Chapter 14
Using Simulation Systems for Decision Support

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ABSTRACT

This chapter describes the use of simulation systems for decision support in support of real operations, which is the most challenging application domain in the discipline of modeling and simulation. To this end, the systems must be integrated as services into the operational infrastructure. To support discovery, selection, and composition of services, they need to be annotated regarding technical, syntactic, semantic, pragmatic, dynamic, and conceptual categories. The systems themselves must be complete and validated. The data must be obtainable, preferably via common protocols shared with the operational infrastructure. Agents and automated forces must produce situation adequate behavior. If these requirements for simulation systems and their annotations are fulfilled, decision support simulation can contribute significantly to the situational awareness up to cognitive levels of the decision maker.

INTRODUCTION

Modeling and simulation (M&S) systems are applied in various domains, such as

- supporting the analysis of alternatives,
- supporting the procurement of new systems by simulating them long before first prototypes are available,
- supporting the testing and evaluation of new equipment by providing the necessary stimuli for the system being tested,
- training of new personnel working with the system, and many more.

The topic of this chapter is one of the most challenging applications for simulation systems, namely the use of simulation systems for decision support in general, and particularly in direct support of operational processes. In other words, the decision maker is directly supported by M&S applications, helping with

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- "what-if" analysis for alternatives,
- plausibility evaluation for assumptions of other party activities,
- consistency checks of plans for future operations,
- simulation of expected behavior based on the plan and trigger the real world observations for continuous comparison (are we still on track),
- manage uncertainty by simulating several runs faster than real time and display variances and connected risks,
- trend simulation to identify potentially interesting developments in the future based on current operational developments, and additional applications that support the meaningful interpretation of current data.

While current decision support systems are focused on data mining and data presentation, which is the display of snap-shot information and historical developments are captured in most cases in the form of static trend analyses and display curves (creating a common operating picture), simulation systems display the behavior of the observed system (creating a common executable model). This model can be used by the decision maker to manipulate the observed system "on the fly" and use it not only for analysis, but also to communicate the results very effectively to and with partners, customers, and supporters of his efforts. As stated by van Dam (1999) during his lecture at Stanford: *"If a picture is worth a 1000 words, a moving picture is worth a 1000 static ones, and a truly interactive, user-controlled dynamic picture is worth 1000 ones that you watch passively."* That makes simulation very interesting for managers and decision makers, encouraging the use of decision support simulation systems. Another aspect is that of complex systems: nonlinearity and multiple connections. In order to understand and evaluate such system, traditional tools of operational research and mathematics have to be increasingly supported by the means of modeling and simulation. The same is true for decisions in complex environments, such as the battlefield of a military decision maker or the stock market for an international investment broker.

To this end, the simulation system must be integrated into operational systems as a decision support service. In order to be successful, not only the technical challenges of integration, discrete and other simulation technologies, into operational IT systems must be solved. It is also required that the simulation system fulfills additional operational and conceptual requirements as well. Simulation systems are more than software. Simulation systems are executable models, and models are purposeful abstractions of reality. In order to understand if a simulation system can be used for decision support, the concepts and assumptions derived to represent real world objects and effects in a simplified form must be understood. The conceptualization of the model's artifacts is as important as the implementation details of the simulation. As stated in Tolk (2006): *interoperability of systems requires composability of models!*

The author gained most of his experience in the military sector, integrating combat M&S into Command and Control (C2) systems. The development of the Levels of Conceptual Interoperability Model (LCIM) capturing the requirement for alignment on various levels to support decision support is a direct result of the experiences of integrating M&S services as web-services into service-oriented C2 systems (Tolk et al., 2006). It is directly related to the recommendations found in the North Atlantic Treaty Organization (NATO) Code of Best Practice for C2 Assessment (NATO, 2002) that was compiled by a group of international operational research experts in support of complex C2 analysis. It was also influenced by the recommendations of the National Research Council (2002, 2006), as using simulation for procurement decision or for analysis and using this analysis for decision support are closely related topics.

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