

Preface

Both the editors of this book were exposed to human-in-the-loop simulations while pursuing their doctoral degrees in the Center for Human-Machine Systems at Georgia Tech. In fact, S. Narayanan served as Ling Rothrock's teaching assistant for the simulation course taught by Prof. Christine Mitchell. It has been over 15 years since our Georgia Tech days and we have both been continuously active in human-in-the-loop simulation research. The purpose of this book is to leverage the lessons we learned to provide researchers and teachers with a handbook on how human-in-the-loop simulations can be used to study human interactions in various contexts.

A human-in-the-loop (HITL) simulation is a modeling framework that requires human interaction. Traditional simulation studies regard human interaction as an external input to the system being considered. However, studies of complex systems in today's technological landscape must include humans as active participants. For example, a study of highly automated call centers must include human judgement and decision making and the accompanying task context. The emergence of HITL technologies, therefore, enables researchers and practitioners to investigate the complexities of human-involved interactions from a holistic, systems perspective. The handbook consists of contributed chapters from experts in academia and industry in the area of human-in-the-loop simulation. By reading it, the reader should gain an understanding of what an HITL simulation is and how it differs from traditional simulations, an appreciation for how HITL simulations can be used to study human involvement in complex systems, and an understanding of the current research thrusts involving HITL simulations.

The first section of the book consists of three foundational chapters to introduce HITL simulations. In [Chap. 1](#), S. Narayanan and Phani Kidambi provide an overview of the history, features, and trends of HITL simulations. In [Chap. 2](#), Ling Rothrock discusses the human performance measurement and evaluation of HITL simulations using a temporal logic framework to represent windows of opportunity. In [Chap. 3](#), Michael Matessa and Walter Warwick describe a graph-based interface language called GRBIL that facilitates interaction between human operators and the task environment within an HITL simulation.

The second section of the book consists of three chapters that use HITL simulations to study cognitive models. In [Chap. 4](#), Hui Xi, Seungho Lee, and Young-Jun Son discuss the requirements for an HITL simulation to validate an integrated model of human behaviour at both the tactical and strategic levels of decision making. In [Chap. 5](#), Frank Ritter, Michael Schoelles, Karen Quigley and Laura Klein assess the need for HITL simulations to inform cognitive model development. In [Chap. 6](#), Anand Tharanathan, Paul Derby, and Hari Thiruvengada present a study of metacognition using HITL simulations.

The third section of the book contains two chapters that describe human-in-the-loop processes for complex simulation models. In [Chap. 7](#), Timothy Simpson, Dan Carlsen, Matthew Malone, and Joshua Kollat present a human-in-the-loop process to guide simulations which explore trade spaces to optimize engineering designs. In [Chap. 8](#), Dhananjai Rao, Alexander Chernyakhovsky, and Victoria Rao demonstrate the use of human-in-the-loop to guide bio-simulations to conduct epidemiological analyses.

The fourth section of the book consists of four chapters that characterize the use of HITL simulations addressing specific problems in particular contexts. In [Chap. 9](#), Michael Hass, Robert Mills, and Michael Grimaila use HITL simulations to increase understanding of the potential effects of cyber-attacks in order to guide the development of contingency planning. In [Chap. 10](#), Subhashini Ganapathy, Sasanka Prabhala, S. Narayanan, Raymond Hill, and Jennie Gallimore use HITL simulations to compare the effectiveness of a human-computer integrated routing application against an automated planner for the military. In [Chap. 11](#), Hari Thiruvengda, Anand Tharanathan, and Paul Derby use HITL simulations to train cognitive skills required for military operations. In [Chap. 12](#), Sasanka Prabhala, Jennie Gallimore, and Jesse Lucas use HITL simulations to assess the impact of different levels of automation on human control of semi-autonomous systems.

We expect the book to be of use to engineers interested in advancing the design and implementation of test beds to investigate human-machine interaction, to psychologists seeking to understand human judgment and decision making in dynamic task environments, and to computer scientists interested in building hybrid systems to facilitate human-machine cooperation.

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