

all over the country. They arrived being able to use only “home sign,” a rudimentary form of signing idiosyncratic to each of the children and their immediate social group. At the most, home sign shows only the most rudimentary, “resilient” forms of language, or protolanguage (Goldin-Meadow, 2002). The curriculum at the school was focused on teaching the children to acquire spoken language by acquiring the ability to read lips and to read and write in Spanish. However, outside of the classroom, the children began to create new hand gestures. Over time (which in this case means over 25 years, during which many new children came to the school) new generations of children were exposed to the social practices, the vocabulary of signs increased dramatically, and there emerged a system for stringing signs together to form longer utterances – a grammar.

Three facts concerning this process are of particular interest for the present discussion. First, this language was created without a ready-made model to learn from, “on the school bus and in the play yard” as one of the researchers put it. Second, when a new cohort of home-signing children came to the school, the sign language they encountered in their social interaction with the “idioculture” of the children attending the school was akin to a pidgin language. They not only acquired this pidgin language, but also invented new and more complex linguistic forms, refining and systematizing the forms they initially encountered, so that what initially was akin to a pidgin language began to evolve into a more complex form of signing, akin to a creole language. Third, the language change over successive generations was not the result of innovations by the oldest students but the *youngest* ones.

We need not get into controversies about the significance of these findings for debates about whether or not children have an innately specified language module that causes the development of the Nicaraguan sign language. Clearly, humans have a special proclivity to interact with each other through language; moreover, contemporary students of language evolution make a strong case, à la Vygotsky, that language evolution is driven by the need to create and sustain culture, which is the essential adaptive medium of human life (Christensen & Kirby, 2003).

What makes the case of Nicaraguan sign language so relevant to our discussion of Engeström’s ideas about development is that it brings together concerns about conditions under which culture does or does not provide a teleology for development in ways that link directly to the idea of development as opening up and breaking away. At the Nicaraguan school for deaf children, the cultural environment arranged by the adults was *clearly not adequate* for the children. As many have noted, socialization practices that

restrict deaf children's access to language to lip-reading generally fail, and even for those few deaf people who become relatively proficient lip-readers, their language and their cognitive and social development are slowed down and limited (Padden & Humphries, 2005). By contrast, children who acquire a mature sign language such as American Sign Language, as part of the everyday cultural practices of the social group into which they are born, show perfectly normal development.

In the framework of the current discussion, it seems clear that we can consider dysfunctional the initial conditions that the children encountered when they were removed from their homes and put into a strange social environment. The culture of the school embodying the adult "teleology" for the children was the intended medium for their development. However, the fact that the children did not spend all of their time in the classroom, and could organize their own interactions with others who shared their biological capacities in the gaps between adult-controlled, orally mediated activities, made it both necessary and possible for them to start "breaking away and opening up" early in life.

We have not seen recent reports of changes in the schooling practices of the adults at this school, but earlier reports (Helmuth, 2001) indicated that the new linguistic practices of the children have had an effect on the practices of the hearing adults, who have started to use the children's sign language (now referred to as Nicaraguan Sign Language [NSL]). Consequently, this unusual case supports Engeström's emphasis on the way in which such breaking away opens up new possibilities not only for the principal characters themselves but for their social group as well.

To return to the case of well-established cultural systems, such as those that serve as the context of children's development in most parts of the world most of the time, the language and culture of the adults is, generally speaking, adaptive and hence can serve for a time (how much time depends on the stability of the overall ecology that gave rise to the culture in place at the moment) as a cultural teleology nurturing children's development. In such conditions, not only the children but also the adults can be lulled into believing that they really do know what is best for the children – which way "is up." In such conditions, it is not until they reach adolescence that most children discover that a lot of the seeming sensibleness and power of adults is a partial sham in need of repair, which is why the innovation and breaking away are not seen in such populations earlier. Such innovative changes, with their destructive as well as constructive consequences, as we have argued earlier and as Engeström emphasizes, are always there. It is just that they have been rendered invisible by their very ordinariness. Like

fish in water, adults in relatively stable cultural circumstances fail to see the medium that sustains their life. Unlike fish in water, human children, in acquiring the competencies to propagate the life of their social group constantly change that medium as a condition of maintaining it.

Many years ago, the embryologist Charles Waddington (1947) asserted that every new level of development is a new relevant context. Although seemingly far distant from Waddington in the focus of his interests in development, Yrjö Engeström's ideas seem to be fully compatible with Waddington's formulation. If we think about development during the embryonic period, each of Engeström's key formulations concerning developmental principles can be seen to apply.

Two Theories of Organizational Knowledge Creation

JAAKKO VIRKKUNEN

LEARNING WHAT DOES NOT YET EXIST

In the mid-1990s knowledge management became an important area of business management studies (Swan, Robertson, & Bresnen, 2003). Ikuro Nonaka and Nobuko Takeuchi set the scene for much of the later discussion in their seminal book *The Knowledge Creating Company* (1995). The authors quote Herbert Simon's (1986) definition of the task of modern organization theory:

A major target for research in organisations today is to understand how organisations acquire new products, new methods of manufacture and marketing, and new organisational forms. This is the unfinished business that Chester Barnard left for us. (Nonaka & Takeuchi, 1995, p. 50)

According to Nonaka and Takeuchi, it is even more important to understand how organizations create the new knowledge that makes innovations possible.

After reviewing how knowledge creation has been dealt with in different traditions, they conclude:

Even though many of the new management theories since the mid-1980s have pointed out the importance of knowledge to society and organisations in the coming era, there are very few studies on how knowledge is created within and between business organisations. At the core concern of these theories is the acquisition, accumulation, and utilization of existing knowledge; they lack the perspective of creating new knowledge. (Nonaka & Takeuchi, 1995, p. 49)

Eight years earlier, Yrjö Engeström's book *Learning by Expanding* (1987) had been published, with the following blurb on the back cover:

Traditional learning theories regard learning as a process of acquisition and reorganisation of cognitive structures within the closed boundaries of given tasks or problem contexts. This kind of learning is incapable of meeting the demands of complex social change and creation of novel artefacts and social structures. On the other hand, traditional conceptions of development picture expansion as an uncontrollable, spontaneous phenomenon. This study presents a conceptual framework for a theory of expansive learning activity that transcends both traditional forms of thought characterized above.

The two books have different backgrounds. Nonaka and Takeuchi approach the problem of knowledge creation from the perspective of business management, whereas Engeström takes the point of view of actors involved in a joint activity. Their views on the current challenges of learning theory are, however, strikingly similar. Both theories have arisen from discontent with the preoccupation of mainstream learning research with existing knowledge. Both view knowledge creation as concept formation and highlight both horizontal and vertical dialogue in it. They share the objective of creating a theory that promotes the understanding of creative, practice-related learning processes.

Yrjö Engeström discusses the relative merits of these theories in explaining knowledge creation in his study of innovative learning in work teams (Engeström, 1999e). In this chapter I will compare the view of concept development put forward in these two theories from a broader epistemological perspective. I thereby hope to make visible the importance in the theory of knowledge creation of a historical approach and the concepts of *inner contradiction*, *object of activity and knowledge*, and *generalization*.

The original publication of the theories led in both cases to a great number of studies applying the theory. Here, however, I will focus on the original formulations and their underpinnings. I will first briefly introduce the theories and then compare them with respect to how they conceptualize the unit of analysis of knowledge creation, what they understand knowledge to be, how they describe the process and dynamics of knowledge creation, and finally, how they assess the possibilities of supporting and enhancing it. I will concretize the comparison by reinterpreting one of Nonaka and Takeuchi's examples in the light of the two theories.

THE TWO THEORIES

Nonaka and Takeuchi are management scientists. They see their theory as a further development of the resource-based approach to business strategy (Pralhad & Hamel, 1990; Stalk, Evans, & Shulman, 1992). In addition to

this, they lean on the Japanese intellectual tradition that highlights the oneness of humanity and nature, body and mind, as well as self and other, by focusing on action in the world rather than cognizance of it. They contrast this tradition with Cartesian rationalism, which, according to them, still largely characterizes Western thinking. The inspiration and empirical substantiation of their theory are based on extensive case analyses from large Japanese companies. The theory comprises both a model of the process of organizational knowledge creation and a theory of enabling conditions for knowledge creation in organizations.

Yrjö Engeström's work in the 1980s on the possibilities of changing and developing professional practices took him quite a long way from mainstream pedagogical research and brought him into the arena of collective learning and the creation of new forms of work activities. He published his theory of expansive learning in *Learning by Expanding* in 1987 as a synthesis of several lines of theoretical and methodological thinking inspired by the classics of cultural-historical activity theory. The theory also owes much to Karl Marx's economic theory of the basic contradictions in capitalism, as well as his idea of the historical socialization of forces of production, in other words, the progressively deepening division of labor, the tightening of interconnections between productive activities, and the increasing importance of scientific knowledge in production (Marx, 1973, pp. 705–706, 750; 1977, p. 1024). In line with the interventionist research methodology of developmental work research, which he also developed in *Learning by Expanding*, Engeström puts these theoretical ideas to practical use in the pursuit of changing societal activities.

THE UNIT OF ANALYSIS AND DEVELOPMENT OF KNOWLEDGE CREATION IN THE THEORIES

Nonaka and Takeuchi see the development of new products as the core of organizational knowledge creation, but they analyze it in the broader context of business strategy as a process of forming and generalizing new business concepts. Thus, the basic unit of their analysis is this process of product and business concept formation within a firm. Within this unit, they focus on the interaction between *knowledge-creating entities*: individuals, groups, organizations, and interorganizational relationships as well as the related *tacit and explicit forms of knowledge* and the dynamic interaction and transformations between these forms.

Engeström, on the other hand, elaborates on Leont'ev's (1978) idea that the basic unit of human concept formation is a historically evolving system

of object-oriented societal activity. Activities are delimited by their objects. The object of an activity is, on the one hand, something given, something material or ideal with which the actors are interacting. On the other hand, it is a special cultural interpretation and construction of what is given and a projection of what the givens can be made into with the help of available means. In the latter sense it is the societal motive for collaborative activity. The generally available cultural means of understanding, interpreting, and transforming the objects of societal activities bridge different local activity systems. An activity is thus at the same time a specific local system and an instance of a type of activity as a general cultural phenomenon.

Both authors relate knowledge creation to the conceptualization of objects of productive activities, that is, what is dealt with and produced. Nonaka and Takeuchi take the object of knowledge creation and the knowledge-creating entities as given. Engeström, on the other hand, highlights the coevolution and mutual determination of the elements of an activity system. This difference reflects the basic interests of the theorists: Nonaka and Takeuchi study knowledge creation as a means of business competition, whereas Engeström is interested in revealing realistic possibilities for emancipation and agency.

THE VIEW OF KNOWLEDGE IN THE TWO THEORIES

Nonaka and Takeuchi (1995) define knowledge as *"a dynamic human process of justifying personal belief toward the 'truth',"* highlighting the processual aspect (p. 58). Knowledge is created dynamically in social interactions among people. By sharing knowledge, people construct a social reality, which in turn influences their judgment, behavior, and attitudes. In order to go beyond Cartesian rationalism, the authors lean on Polanyi's (1958) idea that human beings create knowledge by involving themselves with objects, by "indwelling" them. To know something is to create its image or pattern by tacitly integrating particulars. Indwelling breaks the traditional dichotomies between mind and body, reason and emotion, subject and object, knower and known. Tacit knowledge comprises the individual's images of reality, and his or her visions for the future as well as concrete know-how, crafts, and skills. It is therefore bound to the person and the situation and is hard to transfer. Transferable and manipulable explicit knowledge is created by externalizing tacit knowledge. In highlighting the tacit-explicit dichotomy, the authors posit the internal-external dichotomy as essential in knowledge creation.

Engeström's concept of knowledge is based on the Vygotskian idea of tool use as the prototype of human knowledge and tools as physical embodiments of practice-relevant generalizations. According to this view, the development of knowledge is based on the dialectical interplay between generalizations and the processes of their creation and use in man's practical activities (Leont'ev, 1990). These ideas make it possible to abandon the traditional Cartesian assumption about the opposition between the internal and the external worlds, and to replace it with a model in which the important opposition is the one between generalized representation (tool/concept) and the process (tool/concept creation and use), irrespective of whether they are internal or external.

Following L. S. Vygotsky and V. V. Davydov, Engeström distinguishes between everyday concepts and scientific concepts. The former are created by classifying things on the basis of their external similarities and differences and the latter through an analysis that establishes systemic functional relationships between externally different objects and the origin of such relationships. The appropriation of a theoretical concept requires its abstract basic idea first to be learned and then to be concretized step by step through its application in more and more complex situations. Scientific concepts assume meaning and substance from everyday generalizations, and spontaneous everyday generalizations are restructured in interaction with scientific concepts (Vygotsky, 1986, pp. 1481–1449). A generalization can exist in many forms, as tacit or explicit knowledge or in the form and principle of a tool or technical system.

The idea of concepts as generalizations highlights the importance of their relative explanatory power. Engeström's idea of expansive learning is not fully understandable without the Marxian notion of the historical socialization of labor. Each step forward in this historical process means that the objects and systems of productive activities in society become more complex and intertwined. New concepts and forms of knowledge that have more explanatory power than the previous ones are needed in order to master the expanded objects of human activities and the increasingly complex and tight interrelationships between activities.

THE PROCESS OF KNOWLEDGE CREATION

According to Nonaka and Takeuchi, the articulation of tacit mental models is a key factor in the creation of new knowledge, the dynamics of which are based on discrepancies between tacit images and explicit concepts as well as between different views. New knowledge is created in cycles of conversions

of knowledge along two dimensions, which they call *epistemological* and *ontological*, respectively. The former refers to the articulation and explication of tacit knowledge and the transformation of explicit into tacit knowledge, whereas the latter concerns knowledge-creating entities (who knows, who has the knowledge, to what extent the knowledge is shared). They suggest that knowledge is, in a strict sense, created only by individuals, but knowledge creation can be organizationally amplified. In cycles of knowledge creation, one person's tacit knowledge is transformed into another person's tacit knowledge, tacit knowledge is articulated and transformed into explicit knowledge, pieces of explicit knowledge are combined, and explicit knowledge is turned into new tacit knowledge (Fig. 9.1). Externalization, the conversion of tacit into explicit knowledge, is the key to knowledge creation because it creates new explicit concepts through the sequential use of metaphor, analogy, and models.

Successive cycles of knowledge creation form the five phases of organizational knowledge creation, which starts from the sharing of tacit knowledge and proceeds through its articulation and the forming of explicit concepts to the justification and evaluation of the explicit concepts in the organization in order to determine whether or not they are worthy of pursuit. Following its approval, in the fourth phase the new concept is converted to an *archetype* in the form of a prototype, an operating principle,

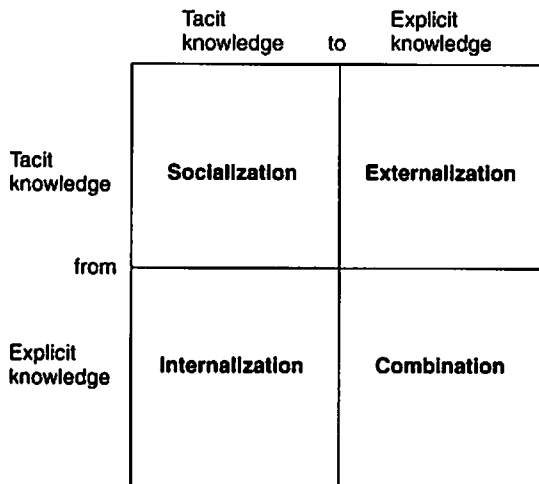


Figure 9.1. The four types of knowledge conversion and the corresponding types of knowledge (Nonaka & Takeuchi, 1995, pp. 71-72).

a novel managerial system, or an innovative organizational structure. Finally, in the fifth phase the knowledge is cross-leveled to other units of the organization, consumers, and affiliated companies.

Engeström's theory also highlights the role of collective reflection triggered by discrepancies in individuals' views and understandings. However, he locates the dynamics of knowledge creation not primarily on the level of representations, but rather on the level of contradictory forces within human activities. The *primary contradiction* within activity systems is between the use value and the exchange value of its elements. When the activity and its context change, the system moves from a relatively stable state first to an unarticulated "need state" and then to a stage of increasingly acute *secondary contradictions* between some elements of it. Secondary contradictions push the system farther and farther away from a quasi-stationary equilibrium, eventually to a bifurcation point at which a new solution is necessary.

Engeström applies A. N. Leont'ev's idea of motivation in his theory. According to Leont'ev, a need does not create a motive for an activity; it only motivates a search for an object that would meet the need. When such an object is found, it becomes a motive. Thus, an increase in the instability and in the number of problems in the activity system leads the actors at some point to a need state, and to making conscious efforts to analyze the causes of the problems and to find a new object for the activity that would meet the need created by the evolving inner contradictions. In the midst of regressive and evasive attempts to solve the problems there emerges the novel "germ cell" of a new object of the activity, which promises to resolve the aggravated inner secondary contradictions. If that idea or prototypic new solution gains momentum, it is turned into a model that is enriched through the design of corresponding new tools and patterns of interaction. When the new model is implemented in practice, contradictions emerge between the new and the old elements of the activity. In the working through of these *tertiary contradictions*, the designed or given new model is gradually replaced by another new one, firmly grounded in practice through the resolving of the contradictions between the given new and the existing forms of the activity. The change of activity, however, leads to *quaternary contradictions* between the central and the neighboring activities. Figure 9.2 depicts the phases of this cycle of expansive development in an idealized and simplified form. The two-headed arrows signify the iterative, nonlinear character of the process.

Because generalizations exist not only in human minds but also in forms of material tools and organizational structures, expansive

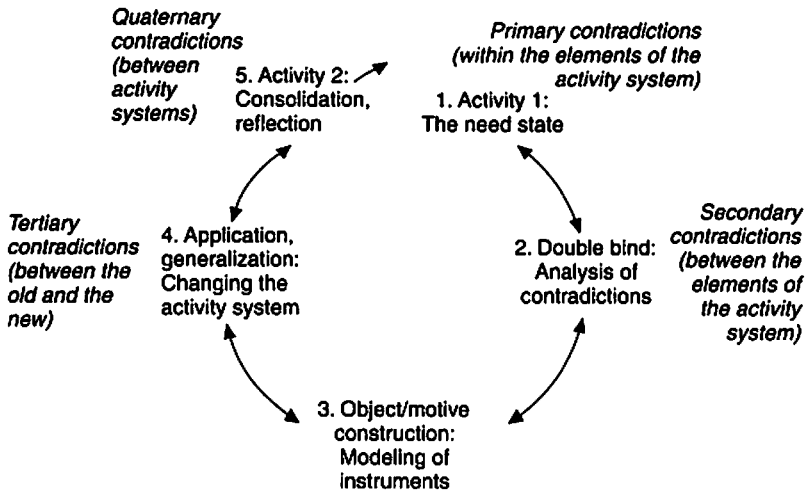


Figure 9.2. Phases of a cycle of expansive development (Engeström, 1987, p. 189).

learning is a complicated historical process involving the transforming of an institutionalized form of social practice. During this process, individual and collective learning, cognitive development, and the development of new artifacts and organizational arrangements interact. The expansive transformation of an activity system may comprise several smaller cycles of expansive learning through which partial solutions are created.

Nonaka and Takeuchi base the phases of knowledge creation on transformations of the form of knowledge. They do not include the need state or the change of activity in the knowledge creation process proper, but focus on the creation, justification, and leveling of new product and business concepts. In Engeström's theory the dynamics and phases of the cycle of expansive learning are demarcated through a change in the type of contradiction, which then becomes central in the new phase of the cycle and defines the current challenges of learning and the further creation of knowledge. He criticizes Nonaka and Takeuchi's way of founding their cyclic model on modes of knowledge representation and of leaving aside problem formation and goal setting, as well as the use of the new knowledge in transforming practice (Engeström, 1999e, p. 380).

SUPPORTING KNOWLEDGE CREATION

Nonaka and Takeuchi do not see any way of influencing knowledge creation directly and instead identify five enabling conditions. The first of

these is *organizational intention*, a vision of what kind of knowledge should be developed, and the second is *autonomy* in individuals and groups. Then there is *fluctuation* and *creative chaos*, which create “breakdowns” of routines, habits, and cognitive frameworks, and present the members with a challenge and the opportunity to reconsider their fundamental thinking and perspectives. Uncertainty, as well as interpretative equivocality created consciously by the management, may trigger reflection in the members and a search for new ways of thinking. The fourth enabling condition is *redundancy*, in other words, the existence of information that goes beyond the immediate operational requirements of the present work of the organization’s members. The fifth condition that helps to advance the knowledge spiral is *requisite variety*, internal diversity in the organization that matches the variety and complexity of the environment.

One way of managing creative chaos is through *middle-up-down management*. According to this model, top management articulates the vision or dream of the company, while frontline employees down in the trenches look at the reality. The gap between the dream and the reality is narrowed by middle managers who mediate between the two by creating middle-range business and product concepts.

As Engeström sees it, knowledge creation and expansive learning may become a conscious collaborative activity, beginning when individuals question the accepted practices and concepts. This could then gradually expand into expansive learning activity, in which the actors jointly inquire into the root causes of problems in the current activity system and transform it expansively in order to avert the threat of crisis. This activity is carried out through individually and jointly taken epistemic actions such as questioning the prevailing practices and ideas, analyzing and modeling the systemic causes of problems, modeling the new object and form of the activity, and implementing the new model in practice (Engeström, 1999e, pp. 383–384).

The practitioners need intellectual and practical tools for taking epistemic actions and creating new concepts. *Springboards* are “facilitative images, techniques or socioconversational constellations (or combinations of these) misplaced or transplanted from some previous context into a new, expansively transitional activity context during an acute conflict of a double bind character” (Engeström, 1987, p. 287). Nonaka and Takeuchi, (1995, p. 12) present, in their case analyses, a number of interesting examples of what Engeström would call springboards. For instance, the design group in Honda used the biological idea of evolution to create the idea of a new car type. *Instrumental models* such as exemplars or prototypes, classifications,

procedural rules, systemic models, or a germ cell model of the basic contradictory relationship of a system may be used, as are conceptual tools produced in research and development activities as well as models arising from more advanced forms of the same activity. These different kinds of intellectual tools are useful when applied in a *multivoiced discussion*, in which "all the conflicting and complementary voices of various groups and strata in the activity system under scrutiny shall be involved and utilized" (Engeström, 1987, p. 316).

The researcher following the interventionist research methodology of developmental work research helps the practitioners to take the necessary epistemic actions and to engage themselves in expansive learning activity. The researcher, together with the practitioners, produces data that helps them to question the current practice and to analyze it systematically in order to reveal the historical and systemic causes of current problems. The researcher also helps the actors to model the main inner contradictions in the current activity system. He or she helps the practitioners to find a "springboard" for locating cultural resources and using them in developing a new model for the activity and to transform the activity through the experimental application of new tools that concretize the created new model.

The two theories give different pictures of agency in knowledge creation. Nonaka and Takeuchi's theory ascribes it to project teams organized by middle management in order to reconcile general management's visions and frontline workers' knowledge of the daily realities. Engeström's theory, on the other hand, postulates the historical possibility that the actors involved in a productive activity distance themselves from their daily activity and become engaged in joint learning activity in order to create the knowledge needed for transforming the activity expansively and using the new knowledge for carrying out the transformation. This historical possibility can be realized through the intervention methodology of developmental work research, with which the practitioners can be helped to become a collective subject of knowledge creation and a collective agent of the expansive transformation of their activity system.

AN EMPIRICAL CASE VIEWED THROUGH THE LENSES OF THE TWO THEORIES

To further elaborate on the differences between the two theories I will, in the following, present a shortened version of Nonaka and Takeuchi's (1995, pp. 95–123) description of the development of the Home Bakery product in

the Matsushita Electric Industrial Co. and then interpret it in the light of the two theories.

Matsushita's Home Bakery was the first fully automatic bread-making machine for home use when it was introduced in 1987. The process that led to its development began in the 1970s. At that time Matsushita's operational profitability had diminished because the market for household appliances had matured and new low-cost competitors had entered it. In reacting to these challenges, the management announced a three-year plan to increase the competitiveness of the firm's core businesses and to assemble the resources required to enter new markets.

Matsushita produced home appliances in three divisions: the Rice-Cooker Division, which made microcomputer-controlled rice cookers, the Heating Appliances Division, which used induction heater technology in the production of hot plates, oven toasters, and coffeemakers, and the Rotation Division, which made motorized products such as food processors. The three divisions were united in a Cooking Appliances Division in May 1984. During the next two years the new division's profitability increased because excess capacity was eliminated, but its sales kept on declining and people began to question the benefits of the integration. The situation created a sense of crisis in the Cooking Appliances Division. The different traditions and expertise embedded in the previous divisions made mutual communication within the new one difficult, however.

The new division sent 13 middle managers to a 3-day retreat to discuss the current situation and future direction. They came up with the idea of guiding a group of diverse individuals toward one goal. In order to find the new direction, a planning team was sent to the United States to observe trends in the daily lives of Americans. The team observed that women were working outside the home, and therefore home cooking was increasingly simplified and diets had become poorer. The group concluded that the same development would probably also take place in Japan. They thought that women working outside the home would appreciate an appliance that could produce delicious and nutritious food easily. The idea was crystallized in the paradoxical combination of two requirements: easy and rich. Not long after the planning team returned to Japan, another firm proposed an automatic bread-making machine. The Matsushita people immediately saw that this product would meet the easy-and-rich requirement and also allow the division to combine its diverse areas of expertise.

The product development team specified the product features and produced the first prototype. This did not meet the requirements, however.

One of the key problems was finding the right way to knead the dough. In order to do this, a software developer went to learn kneading from a famous baker. He studied thoroughly how a good baker kneaded dough and invented the concept of “twisting stretch” to describe the right movement. After that invention, the product development team was able to create a prototype that functioned adequately; the product was transferred from the laboratory to production and commercialization, and new persons were involved in the project. The success of the Home Bakery encouraged the firm to develop a number of other “rich-and-easy” products. Later, the more general concept of “human electronics” was derived from the “rich-and-easy” concept as the general line of Matsushita’s products.

Nonaka and Takeuchi interpreted the initial crisis in the home appliance divisions as *creative chaos* that created enabling conditions for knowledge creation. The situation prompted individuals’ *intention* and the need to develop a new kind of product that would combine the knowledge of the previous three divisions. In their view, the integration of the departments created further enabling conditions: *requisite variety* and *redundancy of information*.

Management and production in the home appliance divisions are, in terms of expansive learning, different although closely related activity systems (the data do not allow us to depict the network of related systems in more detail). As far as the home appliance production activity was concerned, the integration of the divisions was an externally induced change that aggravated the need state, created by the maturation of the markets, into a double-bind situation dominated by contradictions between the old objects of activity, on the one hand, and the new community (the new integrated division), on the other, as well as by the management’s directive to enter new markets.

According to both theories, the crisis situation simultaneously incorporated the need for change and new elements that could be used as resources in creating it. As Nonaka and Takeuchi see it, the middle managers’ retreat was an attempt to mobilize and share the participants’ tacit knowledge. In Engeström’s thinking, however, the object of an activity resides between the producing activity and the using activity. Therefore, it is understandable that the sharing of tacit knowledge between the home appliance producers did not lead to a breakthrough and that that was achieved only when the planning team traveled to the United States to analyze the situation of potential users. The trip could be seen as a springboard for finding a new object and a new motive for the home appliance production activity.

It is also important to recognize that the expanded redefinition of customer need was formulated by identifying an inner contradiction in the client activity of providing food for the family at home. The “easy-and-rich” concept represents the two elements of this contradiction: “rich” corresponding to the values of traditional housewives and “easy” to their current reality of working outside the home. A tool for making families rich food easily would be an object that would meet the need created by the historically evolved inner contradiction of family life and would therefore create a motive for acquiring such a tool.

When the new generalization concerning customer need was created, the first object to meet this need, the automatic bread machine, was found relatively easily. It could satisfy the customer’s need as well as the division’s need for integrating its separate areas of technological expertise in a meaningful way. Therefore, it became the germ cell model of the new object and the motive of the integrated home appliance production activity.

Nonaka and Takeuchi saw the bread machine as an archetype of a new concept that combined previously existing areas of knowledge. They did not explicitly state what the newly created knowledge was actually about, however. According to Engeström’s theory, the new concept did not just comprise knowledge about how to make a bread machine; it also concerned the kind of object that could meet customers’ and the division’s current needs and help them resolve the historically evolved contradictions in their respective activities.

According to Nonaka and Takeuchi’s theory, this process involved two cycles of knowledge creation. The first one began with the sharing of tacit knowledge among the members of the product development team and proceeded to an explication of the product features that were then crystallized in an archetype (the Home Bakery prototype), which was evaluated against the easy-and-rich concept. As the prototype failed to meet the requirements, a second cycle began with the software developer’s studies of kneading, in which he acquired the tacit knowledge of the baker and explicated it in the concept of “twisting stretch.” This process continued with the creation of the second prototype, which was again justified in terms of the easy-and-rich concept.

Nonaka and Takeuchi do not include the analysis of U.S. family life and the reconceptualization of clients’ needs in the process of knowledge creation proper, and they characterize the easy-and-rich concept as “organizational intention.” This interpretation overlooks the important generalization concerning clients’ needs inherent in the concept, which

is hardly reducible to an explication of the tacit knowledge of the product development team members – or of U.S. housewives. It required a historical analysis of changes in family life. Nonaka and Takeuchi's theory of articulation and explication does not allow for specific epistemic actions of knowledge creation or for the specific tools and methods used in them. The conceptualization of clients' needs was based on taking a step over the boundary of the Matsushita organization and into the world of potential clients. It was this step that led eventually to a new relationship between the division's activity of producing tools for food making and the housewife's activity of feeding her family.

Nonaka and Takeuchi assume that the process of knowledge creation ended when the archetype of an easy-and-rich product was made and the concept was abstracted into "human technology." The transfer of the product from laboratory to production and commercialization was not part of it. According to Engeström's theory, however, this transfer would have started the fourth phase of the expansive cycle, during which the old and new elements in the production and commercialization activities would collide, thereby creating the need for further elaboration of the new form of production and marketing based on the more complicated product that integrated several technologies. Engeström's theory would further predict that before Matsushita's new product concept was fully realized in all retailing channels and the whole network of concerned organizations, the contradictions between the company's traditional way of working and the new approach would have to be overcome creatively.

Nonaka and Takeuchi do not deal directly with the question of the explanatory and generative power of knowledge. Their case description nevertheless convincingly demonstrates the great explanatory and generative power of the easy-and-rich concept. What gave this generalization its explanatory and generative power? They do not ask this question, but they do hint at a response. According to Leont'ev (1990) the proper content of a generalization can be revealed only through an analysis of the process of its creation. "Easy-and-rich" was based on the planning team's historical analysis of the development of family life and the recognition of a historically evolved contradiction within it, as well as on a general principle of resolving the contradiction: an easy way of making rich food. The later formulation of "human technology" seems to be the result of the abstraction necessitated by the diversity of activities in the corporation. It does not convey the generalization of customer need, and therefore a motive for production, as the easy-and-rich concept did, but defines a type of technology.

IS THERE DIRECTION IN KNOWLEDGE CREATION?

Nonaka and Takeuchi, in their theory of middle-up-down management, discuss the vertical dialogue between general management and frontline workers mediated by middle management. In the context of concept formation, they also describe how different areas of expertise are combined to create a new product concept. They go on to discuss the horizontal cross-leveling of new knowledge from unit to unit and highlight the development of explicit, transferable knowledge.

These could be seen as three complementary directions of what Marx termed the historical socialization of forces of production: the vertical socialization that takes place as the centralization of decision making, the systemic socialization that is the integration of specialized activities and forms of knowledge in order to master complex problems and objects of activity, and the horizontal socialization in the tightening of the exchange and transfer of ideas and material between local actors (Virkkunen, 2006b). According to Marx (1973, pp. 705, 750; 1977, p. 1024), an essential aspect of this development is the increasing use and importance of general scientific knowledge in production, knowledge that is progressively more context independent.

On the global level, the historical socialization of forces of production seems to proceed in waves of transformation triggered by technological revolution (Freeman & Louça, 2000). At present, the emerging digital information and communication technology is fueling a great leap in the socialization of human activities, leading to the integration of functions and ever more complex and tightly interconnected systems of human activity. The knowledge management discourse is an offspring of this historical transformation: the socialization of forces of production increasingly involves the deeper division of labor, as well as broader and intensified exchange in the production of knowledge and learning (von Hippel, 2005; Zuboff, 1988). There is an increasing need not only for theoretical generalizations and scientific knowledge in productive activities, but also for new kinds of platforms and instrumentalities for integrating various forms of scientific and technological knowledge in order to master increasingly complex objects (Keating & Cambrosio, 2003).

A fundamental difference between the two theories is in their relationship to historical development. Although topical, Nonaka and Takeuchi's theory is ahistorical in the sense that it abstracts from the historical changes and specificities of forms of knowledge creation. Engeström, on the other hand, focuses on the historical change of forms of learning and elaborates

a hypothesis of a historically new form, a work community's expansive learning activity. In my own work, I have followed that line and have tried to conceptualize the ongoing historical transformation of forms of work-related learning and the practical possibilities of making collaborative learning activity an integrated part of work practices (Virkkunen, 2006b; Virkkunen & Ahonen, 2004).

Contradictions of High-Technology Capitalism and the Emergence of New Forms of Work

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The idea of contradictions as a source of change and development is central to the dialectical tradition in philosophy (e.g., Wilde, 1989). The idea also plays a constitutive role in Yrjö Engeström's theory of expansive learning and the methodology of developmental work research (DWR). The triangle of an activity system would be a truncated model without its connection to historical change, which is analyzed in terms of the contradictions of activities in capitalism. Recently Engeström (2008a) pointed out, "If activity theory is stripped of its historical analysis of contradictions of capitalism, the theory becomes either another management toolkit or another psychological approach without potential for radical transformations" (p. 258). With his comments on a critique of the ways of using the model of an activity system (Engeström, 2006d), he reminds us of the key contribution of Il'enkov to activity theory, namely the idea of "objective dialectical contradictions as the motor of self-development in real systems" (p. 3).

The concept of contradiction was developed in *Learning by Expanding* (1987, chap. 2) in two ways. First, the inner contradictions of school activity, of work activity, as well as of science and art in capitalism are delineated. Second, the concept is elaborated and made operative for empirical research through its relation to the model of an activity system, to the cycle of expansive learning, and to the methodological cycle of DWR. As a result, four types of contradictions are defined. In this chapter I will focus on the relationship between two of them, the primary contradiction (between the use value and the exchange value) and the secondary contradiction (between the elements of activity systems). I think this relationship is important for the identity and methodology of DWR. Besides, it has remained theoretically somewhat unarticulated.

I will proceed as follows. I first briefly present how the primary and secondary types of contradictions are defined by Engeström. Second, I will