Committee on Credible Practice of
Modeling & Simulation in Healthcare
https://simtk.org/home/cpms

Credibility of Computational Methods in Healthcare: A Comparison of Community-based Standards and Guidelines

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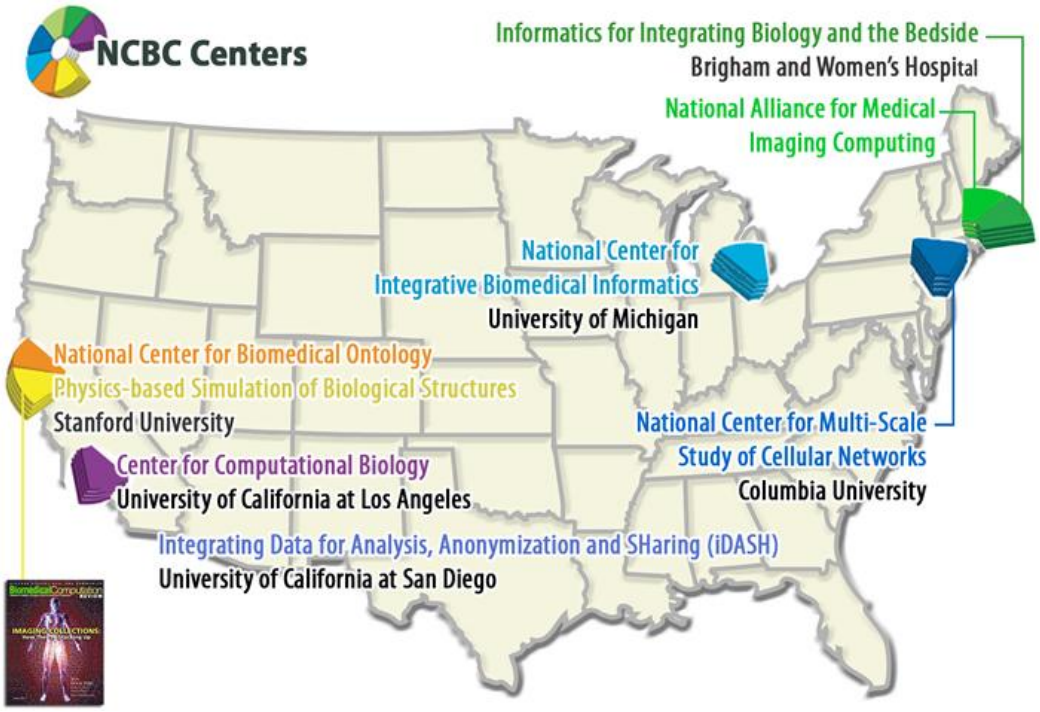
1. IMAG/MSM Committee on Credible Practice of M&S in Healthcare
2. ASME V&V40: Verification and Validation in Computational Modeling of Medical Devices

ASME Verification and Validation Symposium
Las Vegas, Nevada May 18-20, 2016

BACKGROUND

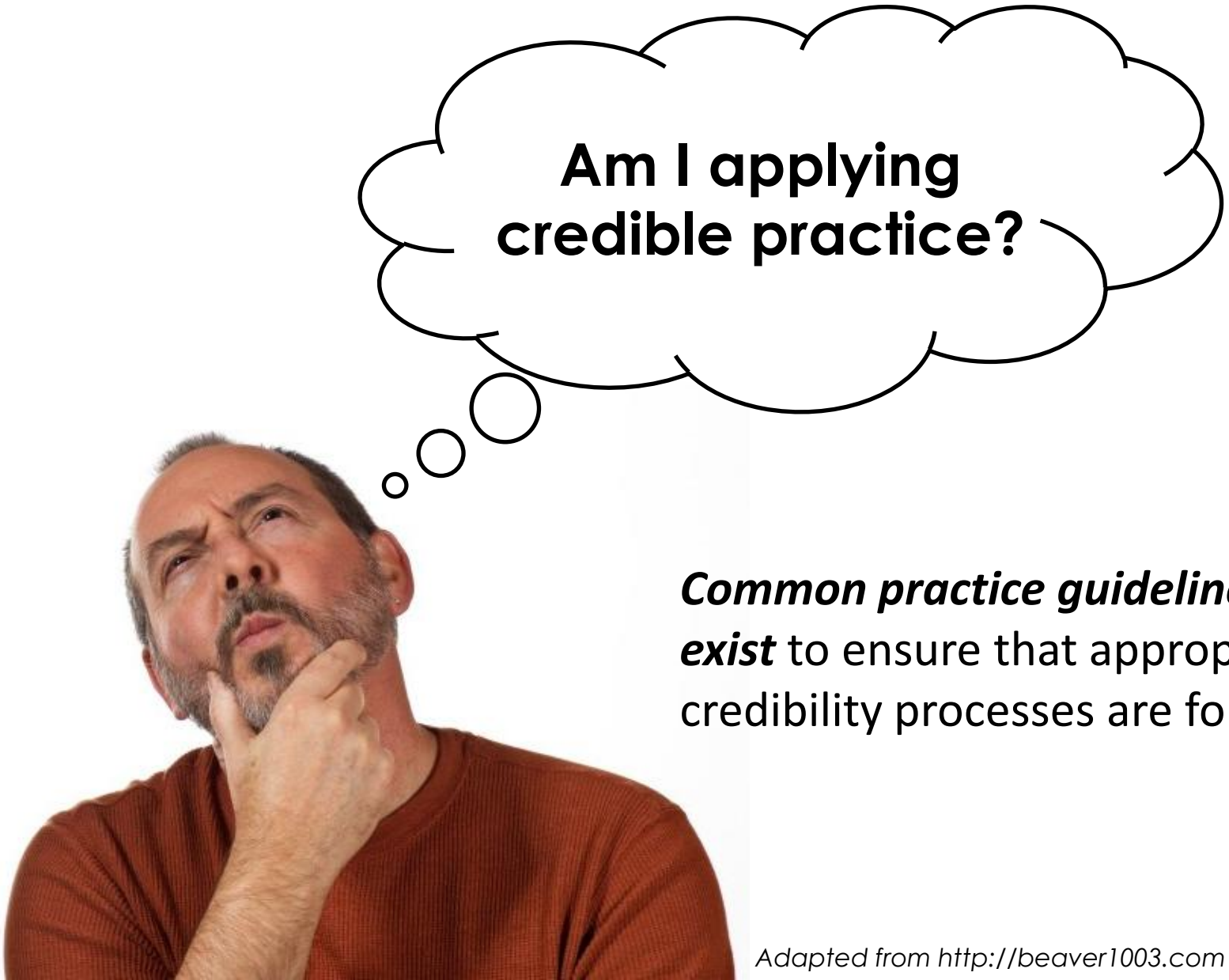
- Computational modeling and simulation (M&S) methods have substantial potential to support research, clinical decisions and education in healthcare

- Government agencies and industry are making substantial investments on R&D activities in simulation-based medicine and notable discoveries are being made



adapted from NCBC website (2014)

The Challenge



Common practice guidelines <u>do not</u> exist to ensure that appropriate credibility processes are followed

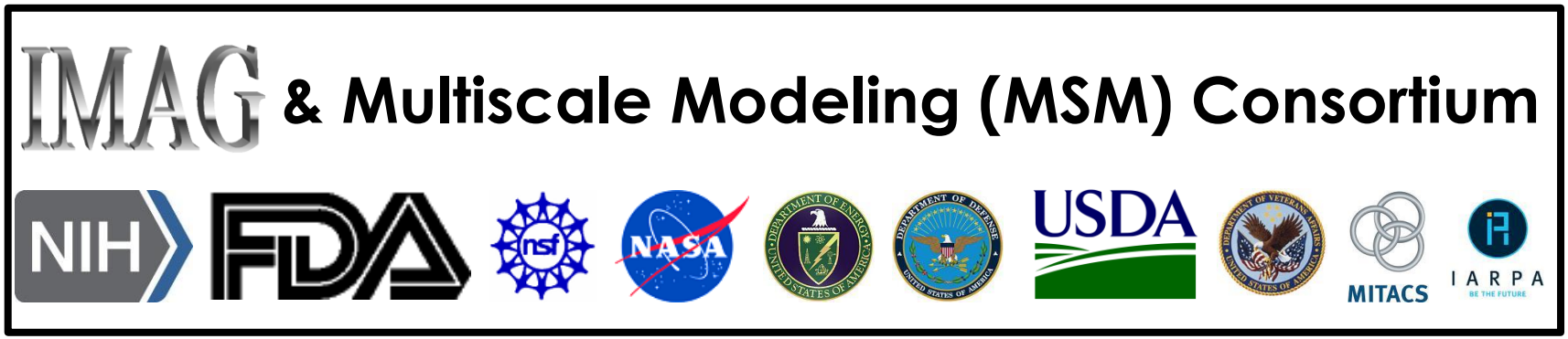
Adapted from http://beaver1003.com

Solution Pathway

To bridge this gap, the

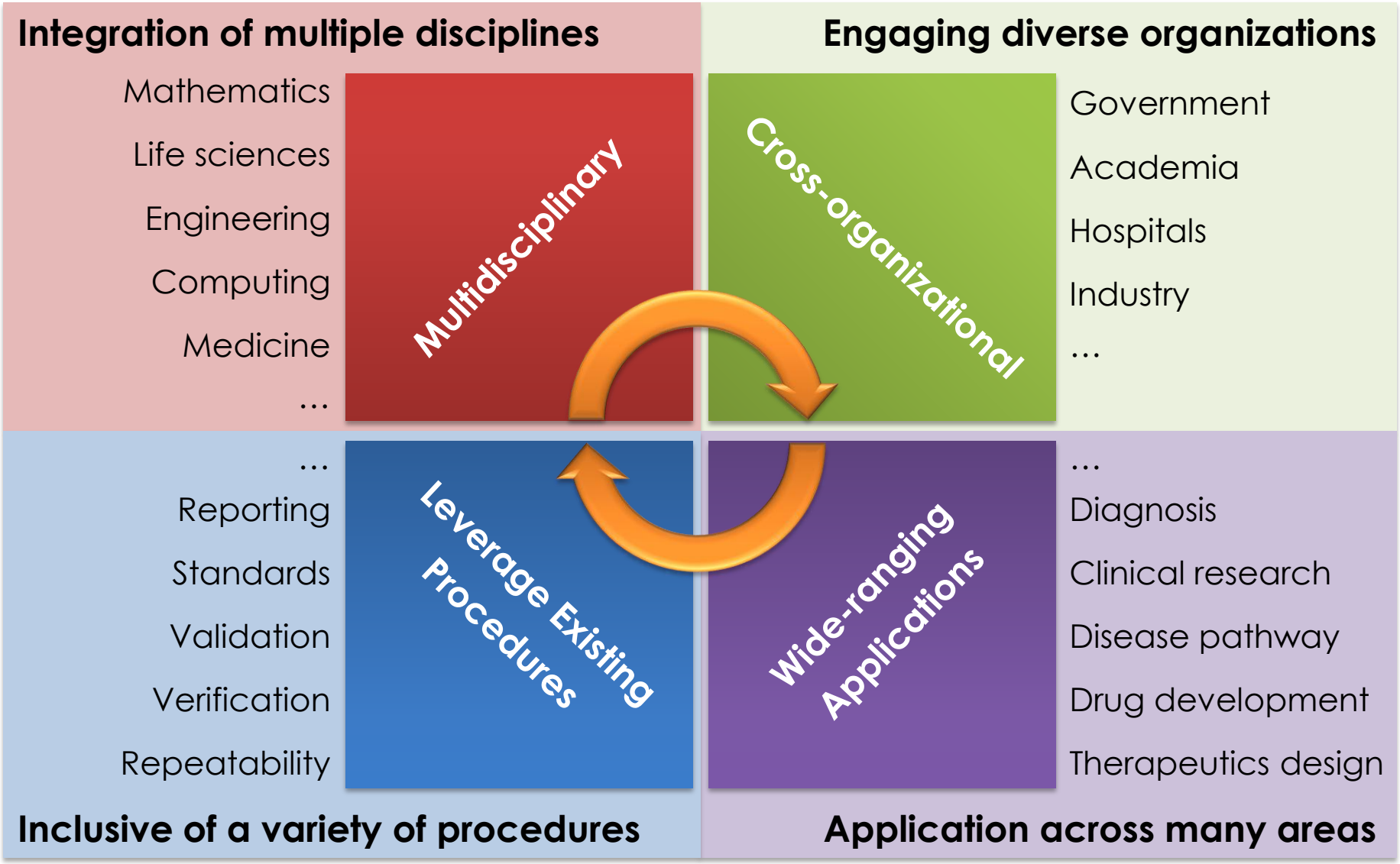
Committee on Credible Practice of Modeling & Simulation in Healthcare

was established under



Primary focus: Computational M&S for clinical research and decision-making

What Makes the Committee Unique?



Committee Implementation Strategy

Committee Executive Members (Execute & Charge)

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L. Mulugeta, M.Sc.
Co-Chair
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FDA

J. Ku, Ph.D.
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Communication ⇕ **Accountability**

Advisory Council (Review & Advise)

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Mayo Clinic

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FDA

M. Steele, Ph.D.
NASA

M. Walton, Ph.D.
Wyle

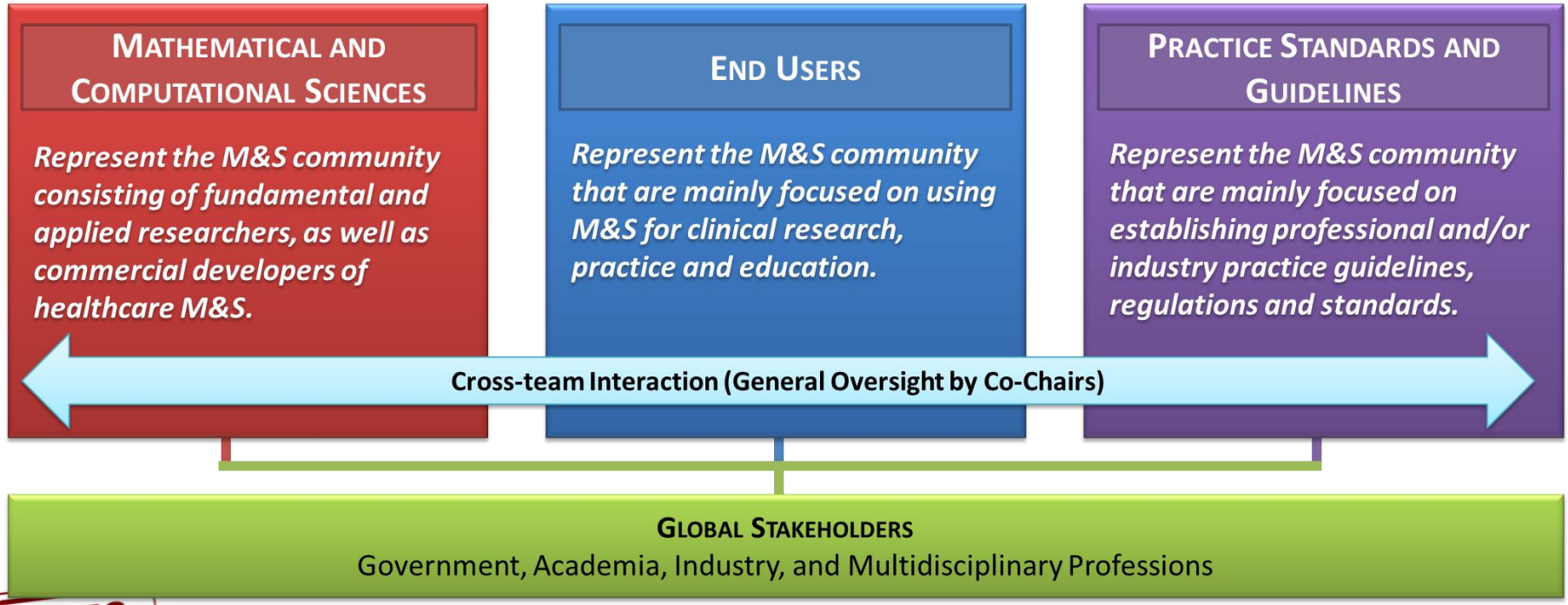
Interagency Modeling and Analysis Group (**IMAG**) & Multiscale Modeling Consortium (**MSM**)

For full credentials of the CPMS members: http://wiki.simtk.org/cpms/CPMS_Members

Committee Implementation Strategy

Use team-based structure to:

- Establish a balanced representation of the interests and perspectives of the different stakeholders
- Bridge synergistic activities in simulation-based medicine throughout the M&S communities



Committee's Charge

- **Guidelines & Procedures**
  - Credible practice in computational medicine
  - Leveraging readily available techniques
  - Define novel translational workflows to enhance credibility practice
- **Demonstrate Workflows**
  - Conduct studies to develop novel credibility assessment procedures
  - Disseminating examples of credibility assessment
- **Consistent Terminology**
  - Unify the use of M&S vocabulary across all stakeholders
- **Promote Good Practice**
  - Bridge synergistic activities within the M&S communities
  - Conduct outreach activities
- **End Products**
  I. "Guidelines for Credible Practice of M&S in Healthcare"
  II. Proposed model certification process
  III. Identify new areas of research to advance I & II

CFMS

Ten Simple Rules of Credible Practice

Primary deliverable: "*Guidelines for Credible Practice of Modeling and Simulation in Healthcare*"

Goal Oriented Activity: The CPMS Task Teams were charged to identify ten key elements or simple rules of credible practice in order to establish a foundation from which the "*Guidelines for Credible Practice of Modeling and Simulation in Healthcare*" can be developed.

Full details of this activity is available at:
http://wiki.simtk.org/cpms/Ten_Simple_Rules_of_Credible_Practice

Initial Survey to Identify the "Ten Simple Rules"

To initiate the Ten Simple Rules task:

1. 26 candidate rules were generated
2. Candidate rules were surveyed internally among the Committee's three Task Teams
3. Results from the three teams were consolidated to arrive at "Ten Simple Rules"

26 Candidate Rules of Credible Practice		
Use version control	Follow discipline-specific guidelines	Define the context the model is intended to be used for
Use credible solvers	Attempt verification within context	Perform appropriate level of sensitivity analysis within context of use
Explicitly list your limitations	Attempt uncertainty (error) estimation	Use consistent terminology or define your terminology
Report appropriately	Make sure your results are reproducible	Get it reviewed by independent users/ developers/members
Document your code	Define your evaluation metrics in advance	Provide user instructions whenever possible and applicable
Provide examples of use	Conform to discipline-specific standards	Use traceable data that can be traced back to the origin
Practice what you preach	Be a discipline-independent/ specific example	Disseminate whenever possible (source code, test suite, data, etc)
Develop with the end user in mind	Learn from discipline-independent examples	Use competition of multiple implementations to check and balance each other
Attempt validation within context	Use appropriate data (input, validation, verification)	

Full details are available at: http://wiki.simtk.org/cpms/Ten_Simple_Rules_of_Credible_Practice/Summary_of_Results

COMMITTEE'S PERSPECTIVE ON TSR OF CREDIBLE PRACTICE

MOTIVATION

- Computational modeling and simulation (M&S) plays a growing role in the development and delivery of healthcare.
- Government agencies and industry are making substantial investments in simulation-based medicine and notable discoveries are being made.
- There is an emerging need to ensure credible decison-making with output from M&S, accommodating broad and multidisciplinary perspectives in healthcare.

***Common practice guidelines**, to ease communication among stakeholders and to allow a unified and appropriate approach **to establish credibility of M&S** in a multidisciplinary environment, **do not exist**.*

GOALS

To identify **broadly applicable common rules** for establishing **credibility in M&S** in healthcare

by

synthesizing discussions within a multidisciplinary Committee, the **Committee on Credible Practice for M&S in Healthcare**.

None of us are experts in everything. We need to learn from each other.

Credible practice of modeling and simulation in healthcare requires *ongoing* **inclusive communications** to establish adaptive **workflows** that can be utilized **broadly**.

CONCLUSIONS

- It is possible to establish broadly applicable overlapping themes for credible practice of M&S in healthcare.

Nonetheless

- These rules are considered "***not so simple***" as their implied meanings may vary, indicating the need for clear and detailed descriptions during their application.
- Perception and relative importance of these rules are likely to be influenced by disciplinary, organizational, and context of use (purpose) factors.

FUTURE

- Gauging broader community's opinion
  Public online survey
  December 2014 - April 2015
  195 participants
- Preparation of a guidance document
  relying on Committee's perspective
  informed by community insight
- Development of a model certification process
  to facilitate systematic evaluation of credibility
- Support by
  establishing consistent terminology
  demonstration of workflows
  outreach

COMMITTEE

EXECUTE & CHARGE — **EXECUTIVE COMMITTEE** — 2 co-chairs, 8 current members including co-chairs, 2 past members

COMMUNICATION ⇅ ACCOUNTABILITY

REVIEW & ADVISE — **ADVISORY COUNCIL** — 12 current members

Committee roster is targeted

- to establish a balanced representation of the interests and perspectives of the different stakeholders
- to bridge synergistic activities in simulation-based medicine throughout various M&S communities

integrating multiple disciplines
mathematics
life sciences
engineering
computing
medicine
…

engaging diverse organizations
government
academia
hospitals
industry
…

leveraging various procedures
reporting
standards
validation
verification
repeatability
…

applications in many areas
diagnosis
clinical research
disease pathway
drug development
therapeutics design
…

TASK TEAMS

Mathematics & Computation Team	Users Team	Standards & Guidelines Team
interest in development of models and simulation approaches	interest in application of models for clinical research and practice	interest in evaluation of models and simulation approaches
7 participants 3 - Executive Committee 4 - Advisory Council	7 participants 3 - Executive Committee 4 - Advisory Council	7 participants 3 - Executive Committee 4 - Advisory Council
scientists engineers	clinicians scientists engineers	scientists engineers directors managers
academia industry government independent	academia industry government healthcare organizations	industry government

initial set of rules → **discussions within task teams** → **individual task team rankings**

Task teams decided upon their own approach to identify top ten rules with or without ranking. Task teams interpreted the rules in their own way and combined rules or added new ones.

INITIAL SET OF RULES

26 rules to start with

• use version control • use credible solvers • explicitly list your limitations • • define the context the model is intended to be used for • • define your evaluation metrics in advance • • use appropriate data (input, validation, verification) • • attempt validation within context • attempt verification within context • • attempt uncertainty (error) estimation • • perform appropriate level of sensitivity analysis within context of use • • disseminate whenever possible (source code, test suite, data, etc) • • report appropriately • use consistent terminology or define your terminology • • get it reviewed by independent users/developers/members • • learn from discipline-independent examples • • be a discipline-independent/specific example • follow discipline-specific guidelines • • conform to discipline-specific standards • document your code • • develop with the end-user in mind • • provide user instructions whenever possible and applicable • • practice what you preach • make sure your results are reproducible • • provide examples of use • use traceable data that can be traced back to the origin • • use competition of multiple implementations to check and balance each other •

COMMITTEE RANKING

Consolidation
- commonality of a rule between task team lists
- relative ranking of a rule in task team lists
- grouping of rules based on similarities
- grouping of rules that enhance each other

Rule 1 – *Define context clearly.*
Plan and develop the M&S activity with clear definition of the intended purpose or context accommodating end-users needs.

Rule 2 – *Use appropriate data.*
Use data relevant to the M&S activity, which can ideally be traced back to the source.

Rule 3 – *Evaluate within context.*
Evaluate the M&S activity through verification & validation, uncertainty quantification, and sensitivity analysis faithful to the context/purpose/scope of the M&S efforts, with clear and a-priori definition of evaluation metrics and including test cases.

Rule 4 – *List limitations explicitly.*
Provide an explicit disclaimer on the limitations of the M&S to indicate under what conditions or applications the M&S may or may not be relied on.

Rule 5 – *Use version control.*
Implement a version control system to trace the time history of the M&S activities, including delineation of contributors' efforts.

Rule 6 – *Document adequately.*
Document all M&S activities, including simulation code, model markup, scope and intended use of M&S activities, users' and developers' guides.

Rule 7 – *Disseminate broadly.*
Disseminate appropriate components of M&S activities, including simulation software, models, simulation scenarios and results.

Rule 8 – *Get independent reviews.*
Have the M&S activity reviewed by independent third-party users and developers, essentially by any interested member of the community.

Rule 9 – *Test competing implementations.*
Use competition of multiple implementations to check the conclusions of different implementations of the M&S processes against each other.

Rule 10 – *Conform to standards.*
Adopt and promote generally applicable and discipline specific operating procedures, guidelines, and standards accepted as best practices.

TASK TEAM RANKINGS

Mathematics & Computation Team	Users Team	Standards & Guidelines Team
first 10 shown	*first 10 shown*	

Status of the Ten Simple Rules (TSR) Activity

- In an effort to draw out globally well-balanced guidelines across the range of disciplines and application interests, a public survey was launched on August 15th, 2014 to obtain input from the broader M&S stakeholder community.
- The survey was closed on April 15, 2015 and the Data Analysis Team has started to analyze the results.
- A forum discussion thread has been initiated: https://simtk.org/forums/viewtopic.php?f=848&t=5616&sid=fdcab3f040d5c52b8667a0b0812d2e2b
- The raw data is also available at: https://simtk.org/websvn/wsvn/cpms/dat/Survey/Complete%20Survey%20Results_Clean_04242015.xlsx

CFMS

Publicly Surveyed Proposed Rules

1	Engage potential end-user base.
2	Make the M&S results reproducible.
3	Develop the M&S with the end-user in mind.
4	Use appropriate data, e.g., for input, validation, verification.
5	Explicitly identify experimental scenarios that illustrate when, why, and how the M&S is false or not applicable.
6	Use competition of multiple M&S implementation methods to check and balance each other.
7	Document the development and use of M&S appropriately.
9	Use version control, i.e., to track different revisions of the model.
10	Be a discipline specific example of good practice.
11	Use data that can be traced back to the origin of source.
12	Disseminate whenever and whatever is possible, e.g., source code, test suite, data.
13	Validate the M&S activity within the context of use.
14	Perform sensitivity analysis within the context of use.
15	Define the M&S evaluation metrics in advance.
16	Make your code readable.
17	Provide user instructions whenever possible and applicable.
18	Provide examples of use.
19	Learn from specialized and broadly applicable guidelines for good practice.
20	Follow discipline-specific guidelines and standards whenever possible.
21	Perform uncertainty estimation/quantification within context of use.
22	Perform numerical error estimation/quantification within context of use.
23	Get the M&S reviewed by independent users, developers, and members of the intended stakeholder community.
24	Explicitly list limitations of the M&S.
25	Make it easy for anyone to repeat and/or falsify your results.
26	Use consistent terminology or define your terminology.
27	Verify the M&S processes within context of use.
28	Report appropriately, i.e., to allow reproducibility, to assess reliability, and to establish accountability.
29	Define the context in which the M&S is intended to be used.
30	Use credible, e.g. verified, solvers (code, software, applications).
31	Conform to discipline-specific standards.
32	Disclose conflict of interests.
33	Adopt and promote standard operating procedures.
34	Document your code.
35	Provide clear descriptions of limitations.
36	Use simulation software with established reliability.

Current Status of Survey Analysis

0	1	2	3	4	5
Not Applicable Not Important	**Low Importance**	**Moderately Important**	**Important**	**Very Important**	**Extremely Important**

- Total responses: 186
- Total valid responses: 148 from
  - 4 continents, 10 disciplines, various levels of education and experience in M&S

Key Overlaps between Committee's perspectives & global M&S community

Simple Rule	Description
Define context clearly	Develop and document the subject, purpose, and intended use(s) of the model or simulation
Use appropriate data	Employ relevant and traceable information in the development or operation of a model or simulation.
Evaluate within context	Verification, validation, uncertainty quantification, and sensitivity analysis of the model or simulation are accomplished with respect to the reality of interest and intended use(s) of the model or simulation.
List limitations explicitly	Restrictions, constraints, or qualifications for or on the use of the model or simulation are available for consideration by the users or customers of a model or simulation.

Future Work

- Publish Committee's perspective, *'Ten "Not So" Simple Rules for Credible Practice of Modeling and Simulation in Healthcare: Perspectives from a Multidisciplinary Committee'*
- Analyze public survey data, and publish results in PLOS Computational Biology in the form of *"Ten Simple Rules of Credible Practice of M&S in Healthcare"*
- Develop and publish the "*Guidelines for Credible Practice in Modeling & Simulation in Healthcare*" and as well as a "*Model Certification Guideline*" based off of the above findings
- Publish glossary of terms to help unify the use of M&S terminology across a variety of disciplines and stakeholders in the field – Draft: http://tinyurl.com/ze4scnx

ASME Committee on V&V in Computational Modeling and Simulation

- Standards Committee
  - Provide procedures for assessing and quantifying the accuracy and credibility of computational modeling and simulation

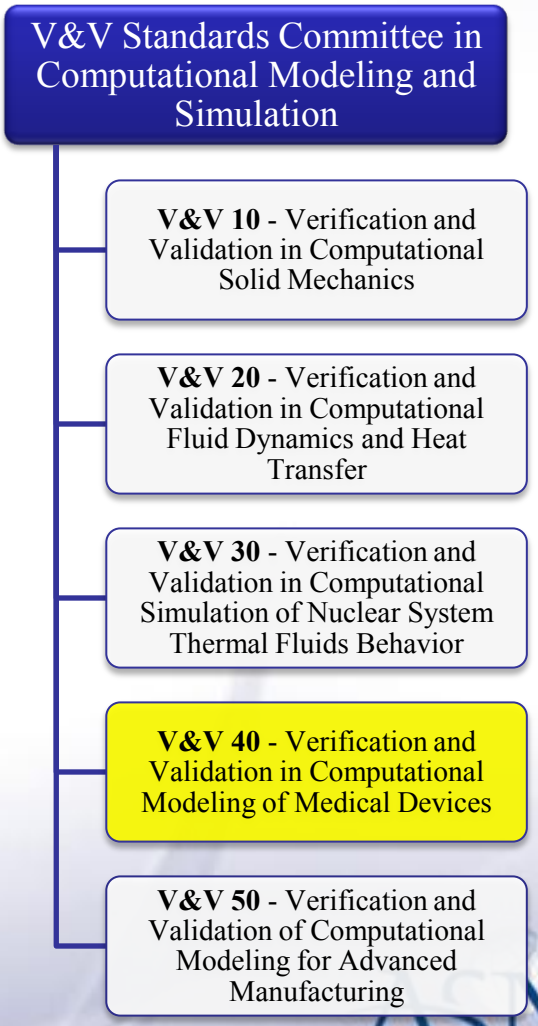
V&V Standards Committee in Computational Modeling and Simulation

- **V&V 10** - Verification and Validation in Computational Solid Mechanics
- **V&V 20** - Verification and Validation in Computational Fluid Dynamics and Heat Transfer
- **V&V 30** - Verification and Validation in Computational Simulation of Nuclear System Thermal Fluids Behavior
- **V&V 40** - Verification and Validation in Computational Modeling of Medical Devices
- **V&V 50** - Verification and Validation of Computational Modeling for Advanced Manufacturing

ASME SETTING THE STANDARD

V&V 40 VERIFICATION AND VALIDATION IN COMPUTATIONAL MODELING OF MEDICAL DEVICES

- ASME V&V 40 Charter
  - Provide procedures to standardize verification and validation for computational modeling of medical devices
  - Charter approved in January 2011
- Motivating factors
  - Regulated industry with limited ability to validate clinically
  - Increased emphasis on modeling to support device safety and/or efficacy
  - Use of modeling hindered by lack of V&V guidance and expectations within medical device community



V&V 40 Subcommittee Membership

Carl Popelar, Chair, Southwest Research Institute

Tina Morrison, Vice-Chair*, FDA

Andrew Rau, Vice-Chair, Exponent

Ryan Crane, Secretary, ASME

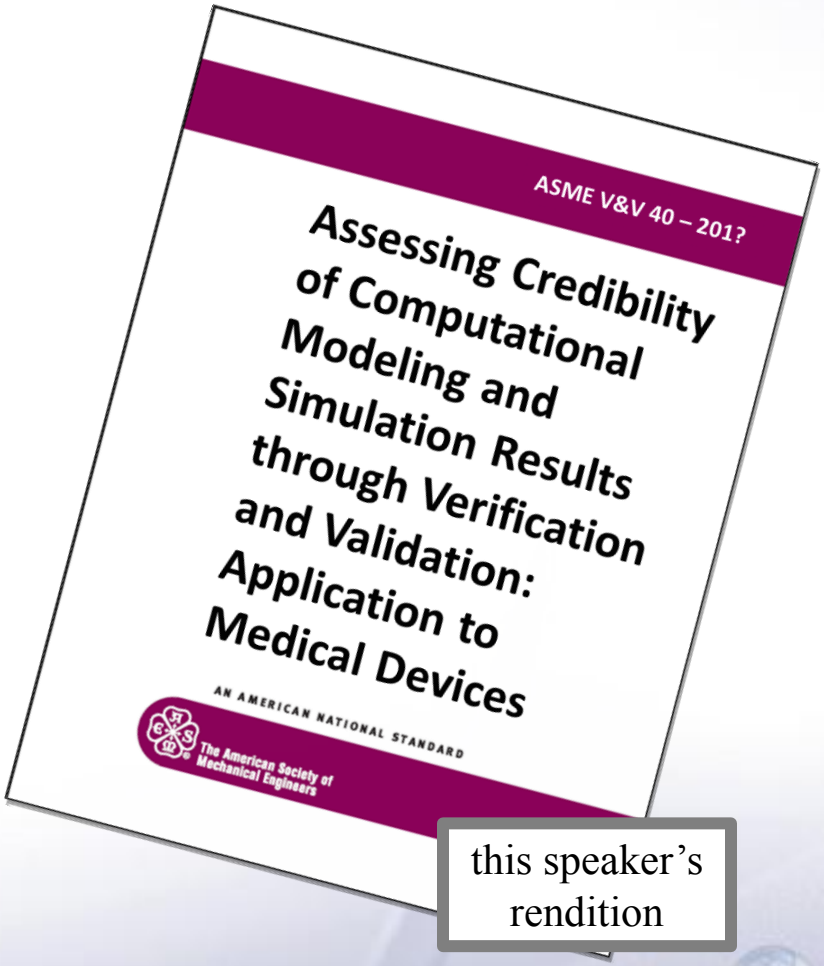
P. Afshari, Depuy-Synthes Spine
B. P. Baillargeon, Dassault Systemes Simulia Corp
D. Bardot, Medical Device Innovation Consortium
A. Bestelmeyer, BD Technologies
J. Bischoff, Zimmer
J. P. Bodner, Medtronic Corp
S. Cheng, Integra Life Sciences
B. D. Choules, MED Institute
R. Chow, Consultant
J. C. Coburn, US Food and Drug Administration
C. Corrales, Baxter Healthcare Corporation
K. K. Debus, Cd-adapco
M. Dharia, Zimmer Biomet
S. Eswaran, Abbott Vascular
C. Funkhouser, Baxter Healthcare Corporation
K. Genc, Simpleware Inc.
M. Goodin, Simutech Group
I. Guler, Boston Scientific Corporation
A. Gupta, Google Inc.
P. Hariharan, US Food and Drug Administration
W. Hary, Heartflow

M. Horner, ANSYS, Inc.*
H. Jin, Medtronic, Inc.
A. Kiapour, 4WEB Medical Inc.
L. Knudsen, Syncroness
S. Kulkarni, VEXTEC Corporation
D. Levine, Zimmer, Inc.
X.M. Li, Consultant
X Liu, Stryker Orthopaedics
B. A. Lurie, W.L. Gore
R. Marinescu, Smith & Nephew
J. Mast, Hill-Rom, Inc.
L. Mulugeta, Independent
W. A. Olson, Ethicon Endo-surgery
T. L. Rossman, Mayo Clinic
P. Saffari, Endologix
C. Scotti, W.L. Gore
R. Swift, Cook Research Inc.
P. Tomaszewski, Depuy Orthopaedics Inc
T. Zhao, Edwards Lifesciences
A. U. Nair, *Alternate*, BD Technologies
N. R. Rebelo, *Alternate*, SIMULIA Western Region

** Standards Committee representative*

V&V 40 Activities

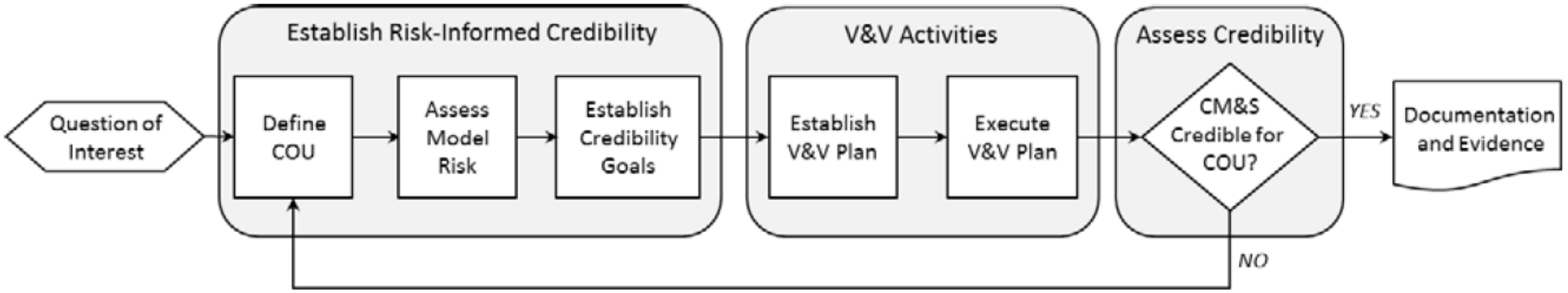
- Current effort focused on completing a standard or guide:
  - Document recently completed 2nd round of sub-committee balloting.
  - Comments were primarily editorial in nature with a few technical issues to be addressed.



this speaker's rendition

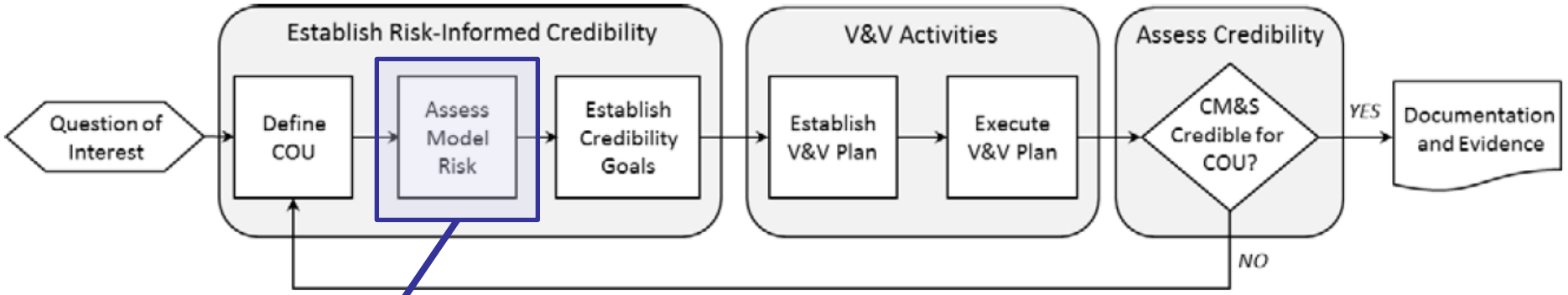
ASME SETTING THE STANDARD

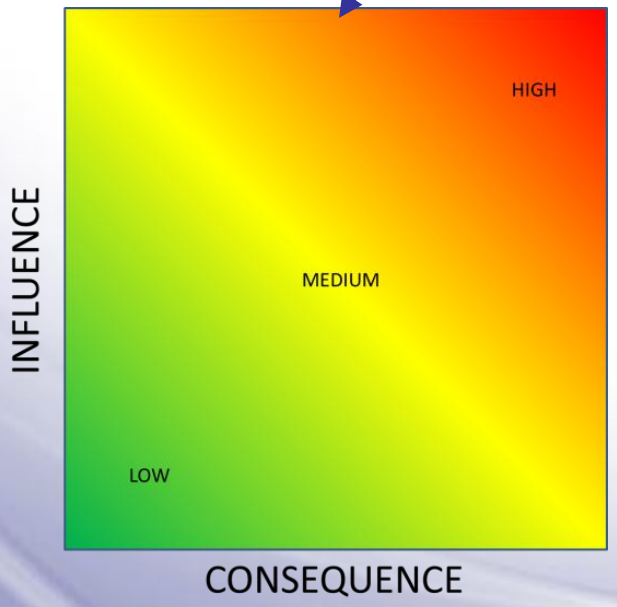
Risk-Informed Credibility Assessment Method



The V&V40 guide outlines a process for making risk-informed determinations as to whether CM&S is credible for decision-making for a specified context of use.

Risk Assessment



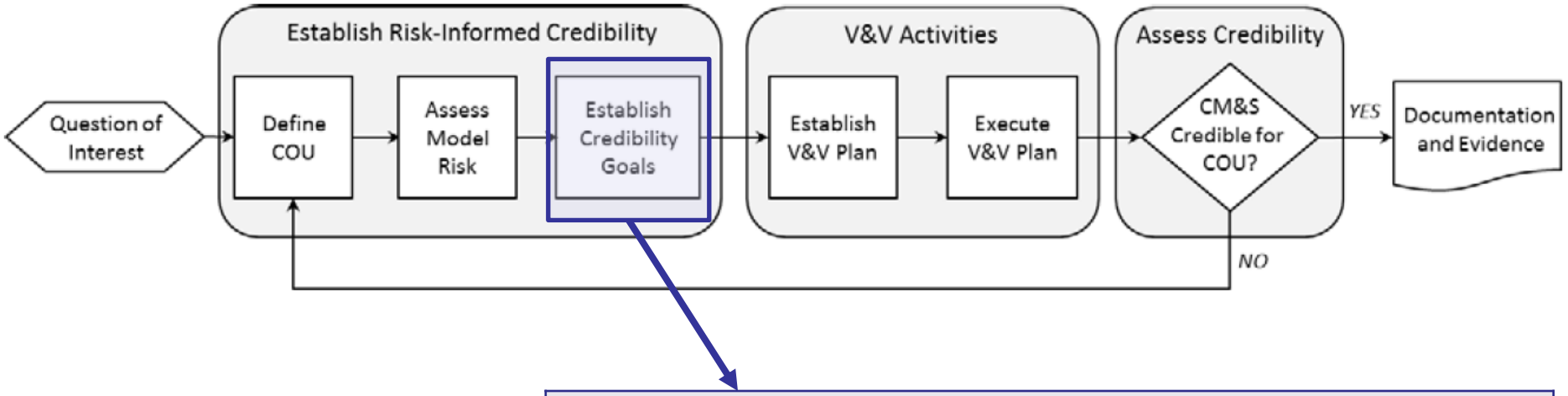


CM&S influence is the contribution of the CM&S to the decision relative to other available evidence.

Decision consequence is the significance of an adverse outcome resulting from an incorrect decision.

ASME SETTING THE STANDARD

Credibility Assessment



Model credibility refers to the trust in the predictive capability of the computational model for the COU.

Trust can be established through the collection of V&V evidence and by demonstrating the applicability of the V&V activities to support the use of the CM for the COU.

Credibility Factors															
Verification					Validation									Applicability	
Code		Solution			Model				Comparator			Output Assessment			
Software Quality Assurance	Numerical Algorithm Verification	Discretization Error	Use Error	Numerical Solver Error	System Configuration	System Properties	Boundary Conditions	Governing Equations	Sample Characterization	Control Over Test Conditions	Measurement Uncertainty	Equivalency of input and output types	Rigor of Output Comparison	Relevance of the Quantities of Interest	Applicability to the Context of Use

Examples

Example 2: Context of Use

Medical device: a new posterior stabilized total knee arthroplasty assembly

Context of Use: Finite element analysis (FEA) will be used to determine if the locking mechanism has sufficient strength to prevent lift-off of the new device. Specifically, the model predicts the QOI of liftoff of the tibial component under a variety of loads. The tibial component liftoff is evaluated exclusively using the computational model. All device configurations will be simulated. No predicate device exists to compare with the computed results. No benc particular device. However, these FEA techniques have beer

Example 3: Model risk

Medical device: centrifugal blood pump for circulatory support

Context of Use: Use computational fluid dynamics identify the key pump features whose dimensional variation could potentially lead to increased hemolysis; those features will be directly assessed with testing. Results will be compared against a predicate device.

CM&S influence: based on the classification scheme below, the model influence is medium because testing will be used to confirm some of the results.

rect decision to alter the key pump feature's dimensional tolerances obin levels during clinical use if hemolysis occurs. Patient injury te intervention of the clinician to monitor patient hemoglobin levels fore, the decision consequence is HIGH.

ledium-High. This result is directly used to determine the validation Output Comparison," see Example 4.

	Consequence		
	Low	Medium	High
Low	1	2	3
Medium	2	3	4
High	3	4	5

Example 4: Rigor of Output Comparison

Medical device: centrifugal blood pump for circulatory support

From Example 3, model risk was determined to be Medium-High. This result is directly used to determine the validation assessment criteria for "Rigor of Output Comparison":

Within the scheme presented, the assessment levels for CM&S validation are as follows:

1. Visual comparison concludes good agreement.
2. Comparison by simply measuring the differences between computational results and experimental data. Differences are less than 20%.
3. Comparison by simply measuring the differences between computational results and experimental data. Differences are less than 10%.
4. Comparison with uncertainty captured and incorporated from the comparator or computational model. Differences are less than 5%, including consideration of some uncertainty, but statistical distributions for further uncertainty quantification are unknown.
5. Comparison with uncertainties captured and incorporated from both the comparator and the computational model, including comparison error. Differences are less than 5%, and statistical distributions are known for rigorous treatment of uncertainty.

Based on a Medium-High model risk for the blood pump, the validation activities should Level 4, demonstrating model accuracy to within 5 with uncertainty captured.

Comparison Summary

	CPMS	V&V40
Mission Statement	To establish credible practice guidelines, consistent terminology and proposed model certification process, as well as to demonstrate workflows and identify new areas of research for reliable development and application of M&S in healthcare practice and research.	Provide procedures to standardize verification and validation for computational modeling of medical devices.
Primary stakeholders	Computational M&S in healthcare as a whole – mainly driven by research initiatives under the IMAG Multi-scale Modeling Consortium	Biomedical device industry, industry service providers, and regulatory and standards bodies such as the US Food and Drug Administration (FDA) and ASME
End-product(s)	I. "Guidelines for Credible Practice of M&S in Healthcare" II. Proposed model certification process III. Identify new areas of research to advance I & II	I. A standard (or guide) for, "Assessing Credibility of Computational Modeling & Simulation Through Verification & Validation: Application to Medical Devices" II. Series of examples that demonstrate application of one or more components of the standard
Approach to developing end-product(s)	• Executive Committee (EC) executes mission • Advisory Council provides guidance to the EC • Extensive use of crowd-sourcing of the healthcare and M&S community through surveys, wiki contributions and forum discussions	• V&V40 sub-committee establishes standard direction through consensus • Sub-groups, working groups, and task groups execute tasks related to governing scientific methods, devices, and content writing.
General credibility workflow	Apply the Ten Simple Rules of Credible Practice with appropriate intensity for given context of use (iterative).	Define Context of Use → Assess Model Risk → Establish Credibility Goals → Establish & Execute V&V Plan (iterative) → Assess Credibility → Document

QUESTIONS?

https://cstools.asme.org/csconnect/CommitteePages.cfm?Committee=100108782

DEFINITIONS

Credible Practice of Modeling & Simulation in Healthcare

dependable *with a* ***desired certainty level*** *to guide research or support decision making within a prescribed application domain and intended use; establishing* ***reproducibility*** *&* ***accountability***

DEFINITIONS

Credible **Practice** of Modeling & Simulation in Healthcare

*any activity involving **development**, **solution**, **interpretation** and **application** of computational representation of biological, environmental and man-made systems and their interaction thereof*

DEFINITIONS

Credible Practice of **Modeling** & Simulation in Healthcare

specifically ***computational modeling****;* ***virtual representation*** *of system(s) of interest in a usable form in order to provide* ***descriptive*** *and* ***predictive*** *metrics for timely and systematic exploration of the system(s)*

Definition of Simulation

Credible Practice of Modeling & **Simulation** in Healthcare

computational solution of models *to quantify descriptive and predictive metrics of system(s) of interest; including related post-processing efforts to calculate these metrics from raw analysis results*

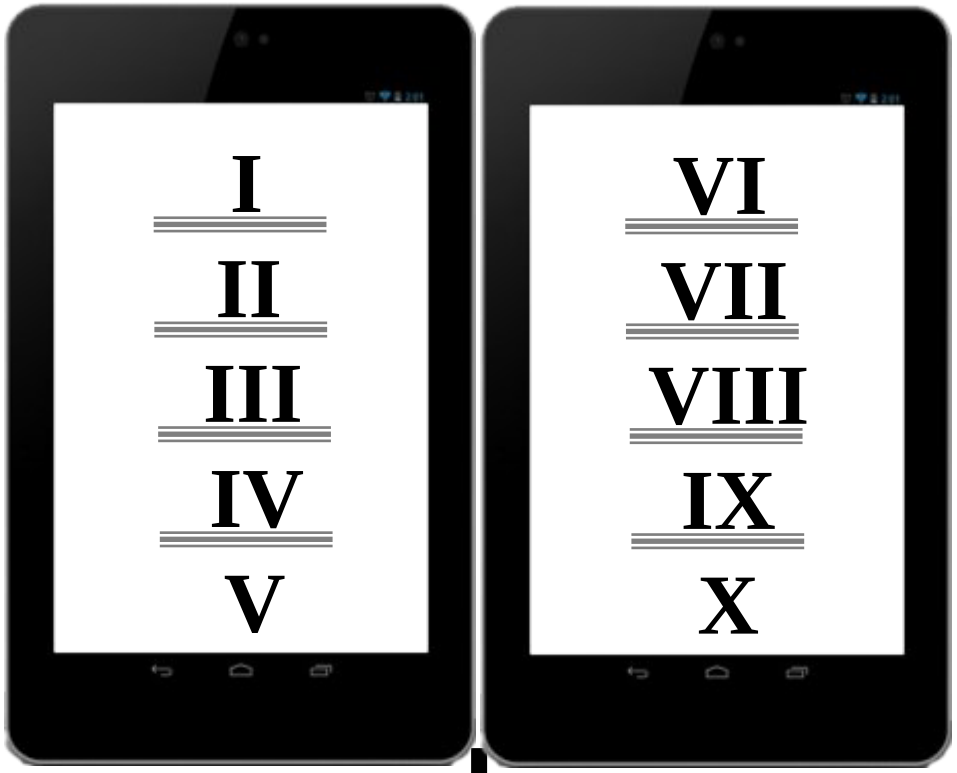
DEFINITIONS

Credible Practice of Modeling & Simulation in **Healthcare**

*any activity involving **development**, **maintenance**, **advancement**, or **administration** of **medical care**; including research, diagnosis, risk assessment, prevention, therapy, rehabilitation, surgery, intervention design, and regulation*

UPCOMING: TEN SIMPLE RULES, GUIDELINES & CERT.

COMMUNITY GENERATED TEN SIMPLE RULES



"GUIDELINES FOR CREDIBLE PRACTICE OF M&S IN HEALTHCARE"

PROPOSED MODEL CERTIFICATION PROCESS

GOAL: A COMMON LANGUAGE ACROSS DISCIPLINES

Goal Oriented Activity: A glossary of terms is being generated on the Committee's to help unify the use of M&S vocabulary across a variety of disciplines and stakeholders in the field

We strongly encourages all stakeholders (e.g. SSH community) to help establish these terms and definitions by visiting: http://wiki.simtk.org/cpms/Glossary_and_Definitions

Example

Simtk Wiki - cpms Glossary and Definitions/ credibility

Overview
Team
Downloads
Documents
Wiki
Publications
News
Public Forums
Advanced

Downloads & Source Code

This project has no public downloads, but makes source code available.

FrontPage | RecentChanges | FindPage | HelpContents | credibility

Immutable Page Info Attachments More Actions:

Credibility

Dictionary Definition

Needs contribution

Committee Definition

Needs contribution

Domain Specific Usage

Engineering and Biomedical (NASA): The quality to elicit belief or trust in M&S results. [1]

Notes

1 from NASA STANDARD FOR MODELS AND SIMULATIONS – https://standards.nasa.gov/documents/detail/3315599.

CPMS

GOAL: ADOPTION OF GUIDELINES BY STAKEHOLDERS

Goal Oriented Activity: Active engagement of the global stakeholder community to ensure that the guidelines established capture the primary interests of the computational medicine community, and are widely adopted

Open discussions and contribution to activities:

- Wiki pages
- Discussion forum
- Meeting minutes
- Subversion repository access of all presentations, abstracts and posters

URL: https://simtk.org/home/cpms