizations not only knowledge conversions between individual knowledge and organizational knowledge must be studied, but also transitions between the two and interorganizational knowledge (see Figure 3). To coordinate actions in interorganizational networks the knowledge of individuals and single organizations

must be modified to support the collaboration of a network. Interorganizational knowledge consists of mutual knowledge, unique to the collaboration and independent of any single organization's knowledge.



**Fig. 3.** Framework of Learning in Interorganizational Knowledge-creation.

In Nonaka and Takeuchi's model the basic source of innovation is tacit knowledge, which needs to be socialized and then explicated in order to be transformed into knowledge that is useful at the levels of the group and the whole organization. Holmqvist [4] adds the dimension of interorganizational interactions to the knowledge spiral, arguing that in networks the source of innovation is twofold. First, collaboration of individuals of the network may come together and work closely on a project, having opportunities to create mutual tacit knowledge. In these situations they are also forced to articulate what they individually take for granted given the diverse backgrounds of involved actors. Second, knowledge related to an organization's rules and routines may be tacitly transferred between members of different organizational actors. The presence of "outsiders" may also force reflection of organizational tacit routines and articulation of organizational tacit knowledge into interorganizational explicit knowledge.

## 2.2 Practice and Knowledge in Organizations

Other analogies for types of knowledge that follow the lines of tacit vs. explicit, are "stickiness" vs. "leakiness" and "know-how" vs "know-that". First analogy represents the challenge of moving knowledge inside organizations and, by contrast, undesirable flow or loss of knowledge. Second one represents the division between procedural,

embodied knowledge and propositional or declarative knowledge. The basic assumption in all analogies is that the first type of knowledge is embodied in individuals while the second one is explicit, decontextualized knowledge. Several researchers, however, argue that in an attempt to conceptualize knowledge in organizations this kind of division is insufficient or even fundamentally flawed.

The problem is that it appears as the same knowledge can be both “sticky” and “leaky” [5]. The same knowledge that may be hard to pass inside an organization is easily leaked outside. The notion of tacit and explicit knowledge includes that there is always an irreducibly tacit aspect to any explicit knowledge [6]. This is often acknowledged, but no real effort to analyze the epistemological implications is made<sup>1</sup>. Brown and Duguid[5] propose the concept of practice as the “epistemic barrier” among the different communities inside a complex organization. “Stickiness” of knowledge or problems in creating explicit knowledge would be due to this barrier that rises from different practices inside an organization. In a complex organization practitioners most likely have more in common with their peers in other organizations than other employees in their own organization. Practice creates epistemic differences among the communities in a firm and the firm’s advantage over the market lies in dynamically coordinating the knowledge produced by these communities despite such differences [6]. In other words, it seems as practice would be closely related to the utilization of knowledge.

### **2.3 Practice, Objects and Knowledge Creation**

It seems that practice acts as a “gatekeeper” in knowledge conversion between tacit and explicit knowledge in same way as organizational structures and division of labor regulates knowledge conversion between individual and organizational (or interorganizational) level. This suggests that it would be fruitful to concentrate analysis of knowledge creation on the descriptions of the different actions of knowledge conversion.

While the concept of practice helps us to identify a possible weakness in the epistemological background of Nonaka and Takeuchi’s model in pointing out that learning and understanding of knowledge is affected by boundaries of practice as well as boundaries of organizations, it does not help us further in explaining how new knowledge is created. Paavola and his colleagues [7] propose three metaphors of learning to emphasize processes of knowledge-creation. First metaphor is learning as knowledge acquisition, which views individual mind as a container of knowledge where learning is a process that fills the container. Knowledge is understood as a property of an individual mind. Second, participation metaphor sees learning as process of participation in various cultural practices. In participation metaphor knowledge is seen as inseparable from the practice where it is used. Third metaphor views learning as a process of knowledge-creation which concentrates on mediated processes where common objects of activity are developed collaboratively. Such processes include Nonaka and Takeuchi’s model of organizational knowledge-creation as well as Engeström’s theory of expansive learning [8],[9].

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<sup>1</sup> Both Nonaka & Takeuchi and Holmqvist write about “tacit component” in explicit knowledge

Theory of expansive learning is based on cultural-historical theory of activity that seeks to explain qualitative changes in human practices over time. Human cognition and behavior is considered to be embedded in collectively organized, artifact-mediated activity systems where activities are social practices oriented at objects [10]. The object of activity is constantly enacted and reconstructed in the social practice through temporally shorter actions. These short actions have clearly defined beginnings and ends while the object of activity is never fully reached or realized. Knowledge creation in cultural-historical theory of activity is closely related to this process of object construction and redefinition [11]. Engeström points that Nonaka and Takeuchi's model starts with a relatively defined task and has no clear place for debate and analysis. However, he does suggest that Nonaka and Takeuchi's categories of knowledge conversion may be useful for analyzing different types of knowledge representation that are employed in the course of collaborative knowledge creation.

Despite their epistemological shortcomings Nonaka and Takeuchi's theory and Holmqvist's elaborations of levels of individual, organizational and interorganizational knowledge appear to be useful in the analysis of interorganizational knowledge creation, if the notion of social-practice perspective and process of object construction are taken into account.

### **3 ICT supported interorganizational learning in KP-Lab project**

The empirical case presented is carried out in Knowledge Practices Laboratory – project [12], a 5 year IST project co-funded by the European Community. One of the main arguments of the project is that professional knowledge practices are still focused on the knowledge acquisition and participation metaphor of learning, while processes of knowledge-creation have been neglected.

A central aspect in approach on knowledge-creation is the interaction between different forms of knowledge (such as discursive knowledge, practice-related know how, tacit knowledge), organized in long-term processes. This has been a recurrent requirement put on information technologies during last years as far as knowledge management is concerned: how to facilitate the discovery and exploitation of tacit knowledge, how to be able to isolate, qualify and classify best practices through reflexive approaches, and how to appropriate distributed creativity. As such, one of the objectives of the project is to build ICT tools to enhance practices, retain and reuse knowledge and experience in new activities, and share informal knowledge and experience.

#### **3.1 Pöyry Case: Networked engineering company**

Research and development work described above is carried out in pilot sites, such as Pöyry plc. Pöyry is a client- and technology-oriented, globally operating consulting and engineering firm. Its core areas of expertise: energy, forest industry and infrastructure & environment. The Group's business concept is based on early involvement in its clients' business development. Pöyry offers services related to

consulting, project development and implementation, and operations management and maintenance planning in all of its business sectors

Pöyry is facing a major challenge in transition from the locally managed Finnish company to a globally distributed network of business units. The new units are acquired mainly through corporate acquisitions. The traditionally held view of the corporate culture has been replaced by the variety of not-so-easily captured cultures and practices. At the same time, the entire concept of forest industry consulting and engineering is undergoing a profound change as proportion of bulk engineering is decreasing in the Western-European units and moving to developing countries either through corporate acquisitions or partnership contracts.

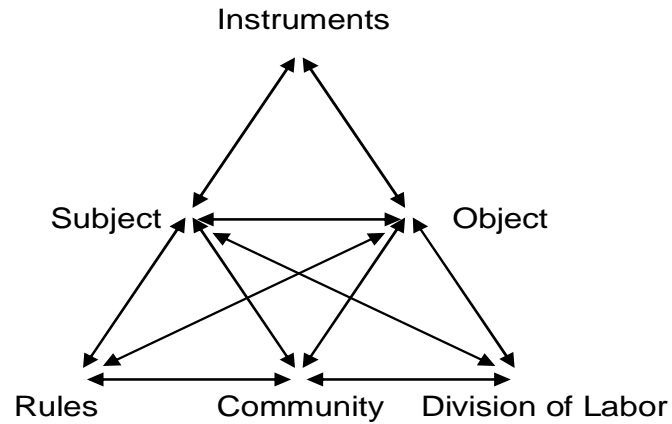
Design work is carried out in a network and the habitual way of working in the locally managed projects contradicts the project work being done in a global network. Pöyry is facing a challenge of how to reach shared practices and ways of running projects even when operating in a network and in the same time to ensure in a systematic way learning from one project to another over time.

The pilot aims at organizing the learning processes to support work at Pöyry by creating a new learning system for the company that will meet the concept-level changes of the core business activity.

### **3.2 Change Laboratory as a Facilitator of Interorganizational Knowledge-creation**

To reach its goals of creating shared knowledge practices in networks, the pilot utilizes the method of Change Laboratory (CL) which is an application based on the conceptual framework of Cultural-Historical Activity Theory and expansive learning [11][13]. The framework relies on theoretical tools that simultaneously address individual and social as well as material and organizational transformations. Its central tool is an activity system model (Figure 4), which points to cultural mediation, object-orientedness of human activity, and contradictions emerging between the elements of the system.

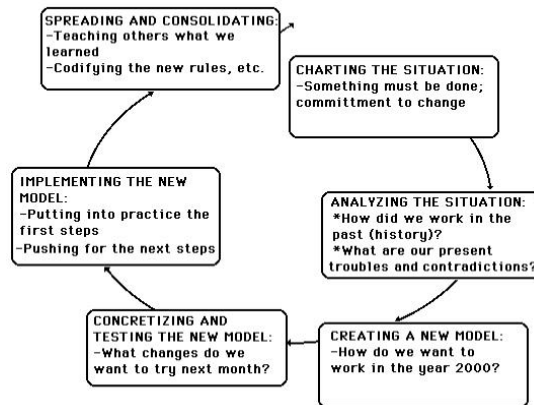
Interorganizational knowledge-creation and collaborative networks can be seen from the view point of interacting activity systems where each organizational unit constitutes a single activity system. Activities transform over lengthy periods of time and remediate their social basis, such as rules and division of labor, as well as material and symbolic tools, such as instruments and concepts. The contradictions generate dilemmas and problems in the activity, which may entail a crisis or, alternatively, a willingness to question normal work routines and carry out novel actions that may solve the dilemmas [14].



**Fig. 4.** Activity system model.

Change Laboratory [15] is a specific intervention method which is used to systematically support the knowledge-creation process. The method enables ways of collaborative reflection of activities by structured combination of various qualitatively different representations of data. As a method of intervention, CL relies on a set of representational artifacts. Its core methodological principle is crystallized in the central tool of “a 3x3 set of surfaces for representing the work activity”. The representational tool combines three surfaces of two dimensions: The vertical dimension of the surfaces represents movements in time, between the past, the present, and the future. The horizontal dimension displays the mirror surface reflecting the work at stake by videotaped episodes and interviews particularly on problem situations and disturbances, the surface reserved for ideas and tools articulated by the participants in the course of the CL sessions, and the model/vision surface of theoretical tools and conceptual analysis in which the triangle model is represented as a central tool for analyzing.

The process of CL is constituted according to the cycle of expansive learning, sequence of epistemic actions ascending from the abstract to the concrete (Figure 5). The process of expansive learning is seen as construction and resolution of successively evolving tensions or contradictions in a complex system that includes the object(s) of activity, mediating artifacts and the perspectives of the participants [11].



**Fig. 5.** Cycle of expansive learning

One of the main challenges in KP-Lab project is to develop ICT support for the Change Laboratory process. Traditional Change Laboratory setting consists of very few ICT tools, which presents a problem for implementing knowledge creation in organization networks which rely heavily on virtual communication. This sets a requisite to develop ICT to support implementation of Change Laboratory in organization networks.

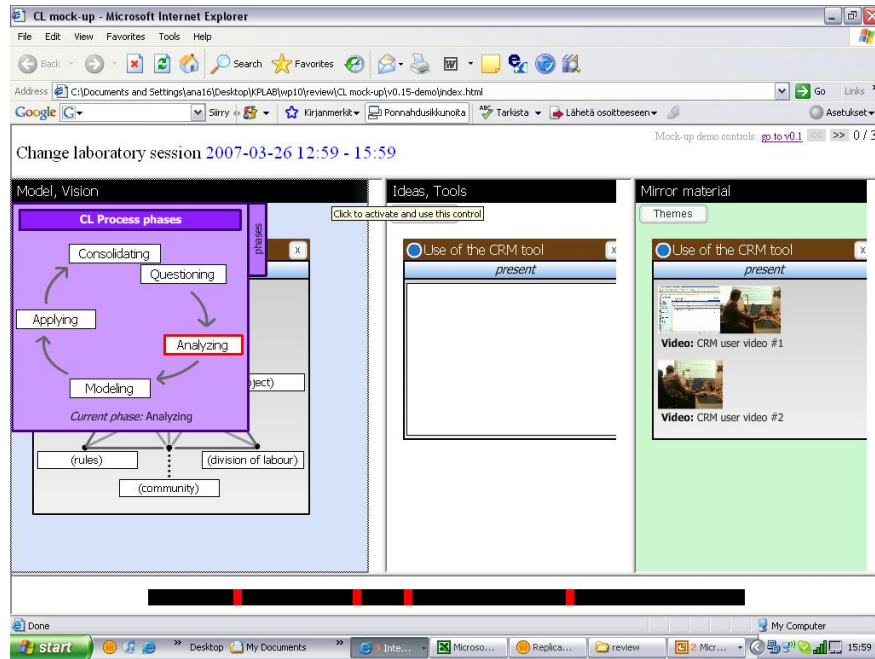
### 3.3 Development of ICT support for Change Laboratory pilot

First Change Laboratory pilot in Pöyry has commenced in February 2007. Development of ICT solutions is carried out in close collaboration with the pilot participants and the CL user community in Finland. The first phase of the development work consisted of defining the use cases for ICT supported CL and defining the solutions and framework for software components. Envisioned solutions consist of:

*Virtual learning environment* to support activities specific in the context of CL. The environment consist of file management system for data gathered in the process, tools to manage and coordinate the collaborative CL process and synchronous communication tools to facilitate and capture virtual discussion. Further, it acts as a platform for the other functionalities.

*Shared whiteboard for presentation of different modes of knowledge.* The first developed software component is called “virtual whiteboard”. It is an application that allows presenting multimedia content of actual working situations and linking this material with visual modeling of concepts and relations. The application is used to collaboratively identify and conceptualize practices within organizations or organization networks. The composition enables presentation of debate and multiple interpretations. First snapshot (Figure 6) shows the analysis phase of the Change Laboratory process considering a certain development object, in this case the use of

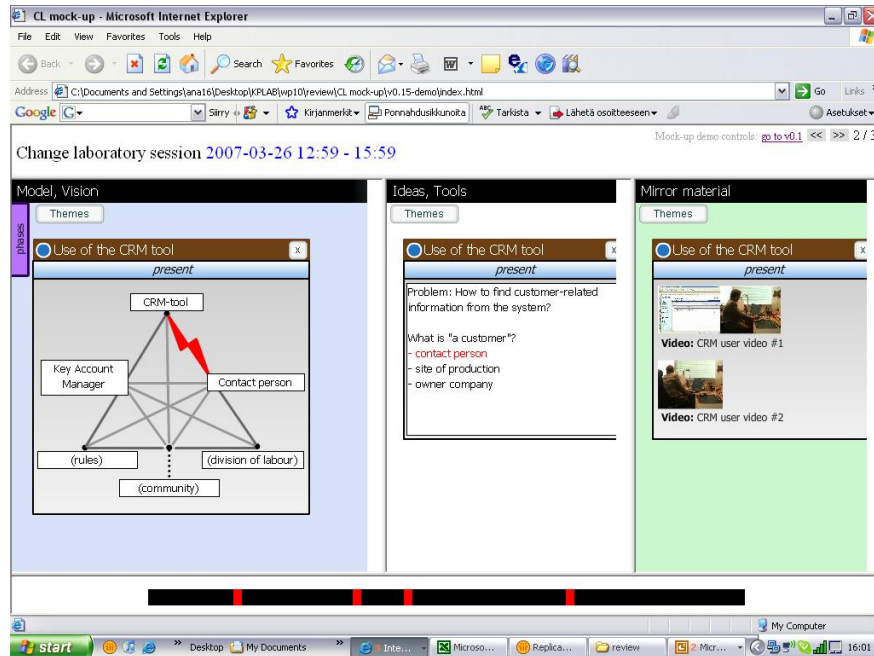
Customer Relations Management (CRM) tool. Videotaped empirical data of working practices with the CRM tool is available for joint analysis of all users.



**Fig. 6.** Snapshot of Virtual Whiteboard in the beginning of collaborative reflection of practices.

Presentation of previously selected short videotaped clips of problematic situations in an activity is used as a means to “force” reflection of ones own practices. Collaboration and communication tools allow the presentation different views on the practice while theoretical models are used to conceptualize the reflection. Presented views are recorded in an audio file of the discussion as well as in a shared memo.

Second snapshot (Figure 7) shows the representation of multiple “voices” while analyzing the concept of “customer”. A potential problem in the activity is introduced by showing two video clips of practitioners in their work. While analyzing the Key Account Managers’ practice, this has led to identification of a contradiction between the instrument (CRM tool) and defined object of activity (contact person). Several definitions of the closest concept in CRM tool (customer) have been presented by different practitioners in organization network and some of them are not compatible with the CRM tool.



**Fig. 7.** Snapshot of Virtual Whiteboard with collaborative “multi-voiced” analysis of customer concept in the practice of using Customer Relations Management (CRM) tool.

*Semantic linking* of created content. This functionality consists of linking data objects, timestamped log events of virtual whiteboard manipulation and recording of synchronous discussion around the whiteboard and further, linking of saved data and CL process (steps of expansive learning).

*Toolkit for content analysis.* The toolkit contains multimedia annotation tool for analyzing video, audio, graphical and textual data using ontology of activity theoretical framework to perform preliminary analysis of activity by marking and classifying and linking relevant segments of data. Analysis supporting functions such as profiling of activities, predictive analysis of CL process, or glossaries of theoretical concepts may be implemented as enough material has been collected.

From the viewpoint of interorganizational knowledge creation the CL tools will provide a platform for all types of knowledge conversion in individual, organizational and interorganizational level. The learning environment will facilitate the process of socialization via virtual communication tools. The virtual whiteboard combined with rich ethnographic data of work practices forces users to articulate their view on the practices collaboratively. For example, in the illustrated example (figure X) representatives from different organizations produced different meanings for customer. Produced new concepts can be semantically linked to concepts of the cultural historical theory of activity to provide a coherent set of organizational

concepts allowing combination of explicit knowledge. Further in spreading and consolidating of the new practice the system provides explicit knowledge that may eventually lead into internalized routines.

## 4 Discussion

Interorganizational knowledge-creation can be seen as collaborative learning in organization networks that produces new solutions, procedures or systematic transformations in organizational or interorganizational practices. The pursuit of new knowledge seems to require transformations in individual, social, material and organizational level. With suitable conceptual tools that allow reflection, tacit knowledge concerning a practice may be articulated. Interestingly enough, interaction with an “informed outsider” has been reported to be useful in knowledge creation [3],[5],[6]. This would imply that practice is more of an epistemic boundary of knowledge creation than an active element. Further, it seems as the ICT solutions developed for Change Laboratory may act as this kind of “informed outsiders” that drive reflection and knowledge-creation.

In theory of organizational knowledge-creation the organizations rules and routines are produced and reproduced by individual’s actions while in activity theory the “engine” of transformation is the reproduction of object of activity. Therefore, it appears that in order to support knowledge-creation ICT should be able to facilitate this kind of dialectic “motion”. Definition of such requirements is a challenging venture where new innovative solutions are needed.

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