

# **MASTER OF SCIENCE IN MODELING, VIRTUAL ENVIRONMENTS, AND SIMULATION**

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## **A COMPARISON OF COMPUTATIONAL COGNITIVE MODELS: AGENT-BASED SYSTEMS VERSUS RULE-BASED ARCHITECTURES**

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Increased operational costs and reductions in force size are two of the major factors driving the need for improved computer simulations within the military community. Human performance models are used in various aspects of simulation, including controlling computer generated forces, tactical decision aides, intelligent tutoring systems, and new system design. This research makes a comparison between two categories of human performance models, multi-agent systems and rule-based architectures. Each type of model has its own strengths and weaknesses, and is therefore better suited for certain applications. Complex military simulations need human performance models that take advantage of the strengths of more than one type of model. The purpose of this research is to compare the implementation and performance of these two models, and to demonstrate the need for hybrid systems that employ the best aspects of models for a given situation.

**KEYWORDS:** Human Performance Modeling, Computational Cognitive Architectures, Human Factors, Decision Making, Multi-agent Systems, Naturalistic Decision Making

## **REDEFINING ATTACK: TAKING THE OFFENSIVE AGAINST NETWORKS**

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The Information Age empowers individuals and affords small groups an opportunity to attack states' interests with an increasing variety of tactics and great anonymity. Current strategies to prevail against these emerging threats are inherently defensive, relying on potential adversaries to commit mistakes and engage in detectable behavior. While defensive strategies are a critical component of a complete solution set, they cede initiative to the adversary. Moreover, reactive measures are not suited to quickly suppress adversary networks through force. To address this shortfall in strategic planning, the science of networks is rapidly making clear that natural systems built over time with preferential attachment form scale-free networks. These networks are naturally resilient to failure and random attack, but carry inherent vulnerabilities in their highly connected hubs. Taking the offensive against networks is therefore an exercise in discovering and attacking such hubs. To find these hub vulnerabilities in network adversaries, this thesis proposes a strategy called Stimulus Based Discovery, which leads to rapid network mapping and

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then systematically improves the accuracy and validity of this map while simultaneously degrading an adversary's network cohesion. Additionally, this thesis provides a model for experimenting with Stimulus Based Discovery in a Multi-agent System.

**KEYWORDS:** Information Age Warfare, Information Superiority, Stimulus Based Discovery, Targeting, Multi-agent Systems, Complex Adaptive Systems, Relationships, Networks, Connectors, Tickets, Simulation, Network Centric Warfare, Counter Terrorism, Strategy

### **A HYPERMEDIA REPRESENTATION OF A TAXONOMY OF USABILITY CHARACTERISTICS IN VIRTUAL ENVIRONMENTS**

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The goal of much work in Virtual Environments (VEs) to date has been to produce innovative technology but, until recently, there has been very little user-centered, usability-focused research in VEs that will turn interesting applications into usable ones. There is beginning to be at least some awareness of the need for usability engineering within the VE community. A handful of articles address usability concerns for particular parts of the VE usability space. From this point, Gabbard and Hix [1997] has proposed a taxonomy about usability characteristics in VEs to help VE usability engineers and designers. This taxonomy can be used in learning characteristics of VEs or in developing usability engineering methodologies specifically for VEs.

In this study, a hypermedia representation of the taxonomy was built and the effectiveness of the user interface was evaluated by using the scenario based formative usability engineering method developed by Hix and Hartson [1993]. First, the need for usability engineering for VEs was discussed and a proposed usability engineering methodology [Gabbard and others, 1999] for VEs was reviewed. Second, a hypermedia based web-site taxonomy was implemented and then evaluated iteratively. Last, a new study was added to show the dynamic nature of web-site application.

**KEYWORDS:** Taxonomy, Usability, Usability Characteristics, Human Factors, Human Computer Interaction, Virtual Environments, Evaluation, Formative Evaluation, Experiment, User-centered Design, Web Site Design