HARNESSING INTRANET TECHNOLOGY FOR ORGANISATIONAL KNOWLEDGE CREATION

Jan Damsgaard
Weatherhead School of Management
Case Western Reserve University
10900 Euclid Avenue, Cleveland, OH 44106
Phone: +1 216 368 4640, Fax: +1 216 368 4776
E-mail: jxd86@po.cwru.edu
Rens Scheepers
School of Information Technology, Swinburne University of Technology,
PO Box 218, Hawthorn, Victoria 3122, Australia
Phone: +61 3 9214 8439, Fax: +61 3 9214 5501,
E-mail: rens@it.swin.edu.au

ABSTRACT

Many organisations have embraced intranets with the intent of harnessing the technology to support knowledge manage-
ment initiatives. Despite the promise that intranet technology holds in this regard, many of the early research studies indi-
cate rather disappointing results. In this paper we propose a model that organisations can use to conceptualise 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 find-
ings 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.

INTRODUCTION

The mid 1990s marked the global adoption of the Internet, and especially the Web in many spheres of society. In
organisational contexts in particular, Web technologies have opened up opportunities for much wider participation
by workers without the need for specialist IT skills. Intranets in particular have been embraced in record time by
many organisations. From being a largely unknown technology only a few years back, a vast number of knowledge-
intensive organisations have now embarked on large-scale intranet implementations. Organisations have imple-
mented intranets for a variety of reasons including to share information, to enhance organisational communication in
general, and to support collaboration across departmental, functional and regional boundaries (Bernard, 1996; Scac-
chi & Noll, 1997; McNaughton et al., 1999). A recent development is the organisational application of intranet tech-
nology to support knowledge management (KM) processes (Scott, 1998; Alavi & Leidner, 1999; Newell et al., 1999;
Alavi & Leidner, 2001).

The ideas that underpin KM are not fundamentally new (Spiegler, 2000) and can be traced to concepts such as the
learning organisation (Senge, 1990) and organisational memory (Huber, 1991). In addition, the role of information
technology (IT) in enabling and supporting knowledge work and knowledge workers in organisations has been well
documented in the past (eg. Ciborra, 1996; Davenport et al., 1996; Sviokla, 1996). However, the more recent mass
organisational 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 KM.

There have been some descriptive case studies that document the various approaches being followed by organisa-
tions (especially the professional services firms) with regard to their in-house knowledge management systems
(KMS) development (eg. Alavi, 1997; Ezingeard et al., 2000; Gottschalk, 2000). Considerable uncertainty remains as
to how organisations can successfully harness these technologies to foster their KM processes (as reflected by the
number of current suggested research agendas pertaining to KMS (eg. Hahn & Subramani, 2000; Alavi & Leidner,
2001). Although attention is directed towards specialised knowledge management systems, Alavi & Leidner (1999)
found that companies that pursue KM initiatives most often do so by relying on an intranet (as opposed to an isolated
KMS).

Despite the promise that intranet technology holds in this regard, there are however few documented examples of
successful intranet-supported KM initiatives. In fact, some of the available research studies on intranet supported
KM initiatives report rather discouraging findings (eg. Newell et al., 1999). We suspect that there are two reasons for
such disappointing findings. Many intranet studies to date have focused mainly on only one popular application of
the technology, namely publication of organisational 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 dis-
appointing findings may relate to a fairly static view of intranet technology as a "given", packaged technology with
universal characteristics and features (Lyytinen & Damsgaard (2001) warn against 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 organisational 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 moulded and shaped according to the social forces at play in the organisation (Hughes, 1987; Williams & Edge, 1996). This explains why the same technology can manifest adversely in different organisational settings (as observed by Bansler et al., 2000).

While some other researchers have explored the potential of intranets to support KM in broad terms (eg. 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 to support 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 summarised, we conducted an in-depth interpretive field study of intranet implementations in four large organisations (two in Denmark and two in South Africa) over a period of five years from 1997 to 2001. Formal and intensive rounds of data collection were interspersed with periods of informal data collection. Semi-structured formal interviews formed the basis of the study and in each case we interviewed a wide variety of organisational actors who were involved with the intranet. Data was also collected on a more informal basis by means of regular e-mail and phone contact, lunch meetings, discussions and by attending presentations made by the case organisations. Such data included notes from discussions, e-mails, policies, reports, demonstrations, intranet usage statistics, and our own inspection of the intranets. Details of the empirical field study have been published elsewhere (see Damsgaard & Scheepers, 1999; Bansler et al., 2000; Damsgaard & Scheepers, 2000).

This paper is outlined as follows. Firstly, some features of intranet technology are highlighted by drawing upon a taxonomy of five primary intranet use modes. Thereafter Nonaka's well-known model of knowledge creation is briefly presented. The model of knowledge creation and the taxonomy of intranet use modes are then combined. The combined model is illustrated with findings from our own empirical intranet field studies and other documented intranet-related KM research. Some implications of the combined model are discussed and avenues for further research are suggested.

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 organisation). Well-understood and widely available Internet technology and standards (web servers, browsers, protocols) are employed, but access is restricted exclusively to specified organisational members, typically by means of passwords and/or firewalls (Oppliger, 1997; Laudon & Laudon, 2000). The technical set-up of an intranet 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.

Intranet technology characteristics

Intranet technology is multi-purpose, richly networked and integrates text, graphics, sound, and video (Bernard, 1996; Hills, 1997; Damsgaard & Scheepers, 1999). Intranet technology supports both structured and unstructured data, mostly by means of HTML (Hypertext Mark-up 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 organisation and across functional boundaries. Such exchanges are facilitated through departmental intranet servers located behind the organisational firewall which organisational 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 organisation into one rich "system" with the Web browser as the universal interface.

Intranet technology usage

The organisational 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 exhibits the organisational learning involved in applying the technology (Attewell, 1992). Initially, the technology is typically used for *publishing* "static" information (eg. departmental home pages, technical documents, product information). 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, organisations can save the obvious costs associated with printing, publishing and distributing 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 organisation becomes more familiar with the technology, it may be applied for more advanced purposes (Bansler et al., 2000). Intranet technology can be applied in different "use modes" simultaneously (Damsgaard & Scheepers, 2000). These range from simple use modes such as publishing discussed above, to more advanced use modes such as organisational-wide *searching* for information; *transacting* with functionality on intranet pages and other organisational computer-based information systems; *interacting* between individuals and groups in the organisation; and even the *recording* of the computer-based "organisational memory". The five intranet use modes and typical application examples are summarised in Table 1.

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

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

A MODEL OF INTRANET-FACILITATED KNOWLEDGE CREATION

We now propose an integrated model of intranet-facilitated organisational knowledge creation. We do so by combining Nonaka's well-known model of knowledge creation (Nonaka, 1994; Nonaka & Konno, 1998) with the taxonomy of intranet use modes as described above. To position the model, we briefly explore facets of knowledge, knowledge management and knowledge creation processes. The combined model is illustrated with findings from our own empirical intranet field studies and other documented intranet-related KM research.

Facets of knowledge and knowledge management processes

A detailed examination of the nature of knowledge itself and of the complexities of organisational KM is beyond the scope of this paper. Instead we highlight some facets of knowledge and its organisational management that are fundamental in conceptualising any proposed information technology support for the process.

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

KM is often subdivided into four highly intertwined organisational processes (Wiig, 1993; Alavi & Leidner, 2001). The first process is knowledge creation and involves the creation and addition of new knowledge to the organisation's knowledge repository. The second is knowledge storing/retrieval and involves the identification and access of relevant knowledge from the knowledge repository. This is also referred to as "accessing the organisational memory" (Huber, 1991). The third process is the transferring of knowledge whereby organisational actors share and dissemi-

nate knowledge within the organisation. Lastly, knowledge application refers to the steps where knowledge is translated into action. In this respect, Alavi and Leidner (2001) point out that improved organisational performance hinges not on knowledge itself, but on the ability to translate knowledge into effective action.

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, 1999). 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 & Prusak, 1998). Tacit knowledge is personal and difficult to formalise, 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 their ideals, values and emotions (Wiig, 1993). According to Davenport & Prusak (1998) knowledge originates and resides in the minds of knowers, but it also becomes embedded in organisational documents, repositories, routines, processes and norms.

Knowledge creation

Nonaka and Konno (1998) model knowledge creation as a process of interactions between explicit knowledge and tacit knowledge. Their model incorporates four knowledge creation modes based on the conversion processes between tacit and explicit knowledge: socialisation, externalisation, combination and internalisation (see Figure 1). In Table 2 we summarise Nonaka and Konno's four knowledge creation modes.
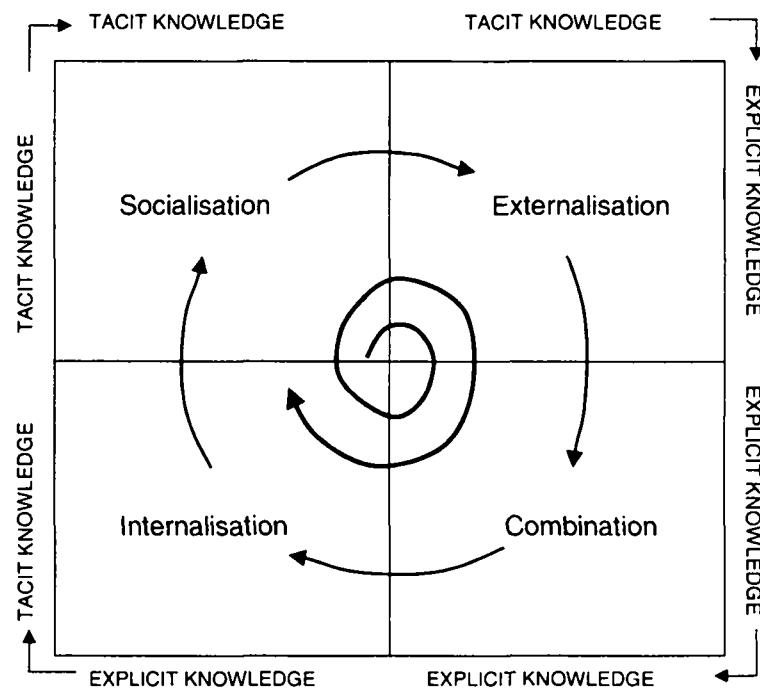

Figure 1: The model of Nonaka and Konno of organisational knowledge creation processes

Table 2: A summary of four knowledge creation modes (Nonaka & Konno, 1998)

Knowledge Creation mode	Description
Socialisation	The exchange of tacit knowledge between individuals by means of joint activities and social interaction (eg. the traditional notion of apprenticeship).
Externalisation	The expression of individual tacit knowledge into comprehensible codified forms that can readily be understood by others (eg. expressing ideas, images as words, concepts, figurative language, and visuals).
Combination	The processing and combination of explicit knowledge into more complex sets of explicit knowledge (in useable formats). This involves the capturing, combination, dissemination and the systematisation of knowledge (eg. the development of business plans based on various existing data sources).
Internalisation	The conversion of explicit knowledge into the organisation's tacit knowledge. This requires individuals to access the knowledge of the group or the entire organisation (eg. via organisational training programs, learning-by-doing exercises) and identify knowledge relevant to their own roles.

Intranet-facilitated organisational knowledge creation

Much of the KM literature is based on an information systems perspective and the belief that KM systems, for example intranets, can be used to capture and store organisational 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 redraw the borderline between tacit and explicit knowledge domains.

The cheap and proven intranet technology makes it economically attractive and feasible for organisations to codify a larger portion of their tacit knowledge base. However, it has been pointed out that this does not diminish the importance of tacit knowledge (David et al., 1999). On the contrary, it stipulates the need for high skill levels and competence when selecting the appropriate codified knowledge.

In the following we associate intranet use modes to each of the knowledge creation modes in Nonaka and Konno's model. Our model is depicted in Figure 2. For analytical reasons, we associate only the primary intranet use mode to each knowledge conversion process, with intranet publishing underpinning all the use modes. We stress that we make 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.
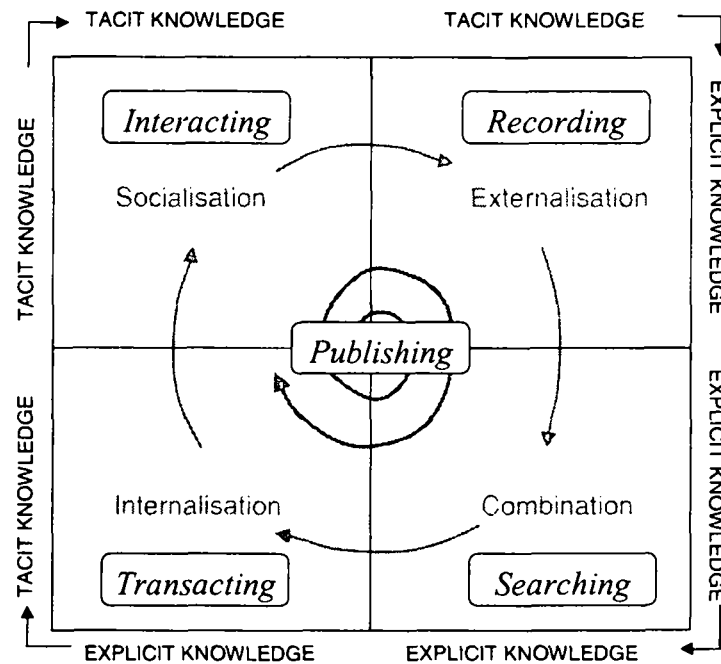
Figure 2: Primary intranet use modes for facilitating knowledge creation

Socialisation (facilitated by intranet interaction)

Traditionally, socialisation involves capturing knowledge through physical proximity (Nonaka & Konno, 1998). 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 socialisation. 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.

Though it may be more efficient, face-to-face social interaction is not necessarily a prerequisite to acquire tacit knowledge. Indeed, the socialisation process can be richly facilitated electronically. 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 emotions like the "smiley" (:-)) in emails shows how simple ASCII characters may be used to convey shared connotations between members of a social system.

We see the primary intranet use mode for socialisation as *interaction*. Intranets can support various forms of personal interaction, thereby connecting knowledgeable individuals to each other. In its simplest manner it may be in the form of one-to-one 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). A site focusing primarily on interaction does not necessarily have to reside physically on an organisation's web server, but might as well be hosted somewhere else and be accessed via the intranet (eg. *groove.net*).

Compared with face-to-face, the intranet is neither an obvious nor the best facilitator of interaction-based knowledge conversion. However when physical distance, time differences or working conditions make face-to-face 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 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.

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 recognised 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 reinforced this undesired behavioural pattern in the organisation (for similar observations see Scheepers & Damsgaard, 1997; Newell et al., 1999; Lamb & Davidson, 2000).

Externalisation (facilitated by intranet recording)

In practice externalisation 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). 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 (Boehm, 1988; Mathiassen & Stage, 1992). We see the primary mode of intranet use for externalisation of knowledge as *recording*. The ease with which information from a variety of quarters in the organisation can be assimilated and integrated using intranet technology, means that the intranet can ultimately become the medium for the "organisational memory" (as Huber (1991) envisioned the concept).

By using the intranet as "definitive record" for organisational processes as they unfold, the intranet may mature into a rich record that can be "excavated". In this manner key events could be "replayed" to (re)create knowledge by reflecting on previous solutions to problems, recurring problems, rationales for decisions 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 program manager commented that they meticulously record all their project documentation, customer meetings, minutes, and their informal project notes and comments 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 papers 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 use mode can capture a rich account of factors that may become valuable only in hindsight. For example, when carefully examining several projects *ex post* some pattern may emerge that could not be observed from within a project or observed by examining one project alone. Although we have seen many examples of such diligent intranet recording, we have not yet seen a similar level of activity in "excavating" this record carefully.

Combination (facilitated by intranet searching)

Nonaka and Konno posit that combination mode of knowledge creation relies on three processes. Capturing and integrating new explicit knowledge is pivotal. This includes collecting externalised knowledge from inside or outside the organisation 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 eg. by means of presentations or meetings. Hereby, new knowledge becomes readily accessible to other members of the same social system. The systemisation of explicit knowledge involves the editing or processing of explicit knowledge into plans and reports to make it more useable. In the combination process, justification occurs allowing the organisation to formulate practical action steps.

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 that an appropriate navigation path exists to this information.

Apart from intranet home pages, 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 organisation. Similarly, many other portals to the same information space can be set up (eg. with a customer, departmental, product or project view in mind). In addition to these searches, we may see even more ad-

vanced searching on intranets (for example as agent technologies mature (Caglayan & Harrison, 1997)). A necessary prerequisite is the use of more powerful mark-up languages than basic HTML; here XML (extensible mark-up language) appears a promising candidate due to its powerful tagging feature and the useful separation of content and presentation.

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; Cecez-Kecmanovic et al., 1999; McNaughton et al., 1999). Searching the organisational intranet helps to identify potential useful knowledge, which in combination with other knowledge might bring about valuable new 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 organisations to invest in advanced search features on their intranets. In our field study numerous users have criticised the lack of sophistication of their organisation's current intranet search functionality.

Internalisation (facilitated by intranet transaction)

Nonaka and Konno argue that in practice internalisation relies on two dimensions. Firstly, explicit knowledge has to be embodied in action and practice. Thus the process of internalising explicit knowledge actualises concepts or methods about strategy, tactics, innovation or improvement. For example, training programs help the trainees to understand the organisation and their role in the whole. Secondly, 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.

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

Using HTML forms and relying on the standard Internet protocols, many existing organisational computer-based information systems can be accessed via the intranet (provided of course that the necessary linkages are introduced, eg. 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 a 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 organisation. Prior to intranet technology, such cross-functional information access 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 organisation, 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 organisational 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 familiarise themselves with peoples' appearance and backgrounds prior to meeting them in person.

DISCUSSION

In the following, we outline some aspects of our model in terms of its conceptualisation and application potential. Behavioural aspects pertaining to intranet use are central to the model's application potential. In the following we list some intranet use patterns emerging from our field studies that we believe are conducive to the knowledge creation processes in the model we have proposed.

Unlike 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 can read and inquire without being identified (ie. anonymous use). Compare this to a telephone call or an email where the inquirer reveals her identity in the process of asking. In this respect, many 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 (such as the comment above from the new employee).

A further behavioural aspect concerns the question whether individuals would voluntarily put information onto the intranet (Alavi & Leidner, 2001). 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 individuals viewed the intranet as a means to gain some organisational visibility and repute (similar findings are also reported by (Davenport & Prusak, 1998)). The following quotations from our field study illustrate this behaviour:

> "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]

The exhibitionist behaviour supplements organisational initiatives for KM such as incentive schemes or mandated intranet use (eg. requiring the establishment of a project website prior to resource release).

We have also noticed some changes in information distribution and seeking behaviour 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 eg. e-mail folders, file systems, etc.), the intranet is beginning to evolve into a "definitive organisational record". This also fosters a "just-in-time" information seeking behaviour:

> "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]

Although much of knowledge creation and exchange processes we indicate in our model occurs "in public" on the intranet within the organisation, this does not preclude private exchanges between communities within the organisation. In this respect we have noticed the use of security mechanisms such as passwords and even internal firewalls within the larger intranet to restrict access to sites focussing on sensitive or community-specific issues.

The model suggests that the availability of rich intranet content is conducive to knowledge creation. However, content creation behaviour resulting in information overload and intranet "chaos" is detrimental to the process. These dangers are captured in the following quotations from our fieldwork:

> "The biggest challenge is when people search information on the intranet they get drowned in information – how do you sort it?" [Vice President, October 1998]

> "...we are drowning in information, but starved of knowledge." [IT Manager, October 1998]

To foster knowledge creation effectively (especially the combination mode), organisations would need to revisit their intranet content generation and retrieval strategies. Attention should be paid to effective intranet content generation (perhaps by laying down minimum content standards). At the same time effective search and indexing approaches should be explored. The emergence of intranet-enabled document management products, search agents, automated indexing of intranet content and concept-based retrieval technologies (eg. *80-20.com*) hold promise in this regard.

Returning to the disappointing findings reported by some authors regarding the potential of intranets for KM (as outlined in the introduction), we argue the following. As indicated by our model, organisations need to set their sights beyond pure publication if they seek to harness the full potential of intranets for knowledge creation. Although pub-

lication 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, organisations need to carefully consider how their intranet should be deployed so as to reap the maximum benefit in terms of knowledge creation.

We are witnessing a large number of KMS applications being offered by third parties (compared to in-house development) (Karlsbjerg & Damsgaard, 2001). Such applications can be purchased and installed on the company intranet or they might be offered and operated by a third party ASP (Application Service Provider). These applications are typically second or third generation KMS tools focusing on advanced features such as context sensitive searching or virtual team support. What is common for all of them is that they piggyback on an already well-established and expanded intranet. They can only be added to a mature intranet where the level of implementation is well beyond creating a critical mass of users and content (Damsgaard & Scheepers, 2000). Despite these tools' complexity, once reduced to their simple parts they can readily be housed within our taxonomy of intranet use modes. Some of these tools encompass several of the use modes simultaneously.

It should be emphasised that KM is not at all limited to intranet technology, as only a fraction of KM creating activities can and should be supported via technology. There are many opportunities for developing web based KM tools in other contexts. One promising avenue for researching critical KM technology application – currently not well understood – is informal know-how trading among peers (even across competing firms) (von Hippel, 1987). In this respect, further research is necessary to understand how intranets will merge with other distinct technologies (eg. extranets, ERP, and Internet) in forming ubiquitous (wireless) computing environments in the near future. One particular challenge here is that different technical interfaces (monitors, televisions, mobile devices) call for completely different presentations of the knowledge domain. A further challenge is how a particular knowledge domain, captured by a web of information sources on an intranet, could be represented on these platforms. The context free hypertext format (HTML based) that currently makes up the majority of existing intranets is not flexible enough to allow for such representation. XML is a promising improvement over HTML, but we expect that XML will have to fight an uphill battle in substituting HTML in the intranet context. The co-existence of both standards nullifies many of the benefits that the enhanced capabilities of XML offer. Again, it seems that (as in many other cases) the first technology to attract a critical mass of usage sets the stage for subsequent technology innovation.

Our intention here was not to depict some universal intranet knowledge creation model that can be approximated to fit any organisation 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.

CONCLUSION

In this paper we have proposed a model for how intranets may be applied to create knowledge. Our model is based on Nonaka's well-known 2-by-2 matrix of knowledge creation and a taxonomy of intranet usage modes. For each of the four knowledge creating activities, we have associated 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 early disappointing research findings on intranet-supported KM processes to a fixation on publication as the 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 organisation.

Our approach here was to 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.

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