

Trusting Digital in the Nuclear Age



Sandia's MBE Journey so far

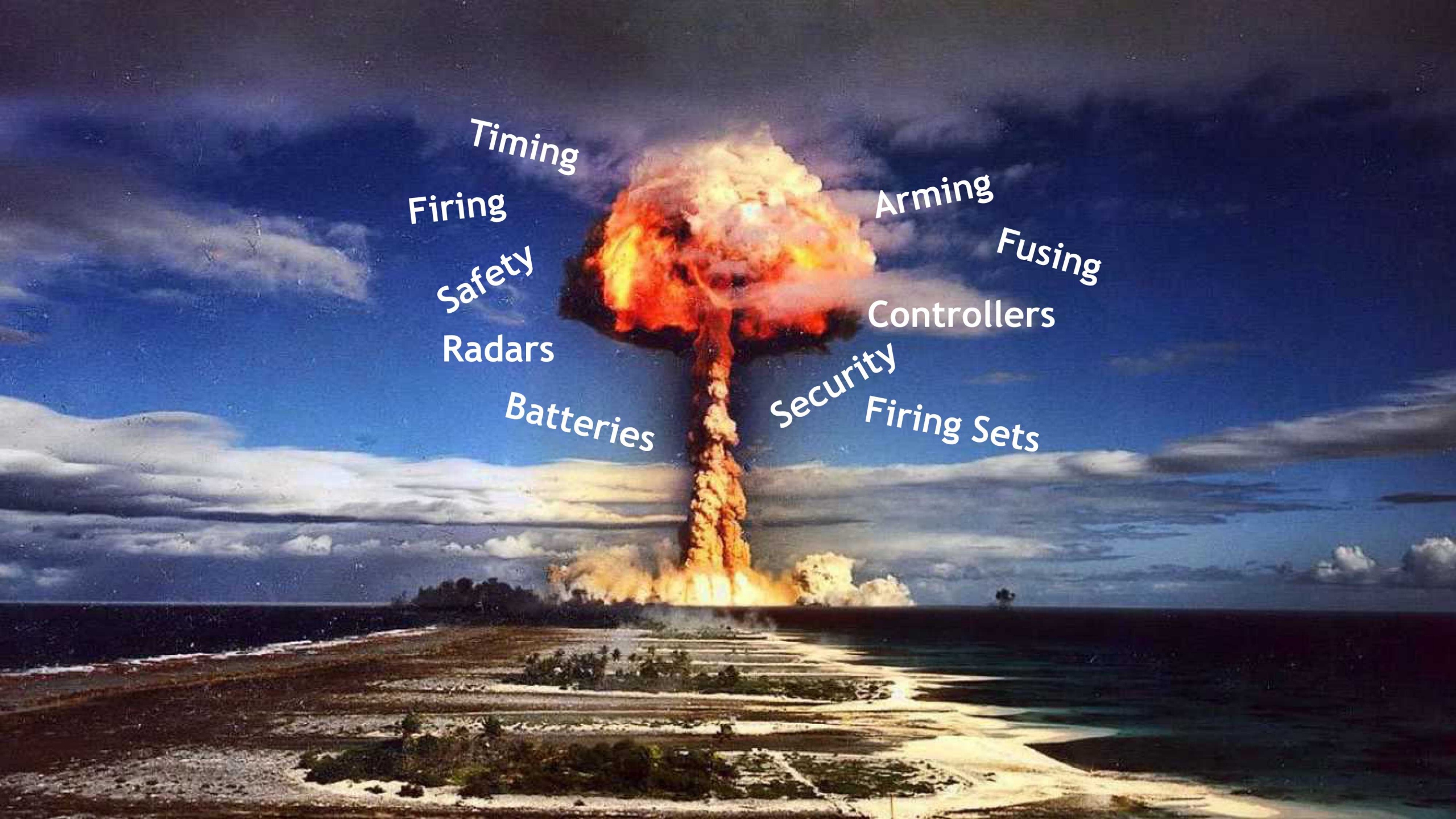
Sarah Hale



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Timing
Firing
Safety
Radars
Batteries
Arming
Fusing
Controllers
Security
Firing Sets

Nuclear Security Enterprise

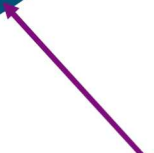
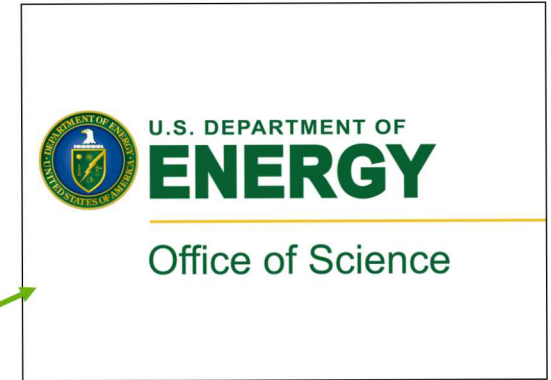


➤ 10 Locations

➤ 7 Maintenance & Operations Contracts

➤ 2 Security Environments

Extended Enterprise



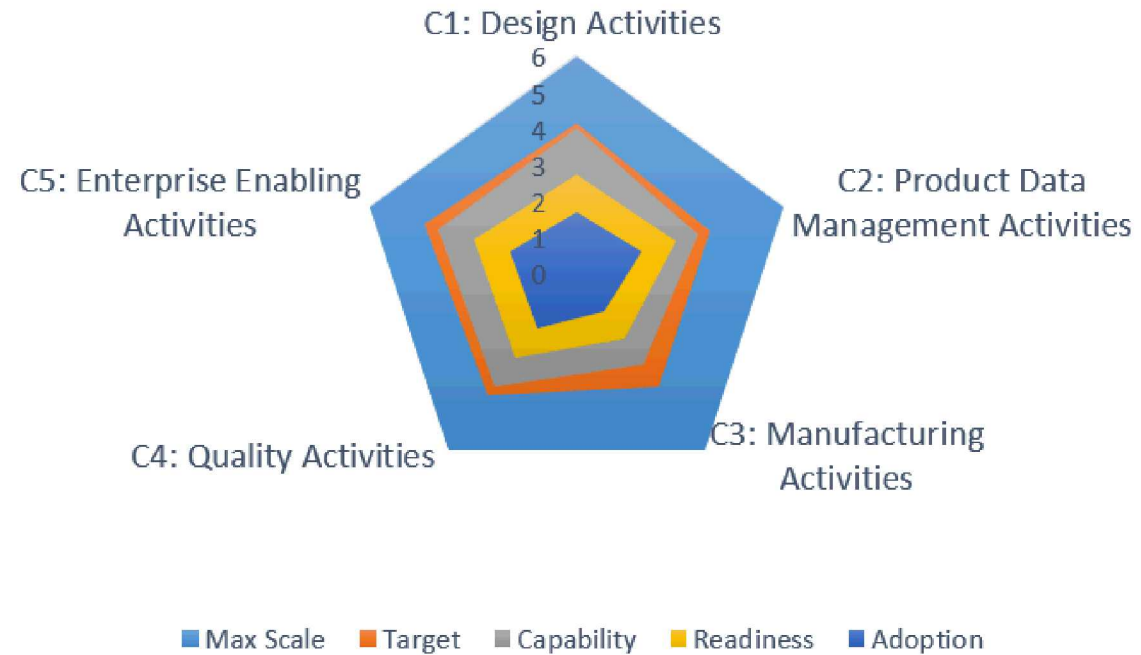
Building Trust Across the Enterprise

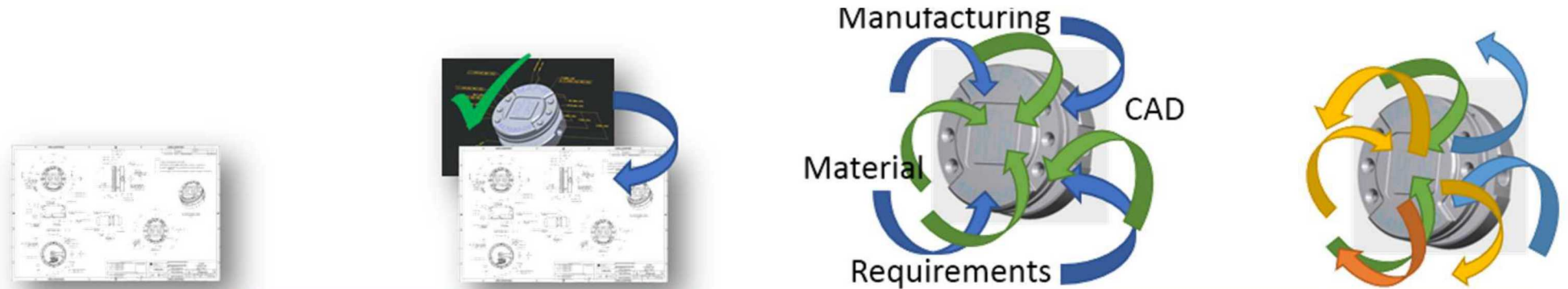
MBE Category / Topic / Facet		Description: how the organization . . .	Transition: As maturity increases, the	Drawing-Centric (L0)	Model-Centric (L1)	Validated Model-Centric (L2)	Model-Based Definition (L3)	Trusted Model-Based Definition (L4)	Integrated Model-Based Enterprise (L5)	Extended Model-Based Enterprise (L6)
Assessment Identifier (AID): [organizationally unique identifier]		Organization under assessment (OUA): [name of organization]		Description of Environment: [bounding conditions that establish and differentiate the organization under assessment]					Assessor: [Individual(s) or group]	
MBE Maturity Index - WIP Draft: 20190820										
Maturity Level Name Level # Categories (e.g., C1) ↳ Topics (e.g., T3) ↳ Facets (e.g., F2)	Description: how the organization . . . Transition: As maturity increases, the organization's . . .		Drawing-Centric	Model-Centric	Validated Model-Centric	Model-Based Definition	Trusted Model-Based Definition	Integrated Model-Based Enterprise	Extended Model-Based Enterprise	
			L0	L1	L2	L3	L4	L5	L6	
C1: Design Activities	Activities involved in developing a design for product definition or other lifecycle activity.	Product definition becomes the trusted model-based definition dataset.	2D Drawings used for all activities	2D Drawings derived from models	2D Drawings and other derivatives from Validated Model	Semantic PMI included with model	Certified, Authorized MBD	MBD Dataset made useable for all lifecycle activities within enterprise	MBD Dataset made useable for all lifecycle activities	
C2: Product Data Management Activities	Activities that relate product lifecycle data to product definition.	Data Management processes change from manual to automated, from document-centric to part-centric, from CAD files to product lifecycle data. Once mature, PDM integrates with other systems and extends to the trusted supplier.	File-Sharing Directory	Document-Centric PDM	Document-Centric PDM; Disconnected with Models	Part-Centric PDM; Product Related Disciplines	Part-Centric PDM; Product & Process Related Disciplines	Digitally "One" Part-Centric PDM within Enterprise	Extended digital exchange part-centric PLM with trusted suppliers	
C3: Manufacturing Activities	Activities involved in making a product.	Make it easier to manufacture your parts. Manufacturing process changes from drawing-based to model-based to automation; and from document-centric to part-centric and extends to the trusted supplier.	2D Drawings used for all Manufacturing Related Activities	Manufacturing via 2D drawings supported by disconnected derivative (e.g. STEP) or recreated models	Manufacturing via validated derivative models along with 2D Drawings	Manufacturing via validated derivative models supported by 3DIVs.	Digital Manufacturing via trusted MBD.	Digital manufacturing via smart derivative models.	Automated manufacturing processes extended to trusted partners via smart derivative models.	
C4: Quality Activities	Activities involved in manufacturing verification, part inspection, and product acceptance.	Make it easier to validate and accept your parts. Verification and acceptance processes change from drawing-based to model-based to automatic; from document-centric to part-centric; and extends to the trusted supplier.	2D Drawings used for Verification, Inspection, Testing, & Acceptance Activities	Verification & Acceptance performed from 2D drawings with disconnected derivative (e.g. STEP) or recreated models.	Verification & Acceptance performed from 2D drawings with validated derivative models.	Verification & acceptance performed from 3DIVs with certified derivative models.	Digital Verification, Inspection & Acceptance via trusted MBD.	Digital metrology via smart derivative models with product characteristics	Automated metrology processes, extended to trusted partners via smart derivative models	
C5: Enterprise Enabling Activities	Activities that enable an enterprise to act as a MBE, do not directly add value to a product's lifecycle.	Make it easier to enable an enterprise to develop, implement and sustain an MBE.	Non-existent MBE	MBE Awareness	Reactive MBE	Repeatable MBE	Digital MBE	Integrated MBE	Optimized MBE	

Building Trust Across the Enterprise

TO-BE Level	AS-IS Level		
Target: Tailored for Organization	Capability: Tools are Available?	Readiness: Processes are Ready?	Adoption: People are Using?
4.1	3.7	2.7	1.7
4.2	4.0	2.7	1.7
5	5.0	2.0	2.0
	5	2	2
N/A	N/A	N/A	N/A
	N/A	N/A	N/A
	N/A	N/A	N/A

MBE Maturity Index





Level Name	Drawing-Centric	Model-Centric	Validated Model-Centric	Model-Based Definition	Trusted Model-Based Definition	Integrated Model-Based Enterprise	Extended Model-Based Enterprise
Level Identifier	L0	L1	L2	L3	L4	L5	L6
Level Theme	<ul style="list-style-type: none"> 2D Drawings Only Disconnected Enterprise 	<ul style="list-style-type: none"> 2D Drawings & STEP Derived from 3D Models Drawings Managed Disconnected from Models 	<ul style="list-style-type: none"> 2D Drawings & Equivalent Derivatives from Validated 3D Models Drawings Managed Disconnected from Models 	<ul style="list-style-type: none"> 3D Models with Semantic PMI Added Producing 3D Interactive Viewables Managed as Part-Centric 	<ul style="list-style-type: none"> Digital Model-Based Definition (MBD) Dataset Certified and Authorized Managed and Sourced as Part-Centric 	<ul style="list-style-type: none"> Enterprise Integrated from an Optimized Trusted Digital Product Definition Dataset Process Data Managed with Part-Centric 	<ul style="list-style-type: none"> Enterprise Extended with Optimized Capabilities and Extended Partners



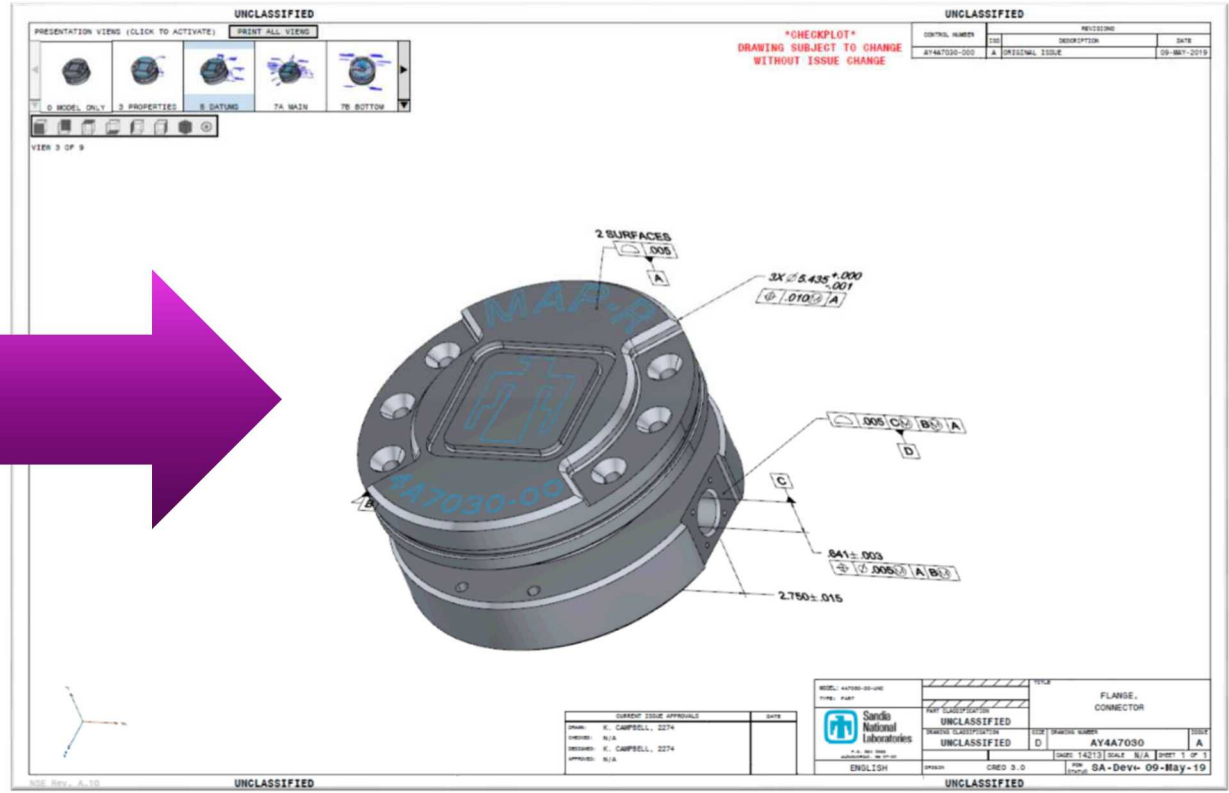
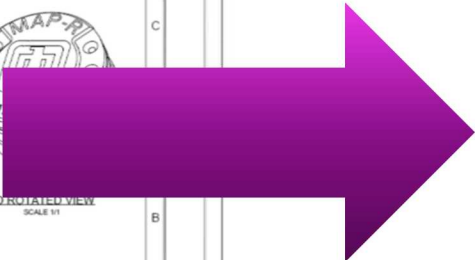
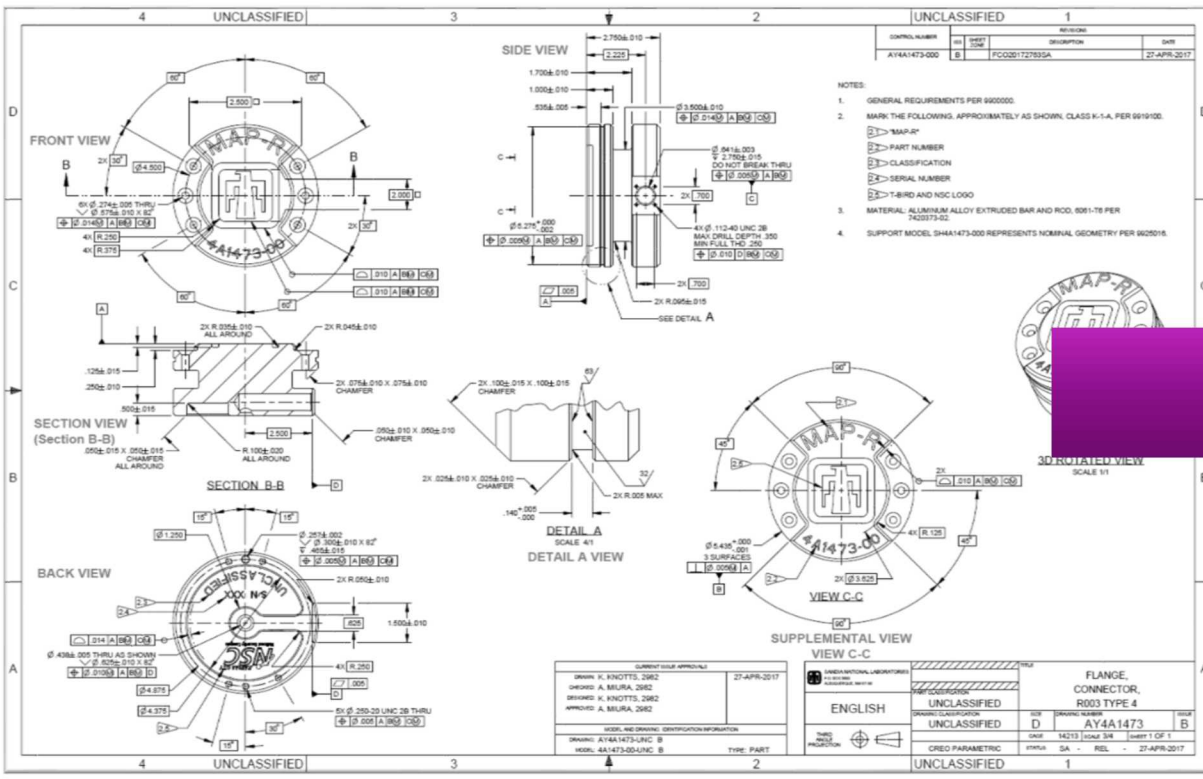
Building Trust Across the Enterprise

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			L0	L1	L2	L3	L4	L5	L6
C1: Design Activities T1: Product Authority T2: Product Requirements T3: Product Definition Representation T4: Model Quality & Certification T5: Model Derivatives T6: ECAD/MCAD Collaboration T7: Design Analysis & Simulation (includes DfX)	Activities involved in developing a design for product definition or other lifecycle activity.	Product definition becomes the trusted model-based definition dataset.	2D Drawings used for all activities	2D Drawings derived from models	2D Drawings and other derivatives from Validated Model	Semantic PMI included with model	Certified, Authorized MBD	MBD Dataset made useable for all lifecycle activities within enterprise	MBD Dataset made useable for all lifecycle activities
C2: Product Data Management Activities T1: Data Management Authority T2: Data Management Approach T3: Product Definition Management T4: Process Data Management T5: Bill of Materials (BOM) Management T6: Common Digital Libraries T7: Long Term Archival & Retrieval	Activities that relate product lifecycle data to product definition.	Data Management processes change from manual to automated, from document-centric to part-centric, from CAD files to product lifecycle data. Once mature, PDM integrates with other systems and extends to the trusted supplier.	File-Sharing Directory	Document-Centric PDM	Document-Centric PDM; Disconnected with Models	Part-Centric PDM; Product Related Disciplines	Part-Centric PDM; Product & Process Related Disciplines	Digitally "One" Part-Centric PDM within Enterprise	Extended digital exchange part-centric PLM with trusted suppliers

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T1: Manufacturing Process Definition									
T2: Tooling Definition & Realization									
T3: Manufacturing Process Instructions									
T4: Manufacturing Code Generation									
T5: Manufacturing Analysis & Simulation									
T6: Manufacturing Operations									
T7: Product Procurement									
C4: Quality Activities	Activities involved in manufacturing verification, part inspection, and product acceptance.	Make it easier to validate and accept your parts. Verification and acceptance processes change from drawing-based to automatic; from document-centric to part-centric; and extends to the trusted supplier.	2D Drawings used for Verification, Inspection, Testing, & Acceptance Activities	Verification & Acceptance preformed from 2D drawings with disconnected derivative (e.g. STEP) or recreated models.	Verification & Acceptance preformed from 2D drawings with validated derivative models.	Verification & acceptance performed from 3DIVs with certified derivative models.	Digital Verification, Inspection & Acceptance via trusted MBD.	Digital metrology via smart derivative models with product characteristics	Automated metrology processes, extended to trusted partners via smart derivative models
T1: Quality Process Definition									
T2: Quality Product Characteristics & BoC									
T3: Quality Process Instructions									
T4: Inspection Code Generation									
T5: Quality Results Management & Analysis									
T6: Test Equipment Definition & Realization									
T7: Inspection Operations									

Building Trust by using MBD in Current Processes

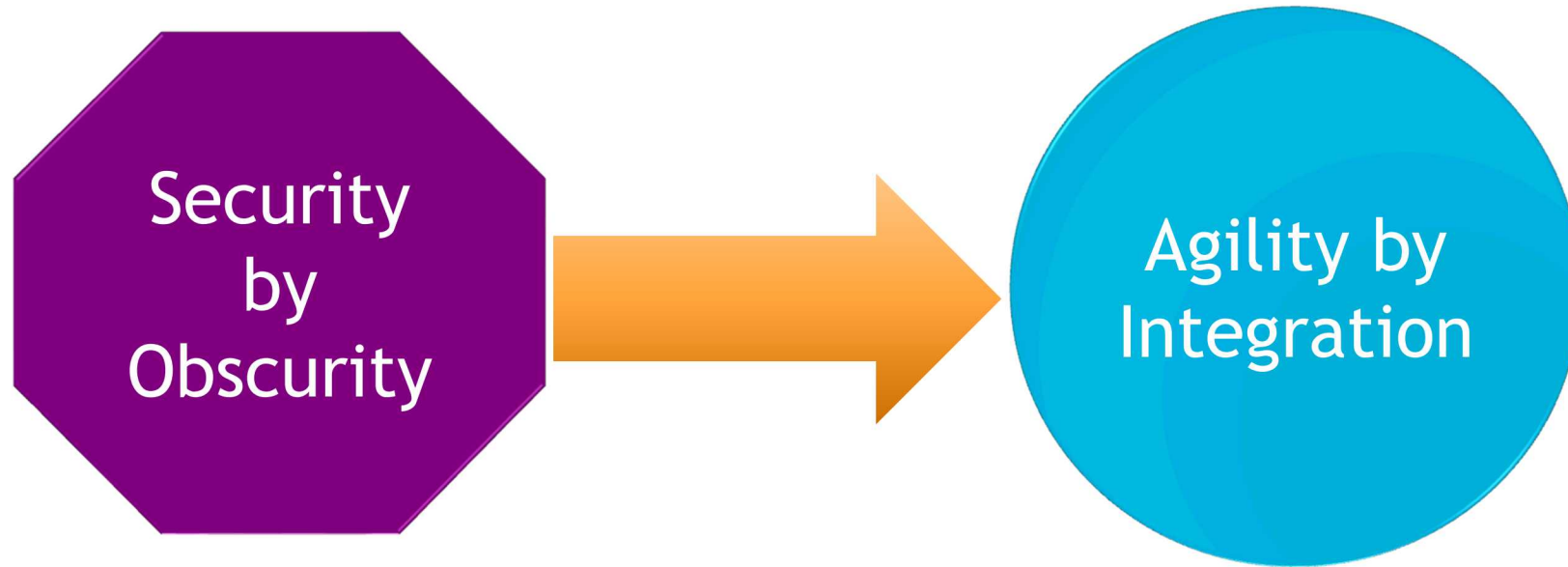


Next Challenges

- Change processes
 - Requires redoing automation based on old formats
 - Executing via 2 processes for some time



Explore new tools to connect the digital thread



How do we maintain security in the new paradigm?

How do we know software is only doing what we expect/see?