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SPECIAL FEATURE:

OPERATIONAL TEST AGENCIES: M&S CHALLENGES AND ISSUES

JITC:
M&S Applications to National Security Systems / Information Technology Systems (NSS / ITS) Test and Evaluation

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with contribution from
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USAOTC:
The Role of Modeling and Simulation in Operational Testing

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COMOPTEVFOR:
Modeling and Simulation—Applications in Navy Operational Test and Evaluation

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MCOTEA:
Modeling and Simulation in Support of U.S. Marine Corps Operational Testing and Evaluation

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AFOTEC:
Operational Test & Evaluation Challenges: Modeling and Simulation

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TECHNICAL PAPER ABSTRACTS:

Assessing the Value of Physics-Based Modeling in Test and Evaluation

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An important cutting-edge technology in the advanced test and evaluation of undersea warfare and environmental systems is physics-based modeling (PBM). By definition, PBM is the virtual simulation of physical events or phenomena governed by the laws of physics. These simulations are usually mathematically intense and are based on solving robust series of equations. The equations are derived from the fundamental principles of physics to describe the complete response of a platform, system or component subjected to a physical event.

continued

A Real-Time Meteorological Data Assimilation and Forecast System to Support Army RDT&E

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This paper describes a system in which meteorological observations are used in near real time with a full-physics mesoscale meteorological model to obtain an optimum analysis of current conditions and short-term forecast of future conditions. This real-time four-dimensional data assimilation (RT-FDDA) system is intended to: (1) improve the information available to support real-time go/no-go test conduct decisions; and (2) provide high-resolution gridded analyses of atmospheric conditions to support post-test forensic analyses and virtual testing. The prototype RT-FDDA system is operational at Dugway Proving Ground, Dugway, Utah, and similar systems will be deployed at the major Developmental Test Command test centers during Fiscal Years 2002 and 2003.

Application of Modeling and Simulation to At-Sea Testing of Undersea Warfare Systems

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The use of distributed testing that employs modeling and simulation (M&S) can enhance test capabilities while preserving the validity of the test itself. This paper examines the view that live testing and M&S can coexist in the same test event and that M&S can be seen as a cost-effective and value-added tool to enhance the overall value and realism of testing.

Starship: Supporting the Testing of Developing Army Technologies as a Test Command and Control Platform

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A primary mission of the U.S. Army Electronic Proving Ground (EPG) is to perform command, control, communications, computers and intelligence (C^4I) developmental test and evaluation (DT&E) for the Army. With Department of Defense focus on finding more effective ways to perform DT&E, the Army is acquiring increasingly complex digital C^4I equipment, with a resulting dependence on increased automation, modeling and simulation. In order to conduct C^4I DT&E more efficiently, EPG has developed a vast array of hardware and software tools that keep it on the DT&E technology forefront worldwide. One such effort is the Starship project,an intuitive, expandable collection of tools to control and monitor EPG and non-EPG testing and test instrumentation.

It is at about this time of year when the seeds of cautious optimism among ITEA's Board of Directors take root and creep into play as we begin our upcoming program. We wonder whether we have assembled the right mix of workshops, tutorials, themes and locations, and we hope that all the required supporting activities will dovetail in the proper fashion. This year the feeling is magnified due to the dramatic events of last September and by our nation's commitment to homeland defense and the intense military campaign overseas.

I am happy to report that the 2002 program began on a high note with an extremely successful workshop on "Information Assurance Test and Evaluation," hosted by the Fort Huachuca Chapter in February. This first-time theme workshop attracted 176 attendees and produced a white paper that summarizes the challenges, problem areas and ways ahead for the increasingly important area of information assurance. Congratulations go to Workshop Chair Greg Lamberth, the workshop committee and the Fort Huachuca Chapter for executing one of the most popular new-themed workshops ITEA has had in recent memory.

The 2002 program includes several workshops featuring brand-new themes, including "The Value of Test and Evaluation," hosted by the Francis Scott Key Chapter and scheduled for July 16-19 in Annapolis, Maryland, and "Directed Energy Test and Evaluation," hosted by the Roadrunner Chapter, in partnership with the Directed Energy Professional Society, and scheduled for August 13-15 in Albuquerque, New Mexico. I believe that these two exciting workshops will attract larger than normal attendance.

Last December, I established a Blue Ribbon Panel to examine options for the composition of our future years' programs. My challenge to the panel was to find ways to optimize our events and make them more relevant to the interests of the typical conference attendee. The panel recently reported its findings and recommendations to me. Panel members also suggested some changes to strengthen this year's Annual ITEA International Symposium in Las Vegas. I want to thank the panel members for addressing these issues head-on and for developing recommendations in a relatively short amount of time. I will share these recommendations with you in my next "President's Corner."

With this edition of the "President's Corner," I am initiating a section called "Points to Ponder." I welcome any insights readers may have, as well as suggestions for future "Points." My hope is that these items will plant the seeds for further discussion and serve as possible "ticklers" for future ITEA workshops and short courses. I do not propose to take any position, either personally or on behalf of ITEA. I offer these four points, overheard in the corridors and exhibit halls of various workshops and conferences, for this inaugural effort. Enjoy!

Dr. John B. Foulkes

■ ***Is T&E really a wise investment?*** Many people argue that test and evaluation (T&E) is a very expensive business. In an absolute sense, it probably is. But compared to the system development and acquisition business that T&E supports, whether it be Department of Defense (DoD) or commercial, the costs of (and risks to) successful system acquisition that result from *not* planning and executing robust T&E support *far exceed* any upfront investment.

■ ***There's education, and then there's education.*** "Targets of opportunity" are not so much the new, young talent that is entering the T&E workforce, but rather, much of senior leadership who, in their positions of authority, can make sweeping decisions affecting the T&E business without really knowing what the business is.

■ ***How much infrastructure do we need?*** The defense T&E infrastructure is in a woeful state of decline. Recapitalization rates are a fraction of what they are in comparable commercial sectors. (I read recently that late-night television talk show host David Letterman was renegotiating his annual contract between two rival television networks for the staggering amount of $31.5 million. What we could do with that kind of money in rehabilitating our test infrastructure!)

■ ***Let's network the world.*** This is clearly happening. Just look at the cellular telephone industry. Look at wireless internetting. So, let's wire all of our T&E ranges together, and throw in the training ranges for good measure. We can worry later about figuring out what to do with it all.

The upcoming year has the potential of being ITEA's best yet. I applaud the hard work of our chapters and committees, and I sincerely appreciate their commitment to excellence. As I begin my second year as ITEA's president, I am committed to exploring opportunities for the continued growth and relevancy of our association.

John B. Foulkes

Using Simulation—The Past as Prologue…Probably

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The use (and the utility) of simulation as a complement to physical testing is a historical fact. More to the point is the question: "What can we expect of the future?"

From a few historical examples and with an appreciation for today's technical and programmatic environment, we are confident that, in addition to "more of the same," we can expect certain new types of modeling and simulation (M&S) usage to evolve naturally and inevitably from past practices and current circumstances.

Relationship of M&S to testing (and evaluation)

A simple but effective indication of the fundamental relationships among simulation, testing and evaluation is provided in *Figure 1*. Simulation and physical testing are symmetrically related to evaluation—being influenced by evaluation requirements and providing information for the evaluation-decision-action process. Likewise, they are both clients to one another's information-server functions: simulation supports test planning and analysis; and testing supports simulation validation. These static relationships have occurred progressively in both technical variety and in programmatic scope.

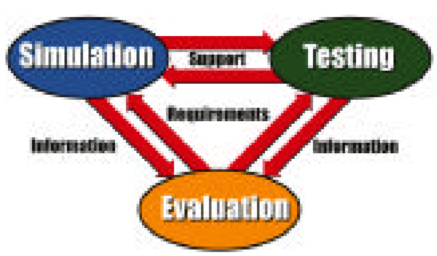

Figure 1. Fundamental relationships among simulation, testing and evaluation

By looking at the past, wherein this simple paradigm has become progressively richer, and by considering the present (with its immanent pressures and opportunities), we expect to see a little way over the horizon to a regime of continuing evolution of simulation use that complements physical testing.

William F. Waite

Experience domain

To survey the use of simulation's constructive relationship to physical testing, we confine ourselves to consideration of hardware-in-the-loop (HWIL) simulation of Army missile systems where the history is rich and suggestive. We are careful, however, not to let this focus-of-convenience artificially foreclose the validity of subsequent conclusions and recommendations.

Appreciating the past

As early as the late 1970s, the simplest uses of simulation and the exercise of the constructive relationships between simulation and test were clearly evident. Chaparral and Stinger air-defense missiles were represented in real-time HWIL simulations, often with test-article hardware, to provide predictions of test behaviors for range safety involving sophisticated guidance and infrared counter-countermeasures phenomena.

Conversely, telemetry and dynamic flight test data, gathered from test operations intentionally crafted for that purpose, were assiduously collected, analyzed and provided to simulation laboratories to provide a realistic basis for comparison of simulation prediction and real-world behaviors. Such simulations were (eventually) accepted as admissible for generation of performance-assessment data—one significant determinant of acquisition/deployment decisions. Subsequently, similar HWIL tools, often with digital signal processor HWIL components, were used in support of target acquisition, countermeasures and guidance precision product improvement programs.

Similarly, Hawk missile product improvement modifications came to be accepted primarily on the basis of simulation studies and analyses, sometimes corroborated with only a single physical test intercept. In addition, simulation facilitated covert exploratory development of Hawk-based variants throughout the 1970s and 1980s.

Patriot system PAC-2 missiles were subject to extensive HWIL simulation investigation to educe their electronic countermeasures performance with respect to design requirements. As usual, a continuous process of simulation validation with respect to physical test results was pursued. As Patriot progressed into its PAC-3 version,simulation took on greater effective significance for system development. On one hand, simulation was accepted as a form of "entry criterion" for physical flight testing. On the other hand, however, simulation came to be explicitly accepted as a viable, economical substitute for some physical flight tests. Today, Patriot initial operational test and evaluation (IOT&E) decisions are being predicated partly on simulation results, including those generated by HWIL and other techniques.

In an uncommon, but not unique, bit of serendipity, the use of HWIL simulation in support of the millimeter-wave Longbow missile system revealed unappreciated operational capability and thus facilitated missile production. This occurrence thereby extended the influence of HWIL simulation operations beyond the system's intended domain of application and consequently beyond its expected range of utility.

At about the same time, program managers typically came to accept use of the HWIL simulation for the sophisticated SADARM multimode, precision-guided submunition. Simulation became progressively more appreciated—and consequently more valuable—by virtue of being planned in accordance with the needs of the weapon's life-cycle development program. The value of the HWIL simulation supporting preplanned product improvement of the BAT system (another multimode precision-guided weapon) is so firmly established that HWIL simulation operation is practically on the critical path of development-program execution.

Most recently, systems such as the Missile Defense Agency's Theater High-Altitude Area Defense (THAAD) missile system and the Ground-based Midcourse Defense segment have extended HWIL simulation beyond representation of missile fly-out and intercept, to end-to-end operations involving ground support equipment ballistic missile command, control, communications, computers and intelligence (BMC^4I) processes. Single simulation components are being used in federations of simulation ensembles, and distributed collaborative operations are becoming common.

Summary analysis

Even in our relatively limited historical review, it is apparent that a few trends are influencing the use and utility of simulation in conjunction with physical testing and evaluation. Increasing M&S feasibility, illustrated in HWIL examples by the evolution of practical multimode environments, distributed assets and collaborative operations, motivates more simulation investment and expectation of recovery of investment. Economic pressure, together with expanding missionary responsibility within the Department of Defense, motivates simulation use when it is the "best investment."

The evolving credibility of simulation, based on practical successes and on more deliberate establishment of an appropriate basis of confidence for simulation accreditation, removes long-standing inhibition of the use of simulation. Finally, the growing perception of simulation in the context of broader missionary and weapons systems life-cycle management, and the expectation of new kinds of value to be recovered, invite new prospective simulation uses.

Extrapolation to the future

What sort of future does this description suggest? Will we have more of the same (simple extrapolation of instances, confidence and influence of simulation), or some new *kind* or whole new *level* of relationship between simulation and testing?

More of the same

Certainly, we might reasonably expect that the trends illustrated here will continue and diversify. More modes of simulation, applied more systematically, more intensively and more expertly—and in ways more intimately related to physical testing and evaluation/decision processes—must be employed in order to recover more kinds and degrees of cost benefit. Such a future is not undesirable—but it is not necessarily all there is to look forward to!

A new deal?

In addition to this progressive future, it is most likely that we may reasonably expect to see a significant new concept of operations, signifying a more highly integrated systems engineering paradigm than has typified the past.

Several factors today are influencing the uses of simulation in all of its manifestations and relationships, not only to physical testing and evaluation, but to all facets of systems engineering: requirements, development, manufacturing, testing, training, operations and maintenance. These factors are best conceived as part of technical cultural changes that are "bigger than both of us" (that is, simulation and testing). The potential exists, consequentially, for significant changes in the future of test-simulation relationships.

A variety of technical architectures are being developed and used that may well provide the structural context for significant unification of simulation and testing. High-Level Architecture (HLA) standards, as well as synthetic virtual environments for simulation-based systems development, training and evaluation, are clearly analogous to Test and Training Enabling Architecture (TENA) and Virtual Proving Ground (VPG)–type initiatives for testing facilities investments and operations. Collaborative maturation of these complementary architectures is already underway.

The pervasiveness of simulation applications across all phases of objective-system life cycles is already commonplace. More explicit relationships of simulation with developmental and operational testing and evaluation over this life cycle might reasonably be expected.

Finally, the place of simulation and testing in the context of the rapidly evolving defense acquisition enterprise perspective is of mutual concern to both constituencies. Simulation, testing and the relations between these will be influenced significantly by enterprise-echelon concerns. Some of these concerns are attention to broader economic issues, maturation of materiel acquisition strategies, full life-cycle systems engineering processes, collateral investment in facilitization, operations and maintenance and distributed, collaborative behaviors.

The challenge

The future will be what we make it. Our intentions, invention and influence will define tomorrow's uses of simulation in relation to physical testing and evaluation. That there is considerable opportunity to recover value from the constructive use of simulation and testing in explicitly complementary forms is incontestable. That we will, in fact, reap this harvest, is less certain. It is unclear whether simply taking the "high ground" perspective of systems engineering, acquisition and interoperability will alone yield the value we seek. More likely, a deliberate and methodical collaboration between the simulation and physical testing communities will be necessary. How will *you* contribute to *making this relationship work?* o

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