Efficacy of Modeling & Simulation in Defense Life Cycle Engineering

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Topics

• Introduction
• DoD M&S View
• DoD Acquisition
• Military Logistics
• M&S Tool Example
• Conclusions
Thank you!
Introduction

- US DoD is world’s largest single consumer
- Simulation Based Acquisition
- Logistics M&S lags engineering
- Increasingly important – selection discriminator

DoDD 5000.1  DoDI 5000.2
Defense Acquisition Guidebook

Definition of Simulation Based Acquisition (SBA)/(SMART)

The Army’s vision for SMART is a process in which we capitalize on Modeling and Simulation (M&S) technology to address the issue of system development and life-cycle costs through the combined efforts of the requirements, training and acquisition communities.
Importance of M&S

Lessons Learned Through Acquired Experience

Apache
(Legacy system upgrades using M&S)

Crusader
(Relied heavily on M&S to support systems engineering)

Comanche
(Down select based on M&S)

Grizzly
(Revitalized the program with M&S)

Aerial Common Sensor
(Using virtual prototypes for source selection)

Future Scout and Cavalry System
(Collected Data)
Characterized Levels of DoD M&S

1. “Live” (Man vs Man)
   - Training
   - Development
   - Test & Evaluation
   - Operations

2. “Virtual” (Man vs Simulation)

3. “Constructive” (Sim vs Sim)
Static (Steady State) & Dynamic

- Relationships mathematically defined
- Dependant/Predefined (1:1)
- Equilibrium seeking
- No dynamic temporal effects

- Relationships defined many ways
- Independent & Dependent (1:n)
- Equilibrium no factor
- Dynamic temporal effects
Deterministic & Stochastic

- Totally causal events & decisions
- No random events
- No “degrees of freedom”

Monte Carlo

- Indexed collection of variables
- Random number generators
- Multiple degrees of freedom
Continuous & Discrete Event

- Analog computing
- Differential Equation (partial/ordinary)
- Continuous between $f(x)$ limits
- Approximated by digital computers

- Time referenced events
- Models independent of simulators
- Models respond to events
- DEVS: Formalization = less errors

Unitary vs Distributed Simulation

- High Level Architecture (HLA).
- Test and Training Enabling Architecture (TENA)
- Aggregate Level Simulation Protocol (ALSP)
- Distributed Interactive Simulation (DIS)
Military Logistics

- Military logistics is the science of planning and carrying out the movement and maintenance of armed forces. In its most comprehensive sense, those aspects of military operations that deal with:
  
  - a. design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposition of materiel;
  
  - b. movement, evacuation, and hospitalization of personnel; acquisition or construction, maintenance, operation and disposition of facilities; and acquisition or furnishing of services.
DoD Acquisition Framework

User Needs & Technology Opportunities

- Process entry at Milestones A, B, or C
- Entrance criteria met before entering phase
- Evolutionary Acquisition or Single Step

ICD → CCD → CPD → IOC → FOC

Program Initiation

User Need

Concept Refinement

Technology Development

System Development & Demonstration

Production & Deployment

Operations & Support

Graphics Sourced from the Defense Acquisition University
New Cargo Jet Specification
Military Logistics
Defense Acquisition Guidebook (Chap. 5.0)

Total Life Cycle Systems Management (TLCSM)

1. Supply Chain
2. Manufacturing
3. Transportation
4. Storage
5. Deployment & Disposal

Performance Based Logistics (PBL)

TLCSM: The PM is mandated for Life Cycle Logistics (LCL), emphasizing LCL in Systems Engineering and implementing products support through Performance Based Logistics (PBL).
Life Cycle System Model

Supply Chain

Component Integrator

System Integrator

Disposal

Transport

Consumption

Spares $ Maintenance

Integration/Manufacturing

Depot Storage

Deployed Storage

Warfighter

Civilian

Military
Supply Chain

- Manufacturing Process
- Low fidelity models - parameterize assumptions
- Obsolescence management
- Socio-political & economic effects
- KPPs:
  - Consumption driven – model demand drivers
  - Cost, capacity, lead-time, etc
Manufacturing (Integration)

- Optimize processes & material flow
- Cost (risk) reduction
  - Dynamic – Discrete Event Simulation
  - Supply Chain model integration
- KPPs
  - Cost, Process, Flow
  - Resource Allocation, etc.
Transportation

- Military & Civilian
- Touch Labor
- Damage
- KPPs
  - Reliability, Availability
  - Lead Time (customs, etc.)
  - Cost, Choke Points
  - Sustainment, Surge
Storage

• Location
  – Depots (Strategic)
  – Theater (tactical)

• KPPs
  – Inventory (operations, spares)
  – Cost, availability, reliability
  – Assembly
Deploy & Dispose

- Inventory levels
- Asset visibility
- Surplus or Destroy?
- Life Extension
  - Training
  - Recycle
M&S Tool Example

Extend®
(Issume That, inc)

Issues:
- Infant failures
- Transportation
- Storage Environmental
- BIT testing
- Training use
M&S Resources

• **Military**
  - Defense Modeling & Simulation Office (DMSO)
  - Modeling and Simulation Information Analysis Center (MSIAC)
  - Advanced Air Force Modeling & Simulation (AFAMS)
  - Navy Modeling & Simulation Office (NMSO)
  - Army Modeling & Simulation Office (AMSO)
  - Army Simulation, Training & Instrumentation (PEO STRI)
  - National Security Council (NSC)

• **Industry**
  - Simulation Interoperability Standards Organization (SISO)
  - Association of Computing Machinery (ACM)
  - Society for Modeling and Simulation International (SCS)

• **Academia**
  - University of Arizona
  - Georgia Institute of Technology
  - University of Pennsylvania
  - INFORMS College on Simulation
  - Old Dominion University
  - California State University
  - University of Magdeburg
  - University of Central Florida
Conclusion

- M&S is increasingly important in Military Logistics
  - Contractually required by many DoD programs
- Beneficial in all phases of life cycle
- Highly useful in logistic modeling & management
  - Highly granular (high fidelity)
  - Dynamic inventories & environments
  - Interoperable with engineering & operational models
- Source selection discriminator
  - Total Lifetime Cost analysis (TLC)
  - Logistic support capability
Questions?

Thank You for Your Attention!