Reviewing Digital Engineering Data

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Abstract

- As programs spend time and money to transform their engineering information from documents to digital data, many fail to realize returns by not fully exploiting the rich data they have created. This presentation discusses how to get value from the investments made in creating models, simulations, databases, and other digital artifacts by changing the way we think about how we consume that data for reviews and other types of analysis. In this presentation, we discuss how to use Digital Engineering (DE) techniques to review DE data and gain new insights, do advanced model analysis, speed up the review process, and catch more errors than traditional review processes. Three dimensions to considering when constructing a model review approach and a three step process are discussed with an emphasis on Model Based Systems Engineering (MBSE) artifacts in the context of a digital thread. Practical examples of specific techniques used on real world defense programs will be provided to demonstrate the analysis.

Reviewing Digital Engineering Data: Setting Expectations

- Scope: For this presentation, what is a review?
  - Peer Review
  - Milestone Review
  - Technical Interchange Meetings (TIMs)
  - "Review" is broadly used here and can mean anything from casual internal analysis of DE content to formally approving a baseline.
- Focus in this presentation is MBSE, but you cannot talk about establishing review processes without considering architectural models in the broader DE context

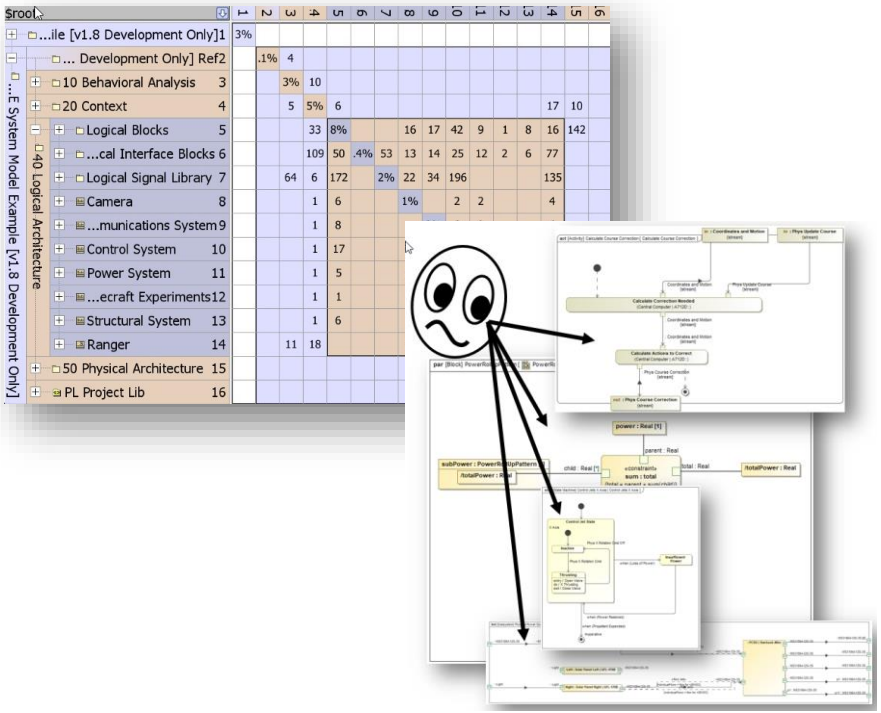
3 Critical Aspects of Reviews to Consider

- **Analytical Techniques**: If we review models like we traditionally review documents:
  - We have wasted the expense of building a model (if we USE it like a document, why not just build it as a document?)
  - We will waste time using manual methods that we could have done semi-automatically or with computer-assisted techniques
  - We will miss more errors than necessary & fail to exploit opportunities the rich data set we created give us to:
    - buy down risk of errors in complex systems
    - increase the quality of reviews
  - We will continue to focus on trivial, easy-to-catch errors at the expense of meaningful, expensive, complicated errors
- **Review & Commenting Tools**:
  - The relevant data may live in multiple software applications; we must review it as a cohesive whole or incur the weaknesses that stovepipes create
  - The tools we choose MUST enable review, approval, and configuration management of **data in database(s)**, not looking at pictures and saying "that looks about right" or "please spell out the acronyms"
- **Workflows, Approvals & Configuration Management**
  - Review processes must not "lock down" work if we are to use DE to achieve speed of relevance
  - Baselines will span authoring tools and therefore must be held in a different layer than the individual authoring applications
  - Are there QM/QA artifacts that need to be generated? Are they still relevant?

What is it?

- A Treadmill or an Overpriced Clothes Rack?

- A Model or an Overpriced Document?



Some MBSE Analytical Techniques for Reviews

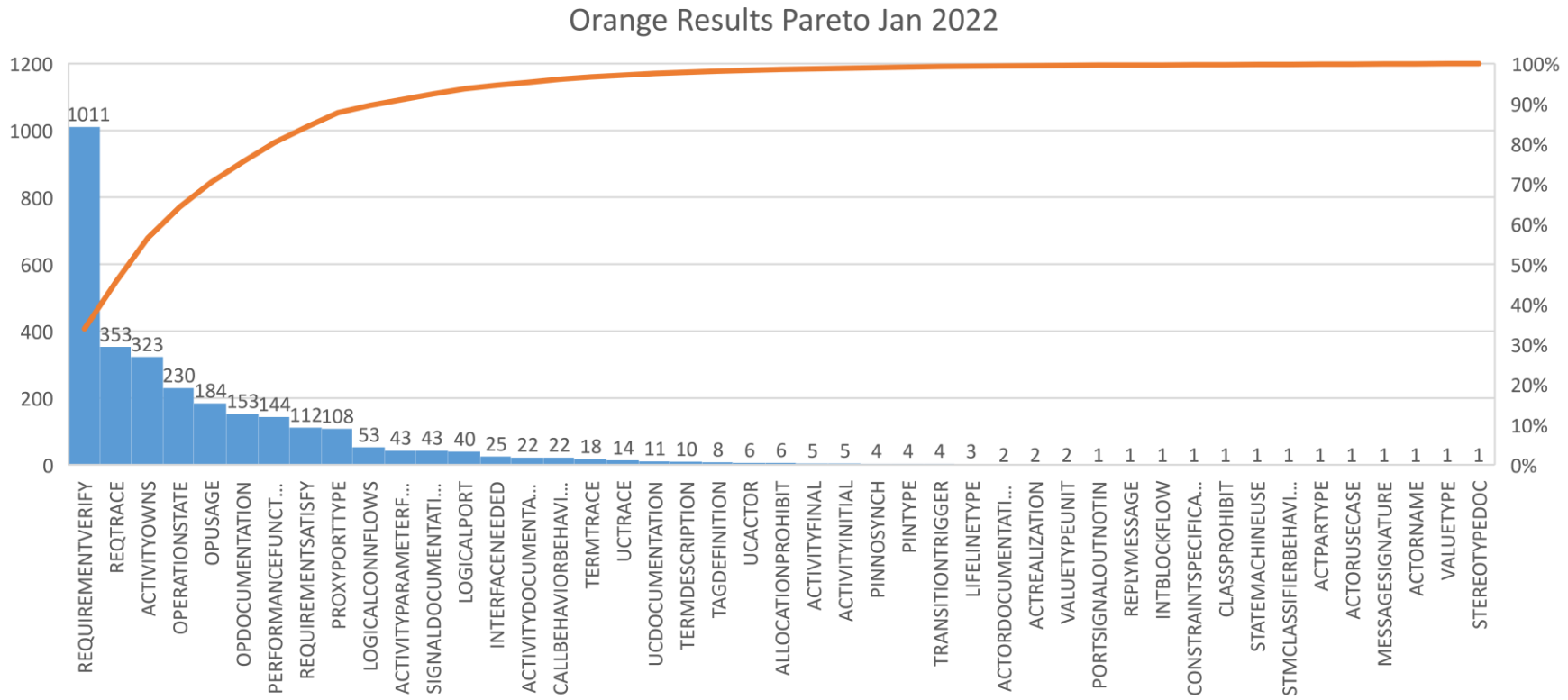
- Criteria vs Content tables (see next slide)
- Automated Validation
  - For SAIC Style
  - For other styles
  - For architectural quality indicators (future)
- Model Analysis Models
  - Add the model under review as a usage and re-scope pre-created tables, matrices, & relation maps (future)
  - Allows you to view the model data in more data-centric views than diagrams, whether or not the model creators made those views
- External Applications
  - Lattix: architecture quality metrics such as coupling, cohesion, & cycles (more in the future)
  - Aras/Other PLM tool: traceability analysis to other data sets
  - M&S: characterization of architectures, solutions, etc. This data may be interconnected with the model; use it!
  - Tom Sawyer? WHAT ELSE IS POSSIBLE? We have a structured data set; what can we do with it??

Identifying Specific Artifacts To Address Review Criteria

#	Name	Contributes to Goals	Relevant Processes	Content Artifacts
1	Use Cases	SFR	Associate Use Cases with Actors() Create Actors() Create Use Cases()	Use Case Elements Use Cases Use Cases - STYLE part 1 Use Cases - STYLE part 2 Use Cases - STYLE part 3 Use Cases - STYLE part 4
2	System Requirements	CDR TRR Test Planning SRR SFR	Import Existing Requirements() Create Requirements from Architecture()	System Requirements System Requirements Trace/Derive/Refine
3	Subsystem Requirements	CDR TRR Test Planning	Import Existing Requirements() Create Requirements from Architecture()	
4	Component Requirements	CDR TRR Test Planning PDR	Create Requirements from Architecture() Import Existing Requirements()	

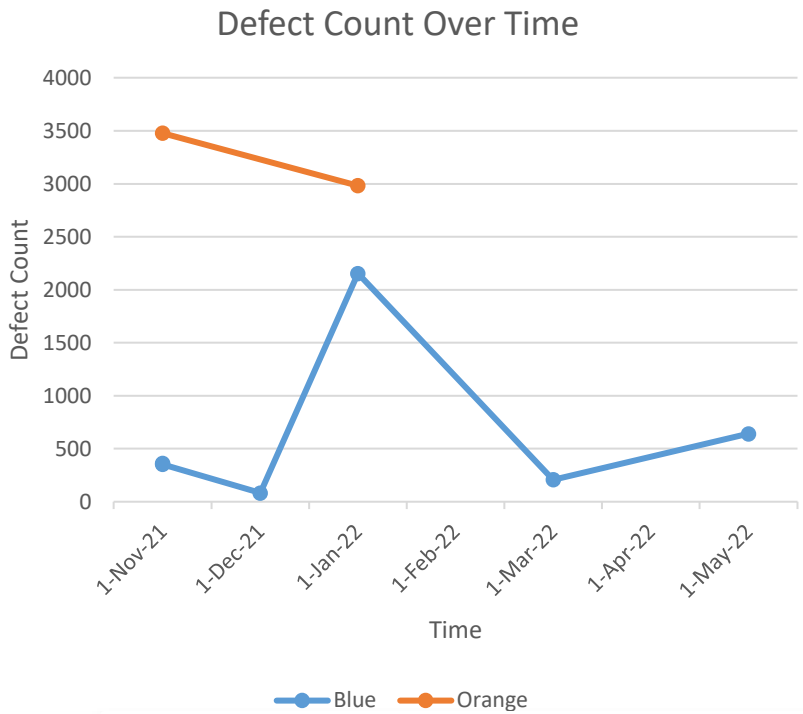
- Import criteria as Business Requirements or Source Content artifacts
  - DID outlines
  - Entry/Exit criteria
  - Trade study criteria
  - Model Content Plan, etc.
- Set up tables & matrices to trace model elements/views to criteria (use any dotted-line relationship that isn't being used elsewhere)
- Content vs Criteria tables establish the content is capable of satisfying the criteria and point reviewers at what is relevant to the review (*example in free SAIC Validation Tool*)

Example of Model Data Analytics



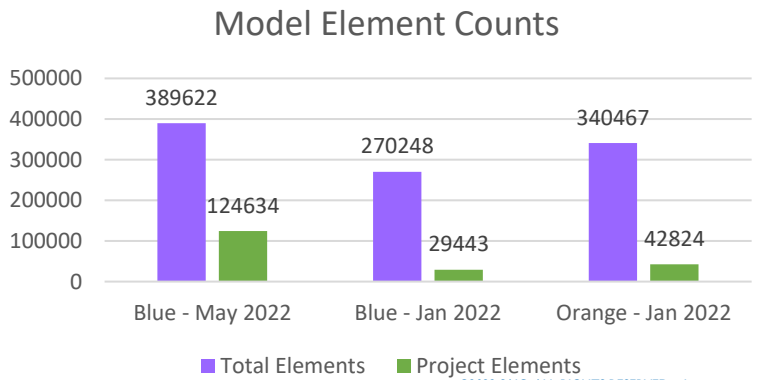
How to interpret validation results with errors in the thousands (2938)

Insights from Defect Tracking Over Time

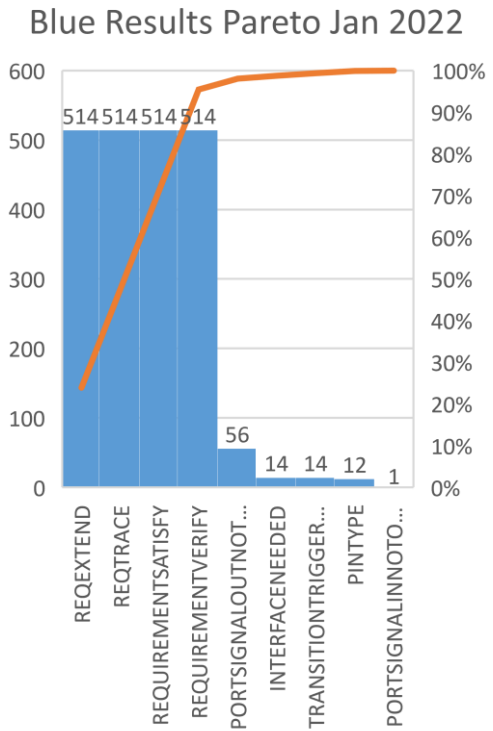


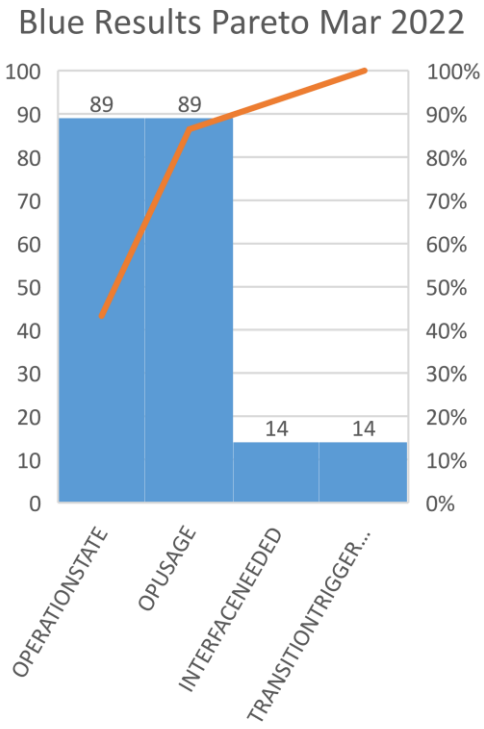
Which contractor do you think has the more mature baseline?

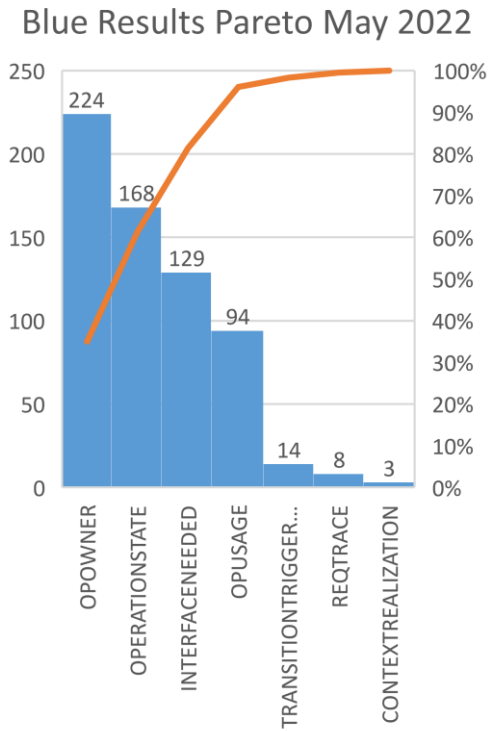
- What can we learn from looking at defect counts over time?
  - Orange has not made a delivery in 5 months… Why?
  - Why was does Orange have so many initial errors?
  - Why did Blue spike in Jan?
- Should we expect to see a steady burn down of defects over time?
  - Hint: the answer is NO… but why?



Snapshots of Data Can Tell a Story Over Time

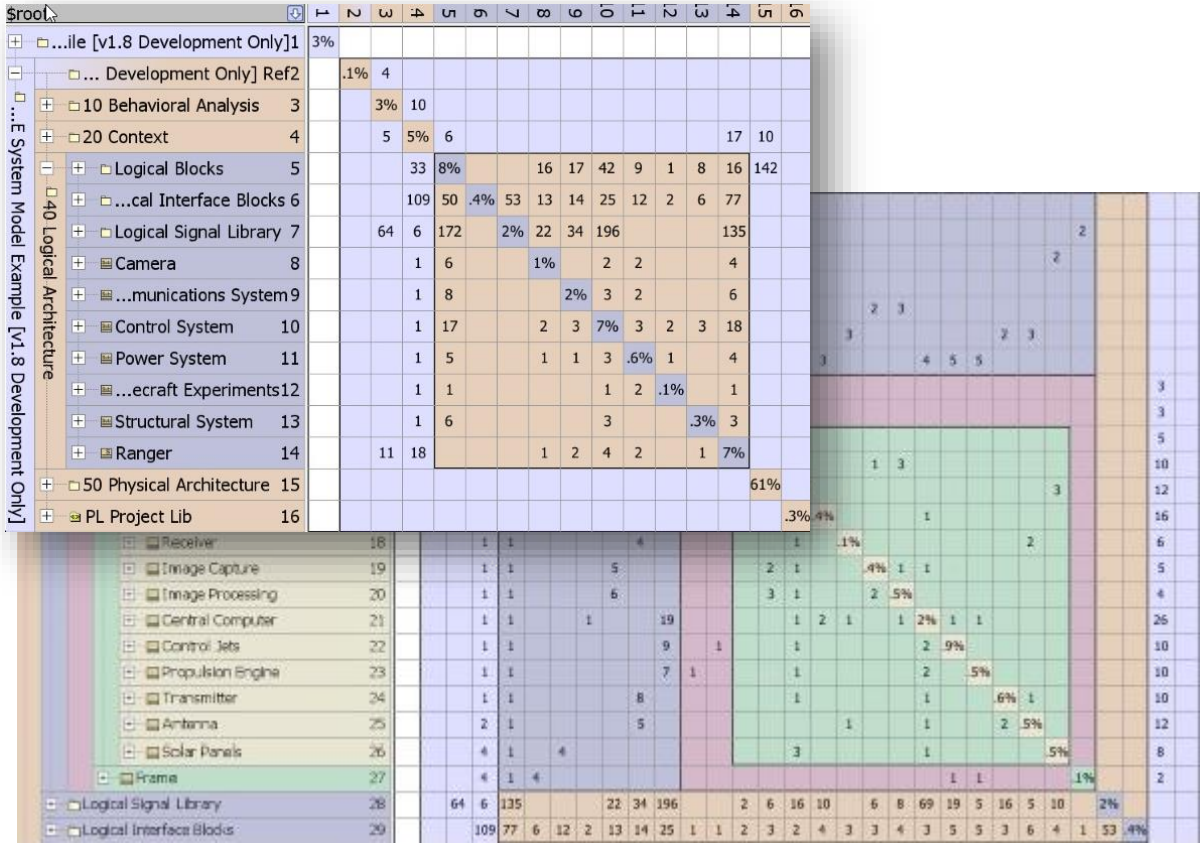






Can we infer what progress has been made over time?

Example of Advanced Review: Design Structure Matrices



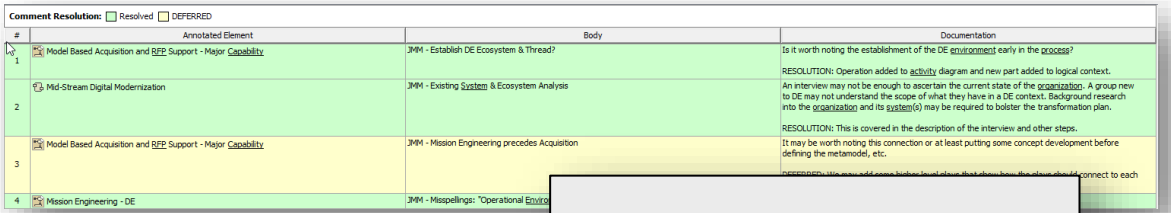
Images from Lattix

DSM is a promising technique with opportunities for semi-automation of analysis of complex, modeled architectures

- Partitioning **Algorithms**
- Metrics!
- One way of understanding, and perhaps even quantifying, architecture *goodness*

Some MBSE Review & Commenting Tools

- The authoring tool itself
  - Use "Problem" and annotate commented elements
  - Attach a legend that tracks resolution
  - Best for peer/internal reviews
- Cameo Collaborator
  - Future presentation will have more details
- Publishing the data to documents
  - *sigh*
  - Will be more expensive and time consuming than you think
- Aras/Other PLM Tool?
  - More broadly user-friendly than authoring tools
  - SOME access to data vs diagrams
  - Should be capable of capturing/resolving comments formally
  - We haven't really tried this yet in production

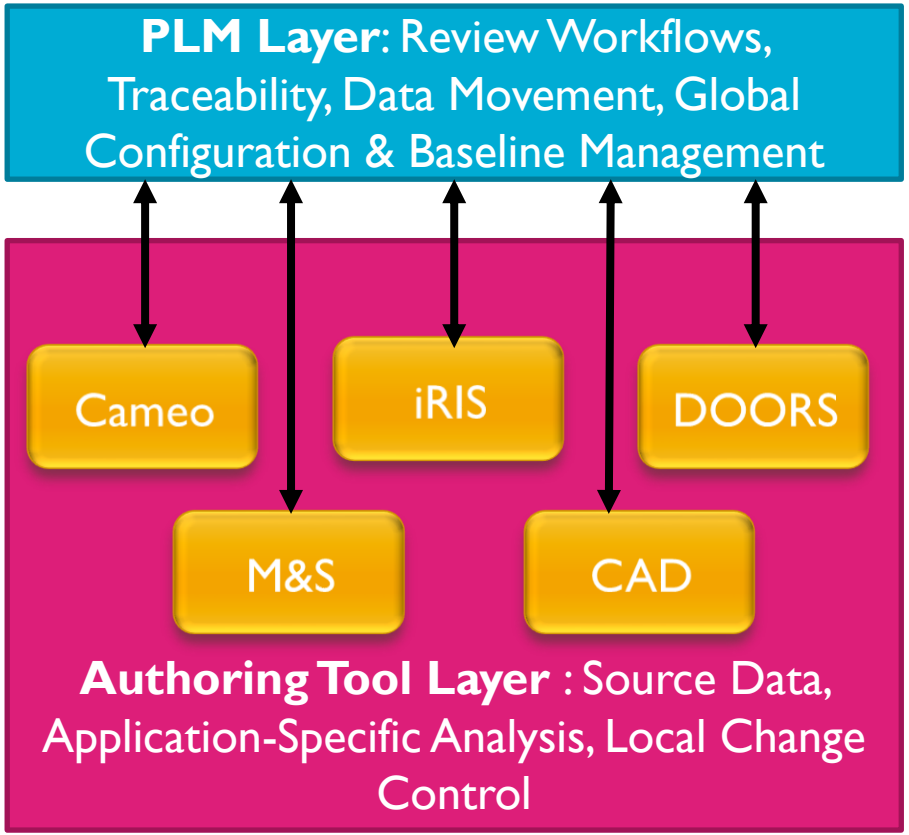


Comment Resolution: Resolved DEFERRED

#	Annotated Element	Body	Documentation
1	Model Based Acquisition and RFP Support - Major Capability	JMM - Establish DE Ecosystem & Thread?	Is it worth noting the establishment of the DE environment early in the process? RESOLUTION: Operation added to activity diagram and new part added to logical context.
2	Mid-Stream Digital Modernization	JMM - Existing System & Ecosystem Analysis	An interview may not be enough to ascertain the current state of the organization. A group new to DE may not understand the scope of what they have in a DE context. Background research into the organization and its system(s) may be required to bolster the transformation plan. RESOLUTION: This is covered in the description of the interview and other steps.
3	Model Based Acquisition and RFP Support - Major Capability	JMM - Mission Engineering precedes Acquisition	It may be worth noting this connection or at least putting some concept development before defining the metamodel, etc.
4	Mission Engineering - DE	JMM - Misspellings: "Operational Enviro	

PLM-Based Review Workflows and Baseline Management Concept

- PLM tools can:
  - manage multiple data types (SEIT, Detailed Design, OMS, Logistics, M&S, etc.)
  - have a long history of successfully establishing review workflows,
  - have proven capability to manage data access controls,
  - have robust baseline management capabilities
- The baseline can be held in a PLM tool while work continues in the authoring tools
- PLM tools with 2-way connectors can also push approved baseline data from one tool into another (digital thread backbone), allowing more control over what data is shared between applications



3 Step Process for Digital Engineering Reviews

Review Input Prep:
- Style Validation Results
- Problem-area Pointers
- Advanced Analysis Results
- Criteria vs Content tables & matrices

MBSE Expert

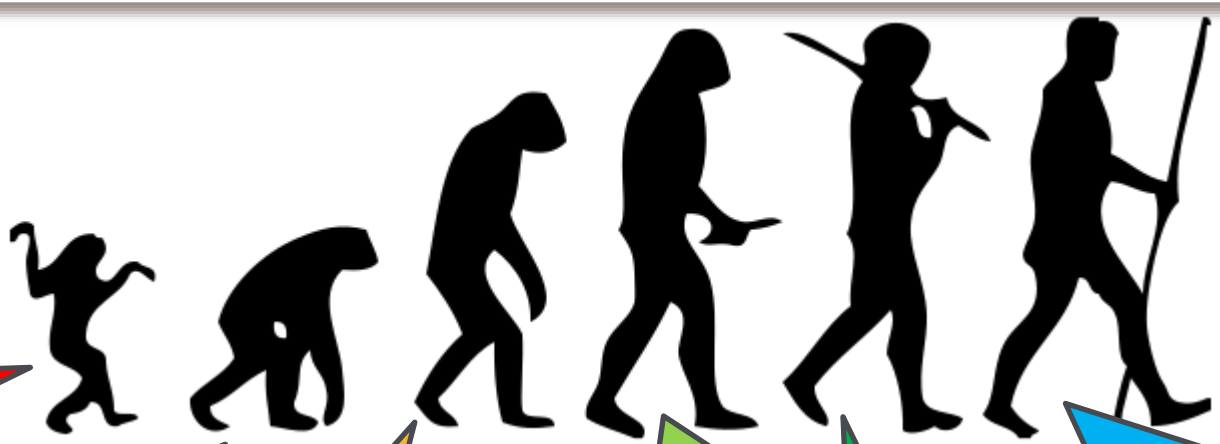
SME Review:
- Managed Workflow
- Global Data Views
- Diagram Views
- Comments
- Sign-Offs

Domain Expert

Baseline Mgmt:
- Global Baselines
- Authoritative Source of Truth
- Digital Thread Data Movement

CM/DM Expert

Building Models Well is Only the First Step in the DE Transformation Journey



No Architecture

Architecture Pictures in PowerPoint

Graphical Interpretation of Architectures using Diagrams in Models

Semi-Automated Analysis of Modeled Architectures

Comparing Architecture Models to the Real World

Semi-automatic Sustainment of Implemented Architecture & Update of Architecture Models

Image by Wikimedia Commons

Using Models Well is the Key to Results

Questions/Discussion

SAIC DE Profile & Validation Rules:

https://www.saic.com/digital-engineering-validation-tool

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