Challenges and Recommendations for Progress in Modeling and Simulation of Individuals, Organizations, and Societies

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The United States’ National Research Council (NRC) recently published a report on Behavioral Modeling and Simulation: From Individuals to Societies (Zacharias, MacMillan, & Van Hemel, 2008). This report encompasses individual, organizational, and societal (IOS) modeling and simulation accomplishments, challenges, and prospects, oriented around the military’s application interests (the report was requested by the Air Force Research Laboratory). Chapter 11 of the report provides recommendations for military-sponsored modeling research, including multidisciplinary conferences and workshops that bring together stakeholders in IOS modeling and focus attention on this key set of four challenges:

- methods for clearly specifying model purpose
- criteria for judging the usefulness of models (i.e., what does it mean to validate a model?)
- reasonable expectations for the certainty of model predictions
- methods for most clearly communicating model results

As a (primarily) military-sponsored, multidisciplinary, M&S-focused conference, BRIMS provides an excellent venue for kicking off a discussion of these issues and what can and should be done to address them. This symposium brings together five speakers with diverse educational backgrounds, work experiences, and professional affiliations to comment on challenges and recommendations for progress in modeling and simulation of individuals, organizations, and societies.

Challenge Problems as a Method for Defining Model Requirements
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Everyone agrees that IOS models should be “useful.” The challenge lies developing systematic methods for defining model purpose and specifying model requirements that will lead to the development of useful models. The problem is fundamentally one of communication between two communities that have different knowledge and speak different languages. Model users need answers to specific concrete operational questions, and often have a deep understanding of the data that may be available to answer those questions. What they often lack is a good sense of what is feasible in the modeling realm. Model developers, in contrast, know what can feasibly be done, but often do not understand the questions the model needs to answer nor the data actually available in an operational context. How can these two groups work together productively to arrive at a clear specification of model purpose that can then drive model development? Zacharias, MacMillan, and Van Hemel (2008) argue for an IOS modeling research program that does not attempt to solve the requirements specification problem in the abstract, but instead starts with the development of specific concrete challenge problems that can serve as a communication medium between the two communities. This presentation will explore the characteristics needed in such challenge problem, how they might be developed, and how they should be used.

Validating a Complex Cognitive Model
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Validation is a fundamental facet of many scientific inquiries, providing assurance to scientists that what they measure, model, manipulate, etc. is what they intended. Unfortunately, validation of behavioral representations rarely, if ever, occurs. Validation efforts are typically stymied by the cost of performing the validation studies and the little available guidance on the appropriate validation process. Indeed, any type of validation guidance for behavioral representations is absent, and some broad guidelines should be established (Zacharias, MacMillan, & Van Hemel, 2008). I will present an effort to validate a computational cognitive process model that is capable of behaving within an uninhabited aerial vehicle (UAV) basic maneuvering task (BMT) (Gluck, Ball, Krusmark, Rodgers, & Purtee, 2003). The UAV-BMT model was developed using the ACT-R computational cognitive architecture (Anderson et al., 2004), and built with two purposes in mind: (1) to predict human performance while (2) maintaining cognitive plausibility. Given that human behavior spans several levels of analysis, the validation process for the UAV-BMT becomes complicated and unclear. I will use the UAV-BMT model to demonstrate our approach to model...
validation and to raise questions regarding behavior representation validation.

**Model Validation: “All models are wrong; some are useful”**

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What does it mean for a model to be “useful?” At best “reality” in modeling is a false hope; at worse, it is dangerous and wrongheaded. Usefulness provides an alternative perspective. In this talk, I review three approaches to validate simulation models, using model usefulness as a criterion: the verification and validation approach, model purpose (Burton, 2003; Burton & Obel, 1995) and validation for decision making (Zacharias et al., 2008). Each addresses usefulness in a different manner – providing very different norms about what is a validated model. I conclude that: reality is dangerous as a validation criterion; validation is multifaceted and not a singular concept; and, validation as it is currently framed has not been practiced – perhaps for good reason. Validation is too important for simple rules; it requires our best thinking as it is really important.

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**Using, Validating, and Communicating:**

**Computational Cognitive Models in Practice**

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How do you determine usefulness and validity of a model, and how do you communicate what the model is? Most theoretical researchers focus on coverage/breadth, parsimony, accuracy, fit to data, and generalization to other situations as methods of assessing validity of models. More applied researchers typically focus on using a model to predict or inform. Our approach takes a slightly different approach for modeling complex cognitive phenomena. We go through an iterative process: consulting theory → modeling → embodying → evaluating

**Consult Theory:** We focus on cognitive science theories/our own and others' experiments.

**Model capability:** We match to data when available to put forward a new computational theory.

**Embody:** We run our model in simulation and on different robot platforms.

**Evaluate:** We evaluate how natural and useful the final embodied cognitive model actually is.

This approach has strong scientific value through theory and modeling and a strong applied focus through final evaluation. Finally, this approach has a strong communication component as well through the embodied component: it is possible to (literally) see what the model is doing in an embodied context.

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**References**


