"Training" for Models: The Role of Knowledge Management in Applying Modeling and Simulation (M&S) to Systems Engineering

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Challenge

- Large scale system engineering (SE) efforts are characterized by complex combinations and interdependencies of technologies, operations, tactics, and procedures that change and evolve over the system's lifecycle and application
- M&S based SE evaluation presents challenges in:
  - Currency and consistency with emerging and evolving doctrine and system application and relevant instances
  - Exploration and analysis of multidimensional trade spaces
  - Prediction of performance across a multitude of design and technology options
  - Performance characterized by several measures of effectiveness (MOEs)
  - Improving and optimizing mission effectiveness across wide parameter spaces
- It really comes down to integrating the current domain and SE process

The Role of M&S in SE

Key Questions		Application of M&S
■ What needs are we trying to fill? ■ What is wrong with the current situation? ■ Is the need clearly articulated?	Need	■ What is it supposed to do? ■ Is this the right requirement?
■ Who are the intended users? ■ How will they use our products? ■ How is this different from the present?	Operations Concept	■ How does it do it? ■ Who does it impact?
■ What specific capability will we provide? ■ To what level of detail? ■ Are element interfaces well defined?	Functional Requirements	■ What does it really do? ■ How does it interact with other things?
■ What is the overall plan of attack? ■ What elements make up the overall approach? ■ Are these complete, logical, and consistent?	System Architecture	■ How do the pieces talk to each other? ■ How does it meet the requirements?
■ Which elements address which requirements? ■ Is the allocation appropriate? ■ Are there any unnecessary requirements?	Allocated Requirements	■ Can the system meet the functional and performance requirements?
■ Are the details correct? ■ Do they meet the requirements? ■ Are the interfaces satisfied?	Detailed Design	■ Can the system meet the requirements without violating the laws of physics and capitalism? ■ What are the tradeoffs I have to make?
■ Will the solution be satisfactory in terms of cost and schedule? ■ Can we reuse existing pieces?	Implementation	■ Can I live with the tradeoffs?
■ What is our evidence of success? ■ Will the customer be happy? ■ Will the users' needs be met?	Test & Verification	■ Does it work? ■ Does it work the way I want it to? ■ How can I test it best?
■ What needs to be done next? ■ How can I upgrade it?	Deploy and Maintain	■ What do I break when I upgrade a part? ■ Does an upgrade matter?

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Knowledge Management

Domain Experts

Knowledge Acquisition

Validation

Knowledge Modeling

Knowledge Publishing

Application Domain

Application Systems

Knowledge Use & Re-use

Knowledge Engineers

Knowledge Support

Knowledge Maintenance

Domain Users

Application Scenarios & User Requirements

And then what?

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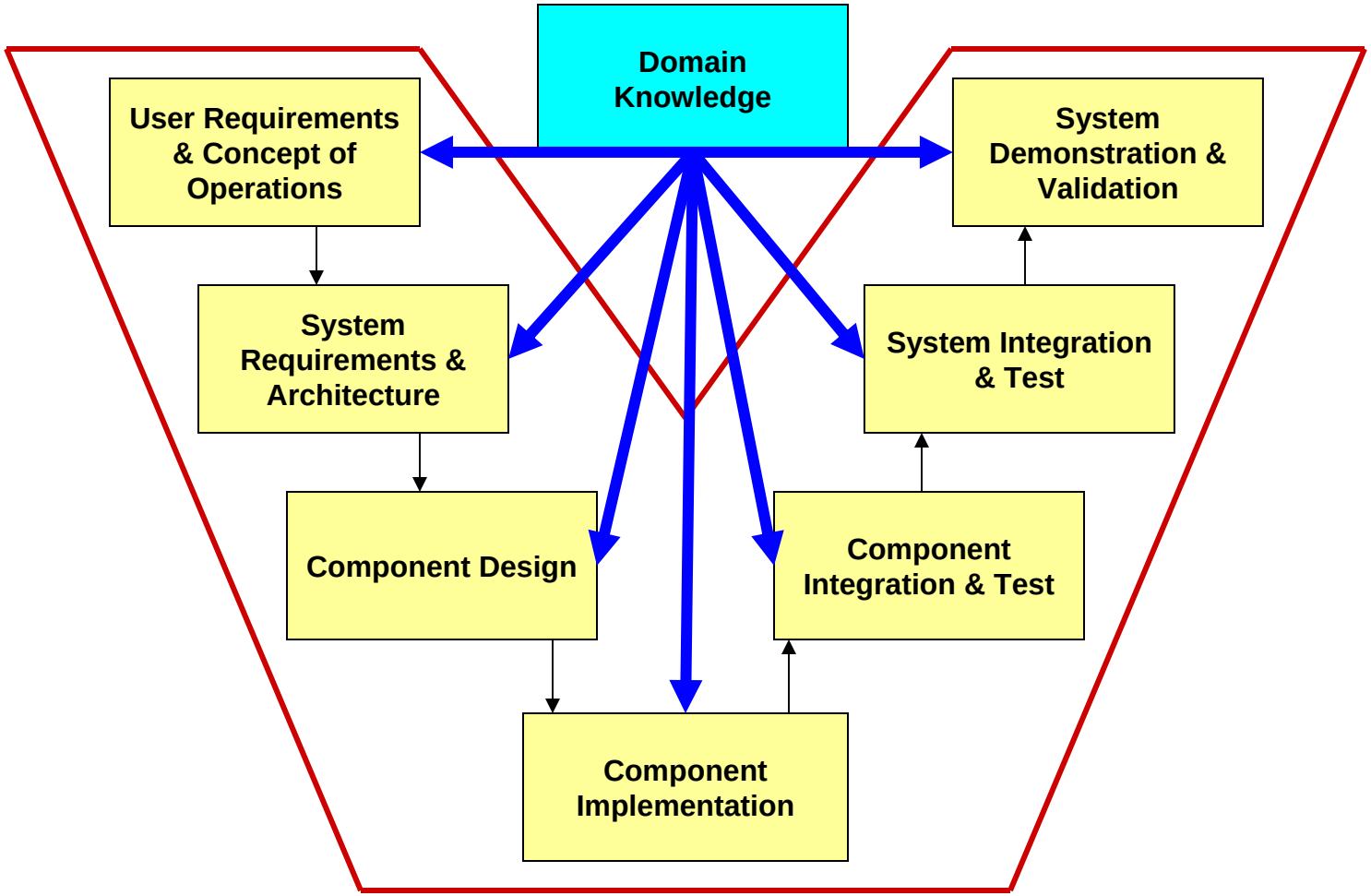
The System Engineering "Vee"



Where is domain knowledge?

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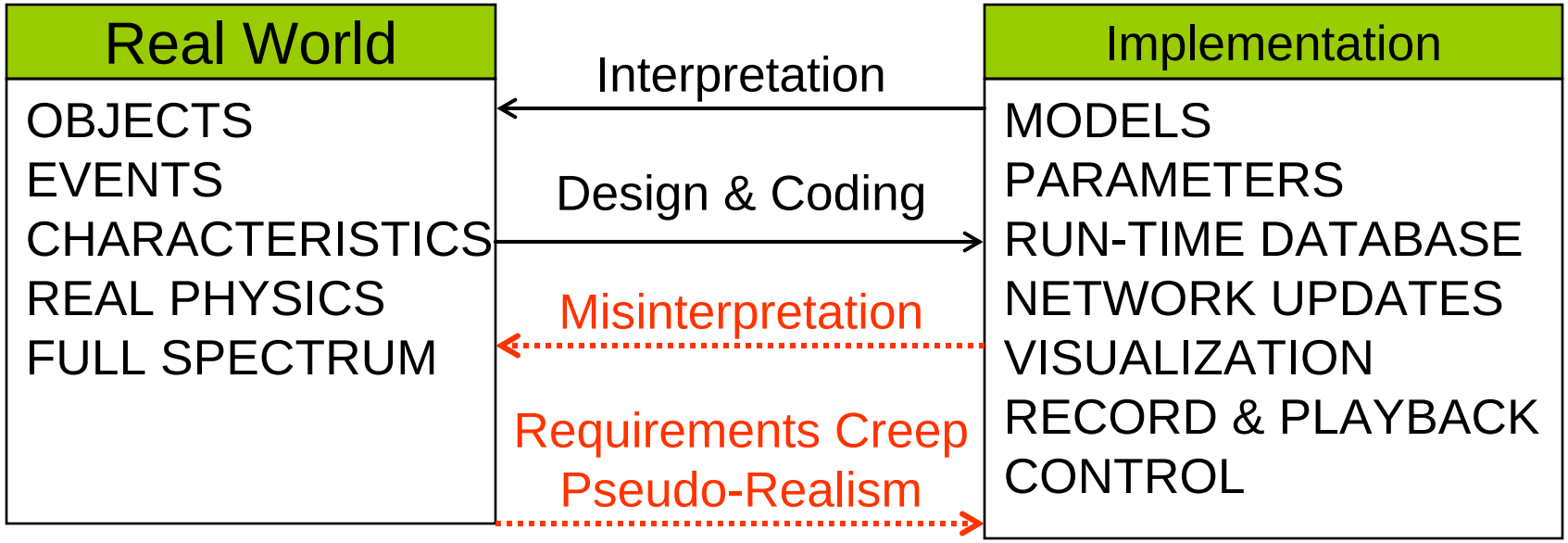
Hmm…

There seems to be a disconnect between the KM and SE processes.



A major challenge is creating computationally amenable descriptions of the infinitely rich world with which the software development team can work.

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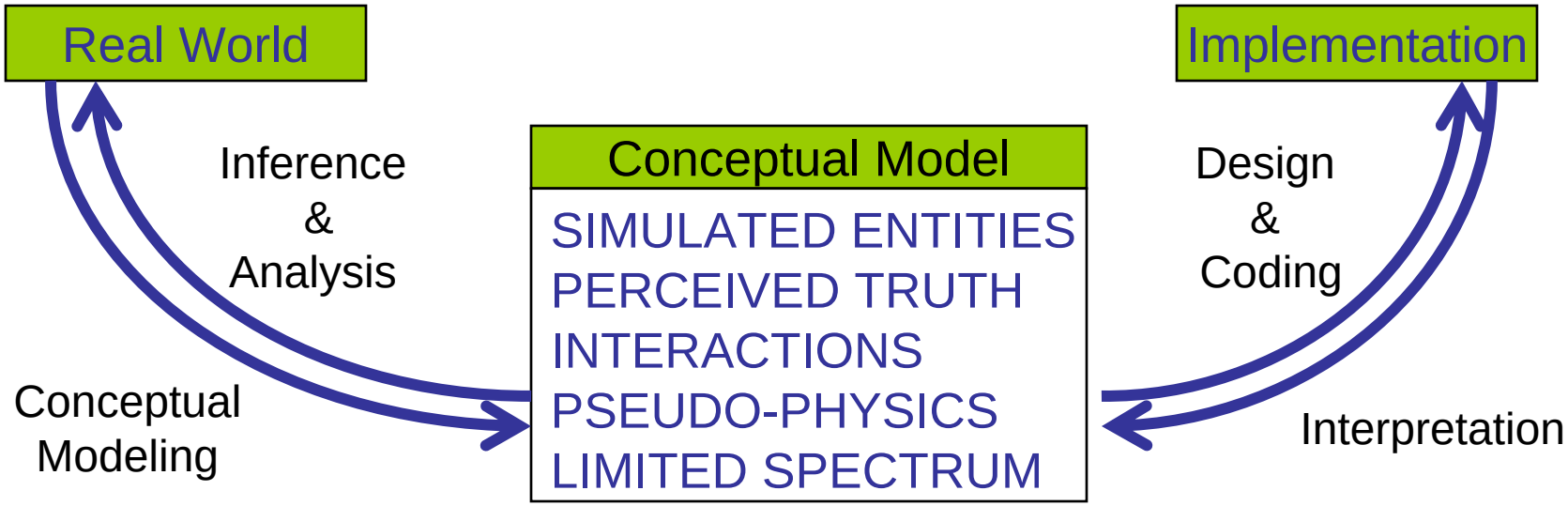
Linkage Using a Conceptual Model



A well-conceived, consistent intermediate model eliminates many problems by providing a representation of the battlespace usable by all participants (customer, domain expert, developer, and user).

But even so, I still have the update problem.

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Knowledge Provisioning™

The knowledge lifecycle includes the production of data, its transformation into information, and the delivery of new knowledge to the consumer.

Data Sources →

Information Objects
- Discrete pieces of information

→

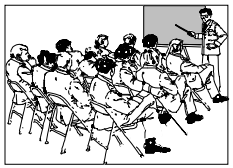
Knowledge Objects
- Conversion of discrete information into knowledge

→

Learning Objects
- Assembly of information/ knowledge into form suitable for training, learning

→

Learning Management System
- Means by which learning objects are delivered for consumption



- **Knowledge Provisioning™ introduces the intermediate concept of "Knowledge Objects"**
- **Knowledge objects enable the certification of information pedigree**
  - **Can track changes in information; provide corrective updates when necessary**
- **Knowledge objects allow the development of a user's "situational awareness vector"**
  - **Identifies who needs new information and enables the delivery of just what's new in a timely and effceint manner**
- **This paradigm offers a solution to the problem of keeping training up-to-date when faced with a highly adaptive enemy**

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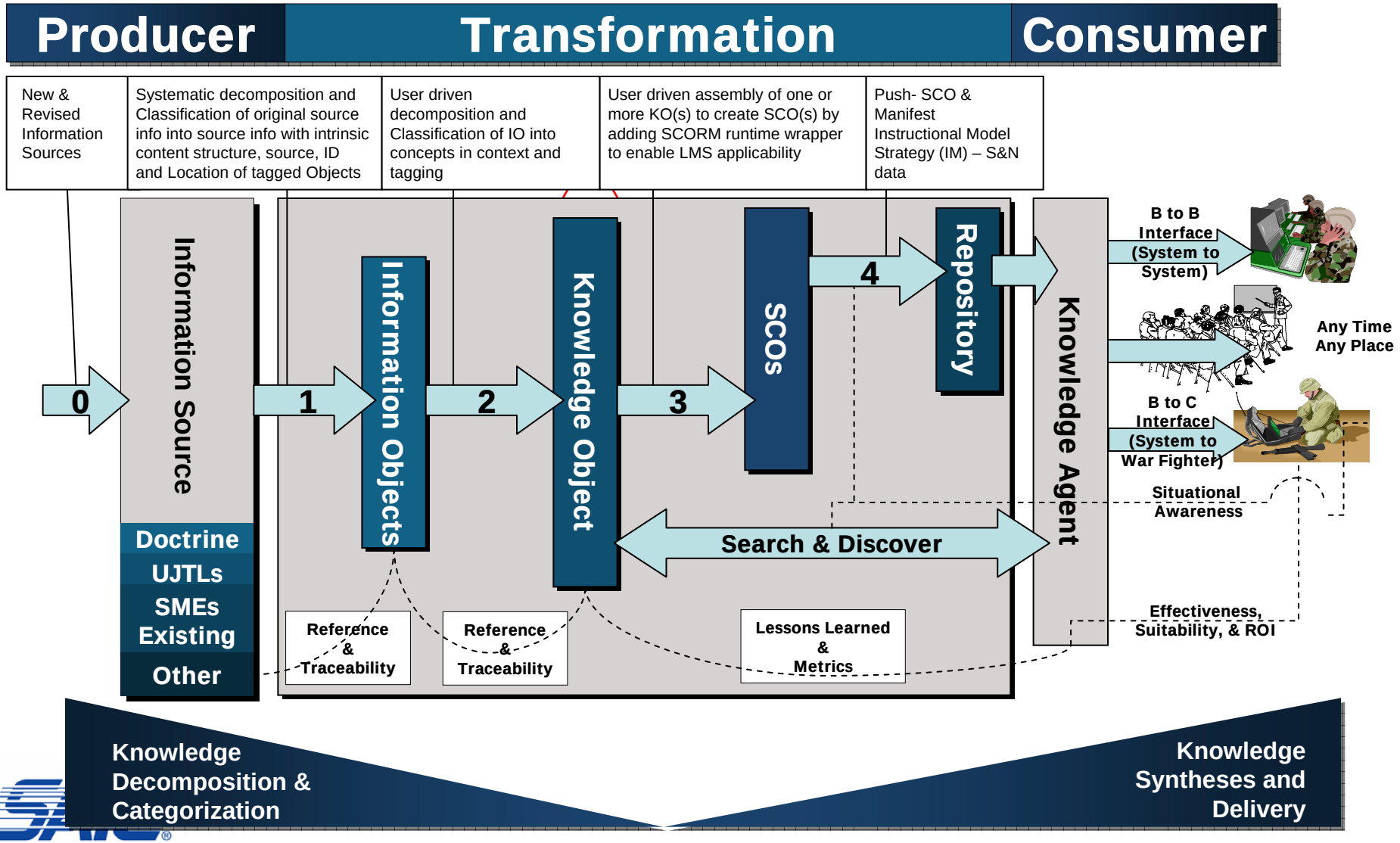
Knowledge Provisioning Process



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Summary

- M&S aids the SE process when it is less trouble than making guesses
- The chasm between KM and SE can be linked by the intermediate conceptual model
- The currency and availability of data can be address by treating the data as components of the product line