Chapter 7 – CONCLUSIONS AND RECOMMENDATIONS

This best-practice guidance is intended to lay the foundation for practical and effective conceptual model development, to serve as a baseline for individual enterprise tailored implementations, and to set the vector for future standardization and conceptual model life-cycle management.

7.1 OBSERVATIONS AND INFERENCES

Conceptual modeling begins, most often unconsciously, at the very beginning of the first idea; long before the official conceptual modeling effort starts. Notes and drawings scrawled in the corner of a napkin already begin the abstraction process, and in doing so, provide the first bias. As in Heisenberg Uncertainty, where a phenomenon is disturbed as soon as one tries to measure it, the referent in a conceptual model is distorted as soon as one tries to represent it. This is one reason so many simulation frameworks have turned out to be unusable or un-reusable while they were modeled as point solutions such as “red against blue”, instead of more composable structures, such as “entities and interactions”. The conceptual modeling enterprise does not get rid of these biases, as much as it makes the choosing of biases deliberate and well documented.

The conceptual model of a simulation is not simulation space implementation independent. It may appear to be so, without any specific references to the simulation space, but the decisions that were made during the conceptual model design inevitably were informed by the underlying need for a simulation capability or an enterprise interest.

Current practice in simulation development rarely includes an explicit conceptual modeling effort. This fact was the primary motivation for the development of this guidance. But study of ongoing enterprises has revealed a few shining examples of deliberate conceptual modeling practices that are encouraging in the commonality of their underlying principles, even as they took varied approaches in the conduct and description of their efforts. The value of this guidance to these and future enterprises is the provision of a broad and flexible process with defined products which can be mapped against current approaches and future plans. Common terminology can also be derived from this guidance to enable better communication of concepts between enterprises.

Once the community is able to produce a critical mass of conceptual model products from a diverse set of enterprises, refining best-practices through a variety of experiences, the methods of standardization and reuse, along with evolution towards automation and machine readability, can bring about substantial efficiencies in the conceptual model and M&S development and their respective life-cycle management efforts.

7.2 RECOMMENDATIONS

The following comprise the recommendations distilled from the experience of the MSG-058 Task Group and which are proffered for consideration in conducting NATO M&S conceptual modeling activity in expected collaborative enterprise environments:

- NATO Nations should adopt this guidance as best-practice for their national and international M&S efforts to enable interoperability and reuse.
- The modeling and simulation community should take this opportunity to deliberately incorporate conceptual model development into their respective M&S development processes, based on the best-practice provided in this guidance.

- Each enterprise should specify its own conceptual modeling process and conceptual model products, using this guidance as a point of reference.
- VV&A of conceptual models should be integral to the development process. Use of the ISO/IEC 9126 standard on software quality is a starting point for the derivation of conceptual model quality criteria, and use of the (draft) GM-V&V standard is directly applicable to V&V of conceptual models.
- Every customization of the guidance should be published to contribute to the body of knowledge of conceptual modeling, to build a valuable experience base for standardization initiatives. Especially important is the documentation of decisions on the mapping of formalisms/views/model-kinds/ primitives, and identification of formalisms that are well suited to particular applications or domains. It would also be useful to develop the body of knowledge to determine the common design patterns and appropriate conceptual model component combinations typically used by the M&S community. Improving the conceptual modeling body of knowledge also involves the development of metrics to evaluate fitness for purpose of a conceptual model design.
- The M&S community and the Simulation Interoperability Standards Organization (SISO) in particular, should use this best-practice guidance as a basis to initiate an international standard for conceptual model development.
- As this guidance was limited in focus to conceptual model development, further work should be initiated to develop best-practice guidance for the entire conceptual modeling life cycle, including design for reuse, collection of conceptual models for repositories, configuration management, verification and validation of conceptual models, and advancing state-of-the-art in development of automated tools.