
METHODS FOR SHARING TACIT NUCLEAR KNOWLEDGE AND EXPERTISE

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Abstract. The ageing of workforce, the lack of training programs and recruits, and the decline in R&D activities have evoked discussion about the need to preserve nuclear knowledge by transferring it from retiring experts to new recruits. Studies conducted in the nuclear and power industries have found that challenges lie especially in transferring tacit knowledge, which the experts have accumulated through long careers and various experiences in professional settings. This paper examines methods with which tacit knowledge is transferred at the Finnish nuclear power plants. The aim of this paper is to provide empirical knowledge of the current state of practices for sharing tacit knowledge that could be utilized at NPPs more generally.

1. INTRODUCTION

There is a growing concern about the preservation of nuclear knowledge due to many concurrent development trends. A significant proportion of the human workforce in the nuclear power sector is ageing [1] simultaneously with fewer people studying nuclear science, nuclear engineering and related fields, with universities giving up their training programs, with R&D activities being cut down and with the amount of new recruits declining [2]. There is a potential loss of “institutional memory”, as the employees about to retire may possess essential but previously undocumented facts and insights [2]. Human resource policies such as internal training through enterprise universities, tutorage of young scientists by seniors, international mobility of workers [1], teamwork, meetings, on-the-job training, site visits, cross-training, shift changes and peer-to-peer communication [3] have been seen as potential solutions for preserving nuclear knowledge.

In knowledge management research and practice, a distinction between explicit and tacit knowledge has been made. Explicit knowledge refers to codified knowledge, which can be verbalized and transmitted in formal, systematic language [4]. In addition to explicit knowledge, some knowledge is deeply rooted in action, commitment and involvement in a specific context. This tacit knowledge indwells in the mental and physical experiences of a person, making it difficult to formalize and communicate [4]. It has been acknowledged that the two types of knowledge, explicit and tacit, are different by nature and should be shared by using different methods and practices [e.g. 5].

Especially it has been viewed that “hard”, explicit knowledge can be captured relatively easily but challenges lie in “tacit learning” deeply embodied in the life-long experience of employees [6]. For example, in the energy sector, it has been found that to share tacit “lessons learned”, the context in which lessons are learned must also be shared [7]. Thus, in order to share tacit knowledge – for example expertise in a technical maintenance task – it is required that the new worker, the “learner”, performs the task or at least observes it being performed in a practical, real life context. This context may not be provided by knowledge management systems. The systems can contain explicit guidelines for performing a work task but may lack applicable, context-specific and detailed information about the causal relationships of each action within a task. Similarly, while studying the implementation and use of organizational knowledge and memory systems in a nuclear power plant, it has been noticed that the systems may not store sufficient context for a novice to understand and use the stored knowledge [8].

The researchers concluded that in order to be able to use previously obtained knowledge, the new members of an organization need linkages to human sources of organizational memory and knowledge [8]. These findings emphasize the importance of communication and interaction between the experienced members of the organization with the inexperienced ones.

According to Nonaka and Takeuchi [9], tacit knowledge can be shared through two processes: socialization and externalization. Socialization refers to sharing tacit knowledge in social interaction by e.g. observation and imitation whereas externalization is a process of explicating tacit knowledge by converting it to concepts, hypothesis or models with help of metaphors and analogies [9]. Teece [10] states that, explicit, codified knowledge does not necessarily require face-to-face contact and can be often shared largely by impersonal means. There again, tacit knowledge is slow and costly to transmit as ambiguities, which are inherent to complex situations, can be overcome and errors of interpretations can be corrected only when communications take place in face-to-face situations [10].

Thereupon, some practitioners and academics claim that all valuable knowledge in organizations, including tacit knowledge, should be codified [11] for being able to diffuse and store the knowledge effectively. E.g. Karhu [12] suggests companies to establish 'expertise cycles', in which technical writers are employed to document the experts' know-how. Some, on the other hand, consider the quality of tacit knowledge being different in essence and sometimes severely suffering when attempted to be articulated [13]. This conception corresponds to the findings of the importance of shared context in transferring knowledge and expertise [7, 8, 14]. From this perspective, e.g. communities of practice [15, 16], mentoring and story-telling [17] have been suggested as proper methods for sharing the complex tacit knowledge.

Even though the nature of tacit knowledge and the difficulties in its diffusion have increasingly been discussed both among academics and practitioners, research on methods for sharing tacit knowledge is still limited. In this paper, current methods and practices for sharing tacit knowledge at the Finnish NPPs are studied in order to find out what kind of methods are utilized in the Finnish nuclear sector and how these methods and practices are experienced by the employees.

By examining the existing methods and their features, these methods can be further developed if needed and/or new methods can be more successfully implemented to complement them. Thereafter, methods which seem appropriate for sharing tacit knowledge can be diffused and taken into use in the organization more extensively. The aim of this paper is to provide empirical knowledge of the current state of practices for sharing tacit knowledge at the Finnish NPPs that could be utilized at NPPs more generally in developing more effective practices and methods for sharing tacit knowledge.

2. MATERIAL AND METHODS

This paper presents results of a qualitative case study in the context of Finnish nuclear power plants in Olkiluoto and Loviisa. Both of the power plants have been established in the late 1970's and their turnover of workers has been low. Currently, a significant proportion of the personnel of these nuclear power plants is beginning to retire, which has brought about an urgent need to find out ways to ensure that the loss of know-how due to the extensive retirement would be minimal.

The aim of the study was to describe and understand the role of tacit knowledge in the nuclear power plant context, the challenges in sharing tacit knowledge, and the existing methods with which tacit knowledge was shared in the organizations. The data of the study was gathered by conducting group discussions and interviews with key persons. Altogether two group discussions were arranged in both power plants. At Olkiluoto 7 persons were interviewed and

at Loviisa 10 interviews were carried out. Based on the data of altogether 17 thematic interviews and 4 group discussions, the role of tacit knowledge and the challenges in transferring it [18] as well as methods for sharing it were analyzed. The data were analyzed using a qualitative content analysis approach, that is, similarities and differences within and across interviews and organizations were identified and a classification of the role of tacit knowledge, challenges in sharing of tacit knowledge and methods for sharing tacit knowledge was yield. This paper presents results in terms of the methods for sharing tacit knowledge and expertise, which were utilized at the two studied power plants.

3. RESULTS

Overall, six existing methods for sharing tacit knowledge were utilized in the organizations. Three of the knowledge sharing methods were connected to sharing tacit knowledge in a tacit form, through socialization [9]. These were mentoring, apprenticeship and occupational instruction.

Firstly, *mentoring* had been used in order to systematically socialize a novice worker to the organization. According to some interviewees, one aim of mentoring was also to ensure that the new worker was aware of the sources explicit knowledge, e.g. relevant instructions and databases. New recruits had been assigned a mentor, with whom the new worker could discuss his/her work, especially the problems the new worker had encountered in work situations. The mentoring relationship lasted one year with the mentor and the new worker meeting on a monthly basis. Mentoring had been in some cases effective but in others less effective, depending on the quality of the mentoring relationship.

Secondly, in order to share the expertise of employees about to retire *apprenticeship* was utilized. New employees had been recruited and given responsibility whilst the aged experts were still available to give guidance and answer to evoking questions. In both the plants the early recruitment of new workers was emphasized as the knowledge to be transferred was complex and sharing it took time. In some cases, especially in maintenance, it was also essential that the aged expert and new worker were able to work together during at least one or two revisions as some tasks could only be performed then. Apprenticeship was used as a 6-month training period during the education of new operators. The expert and the novice worked together in a shift and the new worker was able to pose questions to the experienced expert in problematic situations. As the novice worker posed questions, also the expert got new insights on his work. At Olkiluoto, apprenticeship did not mean that the expert and the new worker worked together but rather that the new worker performed work tasks and, when needed, asked the expert for advice and guidance. In more extensive and significant tasks, for example in technical modification projects, both the expert and the novice participated. At both the power plants, individual differences had been noticed in the motivation and ability of the experts to guide the new workers and in their willingness to share their knowledge and responsibilities. Representatives at both the plants also saw a need to develop apprenticeship into a more systematic method for sharing tacit knowledge as even though master-apprentice pairs had been arranged it was not known what actually happens during the apprenticeship period and in which ways tacit knowledge is or should be shared in practice.

Thirdly, tacit knowledge was shared through *occupational instruction*. During the first year after the recruitment, the new worker received occupational instruction. The new recruit was assigned to perform various, pre-defined work tasks with experienced workers. At first, the new worker only observed or participated limitedly, but in time he gradually received more responsibilities and finally could perform the task independently. All the experienced workers acted as “trainers” for the new workers, contrarily to the mentoring and apprenticeship described above, in which specific, stable pairs of an experienced and a new worker were formed. Although very useful, occupational instruction had not always produced desired

results. The main challenge was enhancing multi-professionalism instead of specialization: even though the new workers learned all the required competencies, some experienced workers wanted to specialize in some specific tasks they mastered well leaving the new recruits performing only some limited tasks. This had in some cases led to experienced workers being overly stressed by their work and new workers being unmotivated by their simple tasks.

In addition to methods by which tacit knowledge was shared in tacit form, there were also methods for sharing tacit knowledge by explicating it. Three methods were connected to the externalization [9] of tacit knowledge: writing memos, compiling situation reports, and producing training materials.

Firstly, *the writing of memos* was used. The employees about to retire wrote manuals, guidebooks and memos, in which they gathered the most relevant and critical knowledge in terms of their work. These documents had been used by some co-workers, who found that some memos were informative and useful but it was difficult to understand some of them. The interviewees saw that, for some experienced workers, it might be difficult to assume the role of the novice and be aware of the kind of knowledge, which should be shared, and the appropriate ways to share it. Tacit knowledge, as it is based on individual experiences, seemed self-evident for the experts, which posed challenges to sharing it. The interviewees saw that all knowledge cannot be explicated and, thus, tacit knowledge plays always a role in work situations, to some extent at least. Moreover, it was often easier to get information by asking the expert rather than searching for it from documents. Thus, even though documents had been made, they were not always utilized.

Also, *situation reports* were made in deviant work situations. In the reports, an employee described and explained the causes for the situation and the consequences which had occurred. In this process, also tacit knowledge that was embodied in the situation was partly explicated and brought to a verbal form.

Finally, *training materials had been produced* in co-operation between an expert and a novice, with the expert knowing the content and the novice posing questions and ideas. In compiling the material, causal relationships in work had been examined and the tacit knowledge of the expert had been shared with the novice and partly explicated in the training material. Producing training materials together had been motivating and interesting for both the experienced worker and the novice worker as they both trained their colleagues or other professionals in the organization with the produced material.

Figure 1 illustrates the methods for sharing tacit knowledge at the two studied nuclear power plants.

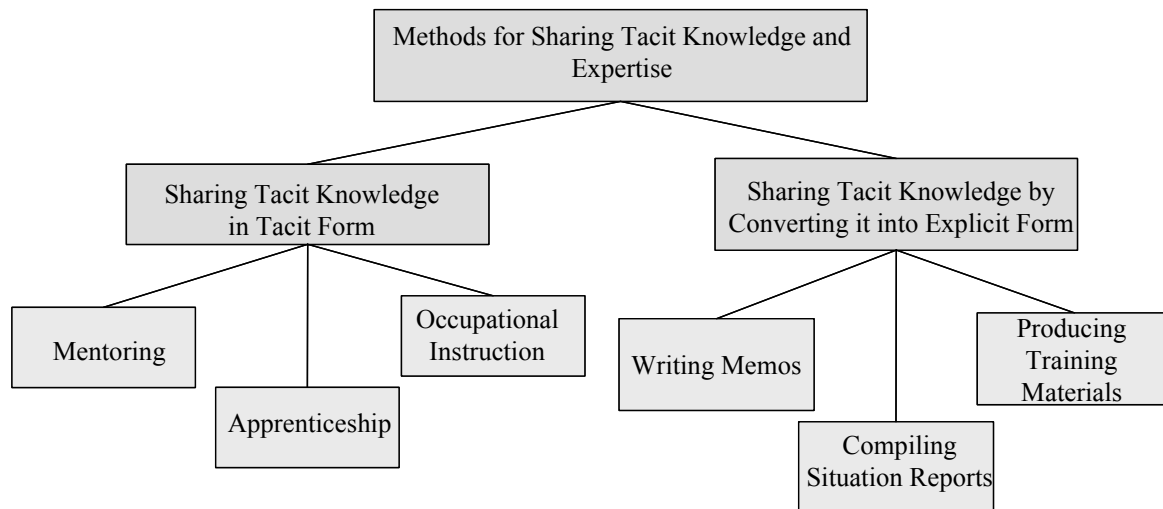


Figure 1. A Classification of the Methods for Sharing Tacit Nuclear Knowledge and Expertise.

Furthermore, managerial tools were used in order to manage the expertise of individuals and the transfer of tacit knowledge. At Olkiluoto, a database was used into which the current skills, the desired skills and the methods for acquiring these skills were updated. Also an Excel-based tool was used for defining the responsibilities and the critical skills and expertise within a department in order to ensure that these skills were preserved despite of the retirement and employee turnover. At Loviisa, apprenticeship and occupational instruction were accompanied by lists of skills and issues, which the new worker was expected to learn. The aim of the lists was to ensure that requisite expertise was transferred systematically to all new workers.

4. CONCLUSIONS

In the view of the data gathered in this study, it seems that tacit knowledge cannot be shared by verbalizing it and disseminating it for example through knowledge management systems – at least not entirely. In the studied organizations, experienced workers had documented their tacit knowledge, but it had been noticed that there were several obstacles to externalizing tacit knowledge and sharing tacit knowledge in explicit form. The experienced workers viewed their expertise as self-evident and were unable to reflect their tacit knowledge without someone posing questions. It was difficult for them to assume the position of a novice worker and know what kind of knowledge should be conveyed and how knowledge sharing should occur. Relatingly, new, novice workers were not able to understand the documents made by the experts as the experts and novices did not share the same experiences and backgrounds. The novice workers could not pose questions if knowledge was shared in an explicit form and it was difficult for them to practically apply knowledge obtained from documents. The interviewees emphasized that tacit knowledge cannot be learned from lectures or documents but builds up in face-to-face interaction when experiences about everyday work situations accumulate.

In face-to-face interaction, psychological and social issues come into play. Motivation and ability to share tacit knowledge were especially highlighted when tacit knowledge was shared in tacit form. The eagerness of the new workers to learn and the enthusiasm and willingness of the experts to share their experience-based knowledge and responsibilities seemed to be determinants of the successfulness of sharing tacit knowledge. Also the ability of the experts to reflect on and communicate their know-how, and the ability of the learners to pose questions to reduce ambiguities seemed to affect effectiveness of the tacit knowledge sharing.

Moreover, if the working culture of a work unit favoured specialization rather than multi-professionalism, new workers were able to utilize newly learned tacit knowledge only in some tasks and expertise acquired in other tasks was in danger of becoming obsolete. It is evident that these issues have to be taken into account when developing existing methods and/or implementing new knowledge sharing methods.

Even though many methods for sharing tacit knowledge were used in the organizations, tacit knowledge sharing occurred fairly unsystematically. The representatives of the organizations knew that tacit knowledge was indeed shared during the periods of mentoring, apprenticeship and occupational instruction. However, it was not known *what actually happened* when an expert and a new worker interact and *how* tacit knowledge was shared in this relationship. In order to develop the existing methods that are used for sharing tacit knowledge within an organization, the ‘how’ question should be answered. For example, through which ways is tacit knowledge communicated? Is knowledge shared through asking questions, observing and imitating or telling narratives? Can knowledge sharing, for example in an apprenticeship relationship, be modelled as a process and do these ways of communication have different implications in different phases of the process? How are the accumulation of expertise of the novice worker and the increase in trust between the expert and the novice in interaction with this process, its phases and the ways of communicating? Nuclear power organizations with ageing human workforce need further research on these complex mechanisms of sharing tacit knowledge to be able to preserve and diffuse the knowledge and expertise in their organizations now and in the future.

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