

Verification & Validation in Computational Solid Mechanics

Presentation to the ASME
Board on Performance Test Codes
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by

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Presentation Outline

I. Committee History (Schwer)

II. Past & Future Efforts in Verification & Validation (Oberkampf)

III. Verification & Validation Standards Petition (Schwer)

Committee History

- AIAA V&V Guidelines Effort for CFD
- USACM ad hoc V&V Committee on CSM
- First Meeting AMSE IMECE Nov 99 Nashville
 - Draft outline of Guidelines
 - Diverse Membership
 - Work under an ANSI approved organization
- Executive Committee
- Email distribution vnv@usacm.org
- Web site www.schwer.net/VnV
- Committee Members
- Organization & Membership Policy [Mar 00]

United States Association for Computational Mechanics (USACM)

- Founded in 1988 to promote, foster, organize and coordinate activities concerning Computational Mechanics.
- U.S. affiliate of the International Association for Computational Mechanics (IACM).
- Bi-annual Congresses: 2001, 1999, 1997, 1995, 1993, 1991
- Over 700 dues paying members (mostly academics)
- Web page www.usacm.org
- *Formed ad hoc V&V Committee August 1999*

First Committee Meeting

ASME IMECE Nov 1999 Nashville

Agenda

Nomination and election of chair and vice chair (All)

DoD V&V requirements and needs (*Mair & Giltrud*)

DoE V&V requirements and needs (*Oberkampf*)

Ford Motor V&V requirements and needs (Yang)

Role of experimental mechanics in CSM V&V (Gran)

Report on standards committees

ASME (*Pifko*) & ASCE (*Saigal*)

Experience in developing the AIAA V&V Guide CFD (*Oberkampf*)

Discussion of using AIAA V&V Guide CFD as starting point (All)

Discussion of expanded membership (All)

First Committee Meeting

Action Items

- Establish a Writing Team to Draft Guidelines (Mair)
- Diversify ad hoc Committee Membership
 - Technical: *Experimental and Probabilistic Mechanics, Software Developers, & Engineering Managers*
 - Organizational: *Industrial, Governmental, and Academic*
- Develop Rules of Operation (Schwer)
- **Pursue ANSI approved Sponsoring Organization** (Pifko & Saigal)

Activities Since Nov 99

- Established an Executive Committee – *Schwer (Chair), Mair (Vice Chair), Giltrud, & Oberkampf*
- Expanded Membership to 28 with diverse backgrounds
- Adopted *Organization & Membership Policy* (Mar 00)
- Established an email distribution list for Committee (vnv@usacm.org)
- Established a Committee web page (www.schwer/net/VnV)
- Draft outline for CSM Guidelines (discuss at 10 Nov 00 meeting)
- Planned two session symposium at USACM Congress Aug 01

Committee Membership

Industry (14)		Government (8)	Academia (6)
ADINA	Boeing	DTRA/DoD	Cal Tech
ANSYS	Northrup Grumman	IDA/DoD	Carnegie Mellon
SRI	John Hopkins	LANL/DoE	Northwestern
Acta	Factory Mutual	NASA	Rensselaer Polytechnic
SwRI	Logicon (R&D)	Navy	Texas A&M
Ford Motor	Consulting (2)	SNL/DoE (3)	U of Texas
General Motors			

Bill Oberkampf co-author of AIAA CFD Guidelines

Patrick Roache author “V&V in Computational Science & Engineering”

Will add liaison from ASME Biomechanics Medical Device Standards Committee

Past and Future Effort in Verification and Validation

- AIAA has 24 Committees on Standards
- All committees accredited by American National Standards Institute
- Computational Fluid Dynamics Committee on Standards was formed in 1987
- Approximately 20 volunteer members from:
 - Industry
 - Government
 - Academia
- Present Chair: Ray Cosner, Boeing/St. Louis



Need for V&V Guidelines in CFD

- Committee recognized the need for V&V Guidelines
- Project begun in 1992
- Purpose of the project:
 - To promote the establishment of basic terminology and methodology for assessment of accuracy of CFD simulations.
- Committee members discussed and debated:
 - Terminology
 - Methodology and procedures
 - Concerns of industry
- Document passed the committee vote and published:
 - “Guide for the Verification and Validation of Computational Fluid Dynamics Simulations” (AIAA G-077-1998)

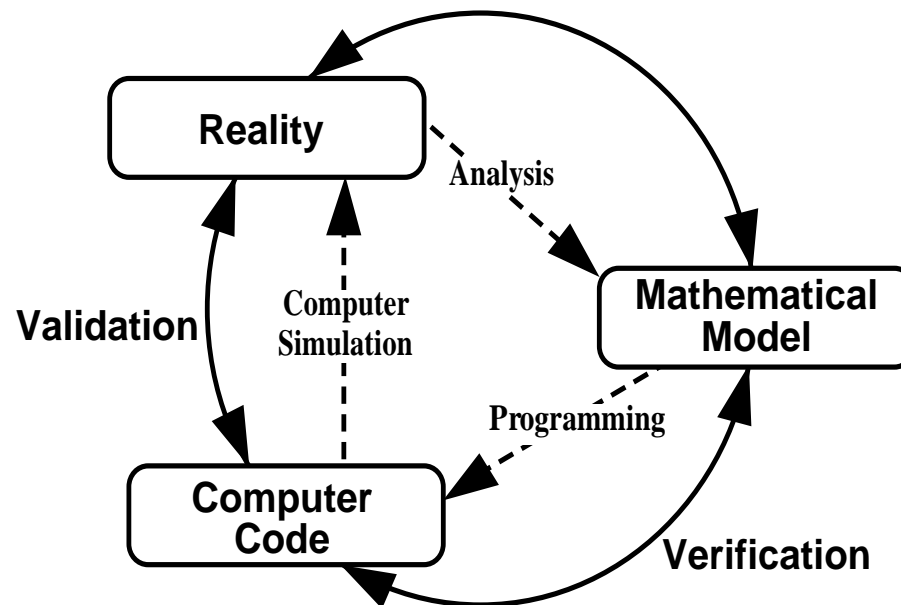
What is Verification and Validation

- Definition of verification:

“The process of determining that a model implementation accurately represents the developer’s conceptual description of the model and the solution to the model.”

- Definition of validation:

“The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model.”



Liability is not an Issue

- Products of the proposed committee on V&V in CSM:
 - Published guidelines for V&V in CSM
 - Recommended practices in V&V
 - Not legally binding
- Committee will not accredit, certify, quality, or endorse:
 - Any computer codes
 - Any analyses or computations

Present Draft Outline Guideline of V&V in Computational Solid Mechanics

1. Introduction

1.1 Background

1.2 Scope and Outline

2. Terminology

2.1 Modeling and Simulation

2.2 Conceptual Model

2.3 Uncertainty and Error

2.4 Prediction and Levels of Credibility

2.5 Calibration

2.6 Verification and Validation

2.7 Theoretical, Experimental, and Computational Mechanics

Outline (continued)

3. Verification

3.1 Verification Phases

3.2 Verification Tests

3.3 Acceptance Criteria

4. Validation

4.1 Validation Phases

4.2 Computational Solid Mechanics

4.3 Experimental Data

4.4 Systems View of Validation

4.5 Computational Solid Mechanics

5. Summary

V&V in CSM Standards Petition - July 00

To develop standards for assessing the credibility of modeling and simulation in computational solid mechanics.

- Identification of Need
- Who is the Customer?
- Broad Constituency

Identification of Need

- Modeling and simulation are valuable tools:
 - Increased productivity/profit by shortening design cycles,
 - Growing emphasis on product reliability & safety with less physical testing.
- Objectives of V&V Guidelines in CSM:
 - Formalize analytical & numerical procedures,
 - Increase reliability & accountability of software,
 - Develop benchmarks for software verification,
 - Improve experimental procedures and error estimates,
 - Improve quantification of validation assessments.

Customer for the Standard

- Software developers who need to verify their numerical algorithms,
- Computational analysts who need to validate the results generated,
- Decision makers who need to accept or reject the results.

Broad Constituency

- Goals
 - A standard with commonality of a sound approach across all of solid mechanics,
 - Combine the needs of software developers, engineering analysts, experimental mechanics, & engineering managers.
- V&V Standards for CSM should **not** to be approached application-by-application, e.g. Biomedical Device Standards.
- V&V Standards address fundamental issues of the CSM discipline, providing a framework for the development of application specific areas.