USING INTRANET TECHNOLOGY TO FOSTER ORGANIZATIONAL KNOWLEDGE CREATION

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ABSTRACT

Many organizations have embraced intranets with the intent to harness the technology to support knowledge management initiatives. Despite the promise that intranet technology holds in this regard, many of the early research studies indicate rather disappointing results. In this paper we propose a model that organizations can use to conceptualize and reflect on their intranet applications with a view towards more fruitful results, specifically in terms of knowledge creation. We do so by drawing upon Nonaka's well-known framework of knowledge creation and combining that with a taxonomy of five intranet use modes. For each of Nonaka's four knowledge creating activities we associate and describe the corresponding primary intranet use mode that we argue can foster the knowledge creation process. We illustrate the arguments with findings from our own empirical intranet field studies and other documented intranet-related knowledge management research. We conclude with some implications of the model and we suggest avenues for further research.

1.   INTRODUCTION

Intranets have been embraced in record time by many organizations. From being a largely unknown technology only a few years back, a vast number of knowledge-intensive organizations have now embarked on large-scale intranet implementations. Organizations have implemented intranets for a variety of reasons including to share information, to enhance organizational communication in general, and to support collaboration across departmental, functional and regional boundaries (Bernard, 1996; Scacchi & Noll, 1997; McNaughton et al., 1999). A recent development is the organizational application of intranet technology to support knowledge management (KM) processes (Scott, 1998; Alavi & Leidner, 1999a; Newell et al., 1999).

Knowledge management is currently positioned as a novel approach to stimulate creativity and innovation in modern organizations (Davenport & Pruzak, 1998; Kanter, 1999; Laudon & Laudon, 2000; Cross & Baird, 2000). Many organizations operate in complex, dynamic and highly competitive global environments. In

order to survive, these organizations exhibit emergent properties such as flatter organizational structures, a more decentralized and networked nature, an emphasis on individual creativity and initiative, and a project-driven culture (Perrow, 1986; Allen & Scott Morton, 1994). The value of developing knowledge workers and effective knowledge management is now increasingly linked to organizational performance and survival (Drucker, 1995; Davenport & Pruzak, 1998; Hackbarth & Grover, 1999; Cross & Baird, 2000).

The ideas that underpin knowledge management are not fundamentally new (Spiegler, 2000) and can be traced to concepts such as the learning organization (Senge, 1990) and organizational memory (Huber, 1991). In addition, the role of information technology (IT) in enabling and supporting knowledge work and knowledge workers in organizations has been well documented in the past (e.g. Sviokla, 1996; Ciborra, 1996; Davenport et al., 1996). However, the more recent mass organizational adoption of intranets, combined with some unique features of the technology (such as its hypermedia capabilities) has stimulated fresh research interest into the application potential of intranet technology for knowledge management. In one survey, Alavi & Leidner (1999a) found that companies that pursue KM initiatives most often do so by implementing an intranet (as opposed to an isolated knowledge management system).

Despite the promise that intranet technology holds in this regard, there are however few documented examples of successful intranet-supported knowledge management. In fact, most of the early available research studies on intranet supported KM initiatives report rather discouraging findings. For example:

"When asked to give an example of the 'most useful knowledge' stored, interviewees responded with the example of the intra-site bus timetable! This was the timetable for the bus which travelled round the different company sites in the particular city, going at regular intervals every 20 minutes or so. Another example given was of the ability to track stationary orders so that an individual could have visibility about where their pencil order was in the system. It is doubtful whether these examples will revolutionise the knowledge base of the particular company." (Newell et al., 1999)

We suspect that the reason for such disappointing findings is twofold. Up to now, many intranet studies have focused mainly on only one popular application of the technology, namely publication of organizational information. We are convinced that richer application modes of the technology beyond publication may indeed be conducive to knowledge creation. A further reason for these disappointing findings thus far, may relate to some authors' fairly static view of intranet technology as a "given", packaged technology with some universal characteristics and features (Lyytinen & Damsgaard (1998) warn of this stationary view). Instead we advocate the idea that to a large degree an intranet takes form after the context in which it is implemented and the organizational culture (Schein, 1996), history and traditions of earlier technology adoptions (Kling, 1980) are important when seeking to understand its manifestation. Thus seen, the intranet is not a "packaged" technology with fixed attributes, but rather a learning intensive and highly malleable technology that is molded and shaped according to the social forces at play in the organization (Hughes, 1987; Williams & Edge, 1996). This explains why the same technology can manifest completely differently in different organizational settings.

While some other researchers have explored the potential of intranets to support knowledge management in broad terms (e.g. Scott, 1998; Gottschalk, 2000), we focus here specifically on how intranets may be used to foster the creation of new organisational knowledge. In particular we distinguish a number of intranet application modes that can be exploited in support of various knowledge creation processes. We do so by proposing a combined model of knowledge creation and intranet use modes. Although this paper is speculative in nature, our research is empirically founded. Briefly summarized, we conducted an in-depth interpretive field study of intranet implementations in large Danish and South African organizations over a period of three years. Our empirical base includes more than forty interviews and follow-up interviews in total, as well as a rich variety of other evidence associated with each organization's intranet use. Details of the empirical field study have been published elsewhere (see Damsgaard & Scheepers, 1999; Damsgaard & Scheepers, 2000; Bansler et al., 2000).

This paper is outlined as follows. First, we highlight some features of intranet technology and draw upon a taxonomy of five intranet use modes. Thereafter we explore issues pertaining to knowledge management and knowledge creation processes in particular. We briefly present Nonaka and Konno's well-known model of

knowledge creation. We then combine the model of knowledge creation with the taxonomy of intranet use modes. We illustrate the combined model with findings from our own empirical intranet field studies and other documented intranet-related knowledge management research. We conclude with some implications of the model and we suggest avenues for further research.

2. INTRANET TECHNOLOGY

Defined technically, intranets are the application of Internet technology (and specifically the World Wide Web service) for a prescribed community of users (typically members of an organization). Well-understood and widely available Internet technology and standards (web servers, browsers, protocols) are employed, but access is restricted exclusively to specified organizational members, typically by means of passwords and/or firewalls (Oppliger, 1997; Laudon & Laudon, 2000). The technical set-up of the intranet technology is relatively straightforward and the first information content can be quite easily created. In the following subsections we address some specific features of intranet technology.

2.1. Intranet Technology Characteristics

Intranet technology is multi-purpose, richly networked and integrates text, graphics, sound, and video (Bernard, 1996; Hills, 1997; Damsgaard and Scheepers 1999). Intranet technology supports both structured and unstructured data, mostly by means of HTML (Hypertext Markup Language) documents as the common language of the Web (Lyytinen et al., 1998). Since HTML describes the presentation of data (independent of any specific computing platform), it enables information exchanges between diverse computing environments within the organization (and across functional boundaries). Such exchanges are facilitated through departmental intranet servers (located behind the organizational firewall) which organizational members can readily access using a standard Web browser (Chellapa et al., 1997).

Unlike most IT, intranets do not exclude the presence of other IT systems (as a new inventory system often excludes the former). Instead intranet technology is the unifier that can integrate existing IT systems and provides "legacy systems" with a new graphical interface. Therefore intranets are often referred to as "glueware" or "middleware" (Lyytinen et al., 1998). As such, intranet technology can unify various computer-based systems in the organization into one rich "system" with the Web browser as the universal interface.

2.2. Intranet Technology Usage

The organizational application of intranet technology tends to evolve and increase in sophistication over time (Scheepers & Damsgaard, 1997; Romm & Wong, 1998). This pattern is not imposed by the technology itself, but exhibit the organizational learning involved in applying the technology (Attewell, 1992). Initially, the technology is typically used for *publishing* "static" information (e.g. departmental home pages, technical documents, product information, etc.). Provided the supporting technical infrastructure exists, setting up a simple intranet website to publish information does not involve a major learning or financial commitment (Ciborra & Hanseth 1998). By creating intranet sites with information that employees can readily access via the browser, organizations can save the obvious costs associated with printing, publishing and distribution of paper-based information to employees. Intranet-based publication also ensures that everyone uses the most recent version of information (compared to the alternative of physically distributing new and removing old copies of some document).

As the organization becomes more familiar with the technology, it may be applied for more advanced purposes. Intranet technology can be applied in different "use modes" simultaneously (Damsgaard & Scheepers, 2000). These range from simple use modes such as the mentioned publishing, to more advanced use modes such as organizational-wide *searching* for information; *transacting* with functionality on intranet pages and other organizational computer-based information systems; *interacting* between individuals and

groups in the organization; and even the *recording* of the computer-based "organizational memory". The five intranet use modes and typical application examples are summarized in Table 1.

Use mode	Description
Publishing	Using the technology to publish information (e.g. home pages, newsletters, technical documents, product catalogues, employee directories).
Transacting	Using the technology to transact with functionality on intranet pages and other organizational computer-based information systems e.g. via web forms.
Interacting	Using the technology to interact with other individuals and groups in the organization (e.g. via discussion groups, collaborative applications).
Searching	Using the technology to search for organizational information (e.g. via search engines, indexes, search agents).
Recording	Using the technology to record the computer-based "organizational memory" (such as capturing best practices, business processes, frequently asked questions).

Table 1: *A summary of intranet technology use modes (Damsgaard & Scheepers, 2000)*

2.3. Intranet Behavioral Aspects

In our fieldwork, we have noticed that intranet technology can trigger new behavioral patterns that we argue are conducive to knowledge creation. Unlike with many information systems and technologies where the target users are often known, this is not necessarily the case with an intranet. To a large extent, this means that the intranet user may read and inquire without being identified (i.e. anonymous inquirers). Compare this to a telephone call or an email where the inquirer reveals her identity in the process of asking. In this respect, many new employees reported to us that the intranet provided them with a very attractive alternative to learn about their working environments without running the risk of revealing their ignorance when asking about specific issues.

On the other hand, the question also arises if people would voluntarily put information onto the intranet. Indeed such an activity was reported as an add-on to an already busy schedule by some interviewees. However, we encountered numerous examples of intranet "exhibitionists" who would dedicate hours of extra work to publish information onto the intranet. Instead of an add-on, these actors viewed the intranet as a means to gain some organizational "visibility" and repute (similar findings are also reported by Davenport & Pruzak, (1998)). The following quotations from our field study illustrate this behavior:

> *"People are joking with me, but I put my name on all the intranet pages I create. I want to go further and get a post as a programmer so I can have a budget for software."* [Technical Official, January 1998]

> *"As secretary, you usually just type what other people think. Now all of a sudden I have an identity of my own."* [Secretary and intranet content provider, August 1998]

We have also noticed some changes in information distribution and seeking behavior in our cases. Instead of sending out all information "just-in-case" people need it (and thus placing the onus upon interested recipients to maintain their own information repositories e.g. e-mail folders, file systems, etc.), the intranet is beginning to evolve into a "definitive organizational record". This also fosters a "just-in-time" information seeking behavior:

> *"We create content – agendas, minutes and background information and just park it on the intranet. We don't email it out to everyone anymore. It's their responsibility to go and fetch it."* [Quality and Information Manager, September 1997]

3. KNOWLEDGE MANAGEMENT PROCESSES

A detailed examination of the nature of knowledge itself and of the complexities of organizational knowledge management is beyond the scope of this paper. Instead we will highlight some facets of

knowledge and its organizational management that are fundamental in conceptualizing any proposed information technology support for the process.

One of the central aims with organizational knowledge management is to leverage the knowledge of individuals or teams so that this knowledge becomes available as a resource for the entire organization. This resource should ultimately not be dependent on particular individuals and should survive the originating individual (Davenport & Pruzak, 1998).

Knowledge management is often subdivided into three highly intertwined organizational processes (Wiig, 1993; Alavi & Leidner, 1999b). The first process is knowledge creation and involves the creation and addition of new knowledge to the organization's knowledge repository. The second is knowledge retrieval and involves the identification and access of relevant knowledge from the knowledge repository. This is also referred to as "accessing the organizational memory" (Huber, 1991). The third process is knowledge distribution whereby organizational actors share and diffuse knowledge within the organization. We focus primarily on the knowledge creation process in this paper, although we touch on the other processes due to their intertwined nature. In the next section we will discuss knowledge creation by reviewing pertinent literature and their findings. In preparation for that discussion, we first examine some characteristics of knowledge itself.

Knowledge is commonly separated into tacit and explicit knowledge. Explicit knowledge can be expressed in words and numbers and shared in the form of data, scientific formula, specification and manuals (Nonaka, 1994; Nonaka & Konno, 1998). This kind of knowledge can readily be transmitted between individuals formally and systematically, and consequently also through modern information infrastructures such as an intranet (Alavi & Leidner, 1999a). Tacit knowledge on the other hand is not easily visible and expressible, and it is hard to transfer because it cannot be stated explicitly (Davenport & Pruzak, 1998). Tacit knowledge is personal and difficult to formalize, which also makes it hard to communicate and share with others. Tacit knowledge is deeply rooted in an individual's actions, skills, and experience as well as in her ideals, values and emotions (Wiig, 1993). According to Davenport & Pruzak (1998) knowledge originates and resides in the minds of the knower, but it also becomes embedded in organizational documents, repositories, routines, processes and norms.

3.1. Knowledge Creation

Nonaka and Konno (1998) model the knowledge creation as a process of interactions between explicit knowledge and tacit knowledge. Figure 1 depicts the characteristics of the four knowledge creation process modes (and the associated conversions between tactic and explicit knowledge). In the following, we briefly summarize the four conversion processes.

Socialization

In the first mode of the knowledge creation processes, tacit knowledge is converted through a socialization process between individuals. Nonaka and Konno stress that they use the term socialization to emphasize that tacit knowledge is exchanged through joint activities and action. For example the traditional notion of *apprenticeship* is exemplary of this kind of knowledge creation.

Traditionally, socialization involves capturing knowledge through physical proximity. The process of acquiring knowledge is largely supported through direct interaction. Information is accessed at the actual job site within the company and the latest available information is collected and interpreted as collective action. Disseminating tacit knowledge is another key aspect of socialization. The process of transferring one's ideas directly to or have them challenged by colleagues is a means to share and create personal knowledge. In short, the key to acquire tacit knowledge is through experience and social interaction.
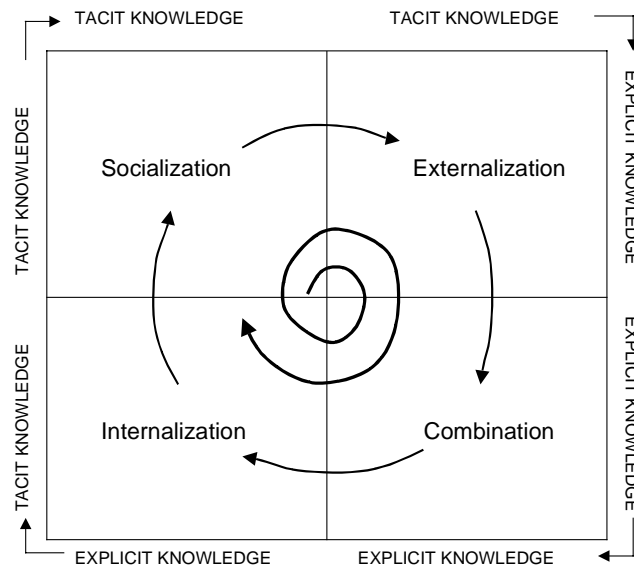
	TACIT KNOWLEDGE	TACIT KNOWLEDGE	
TACIT KNOWLEDGE	Socialization	Externalization	EXPLICIT KNOWLEDGE
TACIT KNOWLEDGE	Internalization	Combination	EXPLICIT KNOWLEDGE
	EXPLICIT KNOWLEDGE	EXPLICIT KNOWLEDGE	

Figure 1: *Nonaka's and Konno's (1998) model of organizational knowledge creation processes*

Though it may be more efficient, face-to-face social interaction is not necessarily a prerequisite to acquire tacit knowledge. Indeed, the socialization process can be facilitated electronically in a rich way. In this regard, Ngwenyama & Lee (1997) demonstrate that even a "lean" communication medium such as email has a rich capacity for exchanging tacit thoughts. For example, the evolution of the "smiley" in emails (such as:-) for a smiling face) shows how simple ASCII characters may be used to convey shared connotations between members of a social system.

Externalization

Externalization requires the expression of tacit knowledge into comprehensible codified forms that can be understood by others. The individuals' intentions, norms and beliefs thus become integrated with the group's knowledge.

In practice externalization is supported by two key factors (Nonaka & Konno, 1998). The first is the articulation of one's own tacit knowledge through techniques that help to express ideas or images as words, concepts and figurative language (such as metaphors, or analogies). Therefore dialogue strongly supports externalization. The second factor is the translation of others' tacit knowledge into readily understandable forms. An example of this from the systems development domain is the altering between analytical and experimental modes of inquiry to determine system requirements (Mathiassen & Stage, 1992; Boehm, 1988).

Combination

Combination involves the conversation of explicit knowledge into more complex sets of explicit knowledge. Central to this process is the integration, dissemination and the systematization of knowledge.

Nonaka and Konno posit that the combination itself relies on three processes. Capturing and integrating new explicit knowledge is pivotal. This includes collecting externalized knowledge from inside or outside the organization and then combining this to create new knowledge. The dissemination of explicit knowledge is based on the process of transferring this form of knowledge directly e.g. by means of presentations or meetings. Hereby, new knowledge becomes readily accessible to other members of the same social system. The systemization of explicit knowledge involves the editing or processing of explicit knowledge into plans and reports to make it more usable. In the combination process, justification occurs allowing the organization to formulate practical action steps.

Internalization

Internalization refers to the conversion of explicit knowledge into the organization's tacit knowledge. This requires the individual to identify the knowledge relevant for herself within the pool of organizational knowledge. Learning-by-doing, training, and exercises allow the individual to access the knowledge realm of the group or the entire organization.

Nonaka and Konno argue that in practice internalization relies on two dimensions. First, explicit knowledge has to be embodied in action and practice. Thus the process of internalizing explicit knowledge actualizes concepts or methods about strategy, tactics, innovation or improvement. For example training programs help the trainees to understand the organization and their role in the whole. Second, there is a process of embodying the explicit knowledge by using simulations or experiments to trigger learning-by-doing processes. New concepts or methods can thus be learned in virtual situations.

4.   A MODEL OF INTRANET-FACILITATED KNOWLEDGE CREATION

Much of the KM literature is based on an information systems perspective and the belief that Knowledge Management Systems (KMS), for example intranets, can be used to capture and store organizational actors' knowledge and make it available to others (Newell et al. 1999). Due to the characteristics of the technology, intranets are an efficient mechanism for distributing codified knowledge, but we argue here that intranets also have the potential to alter the borderline between tacit and explicit knowledge. The cheap and proven intranet technology makes it economically attractive and feasible for organizations to codify a larger portion of its tacit knowledge base. However, as pointed out by Foray & Lundvall (1997), this does not diminish the importance of tacit knowledge. On the contrary, it stipulates the need for high skill levels and competence when selecting the appropriate codified knowledge. In the following we present the model of the organizational knowledge creation process and the primary intranet use mode that can foster each of the conversion processes (see Figure 2).

4.1.   Socialization

We see the primary intranet use mode for socialization as *interaction*. Intranets can support various forms of personal interaction, thereby connecting knowledgeable individuals with each other. In its simplest manner it may be in the form of person-to-person interaction. Another form that is supported can be one-to-many interaction where one individual shares his/her ideas or views using the intranet. The most complex form is many-to-many interaction where a group of people interacts with another group of people using the intranet. For example, the marketing department may interact with the production department about recent sales and the need to reschedule production plans. Popular intranet applications to support such interaction include threaded discussion groups, employee home pages, project pages, group calendars, various types of collaborative applications such as shared workspaces and even concurrent engineering (Coleman, 1997; Scherer, 1997).

Compared to face-to-face interaction, the intranet is neither an obvious nor the best facilitator of this kind of knowledge conversion. However when physical distance, time differences or working conditions makes personal interaction impossible or difficult, the intranet can be a viable alternative.

For example, in one large South African company we found an interactive intranet discussion group called "The Wall" where (dis)pleased employees can express their opinions anonymously by painting graffiti slogans on an HTML background that resembles a brick wall. The Wall was a tremendous success among the employees, who stated that it was an attractive way to "let off steam". The management could also read the graffiti on the Wall and gain a feel of the general atmosphere in the company.
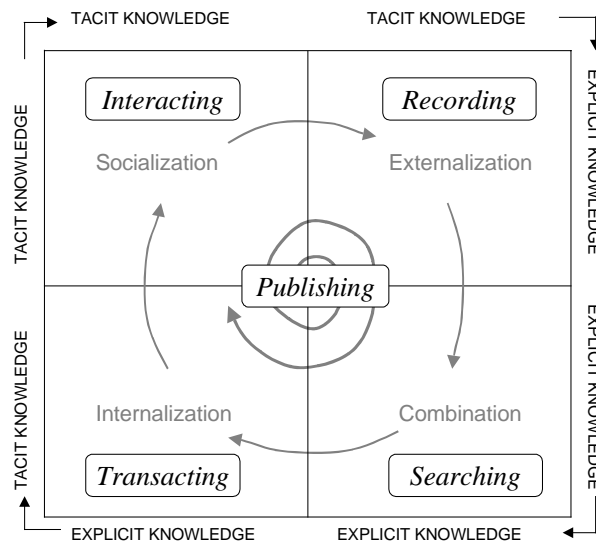
Figure 2: Primary intranet use modes for facilitating knowledge creation

Not all intranet-facilitated knowledge conversion need necessarily be "desired". In one case, we noted the lack of interaction in intranet based cross-functional discussion groups at a large Danish company. The management recognized that information exchanges rarely took place between functions (resulting in functional knowledge "silos"), but had hoped that by implementing an intranet this would change. However, in our interviewees' opinion it became clear that the intranet made the lack of cross-functional interaction even more visible. Interviewees often cited the empty intranet discussion groups and this effectively re-enforced this undesired behavioral pattern in the organization (similar observations have also been reported by others e.g. Newell et al., 1999; Scheepers & Damsgaard, 1997).

4.2. Externalization

We see the primary mode of intranet use for externalization of knowledge as *recording*. The ease with which information from a variety of quarters in the organization can be assimilated and integrated using intranet technology, means that the intranet can ultimately become the computer-based "organizational memory" (as Huber (1991) envisioned the concept).

By using the intranet as "definitive record" for organizational processes as they unfold over time, the intranet may mature into a rich record that can be "excavated" over time. In this manner key events could be "replayed" to create knowledge by reflecting on previous solutions to problems, recurring problems, etc. In comparison to having such information locked away in filing cabinets, the availability of a rich, electronically searchable record holds great potential in this regard. In one of our cases, a senior R&D programme manager commented that they meticulously record all their project documentation, customer meetings minutes, etc. on the intranet. He elaborated:

"(Since the inception of the intranet-based project repository) I don't think I have ever asked a project leader what's going on in his project. The only paper that have arisen out of the project are the contracts that had to be signed. We just don't generate other paper around the project" [Programme Manager, January 1998]

The recording can capture a rich account of factors that only ex ante can be deemed important explanations when seeking to understand the project process. For example, only when carefully examining several projects with hindsight some patterns may emerge. At the time, such a pattern would not be easy to identify or articulate by the individual project members.

Although we have seen many examples of such diligent intranet recording, we have not yet seen a similar level of activity in "excavating" this careful record.

4.3. Combination

We see the primary mode of intranet use in the combination of knowledge as *searching*. Intranet searching can take on a number of forms. A "flat search" could be to navigate from perhaps the intranet home page by following hyperlinks to the desired information (Hills, 1997). This of course requires that the searcher knows what she is searching for and an appropriate navigation path to this information.

Apart from the intranet home page, other intranet "portals" may be created to serve as a starting point or entrance for searches (Bhattacherjee, 1998). An intranet portal can be an index or directory page, or an intranet search engine. For example, the marketing department may decide to create such an internal portal to various marketing-related information in the organization. Similarly, many other portals to the same information space can be set up (e.g. with a customer, departmental, product or project view in mind). In addition to these searches, we may see even more advanced searching on intranets (for example as agent technologies mature (Caglayan & Harrison, 1997)).

By combining codified knowledge from various repositories scattered throughout the intranet, new avenues are opened up for the creation of cross-functional knowledge that is required for example in process innovation and new product development (Scacchi & Noll, 1997; McNaughton, 1999; Cecez-Kecmanovic, 1999). Searching the intranet or child-webs across the organization helps to identify potential useful knowledge, which in combination with other knowledge might bring about new valuable knowledge.

In this regard, a vice president in a large Danish company outlined a typical problem that he expects their intranet will help alleviate:

> *"People sitting only a few 100 meters away from each other do not know they are working on similar things ...I am often amazed how much people re-invent, not because they want to but because they don't know it exists."*
> [Vice President, October 1998]

The potential for creating new explicit knowledge by combining existing codified knowledge, indicates that it is certainly worthwhile for organizations to invest in advanced search features on their intranets. In our field study numerous users have criticized the lack of sophistication of their organization's current intranet search functionality.

4.4. Internalization

We see the primary intranet use mode for internalization of knowledge happening through *transaction* with intranet-based knowledge repositories.

Using HTML forms and relying on the standard Internet protocols, many existing organizational computer-based information systems can be accessed via the intranet (provided of course the necessary linkages are introduced, e.g. by web-enabling "legacy systems" and other repositories) (Ressler & Trefzger, 1997). In the same manner, embedded intranet-based functionality in scripts and applets on home pages of various departments, groups and employees can be accessed.

Using the browser as standard front-end, the intranet enables users (often for the first time) to gain direct access to systems and repositories of information located in other parts of the organization. Prior to intranet technology, such cross-functional information accesses typically required the user to master complex system interfaces or the intricacies of disparate systems.

By having the ability to interpret information from various quarters in an organization, even "non-technical" employees can effectively use the intranet as their own virtual learning environment. In this respect the intranet can especially enable the (new) employee to make sense of her surroundings. This is illustrated by the following:

> *"(The intranet) is a nice place to find information and saves a lot of time. In my old job we never had something like that. As a new employee, I wanted to know what I can find out without asking too many questions"* [intranet user, October 1998]

In one company we studied, going through old project reports or the quality handbook that was made available on the intranet helped employees to gain access to organizational knowledge about what was considered best practice. In the same company we also found that pictures, positions, responsibilities and other information of employees that were made available on the intranet, helped others to familiarize themselves with peoples' appearance and backgrounds prior to meeting them in person.

5.   DISCUSSION

In the following, we outline some aspects of the model we proposed in terms of its conceptualization and application potential. We have associated use intranet modes to each of the processes in Nonaka's and Konno's (1998) model of organizational knowledge creation. For analytical reasons, we have associated only the primary intranet use mode to each knowledge conversion process, with publishing that underpins all the use modes. We stress that we made such distinctions only for analytical purposes. We believe that it is indeed the integration of all the intranet use modes that will unleash the true potential of intranets to facilitate knowledge creating processes.

Returning to the disappointing findings reported by some authors regarding the potential of intranets for knowledge management (as outlined in the introduction), we argue the following. As we indicated by our model, organizations need to set their sights beyond pure publication, if they seek to harness the full potential of intranets for knowledge creation. Although publication can indeed be instrumental in facilitating knowledge *distribution*, we have argued that it is vital to integrate the other intranet use modes to foster knowledge *creation* processes. As such, interaction, transaction, recording and searching become key levers with regards to knowledge creation. Due to the malleability of intranet technology, organizations need to carefully consider how their intranet should be deployed so as to reap the maximum benefit in terms of knowledge creation.

Our intention here was not to depict some universal intranet knowledge creation model that can be approximated to fit any organization and intranet application. Rather, we have attempted to establish a vocabulary for intranet managers and implementers to debate and reflect upon their intranet progress and to formulate development and implementation strategies in the light of knowledge creation processes. Accordingly, we believe that when assessing the proposed model it is crucial to evaluate its application ability as experienced by managers and practitioners, instead of pursuing some rigid theoretical approach to validate the model itself.

6.   CONCLUSION

In this paper we have proposed a model for how intranets may be applied to create knowledge. The model is based on Nonaka's well-known 2-by-2 matrix of knowledge creation and our taxonomy of intranet usage modes. For each of the four knowledge creating activities we have described the corresponding primary intranet use mode that is conducive to knowledge creation and we have described popular applications that we believe can foster the knowledge conversion processes.

We attribute many of the disappointing research findings on intranet-supported knowledge management processes to a fixation on publication as primary intranet use mode and a failure to exploit other use modes of the technology. Computer-based information sharing alone is not sufficient for knowledge creation; even worse, this may exacerbate the information overload occurring in many organisations today. We argue that it is only by purposefully combining intranet publication with the interaction, transaction, searching and recording use modes, that knowledge conversion processes can effectively be fostered between knowers in the organization.

Our approach here was to speculate, propose, and *illustrate* a model for knowledge creation fostered by intranet technology. We did not attempt to empirically validate the model here and therefore future research should test and refine this model empirically, but also in terms of its practical value in supporting intranet

and knowledge managers with their intranet strategy formulation. We are currently engaged in such follow-up research in Denmark and Australia.

ACKNOWLEDGEMENTS

REFERENCES

Alavi, M. and Leidner, D.E. (1999a). Knowledge management systems: issues, challenges, and benefits. *Communications of the Association for Information Systems*, 1, Article 7.

Alavi, M. and Leidner, D.E. (1999b). Knowledge management and knowledge management systems: conceptual foundations and an agenda for research. Working paper, Department of Economics, University of Southampton.

Allen, T.J. and Scott Morten, M.S. (1994). Information technology and the corporation of the 1990s. Oxford University Press, New York.

Attewell, P. (1992). Technology diffusion and organizational learning: the case of business computing. *Organization Science*, 3 (1), February, 1-19.

Bansler, J.P., Damsgaard, J., Scheepers, R., Havn, E., and Thommesen, J. (2000). Corporate intranet implementation: managing emergent technologies and organizational practices. *Journal of the Association of Information Systems,* 1, Article 10.

Bernard, R. (1996). *The corporate intranet*. John Wiley & Sons, New York.

Bhattacherjee, A. (1998). Management of emerging technologies: experiences and lessons learned at US West. *Information & Management*, 33, 263-272.

Boehm, B. (1988). A spiral model for software development and enhancement. *Computer*, 21 (5), 61-72.

Caglayan, A. and Harrison, C. (1997). *Agent sourcebook*. John Wiley & Sons, New York.

Cecez-Kecmanovic, D., Moodie, D., Busuttil, A. and Plesman, F. (1999). Organizational change mediated by e-mail and intranet - an ethnographic study. *Information, Technology & People*, 12 (1), 9-26.

Chellapa, R., Barua, A. and Whinston, A. B. (1997). Intranets: looking beyond internal corporate web servers. In *Readings in Electronic Commerce*, (Kalakota, R and Whinston, A.B., Eds.), Addison-Wesley, Reading, Massachusetts, 311-321.

Ciborra, C.U. (Ed.) (1996). *Groupware & teamwork*. John Wiley & Sons, New York.

Ciborra, C.U. and Hanseth, O. (1998). From tool to Gestell: agendas for managing the information infrastructure. *Information, Technology & People*, 11 (4), 305-327.

Coleman, D. (1997). Collaboration on the Internet and intranets. *Proceedings of the 30th Hawaii International Conference on System Sciences*, (SPRAGUE, R.H. Ed.), 350-358.

Cross, R. and Baird, L. (2000). Technology is not enough: improving performance by building organizational memory. *Sloan Management Review,* 41 (3), 69-79.

Damsgaard, J. and Scheepers, R. (1999). Power, influence and intranet implementation: a safari of South African organizations. *Information, Technology & People*, 12 (4), 333-358.

Damsgaard, J. and Scheepers, R. (2000). Managing the crises in intranet implementation: a stage model. *Information Systems Journal*, 10 (2), 131-149.

Davenport, T.H. and Pruzak, L. (1998). *Working knowledge: how organizations manage what they know*. Harvard Business School Press, Boston, Massachusetts.

Davenport, T.H., Jarvenpaa, S.L. and Beers, M.C. (1996). Improving knowledge work processes. *Sloan Management Review*, 53-65.

Drucker, P. (1995). *Managing in a time of great change*. Truman Alley Books, New York.

Foray, D. and Lundvall, B-Å. (1997). *The knowledge based economy: from the economics of knowledge to the learning economy*. Working paper.

Gottschalk, P. (2000). Strategic knowledge networks: the case of IT support for Eurojuris law firms in Norway. *International Review of Law, Computer & Technology*, 14 (10), 115-130.

Hackbarth, G. and Grover, V. (1999). The knowledge repository: organizational memory information systems. *Information Systems Management*, 16 (3), 21-32.

Hills, M. (1997). *Intranet business strategies*. John Wiley and Sons, New York.

Huber, G.P. (1991). Organizational learning: the contributing processes and the literatures. *Organization Science*, 2 (1), 88-114.

Hughes, T. (1987). The evolution of large technological systems, In *The Social Construction of Technological Systems*, (W. Bijker, T. Hughes and T. Pinch Eds.), The MIT Press, Cambridge, Mass., 51-82.

Kanter, J. (1999). Knowledge management, practically speaking. *Information Systems Management,* 16 (4), 7-15.

Kling, R. (1980). Social analyses of computing: theoretical perspectives in recent empirical research. *Computing Surveys*, 12 (1), 61-110.

Laudon, K.C. and Laudon, J.P. (2000). *Management information systems: organization and technology in the networked enterprise*. Sixth Edition. Prentice-Hall, Inc., Upper Saddle River, New Jersey.

Lyytinen, K. and Damsgaard, J. (1998). *What's wrong with the diffusion of innovation theory? the case of networked and complex technologies*. Working paper, R-98-5010. Department of Computer Science, Aalborg University, Denmark.

Lyytinen, K., Rose, G. and Welke, R. (1998). The brave new world of development in the internetwork computing architecture (InterNCA): or how distributed computing platforms will change systems development. *Information Systems Journal*, 8, 241-253.

Mathiassen, L. and Stage, J. (1992). The principle of limited reduction in software design. *Information Technology & People*, 171-185.

Mcnaughton, R.B., Quickenden, P., Matear, S. and Gray, B. (1999). Intranet adoption and inter-functional co-ordination. *Journal of Marketing Management*, 15, 387-403.

Newell, S., Swan, J., Galliers, R. and Scarbrough, H. (1999). The intranet as a knowledge management tool? Creating new electronic fences. In: *Proceedings of the Information Resources Management Association International Conference, Managing Information Technology Resources in Organizations in the Next Millennium*, (Khosrowpour, M., Ed.).

Ngwenyama, O.K. & Lee, A.S. (1997). Communication richness in electronic mail: critical social theory and contextuality of meaning. *Communications of the ACM*, June, 145-167.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, 5 (1), February 1994, 14-37.

Nonaka, I. and Konno, N. (1998). The concept of "Ba": building a foundation for knowledge creation. *California Management Review*, 40 (3), 40-54.

Oppliger, R. (1997). Internet security: firewalls and beyond. *Communications of the ACM*, 40 (5), May, 92-102.

Perrow, C. (1986). *Complex organizations - a critical essay*. Third Edition. McGraw-Hill, New York.

Ressler, S. and Trefzger, B. (1997). The development of the NIST virtual library. *IEEE Internet Computing*, September-October 1997, 35-41.

Romm, C.T. and Wong, J. (1998). The dynamics of establishing organizational web sites: some puzzling findings. *Australian Journal of Information Systems*, 5 (2), 60-68.

Scacchi, W. and Noll, J. (1997). Process-driven intranets: life-cycle support for process reengineering. *IEEE Internet Computing*, September-October 1997, 42-49.

Scheepers, R. and Damsgaard, J. (1997). Using Internet technology within the organization: a structurational analysis of intranets. In: *Proceedings of the ACM SIGGROUP Conference of Supporting Group Work,* (Hayne, S.C. and Prinz, W., Eds.). Association for Computing Machinery, 9-18.

Schein, E.H. (1996). Three cultures of management: the key to organizational learning. *Sloan Management Review*, 38 (1), 9-20.

Scherer, A. (1997). Supporting concurrent engineering using an intranet approach. In: *Proceedings of the 30th Hawaii International Conference on System Sciences*, (SPRAGUE, R.H. Ed.).

Scott, J.E. (1998). Organizational knowledge and the intranet. *Decision Support Systems,* 23, 3-17.

Senge, P,M. (1990). *The fifth discipline: the art and practice of the learning organization*. Random House, Sydney.

Spiegler, I. (2000). Knowledge management: a new idea or a recycled concept? *Communications of the Association for Information Systems*, 3, Article 14.

Sviokla, J.J. (1996). Knowledge workers and radically new technology. *Sloan Management Review*, 37 (4), 25-40.

Wiig, K.M. (1993). *Knowledge management foundations: how people and organizations create, represent and use knowledge*. Schema Press Ltd, Arlington, Texas.

Williams, R. and Edge, D. (1996). The social shaping of technology, *Research Policy,* 25, 865-899.