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IMPROVING MBSE MODELS USING HUMAN PERFORMANCE SIMULATION

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ABSTRACT

It is important to recognize the human as an integral part of the system and its performance during systems development. However, systems engineers (SEs) currently fail to properly integrate the human into the system. This research aimed to improve system models by incorporating the human into modeling efforts. A set of Model-Based Systems Engineering (MBSE) models were created to describe an example scenario involving a virtual remotely-piloted aircraft simulation. When creating the models, some assumptions were made about the human from a SE's perspective. In order to verify if these assumptions were realistic, a human-focused model of the system was created using the Improved Performance Research Integration Tool (IMPRINT). Running simulations in IMPRINT uncovered fallacies in some of these assumptions, thus demonstrating the value of incorporating the human into system models and re-emphasizing the human as part of the system.

1 INTRODUCTION

Systems engineering has become an increasingly important part of the lifecycle management of Department of Defense systems, offering a holistic approach to system development (Department of Defense 2015). It is important to recognize that the human is an integral part of the system and that the system's performance depends on the effective operation of the human. However, systems engineers (SEs) currently conduct initial system modeling without acknowledging the human (Orellana and Madni 2014), treating the human as a "black box." Failure to properly integrate the human into the system results in higher system costs later in the lifecycle and a system that is less compatible with the user (Mitchell, Agan, and Samms 2011). The purpose of this research was to improve system models by incorporating the human system into modeling efforts.

The example scenario used is based on a synthetic task environment called Vigilant Spirit, which simulates a remotely-piloted aircraft (RPA) surveillance mission. In the scenario, the operator sits in front of monitors displaying simulated RPA camera-feed and flight info. The goal is to search a market for a high value target (HVT) while performing a secondary communication task involving answering questions at regular intervals regarding flight parameters of the RPA.

2 METHODOLOGY

A set of Model-Based Systems Engineering (MBSE) models were created using Systems Modeling Language (SysML) to represent the system. Even though the human is shown, the SysML diagrams were created specifically with the system in mind. Therefore, there were implicit assumptions made about the human from a SE's perspective, such as:

- Finds the HVT 100% of the time.
- Finds the HVT in less than 30 seconds.
- System interaction is independent of the type of interface.
- Workload remains manageable while completing both tasks.

One way to verify if the assumptions and constraints placed on the human and its performance were realistic is to simulate the human. The Improved Performance Research Integration Tool (IMPRINT) was used to create a discrete event simulation of the system model with a focus on the human, thereby modeling both human performance and workload. Several assumptions, such as the operator's task timing and accuracy, were manipulated within the IMPRINT model to test their validity.

3 RESULTS/DISCUSSION

Running the simulations in IMPRINT uncovered fallacies in some of the system's assumptions of the human, to include the following:

- The operator actually finds the HVT 62% of the time.
- The operator finds the HVT in less than 30 seconds only 39% of the time.
- System interaction is not independent of interface.
- The operator experiences an overload of workload when trying to find the HVT and performing the communication task simultaneously.

This study showed the value of incorporating the human into system models in order to verify the feasibility of system models and associated assumptions from a human perspective. Otherwise, MBSE models of the system would potentially miss system-critical information. Further, the research re-emphasizes the importance of the human as part of the system and not just the environment.

4 FUTURE WORK

This research focused on a proof of concept idea using Vigilant Spirit as the basic system. This concept can be expanded for use with more complicated systems, to include systems with automation. Additionally, the method of verifying SE assumptions about the human using simulations can also be used to perform trade studies and determine the effects that possible tradeoffs have on both system and human performance.

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