NDM8

Improved Performance and Reduced Performance Variability of a Joint Cognitive System - a Method of Technology Design

Topic: Intra-Inter Variability in NDM – the person and the context

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Extended Abstract

Intra- and inter-individual variability is frequently the topic of study in decision-making research. However, focusing solely on the decision-making agent unnecessarily narrows the examined problem space and leads to incomplete or erroneous conclusions because two additional components are unaccounted for – decision-aiding artifacts and the naturalistic context (world) in which the decisions are made.

From a Cognitive Systems Engineering (CSE) perspective, cognitive work or naturalistic decision making (NDM) exists at the intersection of people, their environments, and the artifacts they use. Typical studies measure the inter- and intra- variability of the decision-making by the human. In contrast, the Joint Cognitive System (JCS) perspective (Hollnagel & Woods, 2005) focuses on improving the net decision-making performance of the human/artifact team (Potter, Ball, and Elm; 1996). This requires support to the human operators for observability (Woods & Hollnagel, 2006) of all three components of the JCS, the people, the environment, and the artifacts (automated).

In nearly every work domain, supervisors and team members can benefit from having observability of other human-agents. A simple example is the use of turn signals while driving. The surrounding drivers have observability of the other driver's intent, and can adjust accordingly. The example provided in this paper illustrates techniques for increasing inter-agent observability in a command and control domain by providing an aid for the humans to be more aware of actions taken by their human counterparts, minimizing the chances of poor or inconsistent JCS performance based on lack of support for Understanding (Woods & Sarter, 1993) of the team environment.

Secondly, people must be aware of the state and dynamics of their environment, and how their work is related to the particular context. In this paper, we discuss an example of naval command and control where the technology designed provides the humans observability of their environment (Paradis, et al., 2002). The user is able to understand the current state of the domain, how it reached this point, and has a reasonable understanding of the direction of the domain, and how his/her actions will impact the domain. Because of the observability provided, people are able to make decisions with a greater Understanding of the current context, in effect minimizing the variation across decision makers.

Finally, improving an individual's Understanding of automated artifacts within the domain decreases the chances of automation surprise. Because automation doesn't merely replace human tasks, they create new forms of cognitive work for people. The example discussed in this paper illustrates how to not only provide intelligence analysts with the output of an automated agent's algorithm, but to provide the analyst with an aid to understand the reasons behind the answer provided by the automation.

The methods described in this paper result in technology that provides observability of human actions, the environment, and automated artifacts. Three case examples of this application provide insights into the pragmatic development of technology that provides observability. The increase in observability also increases a human decision-maker's Understanding, and is likely to decrease the decision-making performance variability of the Joint Cognitive System.

References

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., Ball, R. W., Jr., and Elm, W. C. (1996). Supporting aeromedical evacuation planning through information visualization. In *Proceedings of the 3rd Annual Symposium on Human Interaction with Complex Systems*. Dayton, OH: IEEE. pp. 208-215.

Woods, D.D. & Sarter, N. (1993). Evaluating the Impact of New Technology on Human-Machine Cooperation. In J. Wise, V. D. Hopkin, and P. Stager, editors, *Verification and Validation of Complex Systems: Human Factors Issues*, Berlin: Springer-Verlag.

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