ABSTRACT

This paper discusses the knowledge management issues involved in developing an integrated, support system for the visa approval process at the US Immigration and Naturalization Service agency. This research combined competitive intelligence analysis methods with an understanding of human knowledge as dynamic, socially constructed and situated in context, to determine appropriate roles for IT and human analysts in a high-pressure, sensitive decision-making environment. We use Nonaka’s (1994) SECI model and risk-analysis techniques based on competitive intelligence analysis to examine the role that knowledge of various kinds played in this process. The contribution of this paper is to provide a knowledge taxonomy and a process-framework by which roles for IT support in a complex and distributed, high-risk decision-making environment may be defined.

Keywords: Knowledge Management, Organizational Learning, Emergence, Decision-Support

Introduction

Much current work in knowledge management is based upon an epistemological interpretation of knowledge that treats knowledge as something that people possess, that can therefore be transferred between individuals. In much of the information systems literature on knowledge management, this argument is extended to suggest that the codification and transfer of information-as-thing (Buckland, 1991) via technology is both feasible and desirable (Johnson et al., 2002). But information management presents too limited a model for the management of organizational, diverse and distributed knowledge (Zack, 2001). This paper takes an opposing view: that mission-critical knowledge is dynamic, socially constructed and situated in context. If
knowledge creation and use is envisaged as a set of emergent, improvisational work-processes (Markus et al., 2002), then it would appear that most knowledge management analysts ask the wrong question. Distributed groups of decision-makes require technology that is appropriate to the type of tasks in which they engage (Boland et al., 1994; Malhotra and Majchrzak, 2004). Instead of asking “what knowledge can we codify?”, we should ask “What processes is it most appropriate to automate and why?”

To explore appropriate frameworks by which to analyze this question, we examine a situation of great interest at the present time: the issuing of work and residency visas to foreign nationals wishing to come to the United States.

**Conceptual Background**

**The Creation Of Organizational Knowledge**

Organizational learning has presented a problem for complex organizations since before the advent of information systems. Typically, organizations develop a recipe for success, or a learning "loop" that dictates action (Argyris and Schöen, 1978). Organizational actors create organizational procedures, documentation standards, rule-based information systems (IS) and other socio-cultural artifacts and processes that constitute an "investment in form" (Star, 1989). These rules and procedures tend to be unquestioned, normative and immutable: they can persist long after they have outlived their usefulness, even in the face of evidence to suggest that they are counterproductive, simply because they acquire ritual status or because they are associated with the organizational value-system (Majchrzak et al., 2000; Markus, 1984; Weick, 1998). We may distinguish between an individual's *espoused theory* of action, the articulated and legitimate rationale for behavior that an individual is capable of communicating, and the individual's *theory-in-use*, the implicit and often inarticulable rationale that guides their actual behavior.
(Argyris and Schön, 1978). Individuals hold theories-in-use that derive from their experience of what works in their day-to-day experience of the organizational world. Individuals engage in conversations, in collaborative activities and in other interactions, both with each other and with the context of work, that permit them to jointly define constructs that help them to make sense of the context in which they work (Boland and Tenkasi, 1995; Suchman, 1998; Weick, 2004). The process of joint sensemaking permits them to construct a shared worldview: through their interactions, organizational actors dynamically and jointly create shared knowledge that is situated in the context of their work. Organizational sensemaking is enacted through the combined use of implicit and explicit knowledge and of individual and shared knowledge (Cook and Brown, 1999; Nonaka et al., 2000). Each type of knowledge performs a role that the others cannot, in providing the "knowing" that guides organizational action. Explicit, shared organizational rules for action provide a partial model of behavior that must be supplemented by an individual, tacit understanding of how, when and why to implement those rules. Individual explicit knowledge provides a supplement to the tacit shared knowledge required for effective work coordination and collaboration. Lave (1991) argues that the process of socially shared cognition should not be seen as ending in the internalization of knowledge by individuals, but as a process of becoming a member of a “community of sustained practice”. Thus knowledge emerges through interactions within a community of practice and is “situated”: knowledge is embedded in the practices of a specific group and local situation (Lave and Wenger, 1991; Suchman, 1987, 1998). People engage in continual improvisations and innovations that rely on contingent understandings of the local context (Suchman, 1987, 1998; Weick, 1998). Knowledge emerges from the practice of work and cannot be defined outside of the local context of that work.
Existing theories of information and knowledge processing in organizations do not scale well to the complex forms of knowledge integration required at the boundary between diverse groups (Carlile and Rebentisch, 2003). Collective action is based on knowledge transformations and translations at the boundary between groups (Carlile, 2002; Star, 1989). Group members often need to engage in unplanned and illegitimate activity to assimilate the domain knowledge required for effective action (Gasson, 2005). We need an understanding of how practice emerges from interactions within the culture of the social community of practice within which people work and from the interrelationship between communities (Wenger, 1998).

Nonaka (Nonaka, 1994; Nonaka and Konno, 1998) proposes the SECI model of knowledge creation and use, based on iterative processes of socialization, knowledge externalization, combination and internalization. The SECI process provides our theoretical base because it incorporates dynamic, socially-situated and emergent aspects of knowledge creation and use, as shown in Figure 1.

![Figure 1: The SECI Process (Nonaka and Konno, 1998)](image)

- **Socialization** is the process of acquiring new tacit knowledge through shared experiences. A typical way of achieving this is through serving a period of “apprenticeship”, during which
time the individual unreflectively acquires “automatic” skills and tacit knowledge relating to local practices.

- **Externalization** is the process of converting tacit knowledge into explicit knowledge, performed through knowledge articulation during conversations between individuals, or reflexivity (for example, the type of self-conscious reflection involved in writing an academic paper, or reflection upon a locally-used metaphor). The externalization process allows us to understand what we know, in the context of a local workgroup.

- **Combination** is the process of converting explicit (articulated and appreciated) knowledge into systematic sets of explicit knowledge that are made accessible to the wider organization. This process may combine both internal and external knowledge.

- **Internalization** is the process of embodying external, explicit, combined knowledge into routines and unreflective procedures, so that it becomes internal to the individual. Nonaka (1994) suggests that the individual “locates themselves” in the organization by identifying organizational knowledge that is relevant to their own work, reflecting upon the way in which this knowledge can be applied and then applying the knowledge until it becomes part of one’s everyday practice.

We operationalize the process-oriented SECI model (Nonaka and Konno, 1998) by observing the processes through which one type of knowledge is transformed into another type of knowledge. Through a focus on the iterative processes of socialization, externalization, combination and internalization, we can appreciate the emergent social processes by which the value of knowledge and the sociocultural practices through which it is applied are constructed. Through an observation of the mechanisms by which these processes experience a breakdown –
at the individual or the collective level – we can understand how organizational learning may be accomplished.

**Breakdowns In Automatic Knowledge-Creation**

The knowledge management problem may thus be viewed from a socio-cultural perspective as one of locating and introducing alternative worldviews to organizational actors and supporting diverse views with technology. Organizational actors must (1) acknowledge the irrationality of their current theory-in-use and (2) pass through a catalytic process that triggers a change in perspective if they are to effect substantive change, (Lewin, 1951), but this is very difficult to achieve (Wenger, 1998). It requires not only a commitment, but also the infusion of resources (time, money and technical and content expertise) that can be applied to the problem without disrupting ongoing operations. Winograd and Flores (1986, after Heidegger, 1962) suggest a theory of cognitive breakdown: a disconnect through which we question and so become aware of the nature of taken-for-granted concepts and artifacts. A breakdown occurs when an individual’s automatic (assumed, axiomatic) definition of how an artifact or process behaves is no longer sufficient to explain the behavior of the artifact or process:

"A breakdown is not a negative situation to be avoided, but a situation of non-obviousness, in which the recognition that something is missing leads to unconcealing (generating through our declarations) some aspect of the network of tools that we are engaged in using. A breakdown reveals the nexus of relations necessary for us to accomplish our task". *(Winograd and Flores, 1986, p. 165).*

A breakdown may constitute a source of learning, as the individual is forced to reflect on and redefine (to themselves or others) the nature of the artifact or process. For example, if a visa officer approves a request for a visa and that person is proven to pose a security risk, the visa officer may be forced to reexamine their approval criteria. Breakdowns therefore provide a productive mechanism for organizational learning, as they force the individual to clarify and to
question their assumptions, and to include new evidence in framing a situation. This leads to revised interpretations of the situation that create new distinctions in the recurrent patterns of conversation that make up the individual’s “language” of work. But breakdowns are not a simple mechanism and a major drawback is that people do not necessarily recognize the need to break out of an existing pattern of work (Winograd and Flores, 1986). We become unable to employ a process seamlessly, because our unconscious assumptions about the nature of the process do not accord with our experience of performing it, so we experience a cognitive breakdown.

Breakdowns are not just concerned with an individual's life-world:

"It is only when a breakdown occurs that we become aware of the fact that 'things' in our world exist not as the result of individual acts of cognition, but through our active participation in a domain of discourse and mutual concern." (Winograd and Flores, 1986, p. 78).

In order to change how knowledge is collected, valued and used within an organization, we need to induce a collective breakdown in organizational actors' interpretation of their social world. To "manage" knowledge as the basis for effective organizational action, we need to first understand, then proactively challenge the socio-cultural constructs that underlie shared sensemaking and collective action in professional practice.

**Enabling Breakdowns Through Risk Analysis**

The combination of appropriate organizational decision models and competitive intelligence tools permit a knowledge worker to generate insights that lead to organizational learning (Heinrichs and Lim, 2005). Individuals’ decision models are guided by mental models (Johnson-Laird, 1983) or cognitive “frames” (Goffman, 1974), that provide the basis for automatic (unreflective) action (Heinrichs and Lim, 2005). To achieve a breakdown in automatic action, we need to consider ways of “breaking frame” (Goffman, 1974; Tannen, 1993). We may break frame by introducing a mismatch between the required behavior and automatic behavior, or
through interactions with others that lead to a discord between automatic (internalized) frame of decision-making or action and an external, proposed course of action (Winograd and Flores, 1986).

Risk management is closely related to knowledge management in its assessment of information, but any risk assessment is based on an analysis of the decision models employed by knowledge workers (Heinrichs and Lim, 2005). Risk assessment therefore provides a useful way of breaking frame, as it requires that the individual surfaces and evaluates their mental model, or framing of the decision-making process from a risk-management perspective. It has been argued that competitive intelligence provides a useful model for national intelligence (the knowledge domain underlying our study), as it considers risk management explicitly (Noyes, 2004; Pattakos, 1998). Most competitive intelligence (CI) process management models take the form of a cycle that provide a variation of stages to plan, assess, manage and monitor CI strategy (Herring, 1998; Noyes, 2004; Pattakos, 1998). We selected a CI process cycle that included a strong risk management element. This is shown in Figure 1 (NCISSE, 1998).

Figure 1: The Risk Management Cycle (adapted from NCISSE, 1998)
Research Method

This study investigated knowledge management practices and the use of specific types of knowledge management (KM) systems, at the US Immigration Service. Where details would infringe national security, these have been disguised. However, we should comment that the use of knowledge-management systems and knowledge-transfer practices have changed significantly in the period since this study was conducted, largely as a result of the consultations and investigations of which this study formed a part.

Thirty-five visa analysts, from three agencies in the US and Canada were involved in developing our understanding of the process and in validating and developing our perspectives of the process. Initial data collection was conducted via semi-structured interviews with the analysts. Follow-up telephone interviews were conducted with the KM system project champion, a senior INS law enforcement official and with two representatives of the prime contractor for the knowledge management system. Findings from interviews were then used to guide a collaborative workshop to generate and discuss the key intelligence questions that they used in their decision-model. The workshop involved twenty-four analysts from the US and twelve Canadian analysts from two law enforcement agencies. These representatives provided a wide range of experience (from 2 to 25 years) and a variety of different knowledge domains relating to visa approval. We applied three levels of analysis, as follows:

1. From the interview data, we obtained a detailed model of visa approval processes, that tracked the process from the receipt of an application to the approve or deny decision. We applied a knowledge-process analysis, using Nonaka’s SECI model (Nonaka, 1994; Nonaka and Konno, 1998) to understand the types of knowledge-processing work involved in visa application processing decisions. This allowed us to provide a framework, within
which analysts could discuss the role of various forms of knowledge in their decision-making processes.

2. We performed a content analysis on interview data to determine the key intelligence topics (Herring, 1998) underlying analysts’ decision model for visa approval. The key intelligence topics (KIT) approach is a recognized competitive intelligence technique for identifying core risk factors. This process generated a set of issues that included the size, location and personal demographics of the applicant pool; application turn-around time; access to decision support (both personal and systems); and quality of training. We explored these issues in a workshop with analysts, to develop and validate a set of key intelligence questions (Herring, 1999) that represent the theory-in-use model (Argyris and Schön, 1978) that analysts used for decision support.

3. We facilitated analysts in exploring the decision-processes that they would use to answer these key intelligence questions. Using the risk management cycle shown in Figure 1 (NCISSE, 1998), we explored knowledge-management processes required to answer the key intelligence questions generated in stage 2 of the analysis, to determine knowledge management priorities for IT systems support and to introduce cognitive breakdowns that would allow analysts to reflect in depth on their decision-processes. We further explored these processes in follow-up interviews with analysts, other officials, and information system vendors involved in the process, to gain a comprehensive understanding of the role of IT in providing decision-support for high-risk decision-making processes.

We present the findings below under the three stages of investigation. The subsequent synthesis and discussion integrates the findings from this study, to develop a set of knowledge-categories
relating to high-risk decision-making and a set of roles for human analysts vs. IT decision-support systems.

**Research Findings**

As discussed above, the findings here represent a historical view of the problems of distributed knowledge management in a highly critical function, that relates to national security. For national security reasons, we cannot reflect the situation as it is, nor do we have access to all of this information. But it is our understanding that knowledge management practices and the communication of relevant knowledge have improved significantly since the problems reported below. Our report of historical practices is therefore intended to illustrate problems of knowledge-sharing that have since been rectified.

**Investigation Stage 1: Processes of Knowledge Creation and Use**

During our investigation, the major issue appeared to be that analysts’ individual knowledge and expertise were under-utilized in making the visa approval decision. The original visa approval process in use at the time of our investigation is shown in Figure 2 (this process has subsequently been changed). The critical link in the visa approval process was identified as the immigration analyst, who was dealing with an avalanche of applications from unknown applicants. We therefore focused on the role of the analyst in acquiring, using and transferring knowledge within the organization.
In discussions with analysts, we examined ways in which Nonaka’s (1994; Nonaka and Konno, 1998) four modes of knowledge acquisition and use were achieved in their work environment:

**Socialization.** This stage is the process of acquiring new tacit knowledge through shared experiences. New INS analysts served a period of “apprenticeship”, working alongside a number of more experienced analysts from the same office, to understand the processes and criteria by which they approve visa applications. By this means, they were permitted to internalize skills and knowledge relating to local practices. They could also observe external events, security warnings and crises, to build a strong store of local knowledge. But they did not have access to the means of socialization that would enable them to become part of a wider community of professional practice (Lave, 1991). They were not permitted to relate local knowledge to the knowledge held by analysts in visa approval offices of other countries or regions. Their knowledge was local: they were experts within their own domain of experience, but relative novices when judging applications outside of that domain.
**Externalization.** This involves a process of converting tacit knowledge into explicit knowledge, performed through knowledge articulation during conversations between individuals in a community of practice, or self-conscious reflection. Analysts had very limited opportunity for externalization, as they were severely constrained by the pressures of work. There were few formal channels for them to engage in “quality circles” or explicit tutorials, except through the informal apprenticeship process in which they train a new analyst. So they did not have the opportunity to subject their decision-making criteria to situations where they might experience a breakdown (Winograd and Flores, 1986) and thus develop or externalize their model of decision-making.

**Combination.** This process involves converting explicit knowledge into systematic sets of explicit knowledge that are externally (to the individual) accessible and may involve both internal and external knowledge. Given the problems of externalization identified above, opportunities for combination were severely limited. The agency recognized and took steps to deal with this problem. Regular external security bulletins were circulated and knowledge of information deriving from security agency warnings was perceived to be high among analysts. But the main process of combination was informal discussions during work breaks and socialization. Some opportunities for breakdown (Winograd and Flores, 1986) were provided by informal discussions. But more explicit and structured channels for this process were required, if analysts’ decision-making frames were to be tested in a sufficient variety of situations.

**Internalization.** This is the process of embodying external, explicit knowledge into routines and unreflective procedures, so that it becomes internal to the individual, requiring reflective practice (Schön, 1983). Analysts’ work offered few explicit opportunities for this type of learning once their initial training was complete and reflective capability was relegated to the personality of the
individual. The pressure of work meant that very little time was allowed for reflection. Attempts to discuss process innovations met with little support because of the standardized, public service culture of the immigration service.

**Investigation Stage 2: Key Intelligence Topics Indicating Significant Risk Factors**

The process used nation-based decision protocols to deal with transnational risks, with limited access to wider information and decision-support. This is not just a terrorist problem: analysts dealt with many problematic situations. For example, we were told of cases such as the individual whose visa had changed status on reentry to the country through their ignorance of the arcane immigration regulations. In the meantime, their spouse had applied for, and had been granted a visa under their previous status and so was an illegal alien, although ignorant of that fact. The bottleneck in the process was caused by reliance on the knowledge and expertise of the individual analyst. We identified a number of critical issues in the management of knowledge within the visa approval process.

- **Unequal knowledge:** There was no "quality control" over training, knowledgeability and decision-making capability of local analysts. This could often vary. Although all analysts were perceived as capable and trustworthy, the extent to which they were able to identify high-risk individuals varied.

- **Locally-specific knowledge:** Analysts relied on a wide variety of local knowledge and needed a wide exposure to many different personal name conventions and high-risk indicators for different sub-populations. Names of individuals may originate from phonetic languages, such as Mandarin or Arabic. The same original name is subject to a wide variety of roman-character spellings, phonetic interpretations and variations due to the individual’s route to the USA.
• Distributed knowledge: individuals might not be in possession of all the information to detect high-risk applications. For example, one analyst may detect multiple applications for entry with the same US national as sponsor, so these applications could be refused. But if the individuals applied via different immigration offices, the multiple applications could go undetected.

• No legitimate way of collaborating or communicating knowledge: Different offices and different agencies operate under different cultural, national and legal frameworks. It was very difficult to communicate information between offices and the different management structures made coordination and collaboration difficult.

• Too high a volume of applications for an individual to screen all completely: Each analyst was operating under severe time constraints that often did not permit the analyst to even check the name and address of the local (US) sponsor of the applicant.

All of these factors led to the conclusion that the identification of high-risk applications should be managed in a different way. But the decision to approve or reject an application depended on a huge variety of variables, risk identifiers and gut instinct. As such it was not easily codifiable. The decision also depended on the combination of a number of factors that were locally-contingent and dynamic. Things change. High-risk factors for individual applicants are constantly being identified and a knowledge base using existing case-based reasoning would not permit the dynamic identification of risk identification factors.

**Investigation Stage 3: Knowledge Management Priorities For IT Systems Support**

Human analysts played the same role in filtering and appraising low-risk applications as they did for high-risk applications. To avoid accusations of favoritism, they used a first-in-first-out system of processing that might appreciably delay many low-risk applications, whilst a high-risk
application was investigated. This was a historical way of working, dating from an era when good technology support to separate routine decision-making from non-routine decisions was not available. But the pressures of work meant that analysts did not have the time or energy to investigate high-risk applications as vigorously as required. So we identified components of the human analyst’s approval decision and applied a risk analysis, to stimulate breakdowns in their automatic assumptional framework. Decisions fell into three categories:

- **Positive verification:** Can we independently validate and verify information?
- **Logical verification:** Does the transaction make sense?
- **Negative verification:** Do we have the use of historical or other risk databases? Are past incidents predictive of future risk? If so, why, and if not, why not?

This was a relatively simple decision, but was based on a complex and dynamic set of variables. We identified two “starting points” of the decision, characterized by internal and external knowledge requirements. The questions that required an answer for internal and external knowledge management are shown in Table 1.

<table>
<thead>
<tr>
<th>Internal knowledge starting point:</th>
<th>External knowledge starting point:</th>
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<tbody>
<tr>
<td>What do you already know?</td>
<td>Is the Applicant the “real” applicant?</td>
</tr>
<tr>
<td>Where is this knowledge?</td>
<td>Do you ask all that you need to know?</td>
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<tr>
<td>How can you maximize your use of this knowledge?</td>
<td>Do you get a truthful response? How do you know?</td>
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<tr>
<td>As you learn, how do you plan to share that new insight?</td>
<td>Can you accurately interpret it?</td>
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<td>When is a “wrong” answer a:</td>
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<td></td>
<td>• lie</td>
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<td>• a natural consequence of a misunderstanding</td>
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<td>• a result of poorly designed questions or enforced choice?</td>
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</tbody>
</table>

Table 1: Internal and External Knowledge Requirements For Approval Decision

Automating the visa approval decision support system involved many factors, among them the verification and authentication of an individual applicant’s personal identity. Example one demonstrates some of the issues involved in translating a name from another language.
Example #1. **Family name.** If an applicant enters NGUYEN, this is a typical Vietnamese family name. This family name would convey ethnicity and residence context as VIETNAM. We would not have any additional meaning, such as whether the applicant was (or was not) a communist, or loyal to the current government, as Vietnamese on both sides of the Vietnam conflict carry this name. However, if the applicant enters NGUY, this indicates that the individual is using a transliterated name from the Chinese, so the name is actually a legal fiction. This name conveys another layer of meaning about ethnicity, probable political persuasion, and even loyalty to family over country of residence, since many Chinese became refugees in the late 1940’s when the Chinese communists pushed the nationalists out of mainland China, resulting in the separation of nuclear and extended families. There is little likelihood that a scoring system built on alphabet matching algorithms will capture these additional layers of meaning, especially if an analyst (in France, Germany or Canada, for example) is not familiar with Vietnamese transliteration systems. Being asked for “ALL” names in an automated visa approval system is not likely to facilitate capture of Chinese characters when the “legal” name is a transliteration and the data is keyed using a Western application via a keyboard.

To illustrate the complexity of combining tacit and explicit knowledge for an automated visa approval system, we present three variations in Example 2, taken from a single related concept, the applicant’s name (family name, first name, middle name).

Example #2. **First name.** The typical Chinese name consists of 3 characters, a family name (character in the “first” position) and a personal name, generally a 2-character combination that represents the equivalent of a first name. This is not synonymous with discrete first and middle names, but the system may not accurately process a compound first name, even if separating the components of the name destroy the name itself. In Figure 2, we take the first of a 2-character personal Chinese name and transliterate it into English using one of the more widely-known transliteration systems, Hanyu Pinyin.

![Figure 2: Three Translations Of An Ideographic Firstname Character](image)

In that transliteration, the character is spelled “KUO.” Using a Vietnamese transliteration, however, the character becomes “QUOC.” In a scoring system that matches letters of the alphabet to determine a score, the likelihood that the system would make the correct association of “SAME FIRST NAME” is slight. The situation is further complicated if a name is translated rather than transliterated. This same character translates as one meaning of the word “STRONG.” However attempting to cross-validate or “reverse look-up” this English word will generally fail, as there are several dozen Chinese characters with rules of use and different meanings for “strong.”
The examples demonstrate the difficulty of simply employing an IT-based knowledge-base to determine identity. The determination of identity requires a great deal of local knowledge, combined with a decision-making model that takes into account the various cultural permutations that apply to different routes of entry to the USA and the countries visited in transit. We focused attention on the subcomponents of the decision, to examine how a knowledge-base system might be utilized and on the breakdowns in decision support experienced by the analyst. Using the competitive intelligence model discussed above, we identified false assumptions embedded in the approval process, based on a global, rather than a local understanding of applicant variables. We identified the need for retrospective re-interpretation of cases based on external conditions. This indicated a need for knowledge system design conventions that embedded flexibility in the design to reflect a dynamic appreciation of risk factors. We identified a key need to incorporate legal and regulatory constraints into systems design. The discussion section focuses on our analysis of suitable action to be taken in managing knowledge roles in the decision-making process.

**Synthesis: Determining Human-IT Role Divisions**

The knowledge management problem was defined as determining a suitable role for the decision analyst, based on the strengths of human vs. machine decision-making and to determine how information systems could best support and codify various types of knowledge involved in the decision.

**Determining A Suitable Role For The Analyst**

We started our analysis by asking: where does knowledge reside in this distributed community of practice? To determine types of knowledge that were involved in the decision and the extent to which they may be codified, we derived the model shown in Figure 4 from a
content analysis of the process-categories reported. Analysts distinguished between context-specific, local knowledge and generalizable rules of decision-making. But they also distinguished between explicit knowledge, that could be articulated in explaining an espoused theory or rationale, and the tacit knowledge that guided their theory-in-use (Argyris and Schön, 1978). When they discussed the problem of local, tacit knowledge, they frequently referred to “hidden knowledge” that could only be discovered through experiential learning.

The model of Figure 4 represents the types of human knowledge management involved in analysts’ decision-making. Transferable knowledge appeared to be managed well, for the existing process. Analysts served an effective apprenticeship and they became competent decision-makers, as a result. The constraint on their competency was imposed by two elements: time constraints and access to sufficient risk-management information. Hidden knowledge was the most problematic. This type of knowledge requires a “breakdown” (Winograd and Flores, 1986). While individual analysts did learn from their mistakes, this was not communicated to other analysts. Opportunities for this type of learning were also constrained by limited access to
information about individuals that they had approved and limited time to peruse available information. This observation indicated a need for discoverable knowledge that could be provided by analysis of historical data. Inference engines and case-based reasoning tools are widely available. We identified the need for a suitable model of risk assessment, to indicate a suitable type of computer support for this knowledge. Finally, programmable knowledge was widely available locally, but its efficacy was constrained by a lack of access to risk-indicator variables that “everybody knew about” at one office, but that were not communicated between offices. Additionally, much of this knowledge was so obvious to experienced analysts that no-one bothered to record it, so it was acquired only slowly by new analysts.

Determining A Suitable Role For Computer-Based Knowledge Management

It would appear that the INS was not sufficiently recognizing a key role of computer-based information systems: to enable individuals and groups to transfer knowledge that they had surfaced at a local level. While many of the knowledge-sharing problems were caused by too much work and too little time to collaborate effectively, there were serious shortcomings (that have since been rectified) in identifying areas where IT could be used to alleviate this situation. While we started from Nonaka’s (1994; Nonaka and Konno, 1998) model of knowledge creation and use to analyze the role of knowledge in the analyst’s work processes and to suggest opportunities for redesign of those processes, this model deals with the human processes of knowledge creation and use. We found that employing a competitive intelligence model of risk analysis (Heinrichs and Lim, 2005; Herring, 1998; NCISSE, 1998; Noyes, 2004; Pattakos, 1998) permitted insights about suitable roles for IT in these human processes.

Processes in the Generalizable/Explicit quartile of Figure 4 could easily be automated. The first role for IT in this process was therefore to provide an application processing system that
dealt with the routine cases. The key intelligence issue was to identify those cases that were sufficiently routine to be processed automatically. A scoring system was suggested, based on standard competitive intelligence techniques, to identify such cases. Early warning is a key factor in managing national security risks. This is a role that is not covered in the SECI model (1994; Nonaka and Konno, 1998), which deals with knowledge generated through human processes.

To improve knowledge management in decision support, the role of the human analyst should be focused on those areas where they need to evaluate intent to harm when a high-risk individual is identified by the knowledge-based information system and to manually enter information concerning high-risk factors that would affect the decision that may not be obtainable from historical data. This gave us a second role of IT: to record novel observations or lessons learned, that are realized during routine work. Such realizations appeared to be generated by cognitive breakdowns (Winograd and Flores, 1986) that are triggered by social interactions with other analysts. In this way, automatic, ritual processes (Majchrzak et al., 2000) and investments-in-form (Star, 1989) could be updated as new risks emerged through discussions of specific cases. These processes of socialization could only take place in a local, face-to-face context. Given the pressure of work, business processes needed to be redesigned for such interactions to occur so that individuals -- even experienced analysts -- could share emergent knowledge (Markus et al., 2002). We would suggest an ongoing mentor or apprentice role, where analysts are rotated regularly between mentors, to facilitate this process. Externalization also required a more formal role in work design. We felt that quality circle discussions, held on a regular basis, would provide opportunities for reflection, knowledge-surfacing and the triggering of cognitive breakdowns (Winograd and Flores, 1986), to suggest changes to automatic decision-making assumptions.
Combination of knowledge across geographically and temporally dispersed analyst groups required the use of a formal knowledge-base system, the third role for IT in this process. A formal knowledge-base would require incentives for use by local analysts, who were often overworked. It was recommended that time spent in updating knowledge-base entries be recognized in work reviews and the compensation system. It was also recommended that time spent using the knowledge-base should be incentivized and that discoveries pertaining to local practices should be formally recorded for use by others, or raised at quality circle meetings. This allowed the use of generalized knowledge to be interpreted within the local set of socio-cultural norms, for adoption within a specific work-group (Lave and Wenger, 1991).

Finally, internalization required opportunities for reflection (Schön, 1983). We felt that this offered a fourth role for IT: to provide an online training system, based on cases from the knowledge-base. Such a system would provide an excellent mechanism for innovation and moving away from automatic decision-making models in the visa approval process.

The resulting model of IT use is shown in Figure 5. It elaborates the four roles of IT and the contribution made by applying a competitive intelligence (CI) model to the analysis of IT knowledge support. This provides a structure for IT system role determination that may be of use in other high-risk decision-support environments.
As this research site is an agency involved with national security, we were not permitted to engage in implementation of the plan. Aspects of the investigation that concerned the development of a suitable IT support system have been discussed elsewhere (Shelfer and Verner, 2002; Shelfer, 2002). We have gathered from news reports and other sources that practice has changed radically in the INS visa approval process. Of course, we did not provide the only inputs to this change consultation process and we cannot take credit for the improvements observed.

Discussion

Zack (2001) asks “if managing knowledge is the solution, then what's the problem?”, assessing his response in terms of complexity, uncertainty, ambiguity and equivocality. We would suggest that these four terms barely scratch the surface in expressing the situatedness and internal, experiential, and dynamic nature of knowledge acquisition and use. We speak of “knowledge transfer” as if it is unproblematic – just a matter of applying a structured set of analytical procedures to produce knowledge that is articulable and externalizable. We have presented a situated analysis of the processes of knowledge creation and use in a complex, emergent and dynamic decision-making environment to illustrate just how messy and social are these processes in real-life. From this analysis, we derived four classes of knowledge that communicate a human interpretation of what knowledge is. It should be emphasized that the four classes of knowledge given in Figure 4 were deeper than the declarative/procedural distinction (Anderson, 1993) that is generally employed. When analysts expressed their concern that certain types of knowledge were inarticulable, they signified that their decision-making frames could not be articulated, even to themselves. When analysts expressed a concern that certain types of decision rested on local knowledge, they were expressing an understanding that a similar
situation might be interpreted differently, depending upon the degree to which an analyst had been exposed to the risks of specific situations. These classes of knowledge were clearly related not to the situation, but to the analyst and their experience within the social context of work.

We subjected these processes to a risk analysis process employing competitive intelligence techniques, to determine suitable roles for human decision-making and for automated decision-support. The framework shown in Figure 5 has a set of stages that develop the concepts of Nonaka’s SECI model (1994; Nonaka and Konno, 1998), to expose multiple levels of decision-making, defining specific types of knowledge or information that are appropriate to human vs. machine processing and decision-analysis. However, the SECI model was limited, in that it only considers human processes of knowledge-creation and use. By combining this with a risk-analysis based on competitive intelligence techniques (Heinrichs and Lim, 2005; Herring, 1998; NCISSE, 1998; Noyes, 2004; Pattakos, 1998), we were able to gain deep insights into appropriate roles for both humans and IT in high-risk decision-making environments.

Conclusions

We attempted to deal with the situatedness of complex, distributed, dynamic and ill-understood knowledge for high-risk decision-making by applying a multi-dimensional analysis process. Following the risk management cycle shown in Figure 1, we used competitive intelligence techniques to identify and to assess critical risks in the process. We then used knowledge management insights to develop a risk management plan.

The case presented in this paper combined insights from competitive intelligence methods and knowledge management techniques, to determine a strategy for risk assessment in US immigration visa approval. The contribution of this paper is to provide a knowledge taxonomy and a process-framework by which roles for IT support in a complex and distributed, high-risk
decision-making environment may be defined. We have exposed the notion that human-IT role-divisions are complex, situated constructs that are only meaningful within a specific culture, location and worldview. We assessed the limitations of Nonaka’s (1994; Nonaka and Konno, 1998) SECI model of knowledge creation and use in determining roles for IT processing in knowledge-management. This suggested an alternative set of knowledge distinctions, given in Figure 4, and a work-process analysis framework, shown in Figure 5, within which IT roles may be analyzed more generally. The case discussed here shows how a multi-level analysis of decision-making in knowledge management can contribute significantly to a very different understanding of how to organize work and knowledge in critical decision-making environments than that obtained from a traditional, functional analysis.

References

Herring, J. (1999) "Key intelligence topics: A process to identify and define intelligence needs," Competitive Intelligence Review (10:2), 4-14.


