Expertise Management: Challenges for adopting Naturalistic Decision Making as a knowledge management paradigm

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ABSTRACT

Naturalistic Decision Making (NDM) offers perspectives and methods for understanding cognitive performance, especially expertise. Knowledge management (KM) is a multi-disciplinary field professing to improve organizational performance by making the best use of knowledge. Since expertise is one of the most valuable assets in any organization, it stands to reason that adopting the perspectives and methods of NDM as a KM paradigm – i.e., Expertise Management – should enable organizations to realize performance improvements. Yet, Expertise Management has not achieved recognition as a KM strategy, and attempts to implement it have been met with significant methodological, practical, and competitive challenges. This paper examines the case for NDM-based Expertise Management as a core KM strategy, and the methodological, practical and competitive challenges for adoption. The authors draw on their collective professional experience in attempting to implement Expertise Management at a diverse range of organizations, and conclude with recommendations for future directions.

KEYWORDS

Expertise; Expertise Management; Macrocognition; Cognitive Task Analysis; Business; Practical Application.

INTRODUCTION

Naturalistic Decision Making (NDM) offers perspectives and methods for understanding cognitive performance, especially expertise. Perspectives include a focus on macrocognition (Klein et al., 2004), while methods include Cognitive Task Analysis (CTA; Crandall, Klein and Hoffman, 2006; Moon et al., 2011). NDM has demonstrated value for revealing the nature of expertise in diverse domains, and providing guidance for translating expertise into the design of systems for enhancing individual and team performance (Klein, 2008).

Knowledge management (KM) is a multi-disciplinary field professing to improve organizational performance by making the best use of knowledge. Duhon (1998) offered one of many comprehensive definitions of the field:

> Knowledge management is a discipline that promotes an integrated approach to identifying, capturing, evaluating, retrieving, and sharing all of an enterprise's information assets. These assets may include databases, documents, policies, procedures, and previously un-captured expertise and experience in individual workers.

The last point expresses relevance for NDM. Since expertise is one of the most valuable assets in any organization, it stands to reason that adopting the perspectives and methods of NDM as a KM strategy should enable organizations to realize the performance improvements at which KM is targeted. The notion of an NDM-based practice of KM was first suggested by Klein (1992), observing that while "(e)xpertise is a key resource in any organization…it is usually not treated with the same care as other resources" (p. 170). Klein described the very situation that KM purports to address: "Few organizations have any methods for preserving or expanding their experience, or even taking stock of their current expertise…When staff members retire, the organization does little to preserve their expertise" (p. 170). The latter insight has become particularly important as the world's workforce skews toward massive retirement (Hoffman & Hanes, 2003). Klein's primary recommendation was the use of "low-technology applications of knowledge engineering" (p. 170), or knowledge elicitation. Specifically, Klein advocated using the Critical Decision Method to capture incident accounts and lessons learned (p. 180-184), building a case that "the various methods of knowledge engineering have the potential for maintaining corporate memory and for preserving organizational expertise (p. 185).

Yet, NDM has not achieved wide recognition as a KM strategy. We can take Koenig's article, "What is KM? Knowledge Management Explained" (2012), published for KMWorld, as an exemplar of the many reviews of the field. It is notable that despite expertise being explicitly cited as a core concept in Duhon's definition, Koenig only tangentially mentions the nature of expertise through referencing Nonaka & Takeuchi's (1995) oft-cited distinction between explicit, implicit and tacit knowledge. Moreover, of the three undertakings that Koenig suggests are "quintessentially KM," none offers guidance on the articulation or acceleration of expertise.

Lessons learned databases, expertise location, and communities of practice are suggested as mechanisms to enable the capture, location and sharing of expertise – in much the way other, more tangible corporate assets are handled. Koenig's historical view of the stages of development of KM is also illustrative: first stage—information technology; second stage—HR and corporate culture; third stage—taxonomy and content management. Noticeably absent is reference to any affiliation with the traditions of NDM, expertise studies or even cognitive psychology and human factors.

Several reasons underlie the apparent lack of recognition of the potential value of NDM for KM. The first concerns stovepipes. The major figures in the field of KM derive from fields such as business studies, organizational theory, management consulting, education, library sciences, and information technology. While these leaders often express a familiarity with elements of the NDM paradigm – e.g., "collective sensemaking" (Dixon, 2015) and knowledge capture – they rarely cite NDM research as the basis of their understanding of expertise. Ackerman and Wulf et al., (2003), while concerned with "sharing expertise," rely principally on judgement and decision making paradigms to guide their views on expertise and computer-supported cooperative work to formulate approaches for getting "beyond knowledge management." There are exceptions as some have recently realized the potential advantages of knowledge elicitation techniques (Gavrilova and Andreeva, 2012).

Another reason is the significant influence of technology-based solutions providers in the KM community. The first stage of KM continues to command significant focus from organizations seeking help with KM challenges; thus, any KM approach that is principally human-centered often struggles to gain audience (Griffiths and Moon, 2011).

But perhaps the primary reason that NDM has not emerged as a core KM strategy is because attempts to implement it have been met with significant methodological and practical challenges. These challenges are the focus of this paper. Collectively, we have gained professional experience in attempting to implement an NDM-based KM strategy – i.e., Expertise Management (EM) – at a diverse range of organizations. Our experience includes:

- Multi-year and pilot implementations, and training events, for major corporations in energy and manufacturing industries and government sector,
- Publications and methodological guidance documents,
- Faculty appointment and curriculum development for a graduate-level course in EM and Knowledge Elicitation, and
- Experimentation with knowledge transfer approaches, including ShadowBox, a scenario-based training method that uses CTA data, for capturing and disseminating expertise (Klein, Hintze & Saab, 2013).

Our experience has revealed many challenges, and propelled us to refine our Expertise Management approaches. We conclude with recommendations for future applied research directions.

METHODOLOGICAL CHALLENGES

To contextualize our review of the methodological challenges, it is useful to present a general model of EM, as we have implemented and taught it. Our model comprises three elements: identify, articulate and engage. Identify refers to approaches for identifying expertise on which to focus the subsequent activities. Articulate references knowledge elicitation activities, typically conducted by an experienced knowledge elicitors working one-on-one with identified experts. And Engage covers activities that are intended to facilitate the acceleration of expertise in others, to include sharing the articulated expertise through representations and training exercises. In some cases, the identification of expertise is straightforward – target experts have already been identified by the sponsor or manager of the effort. In other cases, organizations have needed a principled approach to scaling proficiency in order to focus the effort (see Hoffman, et al., 2014). The bulk of our efforts have fallen under the articulate element, where we have either conducted or trained others how to conduct knowledge elicitation. The engage element has at times either been beyond the scope of our efforts, or pre-determined by the organizations with whom we have worked. In some cases, we have also blended the articulate and engage activities by bringing others into the articulation process so that engagement is concurrent (Baxter, 2013). Recent efforts have seen us focus explicitly on the efficacy of some of our engagement activities. These include demonstrating considerable gains in knowledge transfer using ShadowBox (Klein, Borders, Wright, & Newsome, 2015).

The methodological challenges to NDM as a KM strategy fall into three categories: scope, process, and product.

Scope

By scope, we mean the challenge we often hear from experts and business leaders at the start of our EM engagements: "How are you possibly going to capture everything I've learned in 40 years?" The question is a reasonable one, coming from professionals who have achieved "franchise expert" status (Hoffman et al., 2011), earned through years of compiled experience – yet have very little insight into knowledge elicitation or the purpose of the EM effort. Indeed, while managers may realize the risks of "lost knowledge" (DeLong, 2004) and want to take steps to mitigate it, they too are often not clear about what they can do to mitigate or even what they want to achieve. They often fail to define what specifically about the expertise is of interest and what will be done with the knowledge after it is captured. We have learned this lesson the hard way, for example after being

introduced to nuclear engineers with experience in "instrumentation and controls" or "fuels" (Moon and Kelley, 2010) – huge practice areas implicating vast subdomains, skillsets and tasks requirements. It is very difficult to know from the outset where the most critical macrocognitive elements of performance may lie.

The NDM paradigm is mostly silent on the issue of scoping an EM effort. NDM provides a methodological toolkit for understanding the expertise inherent in the proficient performance of tasks, which can be extrapolated to the understanding of jobs and roles (Crandall, Klein and Hoffman, 2006). But determining which aspects of an expert's experience hold the most potential for realizing a return on the investment of resources in an EM engagements requires honing in on periods in the expert's career, the current and envisioned needs of the organization, and perhaps most importantly the needs of the personnel that will take up the expert's responsibilities. Hoffman and Hanes (2003) advocated for a process that focuses on the elicitation of knowledge that is (a) unique to the individual expert, (2) crucial for the organization and (3) not currently documented—yet even this approach can yield significant candidate topics on which to focus knowledge elicitation methods. EM scoping efforts invariably expand from a focus on the individual expert to the broader context of the organization.

Scoping is also a challenge at the other end of the EM engagement; that is, knowing when to stop. While many CTA interviews typically last something in the range of two hours for a single task or incident, we know from experience that collection and analysis of some protocols and case studies can take many hours (c.f., Hoffman et al., 2000). Experienced knowledge elicitors have heuristics to inform them about when an incident or topic has been thoroughly covered. But when engaged in an EM effort, there are no analogous rules of thumb for how long an EM engagement should last, or when it is "done." There is always another incident that could be captured; always another aspect of the expert's experience that could be explored. We have been fortunate in some engagements to spend upwards of 30 to 40 hours over the course of six to eight months with some experts (Moon and Kelley, 2010) – a luxury in the study of expertise. More often than not, EM engagements end much earlier for practical reasons, not the least of which is the ever-present need to get the expert back to work. Resources also impose constraints on the scope.

Process

The general model of EM that we sketched above could be expanded to show a number of subprocesses that we have managed in our EM engagements. Two in particular have shown to be methodologically thorny. The first regards building and maintaining rapport with the expert. Generally speaking, many of the experts we have worked with are favorably disposed to the idea of preserving some of their critical knowledge and helping others gain some advantage from it. They are motivated by senses of personal and professional legacy and a desire to see the organization succeed. We have, however, been met with experts who were quite disinclined to participate. In one striking case during what was supposed to be a pilot demonstration, an expert approached one of the authors on the eve prior to the pilot and stated bluntly, "I don't want to do this – I think it is a bunch of crap." He later revealed that he felt strongly that his junior colleagues should learn their science and craft the same way he did – through "hard work and getting their hands dirty." This expert's lack of motivation had significant methodological implication on the EM effort, as he was mostly unwilling to engage with any of the knowledge elicitation methods that were to be demonstrated.

A second challenge has been the selection and execution of knowledge elicitation methods during the articulation activities. The Critical Decision Method (Hoffman, Crandall and Shadbolt, 1998) and Applied Concept Mapping (Moon et al., 2011) have been our KE methods of choice because of their established track records in capturing macrocognitive elements of performance. They have not, however, always worked well for our purposes. CDM has been challenging to apply with experts whose key value to the company lied in their vast declarative knowledge – e.g., about historical customer and vendor relationships – and with experts whose tactical experience was so vast that they were challenged to recall any particular incidents. The latter point is particularly important in light of the scoping issue. The initial CDM question, "Can you think of a time when your skills were challenged?" has quite often garnered a response of "many, many times," putting the onus back on the knowledge elicitor to help the expert scope his or her recall. We have learned that starting an EM engagement with a CDM interview is not an efficient way to scope the effort.

Applied Concept Mapping introduces a number of process complexities that have been discussed in detail elsewhere (c.f., Moon, Hoffman, Eskridge and Coffey, 2011). At times, these complexities have overridden the potential value of use. For example, one of the authors was executing an EM project with a nuclear engineer whose career dated back to the dawn of the nuclear age. The engineer was born and raised in Japan, and the legacy of his first language remained quite evident in his accented English. At an age when many workers would be well into their second decade of retirement, this expert reported for assignment five days a week, adding to his already prolific research and publication achievements. He preferred to work mostly behind the closed door of his office. While Concept Maps articulating aspects of his vast declarative knowledge and the reasoning strategies that helped shape his industry-altering ideas would almost certainly have created value for the organization, executing the protocols for Concept Mapping would have been very difficult with this expert.

There exists a tacit assumption in the NDM paradigm with regard to methods for understanding expertise; namely, that the methods can be executed with any expert, under any conditions. While caution for the assumption has been given by suggesting adaptation will always be necessary (c.f., Crandall et al., 2006), our

attempts to implement EM have revealed several boundary conditions that have brought the assumption into high relief.

Products

A goal of EM is to externalize expertise so that it can be preserved in ways that enable others to engage with it. The traditional representational and analysis products suggested by the NDM community include decision ladders, decision requirements tables, Concept Maps, and timelines (c.f., Crandall et al., 2006). While these products have proven useful for NDM practitioners in order to guide design and development activities, their value for EM has been difficult to demonstrate. In the context of EM, we have prepared products ranging from knowledge models, which are hyperlinked sets of Concept Maps and associated knowledge resources (Hoffman and Beach, 2013), to extensive incident accounts, to narrative content formatted by client requirements for corporate intranets and other KM portals. Moreso than is typical of our other NDM work, our EM products have often benefited from iterative review with our experts, though such reviews have introduced additional methodological and practical concerns such as how to reign in an expert's revisions (Moon and Kelley, 2010).

Applied Concept Mapping has presented particular challenges. Very little study has been made of the efficacy of Concept Maps for helping accelerate the achievement of expertise. Moon and Hoffman (2008) demonstrated the potential value for Concept Maps for "rapid idea transfer" in military populations showing slight improvement over PowerPoint presentations but lower efficacy compared to narrative text. Yet Derbentseva and Kwantes (2014) have only seen a "lukewarm response to using Cmaps for communicating information" in the same population. There are also practical concerns. Coffey and Eskridge (2008) have noted the "format problem" with Concept Maps, particularly in the industries where the "format of training materials and procedures is clearly circumscribed and tightly controlled" (p. 17).

While NDM points to the nature expertise, to techniques for its analysis and representation, and to methods accelerating its achievement (Hoffman et al., 2014), guidance for how to preserve and present externalized macrocognition in ways that permit efficient, flexible, context-situated exploration as a means toward acceleration has been underspecified.

PRACTICAL CHALLENGES

Some practical challenges were alluded to above, e.g., time, resources, and regulations. These are not new to NDM-based efforts. Our experiences implementing EM have forced us to confront several other practical challenges in making the case for it and the need for NDM expertise.

Making the case

Making the case for an NDM-based EM is challenging for several reasons. Solving or mitigating problems through an NDM approach is, almost by definition, a time consuming and thus expensive endeavour (Zachary et al., 2012). Expenses are introduced through the expert's and EM expert's time, as well as travel and other expected costs. Personnel charged with mitigating lost knowledge must typically develop a cost/benefit analysis in order to answer the question of return on investment (ROI). The analysis may take other KM "solutions" into account, including software products, mentoring programs and succession plans, which can create competition for scarce resources. While some decision makers in human resources and training departments may be familiar with NDM traditions and requirements for success, the vernacular of NDM (e.g., "macrocognition") does not translate well to front-line managers who stand to gain the most from it. Indeed, as noted above, even many KM practitioners do not speak the language. Thus, providing a straightforward and palatable answer to the ROI question is difficult.

The case has not benefitted from the success stories that have emerged from other applications of NDM, such as cognitive engineering (c.f., Cooke and Durso, 2010). EM is at a stage of development just behind "accelerated learning" (Hoffman et al., 2014). We have many examples of application, including institutionalization at some organizations (c.f., Kelley, Sass and Moon, 2013). We know of many anecdotal examples of success, where "management gained real insight into what the experts truly did, and in many cases, much greater insight into how they did it than they could have had without [EM]" (Coffey and Eskridge, 2008). What remains missing is systematic analysis of the effects and benefits of EM, and measurement of the costs and risks of *not* doing EM.

Need for NDM expertise

Our implementation efforts have included educating KM students, and training and coaching personnel who have taken on KM as primary and collateral duties. In more than a few cases, we have introduced EM to personnel who inherited KM yet had no prior experience in KM or exposure to EM. We have found that some people take quickly to some methods but struggle with others. Some have seen uses for the methods in their other work, beyond EM. During one engagement, one of the authors was coaching two candidate EM practitioners who inherited KM as a collateral duty. After several days of coaching in CDM and Applied Concept Mapping, it became quite clear that one of the candidates was quite skilled at formulating and asking questions while the other was very skilled at creating and editing Concept Maps. Yet neither was very good at the other skill – to the point of bringing interviews to a halt in order to shift roles back to those they were comfortable in.

Many of our trainees have expressed appreciation of the value of our insights into expertise. They have seen first hand through demonstration of knowledge elicitation just how deeply the techniques can unpack expertise. Once they see an interview unfold, they are often surprised at the fluidity with which a skilled elicitor can exercise methods in order to unveil details that would otherwise not have been articulated.

Yet our training and coaching experience has driven home the point that in order to effectively and efficiently work with experts who will be the concern of an EM program, practitioners need a deep level of familiarity with NDM and it models, and a flexible facility with its attendant toolkit. This need for NDM expertise introduces a significant practical challenge to the proliferation of NDM as a KM paradigm. Indeed, the global scope of the expertise loss problem is many orders of magnitude larger than the entire NDM community could service. For KM practitioners who are not steeped in NDM, we have seen the struggle to get up to speed in NDM quickly enough to be effective. Given that there are not many NDM practitioners who are strongly motivated by KM goals, reaching the tipping point of adoption will require new directions.

FUTURE DIRECTIONS

We are encouraged about the prospects for NDM adoption as a KM paradigm by the immense opportunities that KM challenges present. As the global population continues to age, the need for at the very least preservation of expertise will only become more critical. Stories of some organizations losing expertise – e.g., NASA's ability to fly Saturn 5 rockets (DeLong, p. 12) – will continue to amass. Demand will drive the search for KM approaches that show promise for mitigating the problem.

We are also encouraged by the successes of our limited efforts, where success can be measured in client value and empirical findings. Notably, we have realized several of our success stories through adaptations and extensions from our general model. Kelley, Sass and Moon (2013) reported on the maturation and modification of our general model that outlined four types of elicitation sessions: technical content of interest to many, job replacement, facilitation, and critical skill transfer. Each type introduced a different purpose, resource requirements and audience, but every type utilized knowledge elicitation techniques. Client value was realized in "high levels of expert engagement… consistent recommend[ation of] the process to … peers and management" (p. 4). The approach was "viewed as a valid alternative to one-on-one mentoring" (p. 4). In other efforts, we have adapted the model into one-off sessions that are scoped by the client. Value for these clients has been evident through the long-term engagements they have established with us—clearly, these organizations are realizing value, even if organizational effects have not been systematically measured.

Future directions will need to more systematically compare and contrast implementation models of EM and their relative values. Independent variables for exploration should include time spent with experts, knowledge elicitation techniques, and experience of the knowledge elicitors. Dependent variables should focus on realized improvements, preferably at the organizational level. McManus, Wilson and Snyder (2003) demonstrated positive revenue benefits from a "knowledge harvesting" approach, showing that bottom line (i.e., fiscal) improvements are possible. We would also expect to see improvements in macrocognitive performance in organizations. We are very encouraged by recent efforts toward such systematic investigation. Klein et al. (2015) found strong effects using ShadowBox to help military personnel acquire tacit knowledge in the form of a new sensemaking frame. ShadowBox addresses some of the product challenges, and we are eager to explore how the approach can scale for organizations in the Engage stage.

Expertise Management offers potential to improve organizational performance through the introduction of the NDM paradigm into KM programs. We have accumulated lessons learned from the many challenges to implementation. It is our hope that these lessons and future applied research will help establish EM as a viable KM—and NDM—practice area.

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REFERENCES

Ackerman, M. S., Pipek, V., & Wulf, V. (Eds.). (2003). *Sharing expertise: Beyond knowledge management*. MIT press.

Baxter, H. C. (2013). Transferring Specialized Knowledge: Accelerating the Expertise Development Cycle. In *The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC)* (Vol. 2013, No. 1). National Training Systems Association.

Coffey, J. W., & Eskridge, T. (2008). Case studies of knowledge modeling for knowledge preservation and sharing in the US nuclear power industry. *Journal of Information & Knowledge Management*, *7*(03), 173-185.

Crandall, B., Klein, G. A., & Hoffman, R. R. (2006). *Working minds: A practitioner's guide to cognitive task analysis*. Mit Press.

DeLong, D. W. (2004). *Lost knowledge: Confronting the threat of an aging workforce*. Oxford University Press.

Duhon, B. (1998). It's all in our heads. *Inform*, *12*(8), 8-13.

Gavrilova, T., & Andreeva, T. (2012). Knowledge elicitation techniques in a knowledge management context. *Journal of Knowledge Management*, *16*(4), 523-537.

Griffiths, D., & Moon, B. (2011). The State of Knowledge Management. *KM World Magazine*. Volume 20, Issue 10.

Hoffman, R. R., Ward, P., Feltovich, P. J., DiBello, L., Fiore, S. M., & Andrews, D. H. (2014). *Accelerated Learning: Training for High Proficiency in a Complex World*. Psychology Press.

Hoffman, R. & Beach, J. (2013). Lessons learned across a decade of knowledge modeling. *Journal for Educators, Teachers and Trainers*, Vol. 4 (1), pp. 85 – 95.

Hoffman, R., Ziebell, D., Feltovich, P., Moon, B., & Fiore, S. (2011). Franchise Experts. IEEE Intelligent Systems, Vol. 26, No. 5, pp. 72-77.

Hoffman, R.R. and Hanes, L.F. (July-August 2003). The boiled frog problem. *IEEE Intelligent Systems,* pp. 68-71.

Hoffman, R. R., Coffey, J. W., & Ford, K. M. (2000). A case study in the research paradigm of human-centered computing: Local expertise in weather forecasting. *Unpublished Technical Report, National Imagery and Mapping Agency*.

Hoffman, R. R., Crandall, B., & Shadbolt, N. (1998). Use of the critical decision method to elicit expert knowledge: A case study in the methodology of cognitive task analysis. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *40*(2), 254-276.

Kelley, M., Sass, M., and Moon, B. (2013). Maturity of a Nuclear-Related Knowledge Management Solution. Annual Meeting of the American Nuclear Society. June 16-20.

Klein, G. (1992). Using knowledge elicitation to preserve corporate memory. In R. R. Hoffman(Ed.), *The psychology of expertise: Cognitive research and empirical AI* (pp. 170–190).Mahwah, NJ: Erlbaum.

Klein, G. (2008). "Naturalistic Decision Making". *Human Factors: The Journal of the Human Factors and Ergonomics Society* 50 (3): 456–460.

Klein, G., Borders, J., Wright, C., & Newsome, E. (2015). An empirical evaluation of the ShadowBox training method. Accepted for presentation at the 2015 conference on Naturalistic Decision Making, McLean, VA..

Klein, G., Hintze, N., & Saab, D. (2013). Thinking inside the box: The shadowbox method for cognitive skill development. Proceedings of the 11th International Conference on Naturalistic Decision Making (NDM-11). Marseille, France.

Klein, G., Ross, K. G., Moon, B. M., Klein, D. E., Hoffman, R. R., & Hollnagel, E. (2003). Macrocognition. *Intelligent Systems, IEEE*, *18*(3), 81-85.

Koenig, M. E. (2012). What is KM? Knowledge management explained. *Retrieved November*, *6*, 2013.

McManus, D. J., Wilson, L. T., & Snyder, C. A. (2003). Assessing the business value of knowledge retention projects: results of four case studies.

Moon, B., Hoffman, R. R., Novak, J., & Canas, A. (Eds.). (2011). *Applied Concept Mapping: Capturing, analyzing, and organizing knowledge*. CRC Press.

Moon, B., Hoffman, R., Eskridge, T. & Coffey, J. (2011). Skills in Concept Mapping. In Moon, B., Hoffman, R., Novak, J. and Cañas, A. (eds.) *Applied Concept Mapping: Capturing, Analyzing, and Organizing Knowledge*. pp. 23-46. New York: CRC Press.

Moon, B., & Kelley, M. (2010). Lessons Learned in Knowledge Elicitation with Nuclear Experts. Invited Paper. Seventh American Nuclear Society International Topical Meeting on Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies, Las Vegas, Nevada, American Nuclear Society, LaGrange Park, IL. November 7-11.

Moon, B. & Hoffman, R., (2008). Rapid and Accurate Idea Transfer: Presenting Ideas with Concept Maps. Scientific and Technical Final Report. Contract No. W31P4Q-08-C-0229. Washington DC: Defense Technical Information Center.

Nonaka, I. & Takeuchi, H. (1995). *The knowledge creating company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press.

Zachary, W., Hoffman, R., Crandall, B., Miller, T., & Nemeth, C. (2012). "Rapidized" Cognitive Task Analysis. *Intelligent Systems*, IEEE, 27(2), 61-66.