



THE HIDDEN COSTS OF ANALOG DATA IN THE DIGITAL THREAD

(and how MBE pays it back)

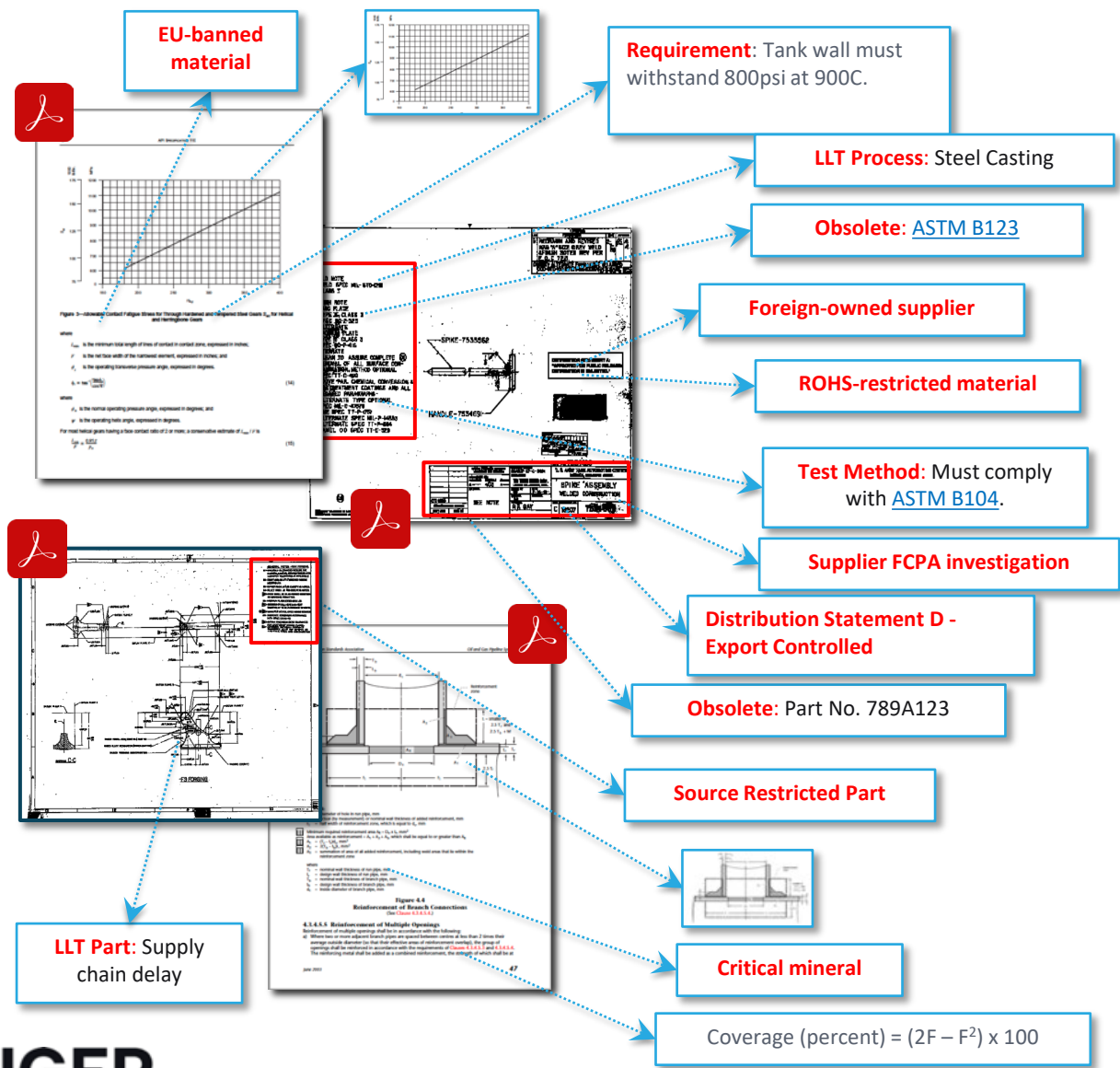
2026 MBE/QIF Summit
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Chicago, IL

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Consider This...

Companies don't store product design data (GD&T),
or accounting data,
or customer information,
or software code,
or compliance data,
in PDF files.

Too Much Critical Data Trapped In Static Documents



Requirements.
References.
Materials.
Processes.
Test methods.
Parts information.
Suppliers.
Supply chain risks.

The Last Mile of the Digital Thread

GD&T data migrated to the digital thread long ago.

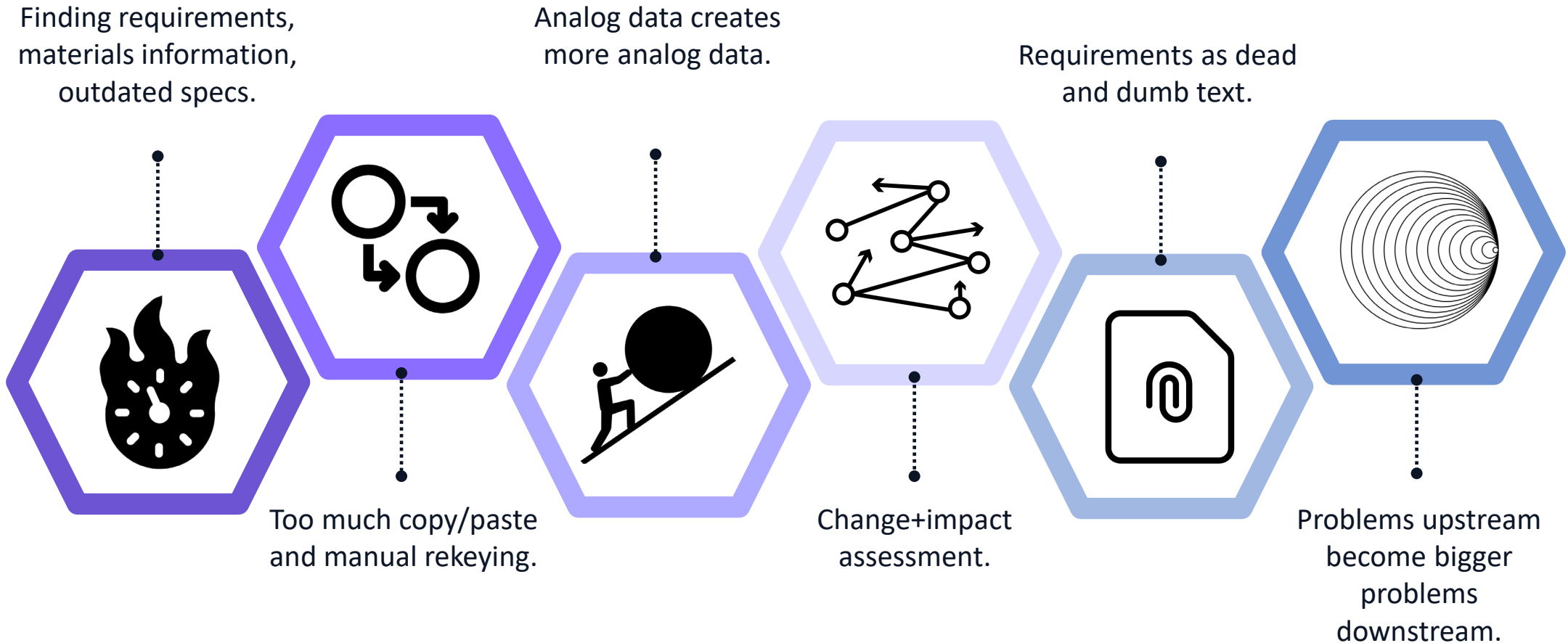
But a lot of product definition was left behind in static formats.

It's time to build the last mile of the digital thread.

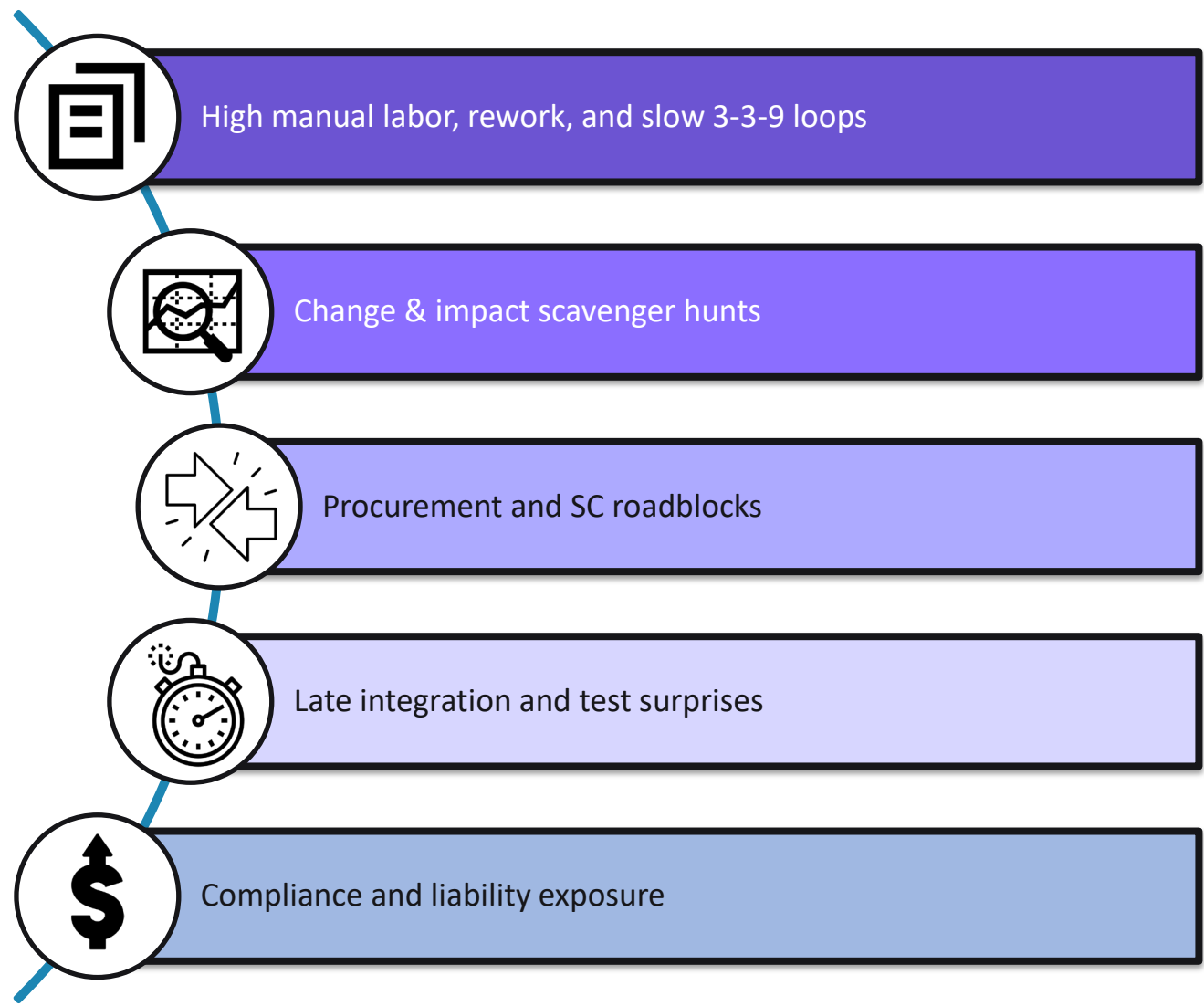
Agenda

1. The costs of analog data, and where they hide
2. Repeatable pipeline from static/analog to “complete MBPD”
3. Tangible capabilities from the transformation
4. Where to find and measure the ROI

Challenges With Analog Data



Consequences



Slow cycles, higher risk, more scrap and rework, slower to market (or slower to field)

Field Examples

Challenges

Consequences

Castings and Forgings

- Complex parts, avg production lead time: 200 days
- Hundreds of parts per month
- Opportunity for additive manufacturing

- Needs manual labor with deep expertise
- Long delays, added costs
- Impact on sustainment speed, mission readiness

Outdated Specs and Standards

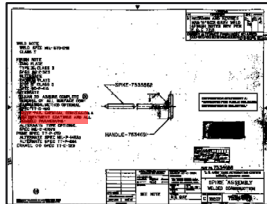
- Drawings/docs/TDPs reference obsolete specs
- DLA 3-3-9 process requires references be validated before procurement and replacements identified

- Tedious manual labor
- Omissions and errors
- Downstream delays and quality escapes
- Typical 3-3-9 request: 30-90 days

Regulated Materials and Critical Minerals

- Procurement must act on regulatory + market changes
- Engineers must manually inspect drawings and BOMs for impacted items

- Tedious manual labor, high error rates
- High risk of restricted or scarce materials
- Difficult to find replacements
- Huge impact on timelines and compliance



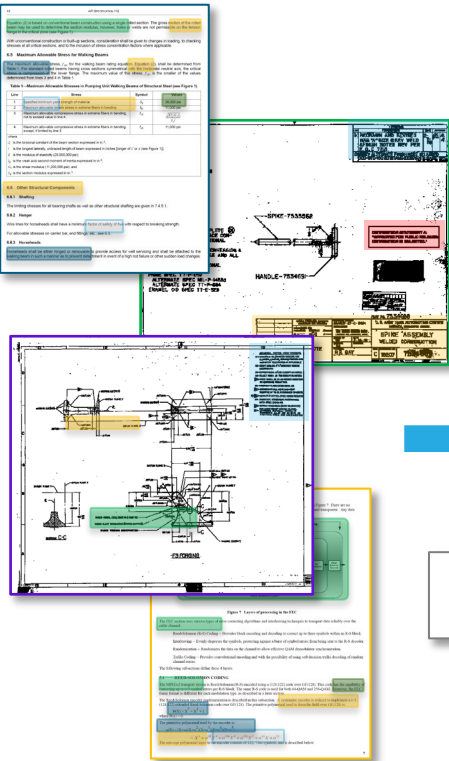
What If...

- Every drawing and specification was in model-based format
- PMI was ontology-driven
- Product attributes were identified, tagged, and semantically searchable
- Requirements and references were automatically extracted, organized
- All data was machine readable, reusable, and traceable downstream
- Data objects were interoperable inside other applications

Turning Analog Text into Decision-Making Data

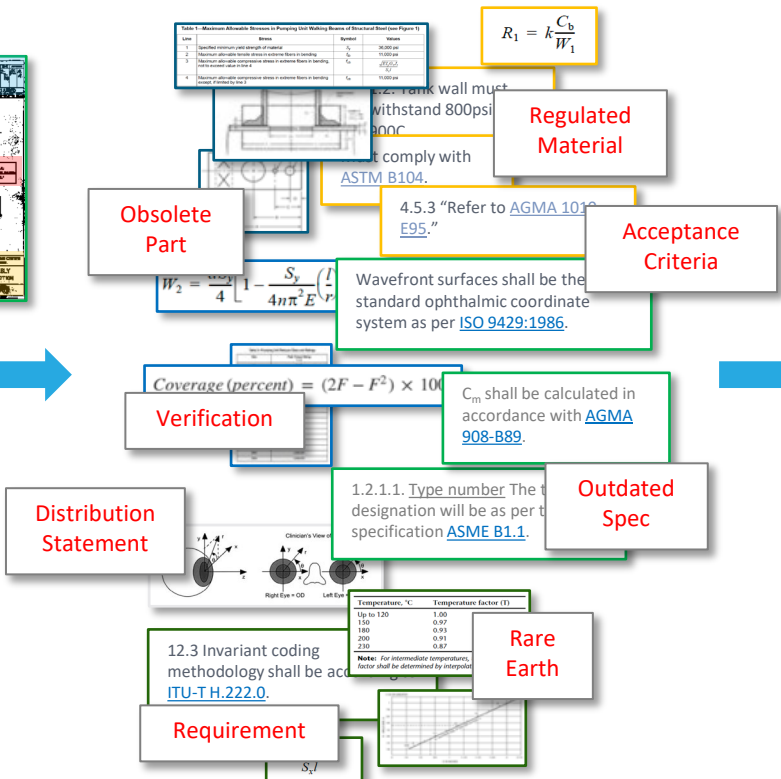
1 ID Data Elements

Documents ingested and converted to individual data elements



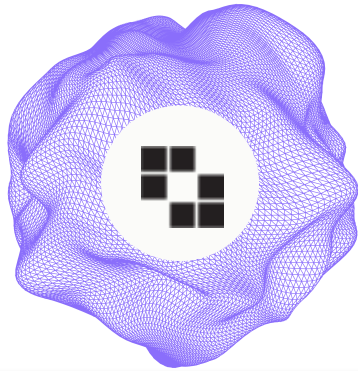
2 Ontology-Driven, Semantic Digital Model

Data elements classified with product attributes, values, tolerances, references



3 Knowledge Graph

Connections and inferences between data and concepts, specs and standards; ~400M+ nodes



Part Information	
PART NAME	Hinge Mount
NSN	1560-00-8858662
CAGE CODE	77272
PART NUMBER	114S1875-1
SUPPLIER RISKS	Click to view
Material Information	
MATERIAL	MAGNESIUM ALLOY
SPECIFICATION	QQ-M-40
STATUS	CANCELLED
HAZARD MTRL	! Cadmium plating !
SPEC REPLACE	ASTM B91
Process Information	
PROCESS1	! FORGING !
PROCESS2	PENETRANT INSPN
PROCESS3	VAPOR DEGREASE
Other Information	
REFERENCES	QQ-M-40 SAE AMS 4352 View all...
REQUIREMENTS	View

4 Deliver to Product Lifecycle

Right information, right place, right format



PLM, CAD, MES, etc.



Manufacturing steps (e.g. work instructions, test plans)



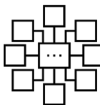
Supply Chain Management (monitor reg'd materials, critical minerals, supplier risk)



Machines, IoT, Cyberphysical Systems



Calculators, Checklists, Software, etc.



Corporate Knowledge Graphs

via API, MCP, etc



Publish to SWISS, XML, SysML, ReqIF, QIF as needed.

What Can a Single Line Tell Us?

MRC[?]	MRC Name [?]	MRC Value [?]
AGAV NAME	END ITEM IDENTIFICATION ITEM NAME	T-2C AIRCRAFT MOUNT, GUN SIGHT
TEXT	GENERAL CHARACTERISTICS ITEM DESCRIPTION	ALUMINUM ALLOY, QQ-A-601 , ALLOY 356 , TEMPER T6

Specification Document

- [QQ-A-601](#) Aluminum Alloy Sand Castings
- Superseded by [ASTM-B26/B26M](#)
- Alloy 356

Materials & Processes

- Manufacturing process: Sand Casting
- Material: Aluminum Alloy UNS A03560
- Temper: T6

Mechanical Properties

- Tensile Strength: 30,000 psi
- Yield Strength: 20,000 psi
- Extension under Load: 0.0039 in/in

CONSTITUENT ELEMENTS

Element	Si	Fe	Cu	Mn	Mg	Zn	Ti	Other	AL
Percentage	6.5-7.5	.60	.25	.35	.20-.45	.35	.25	.15 Max	Bal

Without SWISS: lookup + interpretation + re-keying

With SWISS: structured requirement objects + traceability

Structured Requirements from Unstructured Data



The eyelets shall be brass, with a coated nylon Desert Sand finish, size AA.

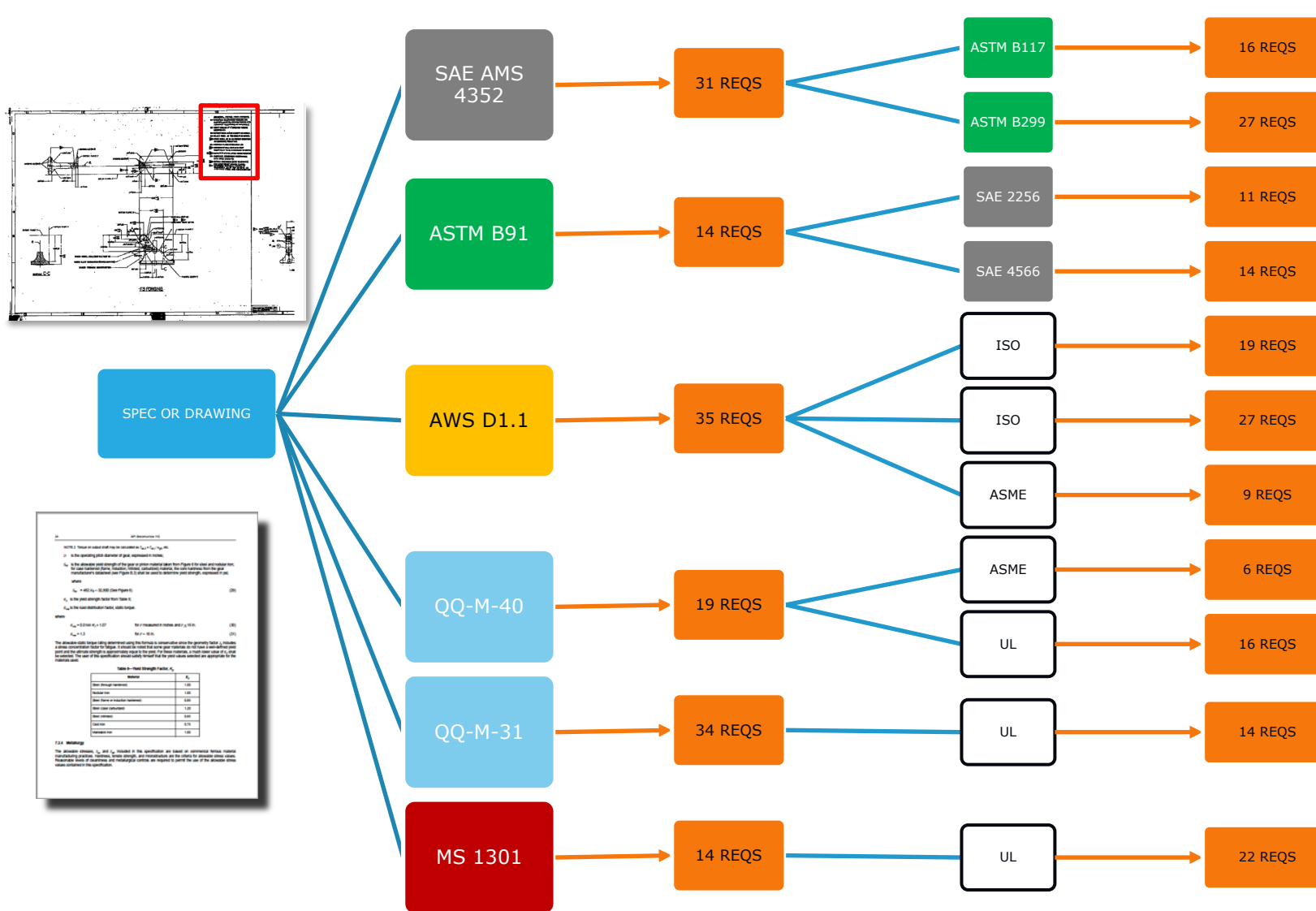
Three different requirements, three different attributes – a challenging requirement to parse, even for a human.



Subject	Attribute	Attribute Definition	Value
eyelets	Material	Material used to make the eyelet	Brass
eyelets	Finish	Finish of the eyelet	Coated nylon Desert Sand
eyelets	Size	Size of the eyelet	AA

SWISS extracts and classifies by Subject, Attribute, and Value, and creates reusable data objects.

The Requirements Challenge

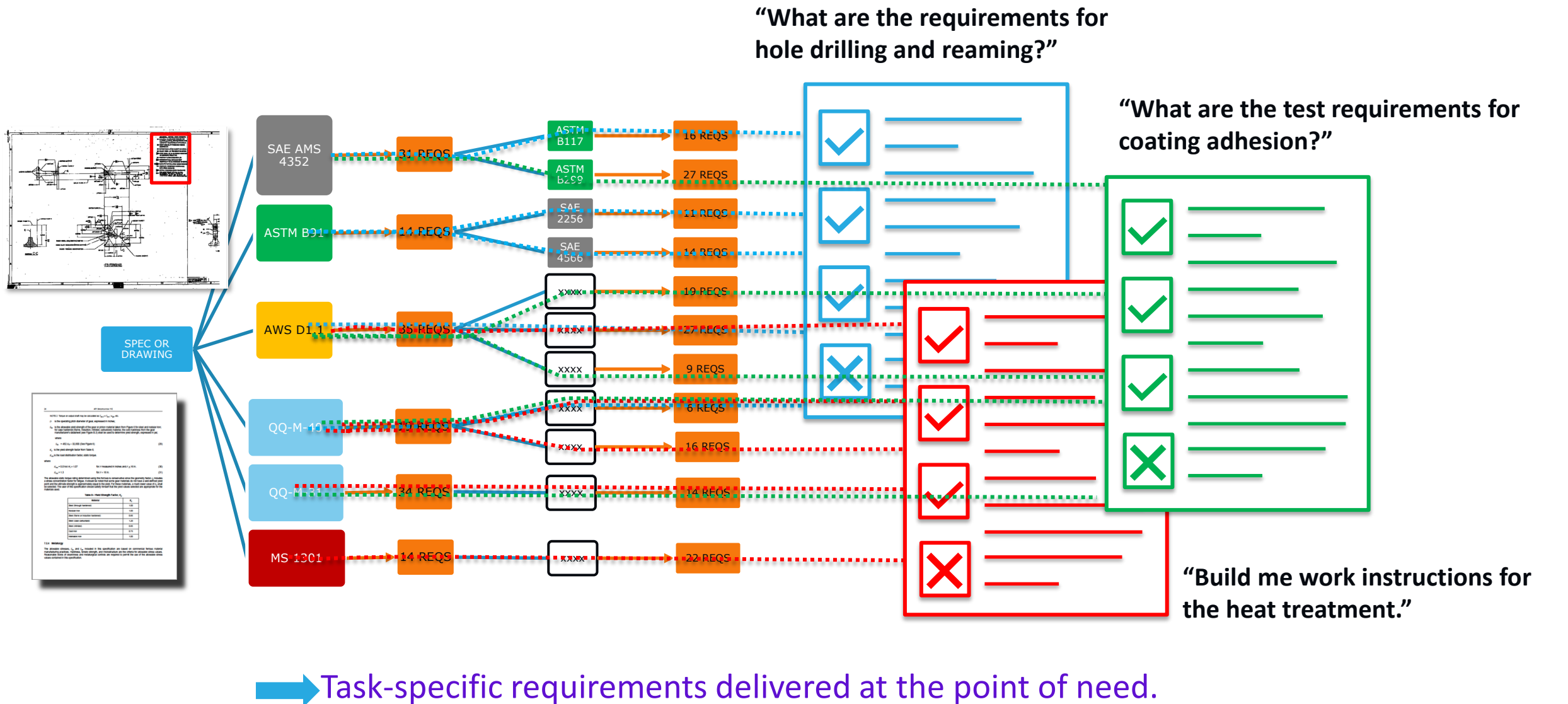


- Dozens of specs
- Hundreds of pages
- Hundreds of requirements

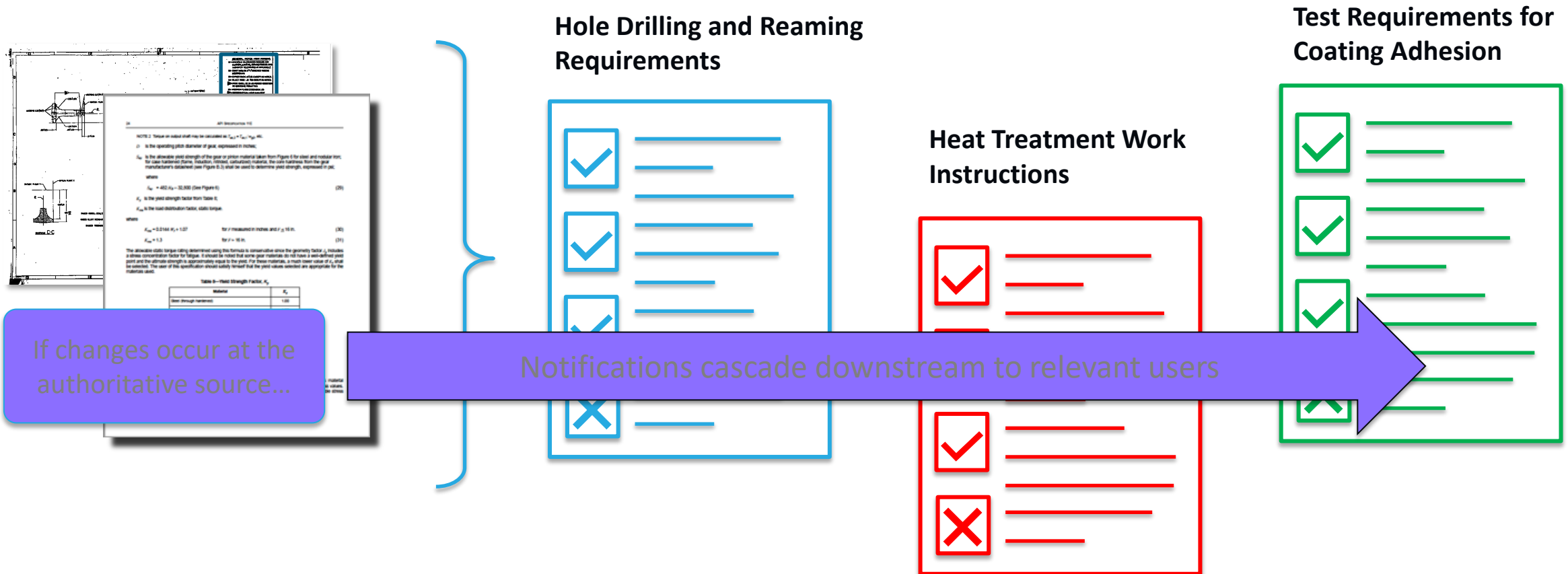
- Manual
- Time-consuming
- Risky
- Requires deep expertise*

*Most experts are older and retiring.

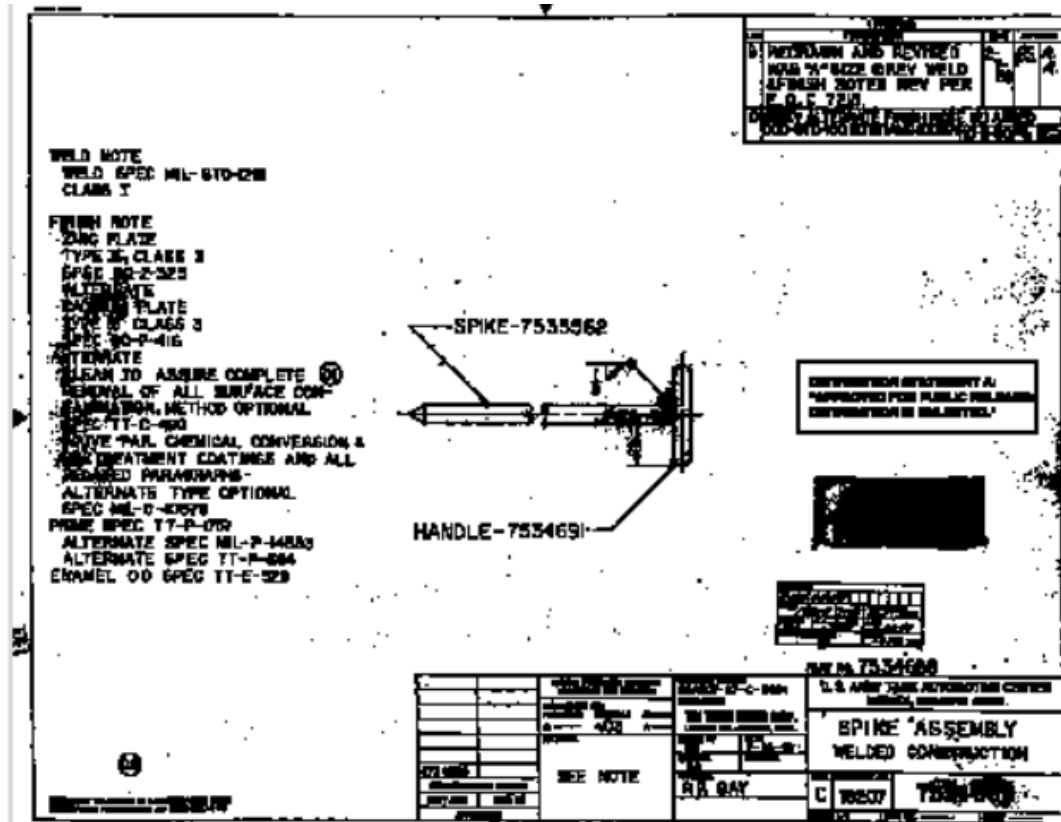
Threaded Requirements



Threaded (and Traceable) Requirements



Legacy Drawings Are a Serious Bottleneck



Machine-readable? ❌

Ontology-driven? ❌

Enables automation? ❌

Critical Data Missing Inside PLM

windchill®
tvldrevich

Products

Actions

Document - 0000061680, 11682350_DZ_F_DSA20150428, A.3

Details

Structure

Content

Related Objects

Changes

History

SWISS Tab

Swiss Links

Replacements (Tree)

Material And Process

Reference Child Objects

Actions

Replacements (Tree)

Actions

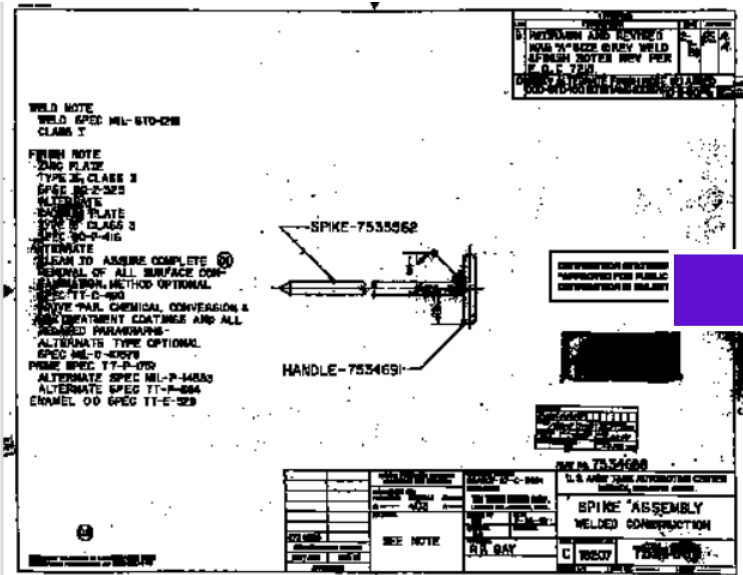
Material Child Objects

Actions

Search | Browse

Navigator

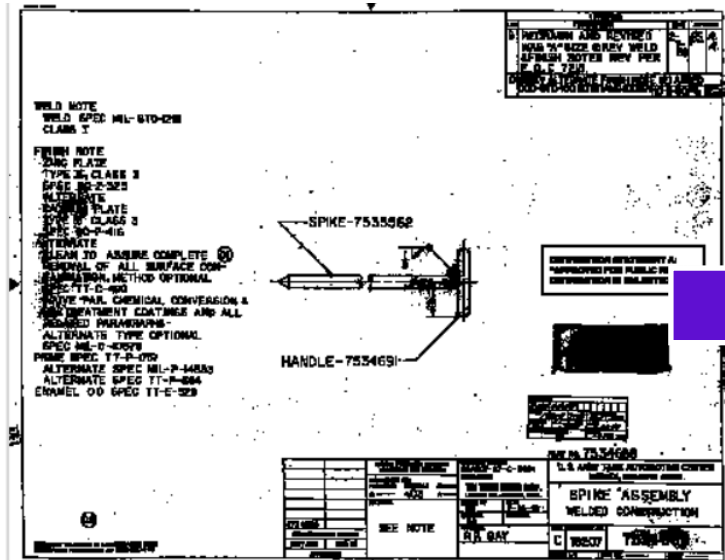
Legacy Drawings → Data



SWISS Drawing Analysis Console

11682350_DZ_F_DSA20150428.pdf	PROCESS	CASTING	MIL-PRF-62122
11682350_DZ_F_DSA20150428.pdf	MATERIAL	POLYTETRAFLUOROETHYLENE	ASTM D2000, MIL-R-3065, ASTM D957
11682350_DZ_F_DSA20150428.pdf	MATERIAL	POLYCARBONATE	ALTERNATE MATERIAL: 48185-3311 MFR-21699-11010 24
11682350_DZ_F_DSA20150428.pdf	PROCESS	LEAKAGE TESTING	ASTM D4066
11682350_DZ_F_DSA20150428.pdf	MATERIAL	ZINC	MIL-STD-171
11682350_DZ_F_DSA20150428.pdf	PROCESS	CHEMICAL DEGREASING	MIL-STD-171

Legacy Drawings → Data → PLM



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Products > XSB Product Demo > Test docs

Search | Browse

Actions Document - 0000061680, 11682350_DZ_F_DSA20150428, A.3

Details Structure Content Related Objects Changes History SWISS Tab

Swiss Links | Replacements (Tree) | Material And Process

Reference Child Objects

Actions

Name	Designation	Publisher Name	State ↑	Release Date
STEEL, SHEET, CARBON, COLD-ROLLED, COMMERCIAL QUALITY (NO S/S DOCUMENT)	ASTM-A366/A366M	ASTM	Canceled	1991-08-15
STEEL, CARBON, (0.15 MAXIMUM, PERCENT), HOT-ROLLED SHEET AND STRIP COMME...	ASTM-A569/A569M	ASTM	Canceled	1991-08-15
Colors Used in Government Procurement (S/S By SAE-AMS-STD-595)	FED-STD-595C NOTICE 2	GOV	Canceled	2017-02-14

Replacements (Tree)

Actions Find in tree

Number	Name	Swiss Status
L-P-509A NOTICE 1	L-P-509A NOTICE 1	In Work
ASTM-D709	Materials, Laminated Thermosetting	Unknown
MS21044H NOTICE 1	MS21044H NOTICE 1	In Work
NASM21044	NUT, SELF-LOCKING, HEXAGON, REGULAR HEIGHT, ...	Unknown
MIL-R-3065E NOTICE 2	MIL-R-3065E NOTICE 2	In Work

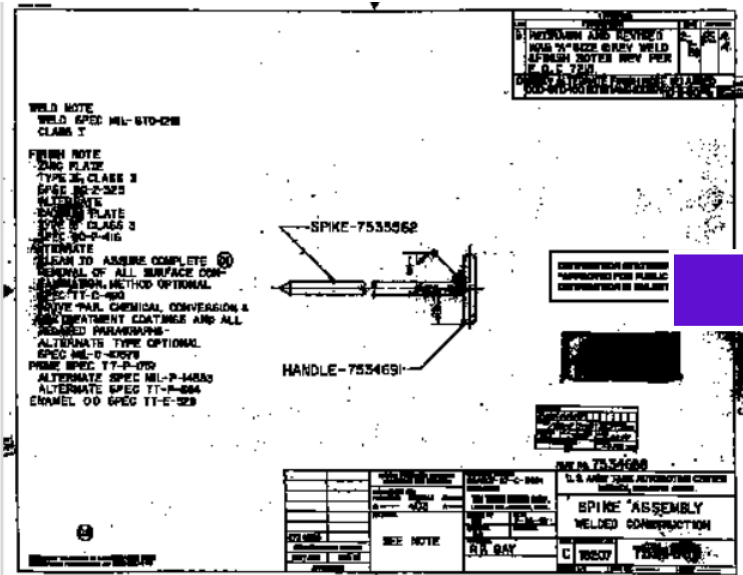
Material Child Objects

Actions

Name ↑	State
Brass uns c84400	Released
Brass uns c85400	Released
Carbon steel	Released
Casting	Released

Navigator

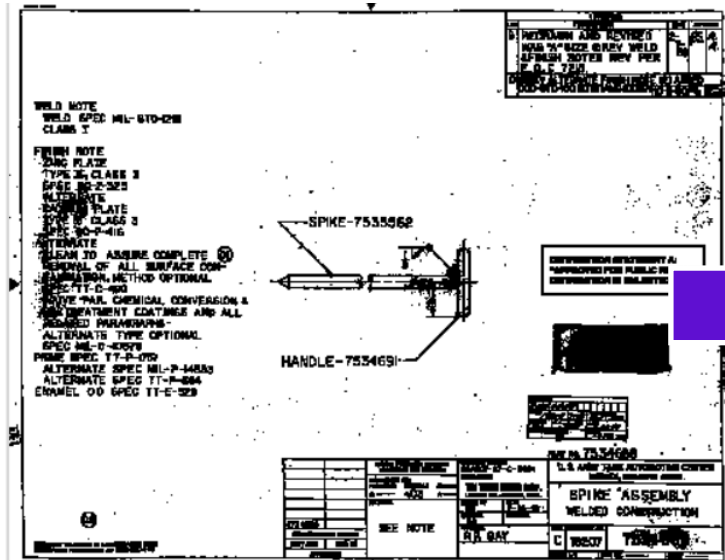
Legacy Drawings → Data



SWISS Drawing Analysis Console

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11682350_DZ_F_DSA20150428.pdf	PROCESS	CHEMICAL DEGREASING	MIL-STD-171

Legacy Drawings → Data → PLM



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Products > XSB Product Demo > Test docs

Search | Browse

Actions Document - 0000061680, 11682350_DZ_F_DSA20150428, A.3

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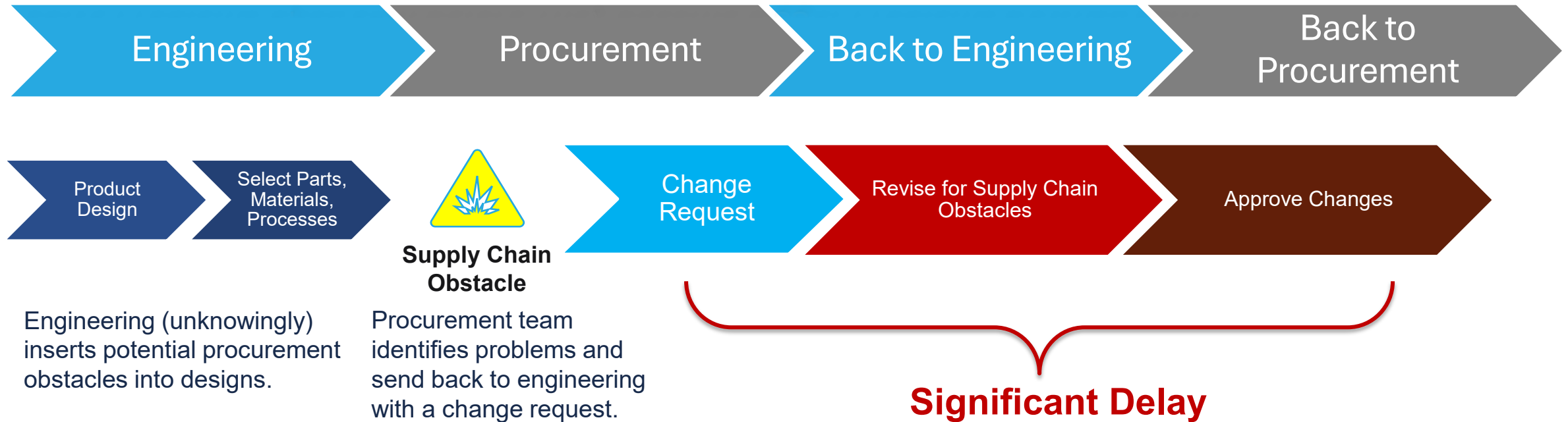
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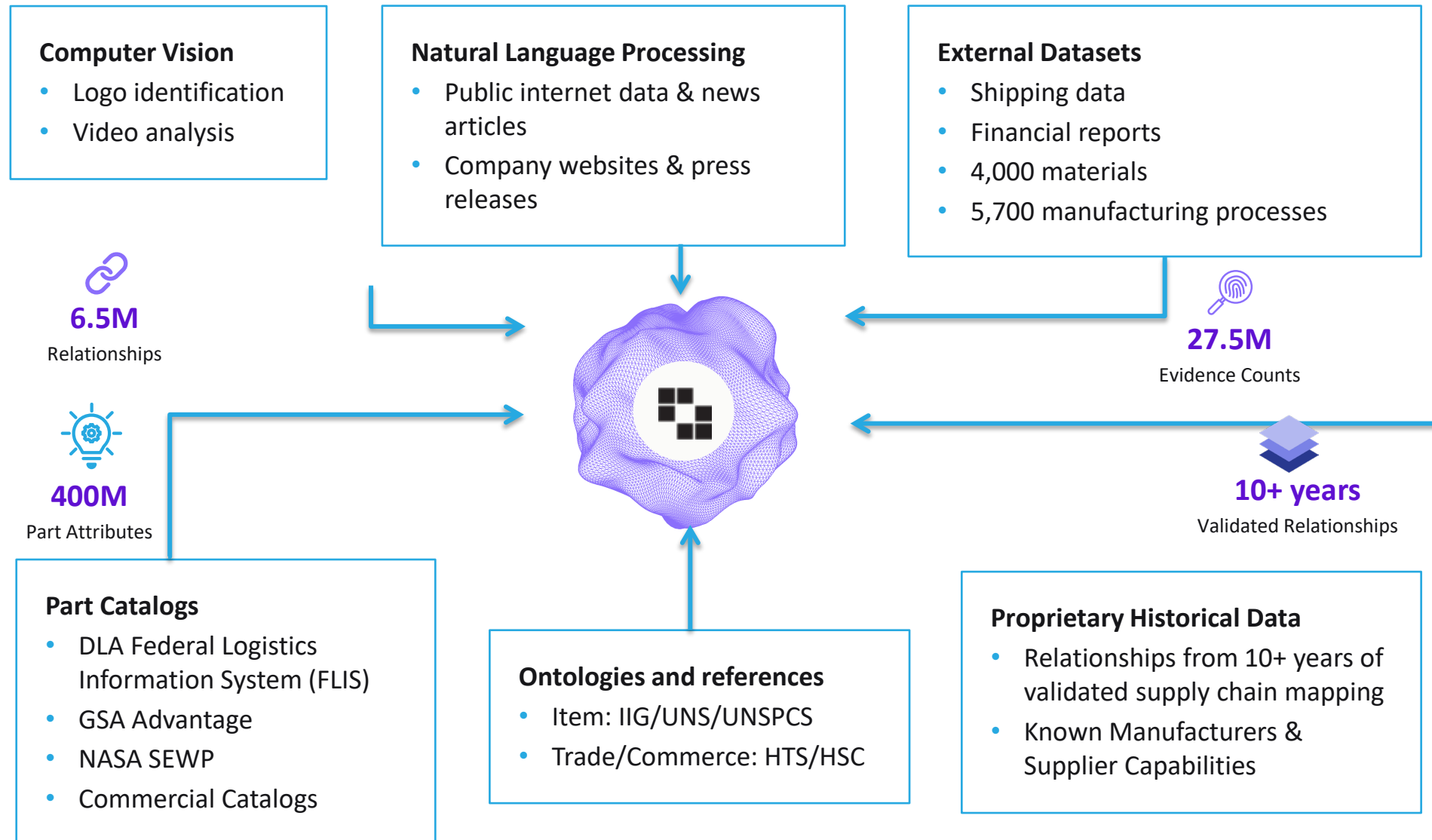
Solve Problems Upstream Before They Become Bigger Problems Downstream



- Detect risk earlier.
- Move from “engineering ready” to “procurement ready” faster
- Shift from reactive to proactive.

Ensemble of Technologies

AI-powered, ontology-aligned knowledge graph that interprets large, complex public & proprietary data sets.



Ontologies: a Shared *System of Meaning*

EXAMPLE 1

Multiple ways to say the same thing:

FLIS: Reference Number Cage Data (Segment C)				
NSN	Part Number	Item Name	CAGE	Company Name
4730012825081	8 F50L0-S	ADAPTER, STRAIGHT, TUBE TO BOSS	30780	PARKER-HANIFIN CORPORATION
4730014790870	8F50L0-S	ADAPTER, STRAIGHT, TUBE TO BOSS	30780	PARKER-HANNIFIN CORPORATION
4730014793855	8 F5OLO-S	ADAPTER, STRAIGHT, TUBE TO BOSS	05779	PARKER, HANNIFIN CORPORATION
4730014793855	8 F5OLO-S	ADAPTER, STRAIGHT, TUBE TO BOSS	30780	PARKER-HANNIFIN CORPORATION
4730014952074	8F50L0S	NIPPLE 1.2 X 1.2	A3958	PARKER HANNIFIN MANUFACTURING SRL

Problem: “Everyone is right locally, and incompatible globally”

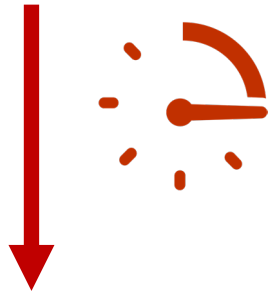
Solution: Ontologies!

EXAMPLE 2

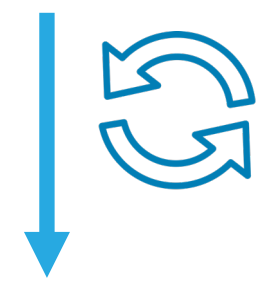
Ø10 THRU, 2X, C'BORE Ø18 x 5 DP

- **No ontology:** store strings or ad-hoc fields
- **With ontology:**
 - Feature:** Hole_1 (type: ThroughHole)
 - holeDiameter = 10 mm
 - quantity = 2
 - hasCounterbore:
 - counterboreDiameter = 18 mm
 - counterboreDepth = 5 mm

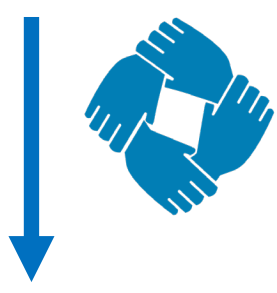
Where's the ROI (and How to Measure It)



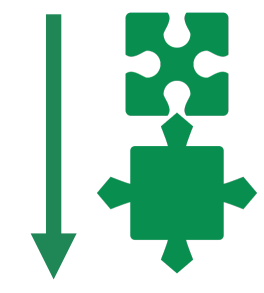
Engineering Hours
(reqs hunting, copy/paste, rekey, document stitching)
What to measure: time logs / sampling studies



Change-to-Release Time
(change mgmt + impact assessment + updates)
What to measure: ECO/ECR cycle timestamps



Supplier Latency
(comms loops, 3-3-9, time to implement)
What to measure: # Q&A cycles / days from release to first pass acceptance



Rework / NCRs
(misinterpretation, outdated refs)
What to measure: NRC tags + root cause (requirements / spec refs)

Industry Momentum and Mandate

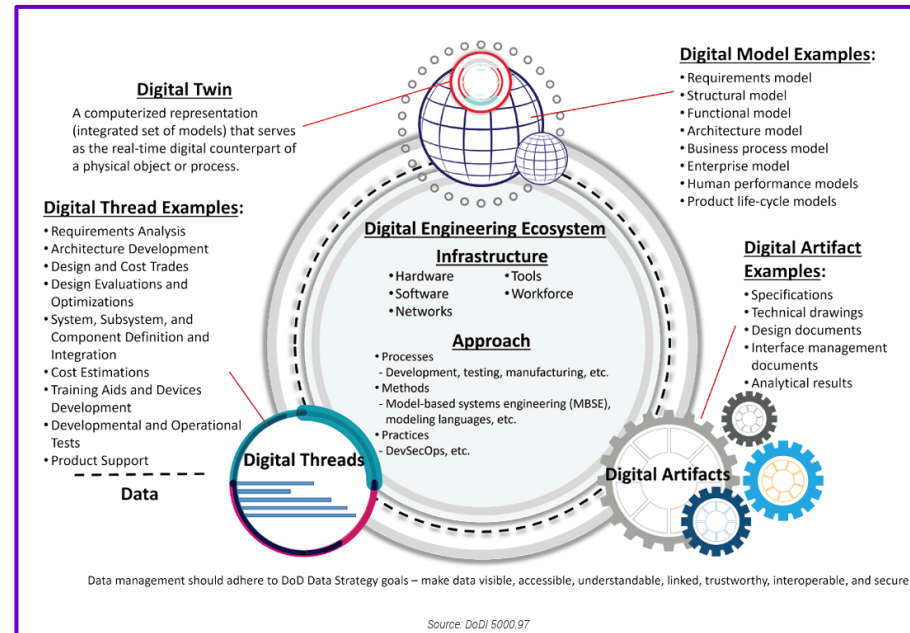


AF Digital Materiel Management Strategy



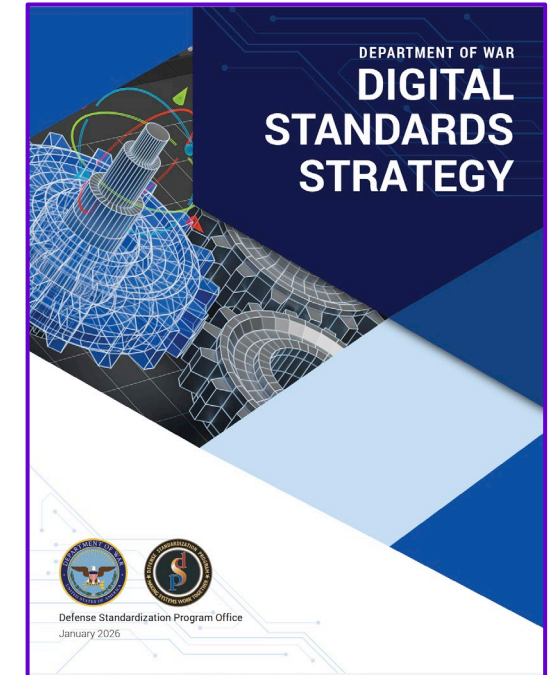
“Build ... model-based representations of systems in COTS architecture tools using **SysML**, or equivalent modeling language” to enable model and data sharing across the digital thread.

DoD Instruction 5000.97



“Moves the primary means of communicating system information from documents to **digital models** and their underlying data.”

Trajectory: shifting to machine-readable and machine-interpretable models



“Eliminate formats that are not machine-readable or machine-interpretable.”

Where to Begin

1. High-repeat use docs
2. High-translation workflows
3. Derivative-building content
4. Bottleneck hotspots: where do engineers/suppliers lose the most time

THANK YOU



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