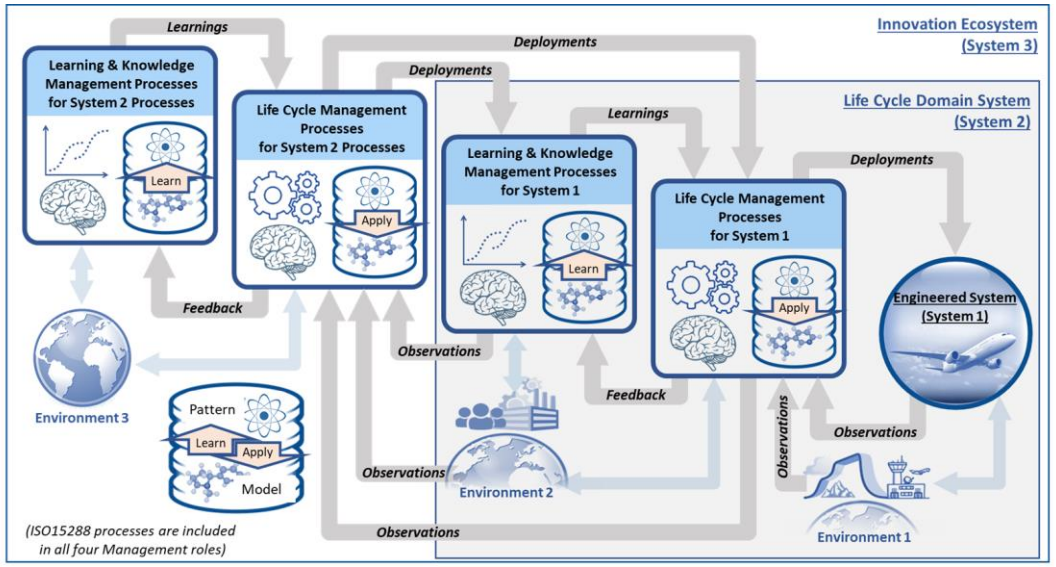
W R Hamilton
(1805-1865 Dublin)

2024
Annual INCOSE
international workshop
HYBRID EVENT
Torrance, CA, USA
January 27 - 30, 2024



Innovation Ecosystem: ASELCM Pattern
(Level 1)

INCOSE Fellows Update: Patterns Working Group

Managed Consistencies, Confirmation Frameworks, and the ASELCM Hamiltonian

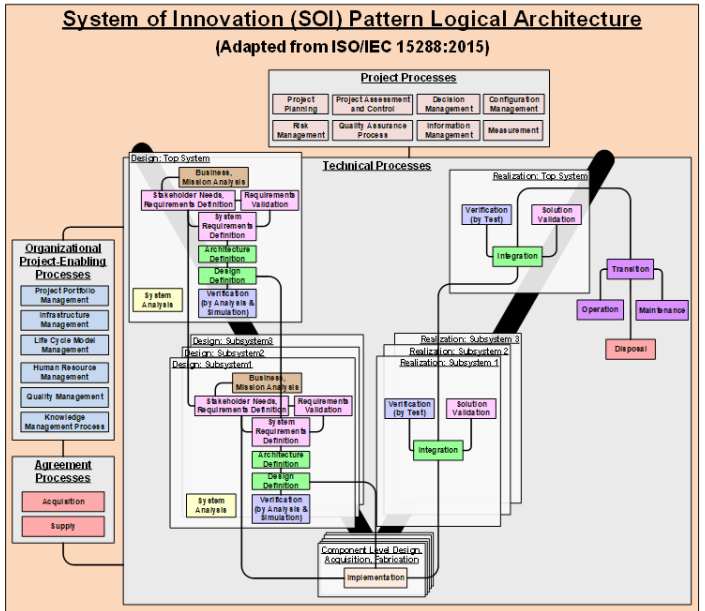
Contents

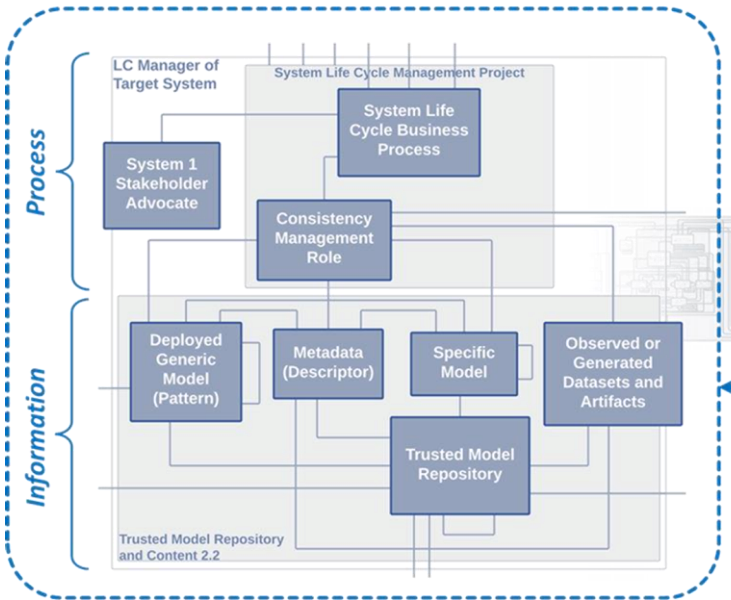
- ASELCM Pattern[1]: Managed consistencies paradigm for innovation ecosystems.
- Related collaboration project: Confirmation frameworks across four technical societies.
- Related SE Foundations project: ASELCM application of Hamiltonians for IT and socio-technical systems.

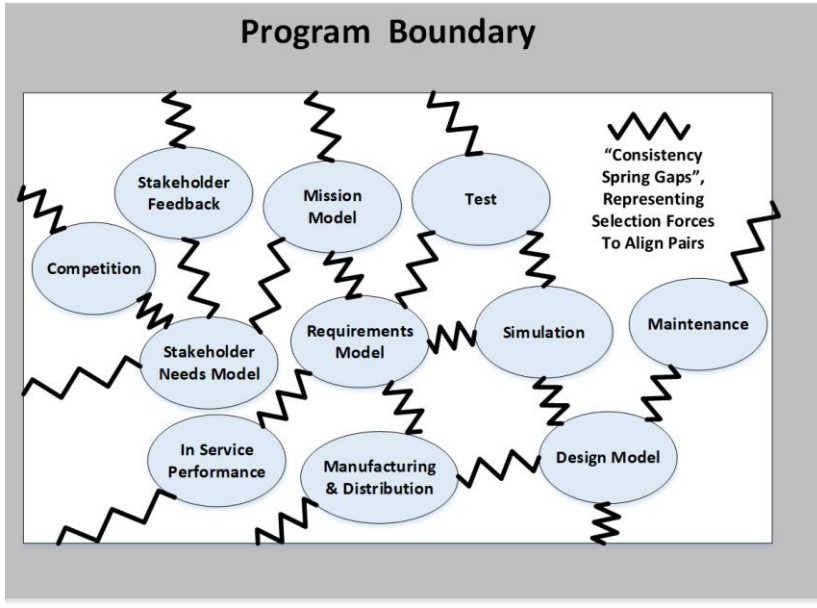
(1) Agile Systems Engineering Life Cycle Management Pattern; aka Innovation Ecosystem Pattern

Consistency gap management paradigm for innovation ecosystems

- The consistency management paradigm is the central information thread running through the ASELCM reference pattern's representation of any engineering/life cycle management / supply chain system's primary activities. [Refs 1-3]
- Including the digital thread and its many precursors. [Ref 4]







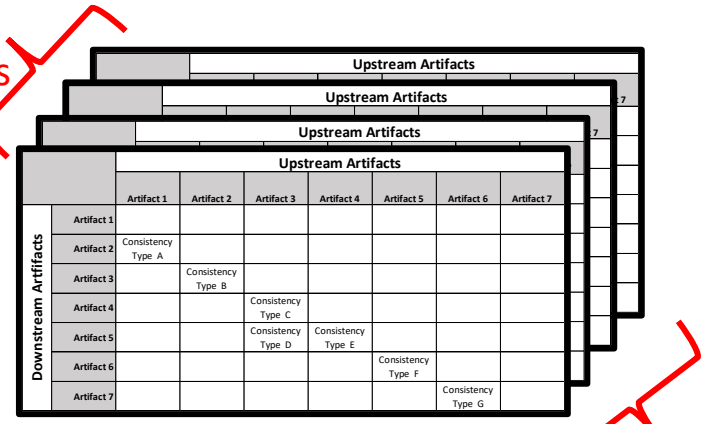
Related collaboration project across four technical societies

- Different discipline communities (e.g., ISO 15288 SE *versus* ASME VVUQ-1 computational modeling communities) have different consistency confirmation frameworks, nomenclatures, standards. [Refs 5-6]
- This can be a challenge when performed "together" for trust-critical integrated systems.
- Working groups of INCOSE, ASME, AIAA, and NAFEMS are collaborating on a comparative "Rosetta Stone" mapping of different consistency confirmation frameworks of different communities. [Ref 7]:

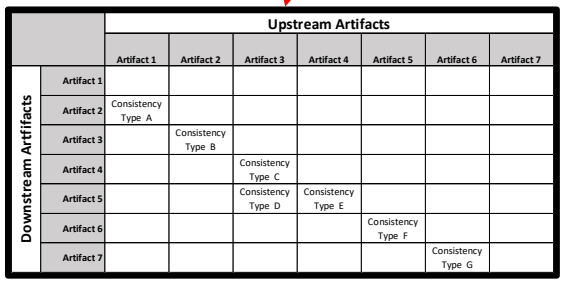
		Upstream Artifacts						
		Artifact 1	Artifact 2	Artifact 3	Artifact 4	Artifact 5	Artifact 6	Artifact 7
Downstream Artifacts	Artifact 1							
	Artifact 2	Consistency Type A						
	Artifact 3		Consistency Type B					
	Artifact 4			Consistency Type C				
	Artifact 5			Consistency Type D	Consistency Type E			
	Artifact 6					Consistency Type F		
	Artifact 7						Consistency Type G	

For one discipline

Multiple disciplines



Merge



Merged multiple discipline mapping

Related collaboration project across four technical societies

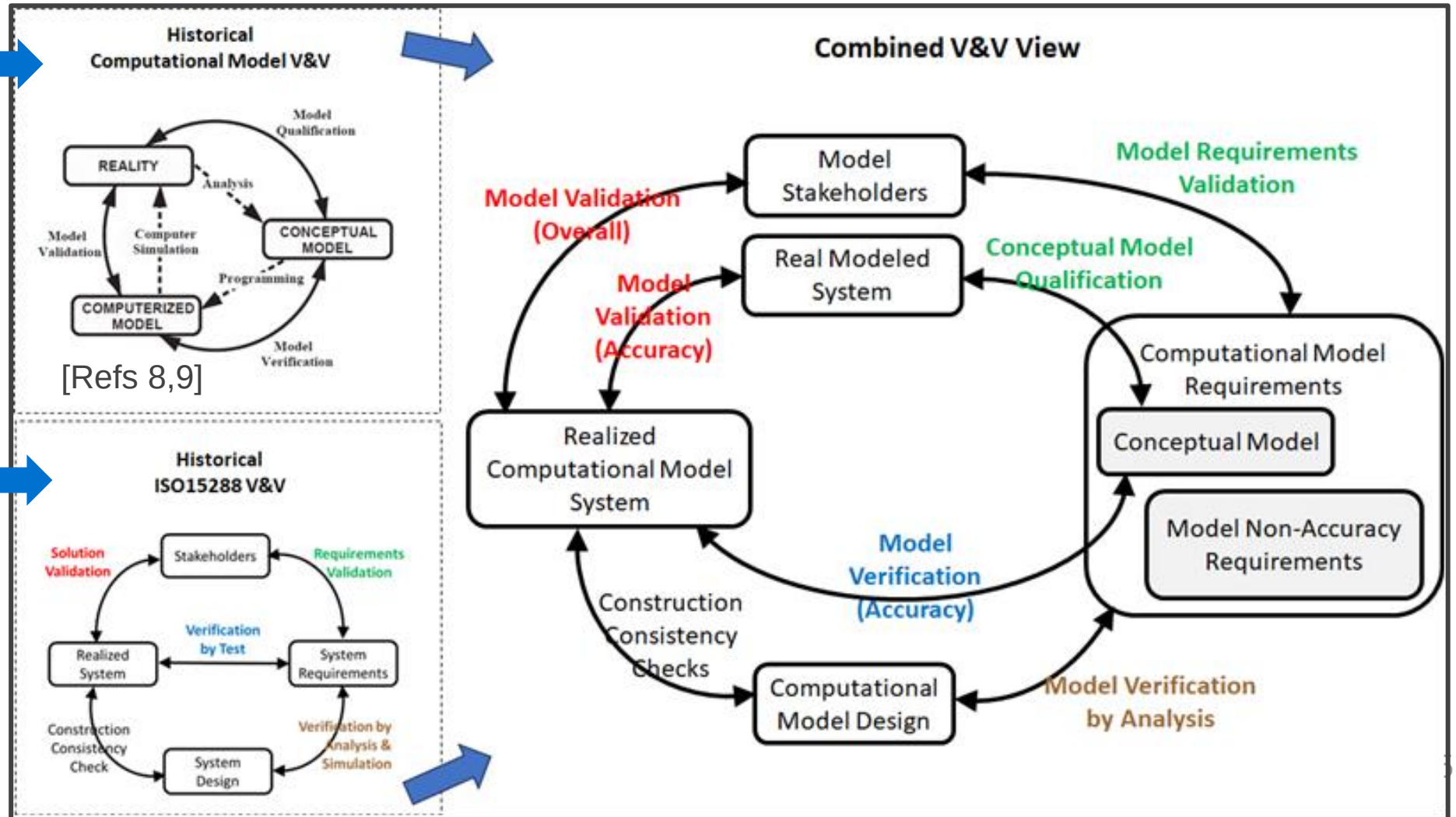
Simple example: Computational model community VVUQ-1 consistency confirmation nomenclature versus ISO 15288 systems engineering consistency confirmation nomenclature:

ASME VVUQ-1 (2022)

[Ref 5]

ISO - 15288 (2023)

[Ref 6]



Related application of Hamiltonians for IT and socio-technical systems

- Adopting W R Hamilton's "characteristic function" perspective enriches interpretation of the nature of momentum and energy, in additional settings:
  - By reasoning in the right order, Hamiltonians can be defined for IT (i.e., digital) and socio-technical systems.
  - *Managed consistency gaps provide the potential energy part of the ASELCM System 2 Hamiltonian*.
- Dublin was Hamilton's home, where we'll expand on the following this summer during IS2024. [Ref 10]

An alternate order for introducing and interpreting Hamiltonian and Hamilton's equations of motion

- Traditional Sequence (based on recognized energies of familiar types):
  - Start from an accepted Lagrangian for a familiar system class, energies (e.g., mechanical).
  - Perform Legendre transformation to obtain Hamiltonian (H). [Ref 11]
  - H satisfies Hamilton's equations of motion, including generalized momentum, conservation of energy, etc., and is directly integrable via symplectic integrators.
- Alternate Sequence (based on observation of state trajectories):
  - Start with any deterministic[2] system and its state variables (state 'positions', velocities).
  - Observe the state trajectories of the system over time.
  - Generate a "characteristic function" H *from the observed state trajectories*[3].
  - This H likewise satisfies Hamilton's equations of motion, defines a generalized momentum, and is integrable via symplectic integrators.
  - Provides a broader interpretation of P.E. and K.E. beyond more familiar mechanical and other "traditional" systems—energy as a "characteristic function" in spirit of Hamilton.

(2) Also formulated for probabilistic and discrete systems. (3) One interesting method: Machine learning [Refs 12-13].

Discussion

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