Designing Competence Systems

Towards Interest-Activated Technology

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Abstract

Despite the considerable research interest shown in various types of knowledge management systems, not much academic work can be found on information technology (IT) support for managing competence. This paper addresses this shortage by presenting an 18-month action case study of the design, implementation, and evaluation of a traditional competence system at Volvo Information Technology AB in Gothenburg, Sweden. In addition, to upset prevailing assumptions and provoke reflection among the organisational members, we implemented and introduced an interest-activated recommender system prototype as a contrasting competence system. Our results increase our understanding of competence systems in two ways: First, we illustrate how inherent problematic aspects of mainstream competence systems can negatively affect the adoption and use of such systems. Second, we show how interest-activated technology can be exploited and developed to support competence management. Building on these results, this paper's main contribution is five general design implications for future competence systems based on interest-activated technology.

Key words:

Competence systems, interest-activated technology, design

Introduction

Although a great deal has been written about the design, implementation, and evaluation of knowledge management (KM) systems (e.g., Ackerman, 1994; Ackerman and McDonald, 1996; Hahn and Subramani, 2000; McDonald and Ackerman, 2000; Schultze and Boland, 2000; Alavi and Leidner, 2001), most of the contributions have either dealt with knowledge in a broad sense or with expertise, i.e., individually held work-related knowledge. This paper concentrates on IT support for managing competence, i.e., organizationally managed work-related knowledge. Relatively little attention has been paid to this sub-group of KM systems and, to our knowledge, there is no research on competence systems apart from our own work. The typical competence system is designed to support organizations in their competence management processes by providing information about competence status and competence development needs of organizational members. Our studies to date have largely considered competence systems that store and categorize individuals' competencies in well-defined and structured ways, i.e., competence systems based on a hierarchical competence structure consisting of sub-levels that are constituted of the competencies (see e.g., Lindgren, 2002; Lindgren and Henfridsson, 2002; Lindgren et al., 2002). In Lindgren et al. (submitted), however, these types of competence systems are problematized. Building on an action case study of an implemented interest-activated recommender system prototype, we suggest a new design rationale for competence systems promoting that such systems should have the potential to detect, visualize, and leverage interests of organizational members. In this paper, we further develop these ideas by presenting results based on an action case study of Volvo IT's competence system Tieto Persona/Human Resource (TP/HR) and the implemented Volvo Information Portal (VIP). More specifically, we describe:

- The emerging organisational understanding of the problematic aspects related to the adoption and use of TP/HR, which is a hierarchically structured and multi-levelled system containing information about formalised competencies. The identified problematic aspects provided useful input to the VIP experiment.
- The agent-based intranet recommender system VIP that facilitates searching for information related to a specified competence. This means that, in sharp contrast to TP/HR, VIP does not rely on database records of formal competencies but on interest-driven actions of the organisational members.

This paper's overarching research question is how interest-activated technology can be exploited and developed in order to support competence management. The main objective is to present general design implications for future competence systems based on interest-activated technology. The paper is organized as follows. Section 2 outlines existing competence systems research. Then follows a presentation of the research method. Section 4 describes competence management at Volvo IT including a presentation of the TP/HR system. The next section introduces the recommender system approach, i.e., the VIP system. In section, six discusses the research results and presents our five general design implications for future competence systems. Section seven concludes the paper.

Competence systems research

The concepts of knowledge, expertise, and competence are closely related, and the literature defines both expertise and competence as knowledge applied and enacted in work practice (cf., Allee, 1997). However, there is a difference between the two: Whilst expertise is typically considered an individual aspect, competence is usually discussed on an organizational level. In the KM literature, there are many studies focusing on IT support for both knowledge and expertise (see e.g., Karduck, 1994; McDonald and Ackerman, 1998; Smith and Farquhar, 2000; Stenmark, 2001). Examples of such IT support are expertise profiles applications and personal skill databases (see e.g., Abecker et al., 1999; Becerra-Fernandez, 2000), which are primarily intended to facilitate expertise identification and project configuration in operative daily work.

Mainstream competence systems store descriptions of employees' competencies in

hierarchical competence structures. With the collected competence data as a point of departure, such systems are supposed to support organizations in having the right competence both in the present situation and in the future. In contrast to expertise profiles applications and personal skill databases, competence systems also include a strategic dimension. Therefore, competence systems have features beyond those that exist in expertise profiles applications and personal skill databases. To be able to support competence management in the long-term perspective, competence systems are geared with features that handle, for instance, resource gap analyses, which aim at identifying differences between existing competencies and future competence demands within an organization. For a thorough presentation of competence systems features, see Lindgren and Henfridsson (2002). Apart from our own work, studies that explicitly focus on competence systems are rare. Accordingly, we shall below account for and summarize our previous work on competence systems to provide a background for this paper. In particular, we draw on the idea of interest as a vital component of competence, as introduced in Lindgren et al. (submitted). The final part of this section outlines this paper's main contribution to competence systems research.

Based on a multiple-case study conducted in six user organizations, Lindgren and Henfridsson (2002) examine barriers to competence systems adoption. By outlining a technology review and a user site investigation, the authors relate technical features of the investigated competence systems with the adoption barriers found in organizations. On the basis of the identified adoption barriers, it is argued that the competence systems can be characterized as merely traditional personnel administration systems with features that passively archive formalized competence descriptions. The authors' main argument is that competence systems need to convey a technology spirit more in line with the knowledge work practice found in organizations.

With a field research study of a knowledge-intensive, fast-growing, and dynamic organization as a point of departure, Lindgren et al. (2002) illustrate how evolution, which refers to the process in which organizations and information systems change over time, can result in competence systems failures. Of particular interest to competence systems research, the authors show how organizational changes such as new business models, new subsidiaries, and new competencies affect the adoption and use of IT support for competence management. Based on their research findings, the authors outline suggestions regarding how the evolution process could be managed.

In Lindgren (2002), two of the adoption barriers (group level imprecision and competence direction inattention) presented in Lindgren and Henfridsson (2002) are addressed. More specifically, this paper describes and evaluates the design of Competence Visualizer, which is a competence system generating competence patterns of organizational groups. The developed system provides novel features that support competence analyses of groups in different sizes and identification of employees' interests for competence development. The evaluation results cover fields of application, future design challenges, and organizational issues.

In Lindgren et al. (submitted), which is the starting point for this paper, we investigate competence systems design based on an action-oriented view of competence. We argue that current IT support for competence management is designed with a rationalistic perspective of competence as a basis. While competence systems based on such a rationale may work in job-based organizations, competence management in knowledge-based organizations requires different types of IT support. With these two organization forms as a starting point, we interpret and classify research findings from an action case study of an implemented interest-activated recommender system prototype. The findings illustrate that competence was apprehended as complex and multifaceted. Three views of the relationship between interest and competence were derived: competence as a formalized merit; interest as a complementary aspect of competence; and interest as something that transcends competence. Drawing on the identified categories, we claim that traditional competence systems only handle the formalized view of competence as applied in the job-based

organization. Since organizations tend to be more and more knowledge-intensive and innovative, the importance of the other two perspectives will increase. Therefore, we argue that competence systems need features that detect, visualize, and leverage interests of organizational members.

While our previous paper (Lindgren et al., submitted) suggested interest-activated technology as a new design rationale for competence systems, this paper contributes with design-specific knowledge about how to exploit and develop such technology for competence management. Based on an action case study of Volvo IT's competence system TP/HR and the implemented VIP system, we seek to inform the general design of competence systems that support organizations striving to activate their members' competence.

Research method

The initial focus of our research was to gain in-context understanding of prevailing attitudes towards competence and examine the practical use of the TP/HR system within Volvo IT. However, since one of the authors was employed by the organization under study, there was also a desire to use this understanding to change the way the organization comprehended competence and improve their IT support for competence management. While not explicitly adhering to the grounded theory research methodology as suggested by Glaser and Strauss (1967), we have applied elements that may be traced back to this framework. The main objective, however, has not been to induce theory but to inform design of competence systems. This will be evident in this section, where we account for our research approach.

Action case research

When the researcher's intention not only is to observe, interpret, and understand, which is typically the objective in post-positivistic case study research (Galliers, 1993), but also to intervene in and change the practice under study, the approach can be described as action case research. In action case, the researcher mixes a deep contextual understanding with small-scale intervention and action case research should be seen as a trade-off between being an observer interpreting case study data and a researcher involved in practical change (Braa and Vidgen, 1999). Much design-oriented work on computer systems has applied what can be categorized as "quick-and-dirty" ethnography (Hughes et al., 1994). The drawback with such an approach is that the snapshot captured depicts merely a specific situation, which can be difficult to interpret without knowledge of the larger picture. This paper is a useful contrast since the authors during their 18-month study have been able to observe how the organization became aware of emerging problematic aspects it had not foreseen at the outset. The in-context understanding in our case thus comes from one of the authors being employed by the organization and from the 18-month study of the competence system implementation project conducted by both authors. The change-oriented part lies in our desire to make the organizational members aware of and appreciative of a broader understanding of competence (see Lindgren et al., submitted) and to inform the design of competence systems capable of embracing this new conception. Since introduction of new information systems normally brings about a certain amount of disruption, the VIP application prototype was instrumental in provoking the organizational members to a more explicit sensemaking than otherwise necessary (cf., Zubuff, 1988; Schultze, 2000).

Data collection

The interpretive part of action case research needs data to work with and since the informants' own interpretations are best captured in interviews, this method should be the primary source of such input (Walsham, 1995). However, critical voices have been claiming that interview data is not a suitable foundation for design (cf., Fagrell, 2000). We have therefore in addition to semi-structured interviews collected data also via observations, archival records, and focus groups. Such triangulation requires both time and human resources and besides the two authors, four master students were engaged in the fieldwork that stretched over 18 months. From the project start on June 1, 1999, six months were spent building a shared understanding of competence, discussing how IT could support competence management, and setting the project agenda.

This was achieved through ten seminars or workshops, which included the authors, the master students, and project members from Volvo IT. The following six months were spent on designing, implementing, and evaluating two different systems. The master students were part of the team that prepared and carried out the implementation of the organization-chosen competence system (TP/HR) and they evaluated and studied the use of the prototype system (VIP), which was implemented by one of the authors. By following the development of these two activities closely, we gained a thorough understanding of capabilities and shortcomings of IT support for competence management in an organizational context.

User viewpoints from the TP/HR competence system were collected through 10 semi-structured interviews, which lasted between 45 minutes and one hour, with employees from different parts of the organization. These interviewees were selected to represent different organizational roles and positions and included management consultants, systems programmers, and personnel from the human resource (HR) department. The interviews focused on the topics of work practice, competence, competence development, and IT support for competence management. Key questions on these topics were followed by questions that depended on the answers of the respondents. All interviews were recorded and later transcribed. We also conducted ethnographic observations of the pilot users while entering competence data into the system and performing competence analyses. Besides interviews and observations, an important source of data was archival records and project documentation. This data consisted mainly of strategy plans for competence development within Volvo IT and written material about technical aspects of TP/HR.

The prototype system (VIP), which was meant to contrast the TP/HR system, was an intranet application informed by previous research (see Stenmark, 1999; 2001) and by the tentative research results from the work with TP/HR. We conducted 16 semi-structured interviews with the prototype system users where each interview lasted approximately one hour. The interviewees again occupied different positions within the organization, ranging from non-technicians such as HR staff members, project managers, department managers, and financial controllers to technology watchers and systems programmers. Questions covered topics such as Internet and intranet applications, portals, information seeking, competence, and competence systems. The purpose was primarily to gain knowledge about how interest-activated technology, such as the VIP prototype system, could be exploited as well as developed to support competence management. During these interviews, the respondents were allowed to express and elaborate the aspects that were most relevant from their perspective. However, in order to test the stability in the interviewees' expressions, we encouraged them to reflect upon their assumptions. Again, all the interviews were recorded and transcribed.

The last six months from June to December 2000 were spent compiling, analyzing, verifying, and writing-up the research results. During this phase, we engaged the organizational members in eight focus group meetings. These meetings, where the organizational members offered comments on and corrections to our interpretations, also played a vital part in our analysis efforts, as described next.

Data analysis

The data given by the informants should not be accepted at face value since it only represents their interpretations of the actions in which they are involved. When the researcher then reads the data, it in turn is subjected to the researcher's interpretation of the respondents' words (Walsham, 1995). To transform these second-order data (Van Maanen, 1979) to useful insights is indeed a complex iterative and comparative process that requires the researchers to reflect also on their own theoretical assumptions. The role of theory in interpretive studies may take one of three forms: as an initial guide to the study as such; as part of the data collection and analysis phase; and as a research outcome (Eisenhardt, 1989). The boundaries between these are obviously somewhat fuzzy. Since we did not enter the research field free of theory, this colored our initial approach. Likewise, our mission was not to test hypotheses but to gain knowledge, including theoretical aspects. However, our

primary use of theory has been as part of the iterative process of data collection and analysis, as in Orlikowski's (1993) study of CASE tool adoption. Instead of contrasting two organizations, as in Orlikowski's work, we studied two different systems within the same organization. The initial theories, which were based on our previous work (Lindgren et al., submitted; Lindgren, 2002; Lindgren and Henfridsson, 2002), were applied to the TP/HR system data in an open-minded manner in order not to stifle "potential new issues and avenues of exploration" (Walsham, 1995, p. 76). Typically, this meant that we let the data itself suggest categories and concepts rather than imposing an existing scheme. This approach is similar to the open coding technique used in grounded theory (Strauss and Corbin, 1990). The TP/HR data were re-interpreted, re-coded, and re-categorized in dialogue with the project members until the categories covered all data and made sense to the practitioners. Out of consideration for the tentativeness of the pilot project, we chose to discard feature-related aspects to focus more on generic themes that were more likely to be generalizable. For example, we dropped integration of free-text and formalized competence descriptions and size-limitation of competence analyses since these obviously were system specific. The aspects of TP/HR that surfaced during this process were boiled down to competence mapping, competence evolution, competence input, and competence isolation. These aspects are further explained in the subsection presenting the TP/HR evaluation.

As suggested by Orlikowski (1993), we deliberately left this first round of analysis rather open and broad. When we next turned to the VIP data, we could be more targeted and seek categories more specifically related to systems design. The concepts derived from the TP/HR case were thus compared with and contrasted to those suggested by the VIP data, and as a consequence, the initial categories were revised and refined when it became evident that they the could not hold all data from the VIP prototype. For instance, the TP/HR study did not explicitly indicate a problem with the relationship between espoused theory and theory-in-use, which was evident in the VIP case. Having updated the set of concepts we returned to the TP/HR data to re-analyze. The progress of the data analysis work thus took place on several levels in an iterative and comparative fashion, until the concepts satisfactory explained both cases. The analysis work also included the use of focus groups, as proposed by Agar and MacDonald (1995), to learn how well ratified categories and aspects were by the group as a whole. The foci concentrated on were the concepts suggested by and derived from the data and the outcome of these focus groups resulted in us re-arranging and/or re-labeling some aspects or categories based on the group members' indexing. To give the reader a feel for the two systems and the attitudes of the organizational members, the next two sections present empirically grounded accounts of the systems in use structured according to the tentative analysis results. The final set of design implications resulting from the synthesized analysis of TP/HR and VIP are then discussed in a subsequent section.

Competence management at Volvo IT

Below, we present the Volvo IT site in Gothenburg, Sweden, and their competence management efforts. We focus our description on the TP/HR system and the results from the system evaluation interviews.

The site

This research was carried out from June 1999 to December 2000 at the Gothenburg office of Volvo IT, which is a Swedish IT service providing company within the Volvo Group. The Volvo IT site was selected basically for two reasons: First, Volvo IT was in the process of introducing and establishing more explicitly formulated competence management routines including IT support and did thus provide excellent opportunities for competence systems research. Second, one of the authors was employed at Volvo IT, which facilitated easy access in general and opportunities to intervene by implementing and deploying prototype systems.

Though being an IT company, the legacy from the manufacturing industry was evident. Volvo IT was primarily organized to meet the business requirements from its customers, which at the time mostly meant the other corporate

companies. Furthermore, like many other large and dispersed organizations, Volvo IT had recognized the major problem regarding knowing who knows what. Accordingly, large investments were being made in both organizational arrangements and IT for supporting competence management. Moreover, Volvo IT planned to start offering their services also on the open market, which meant approaching customers outside the Volvo Group and thereby having to compete with external IT service providers. In such a situation, competence management became even more prioritized in order to take control over the internal competence.

At the time of research, Volvo IT had approximately 2,400 employees worldwide, and as many other large organizations with industrial connections it was rather hierarchically organized. A high degree of standardization was hailed as the optimal situation and its centralized mainframe operation, which had received several international awards for high efficiency and cost-effectiveness, was considered something of a role model. In contrast to the highly standardized mainframe environment, Volvo had a large and rather decentralized intranet. The intranet, consisting of over 700 web servers and approximately 750,000 web pages, was characterized by a bottom-up approach. Although less that 10% of the servers where "official", i.e., administrated by the information departments, these servers hosted nearly 25% of the web pages. Volvo IT's highly distributed and decentralized web-publishing policy, which de facto allowed their employees to publish whatever they considered worthwhile, resulted in many semi- or unofficial web servers. Despite this seemingly uncontrolled situation, the contents of these servers were first and foremost work-related and business-oriented.

The TP/HR project

As explained above, Volvo IT needed to initiate a number of activities in order to strengthen their competence management. One such activity was the TP/HR project, initiated in June 1999. This project had two main objectives: First, to identify a competence structure for Volvo IT that could serve as a foundation for the mapping of employees' competencies. Second, to implement the identified competence structure in the TP/HR system and to define a maintenance organization that on a regular basis keeps the TP/HR's structure updated and relevant. Although the first part turned out to be more complicated than Volvo IT had anticipated and in itself worth further research, we have in this paper focused on the TP/HR system and the process of maintaining it.

The TP/HR system

TP/HR was a commercial off-the-shelf module-based client/server system developed by Tieto Datema AB in Sweden. Running on a Windows 98/NT platform, TP/HR served as an interface between the user and an Oracle database server. This paper's focus is on the Education/Competence module and when we hereafter refer to TP/HR we mean this module only. The TP/HR system was implemented in February 2000 through a top down strategy where the competence structure was defined by management alone. Furthermore, managers were also responsible for the input of the employees' competence data. Volvo IT's organizational structure can be described as hierarchical and this was reflected in TP/HR's closed system structure. While managers were authorized to see competence information about all their subordinates, employees in other positions could only see their own competence descriptions.

In Volvo IT's implementation of TP/HR, competence was divided into functional and technical skills. Functional skills referred to the work tasks an employee performs, e.g., Application/Infrastructure Development or Support, and measured how well the employee carried out the task. Technical skills were about the methods or techniques required by the work tasks, e.g., Programming Languages/Tools or Data Management. What Volvo IT called technical skill was thus what we normally would refer to as competence. The functional and technical skill categories, in turn, had their sub-levels and all this was grouped and ordered in a tree structure, as illustrated in Figure 1.

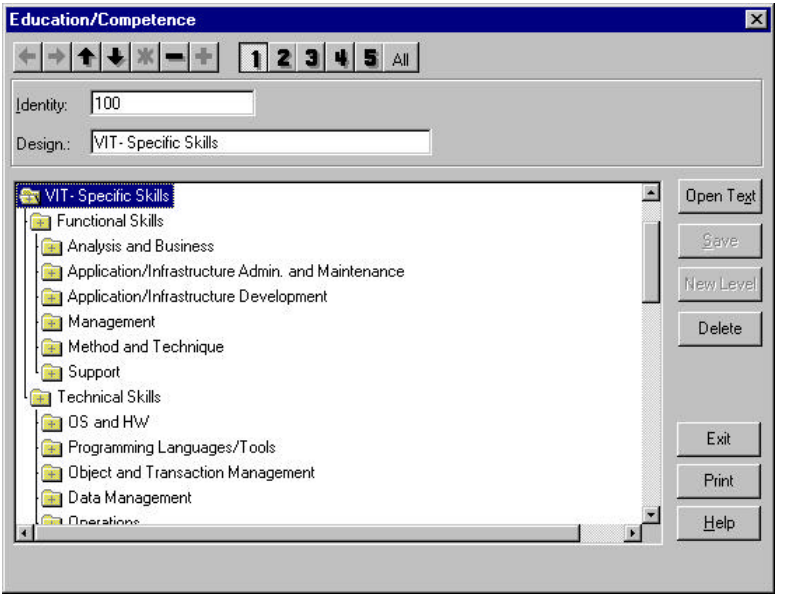

Figure 1: Portion of the competence tree structure in TP/HR

Volvo IT implemented five levels of competence grading ranging from 1 (no competence) to 5 (expert competence). The search feature in TP/HR made it possible for management to search for employees holding a particular competence on a certain level, e.g., a java programmer on level 3 or above. Further, there were features for measuring employees' competencies status and for competence gap analyses. The gap analyses were based on either an individual, a group of individuals, or a work task, and these analyses indicated the differences between existing and wanted competencies. If there is a difference between the existing situation and the future demand for a specific competence, there is said to exist a competence gap. More specifically, there were two types of gap analyses: Group analysis 1 showed how well the employees' competencies matched the given competence demands for each work task. Group analysis 2 indicated how critical competencies related to specific work tasks were distributed within a certain group. Volvo IT planned to use these analyses as a support for organizational activities such as resource and availability planning, internal and external recruiting, goal and personal development discussions, forming teams of employees, finding competence when manning assignments, and mission steering. Consequently, the TP/HR system was assumed to support Volvo IT in managing their competence in both a short and a long perspective.

Evaluation of the TP/HR system

In the previous subsection, we described technical data, features, and organizational aspects of the TP/HR system. Below, we report the four problematic aspects of TP/HR that emerged during the first round of analysis. These aspects are illustrated by quotations from the evaluation interviews.

Competence mapping

Volvo IT tried to implement a competence structure that was common to and accepted by the entire organization. To produce such a map, however, turned out to be a non-trivial task and required much more work and consideration than the project team had anticipated. A management consultant phrased:

"*We have competencies ranging from this more technical, like infrastructure and hardware, to soft systems developers such as management consultants and stuff like that. Consequently, it*

is a wide spectrum of competencies that we have within the organization. The difficult part is that some claim that their way of representing the competencies is the best. They claim they are so unique that they have to have this structure and these groups. Actually, it is not possible to do it differently."

Volvo IT's heterogeneous activity was difficult to map to a single competence structure since different parts of the organization had varying demands on what competencies should constitute the structure.

Competence evolution

Even if a competence structure could be agreed upon, it would not remain correct for long. The pace with which old competencies changed and new emerged made the mapping process even more difficult. A management consultant articulated this:

"*Earlier it was easier since there were few programming languages. Now the development is so fast. Yes, there are the fourth, fifth, and sixth generation. And individuals change as well; their competencies change over time. Things that people do today and did yesterday do not necessarily represent their aspirations for tomorrow.*"

Apart from alterations in the variety of competence within the organization that affected the structure per se, competencies and interests changed on an individual level as well. In order to cope with this evolution, Volvo IT established a maintenance organization for this purpose, but keeping the competence structure and the competence data up to date remained a burdensome task. In fact, the map always tended to be behind the reality.

Competence input

A system is never better than its content and this content has to be provided by someone. One HR manager touched upon the producer/consumer dilemma when discussing input of competence data to the TP/HR system:

"*TP/HR is a tool for management in order to keep track of the employees. But, there has to be a motivating factor for the employees to participate and express their competencies. They should not feel that they are merely parts of a passive register. In some way you have to be motivated to expose your competencies. Otherwise it is difficult to make this system work*."

TP/HR was primarily designed to support management in activities such as recruiting, resource planning, and project steering. The individual employees, presumed to regularly provide accurate information about their competencies, did not get much in return and hence had no incentive for participation.

Competence isolation

In addition to the fact that the TP/HR system was fundamentally designed to serve management, the system was constructed in a way that counteracted the employees' commitment to the system. A management consultant commented:

"*TP/HR is hierarchically structured and closed. As an individual, you can see nobody but yourself. If I search for a certain competence, the system should support me in identifying the appropriate person. Such features are missing in the system. Instead, I have to talk to someone who is familiar with the employees' competencies. In any case, I can't use the TP/HR system for doing it myself*."

Organizational position determines how an employee can use the TP/HR system. Managers were authorized to see every subordinate's competence description, while organizational members in other positions could only see their own descriptions. Consequently, these employees could not use TP/HR in order to find people with a specific competence.

When Volvo IT decided to implement the TP/HR system they did not foresee the problematic aspects above described. Instead, these emerged during the system implementation and while evaluating the system. Based on the troublesome work with creating a competence structure and keeping the structure relevant and updated in combination with the problems regarding competence data input and lack of commitment among the employees, the organization realized the potential danger of the TP/HR system becoming an archive that would passively store increasingly inaccurate competence descriptions. This insight offered an opportunity for our research team to introduce and evaluate

a technology, which, by being based on interest-driven actions instead of formalized representations, contrasted the basic tenet of TP/HR.

The recommender system approach

The rationale behind recommender systems (RS) (Resnick and Varian, 1997) has been the fact that we in everyday life often rely on others with more experience to provide us with recommendations. Such collaborative filtering (Goldberg et al., 1992) based on the "word-of-mouth" (Shardanand and Maes, 1995) is spontaneously performed by humans in order to hint friends and colleagues about what is believed to be things of interest. The aim of early RS was thus to augment this social process by aggregating recommendations from more people that you would normally interact with, thereby increasing domain knowledge and minimizing bias. The focus on connecting people with objects, e.g., books, films, music, or web pages, which characterized early work, has continued to dominate also in more recent group-related research (cf., Grasso et al., 1999). The incentive-related problem faced by the early developers (i.e., we like to receive recommendations, but why would we provide any) has been solved in part by using implicit recommendations. In such an approach, rating is obtained by methods other than obtaining it directly from the user (Oard and Kim, 1998; Claypool et al., 2000) and one alternative could be to engage personalized agents to perform the recommendations.

The fact that people share a certain taste or interest has not explicitly been used by RS to connect the users with each other. Two people, perhaps even in close proximity to each other, may be working with the same problem without being aware of each other and without knowing that they are reading the same literature. However, when both these individuals are using the same recommender system, it is possible to automatically detect similarities between the two as represented by their agents or profiles and introduce these to each other (Foner, 1996; Stenmark, 1999). In line with this reasoning, RS have recently been employed to locate and leverage expertise within organizations (McDonald and Ackerman, 2000) and to find and communicate unarticulated knowledge (Stenmark, 2001). In the latter case, the incentive problem of providing knowledge explicitly is addressed by utilizing the spin-offs from recommending web documents. Armed with this knowledge and tentative indications from the TP/HR evaluation, the VIP system prototype was implemented and presented as a contrasting competence system.

The VIP prototype

VIP was an agent-based recommender system built on Autonomy's AgentWare platform (Autonomy, 2000), which is a commercially available tool that uses neural networks and advanced pattern-matching techniques to find similarities between texts. The AgentWare toolkit provides the developer with a Dynamic Reasoning Engine (DRE), which is the proprietary neural network "black box" and a set of Application Programming Interfaces (APIs). On top of this, the developer is free to code the application and the user interfaces as wanted and to include or leave out whatever features he or she decides upon.

In our implementation, VIP allowed the users to define information agents that searched an index database for intranet documents matching the users' interests. Each user could define several agents targeted on a particular interest area. The interests were defined in a free-text natural language sentence from which the system created an internal digital representation. The search results from each agent were displayed in a simple list similar to those generated by most search engines, and by clicking on the associated hyperlinks the actual documents were retrieved. When the user had read and identified one or more of the returned documents as indeed relevant, the user could provide the agent with explicit feedback by marking the document(s) and clicking the retrain button. The digital signature of the agent was then merged with the signature(s) of the selected document(s) and the result became the new signature, replacing the previous one. From a user's point of view, the motive for using a recommender system is to receive relevant and targeted information as effortless as possible. It is therefore in the users' own interest to set up and cultivate their agents to be as good as possible.

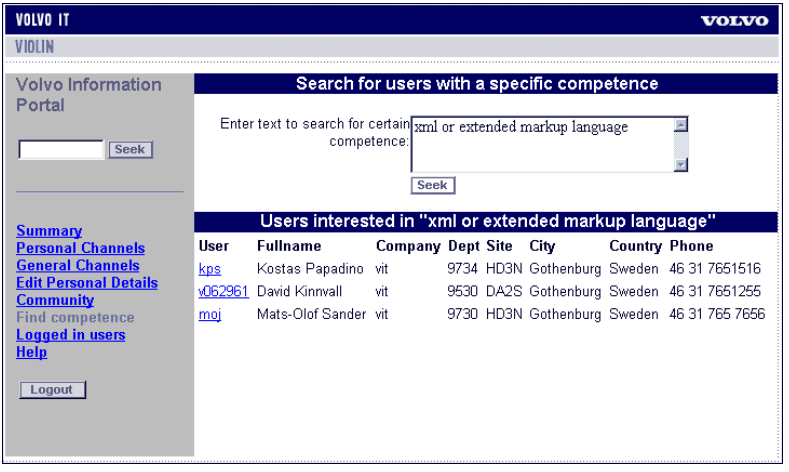

Figure 2: Output from the Find Competence feature.

In compliance with an earlier version of the system (cf., Stenmark, 2001), we designed the VIP system to include a Community feature, i.e., Find Users with a Similar Interest, which was intended to enable users to locate colleagues with similar information needs or interests. When invoking this feature, the profiles of the user's agents were matched with the profiles of all other agents resulting in a list of users who had defined a similar interest. This list displayed the name, company, department, geographical location, telephone number, and email address of the matching users. The intention was to make the users aware of each other's presence and thus facilitate the emergence of informal networks and online communities.

So far, this has all been standard RS procedure. Our research interest is, however, not in recommender systems per se. We simply find RS to be a useful vehicle to study phenomena related to knowledge applied and enacted in work practice (Stenmark, 2001). In addition to the traditional RS features described above, we therefore furnished the VIP prototype with a Find competence button. This feature, illustrated in Figure 2 above, enabled the VIP users to enter a natural-language text describing a specific interest. VIP would then list all users with matching agents, i.e., all users who had agents actively searching for information related to the specified interest. Whereas the Community feature returned the names of those who shared your interest, the Find Competence feature could be used to find a person with an arbitrary interest. To label this feature Find Competence was a deliberate provocation intended to cause the organizational members to reflect. In contrast to general competence systems such as TP/HR, which rely on in beforehand-codified database records of formal competence, the VIP prototype based its results entirely on interest-driven and dynamically detected actions of organizational members.

Evaluation of the VIP system

When interviewed about how they used the VIP system prototype, the respondents discussed their experiences either in terms of existing usage areas or as thoughts regarding possible future enhancements of the system. Below, we shall report our findings grouped according to these categories.

Existing VIP usage areas

Some of the interviewees were aware of or even acquainted with the TP/HR system and often used this circumstance to describe the contrast between the two systems. Some users meant that while TP/HR presents a rear-mirror view of competence, VIP gives an idea of competencies applied on an everyday basis, as the features Find Users with a Similar Interest and Find Competence were based on employees' actions in form of information seeking. The following HR staff member discussed VIP as a tool to find organizational members not based on the formal representation of their competence but on their actions:

"*TP/HR is a lot more about order and to be in control of the situation. And to know what we have and the level of education of our co-workers; how many of these and how many of those. Then this [VIP system] is something else. It's what people do on an everyday basis. It's about for what they use their skills. It's sort of the next step*."

The VIP system, by reflecting implicit roles, could also contribute to the creation of networks or communities of practice within the organization. The respondents considered the building of such informal networks important since they are a prerequisite for cooperation. However, the organizational members' ability to actually be able to do this, according to this project manager, is incorrectly taken for granted:

"*[The Find Users with Similar Interest feature] is very interesting. I see this as a very useful feature; as an enabler for building [human] networks. It is interesting to be able to find colleagues who are interested in the same things. Because our main problem here is that there are people working with similar things everywhere and you don't really find them. When we started the project manager group we thought that since [human] networks have existed since the dawn of times, there must be a whole bunch of people who know how to build them. But, it turned out that there were not*"

This project manager saw how the VIP system could function as a community enabler, and other respondents shared this view. Moreover, there were also interviewees who pointed to VIP's potential as a strategic tool. For instance, one project manager expressed it as follows:

"*If you can utilize people's interests and put that into action in their work, you gain momentum […]. Should you start a new job function and you don't know if anybody in the organization is interested in working with this, then it might be interesting [to use the Find Competence feature]. Because you don't walk around asking all 400-500 managers if they have someone who would be interested in working with this*."

With the results from the Find Competence feature as a point of departure, the above interviewee saw the VIP system as a useful tool when planning the application of the organization's competencies. In addition, one technology watcher highlighted the possibility to use VIP to visualize the development of different competencies over time:

"*The most powerful thing I see is a mapping opportunity. If one could use this tool there is a possibility to map out what is currently happening and to get a quick feeling for where people are heading and what they want. And where they have been, obviously, but that is easy. It is the future that is the tricky part.*"

Alongside facilitating analyses of existing and emerging competencies, the respondents also envisioned VIP as a tool for detecting competence gaps.

Possible future VIP enhancements

Regarding how the VIP system's design could be improved in relation to competence management, the interviewees discussed several areas related to both managerial and non-managerial activities. The two features Find Users with a Similar Interest and Find Competence offered organizational members the possibility to find out more about other individuals within the organization, e.g., name, organizational belonging, position, and telephone number. Several respondents expressed desire for more detailed information than was currently offered in VIP:

"*[In VIP] there are only email addresses. Most of the employees have some form of personal presentations on the intranet. So, had there been links to those pages one could have seen what these persons had created on the intranet. It could be a photo, where they can be found, and what areas they work with. Or information that they have authored*."

Access to a deeper level of personal information is important since the establishment of new contacts depends heavily on trust and compatibility, as this department manager pointed out. More personal data, be it adding a photograph, a link to a homepage, or information about current and previous assignments, can be a means to facilitate cooperation that cut across traditional organizational lines, according to the department manager. A systems programmer suggested an additional way:

"*I am not able to access the [results from someone else's] agent. The fact that [this person is returned by the Community feature] indicates that she has the same interests as me, but the question is how to take this one step further so that this [VIP system] can turn into a forum where individuals share their interests, too. Not just that their search results has a point in common*."

Making it possible for individuals to see the results of other organizational members' agents would support the employees in competence identification, this respondent argued. Besides accessible agents and deeper level of personal information, links pointing to formal competence descriptions was a desired feature. Since VIP handles unstructured information and does not distinguish between different levels of competence, the drawback is that the users must be able to read between the lines and draw their own conclusions about individuals' competencies. A different but related problem is that an employee who has not defined an agent within his or her area of competence cannot be identified as competent in that area. An HR staff member explained:

"I may need information on something I am interested in, but my competence is recruiting and people want to find me for that reason. But, I do not express recruiting competence in this system [by training an agent]. So, there can be a gap [between my agents and my competence]. You can end up finding people who are only interested and not competent. Often, interest indicates competence, but not always."

While the discussion so far has concentrated on enhancements related to non-managerial activities, the following deals with how to support management work. The information in VIP is not compiled or aggregated, which makes it difficult to spot organizational trends. One user said:

"*I can see other people's agents and find things out, but I would like to have a picture of the number of users searching within a particular area. [It would be useful] to get a map of how many looks for a certain topic, not who looks for what.*"

If information could be aggregated more automatically, it would be easier to plot the overall direction of changing interests. Such a comparison would give management a quick and flexible overview of the organization's status, this technology watcher claimed. Other respondents had similar ideas regarding this type of aggregated information-based analyses:

"*Information that would be interesting to find here is some kind of analysis of the persons' agents within an area. If you have two different agents in the same area, then you're really interested. How many [agents you have] and even things like how much time you have spent building your agent, how often it is updated, and that kind of information, is really very interesting*."

A compiled and aggregated picture of the number of agents searching a certain area and how frequently they are updated would show, according to this interviewee, how different groups of individuals use their competence in practice. Furthermore, the users saw the lack of historic data in VIP as a problem. A technology watcher discussed this:

"*The drawback of these agents is that they lose their historic information since they keep changing all the time. Therefore, you would like to take snapshots of the competence development. Historic information is always interesting to get the direction. Because you know for a fact that a certain interest group has a certain appearance right now, but four years later it has changed and you want to be able to see that there has been some development*."

According to this technology watcher, management would need information about the organization's past as well as present competence status, and therefore features to store and handle historic information are important.

Discussion

Today's organizations have a need for quick overall pictures of the present situation as well as to be able to detect trends and directions with regard to changes of the organizational members' competence. Although this particular study has focused on how Volvo IT decided to implement the TP/HR system in order to be able to conduct this type of competence analyses, the problematic aspects that arose are in no way unique to Volvo. We have noticed identical

difficulties, i.e., competence mapping, competence evolution, competence input, and competence isolation, in other Swedish organizations (cf., Lindgren and Henfridsson, 2002). This, we argue, increases the generality of our findings.

In this paper, we have illustrated how the VIP prototype contrasts the TP/HR system in two fundamental ways. Firstly, we have shown how traditional competence systems such as TP/HR describe competencies according to predefined categories. The advantage, once the competence structure has been established, is that it is easy to search for members with a specific competence. The problem, however, is that such a structure can never fully be implemented since it describes a changing world. New competencies emerge, old ones disappear, and individuals change and develop their competencies more frequently than the system is updated. Our experience from this 18-month study is that maintenance of traditional competence systems is very laborious and consequently done very infrequently, which de facto makes TP/HR a "static" system with more of a historic view of the competencies. What people did yesterday do not necessarily express their ambitions for today or tomorrow (cf., McDonald and Ackerman, 1998). Consequently, TP/HR, at best, provides limited support for competence identification. One of the advantages with the interest and action based approach is that the organization can begin to find competencies as soon as they start to emerge. This is particularly important today, when complex and non-routine issues emerging from rapidly changing environments require the application of knowledge and competence that is not known by a single individual (cf., Tsoukas, 1996).

Secondly, we have also shown that a bottom-up approach to competence mapping, which starts with the actions of individual organizational members, can be used as alternative to a predefined top-down categorization. Although we stress the importance of the commitment of the individuals, the VIP approach does not depend on any particular individual. In contrast to a system such as TP/HR, which has to be maintained by some administrator, a recommender system approach is built up by the efforts of all organizational members collectively. On the one hand, the focus of some researchers, e.g., members of the CSCW community, has largely been on the individual and small group level. Consequently, the results may be difficult to apply on or to scale up to an organizational level (cf., Greif, 1998). Researchers within the IS field, on the other hand, discuss theories and applications from an organizational point of view, but tend to neglect or marginalize that organizations consist of individuals and that success on the organizational level often requires commitment on the grass-root level. In this research, we have combined these two approaches by studying individuals and small groups to gather insights that have enabled us to draw organizational implications in relation to the design and use of competence systems for tomorrow.

As we show elsewhere, interest makes a plausible substitute for competence, especially so for competencies of tomorrow (Lindgren et al., submitted). In this paper, we have therefore inquired into the consequences of such a view and examined how a system based on these premises can be exploited and developed. However, we do not advocate a total abolishment of traditional competence systems since, as is evident from our analysis, there are certain aspects worth preserving. Instead, based on lessons learned from both traditional and action-driven competence systems, we offer five design implications for future competence systems based on interest-activated technology.

Implication 1: Search for action-based competence.

Competence management systems of the future should include features for locating people based on what actions they perform on the network. This could include actions such as creating, annotating, accessing, printing, bookmarking, or searching for documents and web pages, sending, printing, or replying to emails, querying databases, or participating in chat forums or discussion groups. Competence systems on the market today merely store formal descriptions of what work tasks or roles the employees have been assigned by the organization, while jobs often require us to act outside such pre-established definitions (Stenmark, 2001). An action-based system has

the potential to reflect the role an employee has de facto assumed. In a project organization, employees' work tasks or roles often vary from one project to another, again making it difficult to keep an explicit record up to date.

Implication 2: Awareness of communities of interests.

Tomorrow's competence systems should support the establishing of informal networks. Relying on the same mechanisms as above, this design feature is not intended to locate experts or possible project members, but to make individuals with similar interests aware of each other. Facilitating communities of practice by allowing users to find colleagues with similar roles and interests in turn supports sharing of competence between individuals (cf., Brown, 1998). These kinds of organizational activities are not supported by today's competence systems, where employees in non-managerial positions typically only can see their own competence descriptions (cf., Lindgren and Henfridsson, 2002). However, though awareness is a necessary condition for social networking, awareness alone is not sufficient. It seems that a certain threshold has to be reached before a person goes from being aware of another individual to actually contacting him or her.

Implication 3: Deeper level of personal information.

It is important for the next generation competence systems to include personal details about the employees, and to let these data be accessible to everyone in the organization. As was indicated in the interviews, the threshold discussed above will not seem quite as high if more knowledge about the person in question is available. A deeper level of personal information would increase the sense of familiarity and thereby make it easier for organizational members to contact each other for information exchange, competence sharing, and building of communities (cf., Davenport and Prusak, 1998). Another important aspect would be to make available more information about the signaling artifacts themselves. By making details such as the updating or visiting frequency available, the users would be able to derive the owners' level of engagement.

Implication 4: Formal descriptions of competence.

Competence systems should pair the dynamic information and the personal details advocated above with links to historical records and formal descriptions of achievements and competencies. As pointed out by McDonald and Ackerman (1998), most recommender systems do not distinguish between different levels of knowledge, which makes it impossible to tell an expert from a novice. An action-driven competence system would thus benefit from including also more formal competence descriptions, e.g., a CV. Such information would not only help eliminate possible misunderstandings and enhance the perception of an individual's background, but also provide the historical coupling that is otherwise missing in ephemeral systems. An alternative approach touched upon above would be to make salient the duration of a user's interests, thereby indicating whether or not the user is new within the field.

Implication 5: Aggregation of competence data.

Future competence systems should be able to aggregate and visualize the competence information known to the system. Today's competence management systems are primarily designed for managerial purposes. Hence, the systems incorporate a variety of features for competence analyses, facilitating organizational activities such as recruiting, resource planning, and mission steering. To be of strategic value, action-based systems must also have these abilities, and there are ways to achieve this. For example, by analyzing the employees' information-seeking activities, management can become aware of which competence areas attract the attention of the organization's members at a specific moment in time. By saving such "snapshots" at regular intervals, it would be possible to take a bearing on the direction of different competence groups within the organization. The difficulty is that the information now has to be compiled and aggregated manually. Mechanisms should therefore be provided to retrieve, aggregate, and visualize this information automatically. This process would give management a tool for a quick and flexible overview of the organization's status and direction. Such features would help facilitate continuous

competence development in order to avoid competence traps (cf., Levitt and March, 1988). Aggregation of interest profiles not only increases the strategic value of the information, but also helps preserve integrity by de-individualizing the information.

Conclusions

Through our 18-month action case study, we have been able to identify four seemingly general problematic aspects of traditional competence systems (competence mapping, competence evolution, competence input, and competence isolation). These difficulties stem from the fact that the systems available on the market are de facto competence silos, which passively store competencies rather than activating them. Although our prototype system was far from perfect, it served its purpose to illustrate that such technology is useful within the area of competence management. Building on the lessons learned with both the TP/HR system and VIP, we conclude that future competence systems based on interest-activated technology should provide features to facilitate:

- Search for action-based competence.
- Awareness of communities of interests.
- Deeper level of personal information.
- Formal descriptions of competence.
- Aggregation of competence data.

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