Transformational activity by top management for the enhancement of safety in a nuclear power plant in Japan

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Abstract: Using Engeström's activity theory, we investigated how company-wide transformational activity was initiated and how it has changed everyday activities in a nuclear power plant in Japan. We renamed 'learning activity' in the theory 'transformational activity' in this paper. It was defined as an activity that continues for a certain amount of period and transforms existing everyday organizational activities into new ones by changing the underlying premises of activities. We described a precise example of transformational activity we observed in our intensive field work in a large electric power company where the first fatal accident in the history of a nuclear power plant in Japan occurred in one plant several years ago. Using the model of activity theory, this transformational activity was depicted as following: the reform committee for maintenance work (subject of activity) acted on existing everyday activities for maintenance (object of activity) and transformed them into new ones (outcome of activity) with the use of requests submitted by subcontracted workers for improvement of working conditions and a budget to materialize them (mediating artifact of activity), in the collaboration with the top management who launched and persistently supported the reform committee, subcontracted workers responsible for the physical labor force in operational fields who actively submitted requests for improvement, and workers of the electric company who reviewed the requests and materialized most of them by a budgetary step (community member of activity and division of labor of activity), and with the shared awareness that any measures should be taken to actualize the lesson from the accident (rule of activity). Prior to the accident, safety was regarded as important as long as efficiency would not be sacrificed. Now, in the everyday activities achieved by the transformational activity, safety in operational fields is emphasized to the extent that anyone could not have imagined until the accident.
Keywords: safety; activity theory; transformational activity; maintenance; nuclear power plant

1 Introduction

Organizational learning has attracted many researchers and practitioners who are interested in organizational changes, incremental or revolutionary, since the concept was originally proposed by Argyris [1, 2] and was practically argued by Senge [3]. The concept represented an important function that had been overlooked behind managerial function taken as a major characteristic of organizations. Argyris argued that a wide range of organizational members required learning to revise underlying thought premises rather than just dealing with the challenges they faced [1, 2]. Senge proposed that dimension that distinguishes learning from more traditional organizations is the mastery of certain basic disciplines or 'component technologies.' He identified five disciplines that converged to innovate learning organizations. They were systems thinking, personal mastery, mental models, building shared vision and team learning [3].

Among the many studies concerning organizational learning, some focused on safety in nuclear power industries. For example, the EU project named LearnSafe in which a series of empirical qualitative studies were conducted with the collaboration of senior managers of nuclear power plants in five different European countries investigated facilitators and hindrances for organizational learning [4]. Based on empirical studies in nuclear power plants as well as chemical plants, Carroll, Rudolph & Hatakenaka proposed a four-stage model of organizational learning that consisted of (1) local learning by decentralized individuals and work groups, (2) constrained learning in a context of compliance with rules, (3) open learning prompted by acknowledgement of doubt, and desire to learn, and

Received date: September 13, 2010
(Revised date: February 28, 2011)

(4) deep learning based on skillful inquiry and systemic mental models [5].

This study is to explore how safety culture can be nurtured in a nuclear power plant from the perspective of organizational learning. It has two major characteristics, the theoretical and the empirical. We used Engeström's activity theory as a theoretical basis and developed a comprehensive conceptual model of organizational learning in our study[6]. Specifically, everyday organizational activities for organizational learning are conceptualized as a set of two interrelated kinds of activity, *i.e.*, performance activities and improvement activities. From that set, existing everyday activities can be transformed into new ones by a kind of activity named transformational activity.

Empirically, we collected specific instances of attempted methods that could contribute to enhancement of organizational learning for safety culture during our six-year fieldwork in nuclear power plants of a certain electric power company in Japan. Each example was located in the conceptual model above[7]. In this paper, we will focus on an instance of transformational activity that was initiated by top management after a fatal accident occurred in one plant of the company several years ago. It was the first fatal accident in the history of a nuclear power plant in Japan.

2 A conceptual model

2.1 Activity theory

Activity theory emphasizes the fundamental social nature of individual actions. In our everyday life, we tend to focus on an individual person when he/she shows either good or poor achievement. Good achievement tends to be attributed to the innate characteristics of the person such as excellent ability or enthusiasm, while poor achievement tends to be attributed to lack of ability or lack of motivation. It is sometimes true that psychological factors such as ability and motivation are critical and thus should be targeted if achievement has to be improved. However, a seemingly individual action often occurs as a part of the larger phenomenon of human collectivity.

Activity theory expands our scope of view to the extent that what looks like an individual action can be located in a larger context of collectivity. Let us start with an individual action and then expand our scope of view step-by-step by following activity theory. At the beginning, an individual action is conceptualized like a *subject* works on an *object* and produces an *outcome*. For example, a particular worker, as a subject, who is responsible for maintenance of a particular piece of equipment in a nuclear power plant works on the equipment as an object and produces good functional status as an outcome. Such an individual action is represented by a central horizontal line in Fig. 1.

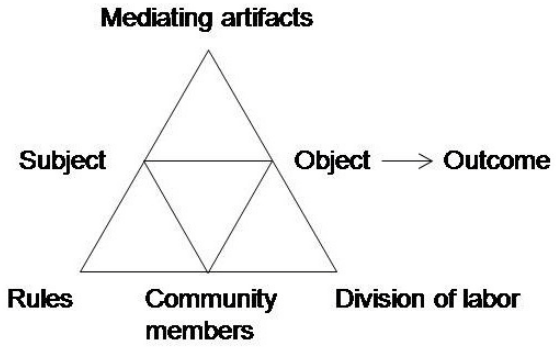

Fig. 1 Structure of activity.

An individual action is always mediated by tools in the sense that a subject works on an object to produce an outcome with the use of any tool. Tools might be physical, like a computer or an operation manual; institutional like an award system; linguistic like technical jargon; informational like specialized knowledge; or human like a person whom you can ask for minor technical help for your computer work. Importantly, tools are sustained and are made available for you by human collectivity. A computer on your desk is made available for you by the diverse efforts of many people who have worked from the manufacturing stage to the sales stage of the computer and many other people who have been involved in software development and internet-related business. Even the person who is in charge of a mail server in your organization is in the collectivity that makes the computer available for your electronic communication. Thus, using a tool always means putting yourself in collaborative relations with people who have made the tool available for you. In the terminology of activity

theory, any action to work on an object to produce an outcome is always mediated by tools, or artifacts that are sustained by a collectivity. In this sense, such tools are called *mediating artifacts*. These are shown in the upper small triangle in Fig. 1.

An individual action is carried out in more direct collaborative relations with other persons than we saw in mediating artifacts. That is true even if you are working alone at a particular point of time. You might bring documents you have completed alone to someone else and ask for assistance doing some work using the documents. This process demonstrates that your work, writing the documents alone, is not a purely individual action but is carried out as a part of collaborative work with someone else. Activity theory locates a seemingly individual action in the work of a collectivity, which was called a *community* by Engeström [6]. This is shown in the lower middle small triangle in Fig. 1.

Having taken a community into our scope of view, we can specify details of the community even more in two ways. First, we can make clear what *division of labor* is maintained in the community. The role of a subject in the division of labor is working on an object to produce an outcome, already represented by a central horizontal line in Fig. 1. Then, we can clarify what role is played by each of the other members in the community, shown in the lower right small triangle in Fig. 1. Second, it is useful to grasp what *rules* are shared in the community, explicitly (consciously) or implicitly (unconsciously). A rule concerns either fact recognition or value judgment. This is shown in a lower left small triangle in Fig. 1.

Now, we have an entire structure of activity that consists of a total of six terms. The structure enables us to expand our scope of view to the extent that an action that tends to be taken as an individual phenomenon at first glance can be located as a part of the larger collectivity. We have put an individual at the position of subject in Fig. 1 so far, but it is sometimes possible or even necessary to put a group of persons at the position of the subject so that an action by the group can be understood as a part of the larger collectivity beyond the group.

From a practical viewpoint, a structural figure of activity provides more ways to improve a term of 'object → outcome.' While focusing on a horizontal central line in Fig. 1, all you can do is to improve an individual's ability, motivation, or personality. In many cases, however, it takes a great deal of energy and time to change the individual by education, training, or personal guidance although those efforts sometimes should not be avoided. But, you have many more options for improvement if you depend on a structure of activity. For example, you might want to improve the outcome by introducing a new tool (mediating artifact). Or, you might want to invite someone who can support the subject and thus create a new team (community), or you might want to change the role played by each member of the community (division of labor), or you might want to change a shred belief (rule) in the community by challenging a conventional way of thinking.

2.2 Performance activity and improvement activity

We will conceptualize organizational learning from the perspective of activity theory. Primarily, we should remember that organizational learning occurs in an organization and thus fundamental activities that are required of any organization, that is, *performance activities* should be considered prior to learning. The most salient characteristic of an organization, as a kind of collectivity, is in its artificial construction when compared with other kinds of collectivities like a family or a community. Enrollment in and withdrawal from an organization is artificially determined by the discipline. Each organizational member is assigned a job responsibility according to vertical (hierarchical) and horizontal (lateral) artificial divisions of labor.

In this sense, performance activities in which a job assigned to each member is performed are indispensable as far as an organization maintains itself as an organization. But, just performing one's assigned job does not grow organizational learning. For organizational learning to be facilitated, performance of an individual member should be recognized by other members through communication so that collaboration can be attained if necessary. The performance activity to facilitate

organizational learning is shown in Fig. 2, in which a member (subject) works on one's assigned job (object) to produce collaboration (outcome) with the use of opportunity for communication like a formal or informal meeting (mediating artifact) together with one's manager, colleagues, or people working in different workplaces (community).

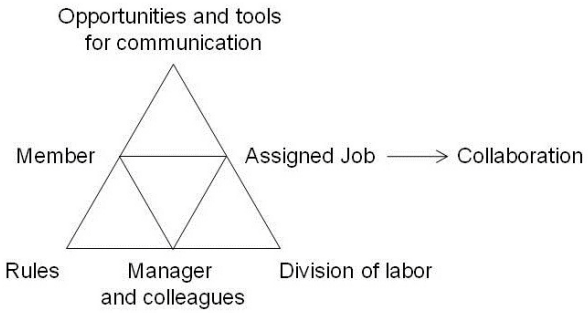

Fig. 2 Performance activities
in learning organizations.

Now, we can make a step forward to consider another kind of activity that has more to do with learning than performance activities, that is, *improvement activities*. The seed to initiate organizational learning is small when discovered by organizational members. They often discover what should be changed or improved in their workplace while carrying out their own jobs. But, it is difficult for them to keep remembering it because they have been working in conventional activities that have been sustained by many people for a long time. Any crucial deficits have already been remedied, otherwise conventional activities would not have continued to work. By nature, conventional activities are those work habits that you feel comfortable doing, take for granted and can rely on with ease. If you make small discoveries, conventional activities tend to make them temporary and disappear even though they could bring about valuable change.

Again, communication plays a critical role in sustaining small discoveries and in developing them into a possible way to improve workplace and work procedures. Your small discovery can get out of your interior world and become a topic of conversation if you can talk about it with someone else. Or, you can start any action to change a situation according to your discovery with the help of someone else. Of course, it is not easy to find such a person to talk with, again, because of the conventional activities in which you are embedded. Your discovery might be taken as something extra without which everything goes well even if you try to talk to someone.

For organizational learning, small discoveries should lead to an opportunity to improve an existing routine into a new one through communication. The improvement activity for organizational learning is shown in Fig. 3. For example, if you find that a particular maintenance procedure should be changed to check a particular portion of machinery more carefully by two different persons, it is not yet an improvement of activity. For improvement of activity to occur, you (subject) work on the small discovery (object) to produce a new routine (outcome) through a meeting for revision of a manual (mediating artifacts) with the collaboration of your manager and colleagues (community).

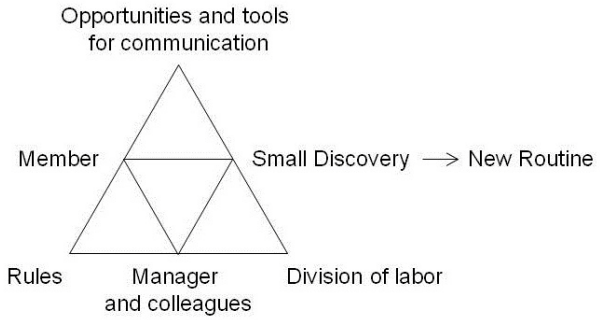

Fig. 3 Improvement activity
in learning organization.

Having the two kinds of activity described above, we can conceptualize everyday organizational activities for organizational learning as the ones that consist of both performance activities and improvement activities. It should be noted here that the two kinds of activity influence each other in organizational learning. That is, collaborative practice attained in performance activities can expand the possibility of small discoveries in improvement activities. If you work with other persons closely, you can learn a new way of observation and thinking which increases the possibility you find something new in your work. Also, a new routine developed by improvement activities will change the job assignment of each member in performance activities.

2.3 Transformational activity

Engeström proposed a concept of learning activity, a kind of activity that works on an existing activity (object) to produce, or transform it into, a new activity (outcome) which stands on quite different premises from the previous one[6]. That concept will be referred to as transformational activity in this paper to illuminate its meaning. Transformational activity is defined as shown in Fig. 4.

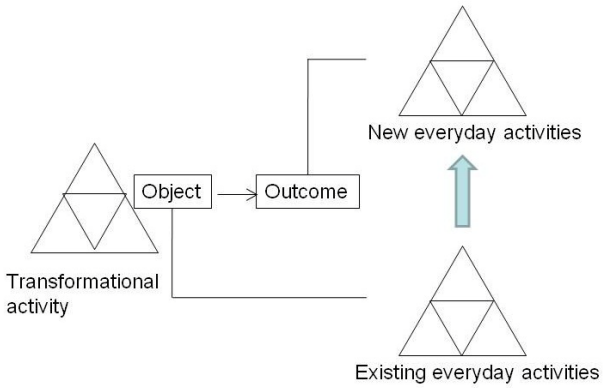

Fig. 4 Transformational activity.

Transformational activity does not occur as often as improvement activity. But, two types of triggers can activate it. One is an extrinsic trigger in the sense that it is brought about by an abrupt challenge to the physical or the societal from the outside of what organizational members are doing. A typical example of physical challenge is a big accident involving loss of life. Such an accident happens suddenly, like a huge earthquake. An example of societal challenge is a rapid change of policy from “for” to “against” nuclear power generation by change of a national or local government.

It is important, however, that all extrinsic challenges, physical or societal, do not become triggers of transformational activity. Often an organization will devote almost all financial and human resources to a shortsighted recovery without paying any attention to initiation of a new effort to change the organization itself. Therefore it is critical whether an extrinsic challenge can become a trigger that creates transformational activity.

The other type is an intrinsic trigger in the sense that it arises from what organizational members are doing. In this case, a seed of transformational activity is planted and growing in the corner of an organization. It is often so small that it is easy for the vast majority of organizational members to ignore it. Actually, we often hear of a success story in which a small group of persons shared a new idea, tried to materialize it, persuaded people around them gradually to accept it, and finally obtained support of top-management. Thus organizational activities changed drastically. It is very probable, however, that such success stories represent just the tip of the iceberg. Many potential seeds of change are hampered by either being ignored or criticized by people around them. Thus, like extrinsic challenges, it is critical whether an intrinsic small attempt can become a trigger of transformational activity. Now, organizational learning can be conceptualized comprehensively by combining a concept of transformational activity with the two kinds of activities, performance and improvement activities, discussed above. First, everyday organizational activities that facilitate organizational learning are constructed by a set of two interrelated kinds of activity, performance and improvement activities. Second, everyday organizational activities can be transformed by transformational activity into new ones that have such new underlying premises that they are beyond imagination in previous everyday activities.

Figure 5 shows our comprehensive model of organizational learning. It should be noted that the model is never a general model of organizational activities but a model of organizational learning activities. It is not rare to see an organization in which an individual member just concentrates on his/her assigned job without any collaboration with other members, or small discovery is forgotten quickly even if it might have possibility to improve a routine, or external challenge or internal attempt is not utilized as a trigger of transformational activity.

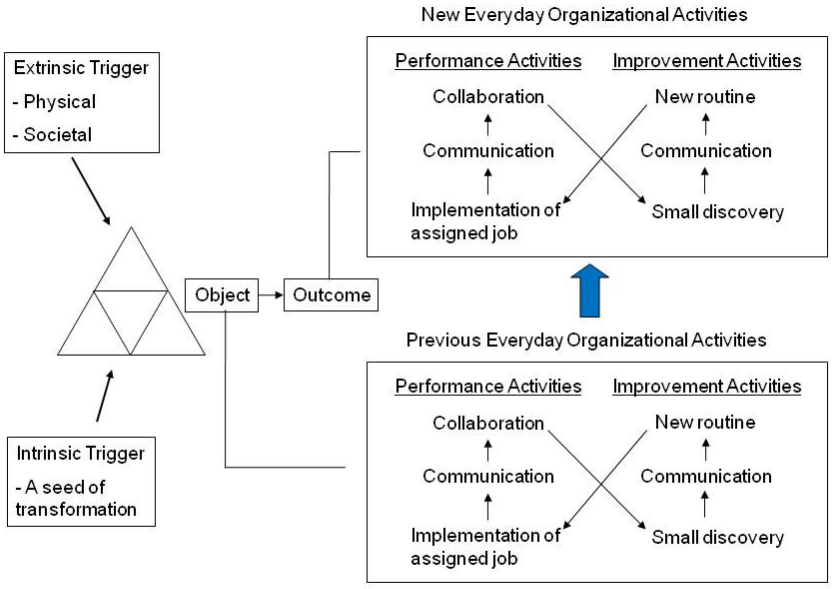

Fig. 5 A comprehensive model of organizational learning.

3 An instance of transformational activity

3.1 Fieldwork

Specific instances of attempts observed in workplaces, taken as contributing to facilitating organizational learning for safety culture, were collected in our fieldwork. The fieldwork was carried out in the maintenance departments in nuclear power plants of a certain electric power company in Japan. The company owns three sites, each of which has three or four plants (a plant is a system including a single reactor). In each site, there are four departments responsible for maintenance of a primary system (reactor), a secondary system (turbine), an electric system, and a measurement system, respectively. Each department consists of two sections that differ in responsible equipment and machinery, and each section has two or three workgroups, each of which is composed of several workers and a head of the workgroup.

In the company above, as well as in other electric power companies in Japan, physical labor tasks to directly inspect and repair equipment or machinery are mainly implemented by workers who belong to subcontractors, while workers of an electric company are mainly involved in preparing the necessary documents and making contracts for regular inspections (once every 13 months) and daily maintenance. However, workers of the electric company were encouraged to visit an operation field where their responsible equipment or machinery was located and to maintain communication with subcontractor employees.

Our fieldwork was carried out in a total of six maintenance departments in three sites of the company for six years. Interviews were made twice or more for all members in each department including a department manager, section chiefs, deputy section chiefs, heads of workgroup and rank-and-file workers. A single interview took 15-30 minutes. At the same time, we could always observe their workplace since interviews were made at a table located in the corner of the workplace. We were often allowed to observe a regular meeting that was held in the workplace. Printed/written documents as well as information shown by a computer display were provided for us unless it was inconvenient for them.

3.2 Results and discussions

Generally, an instance of transformational activity can be observed much less frequently than performance and improvement activities for organizational learning. Fortunately, we were faced with what we may call transformational activity in our fieldwork.

In our interviews during these several years, most people mentioned that improvement requests made by subcontractors had been drastically increased and

that almost all of such requests were being accepted and materialized through a budgetary adjustment by the company. As mentioned earlier, in nuclear power plants in Japan, physical labor tasks are generally conducted by subcontractors' employees in both regular inspections and usual maintenance. Therefore, improvement requests made by workers of subcontractors are important sources of information for improving the reliability of the plants as well as the safety of the workers. However, although a system for making improvement requests had existed previously, the number of such requests made by subcontractors was much smaller until a few years ago.

In such activities, improvement requests of subcontractors were submitted to the company through one of the three routes. First, subcontractors and staffs of the company assessed possible hazards in the workplace where subcontractors' employees were going to work prior to the commencement of each work. If any possible hazards were detected, corrective measures were taken. Second, after the work was completed during a regular inspection period, subcontractors submitted a work report to the company. The report included a portion where they could notate whatever should be improved in machinery they operated and in maintenance procedures. Those points were discussed in a meeting, in which heads of subcontractors and workers responsible for the machinery in the company participated, to clarify what should be improved, and the details necessary to make it materialized. Third, subcontractors could submit an improvement request form that was used among workers of the company. The company sorted these forms by content and assigned them to pertinent sections where their validity was deliberated.

According to activity theory, the activity to materialize improvement requests by subcontractors is one in which subcontractors (subject) work on their present workplace (object) to produce an improved workplace environment (outcome) with the use of improvement requests in collaboration with people of the electric company (community). It had been almost several years since the activity was introduced in each site of the company. Workers of the company, as well as subcontractor employees, were accustomed to the activity in which subcontractors could submit improvement requests without hesitation and almost all of them were materialized by a budgetary step. Such a situation had already become common in each site.

The activity was started because several subcontracted employees, preparing a regular inspection, were killed by high temperature vapors that spewed from an exploded pipe in one plant of the company several years ago. In fact, it was the first fatal accident in the history of a nuclear power plant in Japan. Soon after the accident, inspectors discovered that the portion of the exploded pipe had not been inspected for over 30 years. This accident was so severe that the company had to reconsider its organizational activities of the nuclear power plant from various aspects. One lesson learned from the accident was to pay much more attention to the operational field where machinery was working and to listen to information from people working there, especially information from subcontractors. The activity above was initiated as a major way to actualize the lesson.

We found that such an activity to materialize improvement requests by subcontractors was transformational activity initiated by top management of the entire company. To actualize the lesson from the accident, the top management established a committee named the Reform Committee for Maintenance Work that should take a central role in the company to reexamine and reform maintenance work. The Committee (subject) acted on existing everyday maintenance activities (object) to transform them into new activities (outcome). Sufficient budget for such reform was powerful tool, or mediating artifact, that the Committee could depend on. Needless to say, the top management was persistently collaborated with the Committee by strongly supporting it (community and division of labor) under a rule in which any measures should be taken to actualize the lesson from the accident, that is, to focus on operational fields. Also, the subcontracted workers collaborated with the Committee by submitting as many improvement requests as they want without any hesitation while workers of the

electric company collaborated with the Committee by reviewing the requests and materializing most of them by a budgetary step (community and division labor). The transformational activity is shown in Fig. 6.

The activity above certainly transformed the underlying premises of organizational activities prior to the accident into new ones standing on a new premise concerning the necessity to pay attention to information from subcontractors and improvement of an operational field. In the new premise, an operational field was a focus of attention to the extent that it had been beyond imagination until the accident. In this sense, the transformational activity initiated by the top management can be referred to as a transformational activity that was initiated by making the accident as an extrinsic trigger.

Fig. 6 Transformational activity initiated by top management.

4 Conclusive remarks

We reported a transformational activity that was implemented by a special committee as a subject established by the decision of top management after a fatal accident that occurred several years ago. The transformational activity developed new everyday maintenance activities standing on a new premise that operational fields should be focused on to the extent that it had been beyond imagination until the accident.

It is costly to maintain safety as we saw in the above activity. The activity would have been impossible if sufficient budget had not been available as a mediating artifact. In this sense, decision by the top management to establish the committee and secure necessary financial resources was critically important. An extrinsic challenge does not always become a trigger of transformational activity. The decision that was made by actualizing the lesson from the accident as an extrinsic trigger of transformational activity should be appreciated.

Still, we can suggest a further task. It is required to continue the new everyday maintenance activities that were developed by the transformational activity above and, especially, to maintain the new premise that emphasized operational field to the extent that it could not have been imagined until the transformational activity started. We found that, in these two years, the number of requests submitted by subcontractors decreased because many problems in operational fields had been already resolved. It means that visible activities to improve operational fields by materializing subcontractors' requests by budgetary adjustment have become less and less frequent. Therefore, it has become a new problem how the premise that emphasized operational fields can be maintained. For this, it is important to enhance sensitivity to the deterioration of the premise by drawing on the findings of our study, for example, in which specific instances for everyday performance and improvement activities for organizational learning were investigated[7].

Acknowledgement

This study was conducted under the sponsorship of JNES open application research project for enhancing the basis of nuclear safety.（JNES : Japan Nuclear Energy Safety Organization）

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