Domain Relationships

**Systems Engineering:**
An interdisciplinary approach that encompasses the entire technical effort, and evolves into and verifies an integrated and life cycle balanced set of system people, products, and process solutions that satisfy customer needs.

**Software Engineering:**
The application of a systematic, disciplined quantifiable approach to the development, operations, and maintenance of software: that is, the application of software to engineering.

**Modeling & Simulation:**
The use of models, including emulators, prototypes, simulators, and stimulators, either statically or over time, to develop data as a basis for making managerial or technical decisions. The terms "modeling" and "simulation" are often used interchangeably.

M&S Is A Discipline With Its Own Body Of Knowledge!
Important Distinctions

Banking Simulation

The simulation approximates the operation of the bank. How well?

Banking Software

The banking software tracks your money. How accurately?

Your Money
M&S VV&A Defined

VERIFICATION

The process of determining that a model [or simulation] implementation and its associated data accurately represents the developer’s conceptual description and specifications.

VALIDATION

The process of determining the degree to which a model [or simulation] and its associated data provides an accurate representation the real world from the perspective of the intended uses of the model or simulation.

ACCREDITATION

The official acceptance of a model or simulation or federation of models and simulations and its associated data to use for a specific purpose.

Verification, Validation, and Accreditation (VV&A):
A process for substantiating the credibility of models and simulations.
VV&A and Credibility Assessment

- Verification and Validation starts with development
- Accreditation occurs before use
- Assessing credibility occurs after use
Orion VV&A Process

User/Analyst:
- Establish Need for M&S Based Analysis
- Assess M&S
- Perform M&S Based Analysis
- Assess Credibility

M&S Developer:
- Is M&S Available? Is it Validated?
- Develop M&S Perform V&V
- Technically Sufficient?

Subject Matter Experts:
- Review V&V Artifacts
- Accredit M&S
- Results Acceptable

OMSWG:
- Orion Modeling and Simulation Working Group
- Review Credibility Assessments

Approved for Public Release – Distribution is Unlimited
Four Things Must Be Reported

- Best Estimate
- Uncertainty Statement
- Credibility Assessment Scale
- Any Caveats

![Graph: Best Estimate]

![Graph: Uncertainty]

![Table: Credibility Assessment]

- Best Estimate
- Uncertainty Statement
- Credibility Assessment Scale
- Any Caveats

![CAUTION]

Validated for low earth orbit only

Approved for Public Release – Distribution is Unlimited
The Credibility Assessment Scale

M&S Results Credibility

- Verification
  - Body of Evidence
  - Technical Review
- Validation
  - Body of Evidence
  - Technical Review
- Input Pedigree
  - Body of Evidence
  - Technical Review
- Results Uncertainty
  - Body of Evidence
  - Technical Review
- Results Robustness
  - Body of Evidence
  - Technical Review
- Use History
- M&S Management
- People Qualifications

M&S Development

M&S Operations

Supporting Evidence

Approved for Public Release – Distribution is Unlimited
VV&A Team for Orion

Orion M&S VV&A work is performed for NASA on the Constellation Technical Support Contract (CTSC).

The team includes:

Mike McFarlane/NASA JSC/ER (Orion M&S Lead)
Mike Lowry/NASA ARC
Wei Lin/NASA ARC
Tony Garza/Booz Allen Hamilton
Manette Delgado/Booz Allen Hamilton
Danny Thomas/AEgis Technologies Group
Alexia Joiner/AEgis Technologies Group