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DESIGN PRINCIPLES FOR COMPETENCE MANAGEMENT SYSTEMS: A SYNTHESIS OF AN ACTION RESEARCH STUDY[1]

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Abstract

Even though the literature on competence in organizations recognizes the need to align organization level core competence with individual level job competence, it does not consider the role of information technology in managing competence across the macro and micro levels. To address this shortcoming, we embarked on an action research study that develops and tests design principles for competence management systems. This research develops an integrative model of competence that not only outlines the interaction between organizational and individual level competence and the role of technology in this process, but also incorporates a typology of competence (competence-in-stock, competence-in-use, and competence-in-the-making). Six Swedish organizations participated in our research project, which took 30 months and consisted of two action research cycles involving numerous data collection strategies and interventions such as prototypes. In addition to developing a set of design principles and considering their implications for both research and practice, this article includes a self-assessment of the study by evaluating it according to the criteria for canonical action research.

Keywords: Canonical action research, competence management systems, core competence, design principles, HR management, prototypes, skill-based approach

[1]Michael Myers was the accepting senior editor for this paper.

Introduction

The concept of core competence advanced by Prahalad and Hamel (1990) has not only re-oriented the field of strategic management toward a focus on organizational processes and structures that produce competitive advantage, but has also prompted many organizations throughout the world including those in the United Kingdom and the United States to identify and develop their own core competencies (Scarbrough 1998). Core competencies are defined as the collective knowledge and capabilities that are embedded in the organization; they are central determinants of the organization's competitiveness due to their centrality to customer value, their resistance to imitation and their ability to extend to new business applications (Hamel and Prahalad 1994). The core competence perspective of strategic management reflects the resource-based view of the organization (von Krogh and Roos 1995), which argues that an organization's competitive advantage derives from the valuable, rare, and inimitable resources that it can marshal (Barney 1991). With its focus on organizational knowledge as a key strategic resource, the resource-based view in general, and the core competence perspective in particular, is well-suited to strategy formulation and management in knowledge-intensive organizations (Conner and Prahalad 1996).

Competence management involves the specification of an organization's competence needs, the identification of competence gaps (between needed and actual competence), competence sourcing, competence development through training and coaching, and the staffing of projects (Baladi 1999). While determining the organization's extant and desired core competencies is generally part of strategic management's macro focus (Simpson 2002), managing those competencies at an operational level is usually the responsibility of human resources (HR) management (Bergenhenegouwen et al. 1996). The HR discipline typically concerns itself with the concept of job competence at the level of the individual, i.e., the micro level (Nordhaug 1998; Simpson 2002). Job competence is defined as possessing skills that are critical for the individual to master if he/she is to achieve high performance in the completion of a task (Boyatzis 1982).

Given the recognition that organizational core competence is dependent on and inextricably intertwined with individuals' job competence, there has been considerable effort in the literature to bridge the macro and micro levels of analysis (e.g., Muffatto 1998; Nordhaug 1998; Rothwell and Lindholm 1999; Simpson 2002). These efforts point out that HR systems (processes, policies, and technologies) need to be aligned with the organization's strategy (Hagan 1996). Lado and Wilson (1994) explicitly highlight the possibility that HR systems can damage the organization's competitive advantage by inhibiting the mobilization of new or the exploitation of existing competencies. For instance, HR systems designed to achieve goals such as stability, predictability, and efficiency, which are typically associated with bureaucratic modes of organizing, are likely to generate core rigidities (Leonard-Barton 1992) and unmotivated employees (Morgan 1986).

Despite this prior research on the danger of misaligned HR systems, there appear to be no studies on competence management technologies, that is, information systems specifically designed to help organizations manage competence, both at the individual and organizational level. Given the importance of information technology (IT) in providing a common platform for competence management in such organizations (Alavi and Leidner 2001; Andreu and Ciborra 1996; Davenport and Prusak 1998), we regard this lack of research a considerable shortcoming, especially in light of the strategic role that knowledge and competence play in knowledge-intensive organizations (Alvesson 1993; Starbuck 1992). The research we present here is intended to address this shortcoming by studying competence management systems (CMS) with the purpose of developing and testing design principles that render these systems supportive of knowledge-intensive organizations that are embracing a core competence approach.

Design is central to the information systems discipline (Hevner et al. 2004; Markus et al. 2002),

and the action research method, with its iterative hypothesis development and testing, is particularly appropriate for the development of system design principles (Walls et al. 1992). Thus, we conducted a 30-month action research study, which consisted of two cycles with the following phases: diagnosing, action planning, action taking, evaluating, and specifying learning (Susman and Evered 1978). The study involved six Swedish organizations that also partially funded our project. The remaining financial support came from VINNOVA.[2]

Due to the long duration of the research and the conditions of our funding, we published insights and intermediate results at various stages of the project so as to secure ongoing financial support. These publications reported on CMS implementation failures (Lindgren and Henfridsson 2002), CMS design assumptions (Lindgren et al. 2003), and CMS design principles (Lindgren and Stenmark 2002). The research contribution we offer here goes beyond these earlier publications in that our analysis considers the 30-month action research project in its entirety. We develop an integrative model of competence, a competence typology, and consider the unanticipated consequences of our design principles for the first time. We thus synthesize all the steps in our study and, based on the lessons learned, refine our initial design principles.

The paper proceeds as follows. First, we review the literature on competence and develop a model that integrates macro and micro level definitions of competence and incorporates a typology of competence. This is followed by a method section that describes action research in general, the criteria by which it should be evaluated, and details about our particular action research project. Then, we present our two action research cycles. In our discussion of the research findings, we highlight both the anticipated and unanticipated consequences of our interventions. We conclude with not only a set of revised design principles, but also an assessment of our research vis-à-vis the criteria for evaluating canonical action research.

Competence in Organizations ■

The literature on competence in organizations appears to be divided along disciplinary lines. The strategy literature focuses on the macro or organizational level of analysis and concerns itself with the notion of core competence as a means of generating competitive advantage (Prahalad and Hamel 1990). According to Lado and Wilson (1994, p. 702), core competencies

> include all firm-specific assets, knowledge, skills, and capabilities embedded in the organization's structure, technology, processes and interpersonal (and intergroup) relationships.

Thus, at the organizational level, structural features such as culture (Barney 1986), routines (Nelson and Winter 1982), and learning (Hamel and Prahalad 1994) are sources of a firm's core competence, and hence, its competitive advantage.

In contrast, the HR literature focuses more on the micro or individual level of analysis and views competence as "an underlying characteristic of a person, which results in effective and/or superior performance in a job" (Boyatzis 1982). The personal characteristics that facilitate high performance (and that are therefore part of individual competence) include motivation, disposition, self-image, values, moral standards, norms of social behavior, and traits, as well as communication, general reasoning, and learning capabilities (Bergenhenegouwen et al. 1996; Rothwell and Lindholm 1999).

Given the recognition that macro level competencies are highly dependent on and largely embedded in an organization's human resources (Scarbrough 1998), that is, individual members of the organization, there are considerable efforts to

[2]Swedish Agency for Innovation Systems, integrates research and development in technology, transport and working life. VINNOVA's mission is to promote sustainable growth by financing R&D and developing effective innovation systems. For more information, go to http://www.vinnova.se/.

integrate these two perspectives on organizational competence through the development of taxonomies and theoretical frameworks (e.g., Muffatto 1998; Nordhaug 1998; Rothwell and Lindholm 1999; Simpson 2002). Indeed, competence-based theories of the firm have been developed (Sanchez and Heene 1997; von Krogh and Roos 1995).

A number of these integration efforts highlight the need for alignment between the organization's strategic orientation and the assumptions underlying its HR practices (Bergenhenegouwen et al. 1996; Lado and Wilson 1994). Hagan (1996) suggests that an organization's adoption of a core competence perspective will require shifts in job and reward system design, as well as in staffing and training practices. For instance, in a core competence organization, more work is done in project teams and individuals move around the organization to complete different assignments. In addition to challenging the individual employee by demanding more effort, flexibility, and motivation in such a competence-based organization (Bergenhenegowen et al. 1996), these changes in job design challenge the value of job descriptions and HR practices such as hiring and training that are based on assumptions of more stable jobs and individually-assigned tasks (Lawler 1994).

Lawler and Ledford (1992) distinguish between job-based and skill-based approaches to HR management, and argue that HR departments need to adopt a skill-based approach in order to support their organizations' development of core competencies. They highlight that the traditional, job-based approach develops job descriptions and then tries to find and shape individuals to fit them. They contend that this paradigm is problematic in contemporary organizations because job descriptions are generally based on how the organization has operated in the past, with little or no appreciation for its future needs. Furthermore, the job-based approach fails to take into account individuals' abilities to contribute to the organization's success beyond the boundaries of their job. By incentivizing and evaluating employees within their job description boundaries, capabilities such as learning, flexibility, communication, collaboration, and innovation across organizational boundaries, all crucial in an organization that seeks competitive advantage through core competencies, are generally neither acknowledged nor developed in the job paradigm.

In contrast, the skill-based approach to HR management focuses on the individual and his/her ability to contribute to the organization's core competence and competitive advantage (Lawler 1994). Instead of relying on job descriptions, a skill-based approach relies on person descriptions, which identify the skills and behaviors that an individual needs to be effective in a particular work area. With its emphasis on competence, the skill paradigm focuses more on behavior than on tasks and processes. The skill-based approach is particularly effective in situations requiring knowledge and/or team work, as both imply a relatively high degree of self-management and the individual worker's ability to add unique value to products and services. Furthermore, skill-based remuneration systems reward employees for learning and flexibility, and for developing skills that allow them to complete multiple tasks.

Lawler and Ledford identify a number of challenges that face organizations wishing to manage competencies. Shifting from a job-based orientation to a skill-based one requires significant change in the physical (e.g., systems and practices) and conceptual (e.g., assumptions and beliefs) infrastructure of HR departments. For instance, the selection of individuals for organizational membership rather than for a particular job is relatively foreign to organizations that have traditionally operated in a top-down, planned manner rather than an emergent one. Furthermore, organizations will need to invest in new technology that supports a skill paradigm (Lawler and Ledford 1992).

Having highlighted the need for alignment among the structural features of organizational competence, especially between the organization's strategic orientation and its HR infrastructure, we now turn our attention to individual-level competence and its development. Individual competencies are skills that are critical for individuals to master if they are to achieve high performance in

the completion of a task (Boyatzis 1982). Even though knowledge is central to individual competence (von Krogh and Roos 1995), the concept of competence couples practice (Bassellier et al. 2003) and action (Muffatto 1998) with this knowledge component. Furthermore, Sandberg (2000) highlights that workers' own conception of the work is central to our understanding of competence.

Emphasizing that competence is the enactment of knowledge, Muffatto (1998) suggests that competence is an ongoing accomplishment (also see Orlikowski 2002). It is not an object that either an individual or an organization owns, but rather a continuous process of production and reproduction (Scarbrough 1998). In this ongoing process, competence plays a dualistic role, serving both as input to and output of competent action. Kim's (1993) model of learning is helpful in identifying the various components of the competence development process at the level of the individual. Kim's model is made up of two parts: (1) a dynamic learning cycle consisting of the phases of experiential learning (Kolb 1984), i.e., experience, reflection, abstraction and testing, and (2) memory, a stock of conceptual frameworks and operational routines. Memory is both the source and the destination of the learning process.

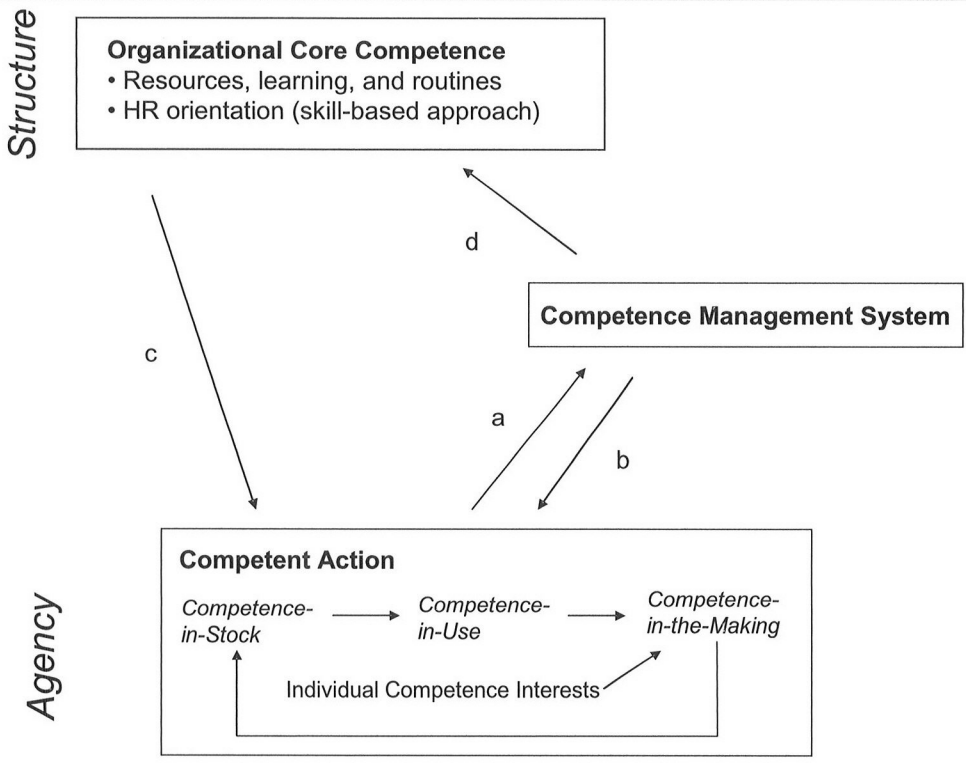
Viewing competence as ongoing accomplishment and applying Kim's model of learning to competence development, we can distinguish between different types of competence. In order to act competently, individuals rely on their stock of competence, which is derived from past actions accumulated over time. However, as with the use of knowledge (Stehr 1994), the use of extant competence is not a mere transfer from stock to a specific situation or action context. Instead, applying stored competence implies a process of re-creation that transforms the competence taken from stock. As such, the previously accumulated stock of competence is distinct from competence-in-use.

Taking a life-cycle perspective of competence, the literature not only suggests a past (*competence-in-stock*) and a present (*competence-in-use*) stage of competence, but also a future stage. For instance, Lawler and Ledford emphasize that "a critical element in an individual developing along a career track is the individual's desire, interest, and learning capability" (p. 386). This suggests that, in addition to developing competence merely through the reproduction of past competencies in a situated context, individuals are also purposive in their competence development, motivated either by their own competence interests or organizational competence needs. We label this form of competence *competence-in-the-making*.

Informed by the literature reviewed thus far and by Giddens' (1984) structuration theory as a way of integrating the mutually dependent realm of organizational structure (macro level) and individual action (micro level), we now develop a model of competence in organizations (see Figure 1). Given our research objective, namely the development of design principles for competence management technology, we chose Orlikowski's (1992; also, Orlikowski and Robey 1991) adaptation of structuration theory for our conceptual infrastructure as it highlights the role of IT in the recursive, organizational structuring process.

According to structuration theory (Giddens 1984), the structural properties of social systems (the structure level in Figure 1) are enacted through recurrent human action and interaction (the agency level in Figure 1). Such enactment is mediated through a number of elements (i.e., facilities, norms, and interpretive schemes) that both enable and constrain human action. Technology embeds these mediating elements (Orlikowski and Robey 1991). As individuals use technology and thereby draw on these mediating elements (shown as technology mediating between the structure and agency level in Figure 1), they recursively produce and reproduce the social structures that shape their action.

Thus, recurrent actions of organizational members draw not only on extant competence (competence-in-stock) to generate new competencies, but also on a variety of assumptions, expectations, and norms embedded in the structural features of the organization, which include core competencies and HR practices (arrow c), and CMS (arrow b). By applying these mediating elements, organiza-



Arrow	Type of Influence	Nature of Influence
a	Technology as a product of human action	CMS as the result of the competent actions taken by system designers and developers
b	Technology as a medium of human action	By embedding interpretive schemes, facilities, and norms, CMS enable and constrain users' competent actions
c	Institutional conditions of interaction with technology	Structural features such as the organization's core competence (resources, learning, and routines), as well as conceptual structures (e.g., a skill-based orientation in HR), define, enable, and constrain individuals' competent actions
d	Institutional consequences of interaction with technology	By reinforcing and transforming the systems of signification, domination, and legitimation, CMS in use shape the core competencies and other structural features of the organization

Figure 1. Model of Competence in Organizations (Adapted from W. J. Orlikowski, "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science* (3:3), 1992. Copyright © 1992 INFORMS. The Institute of Management Sciences, now the Institute for Operations Research and the Management Sciences, 901 Elkridge Landing Road, Suite 400, Linthicum, Maryland 21090 USA.)

tional participants create and re-create the core competencies that characterize the organization's competitive advantage (arrows a and b).

This structurational perspective on organizational competence and its development informed our action research study, which was motivated by our quest to develop and test CMS design principles. As our integrative model demonstrates, CMS form part of the mediating structure that facilitates the smooth interaction between competencies at the macro and micro levels of the organization. In order to support organizational competence management in day-to-day action, the design of CMS must appreciate the reciprocal relationship of the three competence types (competence-in-stock, competence-in-use, competence-in-the-making) and the organization's core competencies.

Method

Action Research

Given our objective of developing and testing design principles that render CMS supportive of knowledge-intensive organizations with a core competence orientation, we selected action research as our mode of inquiry. Action research has been described as "a post-positivist social scientific research method, ideally suited to the study of technology in its human context" (Baskerville and Wood-Harper 1996, p. 235). Even though there are other methods for studying technology in its "natural" context of everyday use, action research distinguishes itself in that it is interventionist and dedicated to the development of knowledge useful to both research and practice (e.g., Baskerville and Wood-Harper 1996; Susman and Evered 1978).

As an interventionist method, action research allows the researcher to test a working hypothesis about the phenomenon of interest by implementing and assessing change in a real-world setting. By analyzing discrepancies between the hypothesized and actual changes in the real-world setting or the client-system infrastructure (Susman 1983), the action researcher gains both theoretical and practical knowledge about the phenomenon.

In addition to generating knowledge through experimenting in a real-world setting, action researchers regard change as an important outcome (Susman and Evered 1978). Merely studying a real-world problem without assisting to resolve or ameliorate it is perceived as unhelpful. In other words, action researchers see it as their responsibility to assist practitioners by not only developing but also applying knowledge (Mathiassen 2002).

Although there are a variety of action research approaches available to IS researchers (Baskerville and Wood-Harper 1998), Susman and Evered's canonical action research method is one of the most widely adopted in the social sciences (Davison et al. 2004). As a canon of action research, the method formalizes the standards of this iterative, rigorous, and collaborative research process by describing it in terms of the following five phases:

- *Diagnosing* refers to the joint (researcher and practitioner) identification of situated problems and their underlying causes. During this phase, researchers and practitioners jointly formulate a working hypothesis of the research phenomenon to be used in the subsequent phases of the action research cycle.
- *Action planning* is the process of specifying the actions that can improve the problem situation.
- *Action taking* refers to the implementation of the intervention specified in the action planning phase.
- *Evaluating* entails the joint assessment of the intervention by practitioners and researchers.
- *Specifying learning* denotes the ongoing process of documenting and summing up the learning outcomes of the action research cycle. These learning outcomes should constitute knowledge contributions to both theory and practice, but they are also recognized as

temporary understandings that serve as the starting point for a new cycle of inquiry.

Evaluation Criteria

Given the variety of action research approaches available to IS researchers (Baskerville and Wood-Harper 1998), it is important to specify the criteria by which a research project should be evaluated. We rely on the evaluation criteria proposed by Davison et al. (2004), as these were developed specifically for canonical action research. This evaluation framework identifies five methodological principles, each including a checklist of specific criteria. The five principles are

- *The principle of researcher-client agreement*: given the importance of collaboration in action research, this principle seeks to ensure that researchers and practitioners (clients) develop a mutual understanding of and commitment to the research project, i.e., its scope, focus, and mode of inquiry.
- *The principle of the cyclical process model*: this principle highlights the importance of rigor in that it advocates progressing through all five action research phases in a sequential and systematic manner.
- *The principle of theory*: seeing that action research without theory does not constitute research, this principle highlights the importance of using one or more theories to not only guide and focus the research activity, but also relate the findings to the extant literature.
- *The principle of change through action*: since the purpose of action research is to change an unsatisfactory situation, this principle stipulates that interventions appropriate to the problem and the client organization should be designed and implemented.
- *The principle of learning through reflection*: this principle highlights the importance of drawing insights from the research and identifying implications for other situations and research contexts.

To assess the quality of our study, we will later compare our action research method to these principles.

Project Setting

Our research project was called the Competitive Knowledge-Intensive Firms project. It was a 30-month (July 1999 to December 2001), collaborative study between the Viktoria Institute (Göteborg, Sweden) and nine knowledge-intensive organizations (Astra Zeneca, EHPT [formerly Ericsson/Hewlett-Packard Telecom], Ericsson Mobile Data Design, Ericsson Microwave, Frontec, Guide, Volvo Car Corporation, Volvo IT, and Volvo Truck Corporation). Following Robey and Markus' (1998) recommendation that practitioner sponsorship should be pursued to help overcome the commonly perceived rigor and relevance trade-off, the project was equally funded by the Swedish research funding agency VINNOVA and the nine participating organizations. To avoid any potential conflicts over each party's contribution to and role in the project (see Rapoport 1970), an agreement specifying the responsibilities of the Viktoria Institute and the participating organizations was signed. This agreement addressed the allocation of resources such as financial support, labor, and equipment, as well as rights and responsibilities regarding the research results.

Of the nine organizations included in the overall research project, six (EHPT, Frontec, Guide, Volvo Car Corporation, Volvo IT, and Volvo Truck Corporation) participated in our research on CMS. All of them fulfilled the criteria of our study in that they (1) represented knowledge-intensive organizations that were embracing a core competence approach and (2) were interested in assessing the role of IT in competence management. They were either evaluating different CMS solutions or had just acquired a CMS when they agreed to participate in our research. The CMS included in our study ranged from packaged solutions by

vendors such as Prohunt, SAP, and Tieto Datema to custom-built applications (Frontec's Compass and Guide's Competence Marketplace).

Research Process

In our quest to develop design principles that would make these systems supportive of knowledge-intensive organizations that embraced a core competence approach, we started with an investigation into the strengths and weaknesses of the technologies upon which our participating organizations had relied for managing competencies in the past (e.g., spreadsheets, Word documents, and databases). Based on the shortcomings of these desktop-based solutions, we formulated two design principles. Since the objective of the first action research cycle was to work within the confines of the CMS that our participating organizations had selected, we translated these design principles into interventions that guided the configuration and implementation of CMS.

We followed Susman and Evered's cyclical action research design, and completed the first of two action research cycles in 4 months (July 1999 to October 1999). During this time, we implemented and assessed our recommendations in the participating organization. To our disappointment, the evaluation of our interventions highlighted a set of barriers that hampered the adoption of the CMS as we had envisaged.

With an understanding of these adoption barriers and a desire to find ways of overcoming them, we embarked on a second action research cycle, a 26-month effort (November 1999 to December 2001). Instead of working within the confines of the organizations' CMS solutions, as we had in our first action research cycle, we sought to develop and empirically test a set of design principles by implementing them in prototypes. Given the considerable effort required to develop, implement, and evaluate CMS prototypes, we invited only two of our six organizations, namely Volvo IT and Guide, to participate in our second action research cycle. Our assessment of the four design principles on which we had built our two prototypes showed that they resulted in both anticipated and unanticipated consequences. A summary of our research project is presented in Table 1.

First Action Research Cycle

With our intent to identify design principles for CMS, we started our first action research cycle by investigating our participating organizations' earlier attempts at using IT to support competence management. Their prior IT solutions included in-house database applications, spreadsheets, and Word documents, and they had been only partially successful. The competence descriptions provided by these systems were inaccurate and incomplete and therefore of little use in practice. A key problem discussed during our workshops with the participating organizations was that the competence descriptions were not updated regularly and were therefore frequently obsolete.

Another problem concerned inconsistencies in competence descriptions across organizational units. While some managers only recorded completed courses, others also included skills acquired from project activities. The most ambitious managers combined different information sources and compiled relatively comprehensive competence descriptions. For example, some managers at Guide documented their group members' career ambitions.

We traced the underlying cause of these problems to the fragmented nature of the desktop applications that the organizations were using. Our working hypothesis of the first action research cycle was that the problem of inaccurate and incomplete competence data could be handled by using CMS (i.e., information systems specifically designed to manage competencies in organizations).

In view of the competence data problems related to prior IT solutions, the research team and the practitioners agreed that it was important to use these experiences as guidance for configuring and implementing CMS. Since we did not consider

Table 1. Summary of Action Research Project

Cycle 1 (July to October 1999)	Cycle 2 (November 1999 to December 2001)
Research Sites and CMS	
EHPT (Prohunt) Guide (Competence Marketplace) Frontec (Compass, Prohunt) Volvo Car Corporation (TP/HR, SAP R/3) Volvo IT (TP/HR) Volvo Truck Corporation (TP/HR)	Guide (Competence Marketplace) Volvo IT (TP/HR)
Phase 1. Diagnosing	
Over a series of workshops involving all six organizations, we collected information about users' experiences with various kinds of IT-based competence management solutions (e.g., in-house database applications, spreadsheets, and Word-documents) that were used prior to the implementation of CMS. We identified poor quality of competence data as a key problem with these prior solutions. We formulated the following working hypothesis: The problem of inaccurate and incomplete competence data can be resolved by using systems designed specifically for the purpose of managing organizational competencies, i.e., CMS. **Data sources** • Technology review • Workshop sessions **Data analysis** The data collected through the technology review and the workshops were discussed and analyzed in collaborative sessions involving both action researchers and practitioners.	Based on our understanding of the adoption barriers identified in the first action research cycle, as well as a more in-depth analysis of Guide's and Volvo IT's CMS, we identified three problems associated with the job-based assumptions embedded in these systems: • The CMS isolate the individual user from other organizational members • The CMS focus on past competence • The CMS are rigid in their reporting of organizational competence We formulated the following working hypothesis: CMS that embody the skills-based paradigm are more effective in knowledge-intensive organizations embracing a core competence approach than are CMS reflective of the job-based paradigm. **Data sources** • Document review • Participant observation • 22 semi-structured interviews at Guide • 10 semi-structured interviews at Volvo IT **Data analysis** Starting with the categories generated in the evaluation phase of our first action research cycle, the documents, field notes, and interview transcripts were analyzed using a more focused grounded theory approach (Strauss and Corbin 1990). This procedure is known as selective coding. Our analysis generated the three problems associated with job-based CMS.

Table 1. Summary of Action Research Project (Continued)

Cycle 1 (July to October 1999)	Cycle 2 (November 1999 to December 2001)
Phase 2. Action Planning	
In collaboration with representatives of the participating organizations, we developed two design principles for the CMS implementations: • The principle of *balanced competence descriptions* • The principle of *user control* The design principles were developed to guide the configuration and implementation of CMS in the six organizations.	We developed the *Competence Visualizer* and *VIP* prototypes in accordance with the design principles derived from the skills-based approach to competence management, namely: • The principle of *transparency* • The principle of *real-time capture* • The principle of *interest integration* • The principle of *flexible reporting* The prototypes were planned to trigger new ways of thinking about competence and competence management among practitioners.
Phase 3. Action Taking	
Our two design principles were implemented to varying degrees in the six organizations: • Frontec and Guide implemented the principle of *balanced competence descriptions* • All organizations implemented the principle of *user control*	• The Competence Visualizer prototype was demonstrated to Guide users, and users were given an opportunity to experiment with it hands-on. • The VIP prototype was installed on Volvo IT's intranet.
Phase 4. Evaluation	
User site investigations were conducted to evaluate the CMS in use. **Data sources for evaluation** • Focus groups • Participant observation • 24 semi-structured interviews (3 interviews were conducted at each research site, except at Guide, where 9 interviews were conducted) **Data analysis** The transcribed material was analyzed by using the open and axial coding techniques (Strauss and Corbin 1990). This analysis generated a set of recurring categories related to competence mapping, competence visualization, change aspects of competence, competence sharing, individual competence development, competence gap assessments, and building short-term and long-term organizational competence. In this analysis, practitioners offered comments on and corrections to our interpretations.	The Competence Visualizer and VIP prototypes were evaluated to assess the implications of the four design principles. **Data sources for evaluation** • 4 focus groups at Guide • 2 focus groups at Volvo IT • Participant observation • 18 semi-structured interviews at Guide • 16 semi-structured interviews at Volvo IT **Data analysis** The transcribed material was analyzed using the open, axial, and selective coding techniques (Strauss and Corbin 1990). This analysis generated two core categories: design improvements and organizational issues. In this analysis, practitioners offered comments on and corrections to our interpretations.

Table 1. Summary of Action Research Project (Continued)

Cycle 1 (July to October 1999)	Cycle 2 (November 1999 to December 2001)
Phase 5. Specifying Learning	
Our working hypothesis was not supported. Despite our attempts to improve data quality by implementing CMS guided by the two design principles, the problems remained. On the basis of the themes identified in the data analysis, a set of adoption barriers associated with CMS implementation and use was outlined (Lindgren and Henfridsson 2002): • fragmented representation of competencies • lack of support for identification of available staff • competence reproduction bias • user isolation • lack of support for knowledge sharing • insufficient support for group level analysis • lack of attention to competence interests • exclusion of strategic planning information These disappointing outcomes encouraged us to initiate a second action research cycle.	Our working hypothesis was partially supported. Our assessment of the prototypes revealed both anticipated (Lindgren 2003; Lindgren and Stenmark 2002; Lindgren et al. 2003) and unanticipated consequences of these design principles. In light of the unanticipated consequences, we developed a set of revised CMS design principles by reflecting on our action research project in its entirety.

CMS as turn-key solutions but rather technologies that needed to be integrated into a social system of everyday work, we relied on a series of collaborative workshops (involving practitioners from all six organizations) to outline design principles that incorporated the lessons learned from the organizations' earlier competence management solutions.

First, tackling the problem of irregularly updated competence descriptions, we agreed that user control is an important prerequisite for keeping competence data in CMS up-to-date. Thus, we formulated the design principle of *user control,* which specifies that knowledge workers whose competencies were captured and stored in CMS would have control over their information. Rather than having the responsible manager enter the competence data, individual knowledge workers should be able to update their own competence information. We reasoned that employees' active involvement in managing CMS would increase their commitment to and understanding of it (see Lawler and Ledford 1992). In our role as action researchers, we therefore initiated and evaluated competence data entry routines for such employee involvement in all six participating organizations.

Second, addressing the problem of inconsistencies in competence descriptions, we agreed that CMS should balance formal and informal indicators of competence in competence descriptions. We refer to this as the principle of *balanced competence descriptions*. While formal descriptions of competence refer to documented knowledge and skills acquired and rated through official channels (e.g., attending training courses or earning a degree), informal descriptions of competence refer to on-the-job experiences, interests, personal characteristics, and behaviors. This principle specifies that the formal and informal aspects of competence complement each other and together provide a more holistic representation of individual and organizational competence. For instance, the

formal competence indicator that an individual speaks German at an expert level is enriched and contextualized by the additional description that the person lived in Germany for many years.[3]

Even though all of the participating organizations recognized the value of representing both formal and informal indicators of competence in their CMS, they implemented our suggested intervention to varying degrees. This was primarily due to the limitations imposed by the design of their CMS packages. For instance, Prohunt and SAP R/3 did not include free-text features, thus limiting the organization's ability to incorporate informal competence descriptions. Therefore, only two organizations, Frontec and Guide, whose CMS could accommodate additional competence descriptions, implemented our first intervention.

At each site, we evaluated the CMS in use. Our evaluation highlighted a number of barriers to the adoption of the CMS (Lindgren and Henfridsson 2002). For instance, users indicated that they did not want to disclose competencies that they were no longer interested in applying or developing. In other words, the CMS stored knowledge workers' extant competencies, which then served as the basis for project assignments. Thus, the CMS tended to reproduce competencies (e.g., once a C programmer, always a C programmer), causing users to misrepresent their knowledge and skill.

Thus, despite our attempts to improve data quality by implementing CMS guided by the two design principles, the problems remained. Our working hypothesis was not supported. The CMS implemented and used by the six organizations were unable to sufficiently solve the problems of inaccurate and incomplete competence data. We concluded that we needed deeper and richer insight into what caused these CMS adoption problems. We suspected that the assumptions about competence embedded in the CMS had hampered the success of our interventions. Thus our two design principles were isolated solutions unable to address a more fundamental problem. We therefore embarked on a second action research cycle in order to identify and test CMS design principles outside the confines of existing CMS.

Second Action Research Cycle

In our second action research cycle, we sought to develop and empirically test design principles by implementing them in prototypes separate from, but complementary to, the participating organizations' CMS. Only two of our research partner organizations, Guide and Volvo IT, participated in this action research cycle. We targeted these two organizations because they had well-established competence management practices covering both strategies and technologies. In fact, this strength could be traced to the fact that Guide and Volvo IT invested a larger portion of their revenues in competence management than the other four organizations and as a consequence they had most HR staff dedicated to develop and maintain these practices on an everyday basis. They were thus better prepared for engaging in a new action research cycle requiring intense researcher-practitioner collaboration.

In addition, we had good access to these organizations. The general manager of the Viktoria Institute had previously served as the chief knowledge officer at Guide and our contact at Volvo IT was a senior information architect at Volvo IT's Web Program Center, who was enrolled in the Viktoria Institute's industrial Ph.D. program. These relationships increased the likelihood that a second and rather lengthy action research cycle could be completed successfully.

Diagnosing

CMS at Guide

The Swedish IT consulting organization Guide was founded in 1988. In 2000, at the time of this study,

[3]This is an example articulated at one of the workshop sessions held at Volvo IT.

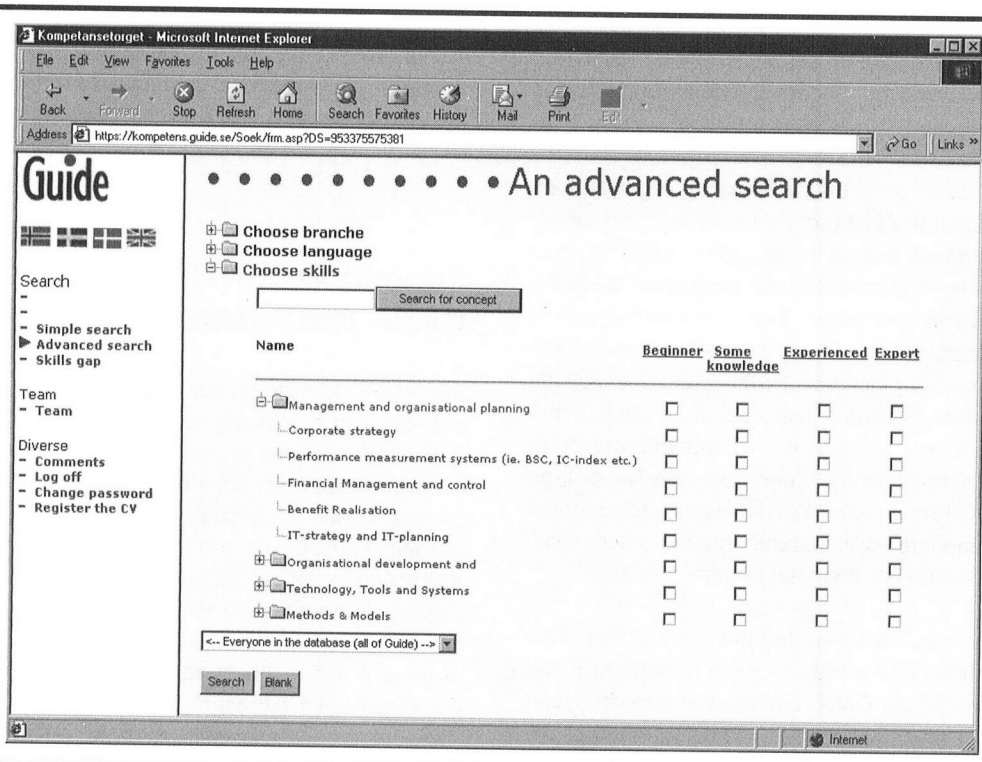


Figure 2. Competence Categories and Levels in Guide's CMS

Guide had approximately 800 employees at 10 offices located in 3 countries. Since 1988, Guide had invested 15 percent of its annual revenues into competence development. Of its many competence-enhancing activities, Guide considered the development of individuals' competencies through project assignments the most important. Guide's business and group managers thus endeavored to staff projects in ways that both satisfied a customer's need and the individual knowledge worker's competence development objectives.

In 1999, Guide implemented Competence Marketplace, a system that was intended to facilitate staff allocation and competence management. At the heart of the system was a database storing descriptions of staff competence levels in areas such as client-server technology and project management. The system organized the different competencies into four major categories: (1) management and organizational planning, (2) organizational development, (3) technology, tools, and systems, and (4) methods and models. The system stored an individual's competencies in terms of four levels: beginner, some knowledge, experienced, and expert (see Figure 2).

CMS at Volvo IT

With offices in Belgium, Brazil, Great Britain, Malaysia, Sweden, and the United States, Volvo IT is the Volvo Group's resource and expertise center for IT. At the time of our study, Volvo IT had approximately 2,500 employees. Some 1,400 of these worked in Sweden, with roughly 900 in Göteborg, Volvo IT's global headquarters. As do many large organizations, Volvo IT recognized the advantage of knowing who within the organization held what expertise. To help manage its network of globally dispersed knowledge workers, Volvo IT

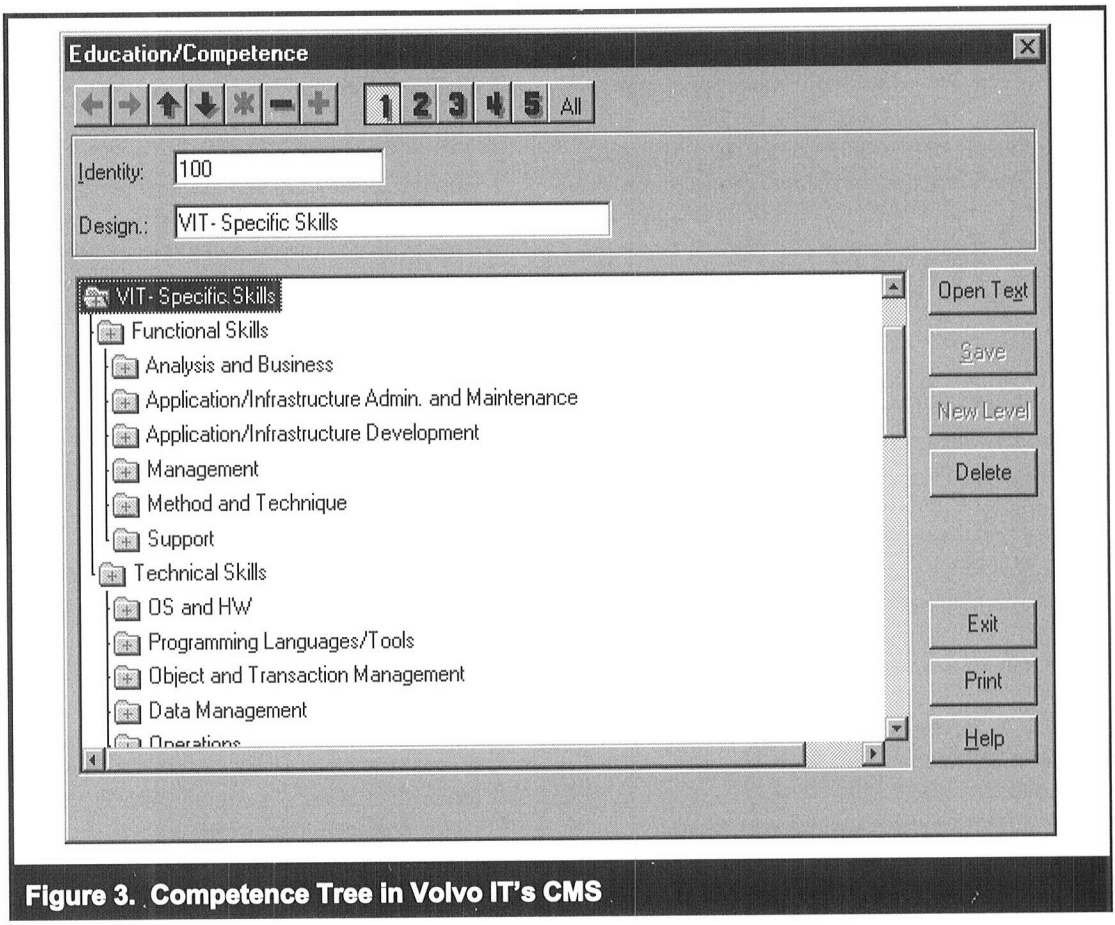


Figure 3. Competence Tree in Volvo IT's CMS

decided to implement a CMS in June 1999. They chose TP/HR, an off-the-shelf, modular application developed by Tieto Datema (Sweden). The focus of our research was the education/competence module.

In Volvo IT's implementation of TP/HR, competence was defined in terms of functional and technical skills. Functional skills referred to the work tasks such as systems analysis, development, or support. Technical skills referred to knowledge of specific programming languages, software, or data management tools. Both functional and technical skills were further divided into subcategories, on which employees were rated on a 1 (no competence) to 5 (expert competence) scale (see Figure 3). Determining individuals' competence ratings was a collaborative undertaking that involved the individual knowledge worker and his/her manager.

Initial Assessment of CMS

In February 2000, we initiated an intensive 2-month assessment in both organizations. We identified several problems with their CMS and traced these to the embedded assumptions reflecting the job-based approach (Lawler and Ledford 1992). In particular, we identified three problems.

First, the CMS at Guide and Volvo IT *isolated* the individual user from other organizational members. This reflects the job-based view of work, in which competent individuals are assumed to possess the

knowledge and skills to fulfill a job without knowledge sharing. In the CMS we studied, individual users could only see their own competence descriptions, not those of others. The restricted access to competence information was intended to limit internal recruiting, but it hampered knowledge sharing and the ability to leverage internal knowledge resources. A project manager at Guide in Göteborg put it as follows:

> Maybe it should be possible to connect this group of people with similar interest profiles in some way. For instance, mark here [in the system] that I'm a member of this network. Then I have more search paths and this would make it easier to find knowledgeable colleagues. At present, there is no interactive forum for exchanging opinions and competence sharing. It is important to make it easier to initiate a dialogue.

Similarly, a management consultant at Volvo IT remarked:

> The TP/HR system is hierarchically structured and closed. As an individual you can see nobody but yourself [in the system]. If I search for 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 [and their competencies].

Second, the competence definitions of CMS at Guide and Volvo IT *emphasized past competence*, namely knowledge and skills that an individual knowledge worker already possessed. As such, the systems were not supportive of learning and competence development, both of which are key objectives of organizations pursuing a core competence strategy. The CMS did not cater for emerging and future competencies, ignoring motivational and behavioral aspects of competence. As the following quote from a systems programmer at Guide's Stockholm office highlights, members of the organization were concerned about the competence-reproducing mechanism of CMS. These concerns threatened to undermine the accuracy with which users represented their competence:

> In order to avoid assignments in certain areas, I hide competencies that I don't want to apply.... I'm capable of working in a COBOL project, but I don't want to do it. If I express my competence in COBOL there is an obvious risk that I have to take on assignments where this type of programming skill is needed. So my group leader advised me to leave out COBOL when I filled in my competence description.

This concern was underscored by an account manager at Guide, who highlighted that the omission of knowledge workers' interests and career objectives in the CMS limited its value:

> The consultants are interested in having the right assignments...[in the Competence Marketplace system] there is no given correspondence between a consultant's competence and wanted work tasks. Therefore it is important to keep track of existing ability as well as ambition of competence development. If the system would handle information about ambitions and interests there would be an incentive for the consultants to use the system....The consultants should feel that they are able to influence which assignments they get by using the system.

The sentiment, that incorporating the future dimension of competence was key to improving the functionality of CMS, was also echoed by a project manager in Volvo IT:

> It is important that we are able to find and take care of people's interests. Definitely you perform better if you are interested in the work-task in question. And surely a person's potential to learn increases when they find the actual area exciting.

One of the HR managers at Volvo IT identified another challenge with regard to the CMS's focus on past competence. He pointed out that in a dynamic and fast-paced environment like IT, maintaining accurate representations of competence required a CMS capable of dealing with skills and knowledge as they evolve:

> 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.

Third, the CMS were *rigid in their reporting* of organizational competencies. The parameters for competence analyses were limited (e.g., for predefined group sizes and at system-stipulated points of time). Since *ad hoc* reporting of competencies for gap analyses, for instance, is increasingly important in volatile business environments, the rigidity of the reporting functions limited the usefulness of the CMS. One project leader at Guide pointed out that the Competence Marketplace was deficient in its support of strategic planning because reporting focused on micro level competencies only:

> It's not sufficient to know the employees' competencies. You must be able to manage those competencies in a strategic way, but [the system] does not contain a complete package. Our intention is to categorize the activity with regard to strategic goals and critical competencies. At present, however, we can merely visualize competencies on an individual level by using the system. But we want to manage competence on a, for instance, departmental level. When analyzing different groups of employees, we need [the system] as a management tool for the activity.

This shortcoming was echoed by a HR manager in Volvo IT:

> The major disadvantage of the system is that it is not possible to make competence analyses of teams and groups different sizes. The system supports analyses on the individual level in an excellent way. But we must be able to use the system in order to form a project team and analyze the total competence level. So the system needs features facilitating evaluation of groups in different sizes. Moreover, the system should also be more flexible with regard to analyses of competence status at a certain point in time and competence status changes over time.

Based on our diagnosis of the CMS used in Guide and Volvo IT respectively, we concluded that the problems associated with their extant systems could be traced back to a system design that embraced a job-based approach to competence management. Applying Lawler's (1994) theorizing that a skill-based approach is more conducive to management of organizational competencies than a job-based approach, we formulated the following working hypothesis: CMS that embody the skills-based paradigm are more effective in knowledge-intensive organizations embracing a core competence orientation than are CMS reflective of the job-based paradigm.

Action Planning

Guided by our working hypothesis, we set out to develop design principles that would improve the usefulness of CMS in our two participating organizations. In formulating these design principles, a process that was completed in collaboration with practitioners from Guide and Volvo IT, we relied not only on the three problems that we had identified in the diagnosis phase, but also on the three types of competence that we had identified in our integrated model of organizational competence: competence-in-stock, competence-in-use, and competence-in-the-making. Thus, we developed the following four design principles:

- ***The principle of transparency:*** CMS should make competence-in-stock visible and accessible to the entire organization. This principle responds to the problem of CMS limiting the opportunities of knowledge sharing by restricting access to competence data.

- ***The principle of real-time capture:*** CMS should track competence-in-use in real time. This principle addresses the problem of inaccurate competence data, which is caused by a CMS design focusing on past competence. The principle promises to generate data about competence as it emerges through knowledge work in action.

- ***The principle of interest integration:*** CMS should accommodate a definition of competence that includes individual knowledge workers' interests in addition to their extant competence. This principle facilitates the capture of competence-in-the-making by accommodating individuals' interests as an indication of the skills and knowledge that they are motivated to develop.

- ***The principle of flexible reporting*:** CMS should support *ad hoc* analyses of the organization's competencies, both with regard to different units of analysis (e.g., individual or group) and time frames (e.g., from-to dates). This principle addresses the rigidity in CMS' reporting functionality. By providing managers with flexible reporting, CMS support strategic competence development by influencing competence-in-the-making.

These four design principles were then applied in the design of two CMS prototypes. These were Guide's Competence Visualizer and Volvo IT's Volvo Information Portal (VIP).

Action Taking

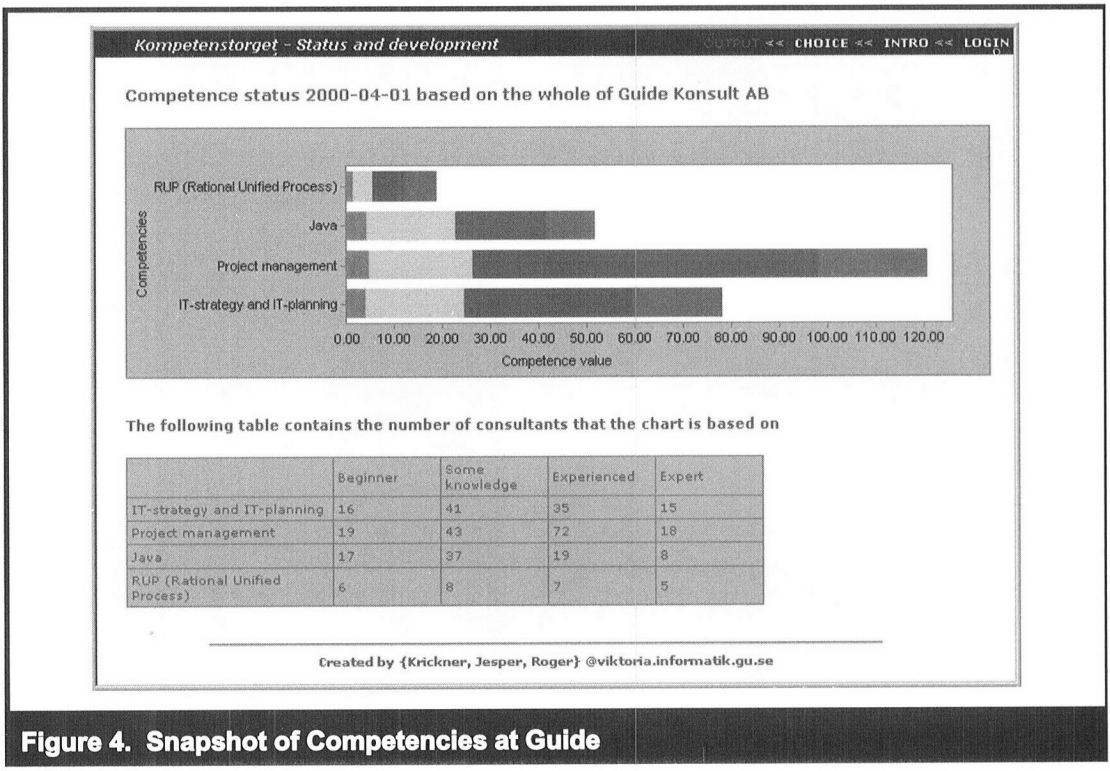
The CMS Prototype at Guide

In collaboration with Guide practitioners and three M.Sc. students, the first author developed the Competence Visualizer, an add-on module to Guide's Competence Marketplace. The Competence Visualizer handled flexible analysis and reporting of the organization's competence-in-stock, as well as competencies that organization members expressed interest in developing. The prototype embraced three of our design principles: transparency, interest integration, and flexible reporting. We could not implement the principle of real-time capture without considerable changes to Competence Marketplace.

Like Competence Marketplace, our Competence Visualizer add-on was based on ASP scripts, an IIS server, and an SQL server. Furthermore, our prototype mirrored the system and data structures of the Competence Marketplace. In other words, the competence tree and the competence rating schemes in Competence Visualizer were identical to those in the Competence Marketplace. However, since the Competence Marketplace system did not capture data regarding individuals' interests in developing certain competencies, we relied on test data for our prototype to enable assessment based on realistic use situations.

As its name suggests, Competence Visualizer relied on graphical modes of presentation to allow users to visualize Guide's competencies-in-stock and competence interests. Users could view competencies at the individual, group, or organizational level. Furthermore, competencies could be shown as a snapshot view (Figure 4), i.e., single point in time, as well as across a user-defined time period (Figure 5). These graphical representations were expected to help users identify patterns and trends in organizational competence needs.

In order to present competence-in-stock and competence interests at the individual and aggregated group or organizational level, Competence Visualizer assigned numeric values to the descriptive competence ratings in Competence Marketplace. A beginner rating was assigned a value of 0.25; some knowledge was 0.5; experienced was a 1.0; and expert was 1.25. To satisfy the design principle of flexible reporting, Competence Visualizer displayed the competencies not only in graphical, but also in tabular form.



	Beginner	Some knowledge	Experienced	Expert
IT-strategy and IT-planning	16	41	35	15
Project management	19	43	72	18
Java	17	37	19	8
RUP (Rational Unified Process)	6	8	7	5

Figure 4. Snapshot of Competencies at Guide

In April 2000, the Competence Visualizer was demonstrated to Guide users. Our original intent was to implement the prototype in Guide so that users could evaluate our system after using it in their everyday work, but we were unable to do so due to unforeseeable organizational changes. In early 2000, Guide merged with the Internet consultancy organization Framfab. This meant that Guide's management was preoccupied with the reorganization following the merger, which made it difficult to move ahead on our implementation plans, particularly as all internal development was put on hold. We thus opted for an alternative evaluation strategy, which involved workshops and focus groups with intended Guide users. We describe our evaluation in more detail later.

The CMS Prototype at Volvo IT

At the time of this research, one of the members of our research team was a senior information architect at Volvo IT's Web Program Center. Based on his knowledge on search engines and recommender systems, the Volvo Information Portal (VIP) system was developed as a complement to TP/HR. VIP captured knowledge workers' competence interests in real time and made competence-in-the-making more transparent. Resource constraints did not allow us to implement all four design principles. The VIP prototype embodied the principles of transparency, real-time capture, and interest integration. In this way, each of our design principles was covered by at least one prototype.

VIP was built on Autonomy's AgentWare platform, a commercially available tool that uses neural networks and advanced pattern-matching techniques to find similarities in textual data. VIP allowed the users to define intelligent agents that searched an index database for intranet documents matching the user's interests. By defining one or more agents, VIP users were thus able to monitor the corporate intranet for items that matched their interests. The users defined their

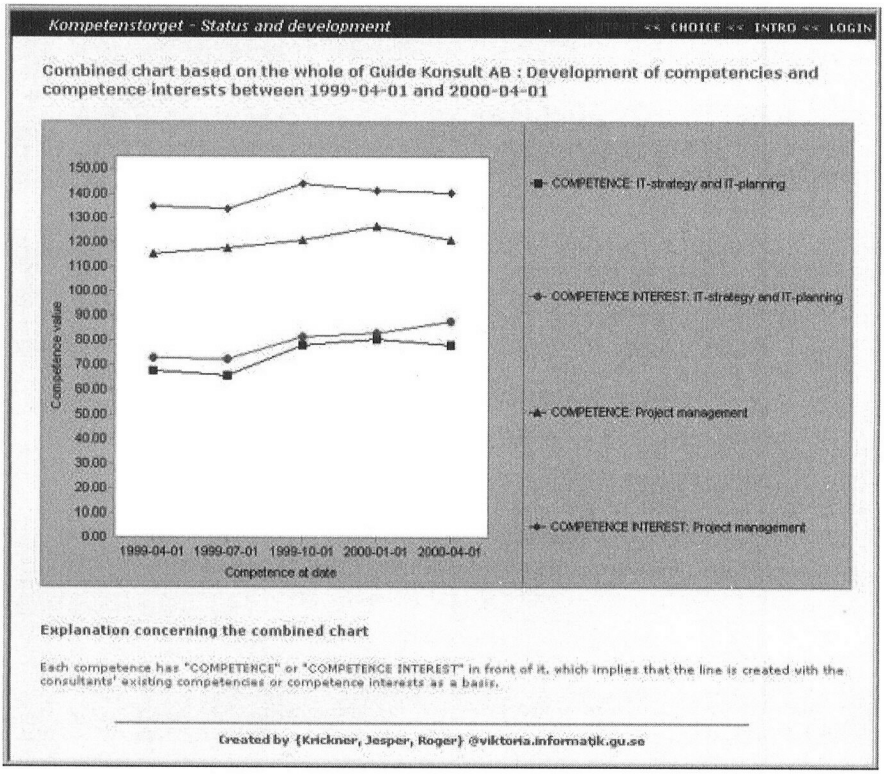


Figure 5. Combined Competence Chart at Guide

interests in a free-text natural language format from which the system then created an internal digital representation.

The search results from each agent were displayed in a simple list similar to those generated by search engines. By clicking on the hyperlinks generated by the agent, users could retrieve the documents matching their interests. When users had read and identified one or more of the returned documents as relevant, they could provide the agent with explicit feedback through a retrain feature, which adjusted the agent's search criteria based on the characteristics of the retrieved document.

The VIP prototype also provided a community feature, which allowed users to find other users with an interest profile similar to their own, thus enabling knowledge sharing and collaboration across Volvo IT's many offices. When invoking this feature, the interest profiles embedded in the user's agents were matched with the profiles of all other agents. Matches were displayed, listing the name and contact information of the identified users. Finally, the VIP prototype supported searches for users with specific interests. VIP users could enter a search for an interest in natural-language format and VIP would return all users whose agents contained the specified interest. Figure 6 presents VIP's response to such a search.

In April 2000, VIP was implemented on the Volvo IT intranet and made available to all intranet users in Göteborg as part of their everyday work. Fifty people tried out the prototype when it was first introduced and there were twenty users with active agents at the end of the evaluation period.

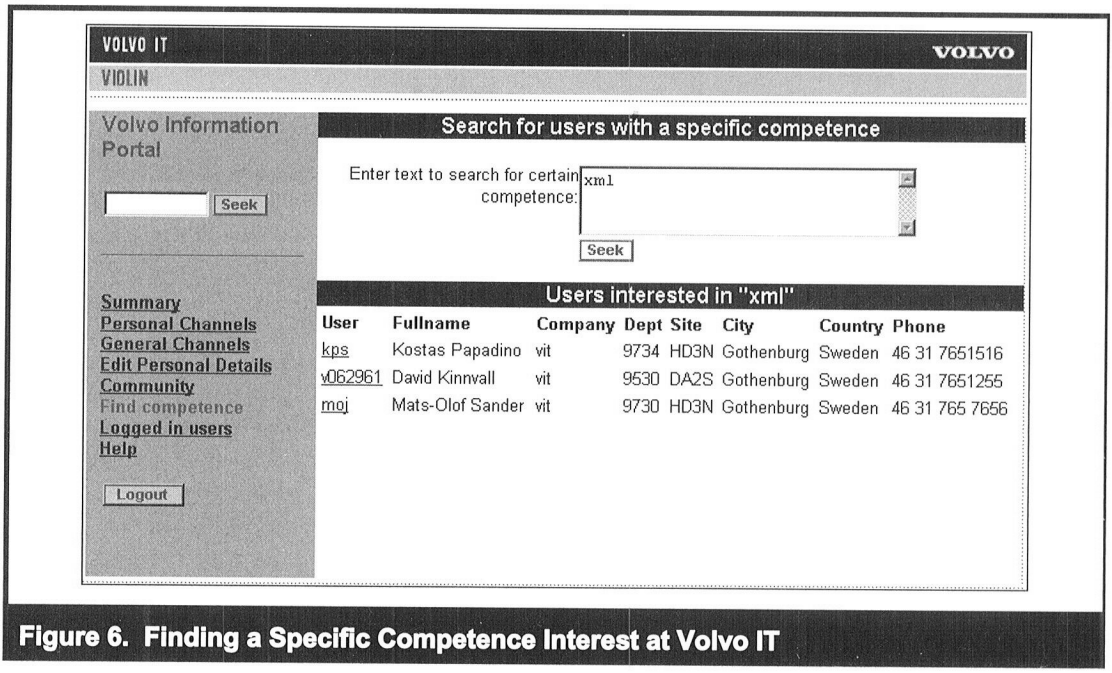


Figure 6. Finding a Specific Competence Interest at Volvo IT

Evaluating

Evaluating at Guide

Due to the merger between Guide and Framfab, we relied on an approach that came as close as possible to an organization-based evaluation process. Our process consisted of system demonstrations and workshops during which Guide users could experiment with Competence Visualizer. Together with the chief technician of Guide's Göteborg office, we made a number of prototype presentations to Guide users in the Göteborg office. Furthermore, we set up a test environment with Competence Marketplace (running real data) and Competence Visualizer (running test data). Users could experiment with the two applications in a hands-on fashion. Over a series of sessions, HR managers, account managers, and project managers tried out Competence Visualizer in this test environment. Afterward we debriefed them to elicit their response to our prototype, e.g., whether they would find it useful in their work and how it compared to Competence Marketplace.

Another evaluation strategy involved four workshops, which were held at three sites (Göteborg, Stockholm, and Oslo) and comprised approximately 30 participants in total. During these workshops we introduced and demonstrated Competence Visualizer, encouraged users to interact with the prototype in its test environment, and then conducted focus group sessions in which users discussed their thoughts on and reactions to our prototype. Afterward, we interviewed 18 participants.

Our evaluation efforts at Guide revealed both anticipated and unanticipated consequences of our prototype. Overall, the prospective user seemed to value our prototype's flexible display of competence-in-stock and competence interests. The capacity to visualize the competencies of different groups at (or across) different points in time was considered valuable with regard to competence-in-stock and competence-in-the-making. For instance, the CEO for Guide in Oslo remarked:

> [The Competence Visualizer prototype] is useful when talking with the employees about the situation. It is easier to understand these charts that show the present situation as well as a future dimension.

> Moreover, it is easier to understand what we mean when we discuss employees' opportunities in relation to the organization's activities.

Additionally, the interest-integration design principle was seen as addressing the data accuracy problem that plagued the original CMS. A group manager at Guide's office in Göteborg used the following example to explain the benefits of incorporating interest competencies into a CMS:

> As an example: I have been working with FORTRAN for 10 years; I'm a really good FORTRAN programmer, but I don't want to work with it. Then I have removed that competence in the system [Competence Marketplace]. For this reason, this interest dimension is good: I'm good at it and I want to work with it, I'm good at it, but I'm not interested in working with it, and my knowledge is limited at the moment, but I'm eager to learn more.

As this group manager highlighted, Competence Visualizer allowed employees to describe their competence in more comprehensive ways. They were able to express both existing competencies (competence-in-stock) and individual competence interests, which drive competence-in-the-making. Thus, competence interests were not represented at the expense of existing competencies, allowing Guide to generate a more accurate picture of its existing and emerging competencies, and to compare them with its strategic core competence goals.

In addition to these anticipated consequences of our prototype, there were some unanticipated ones. For instance, the objective of our flexible reporting design principle was to highlight competence gaps between existing competencies, individuals' competence interests, and the organization's competence needs. As the following interview quote from a Guide group manager highlights, the implication of adopting a skill-based approach to HR management and taking individuals' competence interests seriously, is that organizations have to explicate and publish their competence needs in order to stimulate their development.

> It's quite easy to appreciate the value of this system. It's really interesting to check out the competencies within the organization on a regular basis; be able to find out our strengths and weaknesses. And the interest module indicates what work tasks the employees are interested in working with. But, then it is our duty to create areas of interest. That is basically the best approach. In case we need 15 experienced project leaders within the next 12 months, we have to introduce that specific interest to our employees. In this way you are able to affect both of the curves [of the Competence Visualizer system]; it's simply a matter of marketing.

This interview quote highlights that organizational competence needs and individual competence interests cannot be treated independently in a CMS that embodies the skill-based paradigm. Instead, managers have to work through individuals' competence interests in order to meet the competence development needs of the organization. This approach to competence development might prove to be particularly challenging in situations where employees' interests are at odds with the organization's (and its customers') needs.

Evaluating at Volvo IT

After implementing the VIP prototype on Volvo IT's intranet, we initiated a 10-week evaluation with a workshop at Volvo IT's headquarters in Göteborg. At this workshop, which was attended by department managers, HR managers, project managers, system developers, and technicians, we introduced VIP as a complement to TP/HR and described its basic features. The workshop participants (approximately 30) were then encouraged to use VIP in their everyday work. After the 10-week evaluation period, during which we collected observational data, we interviewed 16 VIP users to

assess their perceptions of VIP, e.g., its usefulness in their work and its value with regard to competence management.

Our assessment revealed that VIP generated both anticipated and unanticipated consequences. With regard to anticipated consequences, a number of the practitioners remarked on the advantages of VIP's ability to capture competence and competence interests in real-time. They noted that the original CMS contained information on neither competence-in-use nor competence-in-the-making, whereas the prototype did. One HR manager felt that the VIP prototype represented a "next step" in competence management as it captured the tasks for which knowledge workers used their competencies:

> TP/HR is a lot about order and being in control of the situation, i.e., to know what we have and the level of education of our employees....Then this prototype is something else. It is what people do on an everyday basis. It is what they use their skills for. It is sort of the next step.

Several practitioners indicated that the interest-integration design principle implied a future orientation for CMS and they believed that this would stimulate competence development. A technology analyst expressed this in the following way:

> Interest is tremendously important for the development of competence. When you appreciate something and find it challenging, the fundamental conditions for learning are in place....So, to cultivate learning, it is important to provide positive tools like VIP; tools that cultivate a positive spirit increase the competence, the interest, the speed, and the quality.

A number of VIP users indicated that the principle of transparency, which allowed users to identify colleagues based on mutual or specific interests, rendered VIP a valuable tool for the creation of knowledge sharing networks or communities. As the CMS project manager highlighted, the transparency principle created the conditions for effective competence management in Volvo IT:

> I see [the find users with similar interest feature] as a very useful feature; as an enabler for building 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.

In addition to these anticipated consequences of our design principles as implemented in VIP, our evaluation also identified a number of unanticipated consequences. For instance, the principle of transparency was expected to increase knowledge sharing in the organization. However, the feedback from one Volvo IT project manager highlights that this is only true if the competence a user seeks exists within the CMS:

> Then you suddenly realize that the topics searched for are of no interest to others. Naturally it is valuable to know that there are no organizational members but me who are interested in these kinds of issues. Resulting from this, you understand clearly that there is no point to walk all over the office trying to find relevant people to talk to.

Thus, in the event that a competence cannot be located in the CMS, the system potentially created disincentives for organizational members to contact each other. Furthermore, the quote above illustrates how the system gives users a perspective of themselves in relation to the rest of the organization. It is unclear what emotional reactions people have when they cannot find anybody in the organization that either shares their interest or possesses the interest or competence that they are seeking. While some may view this as an opportunity to develop a niche in which they can differentiate themselves, others may view it as an indication of their own isolation.

Another unanticipated consequence of the prototype was the increased vulnerability that some knowledge workers perceived. Discussing the VIP system, one process developer suggested that the

system's manipulation of personal information, such as individuals' interests, made some users anxious:

> Typically individuals tend to be a little bit frightened when they are not in control. They are uncertain about how the system works, how detailed they should be, and how much personal information they are supposed to provide. To me it seems that some people feel anxious about the role of the technology.

Since interests are very personal and frequently related to the tentative exploration of a topic (as opposed to a firm commitment to a skill or knowledge, as might be inferred from earning a degree or attending a course), it is not surprising that VIP users felt protective of this private information and concerned about what inferences were made from it. Furthermore, interests are an expression of the self. Thus coupling the principle of interest-integration with the principle of transparency and real-time capture was rather problematic. Indeed, the combination of these three design principles created a system that had the potential of infringing on a user's privacy.

In our first action research cycle, we noted that competence data was frequently inaccurate because individuals did not want to be assigned to projects based on their existing competencies (competence-in-stock) rather than their competence interests. The principle of interest integration was expected to address this issue by allowing knowledge workers to specify their competence interests separately from their competence-in-stock. However, as the following quote from an interview with a system developer at Volvo IT indicates, our interest integration principle was unable to provide sufficient incentives for individuals to report their competence truthfully:

> Sometimes people choose to hide their interests. The main reason for this is basically that people want to remain anonymous. In case you express your personal interests openly there is an obvious risk that people will approach you with their problems and questions, resulting in a heavier workload for you as an individual.

Our prototype evaluation also revealed that there were few incentives for managers to promote the use of the CMS. Due to a lack of metrics and performance criteria related to the tracking of competence-in-use and competence-in-the-making, a member of the HR staff at Volvo IT highlighted the ambivalence managers felt toward our prototype:

> TP/HR is much more about structure, order, and control, and basically the system is intended to support the HR function with statistical analyses of the competence status of the employees. However, the VIP system deals with knowledge too, but in a different way. Fundamentally the system represents knowledge quite differently, and I'm positive about this system's ability to contribute to a lot of things....Although I'm pretty confident that you can't measure everything, the problem with this system is really how to measure it. Because the result generated by the system is not measurable, however, the problem is that nobody can take the credit. If you can't gain credit, you are not willing to deal with it.

In sum, our evaluation of the two prototypes highlighted that our design principles generated not only anticipated but also unanticipated consequences. In light of these findings, we revisited and refined our initial design principles. We discuss these in the next section.

Discussion

Prior research on organizational competence and its management highlights the importance of aligning an organization's core competence orientation with HR practices and systems that support the development of organizational competencies (e.g., Muffatto 1998; Nordhaug 1998; Rothwell and

Lindholm 1999; Simpson 2002). However, there is no prior research on the role of IT in supporting the management of organizational competence. Thus, our research objective was to develop and test design principles for CMS so that these systems support knowledge-intensive organizations embracing a core competence approach. Given that action research is a strategy particularly appropriate for the development of design principles (Walls et al. 1992), we conducted an action research study consisting of two action research cycles (Susman and Evered 1978).

In our first action research cycle, we identified two design principles intended to improve the quality of the organization's competence information. Working within the confines of the CMS that the participating organizations had selected, our interventions—to enhance formal competence descriptions with informal ones and to grant users control over their competence descriptions—were implemented to varying degrees. Our evaluation of the two interventions revealed a number of barriers that hampered CMS use in the participating organizations. For example, we learned that CMS reproduced extant competencies. This meant that knowledge workers interested in developing new skills were inclined to use the CMS in inappropriate ways by, for instance, failing to disclose all of their competencies. These insights provided the impetus for the second cycle of action research.

In the second cycle, we relied on further analyses of two CMS, Guide's Competence Marketplace and Volvo IT's TP/HR, as well as Lawler and Ledford's (1992) argument that the job paradigm is at odds with the core competence orientation of contemporary, knowledge-intensive organizations, to develop four design principles for CMS: the principles of transparency, real-time capture, interest integration, and flexible reporting. These design principles embody a skill-based approach, which Lawler and Ledford considered more appropriate for competence-oriented organizations. We subsequently implemented the four principles in two prototypes: Competence Visualizer and VIP.

Our evaluation of the prototypes in Guide and Volvo IT respectively revealed both anticipated and unanticipated consequences. Reflecting on these results and the entire 30-month action research project, we realized that we had to address the unanticipated consequences of our design principles. In particular, the design principles did not embed the user control idea pursued in the first action research cycle. Thus, we now revise and refine them based on our assessments of the prototypes. As our research did not reveal unanticipated consequences stemming from the principle of flexible reporting, which essentially incorporated the principle of user control, we revised only the first three design principles.

Revised Principle of Transparency

The principle of transparency specifies that competence should be made visible and accessible throughout the organization. This design principle was motivated by the desire to leverage information about individuals' competencies in the building of knowledge sharing networks and communities. By blurring the distinctions between business units in this way, the conditions for core competence development and more flexible, emergent organizational structures are created.

Even though our evaluation of this principle (implemented in VIP) suggested that transparency supports knowledge sharing and organizational learning, it also highlighted a number of unanticipated consequences. These arose out of combining the principle of transparency with the principle of interest-integration. Users expressed a sense of vulnerability as information about their interests, which are frequently more tentative expressions of the self than are competencies acquired via formally recognized means (e.g., courses), became widely available. Related to this is users' concerns that the public display of their competence (both competence-in-use and competence-in-the-making) would lead to increased workloads. Both of these conditions are likely to compromise the quality of competence data as knowledge workers either fail to disclose competence information in the CMS or misrepresent their competencies.

Another unanticipated consequence arises when there are gaps in the organization's competence. As the transparency principle makes these gaps visible to individual knowledge workers, CMS may impede the development of knowledge sharing networks as competence gaps suggest that contacting others is a waste of time.

To address individual users' concerns about too much visibility, we suggest that the transparency principle be renamed "user-controlled transparency." In other words, the control over which competence data is publicly displayed should rest with the individual knowledge worker. In this way, individual users can control the presentation of their competencies and the amount of personal data that is disclosed about them. For instance, in the case of VIP, users should be able to make agents public or private. A public agent would be searchable by other users' agents, while a private agent would not.

Additionally, organizations could address the unanticipated consequences of the transparency principle with management policies. By making knowledge sharing an activity on which the performance of individual knowledge workers is measured, users might see transparency as an opportunity to market their competence rather than as a threat. Indeed, as its name implies, Guide's Competence Marketplace embraced this notion of competence marketing.

Revised Principle of Real-Time Capture

The principle of real-time capture specifies that information about competence should be gathered as it emerges through knowledge work in action. This design principle was motivated by the desire to capture competence-in-use and thereby address the problem of inaccurate, outdated competence data. The user evaluation of real-time capture, as implemented in the VIP system, indicates that this principle is valuable with regard to tracking individuals' application of competence. It also highlights that some users perceived anxiety and vulnerability as a result of using the VIP prototype. This anxiety and vulnerability can be understood in terms of the users' uncertainty about how the system worked and how the information contained in it would be used.

To address this problem, we suggest that the real-time capture principle be refined to read "real-time capture with feedback loop." In short, users must be provided with a clear understanding of how the system handles the competence-in-use and competence-in-the-making data it gathers. Users should also not only have access to the system's representation of their competence data, but also the ability to amend it. For instance, the search criteria contained in an agent (some of which are based on the user's search criteria, and some of which are derived through retraining) should be made accessible to users. Finally, users should be able to edit their implicitly derived competence profiles. By combining implicit and explicit profiles of an individual's competencies, competence data is generated in an emergent, in-use fashion without users relinquishing control over the system's representation of their interests and competencies.

By providing such a feedback loop, the ambiguity associated with real-time capture and, as a consequence, users' perceived anxiety should be reduced. Furthermore, users' periodic review of the implicit, use-derived profile in the CMS might also serve as a basis for individuals' reflection on and learning about their competence and competence development.

The revised principles of transparency and real-time capture seem similar in that they both embody the notion that users should be given more control over their information. However, the first gives the user more control over who has access to their personal information, while the second provides the user control over the content in the CMS.

Revised Principle of Interest integration

The principle of interest integration specifies that CMS should accommodate a definition of competence that includes the individual knowledge worker's interests in addition to his/her extant,

formally recognized competence. This design principle was motivated by the desire to enrich the definitions of competence with interests as an indication of the skills and knowledge that individuals are motivated to develop. Thus, this principle supports competence-in-the-making.

Even though our evaluation of the interest integration principle indicated that this principle led to system features that users valued, especially in the Competence Visualizer system, it was also associated with a number of unanticipated consequences. Specifically, our evaluation of the Competence Visualizer at Guide highlighted that the combination of interest integration and transparency created conditions in which management will have to market the organization's competence needs to its employees so as to generate the requisite interest in the development of the necessary organizational competencies. In situations where employees' interests are at odds with the organization's (and its customers') needs, this approach to competence management promises to be particularly challenging. Furthermore, our evaluation of VIP at Volvo IT highlighted that there were few incentives for managers to promote the use of the CMS because performance metrics related to knowledge workers' interests were nonexistent.

We propose a revision of the interest integration principle, which we label "multi-perspective interest integration." This principle suggests that it is not only the individual's competence interests that should be taken into consideration in CMS, but also the organization's, which are assumed to be reflective of its customers' competence needs. In this way, the potential tension between individuals' interests and the organization's needs can be addressed, as the organization's strategic direction (i.e., the core competencies that it seeks to develop) is made explicit to the system's users.

Our multi-perspective interest integration design principle also provides the foundation for developing metrics and evaluation criteria related to competence-in-the-making. For instance, managers can be evaluated on the basis of a metric that incorporates both the speed with which the knowledge workers reporting to them reach the competence goals set by the organization and the degree to which this competence development is consistent with the competence interests of individuals. Alternatively, a metric representing an overview of the diversity of interests that an organizational unit encompasses can work as an indicator of the unit's flexibility and responsiveness to change. In this way, individual competence interests become highlighted and can be utilized for leveraging the core competencies needed for developing customer value.

Evaluating Our Action Research

In this section we assess how our action research compares to the principles of canonical action research (Davison et al. 2004). Our evaluation shows that our research satisfies all of the criteria put forth by Davison et al. (see Table 2 for a summary). In the ensuing section, we describe our assessment of our study.

The *principle of researcher-client agreement* highlights the importance of facilitating trust-building and knowledge between researchers and practitioners (clients) (Davison et al. 2004). In addition, it stresses the need for developing a mutual understanding of the scope, focus, and mode of inquiry of the research project. In our project, a third party, the research funding agency (VINNOVA) played an important role in outlining the terms for each organization's participation. VINNOVA required that each participating organization sign an agreement specifying resource allocations and regulating the potential commercial utilization of the research results. We believe that this agreement helped foster a working environment where opportunism, which is counterproductive with respect to learning, was minimized. For instance, organizations such as Frontec, Guide, and Volvo IT were willing to participate in the project and contribute resources to it even

though they competed with each other.[4] Thus VINNOVA provided a control structure through which some of the tensions associated with the divergent interests involved in action research could be handled (Avison et al. 2001; Mathiassen 2002).

The *principle of the cyclical process model* asserts that progressing through all five action research phases in a sequential manner is important to ensure that the action research is conducted systematically and rigorously (Davison et al. 2004). While a single research cycle is sufficient in some cases, additional iterations through the five phases can often yield additional learning. We applied Susman and Evered's (1978) action research cycle model composed of diagnosing, action planning, action taking, evaluation, and reflective learning. We relied on the first action research cycle to help us define the research problem and our interventions in an emergent way. With the lack of empirical support for our initial working hypothesis, we embarked a second action research cycle, which was more focused on the key problems of CMS design and use.

Our application of the canonical action research method, including a sequential use of the action research phases over two full iterative cycles, helped us specify and re-specify the research problem based on our own active involvement with it. For instance, the collaborative workshops, the jointly specified design principles, and the evaluations of our interventions in the first action research cycle deepened our understanding of the competence data problem over the different cycle stages. The successive learning eventually led to the recognition that we needed to explore our design principles for CMS outside of the confines of the existing systems.

Stimulated by the cyclical process model, this re-specification was a key element in our efforts to develop theoretically sound and practically valuable research contributions. Indeed, it triggered the development of an integrative model of competence including a competence typology, and this provided the basis for further learning and action. The synthesis conducted in this paper suggests the need of additional action research cycles to test the revised design principles. At the end of our research, there were discussions about a new project that would build on the lessons learned in the first action research cycle. However, no follow-on project was initiated once the research funding ended. Nevertheless, the first author of this paper continued his relationship with Volvo IT as a consultant.

The *principle of theory* highlights the importance of using theory to guide the research activity and relate the findings to extant theory (Davison et al. 2004). The development of the integrative model of competence provided the central theoretical scaffolding for our research, enabling us to synthesize findings from macro and micro level competence literatures. The model and its competence typology guided the analysis of CMS in use, the development of design principles, the interventions, and the evaluation of the prototypes. Using this model, it became possible to draw relevant insights from our action research project for HR researchers working with a core competence perspective. The model also guided our ongoing collaboration with practitioners in that it pinpointed the direction for designing CMS that cater to the three different competence types and that are reflective of skill-based assumptions.

The *principle of change through action* stipulates that interventions appropriate to the problem and the client organizations should be designed and implemented (Davison et al. 2004). This principle also concerns itself with the degree of practitioner involvement throughout the research process. In our case, the practitioner involvement was high throughout the project. This translated into both opportunities and challenges for our research. For example, the second action research cycle involved intense researcher collaboration with Guide and Volvo IT, thus situating prototype development and evaluation in a real-life, everyday context. As such, the solution we implemented promised to be appropriate to the problem.

[4]Even though Volvo IT was a division of the Volvo Group, it competed with IT consulting firms such as Guide and Frontec because Volvo Group's business units were free to source services from external vendors.

Table 2. Evaluating Our Action Research

Criteria		Our Action Research
1. The Principle of Researcher-Client Agreement		
1a	Did both the researcher and client agree that canonical action research was the appropriate approach for the organizational situation?	The early project meetings outlined an iterative research process, comprising problem analysis, action planning, interventions, and evaluations.
1b	Was the focus of the research project specified clearly and explicitly?	The focus of the research was formulated in the project proposal submitted to the research funding agency (VINNOVA).
1c	Did the client make an explicit commitment to the project?	The six organizations collaborated with the Viktoria Institute in finalizing the project proposal.
1d	Were the roles and responsibilities of the researcher and client organization members specified explicitly?	All project participants signed an agreement specifying their roles and responsibilities. This agreement included resource allocations and regulations for the possible commercial utilization of the research results.
1e	Were project objectives and evaluation measures specified explicitly?	The project description specified objectives and evaluation measures for both theory and practice.
1f	Were the data collection and analysis methods specified explicitly?	Methods for data collection and analysis, including prototype development and evaluation, were outlined in the project description and specified during the initial project phase.
2. The Principle of the Cyclical Process Model		
2a	Did the project follow the cyclical process model or justify any deviation from it?	Our project encompassed two cycles of diagnosing, action planning, action taking, evaluating, and specifying learning.
2b	Did the researcher conduct an independent diagnosis of the organizational situation?	We completed an independent diagnosis at the outset of each action research cycle.
2c	Were the planned actions based explicitly on the results of the diagnosis?	In both of our action research cycles, the insights gained during the diagnosing phase informed the intervention we planned.
2d	Were the planned actions implemented and evaluated?	In our first action research cycle, we implemented and evaluated two interventions within the confines of the CMS that the organizations were implementing. In our second action research cycle, we developed and evaluated two prototypes.
2e	Did the researcher reflect on the outcomes of the intervention?	In collaboration with practitioners from the participating organizations, we evaluated and reflected on the outcomes of our interventions.

Table 2. Evaluating Our Action Research (Continued)

Criteria		Our Action Research
2f	Was this reflection followed by an explicit decision on whether or not to proceed through an additional process cycle?	The disappointing outcomes of our interventions in the first action research cycle led us to proceed with an additional cycle of research.
2g	Were both the exit of the researcher and the conclusion of the project due to either the project objectives being met or some other clearly articulated justification?	The exit involved discussions about a new project that would build on the lessons learned from the completed action research cycles. No follow-on project was initiated, however. Nevertheless, the first author continued his relationship with Volvo IT as a consultant.
3. The Principle of Theory		
3a	Were the project activities guided by a theory or set of theories?	We relied on an integrative model of competence in organizations including a competence typology and distinctions between job-based and skill-based approaches to HR management as a theoretical basis for this research.
3b	Was the domain of investigation, and the specific problem setting, relevant and significant to the interests of the researcher's community of peers as well as the client?	The research objectives were developed in collaboration with practitioners to ensure that design principles for CMS represented an authentic problem. From an academic point of view, CMS represented an important and under-researched aspect of HR management and the systems that support it.
3c	Was a theoretically based model used to derive the causes of the observed problem?	In action research cycle two, the job-based approach to HR management was applied for understanding the observed problem.
3d	Did the planned intervention follow from this theoretically based model?	Our interventions were guided by our competence typology (competence-in-stock, competence-in-use, and competence-in-the-making), as well as the argument that the skill-based approach to HR management is more conducive to the support of an organization's core competence goals than the job-based approach.
3e	Was the guiding theory, or any other theory, used to evaluate the outcomes of the intervention?	We relied on our competence typology to assess the effectiveness of our intervention in the second action research cycle.
4. The Principle of Change through Action		
4a	Were both the researcher and client motivated to improve the situation?	With its mission of applied research, the Viktoria Institute is expected to improve practice in all the collaborative research efforts it pursues. The participating organizations were all seeking ways to improve their use of IT in competence management.

Table 2. Evaluating Our Action Research (Continued)

Criteria		Our Action Research
4b	Were the problem and its hypothesized cause(s) specified as a result of the diagnosis?	The problems and their hypothesized causes were collaboratively identified and formulated by researchers and practitioners during the diagnosis phase of each of our action research cycles.
4c	Were the planned actions designed to address the hypothesized cause(s)?	In action research cycle one, the implementation and configuration of CMS, guided by the two design principles, were planned to address the data quality problem. In the second cycle, CMS prototypes instantiating skill-based assumptions were developed to address the problems stemming from job-based CMS.
4d	Did the client approve the planned actions before they were implemented?	Actions were discussed, planned, and approved at regular project meetings involving both the researchers and the participating organizations.
4e	Was the organization situation assessed comprehensively both before and after the intervention?	The first action research cycle included assessments of the six participating organizations both before (technology review and workshop sessions) and after (focus groups, participant observation, and interviews) our interventions. The second cycle included assessments before (document review, participant observation, and interviews) and after (focus groups, participant observation, and interviews) our interventions.
4f	Were the timing and nature of the actions taken clearly and completely documented?	Throughout the complete action research project, all activities were documented and compiled as progress reports to the research funding agency.
5. The Principle of Learning through Reflection		
5a	Did the researcher provide progress reports to the client and organizational members?	Executive summaries and research papers were provided to the organizations at different stages of the project. In addition, oral communication was provided on a regular basis.
5b	Did both the researcher and the client reflect upon the outcomes of the project?	All data analysis included time for collaborative reflection over the results and their consequences. Typically, such collaborative reflection took place at specific project meetings where the action researchers presented their temporary understandings and preliminary implications as inputs.
5c	Were the research activities and outcomes reported clearly and completely?	Research papers were written and published throughout the duration of the project. In addition to scholarly publications, progress reports were regularly delivered to the research funding agency.

Table 2. Evaluating Our Action Research (Continued)

Criteria		Our Action Research
5d	Were the results considered in terms of implications for further action in this situation?	After the termination of our action research project, both Guide and Volvo IT initiated new CMS projects in which they applied the theoretical principles to which our action research project introduced them.
5e	Were the results considered in terms of implications for action to be taken in related research domains?	Our results were discussed in terms of their implications for other types of HR systems in the participating organizations. In particular at Volvo IT, implications for career management, recruitment and selection, and training were discussed.
5f	Were the results considered in terms of implications for the research community (general knowledge, informing/re-informing theory)?	The research implications of our results are relevant for HR researchers working with a core competence perspective. In this regard, it is important to note that "theory may never be scientifically generalized to a setting where it has not yet been empirically tested and confirmed" (Lee and Baskerville 2003, p. 240). This means that generalization always involves extrapolation into new research settings. Following Lee and Baskerville, our generalizations should be taken as well-founded but as-yet untested hypotheses.
5g	Were the results considered in terms of the general applicability of canonical action research?	Our project benefited from the cyclical process model, rigorous structure, and collaborative researcher involvement of the canonical action research method. In this way, the canonical action research method was generally applicable to our project context. The advantages and drawbacks of our prototype use might provide input to improve the canonical action research method for design-oriented IS research. The practical challenges of handling the socio-technical challenges of prototype use must be balanced with the scientific process of operationalizing theory into design principles (action planning), converting design principles into IT artifacts (action taking), and inferring use data back to theory (evaluating/specifying learning). Such guidance would have enabled us to focus more on learning and reflection about the interplay between the knowledge generation and emergent changes in the client-system infrastructure.

At the same time, high practitioner involvement also requires a high degree of sensitivity toward the demands that everyday work places on the participants. For example, Guide's merger with Framfab meant that the resources for and the interest in our Competence Visualizer prototype declined. Thus, to complete the project, we relied on evaluation strategies involving workshops and focus groups to simulate as realistic an environment as possible for the intended Guide users. Nevertheless, we do not consider these evaluation methods as authentic as the ones we were able to use in Volvo IT.

The *principle of learning through reflection* highlights the importance of drawing insights from the research and of identifying implications for other situations and contexts. Apart from providing progress reports and research papers throughout the stages of an action research project, this principle highlights that it is central to investigate the magnitude and sustainability of the research efforts over time. Even though it is difficult to measure the extent to which our research outcomes resulted in further action in practice, it should be noted that Volvo IT initiated a worldwide project to outline its competence management strategy. In this project, personal interest profiles were incorporated into individuals' competence descriptions. We contend that this feature can be traced back to the interest dimension of our integrative model, which was also incorporated into the VIP prototype. Guide practitioners also recognized the learning implications of our project. For instance, Guide developed a new version of Competence Marketplace that incorporated features of Competence Visualizer. This system became part of Guide's offering to their customers. Moreover, we believe that our results were important in terms of its implications for other types of HR systems. In our collaboration with Volvo IT, for example, the implications of our research were discussed as part of career management, recruitment and selection, and training sessions.

As action researchers we need to balance the theoretical demands of academia with the problem-solving demands of practitioners. In practice, this means that theory has to be made accessible to practitioners and practice has to be made accessible to academic theory. In this regard, we found that our prototypes played an invaluable role as boundary objects; they made theoretical concepts more tangible and comprehensible. For instance, the VIP prototype at Volvo IT afforded our practitioner collaborators sensemaking opportunities, especially with regard to their current CMS' support of the different types of competence. The prototypes also facilitated discussion about the distinction between skill-based and job-based assumptions. We thus found the prototypes effective in communicating, collaboratively developing and evaluating our theoretical ideas.

As our project also illustrates, however, the use of prototypes can divert the attention from the original research agenda. In our case this was due to the considerable effort—both technical and social—needed to develop and implement prototypes within the realm of practice. Our interventions in the second action research cycle were based on the disappointing outcome of the first cycle and informed by skill-based assumptions. However, in our quest to develop CMS that support competence-in-use and competence-in-the-making, we failed to consider the increasing exposure of the user following the transparency and the real-time capture principles. In this regard, we did not pay enough attention to our initial user control principle in the development of the design principles in our second action research cycle.

The strengths and weaknesses of our use of prototypes might provide input to improve the canonical action research method for design-oriented IS research. In our case, it would have been useful to have guidelines to help us ensure that the prototypes contributed to both knowledge generation and the implementation of change. The development of design principles is not simply about operationalizing theory into neat principles for normative action, but it involves also an assessment of available tools and situated conditions such that these principles render to technically and organizationally feasible solutions. As suggested above, the complexity and magnitude of the technical challenges made us lose sight of users' needs and concerns. This was not the case

in the first cycle in which we could focus on the user and organizational requirements with respect to competence management.

In design-oriented action research, the practical challenges of handling the socio-technical challenges of prototype deployment must be balanced with the scientific process of operationalizing theory into design principles (action planning), converting design principles into IT artifacts (action taking), and inferring use data back to theory (evaluating/specifying learning). Neither canonical action research (Davison et al. 2004; Susman and Evered 1978) nor the newly developed framework for the dual imperatives of action research (McKay and Marshall 2001) addresses this dimension of action research in IS.

Conclusion

Synthesizing the insights gained from a 30-month action research study involving numerous data collection strategies and interventions such as prototypes, our study has generated an integrative model of competence in organizations, a competence typology, and a set of design principles for CMS. Our integrative model contributes to the body of literature seeking to align the macro and micro levels of competence (e.g., Muffatto 1998; Nordhaug 1998; Rothwell and Lindholm 1999; Simpson 2002). It provides a conceptual framework for incorporating IT into our understanding of competence management in organizations. Informed by Orlikowski's (1992) structurational model of technology, we conceptualize IT as a mediating element in the integration and alignment of competent action at the micro level and core competencies at the macro level. Given the increasingly important role of IT in competence management (Alavi and Leidner 2001; Andreu and Ciborra 1996; Davenport and Prusak 1998), the literature on aligning macro and micro level competence is incomplete if it fails to make IT an integral part of its theorizing. Our integrative model further extends the conceptualization of competence at the level of the individual worker. Relying on learning theory (Kim, 1993; Kolb 1984), we identify a competence typology including three types of competence: competence-in-stock, competence-in-use, and competence-in-the-making. Our findings suggest that for CMS to be successful, they will have to support all three of these competence types.

Our four CMS design principles extend earlier work on HR management by empirically demonstrating that an infrastructure reflective of the job-based paradigm present problems for competence management in contemporary, knowledge-intensive organizations (Lawler 1994; Lawler and Ledford 1992). As our assessment of CMS in organizations during our first action research cycle demonstrated, systems embodying the job-based paradigm with its predefined job descriptions and taxonomies of formal competence create barriers to the adoption and appropriate use of CMS. Furthermore, the findings of our second action research cycle suggest that HR infrastructures that embrace the skill-based approach must be accompanied by sufficient user control over the information that represents the user's competence. Our findings highlight the interdependence between organizational needs for competence and individuals' competence interests. Organizations adopting a skill-based approach will find that they have to market their competence needs to their workers in order to stimulate individuals' interests in a particular competence.

These insights elaborate on Lawler and Ledford's assertions about the skill-based approach by providing an empirically grounded picture of it. Furthermore, through our revised design principles, we identify ways of addressing the problems that are likely to arise in the application of the skill-based approach. For instance, our principle of multi-perspective interest-integration seeks to resolve the potential conflict between organizations' competence needs and individual knowledge workers' competence interests. Our revised design principles, therefore, serve not only as the basis for future academic research on design principles, but also as guidelines for practitioners seeking to design and implement CMS in knowledge-intensive organizations that are pursuing a core competence orientation.

First, our research has highlighted that the degree of competence transparency in a CMS is a challenging design choice. While transparency is desirable because it facilitates the transfer of expertise and the sharing of knowledge, our research highlights the trade-off between competence transparency and users' privacy. Our design principle of user-selected transparency captures the need to make transparency subordinate to user control. Another design challenge is to support data accuracy and system flexibility, especially with regard to the emergence of competence. While real-time capture promises data accuracy as it tracks what competence knowledge workers apply in their everyday work and what interests they are pursuing, our research revealed that implicit, system-generated descriptions of users' competence and interests creates anxiety among users. Our revised design principle of real-time capture with feedback loop highlights the importance of providing users access to system-generated, implicit profiles. The implicit profiles should be made adjustable through users' explicit rankings of their competence and interest. Thus, again, user control should override the designer's desire for the accuracy and efficiency of real-time data capture.

In addition, CMS need to support not only individual knowledge workers' needs, but also the needs of the organization. Our research identified the potential for tension in competence management when the organization's (and its customers') competence needs are subordinate to individual knowledge workers' interests. Our design principle of multi-perspective interest integration captures the notion that the organization's competence needs and strategic competence direction must be balanced with individual knowledge workers' competence development interests. Finally, given the strategic importance of competence in knowledge-intensive organizations, the summary, visualization, and reporting of competence information is a key design challenge. Our research has highlighted the need for flexible, user-controlled reporting in CMS.

IS research on design theories distinguishes between design principles that address a system's functionality and its development methodology (Markus et al. 2002; Walls et al. 1992). Our research has focused only on the former. We thus see the need for future research on not only the efficacy of our revised, functionality focused design principles, but also on design principles that guide the CMS development methodology.

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