

## THE ROLE OF TACIT KNOWLEDGE AND THE CHALLENGES IN TRANSFERRING IT IN THE NUCLEAR POWER PLANT CONTEXT

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**Abstract.** Explicit knowledge and implementation of proper IT systems have been of concern of many organizations which recognize the importance of managing knowledge for safety operation and sustainable competitive advantage. Data and document management systems have been implemented to capture, store and distribute explicit knowledge. However, recently also awareness of the existence of tacit knowledge in organizations has arisen. What kind of role this undocumented knowledge, which the employees have acquired through their careers, plays in nuclear power plant context? This paper explores the role of tacit knowledge and the challenges related to its transfer at the two Finnish nuclear power plants.

### INTRODUCTION

Competition in the business environment forces organizations to function ever more effectively. Few if any organization can afford to learn the hard way anymore. At the time the first nuclear power plants were put into operation, no one had experience of running a NPP. However, expertise in the operation and maintenance of NPPs has accumulated during the decades. Now, in the current competitive business environment, this expertise needs to be maintained and skillfully utilized in order to ensure maximum safety and profitability of the plants. Knowledge and the capability of creating and utilizing knowledge have been claimed to become the most important sources of organizations' sustainable competitive advantage these days [1, 2, 3, 4, 5]. Maintaining the expertise and knowledge in organizations is especially topical in the NPP sector as the age structure of employees at many NPPs is such that a large proportion of experienced workers is going to be simultaneously retired in near future [6].

Explicit knowledge and implementation of proper IT systems have been of concern of many organizations which recognize the importance of managing and maintaining knowledge for safety operation and sustainable competitive advantage. Data and document management systems have been implemented to capture, store and distribute explicit knowledge. However, recently also awareness of the existence of tacit knowledge in organizations has arisen. What kind of role this undocumented knowledge, which the employees have acquired through their careers, plays in nuclear power plant context?

This paper explores the role of tacit knowledge at the Finnish nuclear power plants. The paper is divided into two sections. First, a literature review will be presented exploring the nature of explicit and tacit knowledge and challenges identified in transferring tacit knowledge in organizations. Second, the results of an empirical study concerning the role of tacit knowledge and the challenges related to its transfer at the Finnish NPPs will be presented and discussed.

### 2.0. Explicit vs. Tacit Knowledge

It has been suggested that knowledge in organizations is built of two types of knowledge: explicit and tacit [7]. Explicit knowledge is defined as the kind of knowledge that can be articulated in a verbal form, be documented and codified, and shared by means of e.g. databases, documents and books. As knowledge management became a topical issue in 1990's, most of the knowledge management efforts focused on managing explicit knowledge as well as information and data with technology intensive solutions and systems. However, most of the knowledge management projects seemed to fail being not adopted as planned and

not ending up with an outcome desired [8]. These failures invoked a doubt that something had been forgotten in planning and implementing the knowledge management systems.

One explanation for these failures might be the strong emphasis put on only the type of knowledge that was explicit and deliverable via IT systems. To some degree knowledge in organizations has been claimed to be tacit and embedded in persons, involving mental models, crafts, skills, intuitions, hunches, attitudes and feelings which may be very difficult or even impossible to articulate [9]. According to Koskinen [10] “tacit knowledge reinforces an individual’s practical preparedness and allows concentration on the key activities of the task since a part of the activity has become automatic through practice.” This kind of expertise is the practical know-how of individuals, which has been seriously acknowledged as part of knowledge management efforts only recently [11].

Tacit knowledge has been claimed to be “the tricks of the trade“, promoting effective organizational functioning, overall know-how, and competitive advantage [12]. Unlike explicit knowledge, tacit knowledge resides in the networks of human beings [13]. It may be shared e.g. through observation, imitation and practice [14], shared experiences [9] and joint activities like being together and spending time together in physical proximity [15]. Tacit knowledge is not usually acquired in a verbal form and accordingly is at best difficult to be shared verbally. A simple example illustrating the essence of tacit knowledge is knowing how to ride a bike: it has been acquired by imitating and doing, and it is quite difficult to be explained in words, much less learned by reading instructions.

### 2.1. Challenges in Transferring Tacit Knowledge

Whilst the awareness of the role of tacit knowledge in organizations has grown, its diffusion in organizations has proved to be tricky. One strategy has been to explicate the tacit knowledge and transfer, then, the explicit knowledge. However, the experts usually lack skills, motivation and time to document their expertise [16]. In some companies, to improve the documentation and transfer of the knowledge and expertise in the organization, technical writers have been recruited to interview the experts and write the documentation. However, problems have still remained as experts have not found time for interviews and sharing the expertise has not succeeded without trust and close relationship between the writer and the expert [16].

However, essential aspects of tacit knowledge are argued to be lost when focusing on the explicating strategy [17, 18]. Another possibility would be to share the tacit knowledge and expertise with all its unconscious and automated elements without impoverishing it into explicit form. Enhancing this process has been suggested to be valuable [7] but the road is rocky. Due to the characteristics of tacit knowledge, it cannot be shared through formal procedures but needs motivation and commitment in an environment of trust and care [19]. Due to the special characteristics of tacit knowledge many challenges in sharing tacit knowledge have been identified: difficulties in perception of one’s tacit knowledge; different language between masters and novices; time required for assimilating the tacit knowledge; value not given to aspects of tacit knowledge like rule-of-thumb and intuition; and distance inhibiting sharing tacit knowledge as face-to-face interaction is considered critical [11]. Accordingly, tacit knowledge requires the existence of ‘strong ties’ in an organization in order to be diffused [20]. Strong ties imply that two individuals have regular contacts with each other embedding friendship and reciprocal favors [21]. Strong ties as compared to weak ties, that is infrequent contacts, are necessary for sharing tacit knowledge at least for four reasons: 1) individuals are willing to spend more time on sharing complex knowledge with each other; 2) motivation to guide and give assistance is higher; 3) two-way interaction enables asking further questions and getting feedback; and 4) individuals can understand each other better [20].

A further challenge with tacit knowledge is that unlike explicit knowledge it cannot be stored in databases but is embedded in people and is taken away with them as the employees leave the company [12]. As a consequence, diffusion of tacit knowledge in organizations has been claimed to become especially essential when tackling the issue of employee turnover e.g. due to retirement [12]. The empirical part of this paper focuses on the role of tacit knowledge and challenges in transferring it at the two nuclear power plants in Finland. These power plants have been built in the 1970's and a significant part of the current personnel has been recruited to the plants back then. Consequently, a large share of the personnel will be retired during the following ten years.

The status of explicit knowledge is significant in the nuclear power plant context as the requirements for documentation are strict and the documentation is controlled by legislation and official regulations. As the norm at NPPs is to carefully document the required information, the NPP context forms an especially fertile ground for studying the role of tacit knowledge: as the required information is already mainly well documented, what is the role for tacit knowledge, if any? This paper brings out the experiences concerning the role of tacit knowledge and challenges related to its transfer at the two Finnish nuclear power plants, TVO in Olkiluoto and Fortum in Loviisa.

#### MATERIAL AND METHODS

The data of the study were collected in March and April 2004 by interviewing 7 key informants from top and middle management as well as training division at NPP A, and 10 key informants from all organizational levels and divisions at NPP B. In addition, two group discussions were held at both NPPs. The interviewees were selected as having a broad view of the operations in the NPP.

The interviewees were asked how they experienced the role of tacit knowledge in their work and at the NPP in general, and if any, what kind of challenges were related to its transfer at the moment. The concept of tacit knowledge had different meanings for the interviewees. The term 'tacit' is translated in Finnish as 'silent' and accordingly some interviewees thought that tacit knowledge is knowledge of people who are not able or willing to discuss their work and what they do. Therefore, the researchers expressed their idea of tacit knowledge in the beginning of the interviews to be able to discuss the concept. The example of riding a bike was utilized to illustrate the concept. The researchers described tacit knowledge as the know-how of individuals including intuitions, feelings and haunches, and the ability to accomplish certain tasks without necessarily being able to explicitly define how it was done and what the reasons for e.g. certain decisions were.

The data were analysed by using a qualitative content analysis approach. This means that the researchers looked for similarities and differences in how the research phenomena, e.g. the challenges in sharing tacit knowledge, were described by the interviewees. The aim of the content analysis was to produce a kind of a summary of the interviews without losing the meaning of the form of the interviews.

#### RESULTS

Even though some of the key informants considered the emphasis of the knowledge in the nuclear power plant context being on explicit knowledge, also the role of tacit knowledge was considered significant. As a consequence of accumulated experiences during the work history, the employees had developed into experts in their own area and this expertise was not considered such that it could have been captured in instructions or documents. An example was given in an interview concerning a situation in which the expert on some component had been retired: A defect that had been earlier routinely repaired took days to be tackled by the new employees with help of written instructions and finally could not be fixed until the retired expert was found. Other examples illustrating the role of tacit knowledge in the

maintenance work of NPPs were given as well: The experts knew from very little hints what they should do and what the consequences of their actions would be. It was considered quite impossible to document all the little hints and their possible combinations together with all the possible consequences of each operation in every situation, especially as the experts were not even themselves necessarily explicitly aware of their problem-solving.

The role of tacit knowledge was seen especially emphasized in knowledge related to certain issues and processes, e.g. the building process of the power plant (e.g. design bases and project know-how); the experience of using the NPPs; interpreting and evaluating the resonance of issues and situations; finding the relevant documentations from the paper files; the know-how embedded in commissioning as well as public approval; domestic and international relations; and fuel acquisition and radioactive waste management. The role of tacit knowledge in the nuclear power plant context was considered critical at least for three reasons: 1) the nuclear technology is remarkably complex; 2) nuclear know-how is only in hands of a few in Finland (cf. e.g. forest industry in Finland); and 3) the safety and quality of operation in the nuclear power plant context are extremely important.

As the most significant challenge in transferring the tacit knowledge was seen the forthcoming retirement of a large proportion of staff which had worked at the nuclear power plants from the beginning. These employees had tacit knowledge related to e.g. the commissioning and initial operations of the power plant, and huge experience in using the power plants as well as effective domestic and international relations. At both the NPPs the responsibilities had been divided between the employees and it was rather the practice than exception that knowledge of a certain issue or component was in hands of only one or at most a few persons at the plant. This had not earlier caused problems as the turnover of the workers had been low. However, now the challenge was seen to be transferring this know-how to the new employees at the plant and preferably having more than just one individual mastering certain tasks and issues. Accordingly, the existing practice of specializing in certain tasks and components and dividing the responsibilities was not desired to be maintained in the future but it was wished that the new employees would develop a wider and more multifaceted base of expertise.

Many challenges were seen in transferring the know-how of the experts: apprenticeship was seen as a way to share the know-how but it was considered taking rather a long time, say two years of working together. This raised a question of finding resources to recruit the apprentices as well as ensuring the motivation of the apprentice to follow the master for a couple of years. The newcomers were given status and own responsibilities by transferring the experts to other divisions, but the connection between the 'master' and the 'apprentice' was similarly reduced. Furthermore, there were differences in the ability of the experts to guide the newcomers and share their expertise. The know-how of the experts was self-evident for themselves and the experts could have trouble in taking a stand of a novice.

Some of the know-how of the experts was considered such that it could have been documented. However, at least some of the instructions would be long and complex and it was suspected that no one would hardly absorb this kind of knowledge by reading instructions. On the other hand, not all of the tacit knowledge embedded in the experts were considered worth transferring: especially some customs and practices were found more effective among the younger generation, and some prevailing practices were not desired to be maintained.

At the other NPP in Finland, a challenge related to the tacit knowledge was also the building of a new nuclear plant and documenting the knowledge related to the process in order for it to be as much in an explicit form as possible and the transfer of the remaining tacit knowledge would be effectively controlled and planned. Furthermore, challenges were also found in

creating new training material and developing more multifaceted and interactive training, which would lead not only to transfer of explicit knowledge but also to effective transfer of tacit knowledge as well.

## CONCLUSIONS

Even though the requirements for documentation at NPPs are high, the role of tacit knowledge seems to be essential for effective operation at NPPs according to this study. Tacit knowledge was seen to result from learning and gaining experience of working at the NPPs and was considered especially significant as the safety of operations at NPPs are critical. The meaning of tacit knowledge had been acknowledged at both the NPPs examined and methods had been searched for in order to transfer the tacit knowledge. Thus, even though the work processes are highly regulated and instructed by explicit knowledge at NPPs, tacit knowledge has also an important role in ensuring the smooth and secure operating of NPPs.

The greatest challenge related to the transfer of tacit knowledge at the Finnish NPPs was seen the forthcoming extensive retirements. Documenting the tacit knowledge was considered worthwhile in certain tasks, but documentation was not seen as solving the entire problem of the transfer of tacit knowledge. Tacit knowledge was seen as complex and intuitive, and even though it could in some cases be documented, it was assumed that nobody would probably be able to absorb the knowledge from the complex documents. The ageing of the NPP operators and maintenance professionals is a globally recognized challenge. According to this study, methods with which tacit knowledge can be shared by ‘masters’ and ‘novices’ learning and working together, must be developed in order to transfer the tacit expertise of aged NPP professionals.

Specialization was also seen as a problem as the experts were retiring. Expertise and tacit knowledge were wished to be shared and the new generation was encouraged to build wider and more multifaceted know-how to avoid similar problems in the future. At the moment, appropriate methods were searched with which to share the specialists’ expertise before their retirement. Thus, the methods with which tacit knowledge is shared should also aim for a greater degree of multi-professionalism and “qualitative flexibility” [22] of the personnel.

This study was a pre-study of a planned two-year research project at the Finnish nuclear power plants. At this point the task was to map the role and the potential challenges in transferring tacit knowledge at the Finnish NPPs. As the results of the pre-study revealed that the sharing of tacit knowledge is indeed an important factor at the NPPs, the aim in the planned project will be to pilot and implement tools and methods at the NPPs in order to enhance the sharing of tacit knowledge in these organizations. Even though the importance of tacit knowledge seems to be acknowledged at least at the Finnish NPPs, systematic methods for sharing this complex knowledge are still lacking.

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