

DOCTOR OF PHILOSOPHY

MODELING REDUCED HUMAN PERFORMANCE AS A COMPLEX ADAPTIVE SYSTEM

Joerg C.G. Wellbrink-Major, German Army

M.S., German Armed Forces University Munich, 1985

M.S., Naval Postgraduate School, 1998

Doctor of Philosophy in Modeling, Virtual Environments, and Simulation-September 2003

Advisor: Mike Zyda, Modeling, Virtual Environments, and Simulation Institute

Committee Members: Maria Rasmussen, Department of National Security

Ted Lewis, Department of Computer Science

Rudolph P. Darken, Department of Computer Science

John Hiles, Modeling, Virtual Environments, and Simulation Institute

CDR Lisa Curtin, USN, Dean of Students, Naval Postgraduate School

Current cognitive models not only lack flexibility and realism, they fail to model individual behavior and reduced performance. This research analyzes current cognitive theories (namely, symbolism, connectionism, and dynamicism). It hypothesizes that reduced human performance can be best modeled as a complex adaptive system.

The resulting multi-agent model “Reduced Human Performance Model (RHPM)” implements reactive agents competing for cognitive resources. Lack of resources is used to trigger the simulation of imperfect perception and imperfect cognition.

The simulation system is calibrated with human experimental data in scenarios involving vigilance decrement, wherein vigilance is decreased during the first 30 minutes of a screening task. RHPM is then validated against previous unknown vigilance task scenarios.

RHPM generates realistic reduced human performance with a new cognitive modeling hypothesis. The developed multi-agent system generates adaptive and emergent behavior. Its use for computer generated forces (i.e. radar screen operator) would improve the realism of simulation systems by adding human like reduced performance.

The main contribution of this research is the development of a well suited tool to mediate between vigilance theories such as signal detection theory and experimental data. It generates insights, creating likely hypotheses to improve the theories.

KEYWORDS: Vigilance, Cognitive Modeling, Complex Adaptive System, Human Performance, Personality, Cognitive Psychology