Dynamic Knowledge Map: Reusing Experts' Tacit Knowledge in the AEC Industry

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Abstract

Much knowledge in the Architecture, Engineering and Construction (AEC) industry is experience-based and tacit. Nevertheless, the typical strategy for knowledge management is focused on computer-based approaches for capturing and disseminating explicit knowledge. AEC firms have been successful at collecting and storing explicit information in enterprise databases, but they are poor at knowledge retrieval and exchange. Consequently, AEC professionals find it difficult to reuse core experts' knowledge for highly knowledge-intensive AEC activities. This situation calls for a method for disseminating tacit knowledge from experts' brains to achieve higher quality AEC projects.

The primary purpose of this paper is to set a theoretical foundation for clarifying the contribution of experts' tacit knowledge in the AEC industry. The secondary purpose is to describe the concept for prototype software, Dynamic Knowledge Map, that can assist in the reuse of experts' tacit knowledge. Dynamic Knowledge Map is a Web-based knowledge navigator that searches for experts and facilitates communication with those experts by using internet technology. Higher performance levels theoretically can be achieved while accelerating the knowledge transfer processes. Future research will test the suitability of Dynamic Knowledge Map for tacit knowledge utilization in AEC organizations.

1 Introduction

There are two kinds of knowledge: tacit and explicit. According to Michael Polanyi's (1966) definition, tacit knowledge is highly personal, context-specific, and therefore hard to formalize and communicate. Tacit knowledge is knowledge housed in the human brain, such as expertise, understanding, or professional insight formed as a result of experience. Explicit knowledge, on the other hand, refers to codified knowledge that is transmittable in formal, systematic language and is easily transferred by using Information Technology (IT).

Because of the orientation toward unique projects, much knowledge in the AEC industry is experience-based and tacit. The knowledge needs are dynamic, depending on the task to be performed or the problem to be solved. Nevertheless, the typical strategy for knowledge management is to make knowledge explicit and store it as computer software and databases. It is driven by the exponential advances in IT. Hansen et al. (1999) and Johannessen et al. (2001) pointed out that IT usefulness is limited to the transfer of explicit knowledge only. Chiti Ho, Chief Technology Officer of 3D/International, also said that the use of IT solutions influences the communication of explicit information only. Therefore, the emphasis on IT may compromise effective tacit knowledge, furthermore, experts' tacit knowledge could be wasted and ignored.

As a result, there are numerous problems with knowledge-based system resulting from the non-applicable conversion of tacit knowledge to explicitly documented knowledge. It is often difficult to extend and enhance a knowledge-based system with additional expert knowledge once the system is fielded. The knowledge-based system works well only if the system contains enough input from human experts. The primary reason that most knowledge-based systems are not well integrated into the AEC process is that it is difficult for project managers to assess the applicability of this technology to the AEC processes (Levitt and Kunz 1985). Within the context of rapidly changing technologies and processes, an existing knowledge-based system might no longer seem capable of meeting the increasingly

complex knowledge demands in the industry. Although the technical capabilities of knowledge-based systems are expanding, they still fall short of applicability to the AEC processes they are designated to support. On the other hand, some AEC companies have tried to implement a “Lesson Learned” system to record personal tacit experiences (Rogus 2001). However, those systems require extensive efforts to record tacit experiences.

AEC firms have been successful at collecting and storing explicit information in enterprise databases, but they are not always good at tacit knowledge retrieval and sharing. Consequently, AEC professionals find it difficult to access core knowledge for highly knowledge-intensive AEC activities. This situation calls for a method for disseminating tacit knowledge from human experts, especially for use by large AEC firms. The primary purpose of this paper is to set a theoretical foundation for clarifying the contributions of experts’ tacit knowledge in AEC industry. The secondary purpose is to describe the concept for prototype software, Dynamic Knowledge Map, to reuse experts’ tacit knowledge more productively.

2 Tacit Knowledge in the AEC Organization

An enormous volume of AEC knowledge is generated during the phases of design, planning, construction, and maintenance of a facility. Throughout the whole life-cycle of a construction project, AEC firms rely on their experiences, professional intuition, and/or other forms of tacit knowledge to accomplish satisfactory work. However, the difficulties of exchanging knowledge among project participants were observed by the author many times while working for general contractors. Specifically, the difficulties are more serious in large, geographically dispersed AEC firms, that have more experience than smaller firms.

In an AEC organization, it is more likely that employees will work on similar projects, although there is no explicit link between projects. Top managers generally assume the AEC professionals already possess tacit knowledge and experience for specific types of projects. This allows experienced workers to share their knowledge and experiences with apprentices through a form of storytelling and communities of practice (Brown and Duguid 1991). Specifically, sophisticated construction methods are successfully applied by highly educated, experienced professionals on job sites. Rogus (2001) pointed out that this knowledge is extremely important to the AEC organization because, once a project is completed, professionals tend to forget it and start something new. Therefore, knowledge utilization is a key factor in productively executing a construction project. However, there are no definite strategies for managing, interpreting, and applying tacit knowledge on a job site.

3 Reusing Experts’ Tacit Knowledge

Michael Polanyi (1966) presented the first theory concerning tacit knowledge in his book, *Tacit Dimension*. Since then, numerous studies have demonstrated the importance of tacit knowledge in real-world performance. In much of the literature, tacit knowledge has been emphasized and regarded as the important strategic resource that assists in accomplishing a task (Baumard 1999; Nonaka & Takeuchi 1995; Sternberg et al. 2000). Polanyi (1966) also insisted that tacit knowledge is the basis of creativity. The research done by Sternberg et al. (2000) showed that much of the knowledge needed to succeed in real-world tasks is tacit. Malhotra (2000) also insists that explicit knowledge typically lacks the context required to be truly useful to the knowledge seeker.

The first attempt to measure the effectiveness of tacit knowledge was performed by Sternberg (2000) and his colleagues. Their goal was to point out the contribution of tacit knowledge to successful performance and to establish a relationship between the possession of tacit knowledge and job performance. They found that tacit knowledge can be quantified. Their studies also indicate that the amount of tacit knowledge is related to both job performance and school performance. Specifically, they insisted that tacit knowledge can be a source of highly effective performance in the workplace. They also pointed out that the efficacy of tacit knowledge depends on effective acquisition and utilization.

In industry, tacit knowledge has been recognized as a critical resource in the development of sustainable competitive advantage and firm growth. Nevertheless, organizations find it difficult to fully

benefit from this valuable asset (Stenmark 2000). According to the theory of organizational knowledge creation (Nonaka and Takeuchi 1995), the key to knowledge creation lies in the mobilization and conversion of tacit knowledge to explicit knowledge. However, converting tacit knowledge to explicit knowledge often fails because of an unawareness of tacit knowledge and the necessity to make it explicit (Stenmark 2000). Herschel et al. (2001) also pointed out that converting tacit knowledge to explicit knowledge is often time consuming and problematic. Sveiby (1997) says that knowledge becomes static when tacit knowledge is made explicit through language. This is why the codification process for the richest tacit knowledge is generally limited to locating experts with the knowledge and encouraging knowledge seekers to communicate (Davenport and Prusak 1998).

One of the more successful initiatives for sharing tacit knowledge is Communities of Practice. These communities are designed to build a network of knowledgeable experts who work together to learn and solve complex problems when the solutions are needed. In general, they operate informally through meetings, video-conferences, or e-mail communications to exchange knowledge and work practices on topics of interest to the members.

There are only a few empirical research studies of tacit and explicit knowledge utilization. Experimental research conducted by Herschel et al. (2001) focused on the comparison of tacit and explicit knowledge representation methods. Their results showed that tacit knowledge representation methods excel at sharing knowledge, but that their effectiveness critically depends on whether the recall process is explicitly structured. Somech and Bogler (1999) used survey research to investigate the relationship between tacit knowledge and student learning and achievement. The results revealed that students who scored high in tacit knowledge achieved higher academic grades than students who scored low in tacit knowledge.

4 Dynamic Knowledge Map

Knowledge maps typically point to people as well as to documents and databases to enable a person to find an appropriate knowledge source (Davenport and Prusak 1998). Conventional knowledge maps locate the holders of knowledge when their expertise is needed rather than spending time with imperfect solutions or searching for explicitly documented knowledge. However, the static nature of most knowledge maps is an obstacle to disseminating tacit knowledge. More recently, the role of knowledge mapping has been changed to expert locater, which allows users to search through a set of biographies for an expert on a particular knowledge domain (Davenport and Prusak 1998).

This paper proposes creating and testing a Dynamic Knowledge Map so that tacit knowledge can be shared within AEC firms. A Dynamic Knowledge Map is a Web-based knowledge navigator that searches for experts and facilitates communication with the experts by using Internet technology. Background theories behind Dynamic Knowledge Map are represented in Figure 1. Socially constructed knowledge is created by socialization, which is a process of sharing experiences, thereby creating tacit knowledge such as shared mental models and technical skills (Nonaka and Takeuchi 1995). This process occurs without intention or awareness (Reber 1993). Reber (1993) also focused research on the phenomenon of acquiring tacit knowledge without intention or awareness. He called it “implicit learning”. Dynamic Knowledge Map will help the “Socialization” process by performing the role of knowledge map and communities of practices. As a result, job performance will be improved by the accessibility of socially constructed knowledge as a form of practical intelligence (Stenberg et al. 2000).

Logging into Dynamic Knowledge Map, the AEC professional would search for an expert with the relevant knowledge, and will connect with him in real time by using instant messaging, e-mail, telephone, or Internet conferencing. As a result, the AEC professional could receive direct tacit help from an expert who had recently experienced a similar problem. At the time of communication, experts’ tacit knowledge will be transferred in the most appropriate forms and applied in business processes. Their dialogue would be audited and stored in enterprise database systems to be searched by others. In this way, the AEC organization extracts valuable tacit knowledge from employees’ human brains and applies those assets to the work process. In this way, higher performance levels theoretically can be achieved by accelerating the knowledge transfer processes.

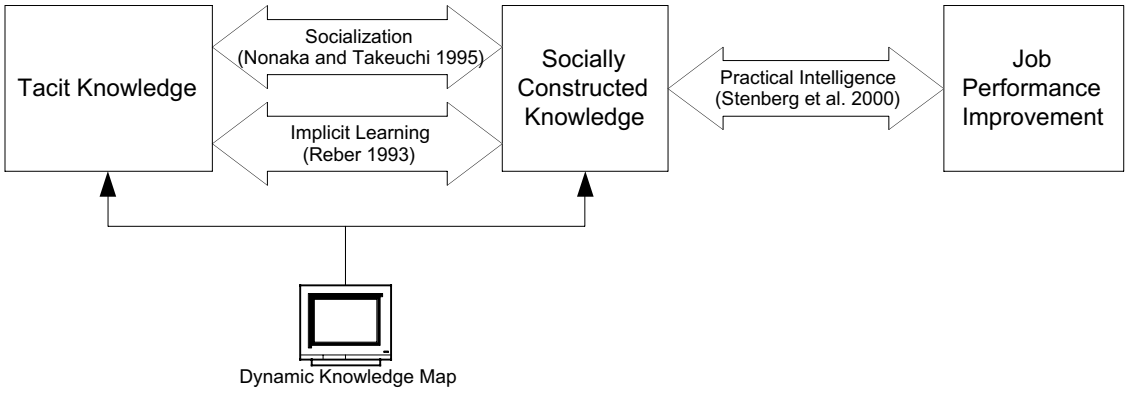

Figure 1. The theories behind Dynamic Knowledge Map

5 Conclusions

The ideas and theories discussed in this paper are an introduction to issues and solutions for reusing experts' tacit knowledge in the AEC industry. The goal of this work is to present a coherent and practical way to use tacit knowledge in the industry. Although tacit knowledge is important to success, AEC organizations often give little recognition to it. For the two types of knowledge discussed herein, there are two types of knowledge management strategy: explicit knowledge strategy and tacit knowledge strategy. The theoretical findings show that tacit knowledge strategy seems more appropriate for the AEC industry. However, explicit knowledge should not be ignored. Organizational knowledge bases are both explicit and tacit. AEC professionals should emphasize tacit knowledge and use explicit knowledge in a supporting role. Knowledge bases should not reside in computerized repositories but in human brains.

6 Future Research

Future research will be conducted in order to test the suitability of Dynamic Knowledge Map for tacit knowledge utilization in AEC organizations. The research will determine whether Dynamic Knowledge Map improves students' learning in an architectural design class. The research also will identify appropriate directions for the use of knowledge management systems in the AEC industry.

First, a Web application prototype of Dynamic Knowledge Map will be constructed as a data collection instrument. A software usability engineering approach (Neilsen 1993) will be considered during software testing for evaluating both computational capability and a graphical user interface. After establishing a Web application prototype, a set of experiments will provide numerical data about participants' performance using the Dynamic Knowledge Map. At the same time observation will provide ethnographic data, including records of participants' behavior, activities, and meanings. The research results will clarify the benefits to AEC organizations of using tacit knowledge assets integrated into business processes.

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