

A Framework for Data Standard Readiness

Brandon Sapp - Boeing

GLOBAL PRODUCT DATA
INTEROPERABILITY
S U M M I T

2019



Bio?

- **Brandon Sapp, MIS, BSIT**
- **18 years @ Boeing Commercial Airplanes**
- **3 years @ PLM Consultant**
- **US TAG Designated Expert to ISO TC184/SC4 and SC5**
- **A&D PAG MBD Leader**
- **PDES MBx User Group Co-Leader**
- **ASME MBE**

Presentation Overview

Problem Statement

Causes/Effects

Solution – Framework for Assessing Readiness

Problem Statement

Many organizations fail to realize the full and complete benefits of using industry data standards because they have not or inappropriately implemented them.

Causes/Effects

Cause 1: Knowledge of data standard's intended use

Cause 2: Poorly implemented in business processes

Cause 2: Inadequate tools to create/consume the data in a standard

Cause 3: Supply chain ability to consume

Effect: Wasted Resources [Rework, Common tools, etc.]

Industry Framework

ISO TC 184 : Automation Systems and Integration

SC 5 : Interoperability, integration, and architectures for enterprise systems and automation applications

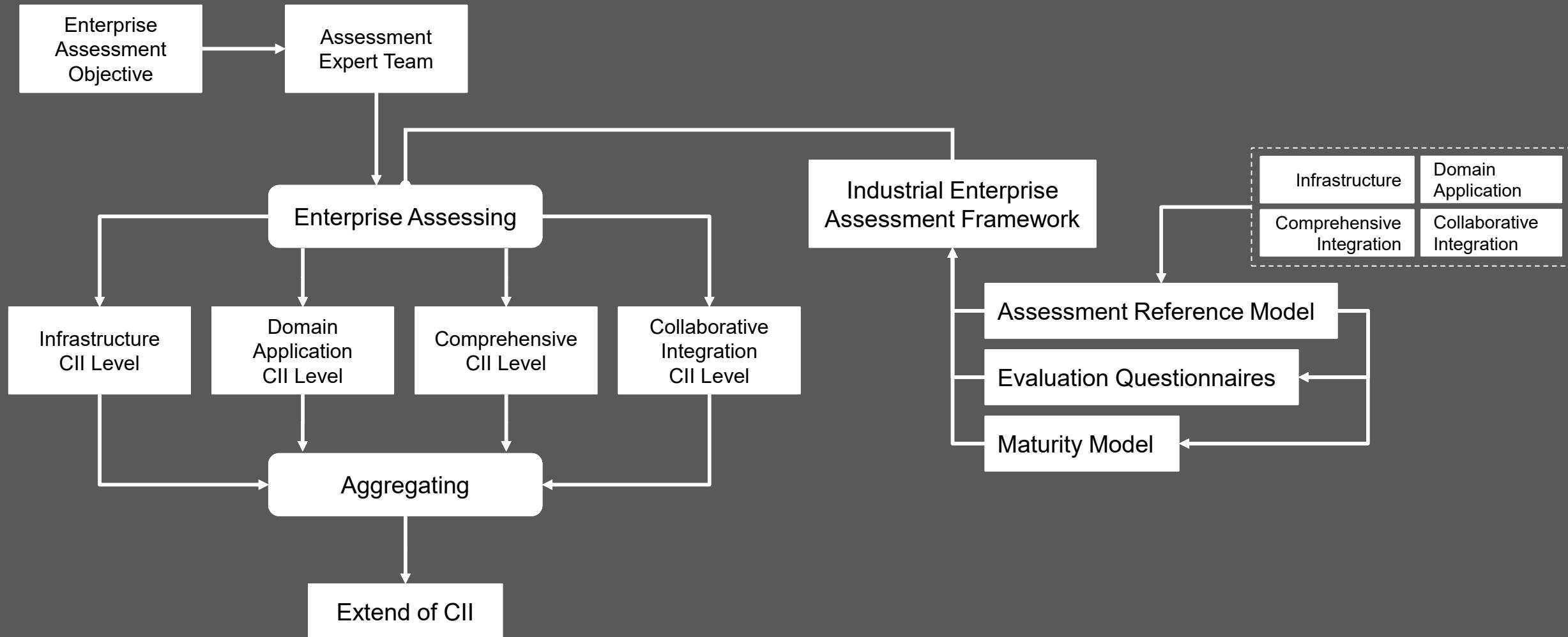
ISO/DIS 22549-1 : Assessment on convergence of informatization and industrialization for industrial enterprises

Part 1: Framework and reference model

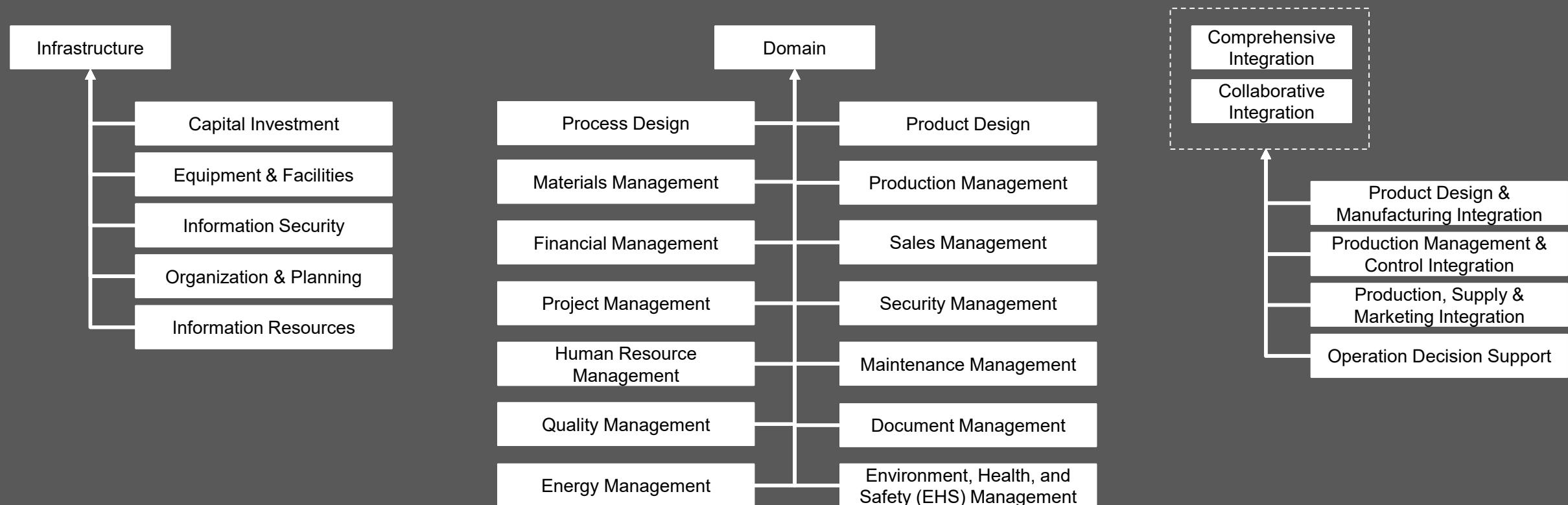
ISO/CD 22549-2.2 : Assessment on convergence of informatization and industrialization for industrial enterprises

Part 2: Maturity model and evaluation methodology

Overview of Assessment System



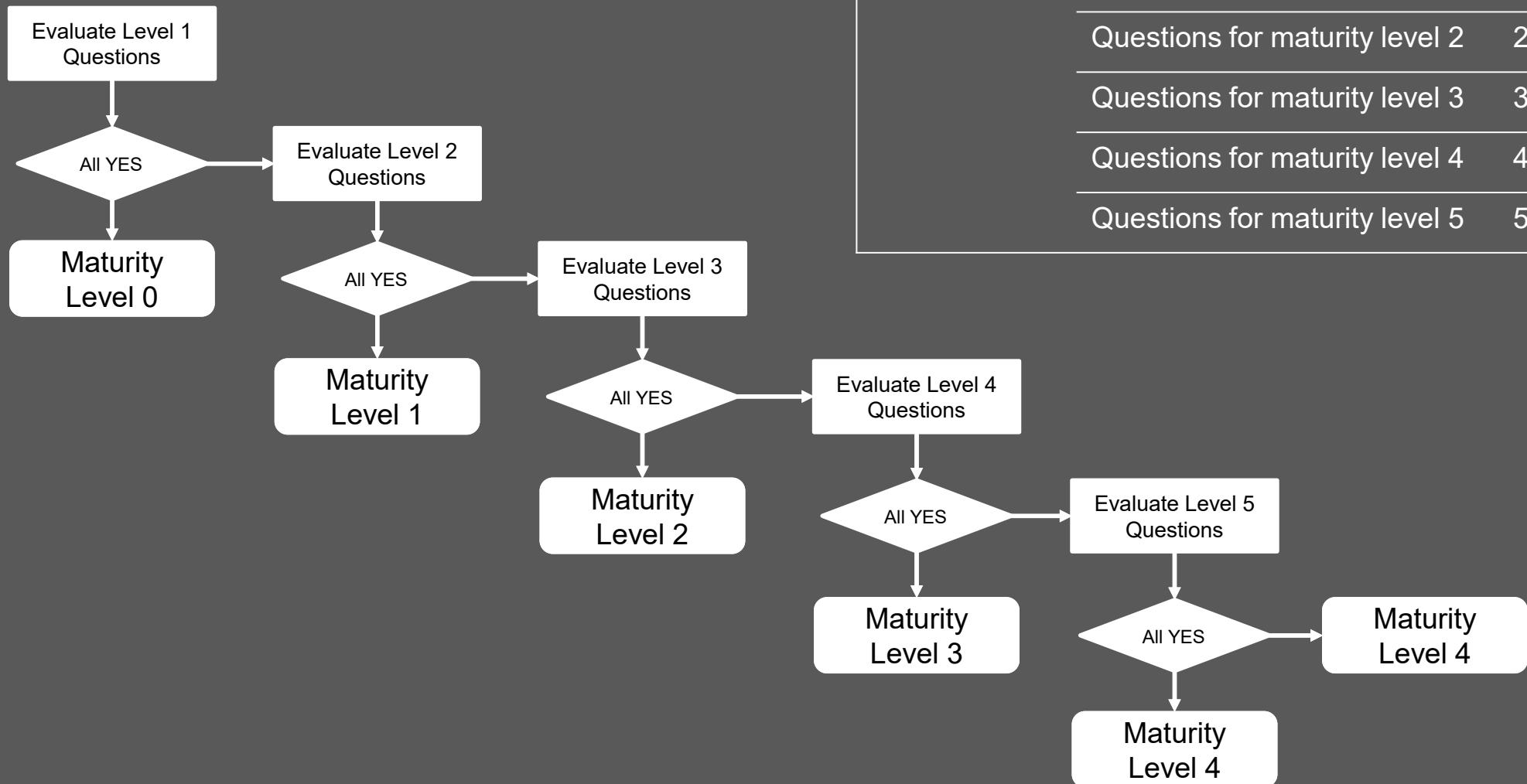
Breakdown of the Assessment Reference Model



Maturity Model Definitions

Maturity Level Indicator	Descriptive Name	Characteristics
Level 0	Unidentified	Little or no systematic documentation available
Level 1	Identified	Tracking and traceability of materials, data and etc. Registration and management of data using information collection devices and systems.
Level 2	Measured	Real time data acquisition of materials, machinery, process and human roles, and data integration. Measurement, aggregation, classification and management of data using information collection devices and systems. Synchronous history of data for the same time, same lot and same product.
Level 3	Analyzed	Data analysis and optimized decision making using aggregated data.
Level 4	Optimized	Automation of processes according to optimized decision making throughout the intra-enterprise and/or the inter-enterprises.
Level 5	Customized	Self-diagnosis and self-healing through cyber-physical system [CPS], Internet of Things [IoT], artificial intelligence [AI], etc. Flexible production of customized products through autonomous control.

Assessment Method



Activity	Question	Maturity Level Indicator
Activity Name	Questions for maturity level 1	1
	Questions for maturity level 2	2
	Questions for maturity level 3	3
	Questions for maturity level 4	4
	Questions for maturity level 5	5

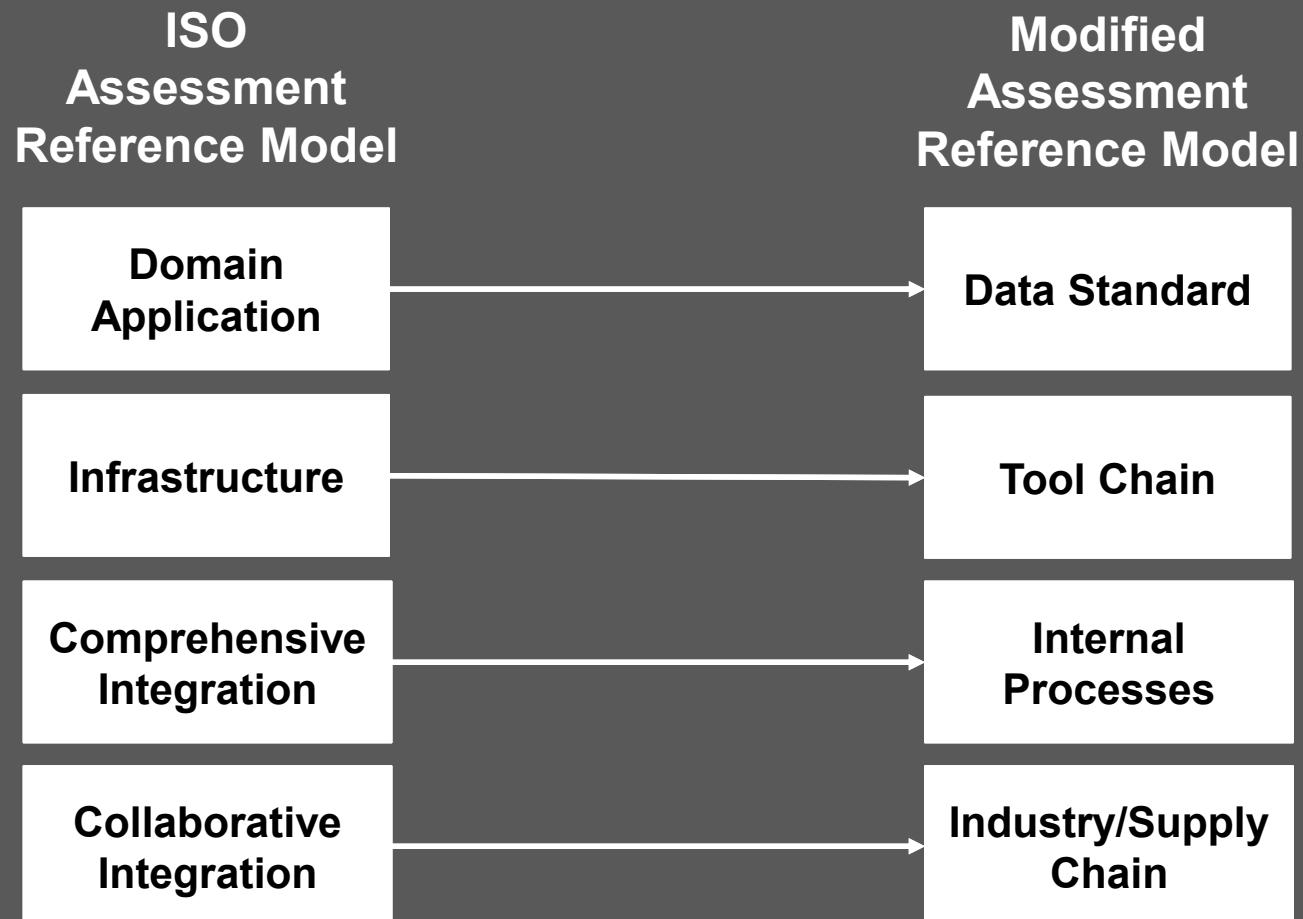
Breakdown of Activities and Sample Questions

Activity	Description		Activity	Description	Level
Environment Analysis	Use of IT systems and applications for environment analysis		Design Automation	Do you design with 2D CAD?	1
Commodity Planning	Use of IT systems and applications supporting commodity planning			Do you design with 3D CAD?	2
Design Automation	Use of designing software systems and smart connected technology for design			Do you analyze and validate with CAE?	3
BOM/Parts Management	Use of BOM/Part management system			Do you design automatically with optimization solutions as one of the following? • Model-Based Parametric Design • Engineering-based Parametric design • Integrated parametrical design	4
Engineering Change Management	Use of engineering change management systems			Do you design a product by using smart connected technology such as IoT, AR/VR	5
Prototyping	Use of IT systems and applications for prototyping and its validation				
Advance Quality Management	Use of IT systems and applications for advance quality management				

Product Design

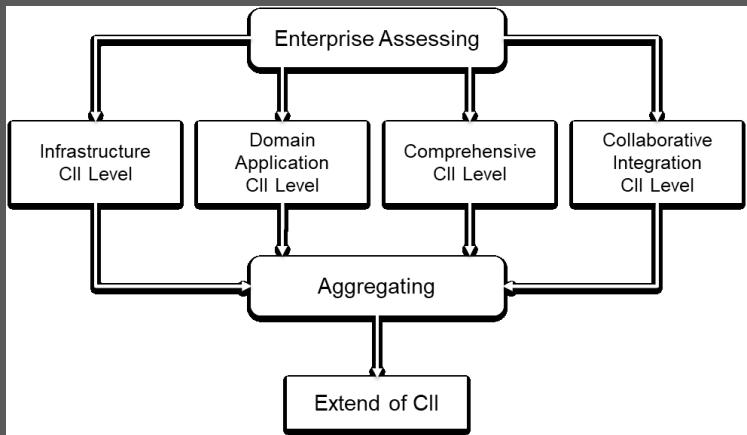
The diagram illustrates the hierarchy of Product Design activities. The innermost circle is red and labeled '0'. The next ring is grey and labeled '1'. The outer rings are white and labeled '2', '3', and '4' from the outside in. The activities are arranged clockwise starting from the bottom: BOM/Parts Management (level 0), Design Automation (level 1), Commodity Planning (level 2), Environment Analysis (level 3), Product Design (level 4), and Advance Quality Management (level 5).

Modified Assessment Model

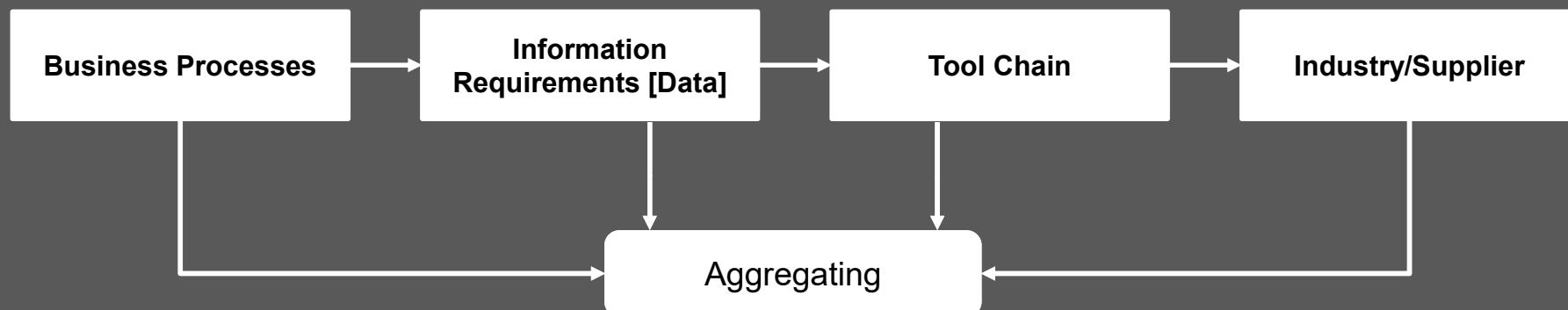


Modified Assessment System

ISO Assessment System

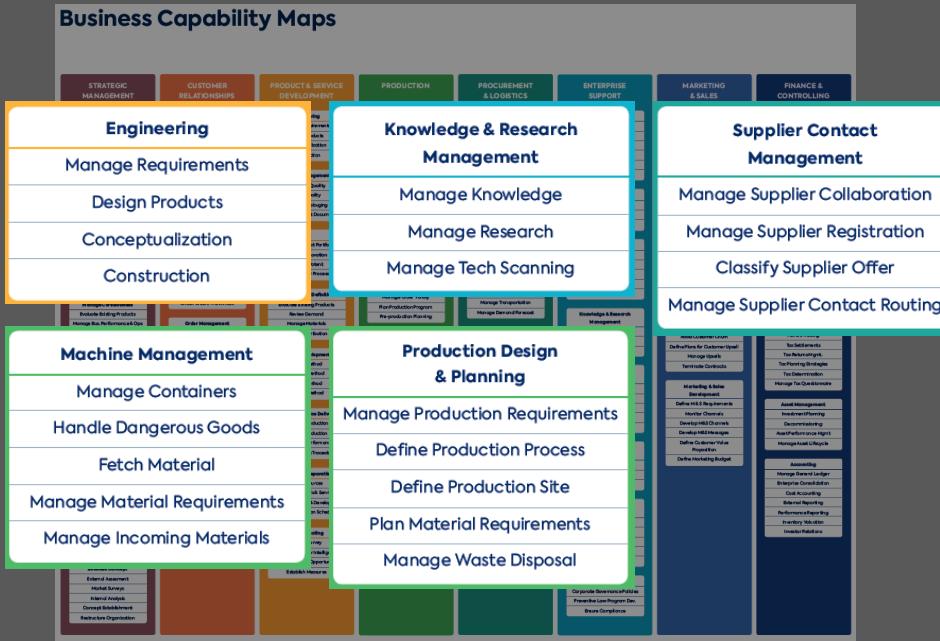


Modified Assessment System



Identify Business Processes

Start with Business Capabilities
Breakdown to the Business Processes



2.0 Develop and Manage Products and Services (10003)	
2.1 Govern and manage product/service development program (19696)	2.1.1 Manage product and service portfolio (10061) 2.1.1.1 Evaluate performance of existing products/services against market opportunities (10065) 2.1.1.2 Confirm alignment of product/service concepts with business strategy (10066) 2.1.1.3 Prioritize and select new product/service concepts (10074) 2.1.1.4 Plan and develop cost and quality targets (10073) 2.1.1.5 Specify development timing targets (10075) 2.1.1.6 Plan for product/service offering modifications (10076)
2.2 Generate and define new product/service ideas (19688)	2.1.2 Manage product and service life cycle (10067) 2.1.2.1 Develop plan for new products/services development and introduction/launch (16824) 2.1.2.2 Introduce new products/services (10077) 2.1.2.3 Refine outdated products/services (10078) 2.1.2.4 Identify and refine performance indicators (10079) 2.1.2.5 Conduct post launch review (11423) 2.1.2.5.1 Carry out post launch analysis to test the acceptability in the market (19845) 2.1.2.5.2 Review market performance (11424) 2.1.2.5.3 Review effectiveness of supply chain and distribution network (11425) 2.1.2.5.4 Apply data and analytics to review supply chain methodologies (19847) 2.1.2.5.5 Review quality and performance of the product/service (11426) 2.1.2.5.6 Conduct financial review (11427) 2.1.2.5.7 Conduct new product development process assessment (11428)
2.3 Define product/service development requirements (19900)	2.1.3 Manage patents, copyrights, and regulatory requirements (19985) 2.1.3.1 Conduct mandatory and elective reviews (19941) 2.1.3.2 Review infringement of patents and copyrights (16826) 2.1.3.3 Determine patent and copyright needs (16827) 2.1.3.4 Define product technical documentation minimum requirements (19837) 2.1.3.5 Manage regulatory requirements (17771) 2.1.3.5.1 Train employees on appropriate regulatory requirements (17772) 2.1.3.5.2 Maintain records for regulatory agencies (17773) 2.1.3.5.3 Manage regulatory submission life cycle (17776) 2.1.4 Manage product and service master data (11740)
2.4 Define product/service development processes (19892)	2.1.4.1 Manage materials master lists (11741) 2.1.4.2 Manage bills of material (11742) 2.1.4.3 Manage routings (11743) 2.1.4.4 Manage specifications (11744) 2.1.4.5 Manage drawings (11745) 2.1.4.6 Manage product/material classification (11746) 2.1.4.7 Develop and maintain quality/inspection documents (11747) 2.1.4.8 Maintain process specification data (11748) 2.1.4.9 Manage traceability data (11749) 2.1.4.10 Review and approve data access requests (11750)

TABLE OF CONTENTS	
	3
	3
	4
	6
	8
	11
	13
	14
	16
	18
	23
	26
	27
	28
	29

Reference:

<http://www.leanix.com>
<https://www.apqc.org>

Identify Business Processes and related Deliverables

Cross Industry Process Framework v721				
	Pe	Pr	Da	To
Total Requirements				
Develop and Manage Products and Services				
Generate and define new product/service ideas				
Generate new product/service concepts				
Formulate new product/service concepts				
Develop products and services				
Design and prototype products and services				
Conduct mandatory and elective external reviews				
Design products/services				
Design and manage product data, design, and bill of materials				

PEOPLE: Training, Certification, Skills, etc.

EX: 2 Classes [1 needing updates]

PROCESS: Business Instruction, User Guides, Modeling Requirements, etc.

EX: 9 Internal Process Docs [4 needing updates]

EX Summary: 11 Total Reqs [5 needing updates] = Score 54

DATA: [Used in STEP 2]

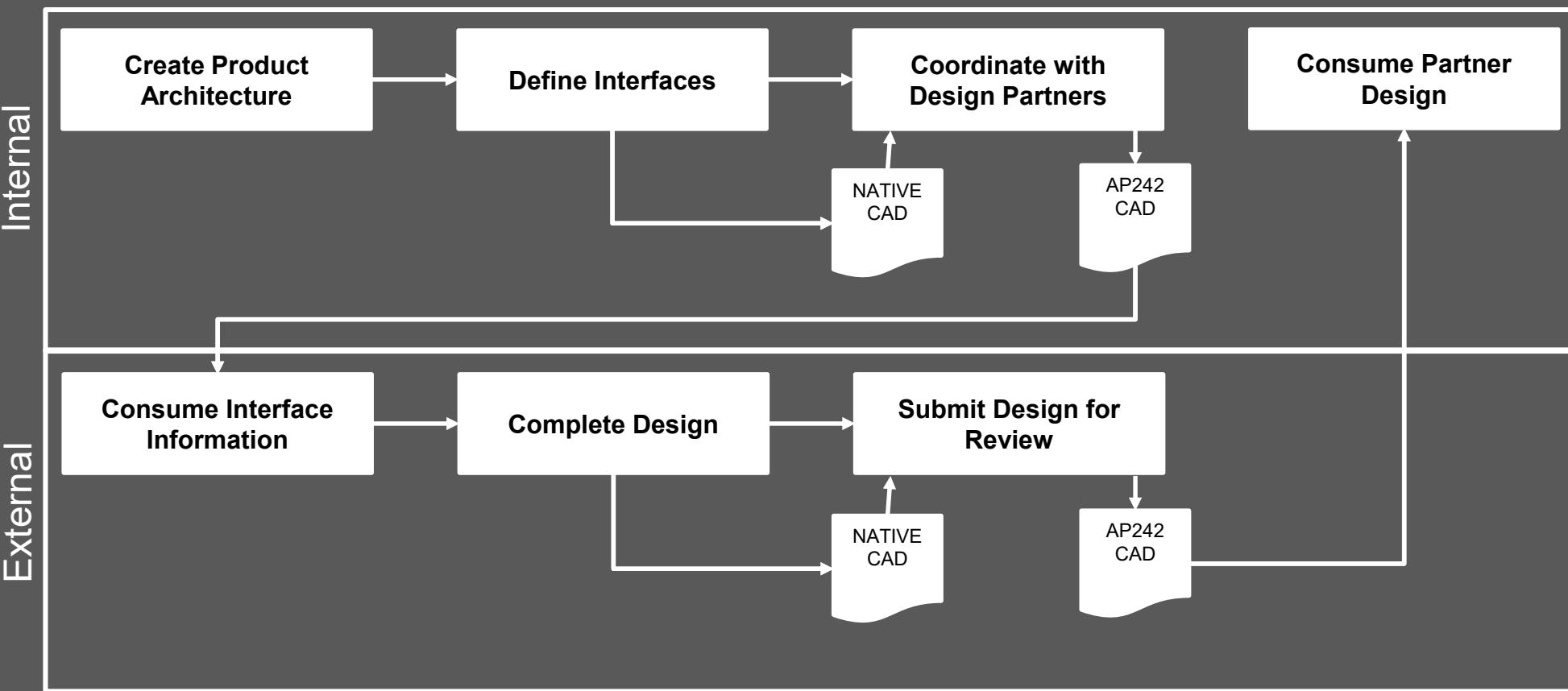
Modeling Requirements that define the format of the information artifacts in the applications that comply with the industry standard

TOOLS: [Used in STEP 3]

Software Applications used to create, manage or consume the information in the form of the data standard format

Identify Information Requirements

Identify the data used by the processes



Identify Information Requirements

Aggregate all the Information Requirements from Business Processes

Use ASME/ISO Authoring Standards or A&D Minimum Digital Thread Position Papers to provide additional perspectives.

Information Requirement	Det	Mach	C/F	SM	Comp	MS	Elec	A&I
Part Number & Revision	x	x	x	x	x	x	x	x
Engineering Definition	x	x	x	x	x	x	x	x
Construction Geometry	y	y	y	y	y	y	y	y
External References								
Reference Geometry	Bend Radius					x		
Marking Requirements - ECCN	Bend Point					x		
Marking Requirements - Approval	Bend Allowance					x		
Axis System	K-Factor					x		
Part Notes	Web	Tube Line				x		
Standard Notes	Flange	Run				x		
Dimensions	SM Features	Tube Spool				x		
Tolerances	Composite Part Construction Attr	Bendable				x		
Annotations	Annotations	Connectors				x		
3D Views	Structural Layout and Sizing Constr	Park Marks				x		
Key Characteristics	Plies Construction Geometry	Sleeving				x		
Limited Area Application Indicator	Composite Part Definition	Internal Splice				x		
Solid Definition	Edge of Part [LAAI]	Dimensions and Annotations Collector				x		
Material Description	Part Orientation Symbol [LAAI]	BackShell				x		
Grain Direction - Complex Detail Forging	Core Ribbon Direction [LAAI]	Lugs				x		
Grain Direction - Forged Block	Play Stack Up Schematics [cross sec	External Splice				x		
Parting Surface	Potting/Edge Fill [LAAI]	Mounting Equipment				x		
Prolongation Area	Composite Fabrication Process Req	Equipment				x		
Test Specimen	Single Insert Connectors					x		
Calculated Weight	Ply Edge Location Tolerance [LAAI]	Backshell Clocking				x		
Draft Angle	Core Edge Location Tolerance [LAAI]	Flag Markers				x		
Intersecting Surfaces [mold lines or points]	Butt Splice Requirements [LAAI]	Connector Shell				x		
Forging Plane (principle die face)	No Splice Requirements [LAAI]	Shop Aid / Parts List				x		
Nondestructive and mechanical proper	Joint Definitions					x		
Mechanical properties of the casting	Fiber Orientation Tolerance [LAAI]	Hole Location[s]				x		
Surface Condition control Casting	Perforation Areas [LAAI]	Hole Drill Requirements				x		
Inspection method and acceptance crite	Ply Wrinkle Allowance [LAAI]	Hole Drill Direction				x		
Forging stock [billet] orientation	Stitching [LAAI]	Fastener Location				x		
Forging Notes	Splicing Requirements [LAAI]	Fastener Drill Direction				x		
	Edge Sealing [LAAI]	Fastener installation requirements				x		
	Porosity Acceptance Criteria [LAAI]	Fastener physical representation				x		
	Minimum Flat Area [Faying] Interface	Sealant Definitions				x		
	Potting/Edge Fill [LAAI]	Sealant Requirements				x		
		Sealant Area				x		
		Shim Definitions				x		
		Shim Requirements				x		
		Shim shape/location				x		

Total Requirements	398
Detail MBD	19
Assembly&Instl MBD	93
PMI	189
Additive Manufacturing	43
Casting/Forging	5
Machined	2
Sheetmetal	5
Composites	23
Mechanical Systems	6
Electrical Wire Harness	13

Identify Information Requirements

Map the Information Requirements to AP242 and Aggregate

EX: 520 unique information requirements, AP242 supports 450 = Score 86

Business Object [Function]		CATIA V5 Object BCA	Gen	Mc	C/F	SM	BG	MS	E
Part Number & Revision	Part Number, Revision		X	X	X	X	X	X	X
Solid Definition	Part Body		X	X	X	X	X	X	X
Material Description	Parameters		X	X	X	X	X	X	X
Engineering Definition	Microfeature Surface Definition		v	v	v	v	v	v	v

PMI Entity			
Tolerances	PMI symbol	Name	Description
Geometric tolerance			
Form	—	Straightness	Form Tolerance
	□	Flatness	Form Tolerance
	○	Roundness (ISO) Circularity (ASME)	Form Tolerance
	∅	Cylindricity	Form Tolerance
	○	Profile any line (ISO 1101:2012) Line Profile (ISO 1101:2017)	Form Tolerance
	○	Profile any surface (ISO 1101:2012) Surface Profile (ISO 1101:2017)	Form Tolerance

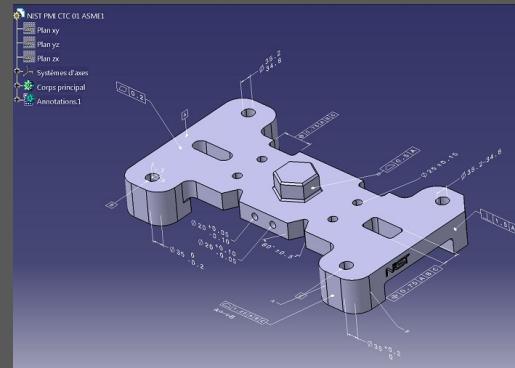
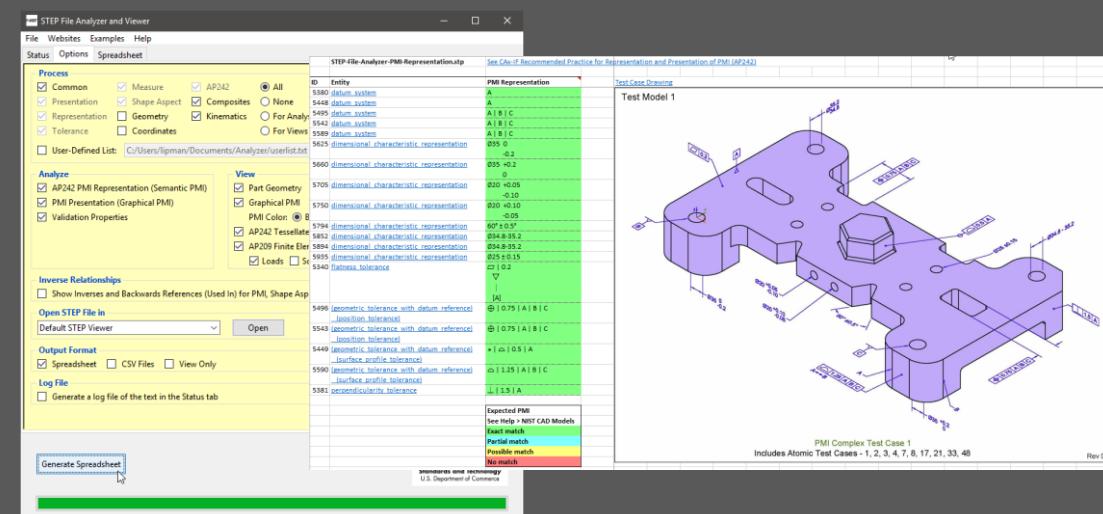
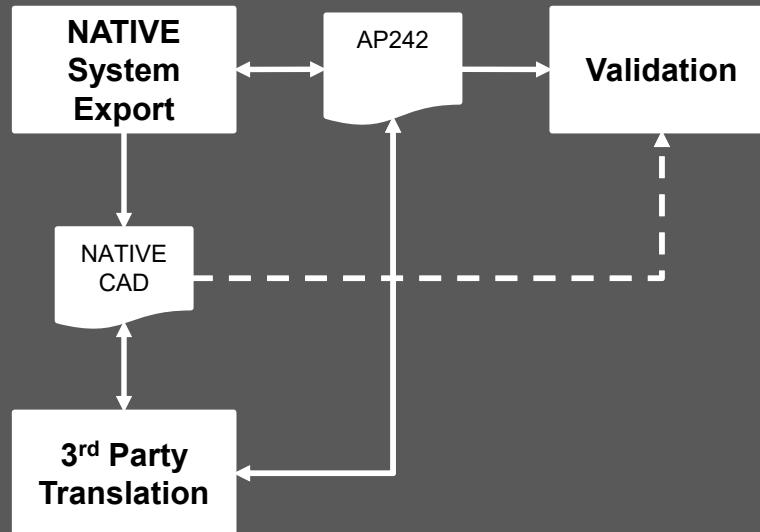
Interop standard							
STEP AP242 ed1	STEP AP242 ed2	Bugzilla number	Module	ARM entity	AIM entity	Rec Practice CAX-I	
YES	YES	ISO/TS 10303-1051:2013-01 Geometric tolerance	straightness_tolerance	straightness_tolerance		YES	
YES	YES	ISO/TS 10303-1051:2013-01 Geometric tolerance	flatness_tolerance	flatness_tolerance		YES	
YES	YES	ISO/TS 10303-1051:2013-01 Geometric tolerance	roundness_tolerance	roundness_tolerance		YES	
YES	YES	ISO/TS 10303-1051:2013-01 Geometric tolerance	cylindricity_tolerance	cylindricity_tolerance		YES	
YES	YES	ISO/TS 10303-1051:2013-01 Geometric tolerance	line_profile_tolerance	line_profile_tolerance		YES	
YES	YES	ISO/TS 10303-1051:2013-01 Geometric tolerance	surface_profile_tolerance	surface_profile_tolerance		YES	

Identify Tool Chain Requirements

Align tool chain to business processes:

- Manual Creation of AP242 focusing on all information requirements
- Automated Creation via Service or Triggered Event
- Control exported content [control IP]
- Validate output
- Consume/Import back into native authoring system

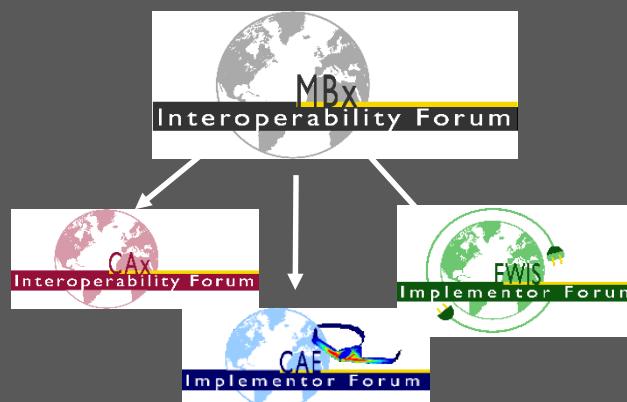
EX: 5 Tool Chain Reqs [3 needing updates] = Score 40



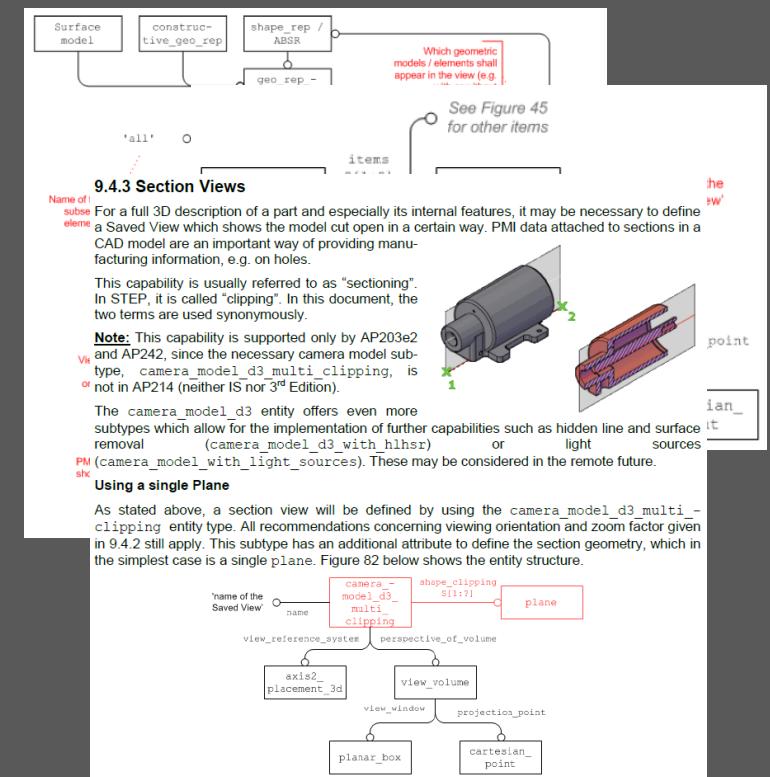
Identify/Supplier Requirements

Analyze needs of the industry [primary or potential suppliers] to support business identified business processes such as design collaboration, build to print or regulatory certification.

- Industry Agreement on data representation of AP242
- Generally Available tools to create/consume AP242
EX: 4 RP [2 needing update] and 3 Imp [2 needing updates] = Score 42



A: Dassault Systèmes (CATIA V5-6R2020) Last updated: Jun 12, 2019		B: Siemens PLM (NX 12) Last updated: Jul 16, 2019							
Recommended Practices	Functionality	AP203 E2 Import	AP203 E2 Export	AP214 IS (2001) Import	AP214 IS (2001) Export	AP214 E3 (2010) Import	AP214 E3 (2010) Export	AP242 Import	AP242 Export
Geometry									
Wireframe									
C	Test Case	A/B	A/B	A/B	A/B	A/B	A/B	A/B	A/B
B		/B							
3									
A									
M									
Com									
C									
Mod									
S									
R									
I									
L									
Asse									
N									
Mate									
Material as Property									
Density as General Property								B	B
External References									
Simple External References	A/B	A/B	A/B	A/B	A/B	A/B	A/B	A/B	A/B
Nested External References	A/B	A/B	A/B	A/B	A/B	A/B	A/B	A/B	A/B
External Element References									
Document Properties	A	A	A	A	A	A	A	A	A



Aggregate

Over All Readiness Summary

57

Ready: Manual creation of partially complete AP242e1, 1 Class and 5 Internal documents

Not Ready: 1 Class, 4 Internal documents and Automated Tool Chain to create complete Ap242

Major Next Steps to Close: Work with external organizations to close on industry capabilities

Data Standard

90

Ready: AP242e1

- Shape Representation, Some PMI/Composites

Almost Ready:

- AP242e2

Actions to Close:

- Incorporate needs [e.g. Mech Sys/Hyd] into AP242e3

Internal Processes

54

Ready:

- 1 Class, 5 Internal business documentation

Not Ready:

- 1 Class, 4 Internal business documentation

Actions to Close:

- Agreement with end users on methods
- Creation of content

Industry/Supplier

42

Ready:

- 2 Partial Commercial Implementations
- 4 Partial Free Implementations

Not Ready:

- 0 Fully Implemented solutions

Actions to Close:

- Provide requirements to implementers

Tool Chain

40

Ready:

- Manual CATIA V5 of partially complete AP242e1

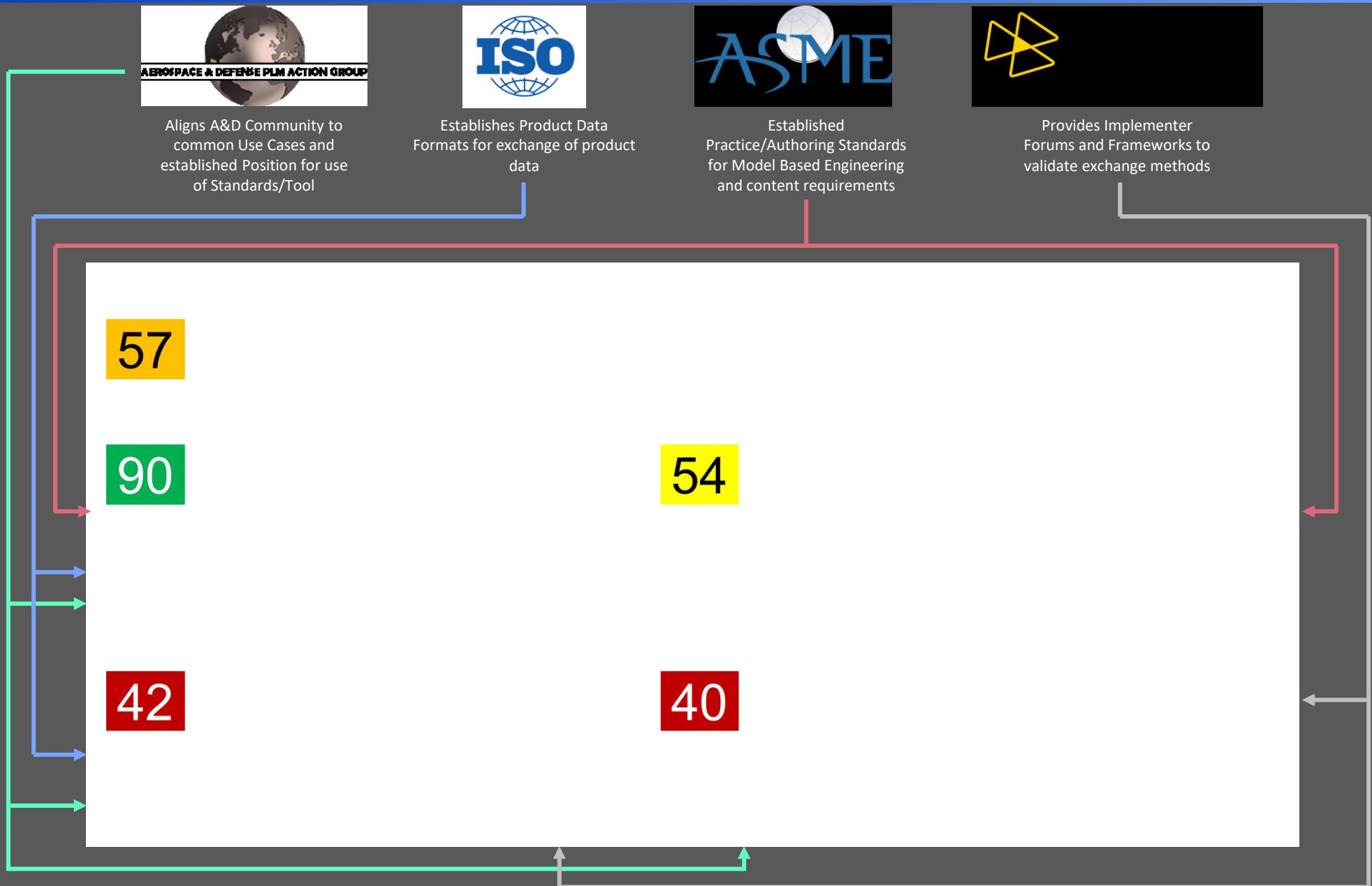
Not Ready:

- STEP AP242e2 Translator and Validator

Actions to Close:

- Internal funding, prioritization, resourcing, purchase, development....

Make a Difference



Summary

The ISO Framework can be adapted to your organizations needs.

Join industry consortiums and standard bodies to ensure your needs are met.

References

ISO/DIS 22549-1:2019, Automation Systems and Integration – Assessment on Convergence of Information and Industrialization for Industrial Enterprises Part 1: Framework and Reference Model

ISO/CD 22549-2:2019, Automation Systems and Integration – Assessment on Convergence of Information and Industrialization for Industrial Enterprises Part 2: Maturity Model and Evaluation Methodology

ISO 15704, Industrial Automation Systems – Requirements for Enterprise-Reference Architectures and Methodologies