Session B5: **V&V (especially validation) for M&S which employ Adaptive Processing**

Session B5 leaders:

Co-Chairs:

Randall Shumaker (U. of Central Florida Institute for Simulation and Training)
Bernard P. Zeigler (University of Arizona)

Session Recorder: **David Gross** (Boeing)

B5 Materials in Foundations '02 proceedings:

Paper

Verification and Validation and Artificial Intelligence (71 pp)
Tim Menzies (University of West Virginia)

Slides (may contain back-up materials and notes)

V & V & AI: Verification and Validation and Artificial Intelligence (94 slides) [in both pdf and ppt formats]
Tim Menzies (University of West Virginia)

Participants in this session are listed at the end of the Discussion Synopsis.

Discussion Synopsis (to provide perspective on papers & briefings identified above).

The primary issues addressed by this session were the growing necessity for dealing with systems that actively adapt, and techniques that might be applicable for dealing with V&V for such systems. Applications in robotics and other semi-autonomous system, deep space exploration vehicles for example, have the design feature that the system you test today may not be the same tomorrow. Similarly, there are many more prosaic systems in use and planned that are inherently adaptive, large scale networks for example, that we would like to model and validate. The invited paper for this session was an excellent overview of techniques for adaptation and suggestions for how to think about and deal with V&V. The session presentation was a subset of the topics in the paper focused primarily on describing various learning techniques, their properties, and potential means for validation and verification.

Two different issues relevant to V&V arise in such systems: non-determinism and adaptation. Many of these systems employ stochastic methods and may be driven by external parameters that are subject to error and variable timing. They are inherently non-deterministic. Moreover such systems employ learning techniques that modify their logic to improve performance based on the specific experience of a particular incarnation of a system. Two otherwise initially identical systems may evolve quite differently. Adaptation may occur either episodically or dynamically, requiring different approaches to V&V. Conventional V&V methods are not well suited to dealing with these combinations of conditions. While statistical methods may apply to dealing with non-deterministic behavior, in combination with adaptive logic these systems present a

serious problem for V&V. While the focus of this session was on engineered systems, many aspects of the discussion also apply to adaptive models of human behavior.

Two suggestions were made on how do we deal with this engendering substantial and wide-ranging discussion. The first, or "weak" conclusion: there is a need to develop rapidly executed or automated processes, which can be executed episodically to repeat the V&V process on the evolved system. The second, or "strong" conclusion: stop focusing on V&V of the device, instead focus on V&V of the process that creates the change. The session speaker advocated the "strong" view as the most viable and reasonable way to proceed. There was lively and substantial discuss about whether a well-validated process could guarantee producing only valid evolved systems. *The general consensus seemed to be that both strong and weak processes would be required.*

A considerable amount of discussion was generated by the contrasts between the twin issues of V&V of adaptive systems (dealing with change), and adaptive methods for V&V (focus resources, reduce cost). This later was a novel and very interesting idea for several people in the session, and may well be one of the significant tangible benefits of this workshop session.

Validation is concerned with the question of "is the model correct for a purpose?" For systems on which we have powerful explanatory theory, it is a legitimate question to ask if the model reflects the theory. But unfortunately we don't as yet have good, agreed upon theories to explain adaptive system behavior. For such systems, the best approach seems to be to compare and contrast different models (a differential approach). Again, the paper and presentation by the session author provided a valuable resource, particular for those with no background in artificial intelligence methods.

It was observed that dealing with adaptive systems will require a move away from "traditional software engineering" in which the system does what it is directed to do, toward viewing software as goal-based in which the software works toward seeking a goal in a process of search. A further complication is that such systems may also adopt new goals. This, of course, raises many questions about how we understand such systems, gain trust in them, and deal with V&V when even the goals sought may have evolved. *A paradigm shift between rigorous, exhaustive V&V, toward adaptive means accepting a new concept of V&V, balancing acceptance criteria against each other, adaptive methods seem to offer promise here.*

A very useful result of this session was getting people with very different worldviews together to discuss an important emerging problem. IBM is developing an autonomic computer, NASA is developing semi-autonomous controls for spacecraft, and the military is proposing all manner of semi-autonomous systems. Adaptive systems have always been an important focus in the AI world. Many of these ideas are moving into mainstream thinking. Adaptive systems are likely to become widespread or even the norm in the future and developing sound means for dealing with V&V of such systems will be critically important.

B5 Session Participants (11)

Omar	Aboutalib	Northrop Grumman Corporation
Robert	Ebert	Sanderling Research Corporation
David	Gross	Boeing
Heikki	Joonsar	SAIC
Michael	McKay	Los Alamos National Laboratory
Tim	Menzies	WVU
Robert	Panoff	Shodor Education Foundation
Randall	Shumaker	Institute for Simulation and Training
James	Smith	Institute for Scientific Research Inc.
Brian	Stolarik	Institute for Scientific Research, Inc
Bernard	Zeigler	AZ Ctr for Integrative M&S