Generic Methodology for Verification and Validation

Overview, Applications and Lessons-Learned
Background

Global Military Trend

Simulation
Increased Joint Operation
More Interoperability & Reuse
Background

Military V&V Issues

- Different Processes & Products
- Different Domains & Applications
- Different Maturity Levels
- Different Interpretations & Concepts
- Different Techniques & Tools

Need

Common Reference & Basis
V&V cooperation & interoperability
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Generic Methodology for Verification and Validation

Initiated and Support by WEAG REVVA projects as the basis; evolved into NATO-STO MSG-073

Key Objectives
Methodology for V&V that embraces a wide variety of M&S technology and uses
Common basis for V&V cooperation, information sharing and tools

Standardization
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Generic Methodology for Verification and Validation

Provides

Framework of Generic V&V products, processes and organizational components
Application guidance by example, tools and techniques catalog

Tailorable
Structured
Risk-driven
Argumentation
Evidence-based

Reproducible, Traceable, Defensible, Interoperable and transferable V&V results
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Technical Framework: Focus on M&S Quality

“A quality system is fit for the users’ purposes, provides the needed features, and contains few, if any, important deficiencies”

- J.M Juran, *Quality is Free*, 1988
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Technical Framework: Quality Properties

M&S hardware and software/code
Correctness
Utility

\[
\Delta = \text{Fidelity}
\]

M&S Abstracts and Approximates Reality

Inherent Uncertainty
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Technical Framework: Risk-Based Decision-Making

Good and Defensible M&S Decisions

“Understanding the limitations in modeling and simulation quality, and the implications (cost, safety, time, effectiveness) for its users”
Objective

“Demonstrate with sufficient confidence that model or simulation fits the intended use and doesn’t pose unacceptable risks; to support well-informed decision making”

Requires Right Evidence

Credible
Useful
Accurate
Auditable
Traceable

V&V Evidence

Initial Uncertainty

Residual Uncertainty

V&V must be quality process itself
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Technical Framework: Business-Driven V&V Approach

Seeking a balance between

“Risk level and tolerances”  AND  “Costs and available resources”
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Technical Framework: Risk-Based V&V Strategy

- Likelihood of M&S quality defects (Technical Risks)
  - Low
  - Medium
  - High

- Impact of M&S quality defects (Business Risk)
  - Low
  - Medium
  - High

Levels:
- Level 1
- Level 2
- Level 3
- Level 4
- Level 5

Component and Integration V&V
System V&V and Acceptance

M&S SoI
Quality Property (i.e. validation metrics)
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Technical Framework: Argumentation Approach

Context information
- M&S intended use *(or domain of use)*
- M&S use risks *(Impact!)*
  Other relevant M&S and V&V context information

Acceptability Criteria
- M&S Sol Quality Properties *(validation metrics)*
- Conformance Tolerance Levels *(if possible)*
- Uncertainty *(initial)* and risk priority
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Technical Framework: Argumentation Approach

Context information
V&V metrics and techniques knowledge
(e.g., rigor, cost)
Reference (experimental/SME) data availability
Other relevant V&V and M&S context information

Evidence solutions
Specific V&V technique
Design of experiments
Test-case specification
Reference data

Prioritize and select on costs, uncertainties & risks!
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Technical Framework: Argumentation Approach

Implement and execute BUT...
it never works out as planned or expected!

V&V Results
Outcomes itself
Log execution and variances
Express uncertainties and risks
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Technical Framework: Argumentation Approach

Associated Residual uncertainties & risks!
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Technical Framework: Argumentation Approach

Traceability
Transparency
Reproducibility
Business Driven Strategy

V&V Experimental Frame → V&V Execution → V&V Results
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Technical Framework: Organizational and Managerial Levels

Effective V&V requires

- Proper project organisation
- Proper project management
- Internal quality control

Efficient V&V projects require

- Enterprise support
- Maturity, knowledge and tools
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Implementation Framework Overview

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GM-VV Implementation Framework Overview
Project Assessment and Control

Decision Management

Risk Management

Configuration Management

Information Management

Measurement

V&V agreement
V&V project status report
V&V enterprise memory

V&V project status report
V&V project plan

V&V agreement
V&V project status report
V&V enterprise memory

V&V agreement
V&V project status report
V&V enterprise memory

V&V project status report
V&V project status report
V&V project plan

Project Planning

Technical Processes

V&V project plan
V&V project status report
V&V project status report
V&V project plan

V&V project status report
V&V project status report
V&V project plan

Project Memory
GM-VV Documentation and Status

Official SISO Material

Useful Reference
GM-VV Application
V&V Studies for the Dutch Ministry of Defense

A Brief Overview, for more technical details

Roza M. et.al. **GM-VV illustrated: an educational example from the human driving behavior research domain.** *SISO Fall-SIW, Orlando, 2010*

Voogd J. et.al. **The GM-VV tailored for a naval ship-handling training simulation.** *SISO Euro-SIW, The Hague, 2011*

Roza M. et. al. **The development, verification and validation of a distributed air operations mission training environment.** *AIAA MST Conference, Boston, 2013*

Voogd J. et. al. **Implementing the GM-VV enterprise, project and technical levels.** *SISO Fall-SIW, Orlando, 2013*
V&V Study with GM-VV
Heavy Weather Ship Handling Simulator

Is simulation valid for training and doctrine?

Key V&V benefit
Defensible ship dynamic model and motion system acquisition decision
V&V Study with GM-VV
Distributed F16 Operation Familiarization Simulation

Is a valid alternative?

Key V&V benefit
Better model, simulator and training requirements
V&V-Study with GM-VV
Public Order Management Serious-Game

Key V&V benefit
Maximized training benefits

How to improve fidelity and training?
V&V-Study with GM-VV
Fighter Aircraft Robust Power Management

Key V&V benefit
Currently in progress

Model replicative and predictive fidelity?
GM-VV Application
Our lessons-learned

Pro’s
- Flexible, versatile and widely applicable
- Scalable and tailorable
- Good structure and guidance
- Facilitates high quality processes and results

BUT...
- Requires initial work before use (*instantiation*)!
- Specific application/domain knowledge, methods and techniques (*SME*)!
- Abstractness and steep learning curve

Knowledge, Skills and Experience
V&V is a Real Profession
GM-VV Application
Closing the gap through the enterprise level

Permanent V&V organization

Ready to use method instance (V&V life-cycle models)

Catalog with application and domain specific
  V&V, risk and uncertainty analysis techniques,
  Acceptance criteria and validation metrics,
  Argumentation language and patterns

Consolidation and leverage of lessons-learned

Trained V&V professionals and tool-suite

Mature, professional and cost-efficient V&V
Questions
Generic Methodology for Verification and Validation
More information
Generic Methodology for Verification and Validation

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