NDM8

Reconciling differences among multiple experts: A framework for developing a common ground

Topic: Intra- and inter-individual variability in NDM – the person and the context

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EXTENDED ABSTRACT

Knowledge elicitation as a basis for the design of decision support systems is standard practice. The NDM literature has many reports of field studies (see Zsambok, C. E., & Klein, G. (Eds.), (1997) for several examples) in which the objective was to understand the decision-making challenges of the particular work environment. Potter, et al (2000) discuss the importance of using multiple, complementary techniques in building up an analytic representation of the work domain. But multiple techniques and multiple SMEs can introduce excessive variability in the knowledge elicitation / cognitive analysis process, if the proper steps are not taken to come to a shared description of the work environment.

Variability among experts takes an array of forms. First, experts can have different "languages" or descriptions of the work environment. In one KE effort, we experienced different descriptions of the environment from the east-coast vs. west-coast navies. Second, experts have different perspectives. Each one will have a certain local area of expertise, and, thus, different perspectives of the decision-making challenges. In essence, experts are simply not all the same. They have different experiences, different mental models, and different strategies. So the question, then, is how to reconcile the differences between experts?

In their 1987 paper, Woods and Hollnagel argued "The real impediment to effective knowledge acquisition is the lack of an adequate language to describe cognitive activities in particular domains…" in order to build a cognitive description of a complex world. They describe a key hurdle: "To escape from the language of the application and to characterize the kinds of cognitive demands that arise in the course of performing domain tasks." KE should not about the verbatim comments from the experts; it's about taking those descriptions and abstracting out from them higher level insights that can help describe the goals and decisions within the domain.

In our experience, the critical element to the solution to this problem is to have a rich set of analytic artifacts to be able to establish a "common ground" for reconciling different insights from the subject matter experts. Our experience in KE and Cognitive Analysis has formed the following criteria for effectively transforming KE insights into requirements for Decision Support Systems (DSS). First, the artifact(s) must be indifferent to particular sources of domain information. Cognitive analysis must be able to take advantage of any number of KE sources. Given the uncertainty in gaining availability to SMEs, one must be opportunistic in terms of the type of KE activity. Second, the artifact(s) must facilitate the discovery of the fundamental, unchanging demands of the decision-making environment. The DSS must support these demands and not the specific interface characteristics that might be the object of a particular expert's comments. Third, the artifact(s) must have sufficient validity to be able to be used as a tool for explicitly discussing differences among experts. In support of this criterion, the artifact(s) must make differences among experts explicit.

We have had great success with using a Functional Abstraction Network (FAN) representation of the decision-making environment (Elm, et al., 2003; Potter, et al., 2003; Gualtieri, et al, in prep) as a primary mechanism for reconciling differences among experts. The applications include military command and control, multi-national operations, and intelligence analysis. This success is based on the artifact's ability to accommodate multiple sources of KE input, explicitly represent the fundamental properties of the work environment, and provide a representation that SMEs can understand and use to argue their particular perspective (as well as come to an acceptance of a reconciled model of multiple perspectives). In addition, this success is based on the emphasis within the methodology (and artifact) to model abstract concepts within the work

environment and identifying the fundamental decision-making demands that must be supported. The iterative construction of a FAN in these analysis efforts as an integral part of KE activities has provided significant insights into the leverage gained in reconciling differences among experts by this representation of the decision-making work environment.

REFERENCES

Elm, W. C., Potter, S. S., Gualtieri, J. W., Roth, E. M., and Easter, J. R. (2003). Applied cognitive work analysis: A pragmatic methodology for designing revolutionary cognitive affordances. In E. Hollnagel (Ed.). *Cognitive Task Design*. New York, NY: Lawrence Erlbaum.

Gualtieri, J., Tittle, J., Potter, S., McKenna, B., and Elm, W. (in prep). *Pragmatic use of CWA in system design: extending current thinking by adapting the mapping principle.*

Hollnagel, E. and Woods, D. D. (2005). *Joint cognitive systems: Foundations of cognitive systems engineering.* Boca Raton, FL: Taylor and Francis.

Paradis, S., Elm, W. C., Potter, S. S., Breton, R., and Bossé, E. (2002). A pragmatic cognitive systems engineering approach to model dynamic human decision-making activities in intelligent and automated systems. In *NATO RTA HFM Symposium on the Role of Humans in Intelligent and Automated Systems*. Warsaw, Poland.

Potter, S. S., Gualtieri, J. W., and Elm, W. C. (2003). Case studies: Applied cognitive work analysis in the design of innovative decision support. In E. Hollnagel (Ed.). *Cognitive Task Design.* New York, NY: Lawrence Erlbaum.

Potter, S. S., Roth, E. M., Woods, D. D., and Elm, W. C. (2000). Cognitive task analysis as bootstrapping multiple converging techniques. In Schraagen, Chipman, and Shalin (Eds.). *Cognitive Task Analysis*. Mahwah, NJ: Lawrence Erlbaum Associates.

Woods and Hollnagel (1987). Mapping cognitive demands in complex problem solving worlds.

Woods, D. D. and Hollnagel, E. (2006). *Joint cognitive systems: Patterns in cognitive systems engineering.* Boca Raton, FL: Taylor and Francis.

Zsambok, C. E., & Klein, G. (Eds.), (1997). *Naturalistic Decision Making*. NJ: Lawrence Erlbaum