Life-Cycle Acquisition Management in a Collaborative Environment

Kevin M. Fahey
Deputy Program Executive Officer, Ammunition
Picatinny Arsenal, NJ 07806-5000
Kfahey@pica.army.com
Comm 973-724-7102, DSN 880-7102

8 September 2003
Disclaimer
(think I need to have this)

- This briefing represents my personal opinions, and is based on my background and experiences
Modeling and Simulation (M&S) are critical tools in today’s environment.

An Integrated Data Environment (IDE) and common development tools are essential to today’s programs (collaborative environment).

A healthy M&S program must evolve out of a robust systems engineering process and can not take on a life of its own.

Today’s programs will not be successful without a Robust M&S program and collaborative environment.
Modeling and Simulation and a Collaborative Environment
Must Start Early

- A robust Systems Engineering process and planning for M&S must be part of S&T programs
- It is not too early to establish a collaborative environment in S&T and start capturing critical data for:
  - Systems Engineering
  - Cost
  - Force and system effectiveness
  - Training concept
  - CONOPS
  - Early M&S is not just experiments
  - We have all seen the chart that shows a large % of costs are locked in prior to Milestone one based on technology development/materiel solution
What Drives Good M&S

- Plan to use M&S across all aspects of Life-Cycle
- Systems Engineering
- Program Management requirements
- Collaborative Environment
- Starting early-early and often
- Program Risk
- Resources
- Combat Development
What is a Collaborative Environment?

- An integrated Data Environment
- Common Developments tools
- Work flow process
- With a good collaborative environment, you will achieve data management and configuration management

Need to establish a good user jury to make sure the Collaborative Environment meets the teams needs.
The Integrated Data Environment enables IPPD by providing:

- A single, secure source of program information to all team members regardless of geographical location
- Includes automation of critical processes
- Everyone is working from the same sheet of music

The Common Development Environment minimizes product development risk through:

- Enabling virtual prototyping & product development through consistent engineering data formats
M&S is Critical for all Aspects of the Life-Cycle

- System Development/Design (all aspects)
- Doctrine Development/CONOPS
- System and Force Analysis
- Training
- Operation and support
- Test and Evaluation

Simulation Support Plan and process is a working document that will mature with the program evolution, much like other critical program management documents
Simulation-based development concurrently and continuously addresses the system’s complete acquisition life cycle.
Old Way Versus New Way and Spiral Development
The Old Way of Doing Business

- The Development Cycle was serial (Developer/Tester/User) and based on “Test-Fix-Test”
- Limited User involvement until it was time to test the hardware
Impact of Simulation Based Development

- The new development cycle is parallel (Developer+Tester+User)
- “Test-Fix-Test” still occurs but in a virtual versus a real environment, “Model-Test-Model”.

<table>
<thead>
<tr>
<th>New Way</th>
<th>R/A &amp; PRELIMINARY DESIGN</th>
<th>BUILD</th>
<th>DEVELOPMENT/USER TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Way</td>
<td>R/A</td>
<td>CONCEPT</td>
<td>DESIGN</td>
</tr>
</tbody>
</table>
Key Benefits of Simulation Based Development

- Allows the development cycle to be shortened
- Establishes a high level of confidence much earlier in development that the design will satisfy the requirement
- In today’s environment can’t afford not to do it

Old Way

New Way

8/9 YEARS

12/15 YEARS
Implications of Simulation Based Development

- The OPM, User and the stakeholders must partner with the Developer through the entire program.
- Critical program information exists in large databases which must be carefully managed and readily accessible by all partners.
- Government is an integral part of the Intergraded Development Teams.

Old Way

8/9 YEARS

New Way

12/15 YEARS
M&S, collaborative Environment and Spiral Development

- Need a comprehensive Collaborative Environment to support Spiral Development
- All efforts in support of all spirals needs to be Integrated and Evaluated in a single collaborative environment
- A sound Spiral Development program requires a robust Systems Engineering effort supported by a healthy M&S program
Traditional Acquisition System: Formula for Problems

- Serial, “big-bang” solution drives cycle time
- Difficult to adjust requirements to reflect asymmetric threats or warfighter “use and learn” experience
- No requirement for collaboration among various players (users, acquirers, testers, etc.)
- Technology reach too long and process lacks flexibility for timely insertion
- Too much time for things to go wrong (budget instability, schedule changes, cost increases, etc.)
Evolutionary Acquisition

- An incremental development strategy
- More than one flavor of evolutionary acquisition
  - Pre-planned product improvements
  - Block upgrades
  - Spiral development
- Spiral differs from others
  - Each increment may have multiple spirals
  - Each spiral yields less than 100% solution (except the last)
  - Each development spiral typically much shorter
  - Spirals apply to new or immature system

A solid program plan, robust systems engineering, adequate budget, and a realistic schedule are the foundation for a successful program.
Traditional, Block, and Spiral Development

Original 100% requirement known

Warfighter, developer, tester, sustainer “use and learn”

Warfighter
= Capability

- P3I/Block - Spiral Development

Time
Focus of Implementing Spiral Development

- Deliver capability to the warfighter faster
  - Deliver in increments that meet the warfighter needs
  - Something in hand in 2-4 years
- Increase collaboration between warfighters, acquirers, and developers
  - Requirements evolve from user learning
- Increase accuracy of budget estimates for current years
  - Create mechanism for incremental budget investment decision based on results
- Increase focus on aligning and transitioning technology
  - Incorporation of technologies into spirals is related to risk

FIELD TODAY’S TECHNOLOGY -- TODAY!
NOT YESTERDAY’S TECHNOLOGY -- TOMORROW!
Implementation Issues with Spiral Development

- Spiral requirements and user angst
  - 100% solution in first spiral
  - Firming requirements without understanding implications
- Over promising by developers, technologists
- Operational testing
- Contracting Strategy
- Competition with legacy programs
- Supportability
- Budgeting
- Total development cost
- Congressional acceptance
Finishing the Reform Foundation

- Collaborative Spiral Development targeted as key to:
  - Reducing cycle times
  - Increasing credibility on cost/schedule/performance
- Current programs are attempting to chart a new course, emphasizing:
  - Collaborative requirements/program management
  - Seamless verification
  - Technology maturation and focus
New Process

Now:

Build MNS

Validated MNS

Concept & Technology Development

MS A

Mission Area Plan

Long Range Plan

Vision

Strategic Plan

Strategy to Task Process

Build ORD

Validated ORD

System Demo & Develop

MS B

Production & Deployment

MS C

Acquisition Process

Proposed:

Build ORD

Validated IRD

Updated IRD

Concept & Technology Development

MS B

Acquisition Process

Build ORD

Validated ORD

Updated ORD

Production & Deployment

MS C

IOC/FOC

Effects Based Capabilities

TF

CONOPS

Effects

Solutions

Sys Lvl

Cap's

CONOPS

Vision

Strategic Plan

Long Range Plan

Mission Area Plan

Strategy to Task Process

Now:

Build MNS

Validated MNS

Concept & Technology Development

MS A

Vision

Strategic Plan

Long Range Plan

Mission Area Plan

Strategy to Task Process

Proposed:

Build ORD

Validated ORD

System Demo & Develop

MS B

Production & Deployment

MS C

Acquisition Process

Build ORD

Validated IRD

Updated IRD

Concept & Technology Development

MS B

Acquisition Process

Build ORD

Validated ORD

Updated ORD

Production & Deployment

MS C

IOC/FOC

Effects Based Capabilities

TF

CONOPS

Effects

Solutions

Sys Lvl

Cap's

CONOPS

Vision

Strategic Plan

Long Range Plan

Mission Area Plan

Strategy to Task Process

Now:

Build MNS

Validated MNS

Concept & Technology Development

MS A

Vision

Strategic Plan

Long Range Plan

Mission Area Plan

Strategy to Task Process

Proposed:

Build ORD

Validated ORD

System Demo & Develop

MS B

Production & Deployment

MS C

Acquisition Process

Build ORD

Validated IRD

Updated IRD

Concept & Technology Development

MS B

Acquisition Process

Build ORD

Validated ORD

Updated ORD

Production & Deployment

MS C

IOC/FOC

Effects Based Capabilities

TF

CONOPS

Effects

Solutions

Sys Lvl

Cap's

CONOPS

Vision

Strategic Plan

Long Range Plan

Mission Area Plan

Strategy to Task Process

Now:

Build MNS

Validated MNS

Concept & Technology Development

MS A

Vision

Strategic Plan

Long Range Plan

Mission Area Plan

Strategy to Task Process

Proposed:

Build ORD

Validated ORD

System Demo & Develop

MS B

Production & Deployment

MS C

Acquisition Process

Build ORD

Validated IRD

Updated IRD

Concept & Technology Development

MS B

Acquisition Process

Build ORD

Validated ORD

Updated ORD

Production & Deployment

MS C

IOC/FOC

Effects Based Capabilities

TF

CONOPS

Effects

Solutions

Sys Lvl

Cap's

CONOPS

Vision

Strategic Plan

Long Range Plan

Mission Area Plan

Strategy to Task Process

Now:

Build MNS

Validated MNS

Concept & Technology Development

MS A

Vision

Strategic Plan

Long Range Plan

Mission Area Plan

Strategy to Task Process

Proposed:

Build ORD

Validated ORD

System Demo & Develop

MS B

Production & Deployment

MS C

Acquisition Process

Build ORD

Validated IRD

Updated IRD

Concept & Technology Development

MS B

Acquisition Process

Build ORD

Validated ORD

Updated ORD

Production & Deployment

MS C

IOC/FOC

Effects Based Capabilities

TF

CONOPS

Effects

Solutions

Sys Lvl

Cap's

CONOPS
Collaborative Requirements & Program Management

- Expectations management - Harmonize requirements with reality
  - Program and requirements concurrent and collaborative
- Goal is total credibility
  - Have high confidence in program estimates
  - Promise = results
  - Don’t say what we don’t know
- Build “Collaborative Requirements and Courses of Action (COA) Processes”
  - Foundation for upfront continuous collaboration and planning by the warfighter, MDA, technologists, developers/acquirers, sustainers, budgeters, and testers
  - Warfighter with acquirer support develops Interim Requirements Document (IRD) focused on needed capabilities and CONOPs
  - MDA/PM with Warfighter develops firm COAs presenting several options - including, schedule, costs, and performance commitments for each COA
  - Warfighter picks desired COA - MDA and MAJCOM Commander sign
- Expected Outcome
  - Shared expectations by warfighter and MDA on strategy, schedule, cost, and performance
  - Incremental/spiral requirements yield faster delivery
In Spiral Development
Requirements Still a Concern

- Spiral Development will get new capability quickly into warfighters hands
  - Less than 100% capability in first spiral and “use-and-learn” development concepts are key to success, but, as yet, are not fully institutionalized
- Requirements are the foundation critical to increasing credibility/setting mutual expectations
  - Collaboration is the key
  - Multiple meetings taking place to improve collaboration, but we must to continue to work this process
- Both requirers and acquirers still want too much specificity in requirements
  - Effects-based, capability-focused requirements must become the norm
What Spiral Development Can Offer

Higher Probability of Success

- Better Technology
  - Spiral development allows flexibility to insert latest technology

- Better Cost Estimates
  - Program separated into smaller manageable chunks in-line with technology half-life

- Better Scheduling
  - Bite-sized chunks make schedule predictable
  - Less changes since shorter time (Administration, world-events, etc.)

- Mutual expectations on spiral content, cost, and schedule
  - Common objectives agreed to up-front between all stakeholders

A Collaborative and Credible Acquisition Process
M&S and Systems Engineering

AGGRESSIVE COST GOAL

Development of Vehicle Concepts

Life Cycle Cost Analysis

Cost/Benefit Analysis

Risk

System/Force Effectiveness Analysis

Operational Performance Requirements

CONTINUOUS OPTIMIZATION OF COST & PERFORMANCE

AWARD FEE

MANPRINT
MANPOWER
PERSONNEL
TRAINING
HFE
HEALTH HAZARDS
SYSTEM SAFETY
SOLDIER SURVIVABILITY

ORD

FROM

TO

OPTIMIZED?

Yes

No

CONTINUOUS OPTIMIZATION OF COST & PERFORMANCE
Systems Engineering Examples

- **System Level System Engineering**
  - Mission Analysis
  - Requirements Analysis/Specifications
  - System Level Control and Analysis
  - Integration of the Software and Specialty Engineering

- **Force and System Effectiveness**

- **Software Engineering**
  - Developing and Updating the SW Architecture
  - Developing and Maintaining the SW Development Environment

- **Specialty Engineering**
  - TPM Management
  - Risk Management
  - Life Cycle Cost/Design to Cost Management
  - Human Factors Engineering
  - MANPRINT
  - Safety and Health Hazard Engineering
  - Survivability Engineering
  - Producibility
  - Configuration Mngmt and Status Accounting
System Concept and System Layout
- Maintaining the Master Model
- Developing the Industrial Concept
- System Survivability Concept
- System Structures

System Design, Integration and Control
- Interface Control
- System Level Modeling and Simulation
- Software Integration

System Integration Lab - Development & Operation
The Many Facets of M&S

M&S
A Cost-effective Approach To Continuous Design Verification and Optimization

M&S Brings Together Hardware, Software and The Human
M&S in Support of Engineering Development

System Engineering
- Visualize system timelines and functions
- Object to function linking

System Integration
- Concurrent integration
- Provide tested SES models

Test & Evaluation
- System test plan development
- Validate & improve models

Mechanical Design
- Provide master model virtual walkthrough

MANPRINT
- Conceptualize screen layout
- Tools and process for human factors analysis

Electrical interfaces
- Provide DOM data for electronics performance modeling (DNM)

S/W Architecture
- Verify the static S/W model
- Provide DOM data for initial software performance modeling

PDTs
- Provide subsystem virtual walkthroughs
- Provide reference models of system operation
- Guidelines for SES model development

S/W Integration
- SES process
- Provide tested SES models

M&S Continuously verifies the Crusader design

M&S is concurrent integration
M&S brings together hardware, software and the human factor
MANPRINT Examples

- **Safework** - Human Modeling tool was used early in PDRR to ensure the emerging designs fully supported the soldier.
  - Crew Cockpit Layout
  - Egress/ingress
  - Access to weapon/cargo compartment
  - Maintenance Task

- **HARDMAN/IMPRINT** - Workload models are used to validate the Crusader Tasks and insure Human Computer Interface is fully compatible with the Crusader Target Audience

- **Hazard Tracking System** - Extensive Data Base which contains all identified Safety and Health Hazards.

- **VAPS** - Rapidly Prototype the Human Computer Interface
Closed Loop Support System

Order Entry
- Memory Cartridge
- Electronic Data Interchange
- Voice: Order Entry Clerk

System Assessment
Anticipatory Logistics
Prognostics, Spares Forecast
Component Redesign
Modernization Through Spares
Engineering Database
Configuration Database

Materiel Management
Integrated Inventory
Local, Central, Vendor, Production

Order/Inventory Management System
- 24 Hour Order Entry
- 24 Hour Order Status
- Legacy System Interface

Field Materiel Requirements
- Pull:
  - Unscheduled or Scheduled
    -- Failure
    -- Prognostics
- Push:
  - Scheduled
  - Prognostics
  - Modifications

Anticipatory Logistics
Prognostics, Spares Forecast
Component Redesign
Modernization Through Spares
Engineering Database
Configuration Database
Simulation-Emulation-Stimulation (SES) Process

- **Supports:**
  - Hardware Development
  - S/W Development
  - System Integration
  - Test
  - Continuing Support Functions

- **Evolving Process:**
  - Initially, purely computational...
  - Then, some software and electronics in the loop...
  - Finally, actual prototype hardware & software
  - Incorporates user, environmental, and test inputs
Knowing the cost, risk, performance relationships enables a search of feasible solutions for the optimal, cost effective system.
Requirements
Methodology
— Benefits—

- Resulting quick response tool helps leadership efficiently focus on key issues
- Impact of alternative courses of action assessed immediately
- Analysis/data collection process solidifies understanding of system level capabilities
- Traceability of impact on performance, cost, risk, and schedule to internal or external program changes
Lessons Learned

- Unfunded mandates don’t work
- Commercial, off-the-shelf software tools have proven as important to reducing design cost as system specific M&S
- Can not make M&S and entity of its own
- Need to resource and not be scared off by the cost to do it right
- Funding instability/appetite suppression remains a big problem
- Must have a user jury with real users integral to the development of the collaborative environment
- Much harder to change than expected
- Collaborative requirements and spiral development embraced in principle, not fully practiced
- Speed is not free - demands upfront dollars
- Congress skeptical/suspicious
Major Progress

- Many best practices and lessons learned documented
- Better tools and computing power
- Better education
- Actual Implementation and results
- Culture is changing
- Established processes
- RDE command is standardizing the way we do S&T and bringing the efforts into a collaborative environment

M&S and a collaborative environment are a must in today’s environment and not just a better way to to business
Challenges

- Resourcing (Robust M&S effort and the collaborative environment is not cheap)
- Culture across the community
- Program evolution and M&S program must be in lock step, can’t let one get in front of the other
- Everyone has an opinion, must do what is right for each specific application
- A collaborative environment can not be affective if used a a tool to do business as usual

Rule: One size does not fit all
Summary

- Simulation Based Development Enables Significant Reductions In Program Development Cost, Schedule, and Risk
- Evolution of the Modeling and Simulation Approach From Simulation to Emulation to Stimulation Is Necessary to Support a Maturing Design
- A Successful Simulation Based Development Approach Requires:
  - Partnering of the OPM/TSM/Stake holders/Developer
  - An Effective Means of Managing and Communicating Large Amounts of Data From Many Different Sources
- M&S Concurrently Brings Together Hardware, Software and the Human
- Concurrent Design Verification and Integration
- M&S Provides Reference Models That Help People Understand the System
- M&S Provides Placeholders That Allow Integration Activities to Continue If Hardware or Software Is Not Yet Available
- End-to-end suite of simulations which will support Crusader through its life cycle
  - Post fielding improvements in hardware and software can be quickly and cheaply analyzed
  - Changes in Tactics Techniques and Procedures (TTP) can be readily evaluated
  - Troubleshooting will be quicker and easier using M&S