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Transforming knowledge creation on the shop floor

Abstract: In the conditions of rapid technological and market development workers meet qualitatively new challenges of learning that cannot be met with the traditional forms of learning and process development. We argue, that, instead of a "one best method" for work place learning and development, qualitatively different forms are needed in different phases of the development of a business concept. This article describes a new method, the Competence Laboratory, for helping the grass-roots teams to create new forms of competence maintenance and development.

Key words: Competence development, Activity theory, Change Laboratory, Continuos improvement

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Transforming knowledge creation on the shop floor

The need for a new kind of developmental tool

In the working life of the modern information society, the contradictory demands of producing and learning are becoming increasingly salient because of the rapid technological development and frequent changes in business, product and production concepts. The workers often work in a context characterized by the coexistence of several generations of technology, all at the same time, as well as the partly overlapping cycles of transformation of business, product and production concepts. The new concepts have rarely been completely finalized and concretized before they are implemented. Rather the workers are "rowing a boat that is under construction".

In such conditions, learning through legitimate peripheral participation and apprenticeship, traditional training or even the continuous improvement of processes are not sufficient for securing the needed competence. Practitioners at the grass-roots level have to orient themselves into the life cycles of successive generations of technology and business concepts and to take actively part in the development of new forms of work and learning.

In this paper, we make out a case for a new type of method for competence creation and maintenance, the Competence Laboratory. We will first discuss the difference between learning and development in the continous improvement of processes in the Total Quality Managagement and the kind of qualitative transformation of the work concept for which the Competence Laboratory is designed for. After this, we will explain the Developmental Work Research methodology for researching and developing work practices behind the Competence Laboratory method, and the method itself. Then, using data gathered in the Competence-Laboratory process in a telecommunications company, we will reconstruct the development of the activity of a team of technicians. We will analyze how the challenges of learning changed as the business activity developed and how the team transformed its way of learning. In the end, we will discuss the relationship between the development of the productive activity and changes in the form of competence maintenance connected with it.

Learning and problem-solving in continous improvement of processes and in the Competence-Laboratory method

At present, probably the most advanced institutionalized form of inquiry and problem-solving based learning and knowledge creation at grass–roots level is the continous improvement of processes in the Total Quality Management system. In TQM work teams switch flexibly from productive work to production improvement and engage themselves in actions of analyzing and solving production problems. After changing the methods and rules of production, they continue to work strictly following the rules they have just modified [1, 2, 3].

Problem-solving in TQM is based on established work standards that also provide the criterion for identifying problems. In the functioning of the components of a production process, there is always both random and non-random variation. A problem-solver should avoid being misled by the random variation. Instead of searching for an immediate ad-hoc solution, he should analyze the variation and the causal relationships in the system and base the solution on sustained non-random changes [4, pp. 50, 101-103].

A quality circle starts [5, pp. 71-72] its work from an analysis of the production process in order to identify the status quo and to reveal problems. After this, the circle selects a few important problems to be tackled and sets a developmental target for the improvement of the process. The quality circle then produces solution ideas and experiments with changes in the production process or the work instructions and the tooling of specific tasks. Finally, the quality circle works out, on the basis of the experiments, a new work standard that prevents the future occurrence of the problems.

Although the workers' active involvement in problem-solving can engender results and motives that exceed the narrow orientation to isolated problems [6], TQM and other forms of process improvement typically fail to advance beyond streamlining the

present form of work. These forms of learning and development take the object and purpose of the activity as given.

Recently, a number of writers have questioned the use of "process" as the unit of analysis in developing work [7,8,9]. Tapscott [7, pp. 29-31] argues that, in the new "digital economy", the starting point should not be a *business process* (as it is in Business Process Reengineering and TQM) but the *business model*, a high-level abstraction of what the business is and could be about. According to him, the new economy demands that companies change their business model, and the new technology enables it. To realize a transformation of a business model, the production teams have to be involved in a learning process that is connected with the transformation.

We see that the essence of a business model or concept is not the product or the production process, but the offering made for the clients and the tools and methods used for keeping the offering [10]. It comprises first the material, social and ideal objects that are attended to, for instance the client's computers , and the outcome and value produced in relation the these objects, for instance the maintenance of the functioning of computers and prevention of disturbances in their use.

Changing the business concept calls for another kind of learning than the optimization of a production process or an existing product. The practitioners have to understand the activity as a historically developing system of producing values and take actively part in creating a new form of the activity. This kind of *expansive learning* [11] is based on collaborative, *theory-driven inquiry and experimentation in order to transform the activity.* It requires a keen cooperation between strategic management of the business and innovative learning and development at the grass roots.

With theoretical knowledge, we mean knowledge about the interrelations between an entity and its appearance, between the original and the derived [12, p. 126]. This kind of knowledge exists in the form of models about the inner dynamic relationships of an entity. In the case of developing work activities, the identified practical problems in the present form of activity represent the appearance which derive from (or are symptoms of) inner structural contradictions in the historically evolved system of

joint activity. A theoretical solution of a problem means that a new object and logic for the activity are created and implemented.

Figure 1 depicts the three levels of problem-based learning discussed above.

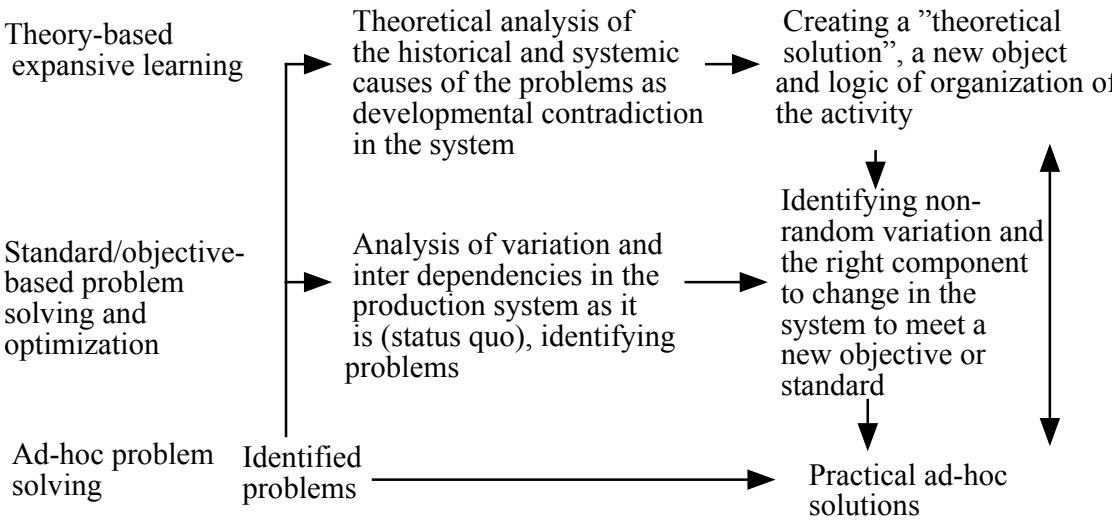

Figure 1. Three levels of problem-based learning

The Developmental Work Research methodology and the Change Laboratory

There are three principally different approaches in studying work activities. The etnographic, ethnomethodological and sociological studies of work focus on describing the existing social practices in work settings and the ways the work organization is sustained and reproduced [13,14]. Rationalization and optimization studies, like those that take place in Business Process Reengineering and TQM-processes, focus on finding ways of meeting a specific objective or standard.

Developmental Work Research is a participatory research approach that differs fundamentally from these two. The purpose of the study is to reveal the needs and possibilities for development in an activity – not in relation to a given standard or objective, but by jointly constructing the zone of proximal development of the activity. Because the developmental possibilities depend to a great extent on the motives, ideas and cooperation of the actors, they can only be studied by involving the

actors themselves in analyzing the activity and building a future model for it. As an interventionist the researcher provides the practitioners with conceptual and practical tools for that and help them in using these tools – without, however, presenting a predefined objective or normative solution. The use of theoretical models as mediating tools in this process helps the practitioners to take a new, wider perspective on their activity and to produce innovative solutions. On the other hand, the process of collaborative development of the activity is at the same time a research process, because analysing and modelling the activity and experimenting with new solutions make the practitioners' learning actions visible and reveal aspects and interrelationships in the activity that an external observer or a rationalizer would not find.

Change Laboratory is the name of a variety of developmental intervention and research methods that are based on the principles of Developmental Work Research [11,15]. The Change-Laboratory is a room or space in the vicinity of the daily work space where a wide variety of instruments for analyzing disturbances and bottlenecks in the prevailing work practices and for constructing new models and tools for it are made available for the practitioners. At the same time, the laboratory is also the forum for the cooperation between the researcher interventionist and the practitioners. In the laboratory, the practitioners take momentarily distance from their individual tasks and make the system of their joint activity into an object of their collaborative inquiry and developmental experimentation.

In the Change Laboratories, the practitioners 1) question aspects of their present form of activity by jointly analyzing disturbances and problematic situations in the activity, 2) analyze the systemic and historical causes of the identified problems, 3) reveal and model the systemic structure of the activity as well as the inner contradictions in the system that cause the problems, 4) transform the model representing the systemic structure of the activity in order to find a new principal form for the activity that would resolve the inner incompatibilities between its components in an expansive way, 5) find a new interpretation of the object/purpose of the activity and a new logic of organizing it, 6) begin to transform the practice by designing and implementing new tools and solutions.

In the Change-Laboratory methods, *activity system* instead of *process* or *community of practice* is used as the basic unit of analysis and development. The empirical analysis of the current practice and the systemic causes of the problems are complemented with a *historical analysis* of the development of the system. This analysis makes it possible to differentiate between developmentally new and old elements in the activity and recognize the already existing sprouts of a possible new form of the activity. The *inner contradictions* of the system are used to explain the developmental dynamics of the activity and the causes of observed problems and disturbances. Besides statistical data about disturbances and variation in the process qualitative data about the object of the activity, the value of the outcome to the customer, as well as historical data are used as "mirrors" to help the practitioners to encounter the problems in their system and to analyze the origin of the daily problems. The model of an activity system and the model of the cycle of expansive development of an activity are used as meta-level tools for modeling the systemic causes of problems in the present form of activity and a possible new form of the activity that resolves the inner contradictions of the present form.

The concept of activity system as a tool for understanding the joint activity

The concept of activity system crystallizes three important theoretical ideas [16]: the thesis, that human practices are always oriented to a culturally determined material or ideal object, the principle of cultural mediation and the systemic interdependence between the joint activity and the individual actors' contributions. An activity system comprises the actor as the subject of the activity, the community of coactors that take part and contribute to the same productive activity, the conceptual and practical tools used in the activity, and, as the central integrating and motivating component, the object and the expected outcome of the activity. These components form a unified, dynamic whole (Figure 2, [11, p. 78]).

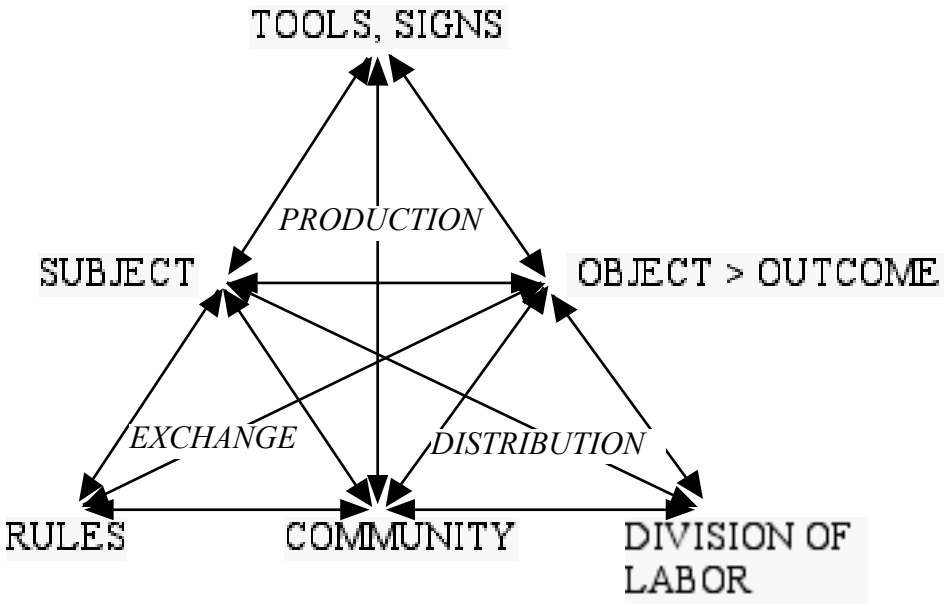

Figure 2. The general model of an activity system

The interaction between the subject and the object is mediated by instruments including symbols and representations of various kinds as well as less visible social mediators of the activity – rules, community and division of labor. The cultural artifacts used as mediators in the activity stabilize the system and make it much more robust and competent than any of its individual members. On the other hand, the components are in constant interaction in the process of activity and keep changing each other and transforming the system [17, p.12]. In any human activity, that has become institutionalized into a relatively stable practice, a variety of signs and tools are used. Of special importance are those concepts and tools that frame and define the object of the activity.

The systemic nature of the activity means first that its various elements do not exist independently of each other and the system. The object of the activity exists only, when there is a tool that makes it possible to produce the outcome, a community that collaboratively accomplishes the activity and subjects, that can use the tool and take the necessary actions and rules that regulate the necessary exchange. Secondly it means that there is an unifying logic and qualitative compatibility of the elements of the system.

The cycle of expansive learning as a tool for understanding the developmental dynamics of an activity

All the components of the activity system have the character of a specific combination of divergent needs, tendencies and interests in the same way as a product concept is a specific solution of the conflicting needs, interests and requirements projected onto it. The most important of these primary contradictions in the activity system is that between the use value of the components in the activity and their market value. The historical changes of the components of the activity system can lead to secondary internal contradictions within it, that is, incompatibilities between some of the components of the system. That is the case when, for instance, the object of the activity changes quantitatively to the extent that the increased amount of work needed cannot any more be accomplished with the tools in use. As the changes proceed the system moves into a stage of an increasingly aggravated inner contradiction and a recognizable threat of crisis. The aggravation of such incompatibilities puts individuals taking part to the activity to double-bind situations of strong contradictory expectations [18].

Parallel to the failures, conflicts and tensions created by the contradiction, there are individual innovative attempts to overcome the limitations of the present form of the activity by analyzing the situation and experimenting with new interpretations, tools and forms of cooperation. At some point there emerges an innovative idea or exemplary way of acting, that becomes the germ cell of a qualitatively new form of the activity. The essence of such a germ cell of the new form of the activity is a new tool-object relationship, that is, an idea of a new conceptual or practical tool, that makes it possible to see and practically master an expanded object and purpose of the activity. The new mediating tools transform the actors' interaction with the object of their activity and with each other and by so doing also transform their motives and roles. These transformations finalize the development of an exemplary new form of production in the activity system (the upper triangle in Figure 2). In the next steps of the transformation, the focus is on extending, stabilizing and developing further the new form as well as on renewing the forms of distribution and exchange (the lower triangles in Figure 3). In this process of extending and implementing the new concept of the activity, conflicts arise between the new ways and customary old ways of

acting. By working through these conflicts, the germ cell of the new form of the activity is enriched into an in-the-practice-created new concept, firmly embedded and grounded in practice [17, pp.17-18]. The idealized and simplified phases of the cycle of expansive learning are depicted in Figure 3. The two-headed arrows signify the iterative, nonlinear character of the process.

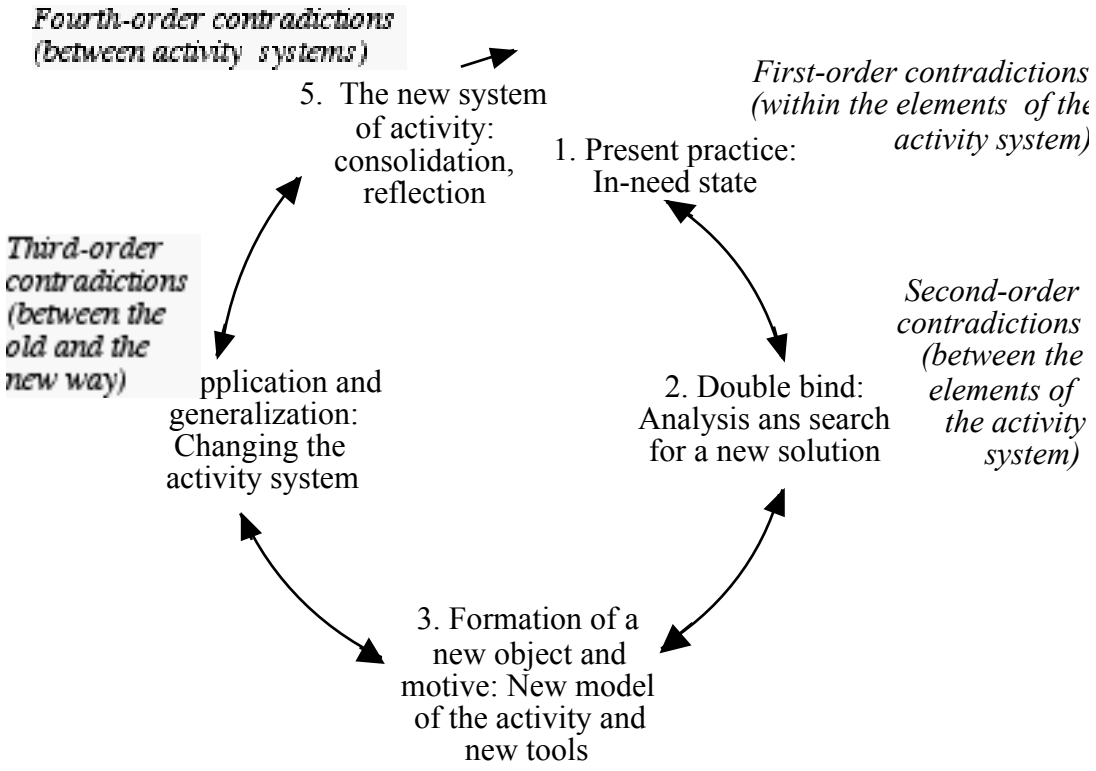

Figure 3. Phases of a cycle of expansive learning [11, p. 189)

In the present conditions of rapid technological development and market changes we can expect the contradiction between producing and learning to manifest itself in all the phases of the qualitative transformation. We can also expect that different forms of learning and development are needed in the different phases. The model helps the practitioners to surpass the narrow view of change as a step from one status quo to a targeted new stable state and to grasp the continuation of the qualitative change of their activity. It also helps them to understand the nature of the developmental phase of their activity and see the interplay between the externally given changes and possibilities for proactive developmental actions they can themselves collaboratively take.

The Competence-Laboratory project in the Telecommunications Corporation (TC)

Telecommunications Corporation (TC) is a large privately owned provider of telecommunications services in Finland. The Integrated Services Digital Network (ISDN) technology is a network technology that remarkably increases the capacity of telephone lines to transmit data. The Telecommunications Corporation began to offer ISDN connections for private households in the early 90s primarily to facilitate the use of the Internet. The sales of ISDN connections developed extremely rapidly during the 90s. While this is a strategically important business area for the firm TC has invested in the development of a new connection technology in a bid for speeding up the growth of traffic in its fixed telephone network.

In order to meet the increasing competition, the TC decided to use the Competence Laboratory for enhancing the capacity of its grass-roots work communities to produce innovations and new knowledge. The Home-ISDN Team was chosen as a pilot team to apply the Competence-Laboratory method.

The Home-ISDN Team

In the early 90s, the department of Technical Service for Private Households in the TC decided to expand its business concept from telephone connections to ISDN service. The first ISDN connections to private households were installed in 1994. Soon after that, the department recruited interested technicians to study the new ISDN technology and PCs and to form a new Home-ISDN installation team. The primary role of the team in the department was to "spearhead" the transition of the business concept at the grass-roots level by learning the ISDN technology, developing the new installation practice, and transferring competence to other technicians when the new ISDN business was growing. At the time of the Competence-Laboratory project, in the spring of 1999, the Home-ISDN Team consisted administratively of fifteen ISDN technicians, three dispatchers to allocate jobs ordered by customers to the technicians, and a team leader.

The Competence-Laboratory process in the Home-ISDN Team comprised five consecutive weekly meetings of two hours in February to March 1999 designed for surfacing problems in the installation work, analyzing the historical and systemic causes of the problems, developing a new model for the team's activity and way of learning, as well as for creating a number of practical improvements as first steps to implement the new model. A follow-up and evaluation session was held about two months later. In this process, the team evaluated its present activity system, created new component level solutions and a vision of the proximal development for its activity, as well as a new form for its learning and competence development. The team also made a concrete plan and time schedule to carry out the intended changes in its activity.

In the following, we present a preliminary analysis of 1) the development of the work concept of the team, 2) the various manifestations of the hypothesized producing-learning contradiction in its activity, and 3) the changes in the form of learning and competence maintenance of the team in different phases of the development of the new ISDN-connection service business activity. The analysis is based on the session reports written by the interventionist (the second author), documents created by the team during the process, as well as the videotapes of the sessions.

1) The Home-ISDN Team's work concept: the cycle of expansive development of the activity

The starting point of the development of the work concept of the Home-ISDN Team was the activity system of the *telephone installation*. The Competence-Laboratory data does not shed much light on the nature of the first phase of the cycle, the in-need state of the telephone installation activity or the aggravation of double binds in it in the late 1980s. It is however evident, that a discrepancy was growing between the business possibilities opening up in the emerging new market of PCs and the Internet and the technicians' competence that was narrowly limited to the traditional telephone technology. Neither do the data tell much about the second phase, analysis and search for new solutions, which eventually led to the experimental pilot installations of the new ISDN technology based connections in 1994 -1995 that started the third phase of the developmental cycle (see Figure 3). The pilot installations were the germ cell of

the new work concept comprising already the new object of activity, the *ISDN installation*, and the new tool, the connection technology. The actual expansion of the business concept of the department from telephone to ISDN service started by establishing the Home-ISDN Team. The formation of the new subject took the form of a systematic training course that lasted one and half year.

The fourth phase of the expansive cycle of the activity began when the Home-ISDN Team started to run and develop the Home-ISDN installation activity. In the early days of constructing the activity, the technicians learned the new technology by carrying out the installations and by discussing and solving problems together through mobile phones and in their team meetings. In 1997, the initial learning task began to be completed. The emphasis of the team's work began to change because the demand for the ISDN-connection services grew rapidly. In 1998, the four regional tepephone-installation teams started to install also ISDN connections. This shift to mass-production phase in applying the business concept can be seen as a landmark of the beginning of the fifth phase of the cycle of expansive development of the team's activity, the phase of consolidation and extension. At the time of the Competence Laboratory, this was still a relatively recent event. At that time, because of the growing demand the team used increasingly time in the ISDN installation work prope*r*, as well as in maintaining and assuring the quality of the connections. The team was, however, also expected to participate increasingly in the product development of the ISDN connections.

Because of the increasing workload in the installations, the team had no more time to discuss technical problems together in their meetings. Each individual technician tried to learn more about technology individually. One way of learning was to take the time at the customer's to find a solution to a tricky problem instead of passing the problem on to other people. This learning strategy run, however, into the economic business objectives set on the team. At the same time, the team began to be more and more aware that the time was approaching when the next-generation connection technology, the ADSL would be commercialized and included as a new product to the business of the department. The team was expected to adopt that technology and create a viable installation-work practice for it. This worry can be seen as an early manifestation of the in-need state of a beginning new cycle of development.

This analysis of the cycle of development of the teams activity provides the basis of analyzing the problems and dilemmas the team expressed in the analysis sessions of the Competence Laboratory.

2) Interpreting the problem themes as symptoms of producing- learning contradictions in the activity system

The three first sessions of the Competence Laboratory focused on questioning aspects of the present practice and analyzing both how the work was actually carried out and how it had developed historically. We identified in the discussions of these sessions the following ten central problem themes which the participants discussed. When possible, we have selected a direct quote to express the kernel of the problem theme.

1. The team manages complex problems by joint problem-solving, but it does not take action to prevent the same kind of disturbance from occurring again.
2. There are shortages in the competence of the regional teams, and in the reception of information from the customers with their ISDN out of order.
3. *"The meetings with the Switching Operation Team are too infrequent, new problems are already at hand before the old ones become solved and the team gets information about the solutions."*
4. The team members use a lot of time with a custome because of the lack of standardization of the ISDN computer cards. *" ... how much time should a technician use trying to do it* [install a card] *?"*
5. The dispatchers have to understand the technicians' and the partners' work better in order to plan the job assignments.
6. Diminishing the team's participation in the installation business would free its time for developing the new competence as well as for transferring it further to the regional teams. That would make the demanding maintenance work more efficient and decrease the number of recurring faults, but it would also diminish the team's earnings: *"who would allow us to work at loss?"*
7. If the team members would use less time with the customer, more customers could be served, but the customer satisfaction rates would drop. On the other hand, *"a difficult case is always an opportunity to learn, you don't like to let it go unfinished even if it takes hours".*

8. At the beginning of the ISDN installation work, as there was not yet much maintenance or help-desk work, *"we used to go through experiences immediately in the team. Now everyone is busy and working more on his own."*

9. *"If we have no time to learn the new things, we – and the TC – are stuck on the present level of competence, and cannot support the learning of the other teams later on. This team should do only maintenance work if we want to improve quality and profitability and make ourselves look necessary, but that would finish everything else – finish the future."*

10. The ISDN installation work has been transferred to the regional teams without making sure that there is enough competent staff in the regional teams.

These problem themes can be traced back to two secondary and one primary contradiction in the activity system of the team that was "rowing the boat under construction and reconstruction":

1. In the fourth phase of the developmental cycle of the activity (see Figure 3), the team's way of learning was based to a great extent on learning by doing and learning by trying [20] while doing the installation at the customers' and on joint discussion and problem-solving via mobile phones and in the team meetings. These *unsystematic and spontaneous forms of learning and development* were functional in the early phase of constructing the practice but became increasingly *incompatible with the rapid growht of the amount of the work and involved technicians* as the activity moved to the fifth phase of consolidation and extension.

2. Because of that relatively newly developed secondary contradiction, the primary contradiction between the use value of the technicians' work *(customer satisfaction, quality, learning for the future)* and its market value (expressed as the *economic result objective the team had to meet*) was aggravated as the activity had become established as a regular business and moved to the phase of consolidation. This primary contradiction put the technicians in *a double bind situation*: if they would use their time to the installation work, they would meet the economic objectives, but they would not fulfil their learning task which they deemed important; if, on the other hand, they would focus on learning, they would not meet their economic objectives.

3. The *standardization of the service and its components*, that is, the rules of the activity had not been developed in the pace of the growth of *the volume of the activity*. This had created the secondary contradiction between the enlarged object of the

activity and its rules. The contradiction was visible in the ISDN-card problem (problem theme number 4) and in the problems in delineating the content of the service (problem theme number 7). The lack of standardization was connected with fourth level contradictions between *the activity of the technicians* and *the activity of their cooperation partners*, the PC firm that provided the cards, the management that configured the service product, the dispatchers that allocated the work assignments and the Switcher-Operator Team that provided technical solutions and know-how.

3) The changes in the form of learning and competence maintenance of the team

The analysis shows that the learning and development challenge of the team changed profoundly as the development of the activity moved to the fifth phase of the expansive cycle. The learning of new technology was in a crisis because of the method of learning and competence maintenance the team had adopted in the fourth phase was incompatible with the growing volume of the activity. At the same time, a new kind of learning challenge was developing because of the surfacing contradictions between the team and the important neighbouring activities. The challenge was to standardize the work processes and to clarify rules and forms of cooperation.

In the system of learning and competence maintenance that had developed in the fourth phase of the cycle of the development of the activity, the subject of learning was the individual technician who cooperated with the other technicians to learn the technology. There was little documentation that would make the learning collective. This system of learning and competence maintenance was incompatible with the changing learning challenge, that was related to the maintenance and quality control in the expanding activity, as well as with the new organization of regional teams.

Before the Competence-Laboratory process, the Home-ISDN Team had already created one new solution to develop its form of learning: a new division of labor in the following up of technological development and quality of installations. This division of labor was based on areas of technology and categories of problems in the installation work. During the Competence Laboratory, the team decided to prepare a form for systematically collecting data about problems related to the installation of the

different types of ISDN cards. The idea was that one of the team members periodically prepares an analysis of a large number of problems and picks up important recurrent problems to be discussed in the team meetings. After the discussion, a check-list for the installations could then be planned in order to standardize the quality of work in the regional teams.

The team also decided that one of the team members should prepare a plan of how they would learn and transfer the knowledge and know-how concerning the next generation connection technology that was expected to be in commercial use in the nearest future. The team also initiated negotiations with the representatives of the neighbouring activities to settle problems, to further standardize the service and to create forums for discussion and joint development. In the follow-up meeting, it turned out that these attempts had partly been successful. The establishment of cooperation with the Switcher-Operator Team had, however, not succeeded. The new system of learning and competence maintenance of the Home-ISDN Team is depicted in Figure 4.

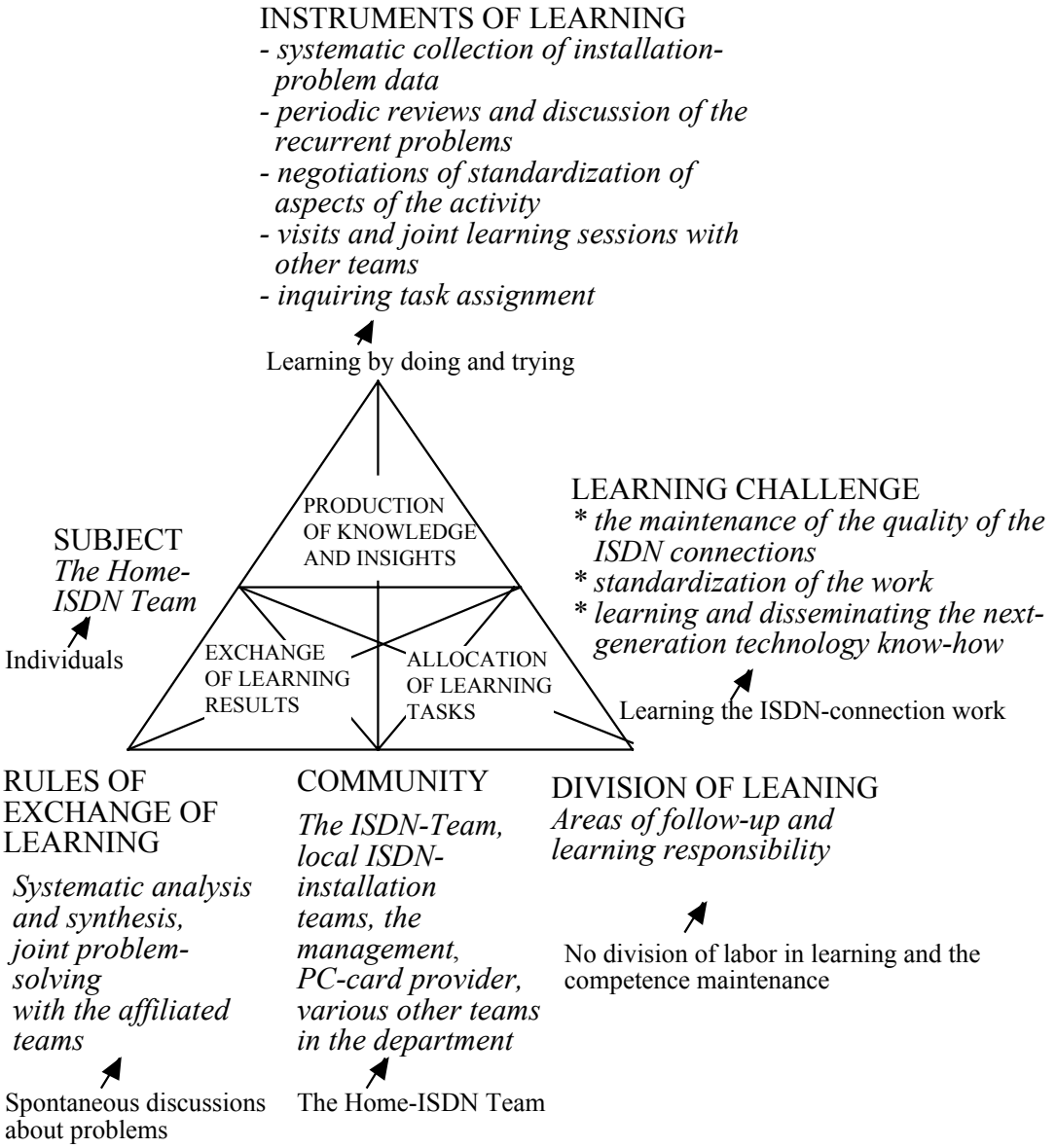

Figure 4. The Home-ISDN Team's system of learning and competence maintenance for the phase of consolidating the new activity created in the Competence Laboratory (the arrows indicate the change from the previous to the new form)

In the created new system of learning and competence maintenance, the subject is the team who has a common plan and idea of the needed learning actions and who cooperates with other teams carrying out those actions. As the business activity expanded and became established, the standardization of the Home-ISDN installation activity became crucial for both efficiency and quality as well as for freeing time for learning actions. The team did not characterize the learning challenge explicitly as the

standardization of the installation work, but many of the new solutions aimed at unifying and explicating the procedures and tools.

A different form of learning is needed in the successive phases of the life cycle of a business activity

The current literature on organizational learning as well as the methods developed for such learning are largely based on an assumption of a linear process of learning and the possibility of finding ”the one best way of learning”. The dimension of development and the possibility that qualitatively different forms of learning are possible and called for in different phases of development of an activity has rarely been [21].

During the developmental cycle of the ISDN-connection service activity, the team had three qualitatively different forms of learning and development. In the early phase of forming the new service, the team members studied the technology in a training program. When the activity started, a form of learning by doing and trying developed, which run into crisis, as the activity extended. The first two forms of learning were connected with the construction of the new work model of ISDN-installation service. The know-how and experience gained through the learning by doing and trying method formed the basis for the standardization work that started in the fifth phase of the cycle, when the business of the department shifted to the mass-production phase. The team had, however, to recognize the crisis of its previous learning method to move on to develope the new form of learning.

The new form of learning and development created in the Competence-Laboratory process is not quite identical with the learning and development in the quality circles, but it has many of its elements. From this point of view, we can maintain that the continous improvement of processes is not a general method for learning and development in production, but a specific method of learning and development for the fifth phase of the cycle of expansive learning, the consolidation of the new form of activity. The use of this type of learning method becomes possible and necessary when a new production concept has been established, begins to extend and has to be consolidated.

There was in the Home-ISDN Team's Competence-Laboratory process also an element of second order learning. The team was already orienting itself to the next developmental cycle of turning the next generation PC-connection technology into a service product within the supply of the department. Using the experience of the ISDN cycle, the team began more consciously to design the process of learning and adopting the next-generation technology. By so doing it began to design a new kind of work, the object of which would be the mastery of repeated new product-implementation processes instead of mastering just the implementation of one new product. The tools needed for that would be the systematic methods for analyzing the new technology and timing its implementation. During the Competence-Laboratory process, one of the technicians analyzed the learning and development challenges the commercialization of the next-generation technology would mean for them. In the fifth session, the technicians planned the timing and method of learning the new technology.

The central thesis of Cultural Historical Activity theory is that human activity is object oriented. This applies also to collaborative inquiry and learning, the object of which is an emerging learning and development challenge in the production-activity system. Our thesis, in this paper, has been that the learning challenges change qualitatively as the activity proceeds from one phase to another in the cycle of expansive development along with the development of the business. The learning and development in the previous phases of development of the activity provide, on the one hand, much of the material and tools for the subsequent learning, but, on the other hand, the qualitative change of the learning challenge renders previous forms of learning and development inadequate. In order to master the change process in the conditions of rapid technological and business development, the practitioners need a second-order, meta-level method that enables them to identify the change of phase of development of their activity and the qualitatively new learning challenges and to create the needed new system for competence creation and maintenance. The case of the Home-ISDN Team as a "spreadheading" team called forth the need for meta-level developmental tools, and the Competence Laboratory functioned as such a method.

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