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ADAPTING C2 TO THE 21ST CENTURY

Evaluating the Resilience of a Human-Computer C2 Team: Decision-Centered Testing

Topics: C2 Metrics and Assessment; Network-Centric Experimentation and Applications; C2 Concepts, Theory and Policy

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EXTENDED ABSTRACT

In developing new C2 systems, it is essential to evaluate the impact of the new system on the decision-making it was designed to support. However, typical evaluation approaches do not truly address the complexities of the warfighter teamed with this new C2 decision support system (DSS). This paper will describe a novel approach to this evaluation need. To begin, we define a Joint Cognitive System (JCS) as the combination of human problem solver and automation/technologies which must act as co-agents to achieve goals and objectives in a complex work domain such as C2 (cf. Hollnagel and Woods, 2005 for their cyclic model of the function of Joint Cognitive Systems). An implication of our Cognitive Systems Engineering foundation is that a JCS needs to be evaluated for its effectiveness in performing the complex cognitive work requirements. This requires using measures that go well beyond "typical" performance metrics such as the number of subtask goals achieved per person per unit of time and the corresponding simple baseline comparisons or workload assessment metrics. This JCS perspective implies that the system must be designed and evaluated from the perspective of the teaming of the warfighter and the DSS. Previous research in CSE and our own experience has lead us to identify a set of generic JCS support requirements that apply to cognitive work by any cognitive agent or any set of cognitive agents, including teams of people and machine agents. Metrics will have to reflect such phenomena as "resilience" of a JCS. This places new burdens on evaluation techniques and frameworks, since metrics should be generated from a principled approach and based on fundamental principles of interest to the designers of the JCS. An implication of the JCS perspective is that complex and cognitive systems need to be evaluated for usability, usefulness, and understandability; each of which goes well beyond raw performance. However, conceptually-grounded evaluation frameworks, corresponding operational techniques, and corresponding measures for these are limited.

In order to address this need and test the effectiveness of a human operator paired with a decision support system, we have developed an evaluation methodology based on principles from Cognitive Systems Engineering (CSE). Decision Centered Testing (DCT) aims at testing the effectiveness of operators teamed with Decision Support Systems (DSS) in any challenging work domain. DCT is grounded in a CSE framework, where the concept of a JCS is central. DCT involves explicit design and analysis of tests based on the key decision making demands within the domain. The result is an explicit test design describing the cognitive problem under test, the hypothesized "edge" or latent potential weaknesses in the JCS, as well as the events that need to be included in the scenario. In DCT, test scenarios are developed to specify a progressive evolution of events that would be expected to stress the defined edge within the JCS. This decision-centered approach to testing has proven effective in discovering fundamentally new ways for evaluating the net decision-making effectiveness of the joint human-technology decision-making team.

STRUCTURE FOR FULL PAPER

A description of the DCT Methodology with an illustration taken from an initial application of the methodology will be presented. The critical aspects of this technique are:

- Focusing the evaluation on an analytical model of cognitive demands of the work domain;
- Identifying the "edges" in the joint cognitive system for the particular focus of the evaluation;
- Defining scenarios explicitly based on this analytical basis in order to exercise the desired cognitive demands;
- Defining "cognitive pressure" to explicitly stress the edges and therefore assess the strength of the JCS.

In this application, insights from the DCT methodology enabled the definition of appropriate test metrics and the construction of unique test scenarios to exercise the decision-making effectiveness. From this application, significant insights were gained regarding the construction of an evaluation framework for assessing the net decision-making effectiveness of a C2 system. These insights will be discussed.

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