Challenges For M&S in Army Test and Evaluation

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Modeling and Simulation in Support of Army Transformation
Quality Control for the US Army

Army Test and Evaluation Command
Challenges For M&S in T&E: Outline

- Reality of T&E Transformation

- Getting Your Needs Identified: Plan & Execute
  - Requirements Identification and Decomposition
  - T&E
  - M&S
  - Architecture
  - V&V –and “A”

- Lack Of Success—From Some Experts!

- Challenge to T&E--Make it Better?
ATEC’s T&E Mission is Changing

Transformation of Test and Evaluation

Yesterday
Test & Evaluation

System Design Moving Toward

• Greater S/W Based Design
• Technological Improvement
• More Complex FoS and SoS Interactions

Tomorrow

Test/simulation & Evaluation

Test/Simulation & Evaluation

Simulation/Test & Evaluation

Bottom Line:
We’ll always test hardware, but are seeing an increased reliance on M&S which will have a more prominent role in our evaluations and increase our need for technical expertise.
Challenge Facing ATEC

Providing fully integrated Test & Simulation Evaluations.

To accomplish that mission ATEC must develop and maintain adequate technical expertise to support the command in the following areas:

What we evaluate

- **Technology Development** – Integrating FoS and SoS technologies and architectures to develop comprehensive evaluation approaches.

How we evaluate

- **Modeling and Simulation** – Tracking the development, VV&A of models.
- **Employing Model-Test-Model** to evaluation phases (pretest--test---post test)
- **Experimental Design** – Designing tests that make the most out of expensive hardware testing while taking into consideration how M&S will be used.
The KEY to being successful is approved requirements ---- driving the evaluation focus areas. If requirements are changing---a ripple effect occurs at every level of the process.
View of M&S Development Process For FCS

- **SOS M&S Reqs**
  - SVF Reqs Panel
    - Mgmt
    - Exec
    - SME
    - Auth
  - Approved / Prioritized Reqs.
  - SVF Build 1…n

- **SOS M&S Development**
  - M&S IPT Panel
    - Mgmt
    - Exec
    - SME
    - Auth

- **SOS M&S VV&A**
  - SVF V&V
  - A

- **S2F/FSE Application**
  - Applications:
    - Spec Demo
    - ORD
    - ESS

- **Participants:**
  - PM / LSI
  - ATEC
  - UAMBL
  - RDECOM
  - DEVELOPERS

- **System Level**
  - LSI System Engineering Verification & Test Process
  - SoS Spec 3
  - SoS Spec 4
  - Plan Together, Test Once, Distribute Data
  - Stimulators, Emulators, Instrumentation
  - M&S Components/Functions for Service-based Architecture
  - Panel Process

- **M&S Reqs**
  - Integrated Verification Method(s)
  - Test
  - Analysis
  - Demo
  - Inspect

- **M&S Selection**
  - Candidates M&S from Providers

- **System Evaluation**
  - Test, Demo, Inspection

**Applications:**
- Spec Demo
- ORD
- ESS

**Participants:**
- PM / LSI
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Getting M&S Requirements Allocated

Functional Decomposition
Capabilities Analysis

Phases Steps per Engineering Iteration

Yields

Slice through

Requirements per phase

Generates

Vetted/Edited through IPTs

SoS Arch

Iteration Specific SV-5 views

Generates

DOORS

is linked

SoS Arch

Used to Annotate
The VV&A Process: Lots to Do Over Time

Program Level

Requirements & Gaps

Mgmt. Level

Data Collection Events

Model Selection & Upgrades

Input Database

Model Events

Validation

Accreditation

Enhanced Model & Database

Evaluator Events

Test Planning

Accred Support Package

Evaluation

SOS Evaluation

MOE Evaluation

SOS Inputs
High Level M&S Challenges (1 of 2)

- Incorporating requirements into tracking and allocation database.
  - If a requirement is uniquely government, who is responsible for that integration?
  - Is the allocation decomposition completed?

- Overlap between test execution and development/execution of the next phase.
  - Is there sufficient time to implement required fixes or apply lessons learned in schedule?

- Bow wave effect of pushing off M&S requirements to future phases.
  - How early are M&S (and T&E) requirements needed to be identified?
  - 2 years before execution?
  - Ability to verify and validate (and increase risk) as schedules slip?
High Level M&S Challenges (2 of 2)

- Changes in plans regarding M&S in test augmentation.
  - Example: ability to test tactical SW in emulators and collect V&V artifacts

- Battle Command Simulation Needed? Yes or NO?
  - Representation of the fully integrated Battle Command capability.
    Available when? Final delivery of the actual code (Phase 4/Post MS C)?
  - Can incremental deliveries of tactical software integrated into the simulation environment be used? Available?
  - Ability to TEST all of the systems together within a full SoS context.
    Test articles with C4ISR and full functionality available when?
  - Ability of M&S to represent full FCS BCT. Available when?

- A V&V Plan—(versus a strategy)—for M&S tools is required.
  - Accreditation criteria needed (ATEC Action)
  - V&V Plan needed (PM-Action)
Example of M&S Challenge Affecting Evaluation

- **Demonstrate low risk of KPP completion at Milestone C**
  - FCS BCT consists of three battalions, cannot realize this complexity in actual hardware
  - Virtual and constructive simulation capability critical

- **KPP’s Not Possible without the network**
  - Must objectively load the network for results to be credible
  - Data, voice, video, messaging, etc..

- **M&S’s critical function is to provide the “wrapper” or stimulus for the objective simulation/software**
  - Must provide an environment from where system and SoS capabilities may be demonstrated
  - Terrain, weather, lethality brokerage, etc…

- **Non-intrusive network simulation and credible aggregate force representations are of the highest priority**
  - Critical to provide “wrap” for the equipment on the range
  - “A Must” to fill out the missing hardware (FCS BCTs/UEx/UEy) in the Experiments and TFTs

- **Non-Intrusive test network for testing at system, FCS BCT, Complementary and Joint systems**
M&S—Not Worked as Often as Liked

- 2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:
  - Inappropriate method of formulating or representing the problem
  - Ill-conceived multi-disciplinary integration
  - Inability to communicate among multi-disciplinary team members
  - Few existing value/reward systems actually reward collaboration
  - Funding sources not deal well with multi-disciplinary work
  - Isolation of modeling community
  - Difficulty in integrating models of different resolution
  - The practical sociology between modelers and decision makers:
    - Modeling should help/be an aid to critical thinking

EXCERPT FROM: PHALANX Article, Sep 2003: “Issues in Model Integration to Support Decision Makers”; by Dr. Ernest Seglie
M&S
Not Worked as Often as Liked

2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:

- Inappropriate method of formulating or representing the problem
  - Requirements Identification process cumbersome (Subcontractors, Prime, Engineering, Test, Evaluation)
  - T&E issue is—can we live with less testing? So, we become a user of these products
  - Example: JTRS: supporting development of FCS NW for Current Force and Future Force
    - Modeling while development ongoing. Objectives are?
    - Is transport layer for FCS; yet architecture definition evolving.
    - Planned integrated approach through PM M&S team, but harder to say what we can bank on

- Ill-conceived multi-disciplinary integration
  - So many systems + Network; Modeling and development ongoing simultaneously
  - Have SOS to address; Who has done this before—at a level of required fidelity?
  - Inability to communicate among multi-disciplinary team members
    - Players: Subs + LSI + ATEC + Evaluation (SEP) + PM + CTO + PM M&S (MSMO) + Training
    - T&E challenge to program is: Communicating requirements for this SOS M&S to this huge crowd— to include JOINT— with varying crowd experience—NOT EASY!
  - What does program integrator know about how ARMY does SOS testing? Evaluation?

EXCERPT FROM: PHALANX, Sep 2003: “Issues in Model Integration to Support Decision Makers”; by Dr. Ernest Seglie
M&S
Not Worked as Often as Liked (continued)

2003 Academy Industry Symposium on Mathematical Modeling discussed reasons for the lack of success in use of models:

- Few existing value/reward systems actually reward collaboration
  - Stove pipe development; scramble for dollars to develop products; parochial views

- Funding sources not deal well with multi-disciplinary work
  - Program dollar cuts; is sudden at times.
  - Other priorities evolve and take over
  - SW development—costly and difficult

- Isolation of modeling community
  - What IS out there that can provide best insights into effectiveness, suitability, survivability?

- Difficulty in integrating models of different resolution
  - Major integration effort on this program; multiple BOS systems

- The practical sociology between modelers and decision makers:
  - Modeling should help/be an aid to critical thinking...

EXCERPT FROM: PHALANX, Sep 2003: “Issues in Model Integration to Support Decision Makers”; by Dr. Ernest Seglie
Challenge to T&E--Can We Make it Better?

Summary

- Encourage programs to integrate modeling into their development and decision process.

- Integrate into T&E evaluation ONLY IF modeling has demonstrated it is an integral part of the program processes and demonstrates it is an aid to critical thinking.
  - Multi-disciplinary team established, in place, and functioning to add information to contractors, PM, and evaluators. Needed 7-10 years before IOT.
  - Feedback loop working through cycle on early component testing and early operational assessments.
  - M&S developed in sufficient resolution so that test planning parameters can be, and are, calculated using the model.

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Conclusion:
Simply the place where someone got tired of thinking.
Great Quotes From Great Skeptics

- Well informed people know it is impossible to transmit the voice over wires and that were it possible to do so, the thing would be of no practical value. *Editorial in the Boston Post* (1865)

- That the automobile has practically reached the limit of its development is suggested by the fact that during the past year no improvements of a radical nature have been introduced. *Scientific American, Jan. 2, 1909*

- Heavier-than-air flying machines are impossible. *Lord Kelvin, ca. 1895, British mathematician and physicist*

- While theoretically and technically television may be feasible, commercially and financially I consider it an impossibility, a development of which we need waste little time dreaming. *Lee DeForest, 1926 (American radio pioneer)*

- There is not the slightest indication that [nuclear energy] will ever be obtainable. It would mean that the atom would have to be shattered at will. *Albert Einstein, 1932.*

- Where a calculator on the ENIAC is equipped with 19,000 vacuum tubes and weighs 30 tons, computers in the future may have only 1,000 vacuum tubes and perhaps only weigh 1.5 tons. *Popular Mechanics, March 1949. (Try the laptop version!)*