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Global Product Data Interoperability Summit | **2020**

GPDIS 2020 PARTNERS

Welcome to the 2020 GPDIS Virtual Sessions!

History and Focus of GPDIS

- **Global Product Data Interoperability Summit (GPDIS) was formed in 2009. It was the consolidation of two conferences (Data Exchange and SOA Deep Dives) addressing integration technologies along with the non-proprietary exchange of data**

- **GPDIS functions as a communications hub for industry principals to foster knowledge through the exchange of ideas, solutions and methods.**

2020 Theme: The Great Race of Digital Transformation

How is your model based enterprise today?

- **Together we will explore digital transformation and what it will take us to FULLY achieve it. Using the Great Race as a metaphor, we will explore the building blocks of digital transformation and how interoperability will enable the digital transformation journey for industry.**

Mark your Calendars! GPDIS 2021 - September 13-17, 2021

CAMSC **MBSE** **ET/IT** **3D MBD** **DevOps** **PLM Roadmap** **PDES**

Digital Engineering Transformation; Expectations, Challenges, and Solutions

Denise Fitzgerald, MIT Lincoln Laboratory

GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2020

Virtual Sessions

Presenters Bio

- **With over 25 years of experience as a precision mechanical engineer, Denise Fitzgerald co-leads the Mechanical Engineering Group at MIT Lincoln Laboratory which develops complex hardware prototype systems critical to national security. She also leads the Laboratory's Digital Engineering transformation initiative. In this role, she is evolving the engineering and operational capability of the Laboratory through the use of analytical models to define and drive process while building a connected and efficient prototyping environment. She is a champion for organizational change and modernization of engineering practice. Ms. Fitzgerald holds a BS in mechanical engineering from Worcester Polytechnic Institute and an MS in Mechanical Engineering from North Carolina State University.**

Digital Engineering Transformation; Expectations, Challenges, and Solutions

Denise Fitzgerald

GPDIS Virtual Sessions

10/15/2020

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Massachusetts Institute of Technology

Technical Excellence Integrity Meritocracy

Campus

- Education, Basic Research
- Open Environment
  - Unclassified
  - International
- Science and Engineering Culture
- Consulting; Start-ups

Lincoln Laboratory

- Applied Research & Dev. for the US Government
- Restricted Environment
  - Unclassified and Classified
  - US Citizens Only
- Primarily Engineering Culture
- Strict Conflict-of-Interest Policy

MIT Lincoln Laboratory

DoD Federally Funded Research and Development Center

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Mission: **Technology in support of National Security**
Key Roles: **System architectural engineering, long term technology development, and system prototyping and development**

FY19 Funding:	$1.1B
Number of Employees:	4,126

Mission Areas

- Homeland Protection
- Air and Missile Defense
- Communication Systems
- Cyber Security
- Air Traffic Control
- Tactical Systems
- Space Control
- ISR Systems and Technology

- Scientists and Engineers
- Government sponsor relationship
- Development/ Engineering of technology
- High level of analytical modeling
- Some prototyping

Advanced Technology

Engineering

- **Engineers/ Designers/Technicians**
- **Design/ Engineering/Analysis of Hardware**
- **Fabrication – PCB and Mechanical**
- **Assembly**
- **Test**

Lincoln's Operational Model

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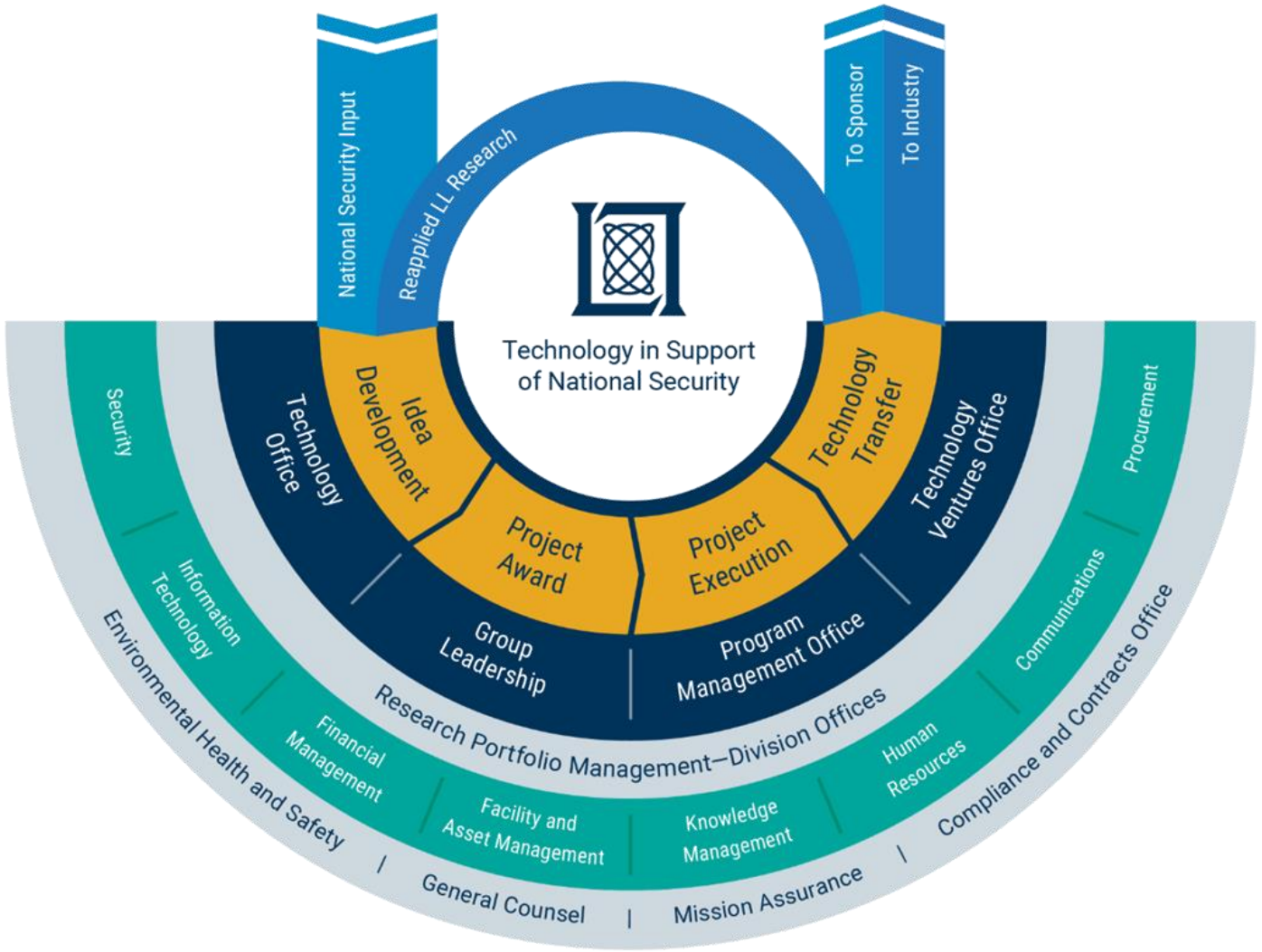
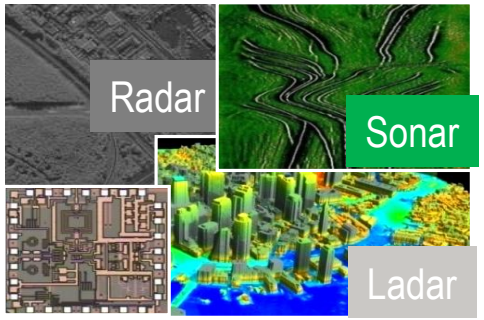


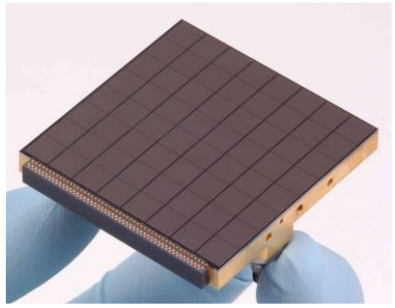
Range of Laboratory Programs

Technologies

Sensing Components Signal Processing

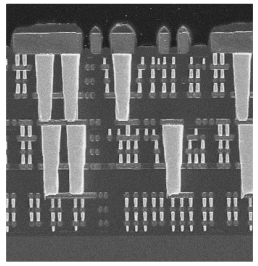


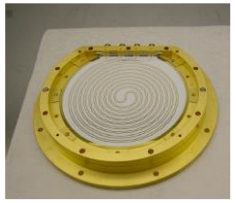
Advanced Imaging



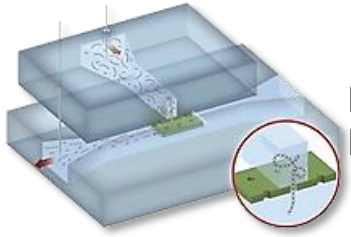
Tactical Networking

Advanced Silicon





RF Technology



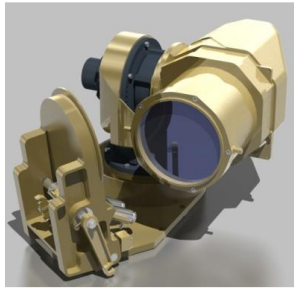
Molecular Diagnostics

Prototypes

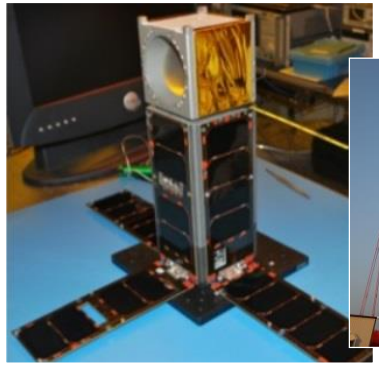
Space Surveillance Telescope

Rapid Agent Aerosol Detector

Lunar Laser Communications Demo



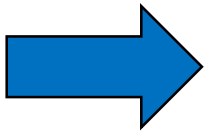
MicroMAS Weather Sensing CubeSat



XTR-1 Radar

HUSIR W-Band

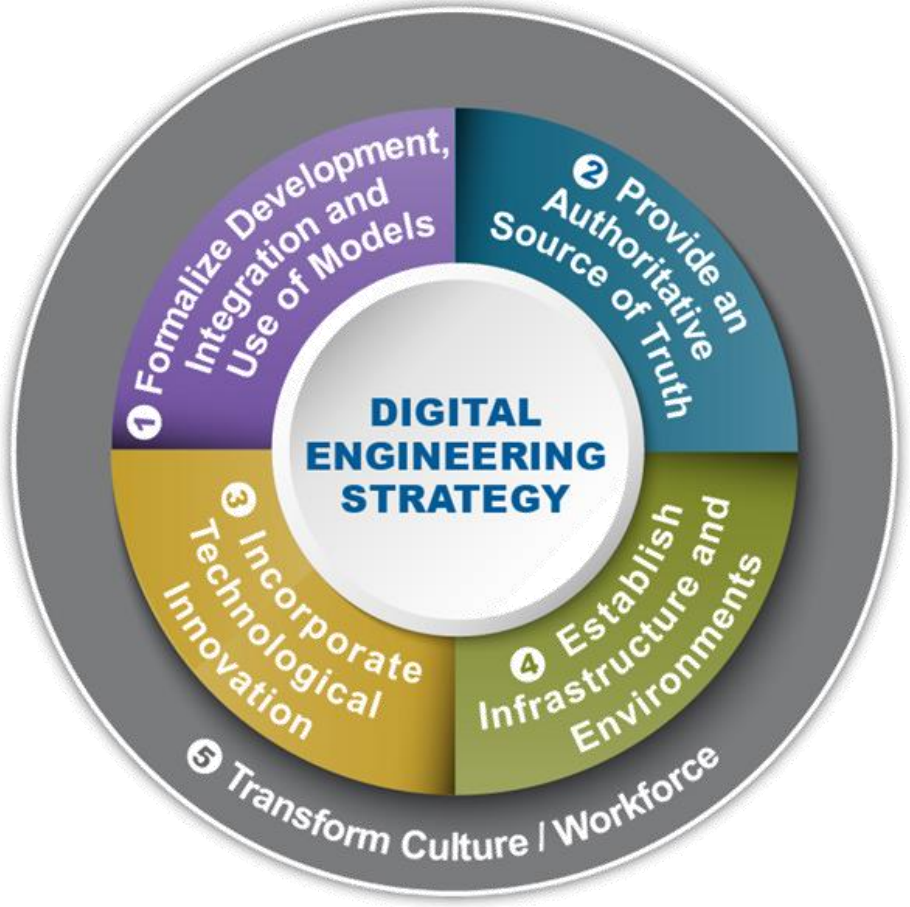
Outline



- **The Problem**
- **The Design Solution**
- **The Reality**
- **The Solution**

DoD Modernization Strategy

- **Emerging adversaries are agile**
- **Adversaries are not bound by decades of bureaucratic structure and process**
- **OUSD – Systems Engineering developed a strategy to address this challenge**
- **The strategy is centered around using digital tools to more quickly develop and collaborate on critical projects**



To continue to make the greatest impact, Lincoln must become digitally mature

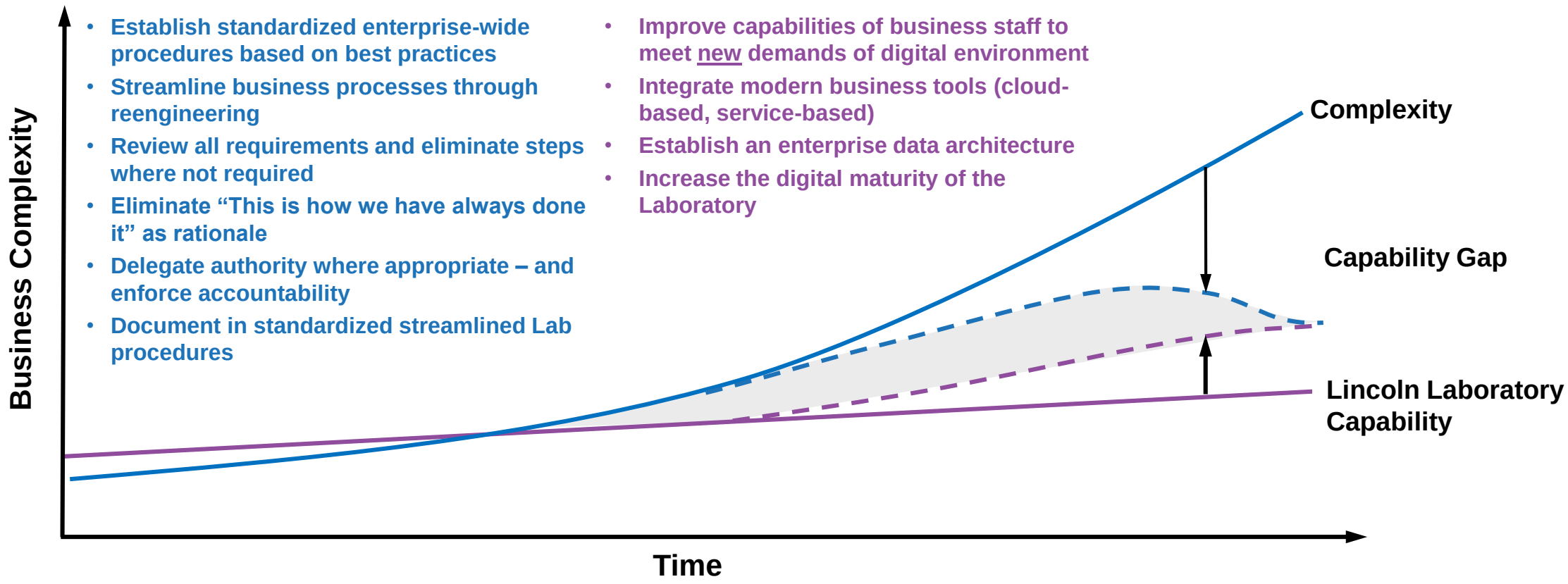
Digital Enterprise Transformation

Reduce Complexity

- Establish standardized enterprise-wide procedures based on best practices
- Streamline business processes through reengineering
- Review all requirements and eliminate steps where not required
- Eliminate “This is how we have always done it” as rationale
- Delegate authority where appropriate – and enforce accountability
- Document in standardized streamlined Lab procedures

Improve Capability

- Improve capabilities of business staff to meet new demands of digital environment
- Integrate modern business tools (cloud-based, service-based)
- Establish an enterprise data architecture
- Increase the digital maturity of the Laboratory



Digital Enterprise Transformation will close the capability gap

Digital Enterprise Transformation

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Lincoln Digital Engineering Strategic Goals

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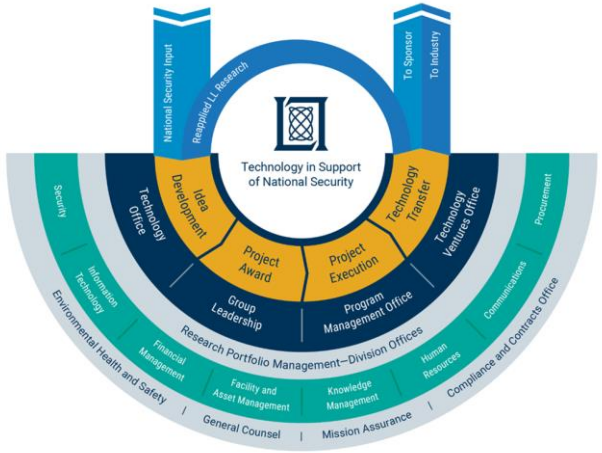
Enable an environment for efficient development of prototypes and dissemination of information



ENGINEERING COLLABORATION

- Integrate and optimize product development processes
- Build a connectivity across the enterprise
- Institute a single collaborative environment for engineering information

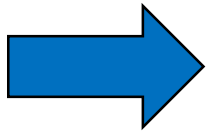
PRODUCTIVITY AND INNOVATION DRIVERS

- Maximize engineering adoption and organizational value
- Develop advanced systems to maintain program information
- Enhance rapid prototyping performance

DIGITAL PRODUCT CREATION & MANAGEMENT

- Build and manage a comprehensive digital product definition
- Create a complete digital thread of product information from concept to delivery
- Evolve the enterprise from low fidelity files to high fidelity models

Outline



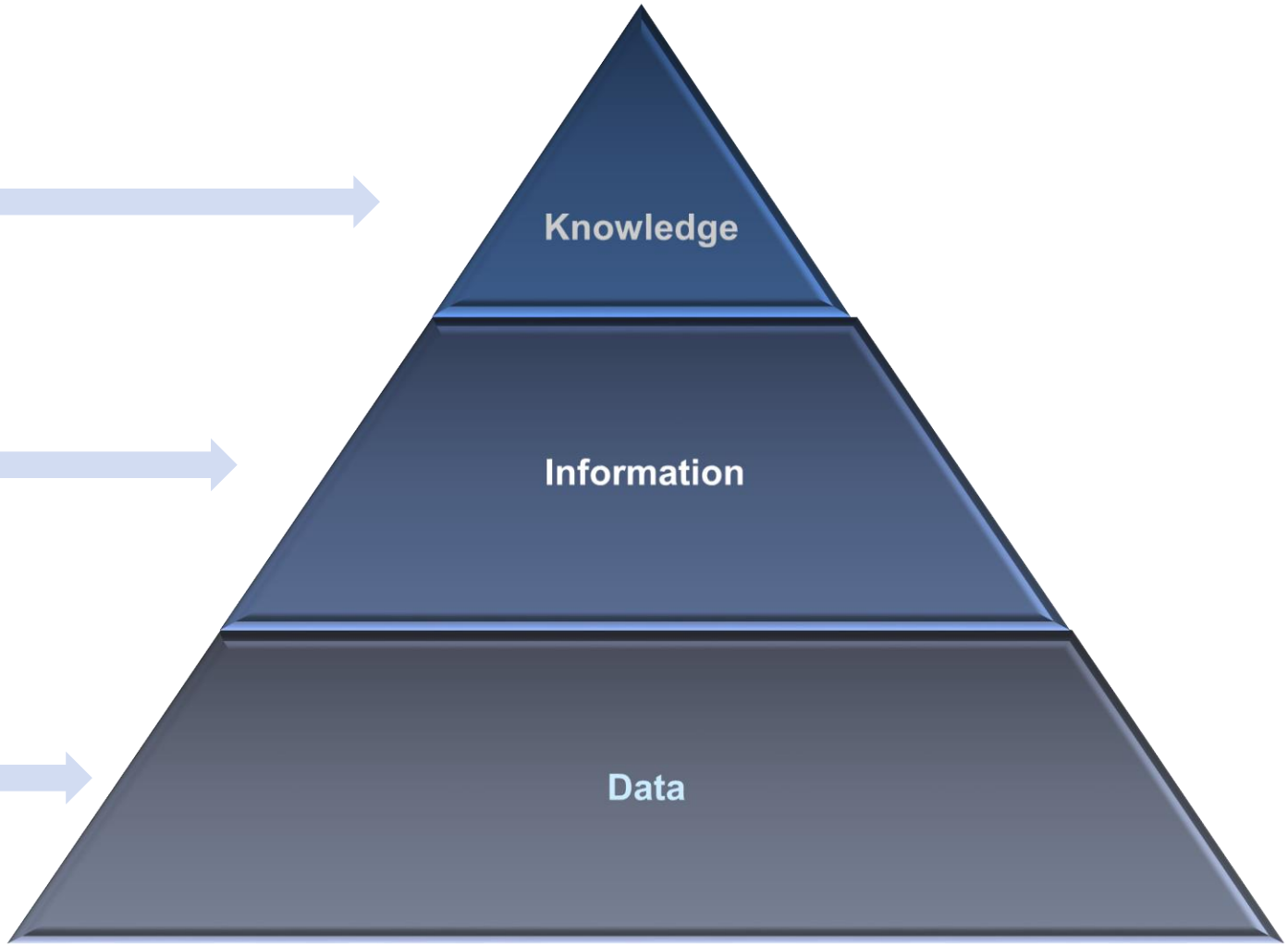
- **The Problem**
- **The Design Solution**
- **The Reality**
- **The Solution**

Digital Transformation

Organizational Value

Reconstruction of Data into for purpose usage

Deconstruction of Work into data items



Deconstruct This

Requirements

Tool List

CAD

Neighbors

Assembly Procedure

1. Thou shall bolt Part 1 to Part 2
2. Measure thy voltage
3. Recordest it here____
4. Takest a photo of thy meter

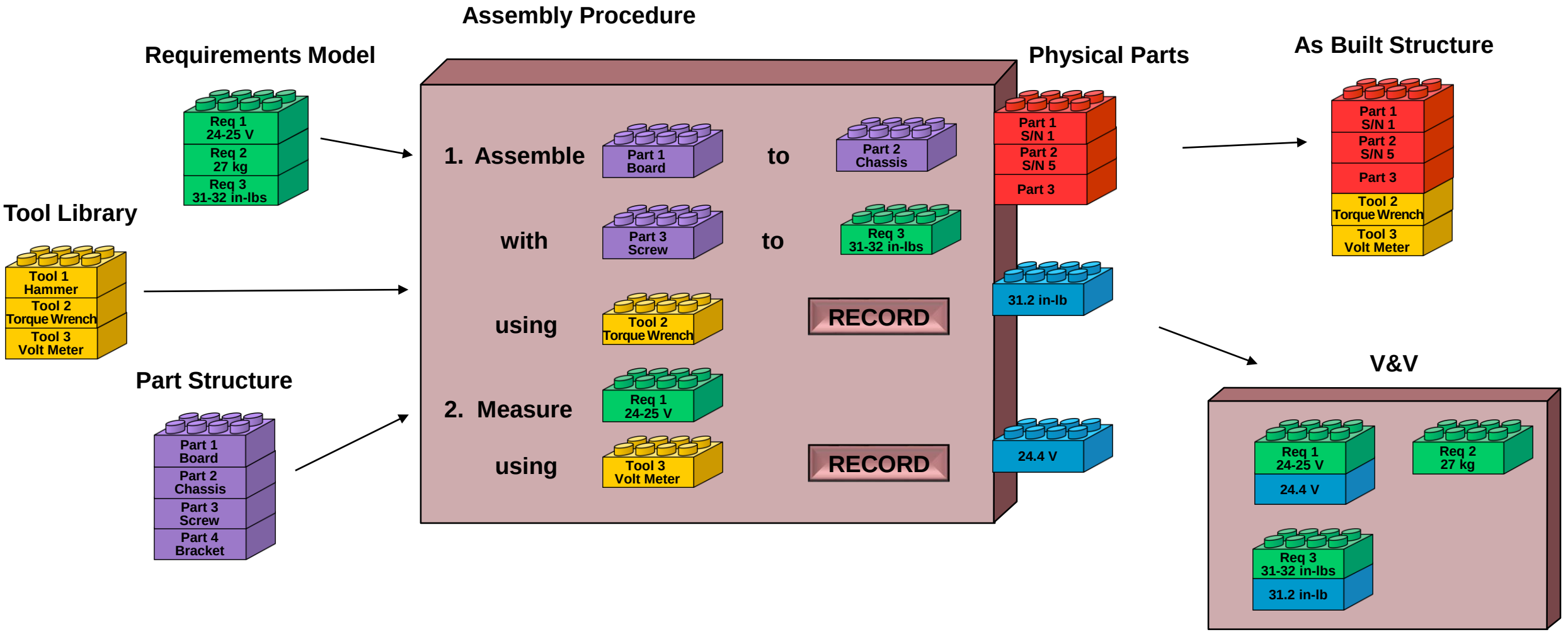
Assembly Procedure

1. Thou shall bolt Part 1 to Part 2
2. Measure the voltage
3. Recordest it here__24.2₩__
4. Takest a photo of thy meter

Ye 'Ol V&V Matrix

22.4₩

Into This


Assembly Procedure
Requirements Model
Req 1
24-25 V
Req 2
27 kg
Req 3
31-32 in-lbs
Tool Library
Tool 1
Hammer
Tool 2
Torque Wrench
Tool 3
Volt Meter
Part Structure
Part 1
Board
Part 2
Chassis
Part 3
Screw
Part 4
Bracket
1. Assemble
Part 1
Board
to
Part 2
Chassis
with
Part 3
Screw
to
Req 3
31-32 in-lbs
using
Tool 2
Torque Wrench
RECORD
2. Measure
Req 1
24-25 V
using
Tool 3
Volt Meter
RECORD
Physical Parts
Part 1
S/N 1
Part 2
S/N 5
Part 3
31.2 in-lb
24.4 V
As Built Structure
Part 1
S/N 1
Part 2
S/N 5
Part 3
Tool 2
Torque Wrench
Tool 3
Volt Meter
V&V
Req 1
24-25 V
24.4 V
Req 2
27 kg
Req 3
31-32 in-lbs
31.2 in-lb

Model Based Systems Engineering
MBSE

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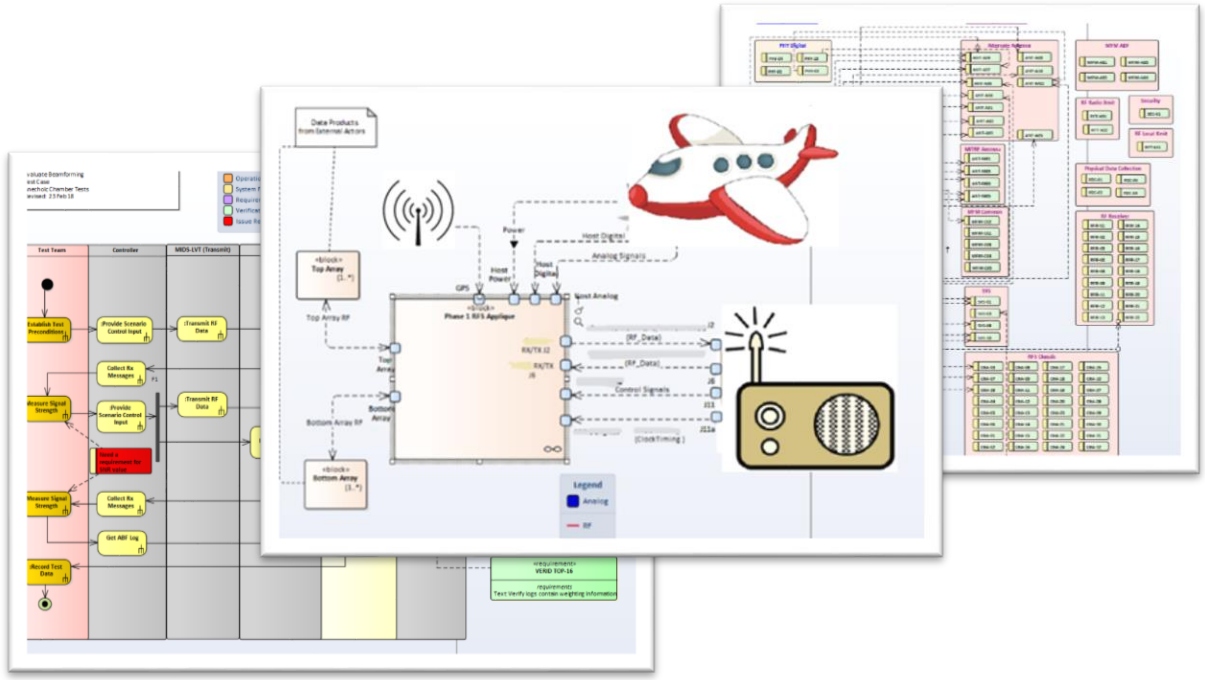
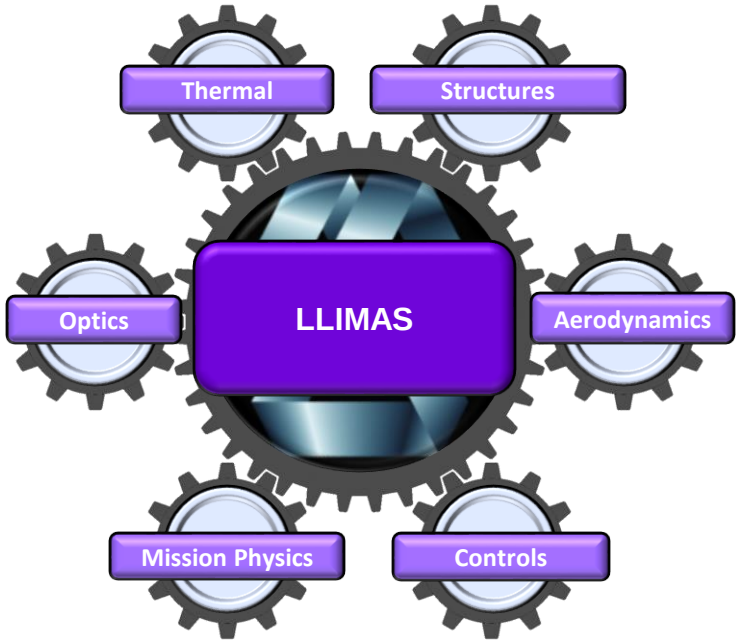
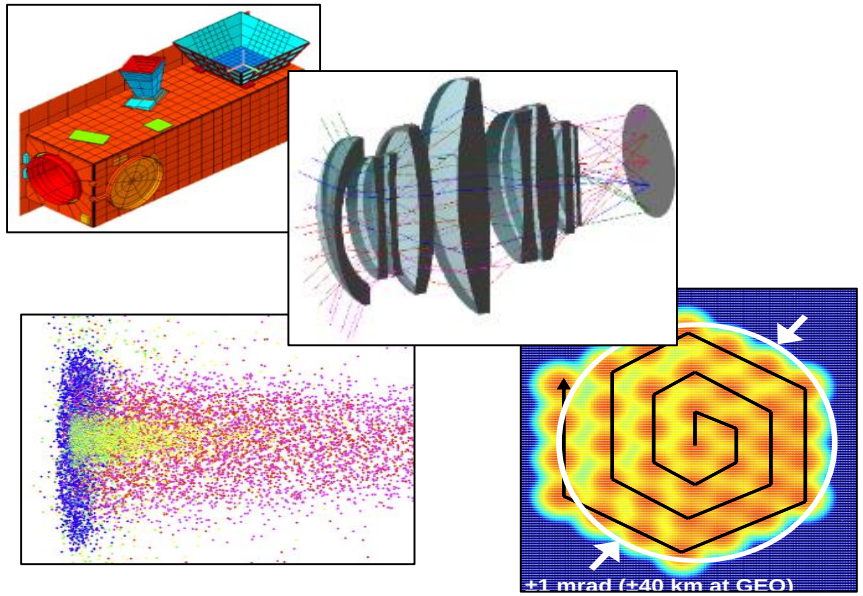


- **Shifting to use of SysML tools to relate requirements, functional, and physical models**
- **Impact of change is recognized throughout model**
- **Growing user community at Lincoln**

LL Integrated Modeling and Analysis System
LLIMAS





- **Use of integrated analysis model framework to optimize design, perform complex trade studies**
- **Connects open source and commercial tools**
- **Post-processing features to distill data into relevant metrics**
- **Extensible framework to meet diverse Lincoln needs, developed in-house as needed**

Model Based Definition
MBD

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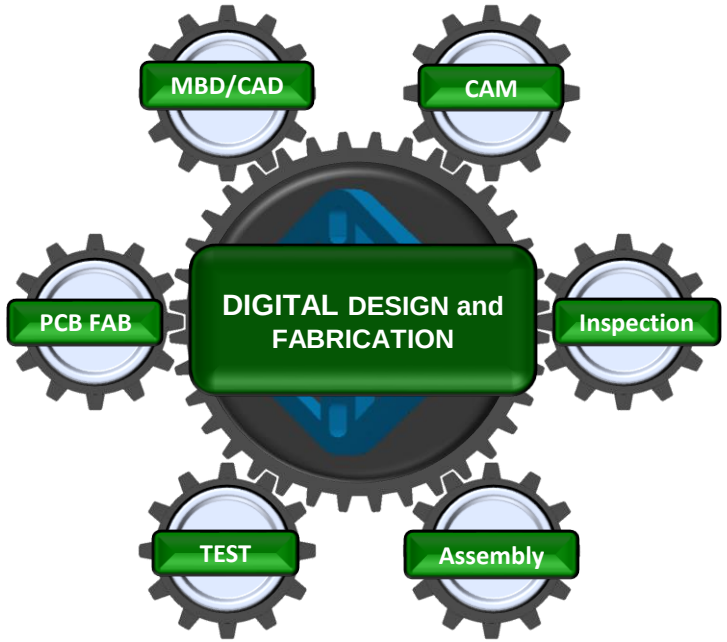
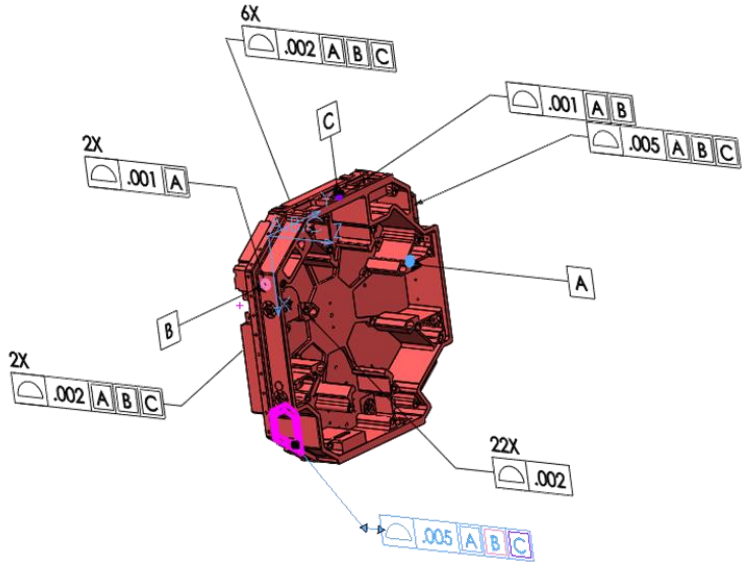
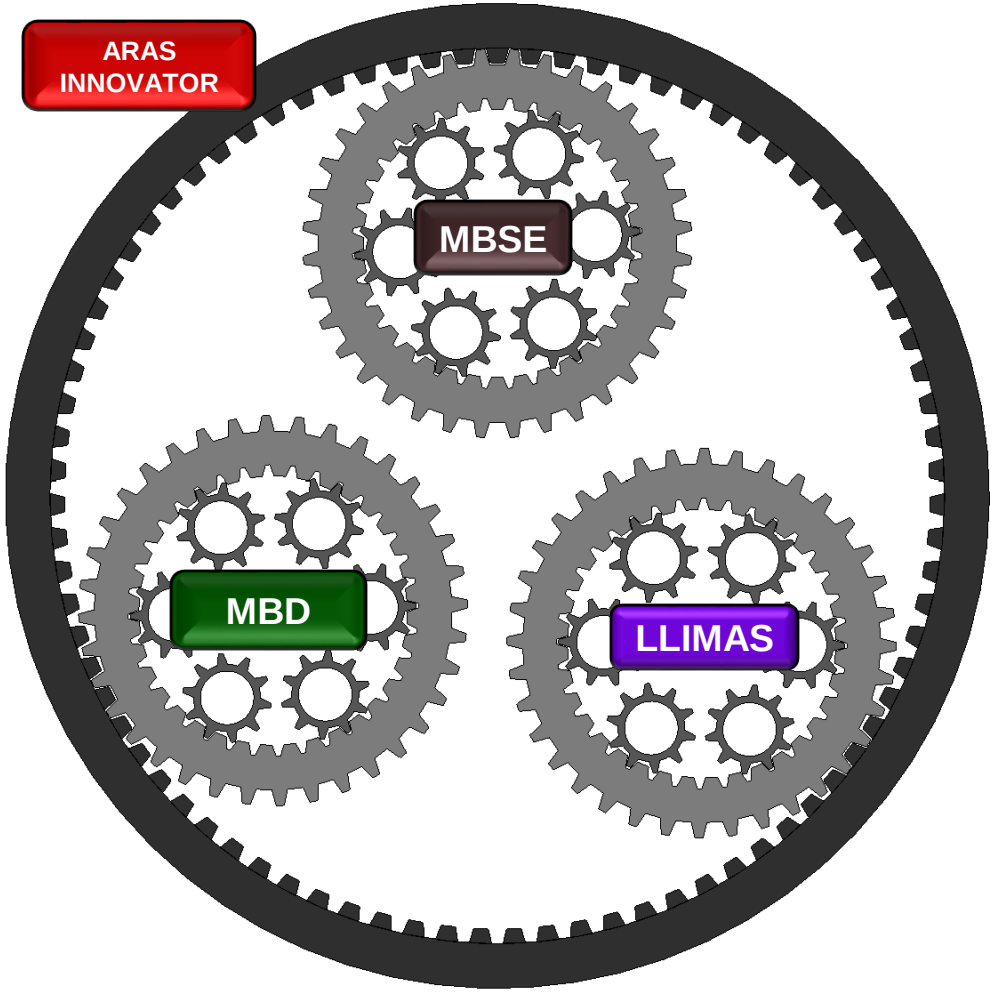




- **Lincoln using model based digital fabrication for 10+ years**
- **Shifting to embedded PMI in models to better communicate with machine tools**
- **Reuse CAD for inspection and assembly**
- **PCB fabrication also model based**
  - **Enabled by tools to transform CAD data into traceable MBOM**

Connected Digital Enterprise

- **PLM controls relationships between models**
- **True impact matrix**
- **PLM also connects to business systems**
- **Traceability of lifecycle from concept development, system design, hardware design, build, and test**

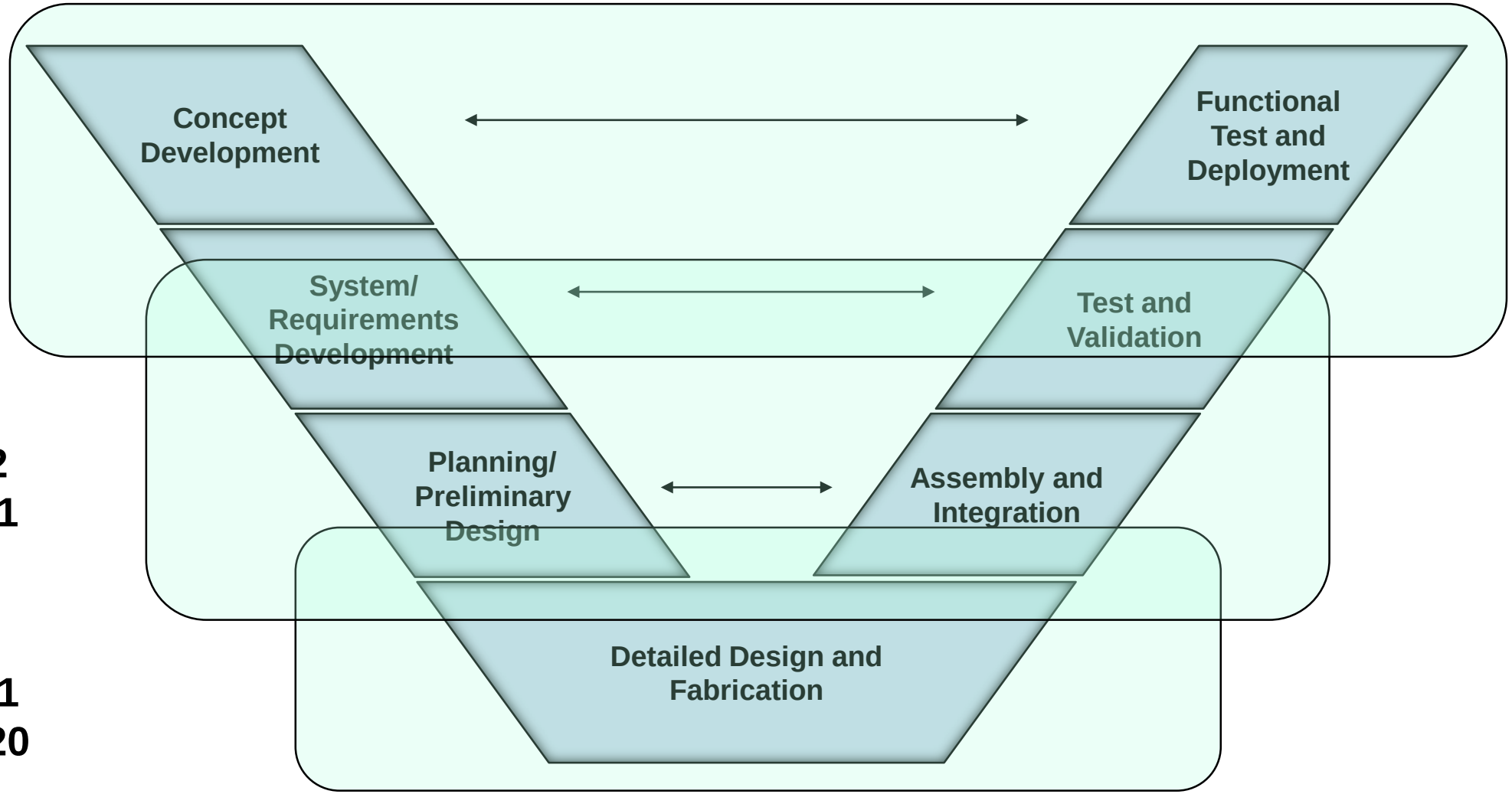


Implementation Strategy

PHASE 3

PHASE 2
2020-2021

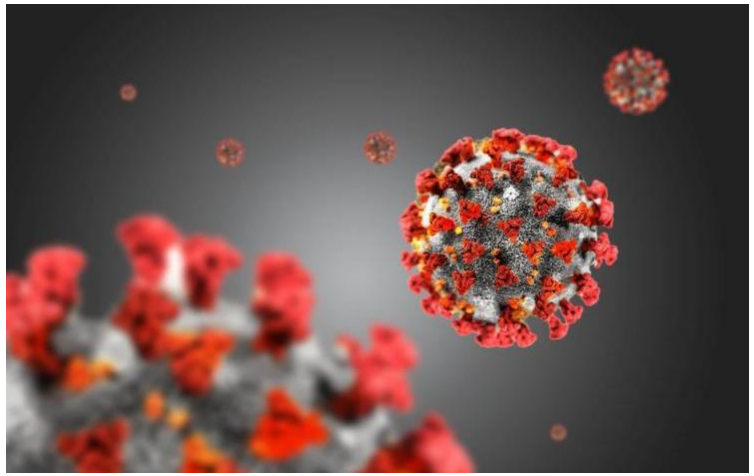
PHASE 1
2018-2020



Outline

- **The Problem**
- **The Design Solution**
- **The Reality**
- **The Solution**

Accelerated Adoption of Tools



- **Unexpected, rapid shift to digital workforce**
- **Laboratory shift from <5% remote to >90% in 5 days**
- **Need to stay operational and effective vs having well developed strategies**
- **Rapid shift in culture**

Platform Interoperability

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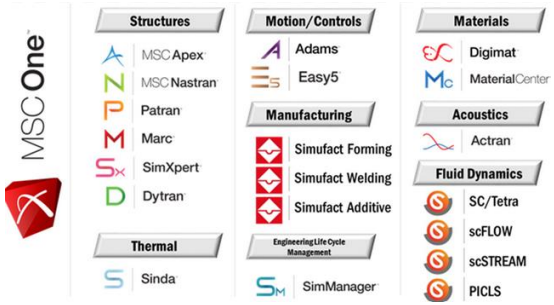
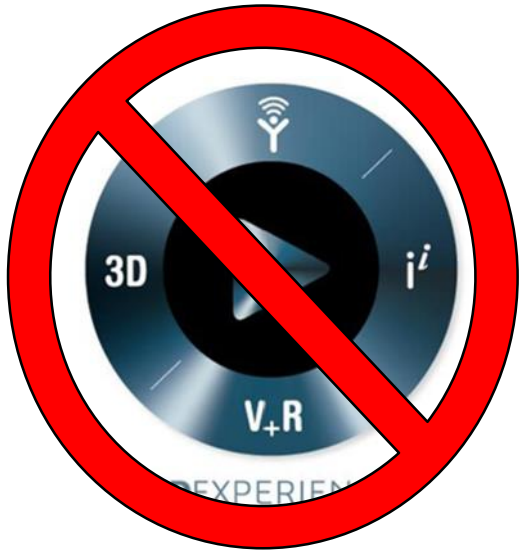
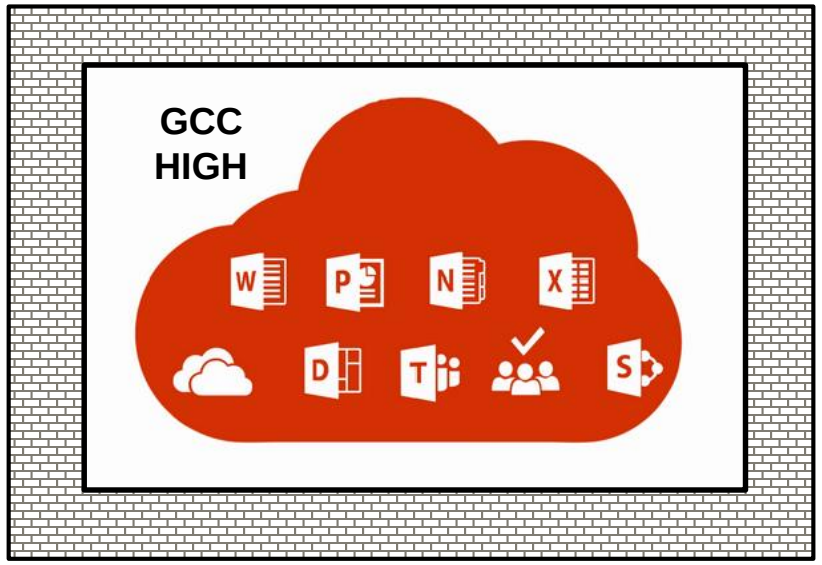


Strong industry trend towards platform rather than stand alone solutions

Security



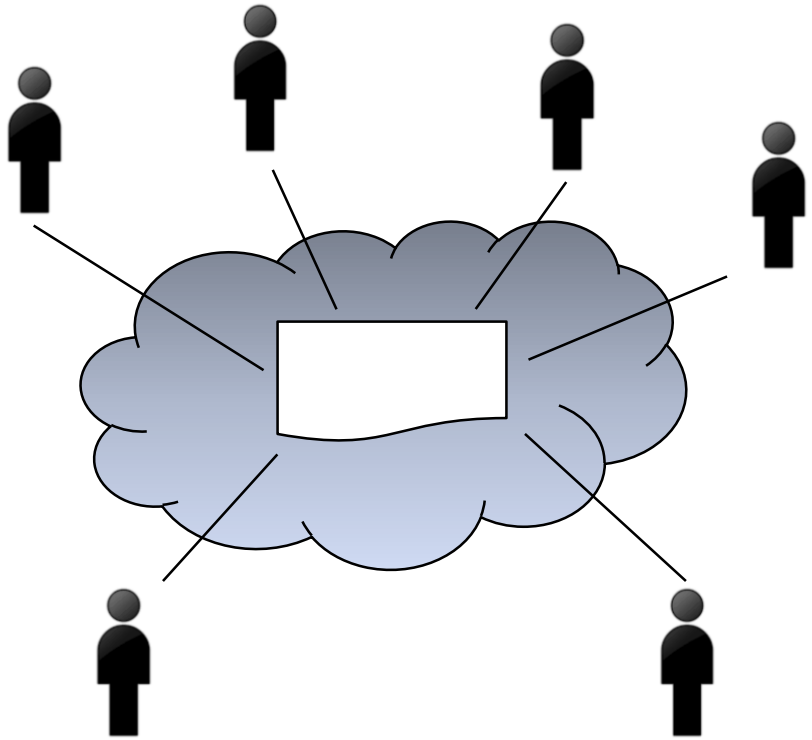
Nuage



- **Desire to move to cloud based platforms**
  - **Not every platform is acceptable for DoD work**
- **GCC High cloud restrictive**
  - **Year lag in features available to commercial platform**
  - **Few connectors to other platforms available**
- **Previous generation, non-platform solutions offered more options for local customization**

Work Interoperability

Traditional CM



Collaborative Workspace

New (and better) collaborative approaches to work are not necessarily compatible with traditional CM forcing hybrid approaches to data management

Architecture Development Model (ADM)*

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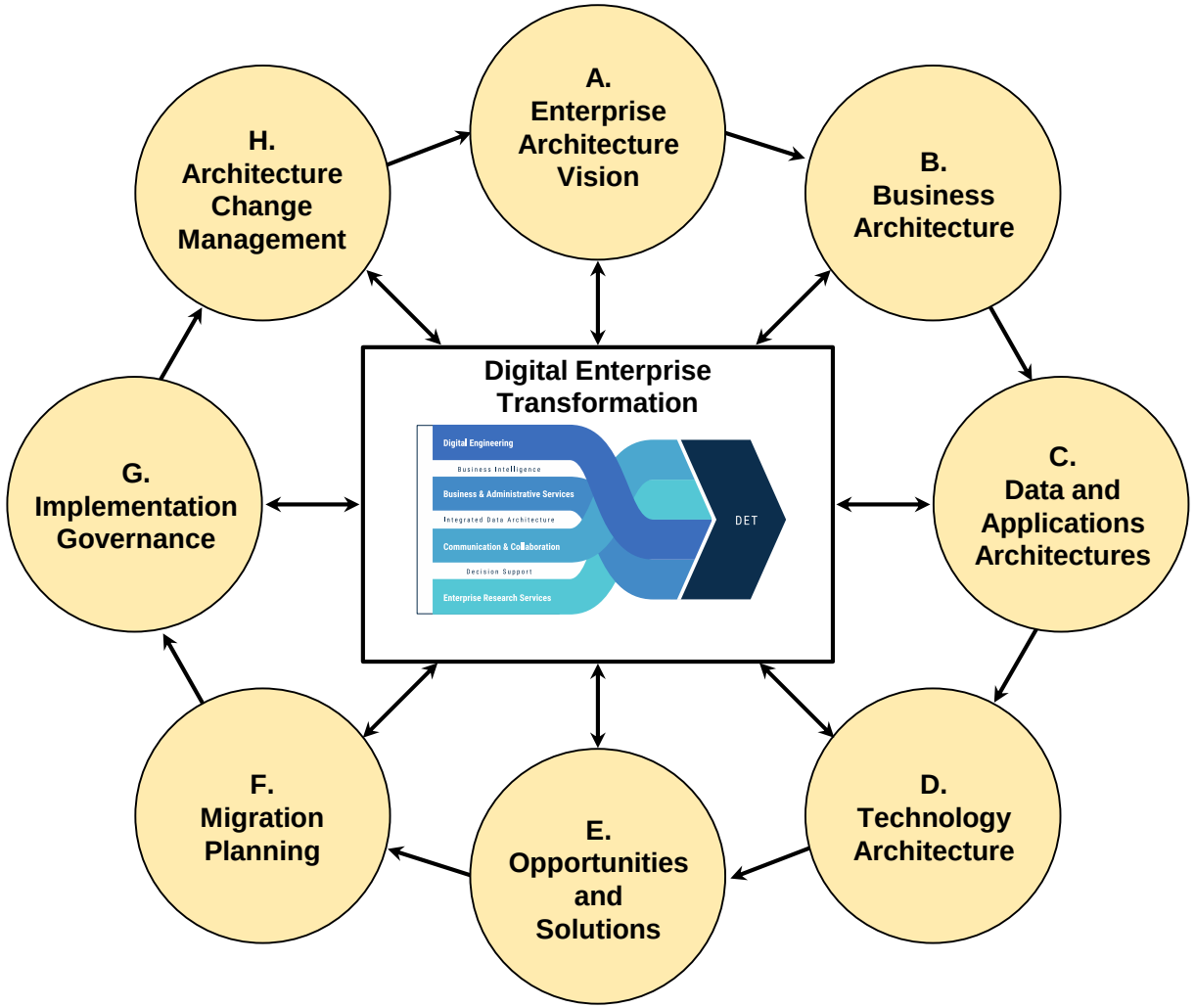
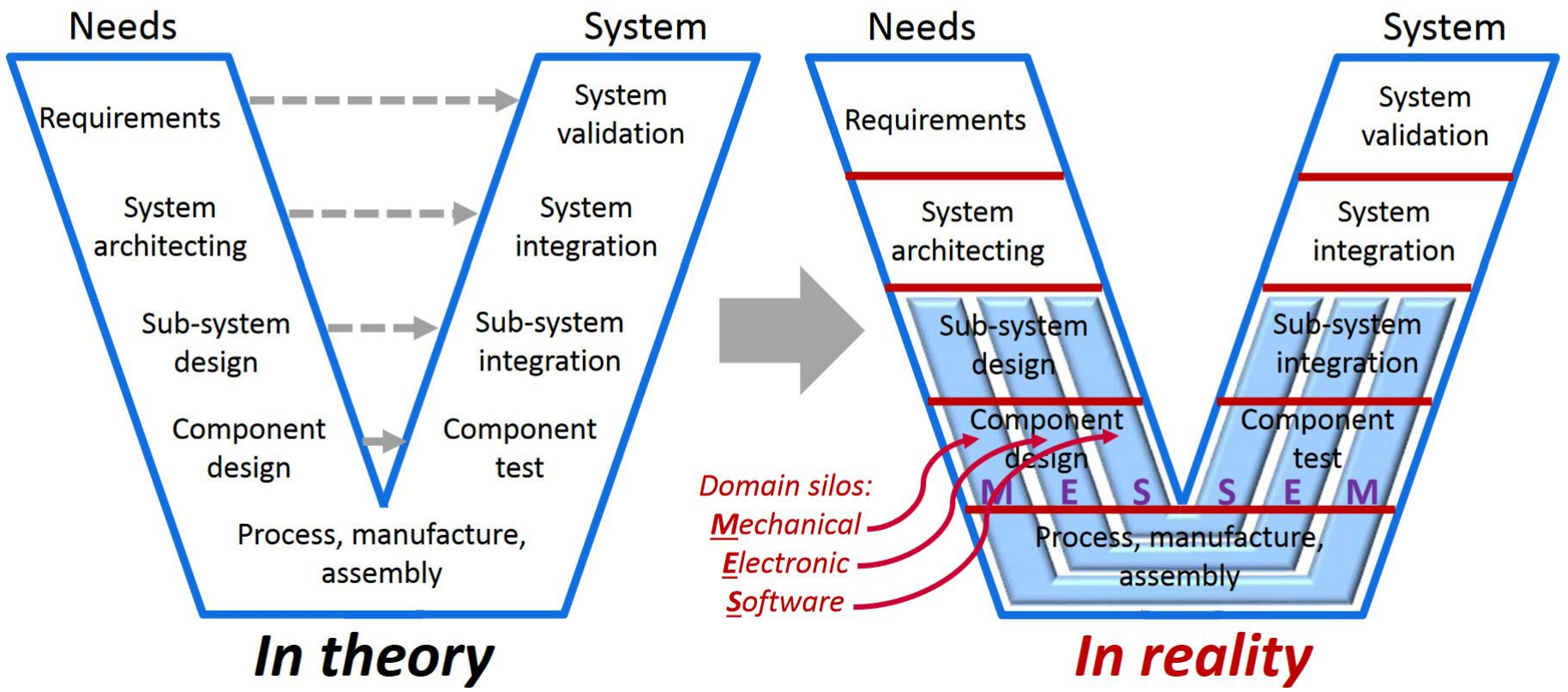


- **DET focus on operational model and enterprise architecture**
- **Lab-wide shift from collection of point solutions to architected enterprise**
- **Challenge of delineating enterprise solution vs local flexibility**
- **Building enterprise solutions with common data backbone**

*Source: The OpenGroup (TOGAF): https://pubs.opengroup.org/architecture/togaf8-doc/arch/chap32.html

V-Process supports Systems Engineering



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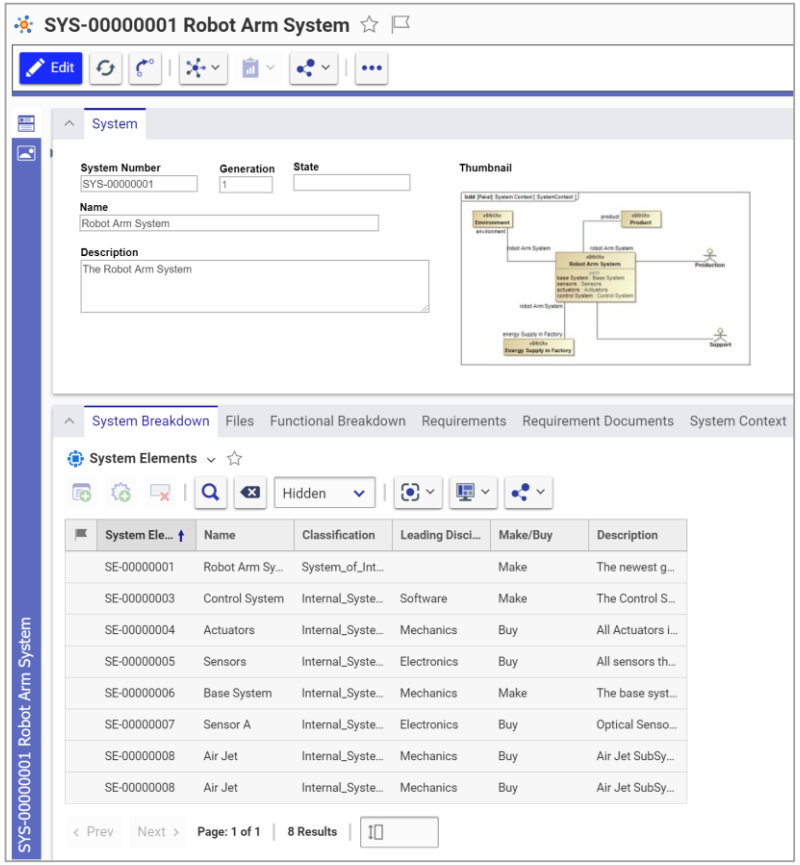
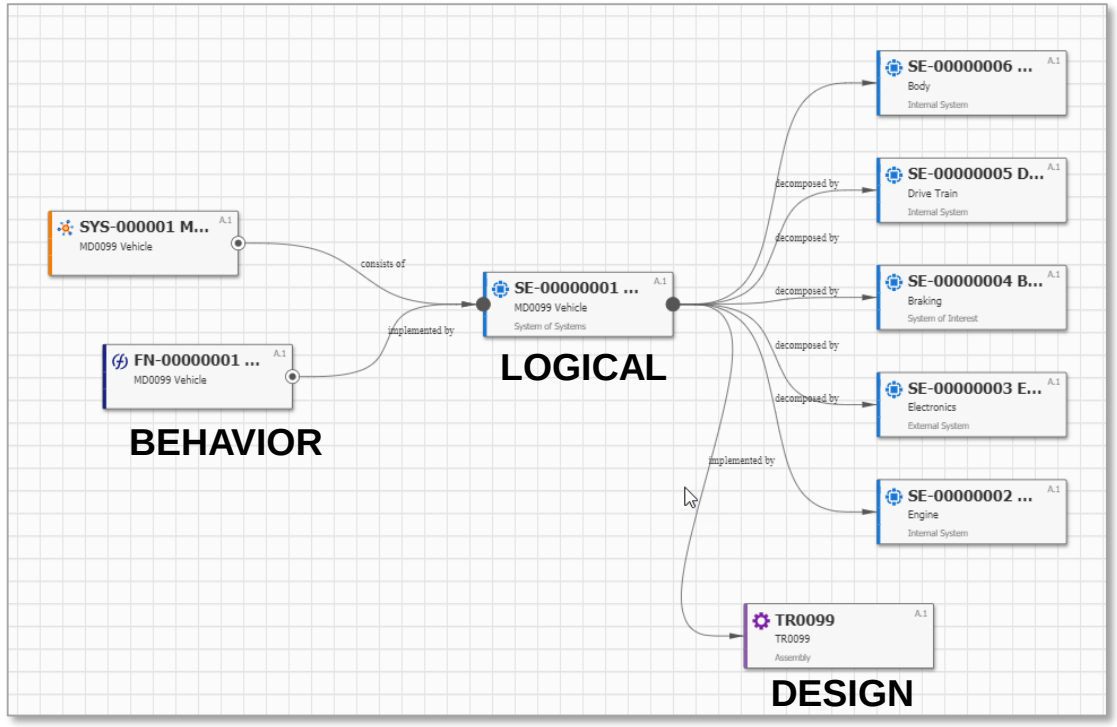
aras.com

- **MBSE connects the hardware related domains through definition of behaviors and logical breakdown**

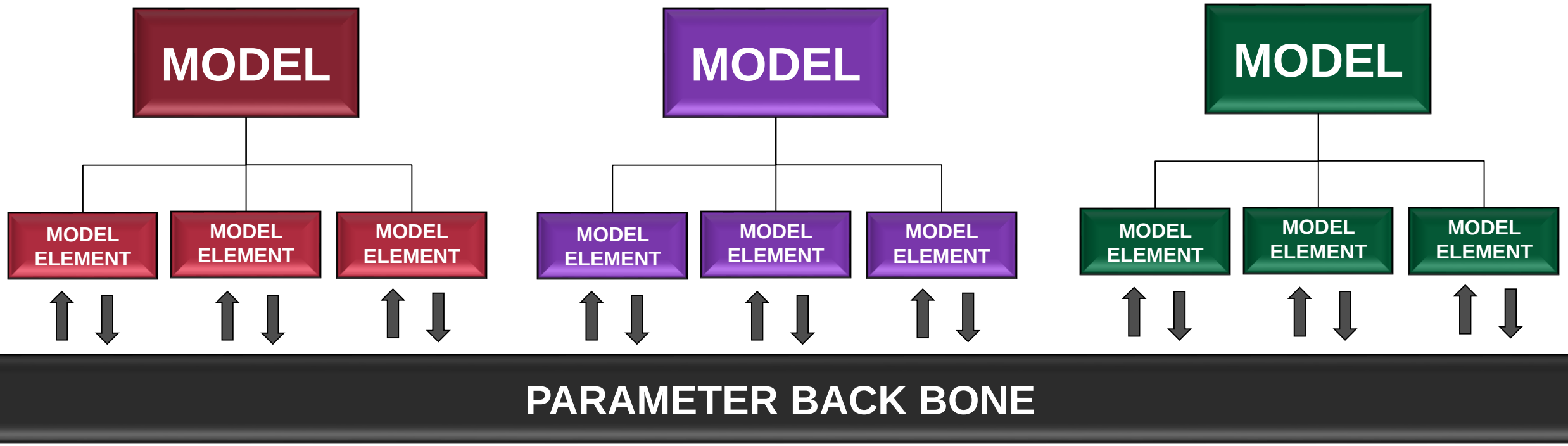
Connection of Model Elements





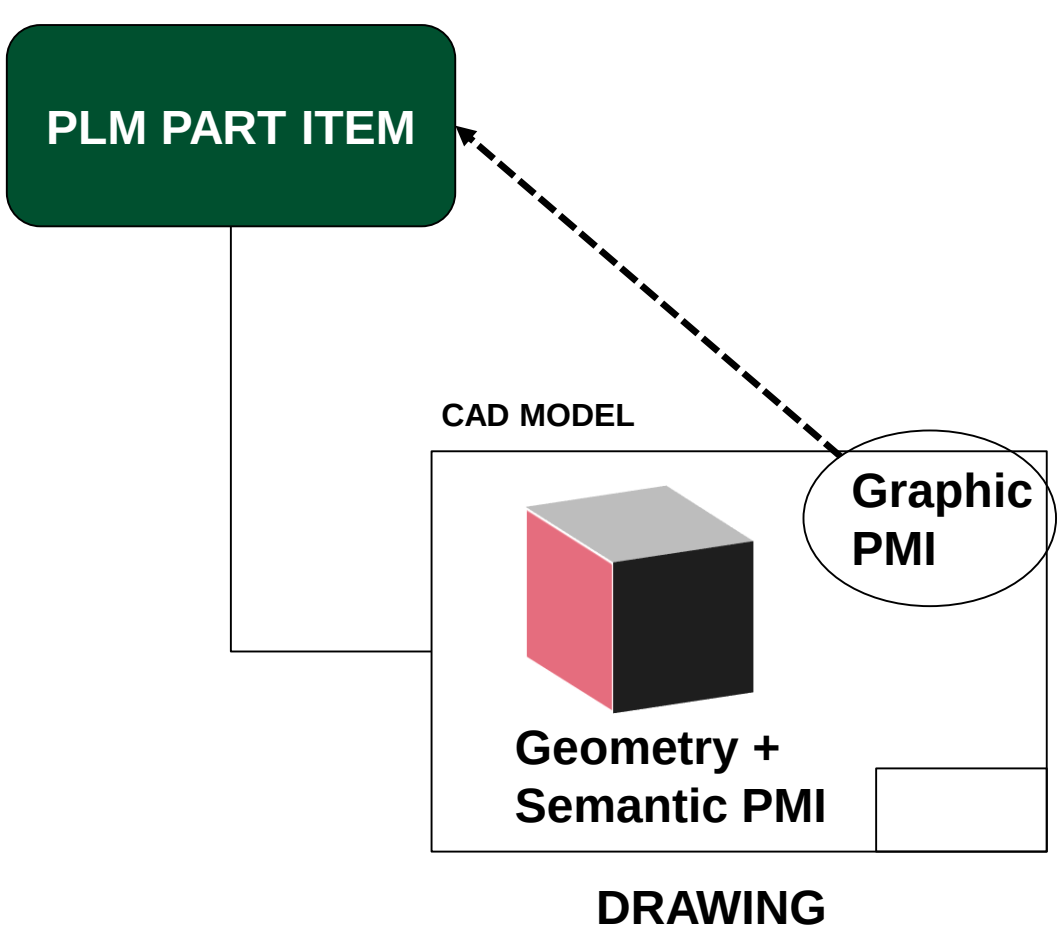
- **PLM elements act as the common language across domain models**
- **Item level connectivity is not enough**

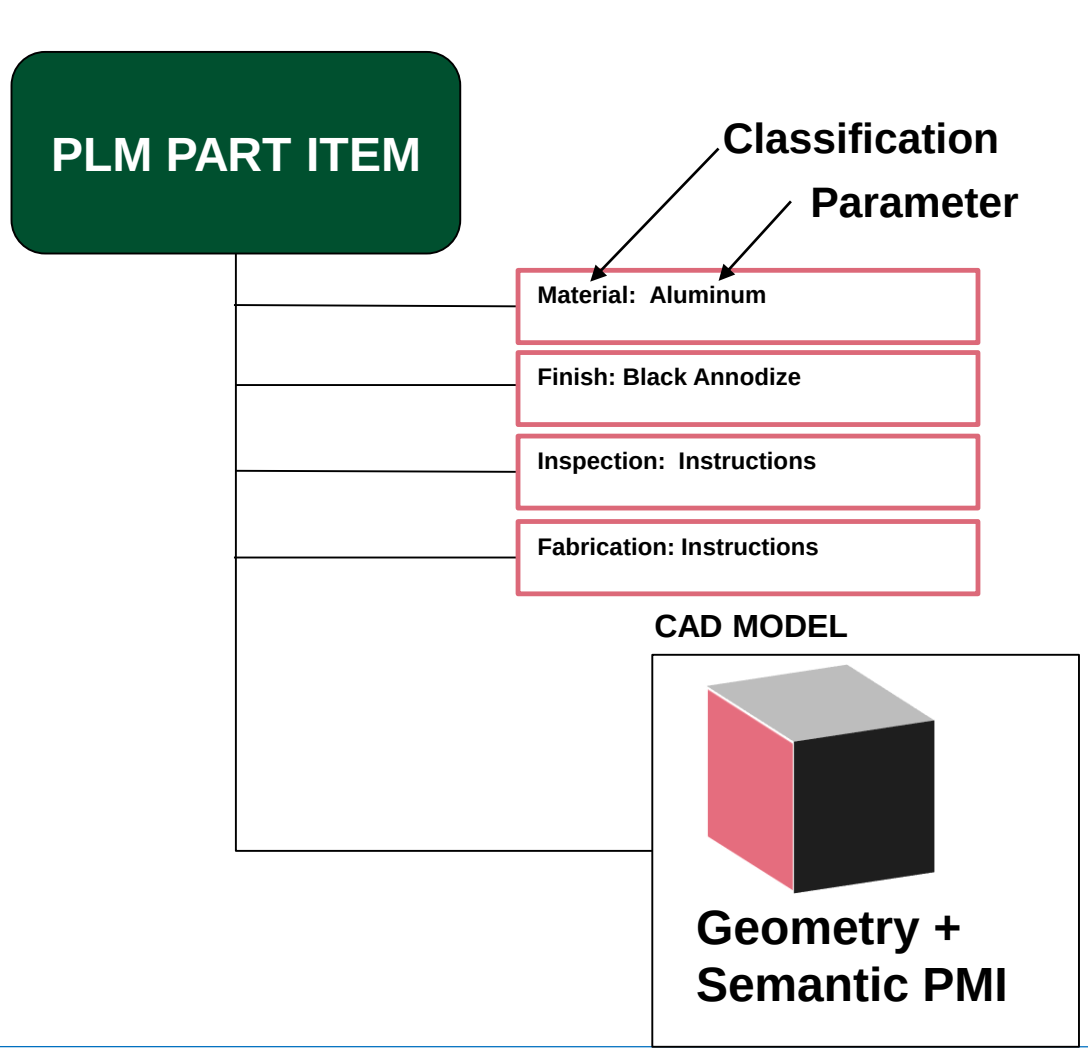
Common Language



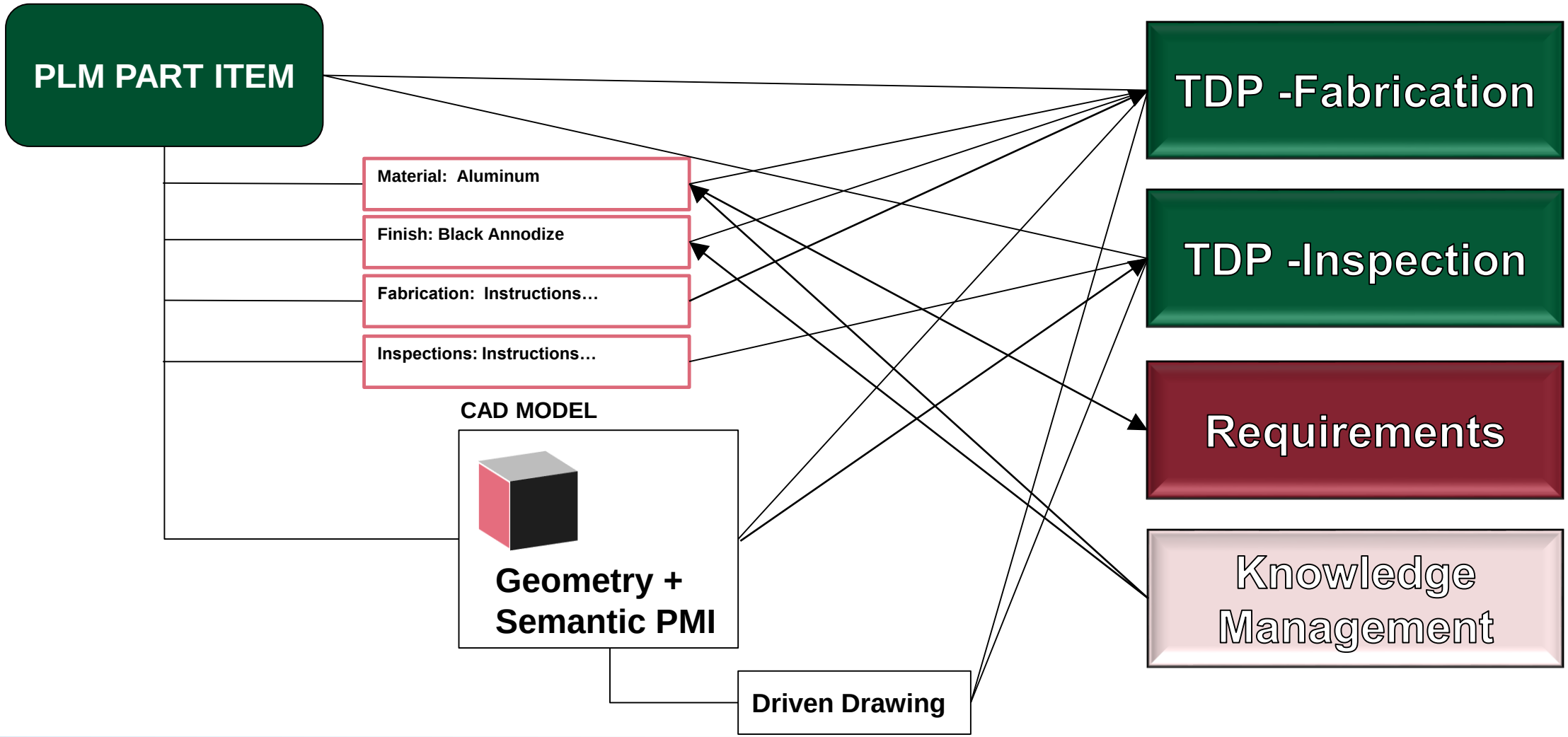
- **Across model domains we need to determine the resolution of connection and define a common language for connectivity**
- **Often "Documents" are the connecting tissue between work in different domains – must have language to build modeled documents**

Two Data Model Approaches - Mechanical Documents





PLM Data Opportunities

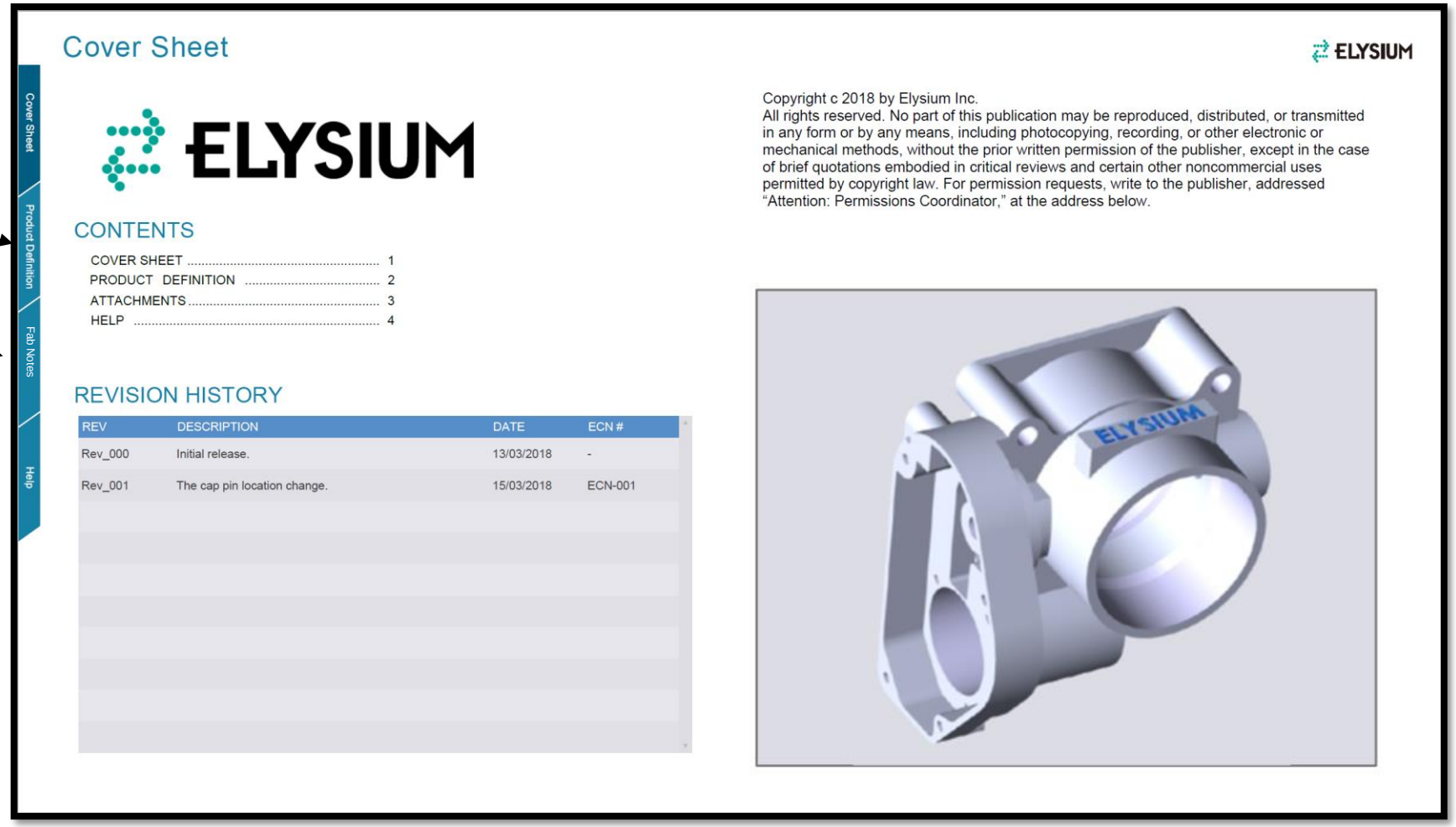


Sample Generated PDF

Part data and image

3D Image and semantic PMI

Notes (graphic PMI)



Cover Sheet

ELYSIUM

Cover Sheet | Product Definition | Fab Notes | Help

ELYSIUM

CONTENTS

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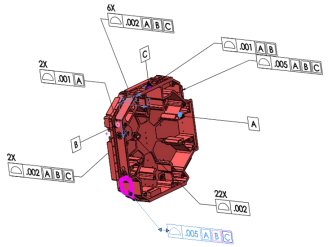
REVISION HISTORY

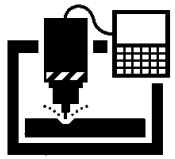
REV	DESCRIPTION	DATE	ECN #
Rev_000	Initial release.	13/03/2018	-
Rev_001	The cap pin location change.	15/03/2018	ECN-001

Current Model Based Capability - Mechanical

Create Fully Annotated Model



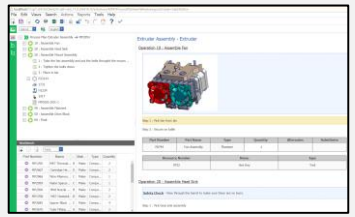
Consume Annotated Model CAM



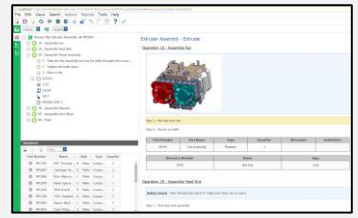
Consume Annotated Model Inspection

Development in Process

Create Modeled Procedure



Execute Procedure



CM PROCESSES AND DERIVATIVE GENERATION

DIGITAL TWIN CREATION (Part)

PLM INFRASTRUCTURE

DIGITAL TWIN CONSUMPTION (Part)

DIGITAL TWIN CREATION (Assembly)

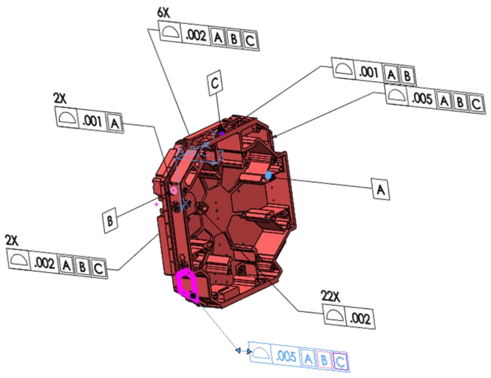
Create Material and Orders in ERP

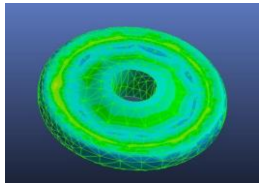
Material Feedback from ERP

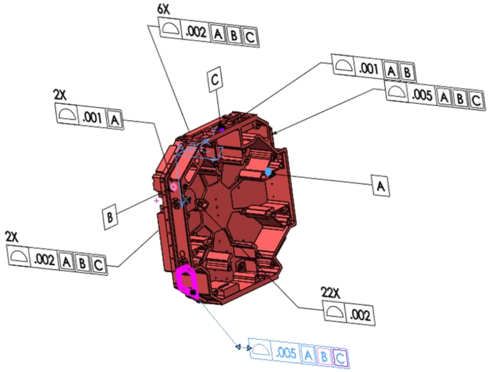
Model Based Hope

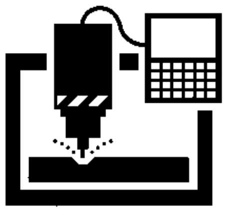
Global Product Data Interoperability Summit | **2020**

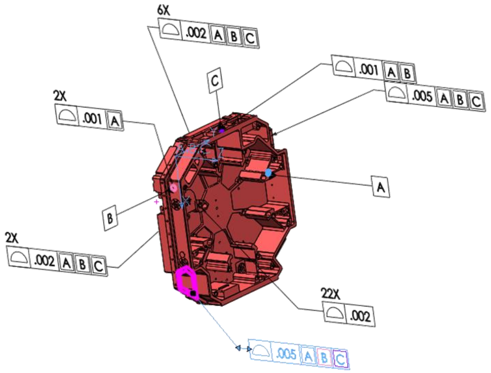
Design, Define → **Control, Publish, Communicate** → **Fabricate** → **Verify**

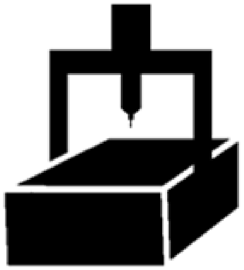


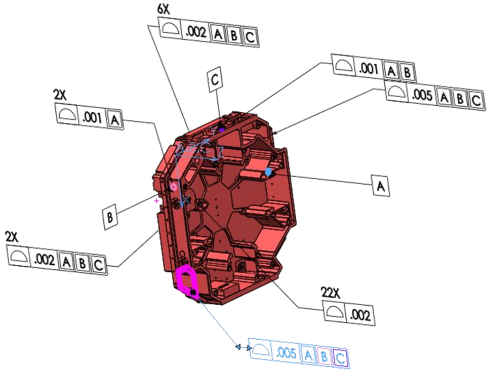




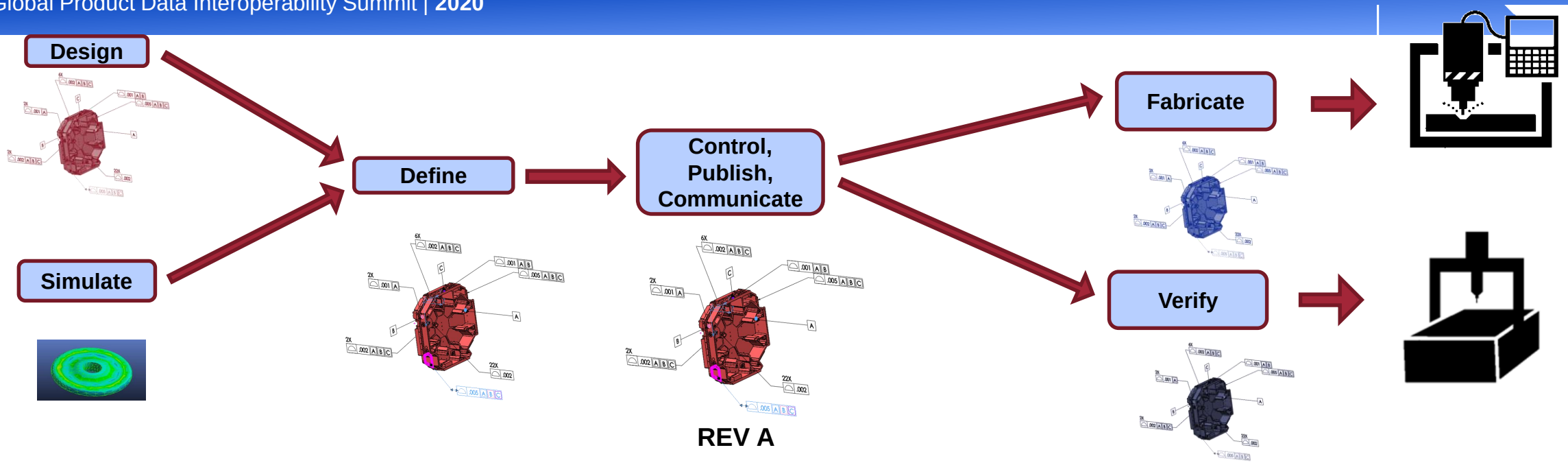


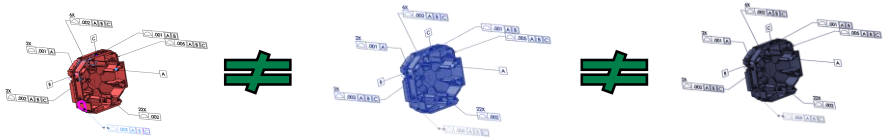






Model Based Reality



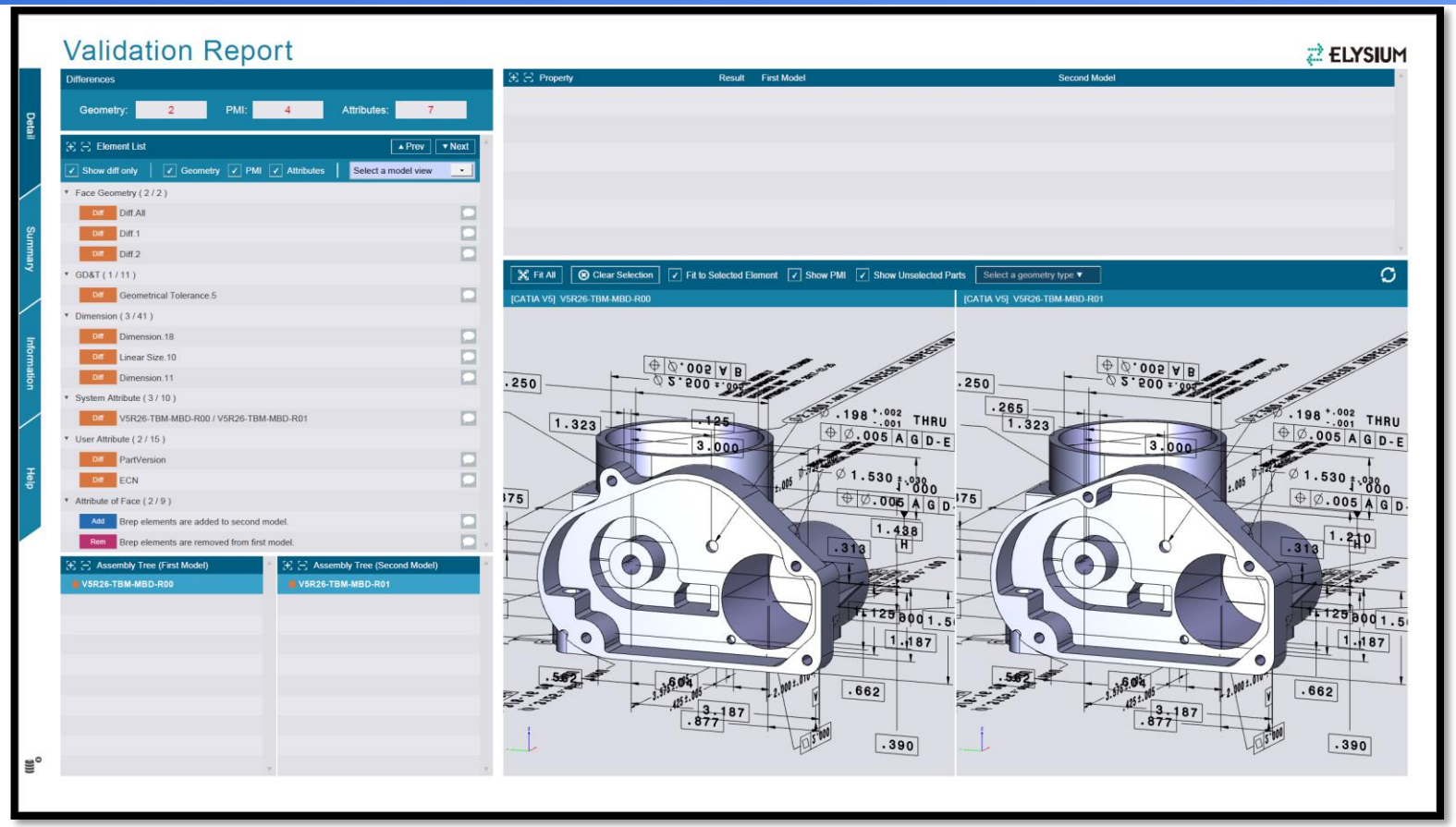


Design REV A ≠ Fab REV A ≠ Inspection REV A

After design Rev approval each discipline changes model for purpose

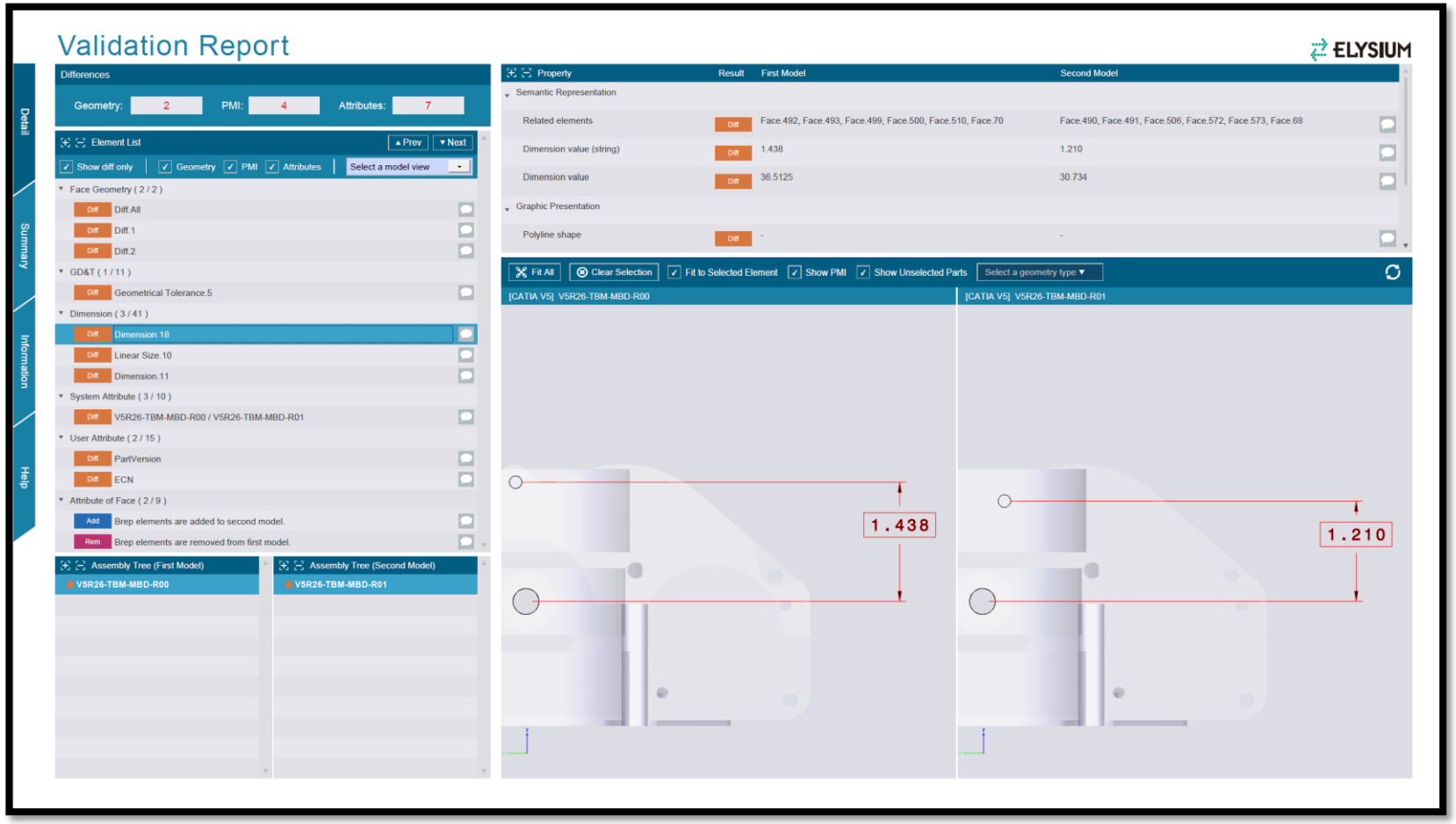
Traditional CM doesn't address multi-use of model

Feature Based Version Comparison



- **If the change can be quantified to feature and parameter level, the change impact matrix can become decision based**

Record of Difference

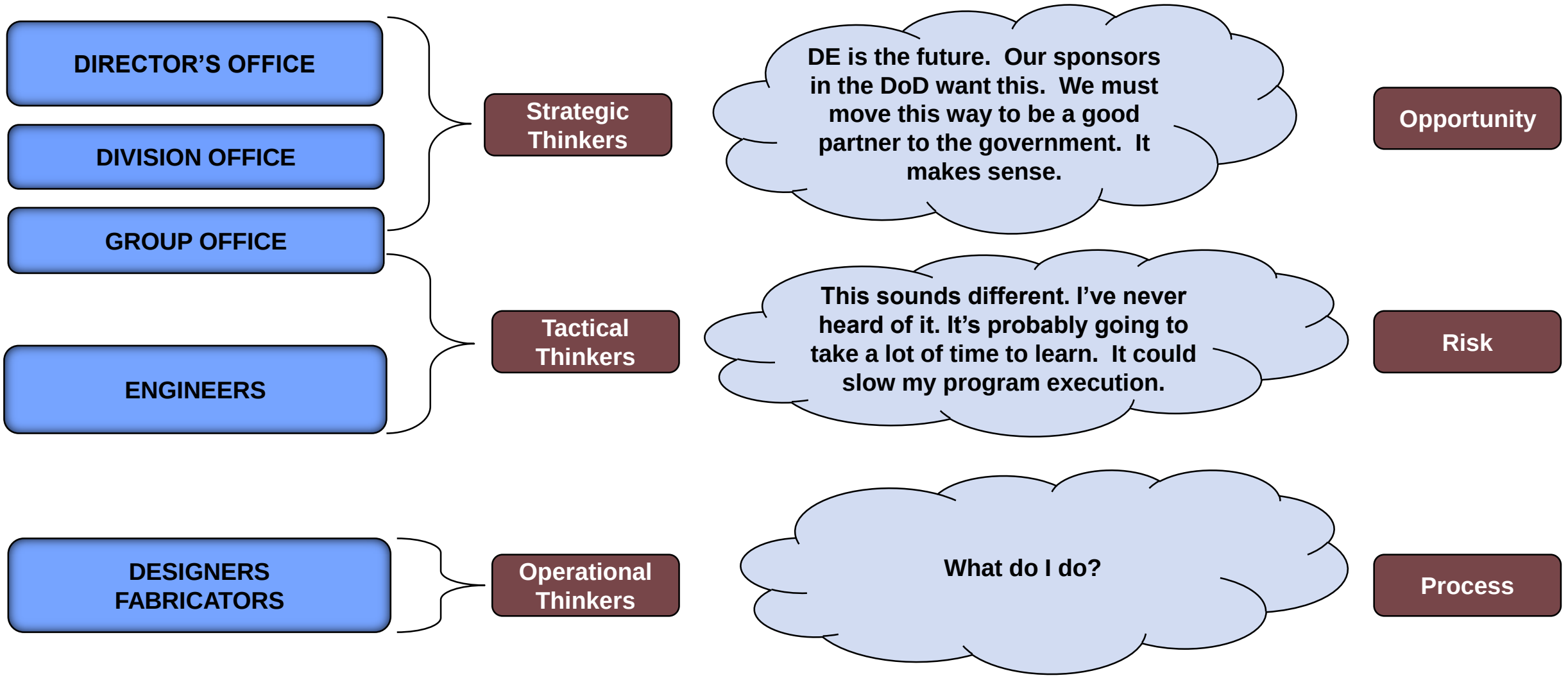


- **TDP approach becomes the record of change as well as the decider**

Cultural Interoperability

- ✓ **Vertically integrated**
- ✓ **High variability in designs**
- ✓ **100 programs/year**
- ✓ **Rapid development cycle**
- ❑ **Engineering (not hardware) centric**
- ❑ **High workload**
- ❑ **Perceived uniqueness**
- ❑ **Process averse**
- ❑ **Low level of central control of engineers**
- ❑ **Conservative/Innovative**
- ❑ **Very low turnover of workforce**
- ❑ **Paper driven**

Lincoln Hierarchy



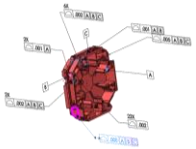
Strategic - Organizational Change Management

We're undertaking a Digital Transformation. Our sponsors and employees expect this of us

Organizational Buy-in

I support you wholeheartedly. We need this

Let me tell you a little bit about what this means



Education

Isn't that exciting! I want you to help build this. What do you think?

Team building

Dashboards!

Realization that digital maturity takes a while to attain. Sometimes bridging the gap with simple concepts is important.

Tactical - Organizational Change Management

Vision Development

Well, you realize it's all a big dashboard. What's on the dashboard?

Everything that will make my job easier. My job is really manual now.

Discovery

OK. Let's gather your requirements.

Someone prints out the file and gives me 3 copies. I throw 2 out. Then I scan the 3rd one. I've always gotten 3.

Proof of Concept

OK. We've deconstructed all the work and rebuilt it into a connected environment. Now you can see it in a dashboard.

But it looks different. How do I get my copies? What do I scan?

Denial

It's a change, but it will eliminate wasted time and give you better information. Why don't you try it?

What if it doesn't work. What if it takes long to learn. What if I push the wrong button.

Realization that risk avoidance rather than reward is the driver in a fast paced environment. Get people on board who are willing to take risks and share their knowledge.

Operational Organizational Change Management

Agile Process

We're using agile. I would like you to comment on the layout. The buttons don't work yet.

I spent all week trying to push the buttons and they don't work. This software sucks.

Realization that users don't understand agile.
Constantly check-in on new ideas.

Participation

Here are the three steps. Please try them and give me feedback.

Where are the folders? This isn't going to work. I don't have time.

Realization that not everyone pays attention to demos.
Have trainers and testers guiding users in new concepts.

User Feedback

Please give me details on your issues and we'll incorporate your suggestions

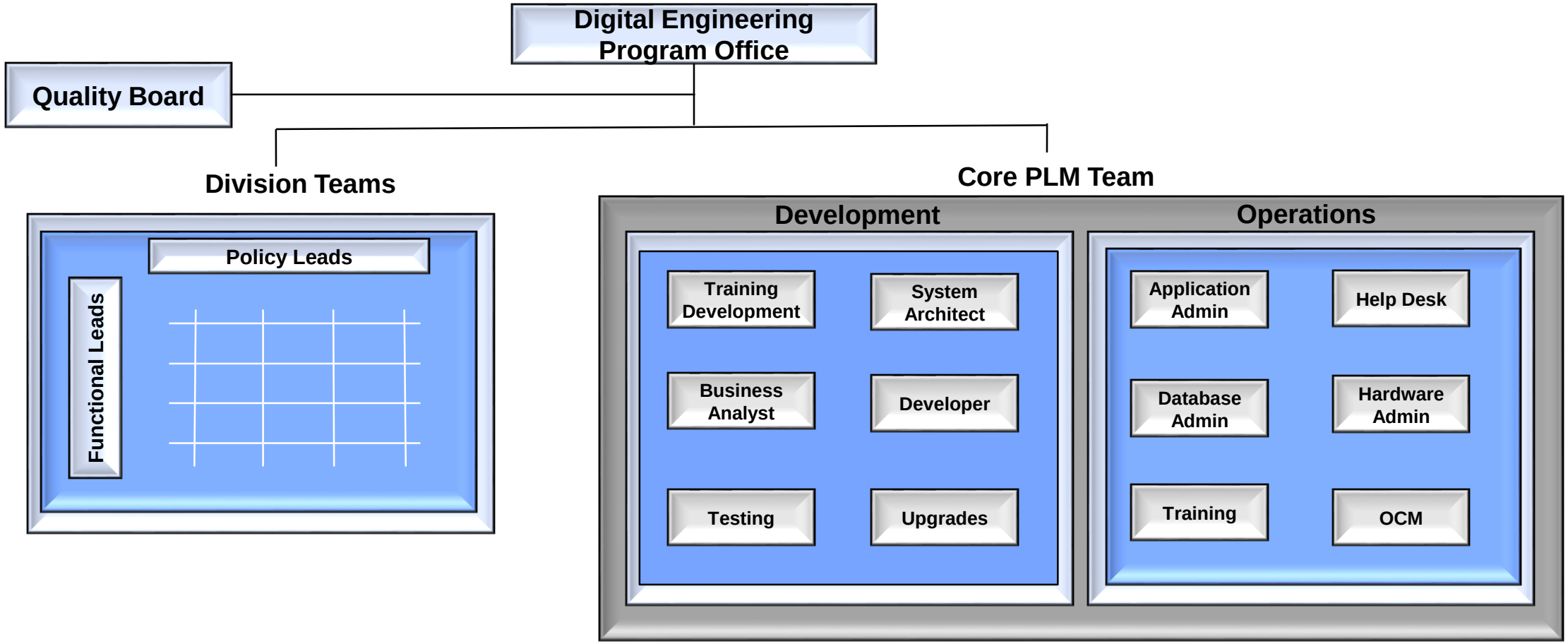
It shouldn't do this.
It didn't work.
I got an error message

Realizing that operational thinkers know when the process doesn't work, but not how to fix it.
Have observers who can ask the right questions.

Go-Live

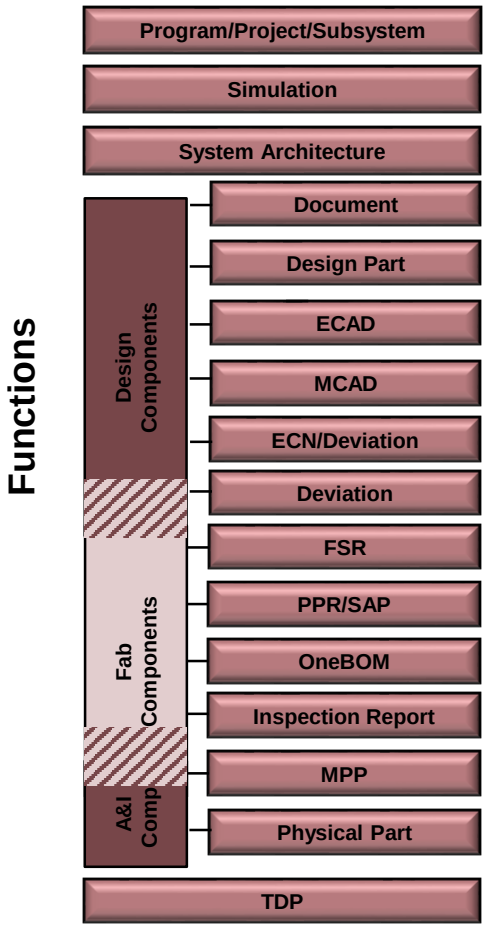
This is it? I wish you had asked me.

Reorganized Structure

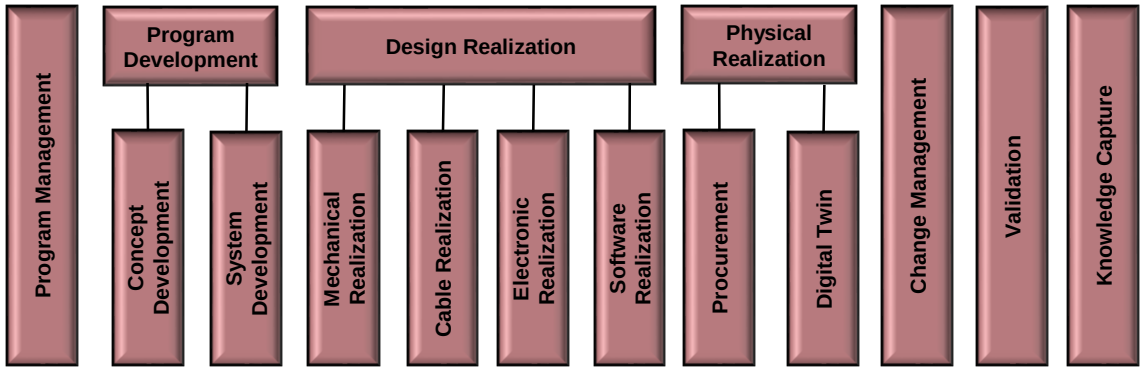


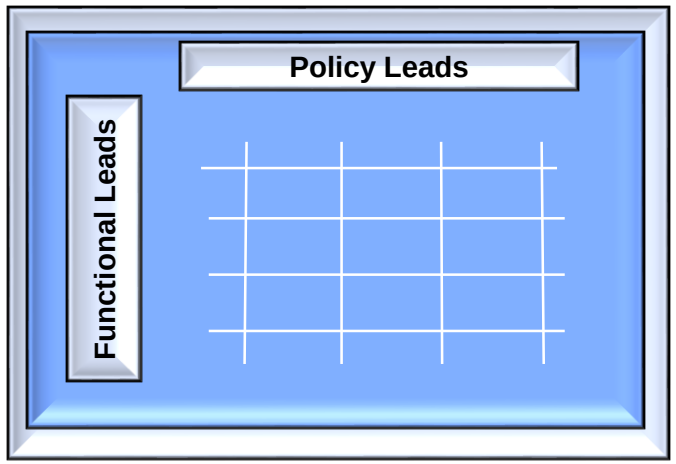
Division Team Structure

Who and How?



Policy Value Streams





What and Why?

- **Broke the Division into the work we do rather than the discipline**
- **All value streams cross groups and disciplines**
- **Forces leaders to think about creation and consumption of data**
- **Matrixed with tactical owners of the process**

Final Thoughts

- **The Problem**
  - **Our goals and overall strategy have not changed**
- **The Design Solution**
  - **Value in design approach evolves over time as you understand the problem more**
- **The Reality**
- **The Solution**
  - **Not everyone shares your vision internally or externally. That won't change. Look for common language and synergy.**

Thank you attending this session

Please join us for the next GPDIS session on Tuesday, October 27

Jack Harris, CEO/General Manager
PDES
Standards Impacting Business Performance

2020 GPDIS Virtual Sessions Agenda

All Sessions From 2:00 PM ET to 3:30 PM ET

Session 1: Friday, October 2nd
Session 2: Tuesday, October 13th
Session 3: Thursday, October 15th
Session 4: Tuesday, October 27th
Session 5: Thursday, October 29th
Session 6: Tuesday, November 10th
Session 7: Thursday, November 12th
Session 8: Tuesday, November 24th

Recordings and presentation decks can be found under the 2020 Presentations at https://gpdisonline.com/event-history/