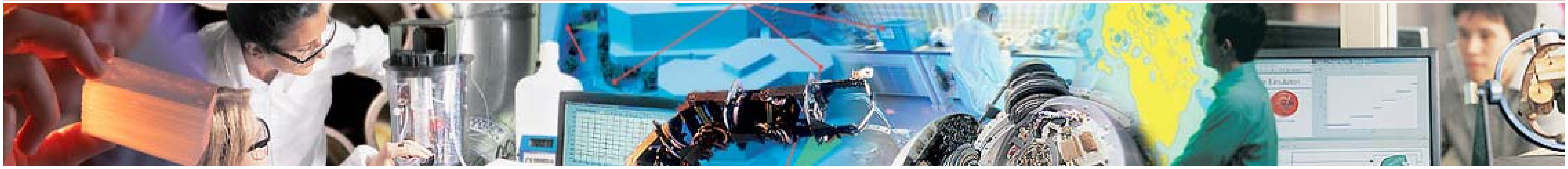


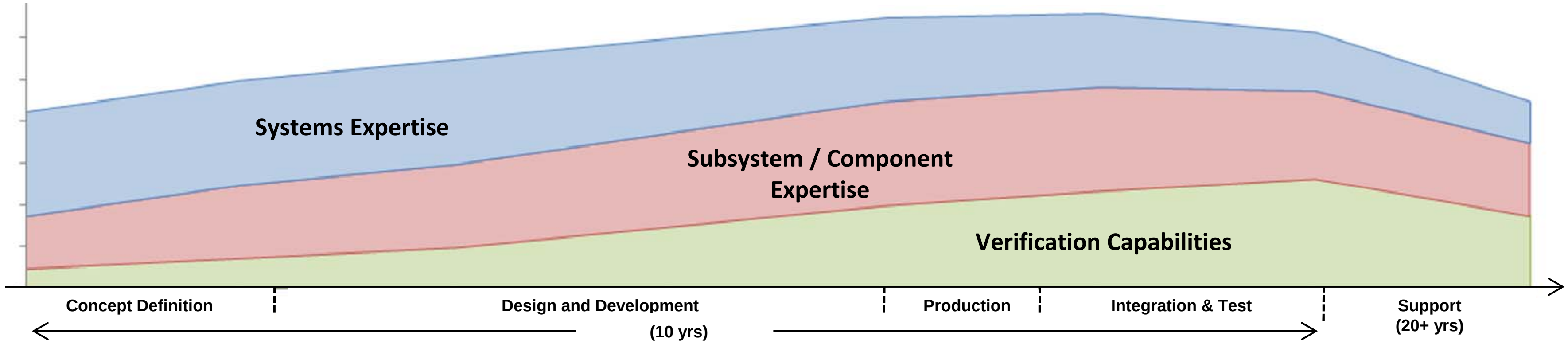
An Innovative Strategy for System Sustainability

NDIA Systems Engineering Conference
30 October 2013
Arlington, VA

Outline

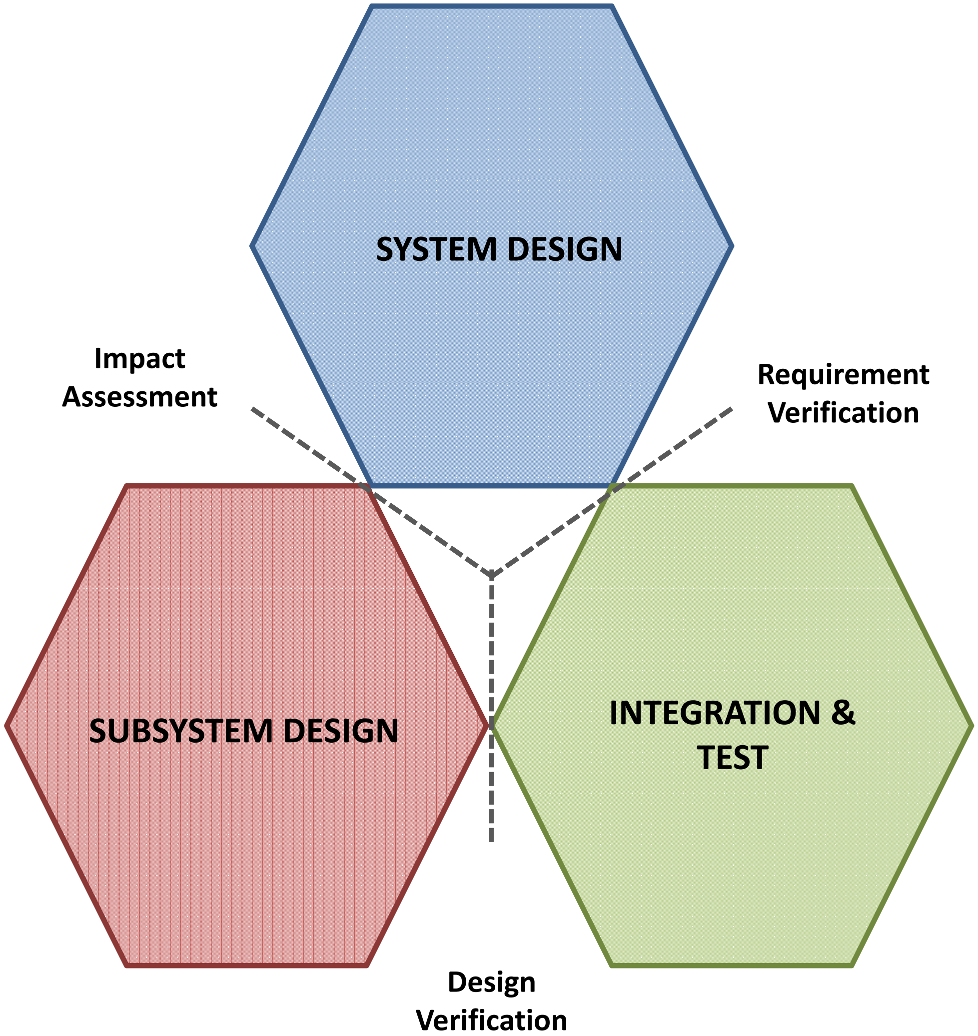
- Problem Statement
- Model-Based Knowledge Capture
- Observed Benefits

Enhanced Retention of System Knowledge Required

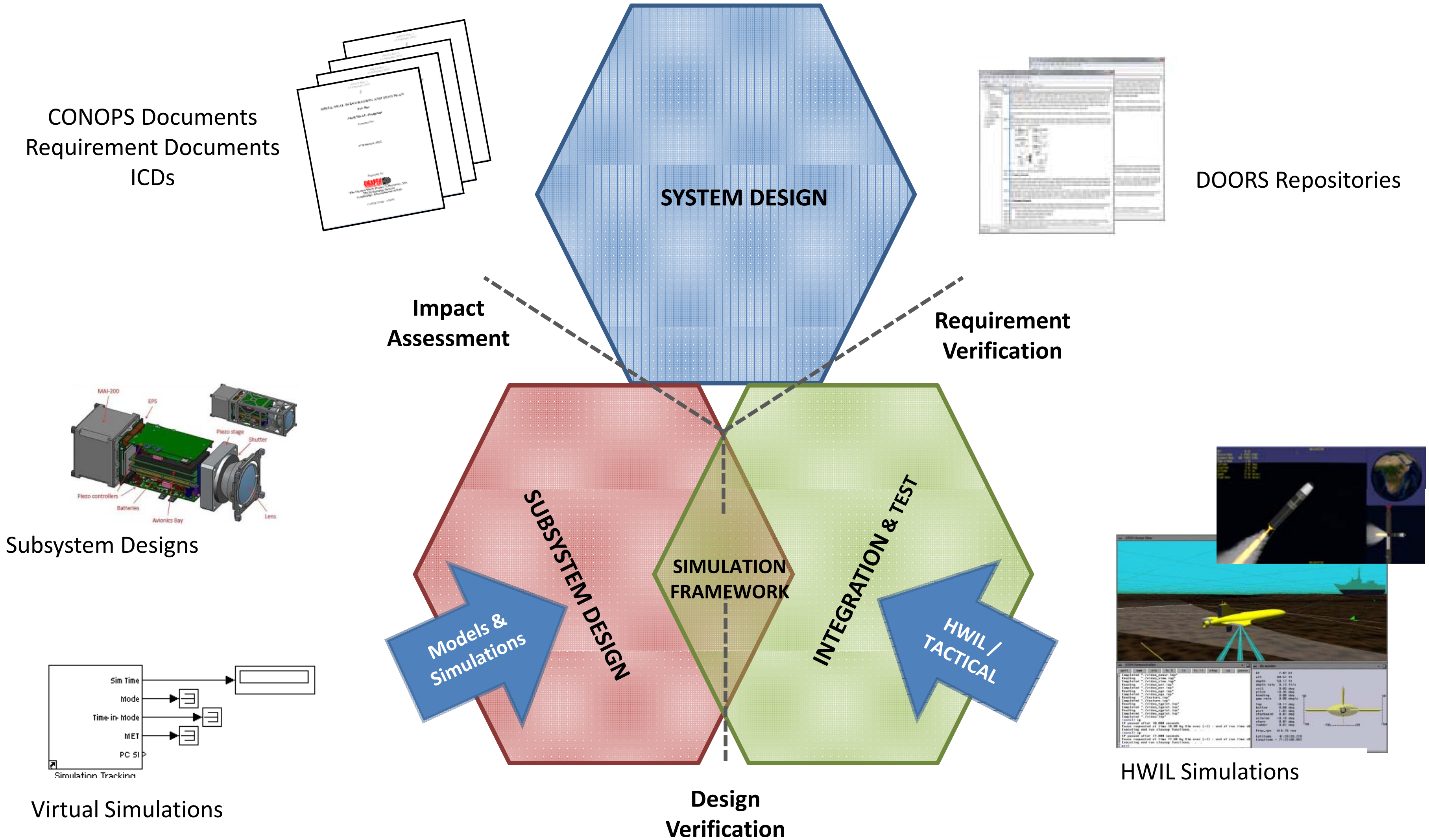


- **Large scale, legacy system sustainment context**
  - Systems experience can diminish in later lifecycle phases
  - Static infrastructure for information and processes
- **Modernization and upgrades often subsystem focused**
  - Subsystem changes yield risk of emergent systems behavior
  - Unable to accomplish systems-level re-optimization
- **System sustainability needs**
  - Prevent erosion of system level knowledge & capability
  - Understand impact of requirement/ design changes
  - Quickly obtain confidence of design's ability to meet requirements

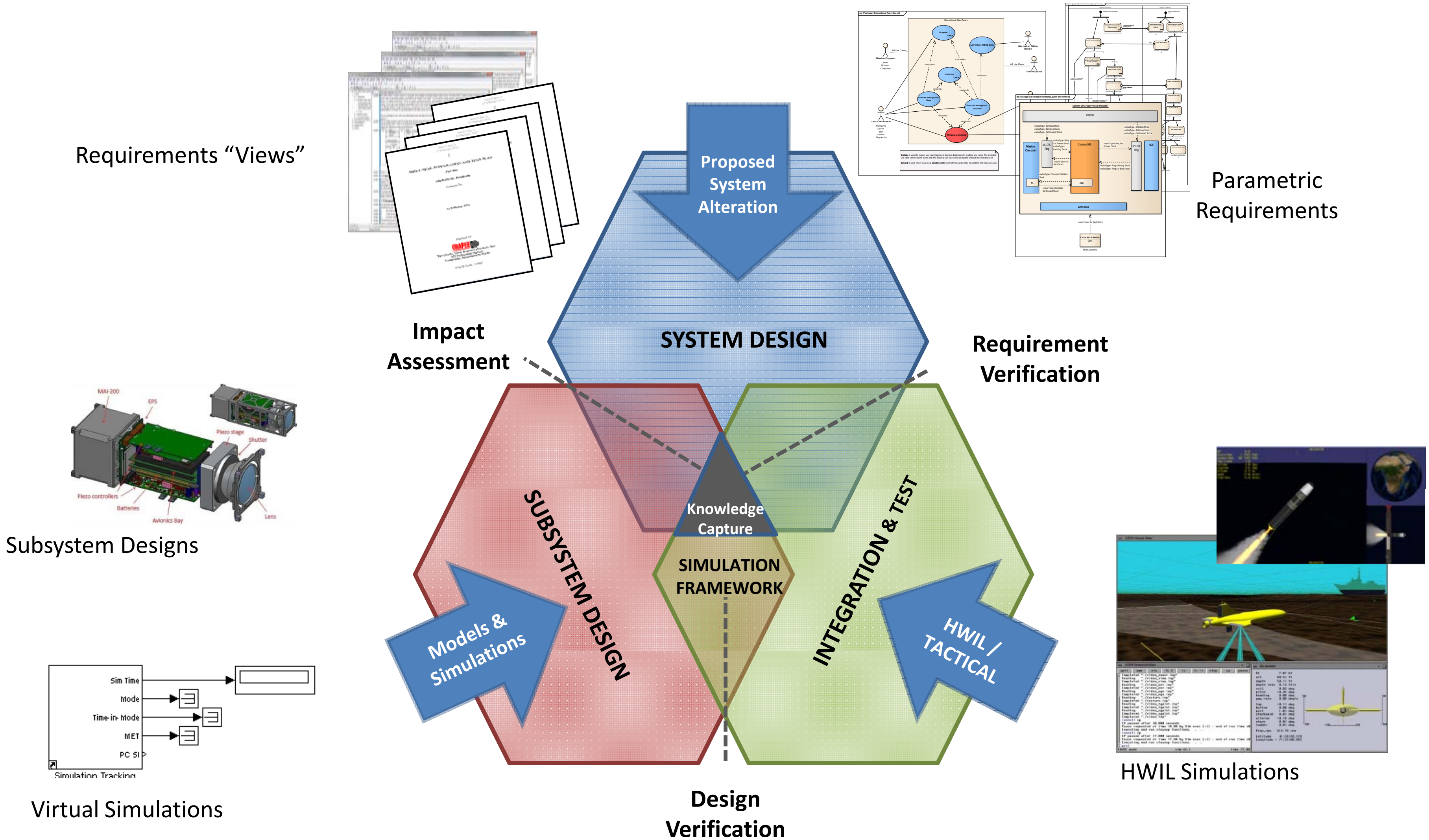
General Product Datatypes



Traditional Data Sharing



Fully Integrated Data Sharing



Traditional Knowledge Capture

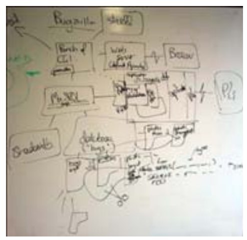
Systems Knowledge

- Federated Documents
  - Manual generation
- Manual traceability of requirements
- Reliance on domain experts to assess impacts

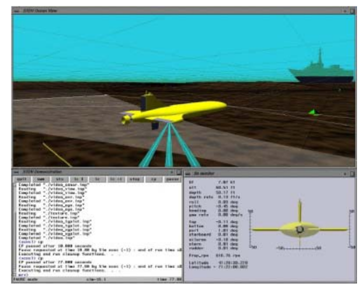
Verification through Simulation

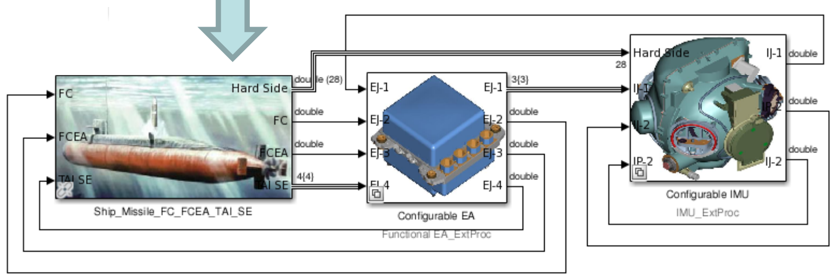
- Now using auto-code generation
- Dynamic parameters setting
- Subsystem requirement verification
  - Often manually performed

System Level Description



Subject Matter Expert Experience





Subsystem Modeling & Simulation

HWIL

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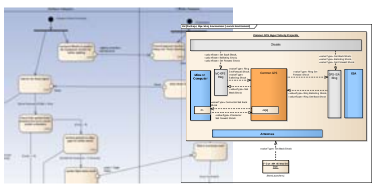
Integrated Knowledge Capture

Systems Knowledge

- Dynamically decompose to subsystem models
- Capture systems requirements, designs, tradeoffs
- Automatic specification generation

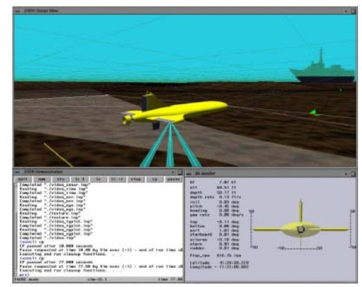
Integration with Simulation

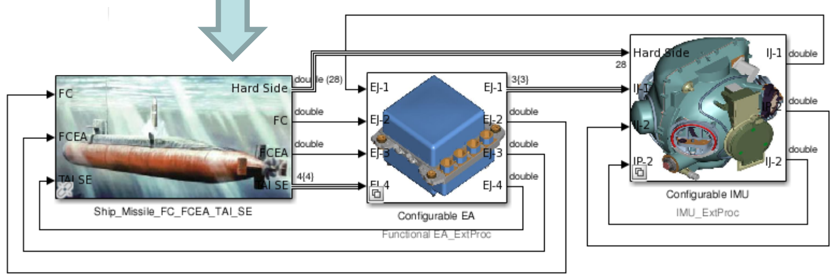
- Shared data
- Automatic requirement verification
- Store results for future reference



System Level Description

View of Descriptions



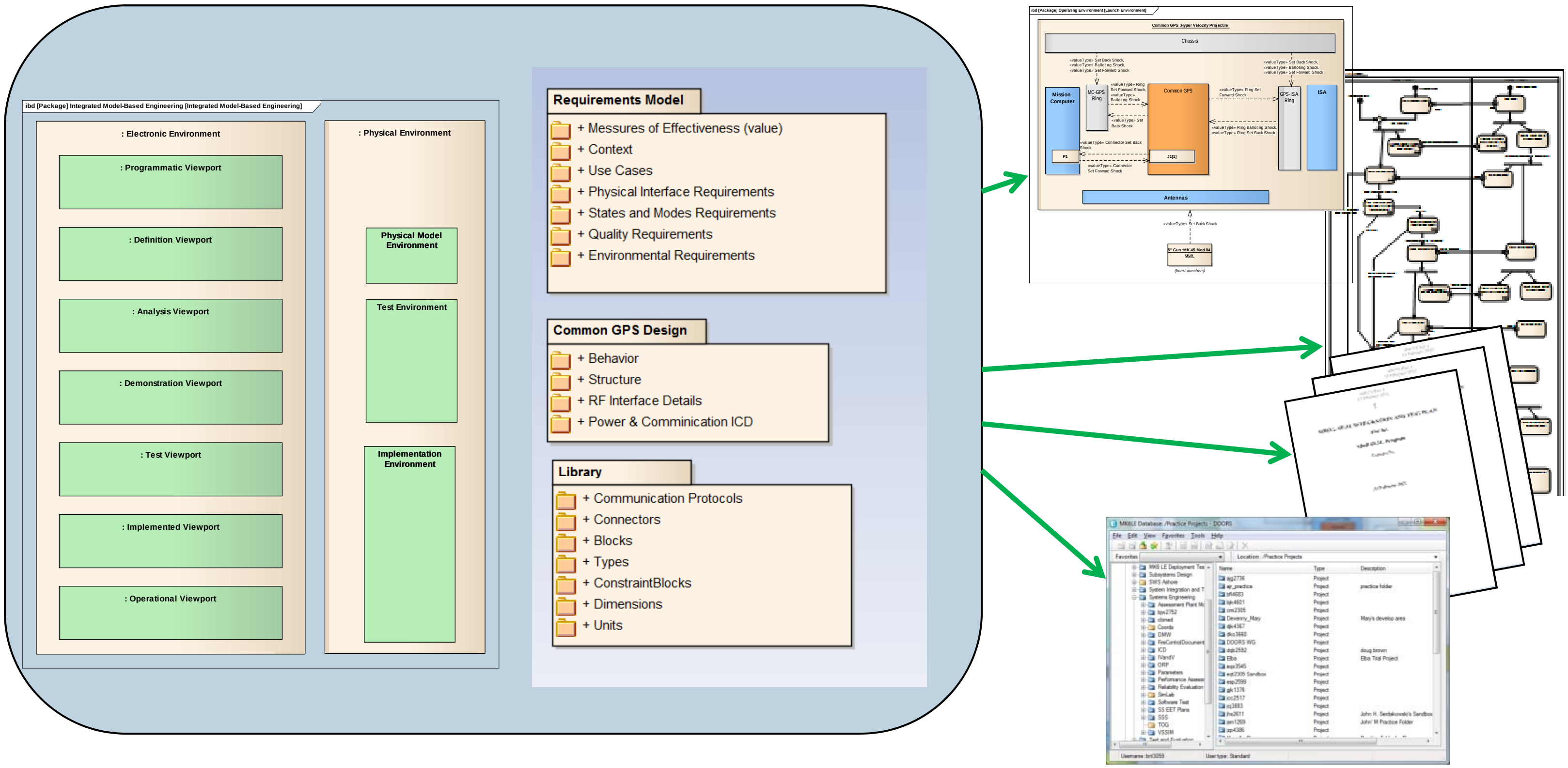


Subsystem Modeling & Simulation

HWIL

Getting the Right Information, Right Away

Common Source of Information → System Decomposition → Artifact Generation → Implement Traceability → Subsystem Simulation → Requirement Verification

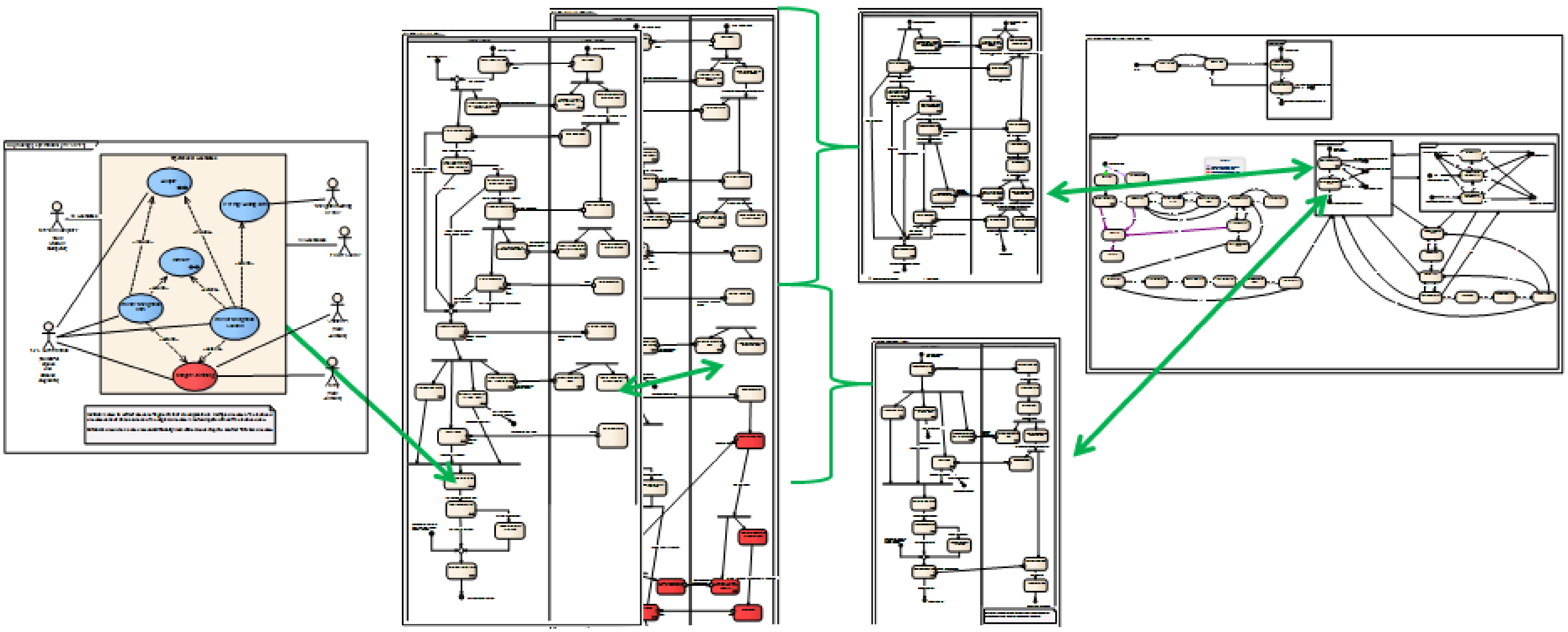


Model provides a central location for access to data where updates are automatically distributed

Insure Consistency through Data Reuse

Capture the Data Once and Reuse as Needed

Common Source of Information → System Decomposition → Artifact Generation → Implement Traceability → Subsystem Simulation → Requirement Verification



Model-based approach enforce consistent relationships - prevent errors and miscommunication

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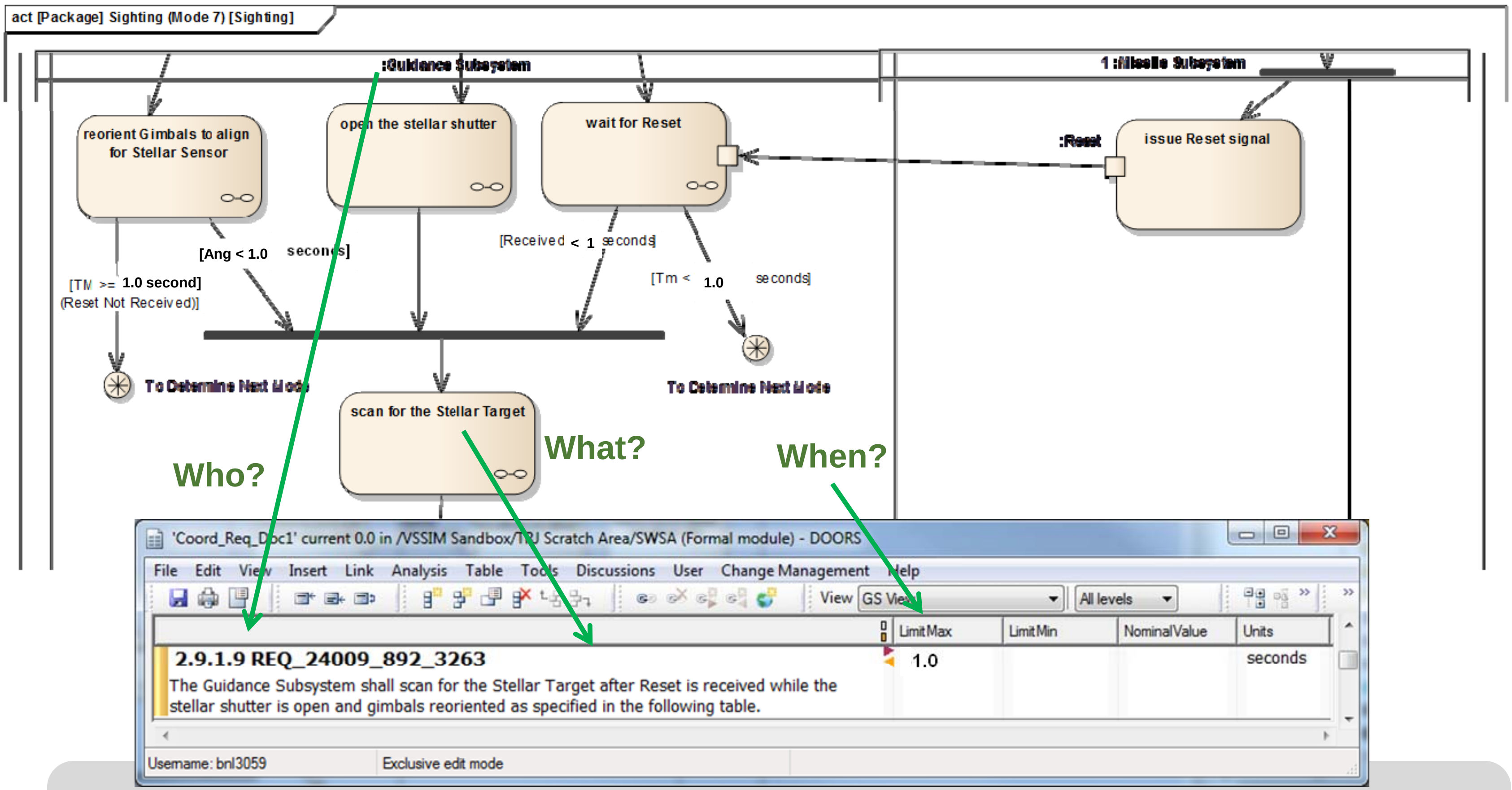
Automatic Requirement Generation

Reducing Manual Translation and Errors

Common Source of Information → System Decomposition → Artifact Generation → Implement Traceability → Subsystem Simulation → Requirement Verification

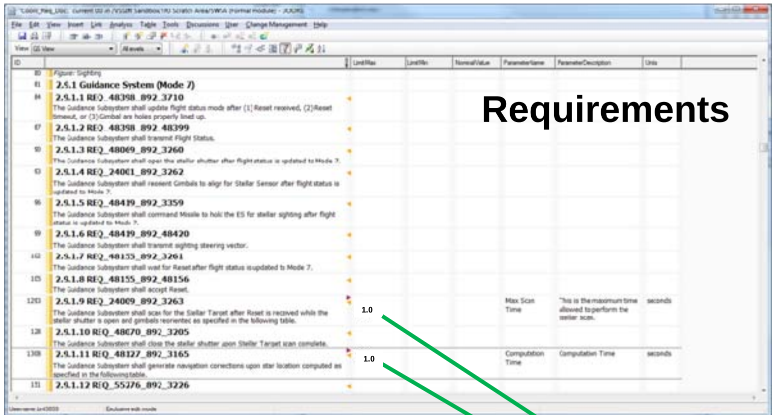


Generating Requirements from Higher Level Design is a Standard Practice - Now Tools Can Do This for Us

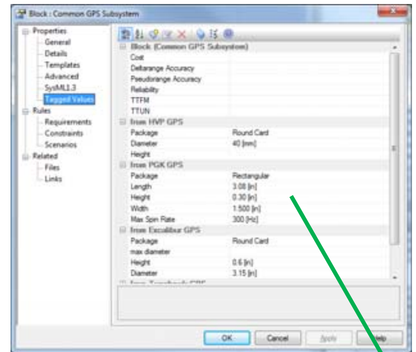
Integration with Subsystem Definition

Link to Requirements or other Design Tools

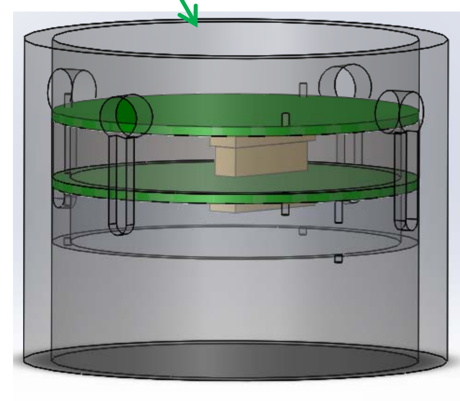
Common Source of Information → System Decomposition → Artifact Generation → Implement Traceability → Subsystem Simulation → Requirement Verification



Requirements

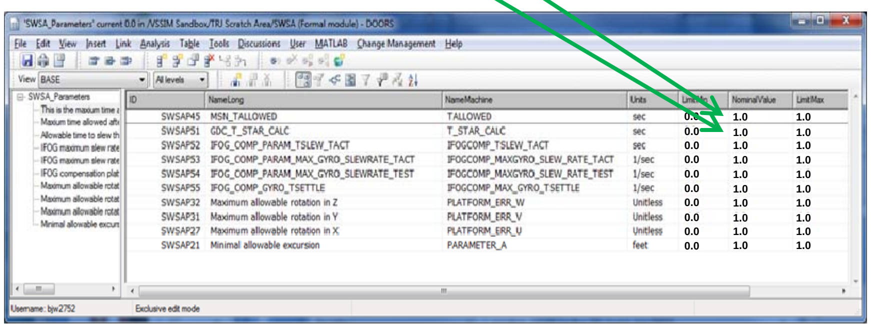


MBSE Specification



3D CAD Implementation

Subsystem Parameters



Inheritance of Inalterable Parameters Insures that Consistent Values are Used in Design and Verification

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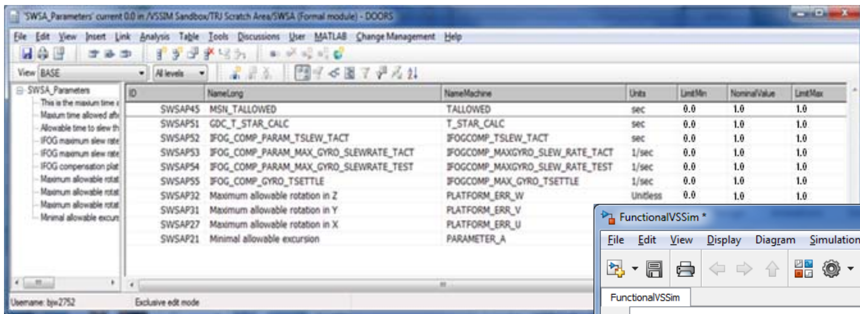
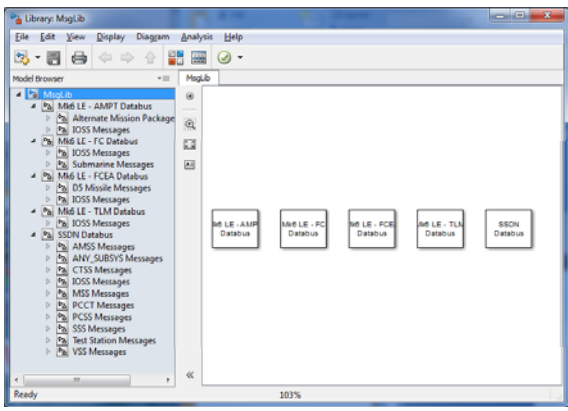
Provide Early Design Confidence

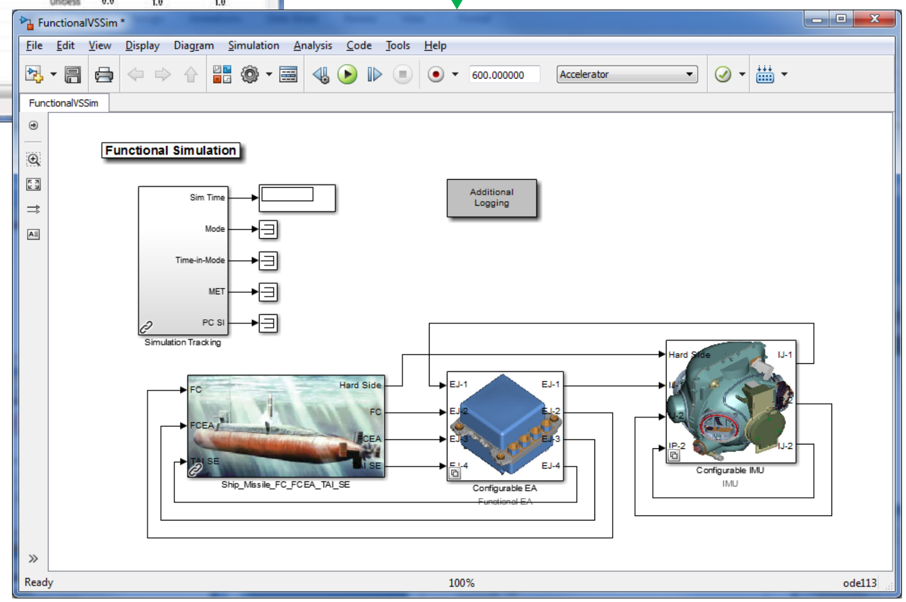
Simulated flights provides confidence that the design meets requirements

Common Source of Information → System Decomposition → Artifact Generation → Implement Traceability → Subsystem Simulation → Requirement Verification



High Level Requirements and Implementation Parameters



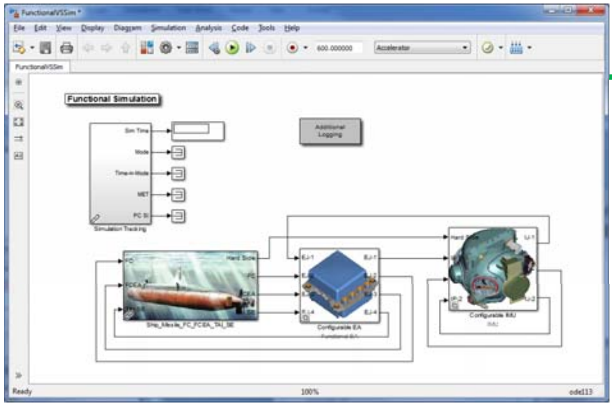


Closed-loop Simulation running externally-specified parameters

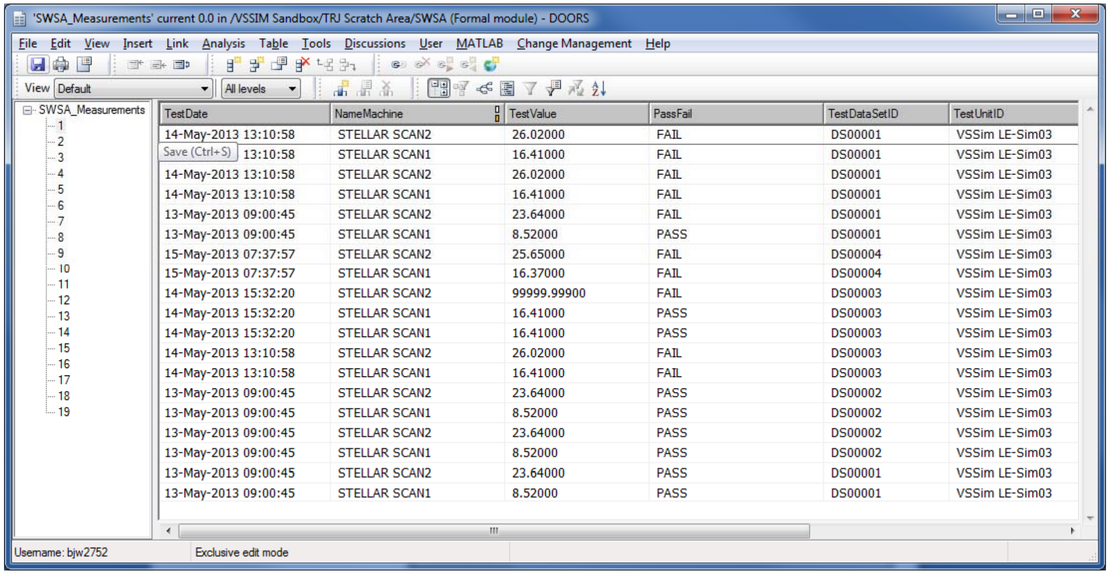
Simulations and Flight SW operate on the same data used to generate ICD

Automatic Assessment of Ability to Meet Requirements

Common Source of Information → System Decomposition → Artifact Generation → Implement Traceability → Subsystem Simulation → **Requirement Verification**



Post results back to repository for review



'SWSA_Measurements' current 0.0 in /VSSIM Sandbox/TRJ Scratch Area/SWSA (Formal module) - DOORS

File Edit View Insert Link Analysis Table Tools Discussions User MATLAB Change Management Help

View Default | All levels

SWSA_Measurements

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2	Save (Ctrl+S) 13:10:58	STELLAR SCAN1	16.41000	FAIL	DS00001	VSSim LE-Sim03
3	14-May-2013 13:10:58	STELLAR SCAN2	26.02000	FAIL	DS00001	VSSim LE-Sim03
4	14-May-2013 13:10:58	STELLAR SCAN1	16.41000	FAIL	DS00001	VSSim LE-Sim03
5	13-May-2013 09:00:45	STELLAR SCAN2	23.64000	FAIL	DS00001	VSSim LE-Sim03
6	13-May-2013 09:00:45	STELLAR SCAN1	8.52000	PASS	DS00001	VSSim LE-Sim03
7	15-May-2013 07:37:57	STELLAR SCAN2	25.65000	FAIL	DS00004	VSSim LE-Sim03
8	15-May-2013 07:37:57	STELLAR SCAN1	16.37000	FAIL	DS00004	VSSim LE-Sim03
9	14-May-2013 15:32:20	STELLAR SCAN2	99999.99900	FAIL	DS00003	VSSim LE-Sim03
10	14-May-2013 15:32:20	STELLAR SCAN1	16.41000	PASS	DS00003	VSSim LE-Sim03
11	14-May-2013 15:32:20	STELLAR SCAN1	16.41000	PASS	DS00003	VSSim LE-Sim03
12	14-May-2013 13:10:58	STELLAR SCAN2	26.02000	FAIL	DS00003	VSSim LE-Sim03
13	14-May-2013 13:10:58	STELLAR SCAN1	16.41000	FAIL	DS00003	VSSim LE-Sim03
14	13-May-2013 09:00:45	STELLAR SCAN2	23.64000	PASS	DS00002	VSSim LE-Sim03
15	13-May-2013 09:00:45	STELLAR SCAN1	8.52000	PASS	DS00002	VSSim LE-Sim03
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19	13-May-2013 09:00:45	STELLAR SCAN1	8.52000	PASS	DS00001	VSSim LE-Sim03

Username: bjw2752 Exclusive edit mode

Requirements satisfaction status is automatically updated

Simple visualization allows teams to quickly identify and react to problems

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Conclusions

- Systems model can greatly increase systems knowledge retention
  - A central data source greatly improves knowledge dissemination
  - Dynamically decomposable models improve data retrieval
  - Models enforce consistency and remove ambiguity
- Linked elements, models, and text facilitate change impact assessment
  - Automatic requirement generation reduces rework
  - Auto requirements saves time
  - Shared data reduces errors and redesign times
- Integrated simulations enable continuous verification
  - Provides design confidence earlier
  - Can reduce the extent of hardware testing
  - Automatic requirement verification reduces “overhead”

Questions?

Brian London

The Charles Stark Draper Laboratory

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blondon@draper.com