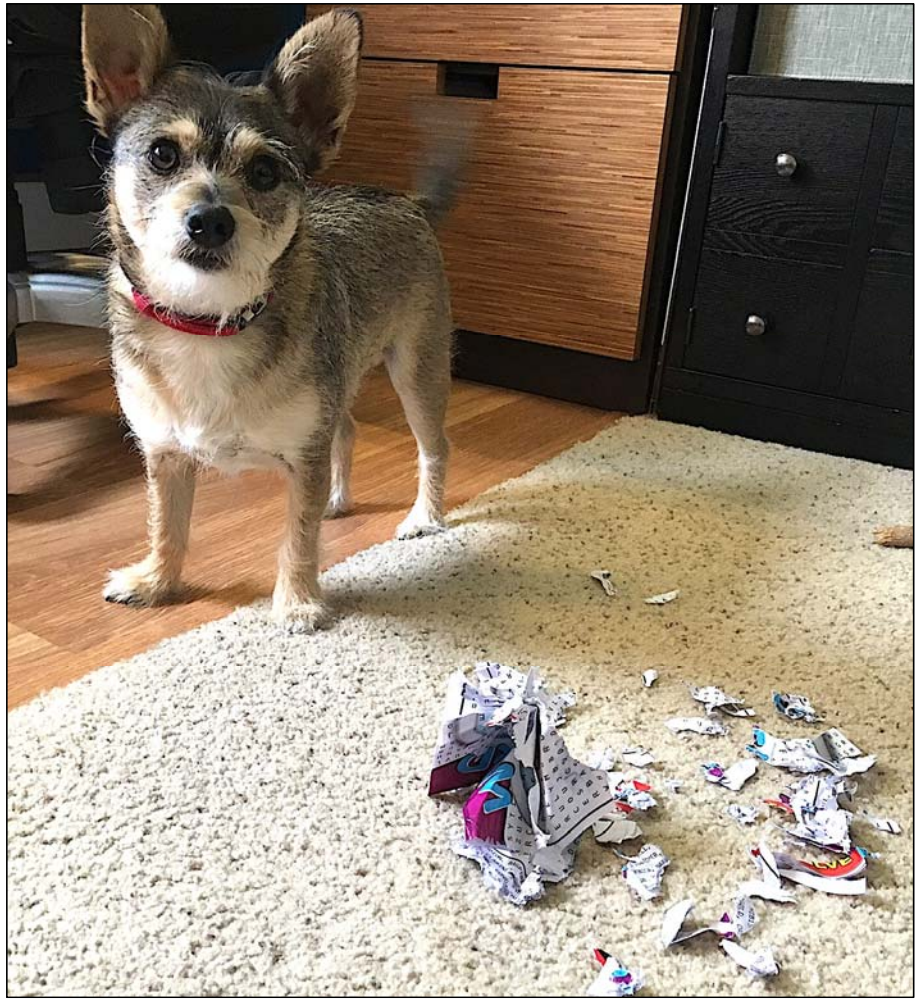
EVOLVE OR DISSOLVE…

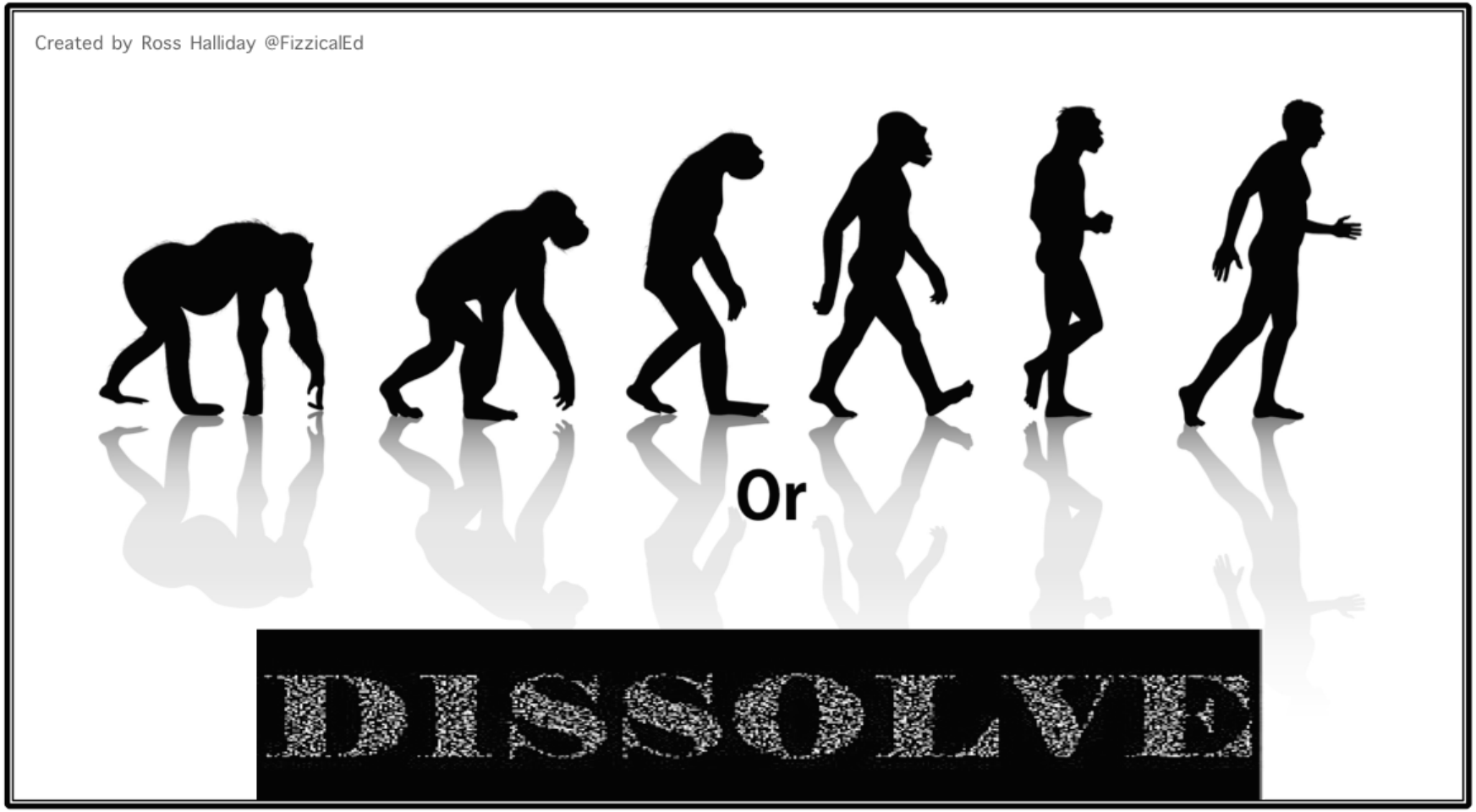
EFFECTIVE MBD/MBE STRATEGY AND BENEFITS

MBE Summit // April 4, 2017

Puppy

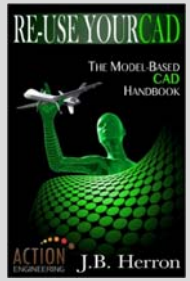


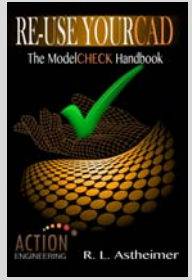
Evolve or Dissolve



Action Engineering Company Information

Model-Based Consulting and Training





TAKE ACTION TO BUILD YOUR DIGITAL ENTERPRISE™

Training

MBD/MBE EDUCATION – CAD Agnostic
Model Based Enterprise (MBE) Overview – What, Benefits, How
Introduction to MBD – What, GD&T, How
PLANNING
MBE Implementation
MBE Planning and Roadmap Building
IMPLEMENTING
Model Schema and Organization – CAD Agnostic
How to Write a Modeling Guide – CAD Agnostic
Reading, Commenting and Publishing 3D PDFs
CAD & PDM IMPLEMENTATION: SOLIDWORKS
Using SOLIDWORKS MBD
Administration, Set-up, and Best Practices for SOLIDWORKS and Enterprise PDM for MBD
Model Checking Automation for MBD
Reading, Viewing, and Reviewing MBD in SOLIDWORKS and eDrawings
CAD IMPLEMENTATION: Creo
Using Creo MBD
Model Checking Automation for MBD – ModelCHECK Administration and Best Practice
Reading, Viewing, and Reviewing MBD in Creo and CreoView
CAD IMPLEMENTATION: NX
Using NX MBD

Industry Organization Memberships

ASME
SETTING THE STANDARD

QIF

Dimensional Metrology Standards Consortium DMSC

DMDII
DIGITAL MANUFACTURING AND DESIGN INNOVATION INSTITUTE

Topics

What does a fully integrated digital enterprise look like?

Why would I bother with MBD?

How can MBD enable smart manufacturing systems?

What about Suppliers and Manufacturing/Quality?

Topics

What does a fully integrated digital enterprise look like?

Why would I bother with MBD?

How can MBD enable smart manufacturing systems?

What about Suppliers and Manufacturing/Quality?

Smart manufacturing requires a **digital enterprise**.

A **digital enterprise** requires **digital data**.

Digital data for product definition is called **Model-Based Definition (MBD)**.

Use MBD to Automate Inspection

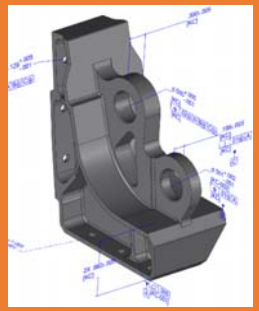
Desired Functionality
In Creo Native:
Compare **Actual to Source**

CAPVIDIA SOFTWARE

ORIGIN SOFTWARE

DMIS Execution File

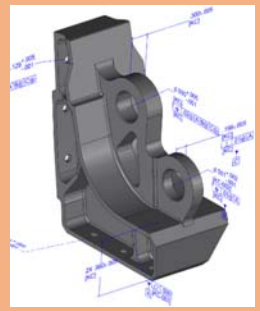
Creo with MBD



MBD defined as:

- Geometry
- Annotations
- Metadata
- Presentation
- Product Characteristics (PC)

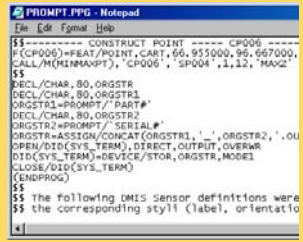
QIF MBD



QIF MBD defined as:

- Geometry
- Annotations
- Metadata
- Presentation
- Bill of Characteristics (BoC)

QIF PLAN



QIF PLAN defined as:

- How to perform measurements
- BoC turned into measurement items
- QPIDS created

QIF Results

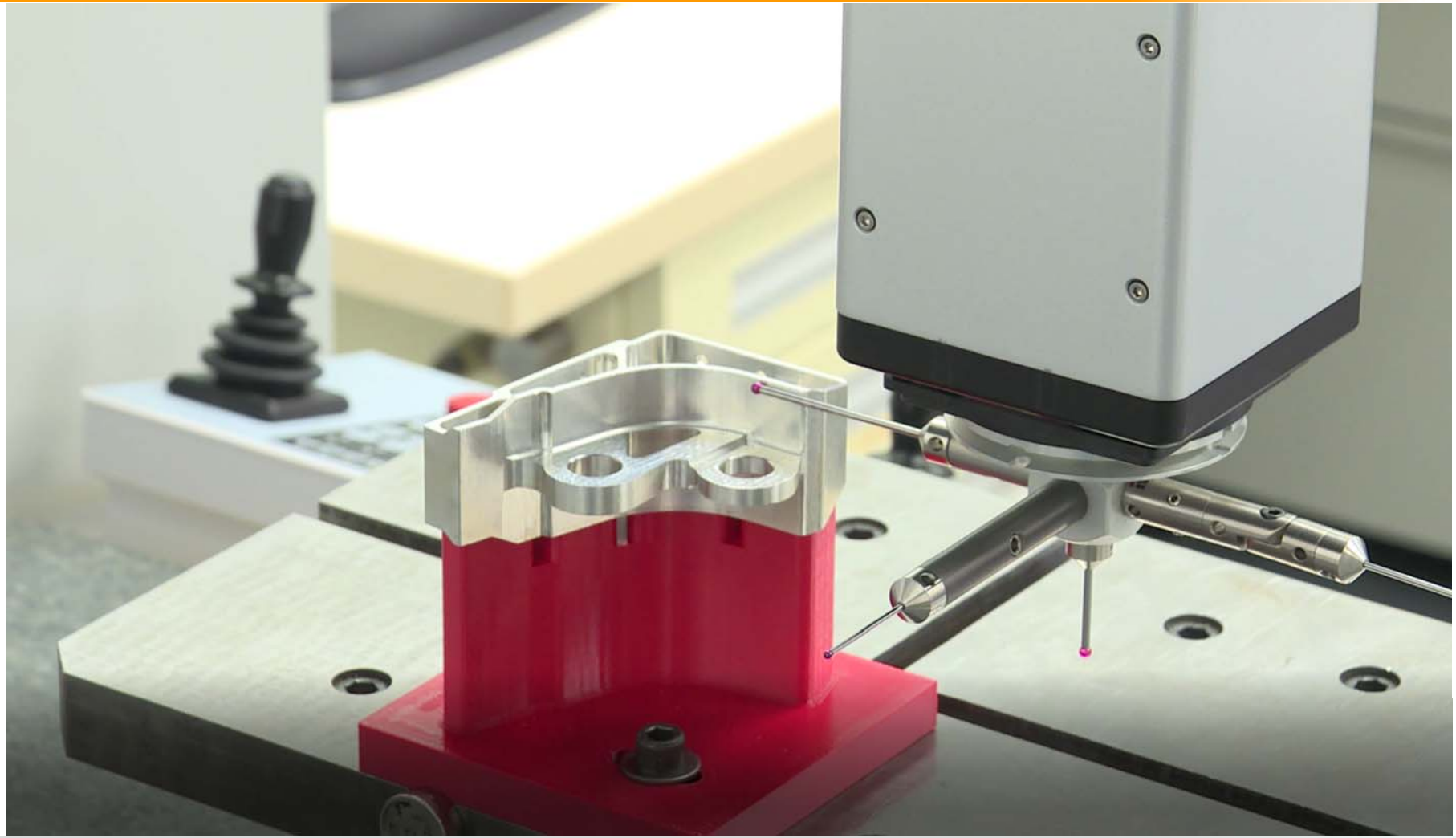
Measurement Execution

CMM:

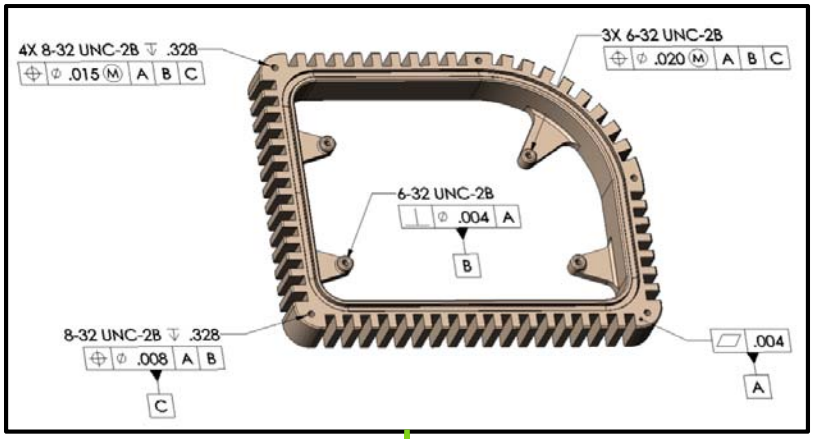
- Part Program
- Measurement Instructions
- Inspection Results

DMIS Output File

Model-Based Inspection Process – Using QIF

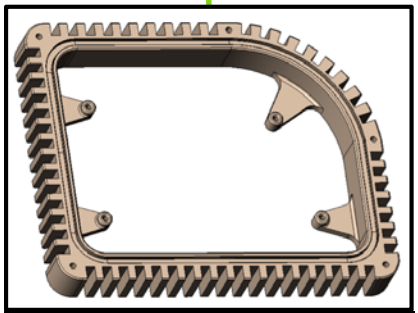


What is MBD?

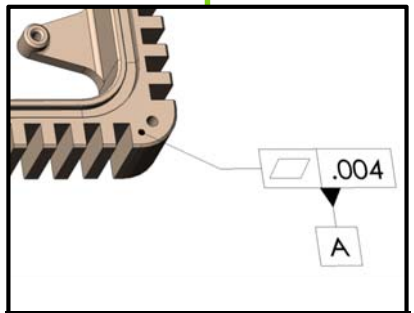


Model-Based Definition (MBD) is a model with Product Manufacturing Information (PMI) and consisting of:

1) **3D geometry** (serves as the basic dimensions)
2) **annotations*** (displayed notes, dimensions and tolerances or GD&T)
3) **attributes*** (metadata and queried data)
4) **presentation*** (saved views, presentation organization)



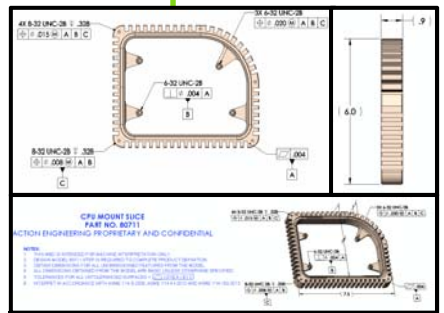
3D GEOMETRY



ANNOTATIONS*

PART NUMBER	8742659
DESCRIPTION	CPU MOUNT SLICE
MATERIAL	AL 6061-T651
COMPANY	Action Engineering
DATA RIGHTS	PROPRIETARY & CONFIDENTIAL
SUPPLIER	ACME MACHINING

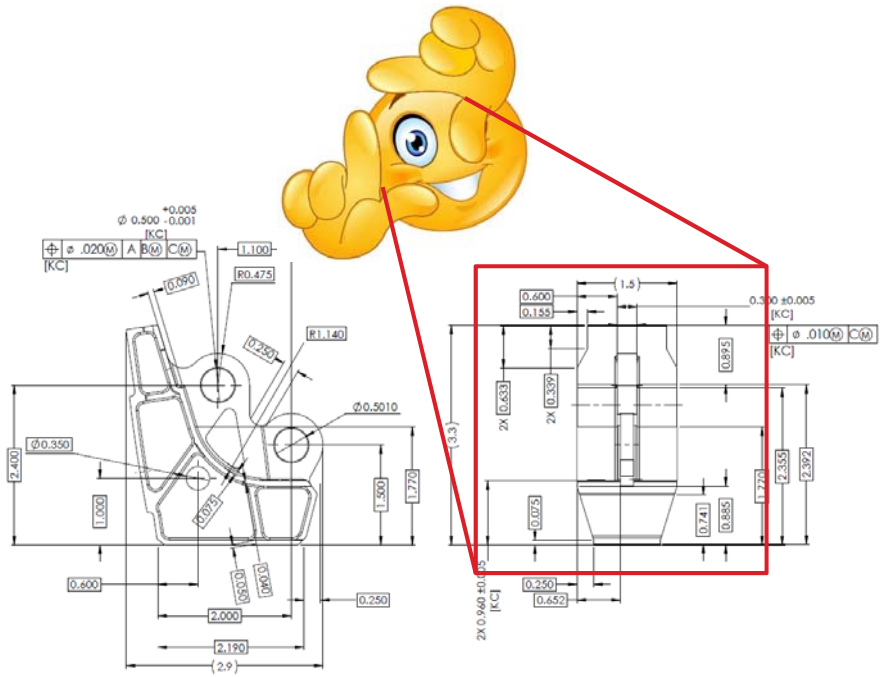
ATTRIBUTES*



PRESENTATION*

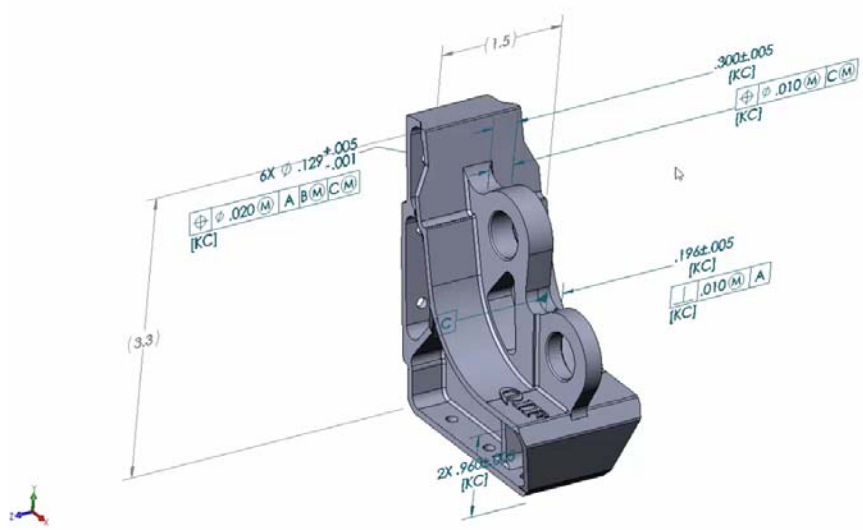
*As defined in ASME Y14 Series

How is MBD different from drawings?

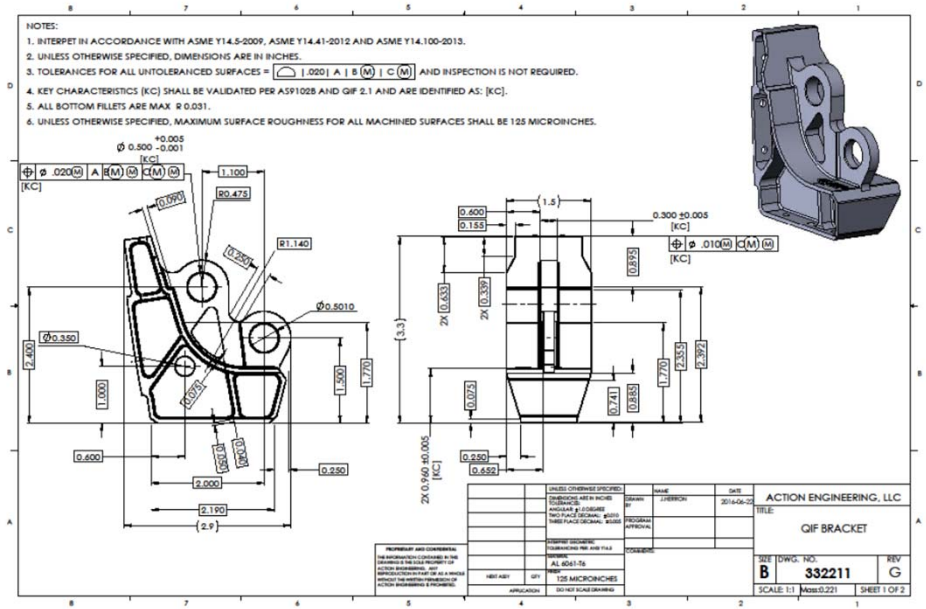


Drawings **REQUIRE** experience

We naturally see in 3D

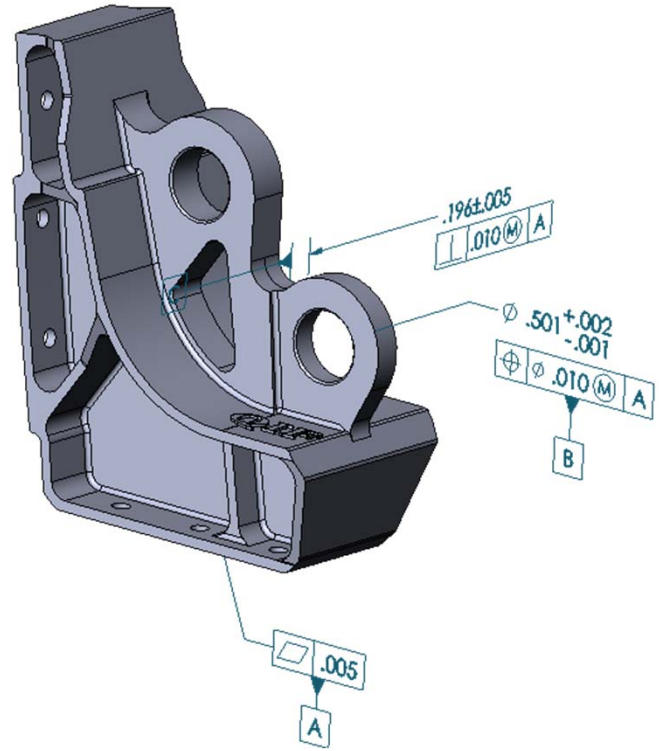


How is MBD different from drawings?



Drawings **REQUIRE** all basic dimensions

The 3D model is the basic dimension



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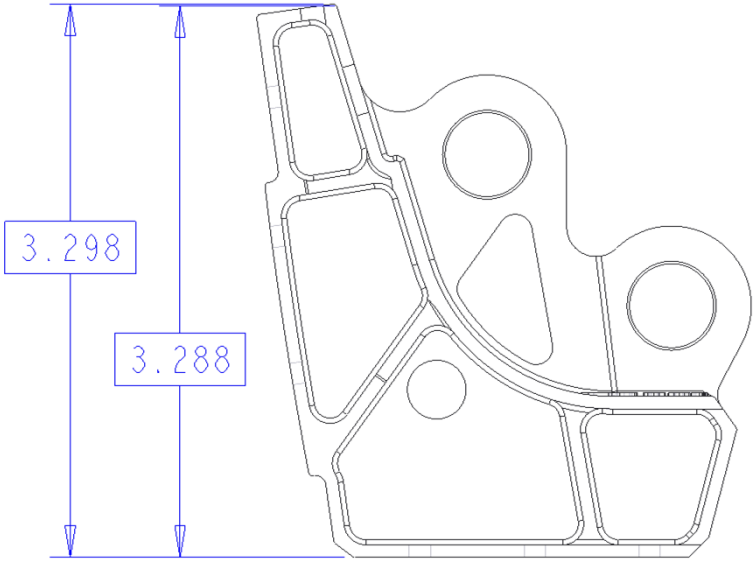
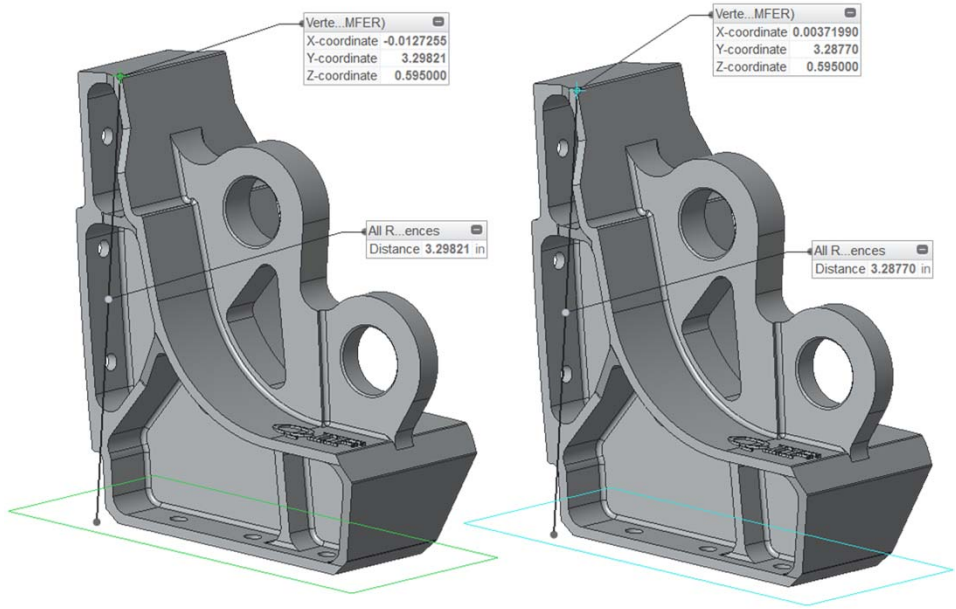
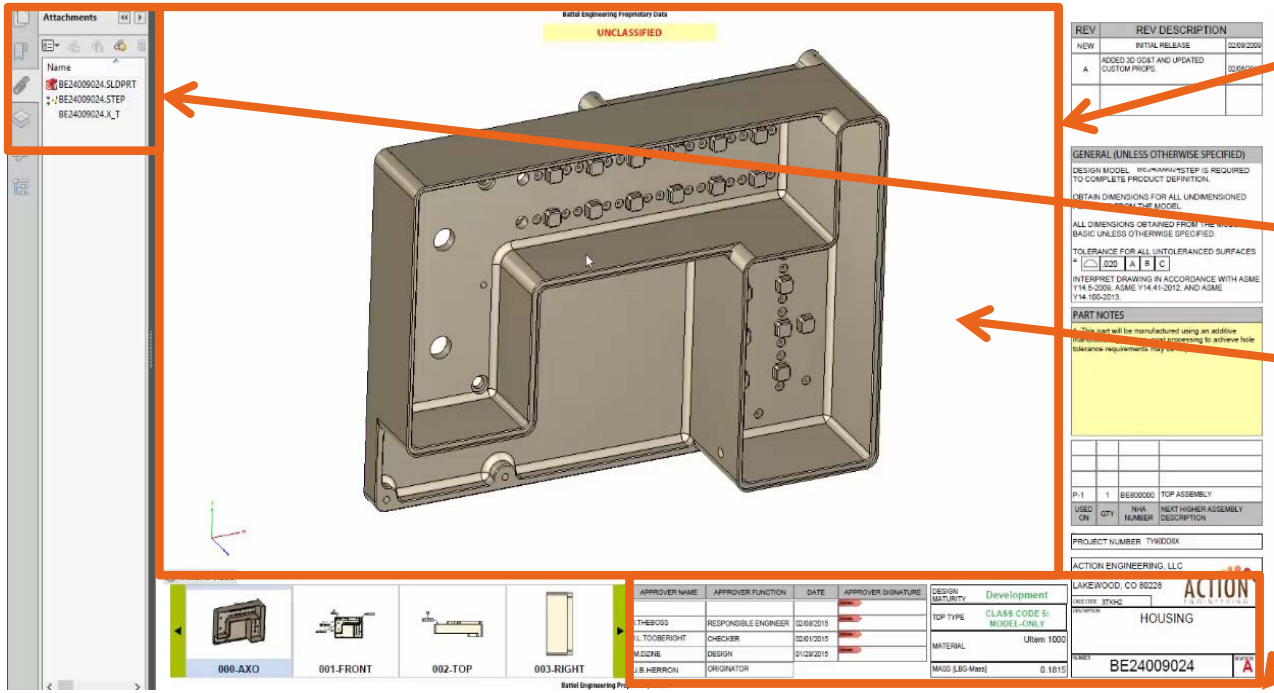


Drawings are **AMBIGUOUS**

The 3D model is **ABSOLUTE**



Anatomy of a Data Package (DD)



Data Package Elements

3D Geometry that is mathematically accurate provides graphical visual representation and dimensional representation

Related Files (3D and 2D) in a variety of formats (STEP, Parasolid, STL, Native CAD, more…)

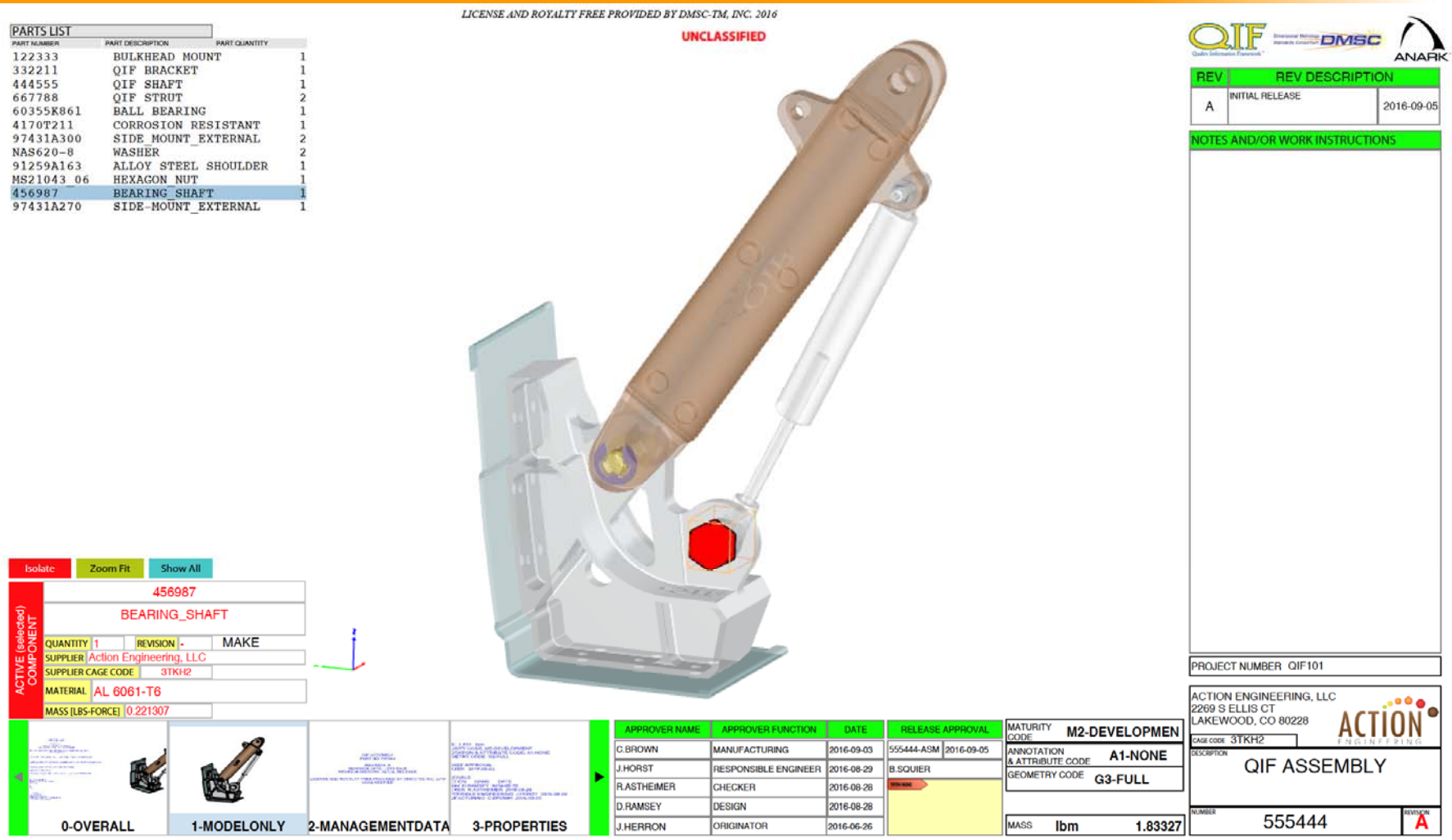
Annotations:

- Datums
- Tolerances
- Notes
- Product Characteristics

Metadata

- Part Number, Description, Revision, Tolerance Block, Material, Finish, Organization Information
- Bill of Materials (BOM) or Parts List (PL)
- Option for encoded data (e.g. Color, IP Rights, Model Precision, CAD Format Compatibility)

Assembly Layout Example



Topics

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Improve Product Data Quality with MBD

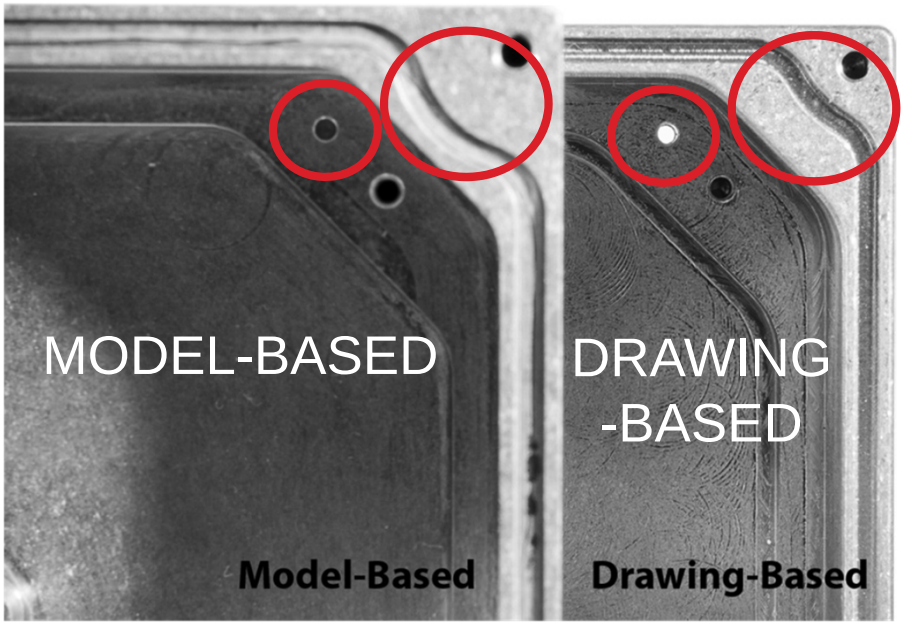


Fig. 7 Comparison of a delivered test case 1 part showing the addition of an unintended through-hole in the drawing-based part

- Drawing-based method
  - Rework required due to human mis-interpretation
- Model-based method
  - Built as modeled

CITATION: Testing the Digital Thread in Support of Model-Based Manufacturing and Inspection, Journal of Computing and Information Science in Engineering, June 2016, Vol.16

MBD Benefits at a Large Scale

LIFECYCLE INSIGHTS

- Migrating to MBD provides quantifiable benefits
- MBD can reduce scrap rate and reduce engineering changes
- Using a minimally annotated model reduces product definition authoring time

REFERENCE:
http://www.lifecycleinsights.com/study/the-design-and-documentation-study/

2014 DATA

Assessing why parts don't fit together
4.9 fewer times per month

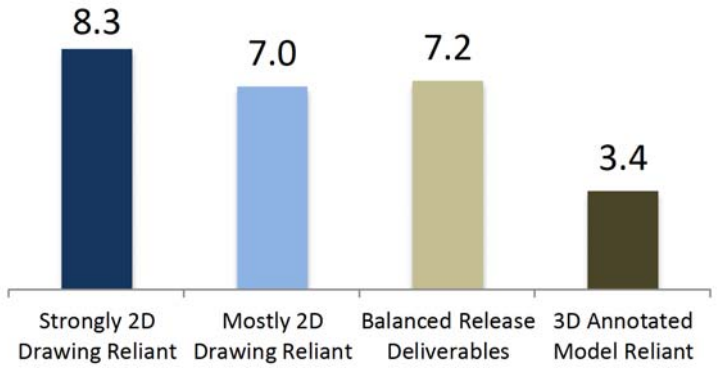
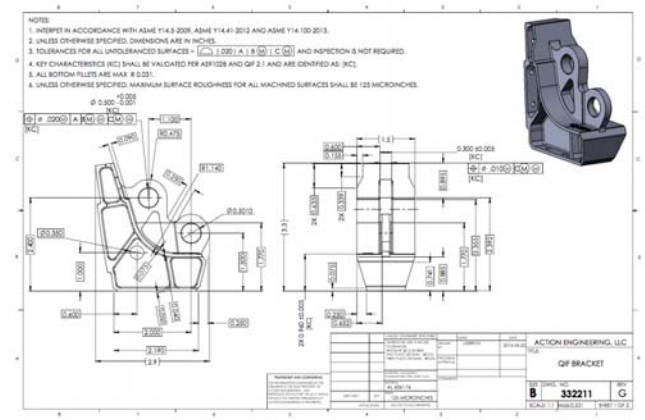


Figure 3: Average times per month the organization assesses why parts don't fit as a result of engineering documentation

REFERENCE: QUANTIFYING THE VALUE OF MODEL BASED DEFINITIONS – Lifecycle Insights - http://www.lifecycleinsights.com

2016 ROI of MBD Study

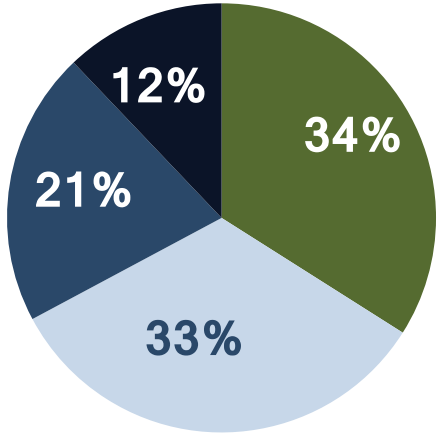


Fully Annotated Drawing

LIFECYCLE INSIGHTS

MBD ADOPTION

2016 DATA

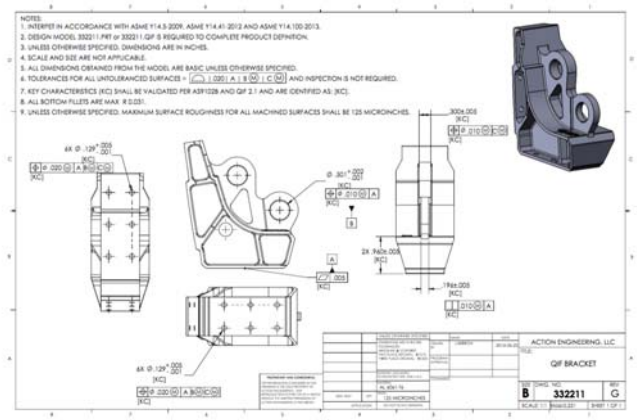


Drawing exclusive

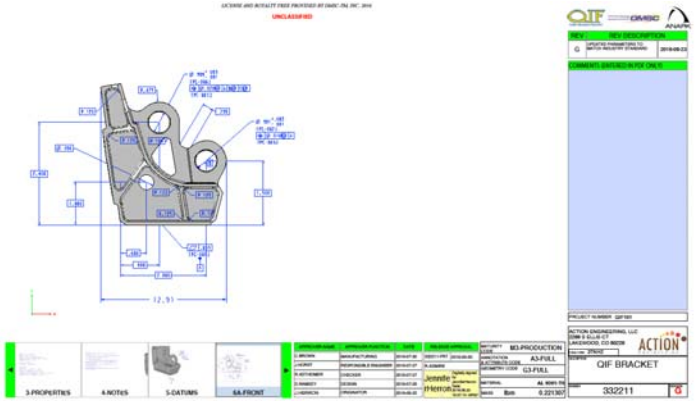
Drawing with model

Drawing with MBD deliverable

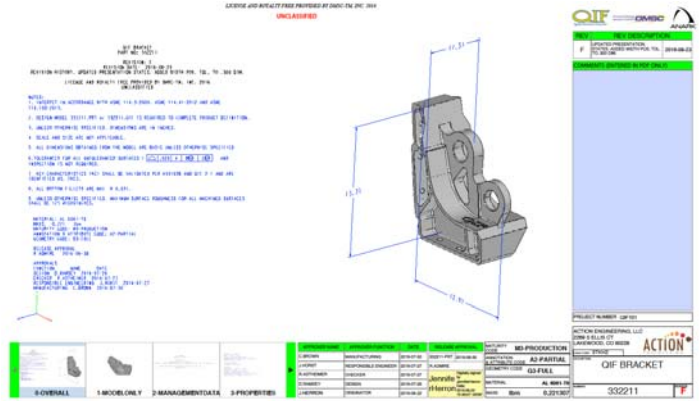
Drawingless



Minimally Annotated Drawing



Fully Annotated 3D Model

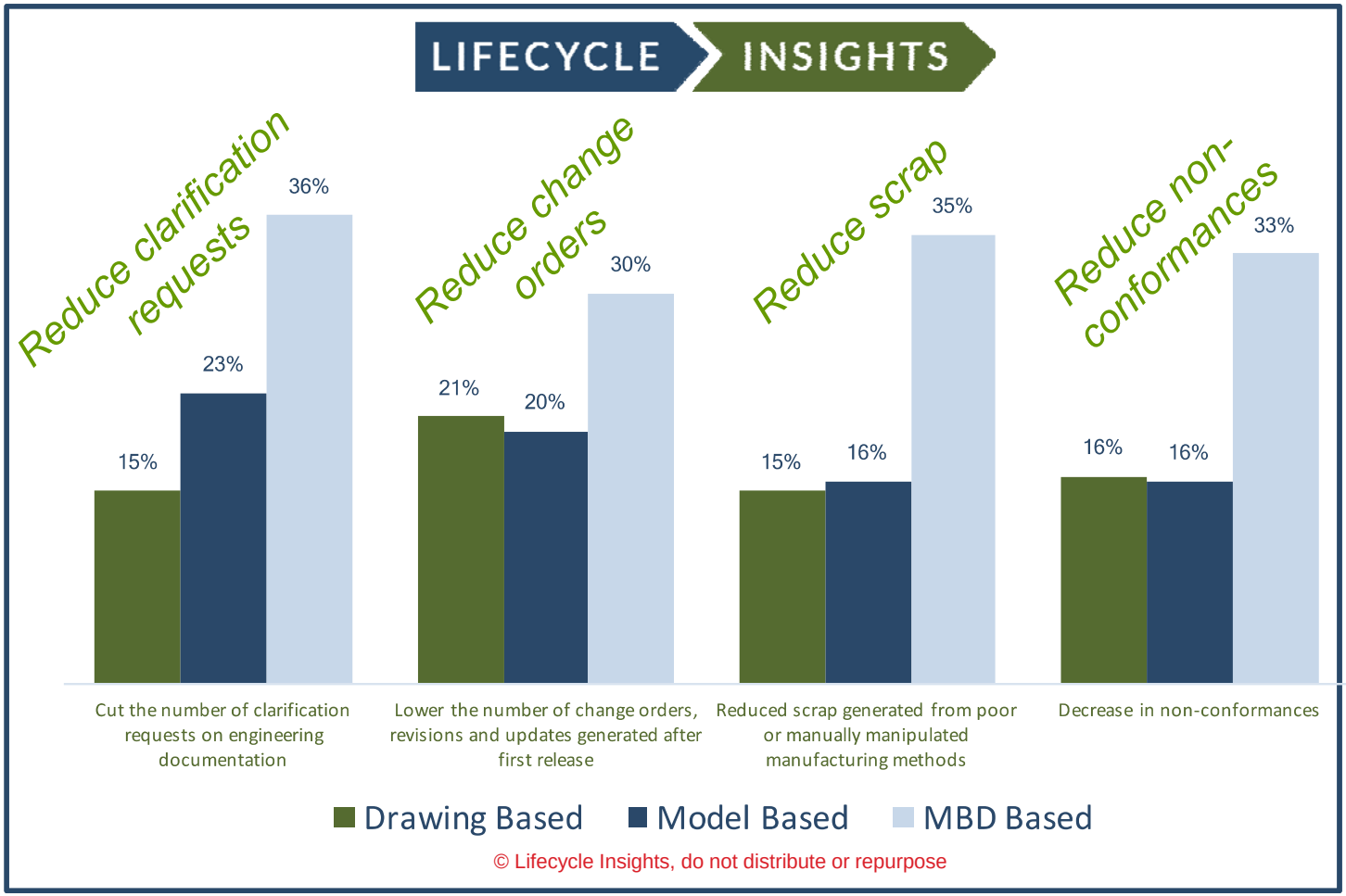


Minimally Annotated 3D Model

REFERENCE: http://www.lifecycleinsights.com/study/the-design-and-documentation-study/

Reduce Changes, Scrap, and Non-Conformances

2016 DATA



REFERENCE: http://www.lifecycleinsights.com/study/the-design-and-documentation-study/

Search-ability

- **CHALLENGE**: Engineers spend too much time searching for data

- **SOLUTION**: Consistently applied MBD can increase the “google-ability” of 3D data

What is your pain?

- High cost & schedule engineering changes
- High scrap rate
- Poor product quality
- High tribal knowledge
- Chaotic Design
  - Engineer To Order (ETO)
  - Configure To Order (CTO)

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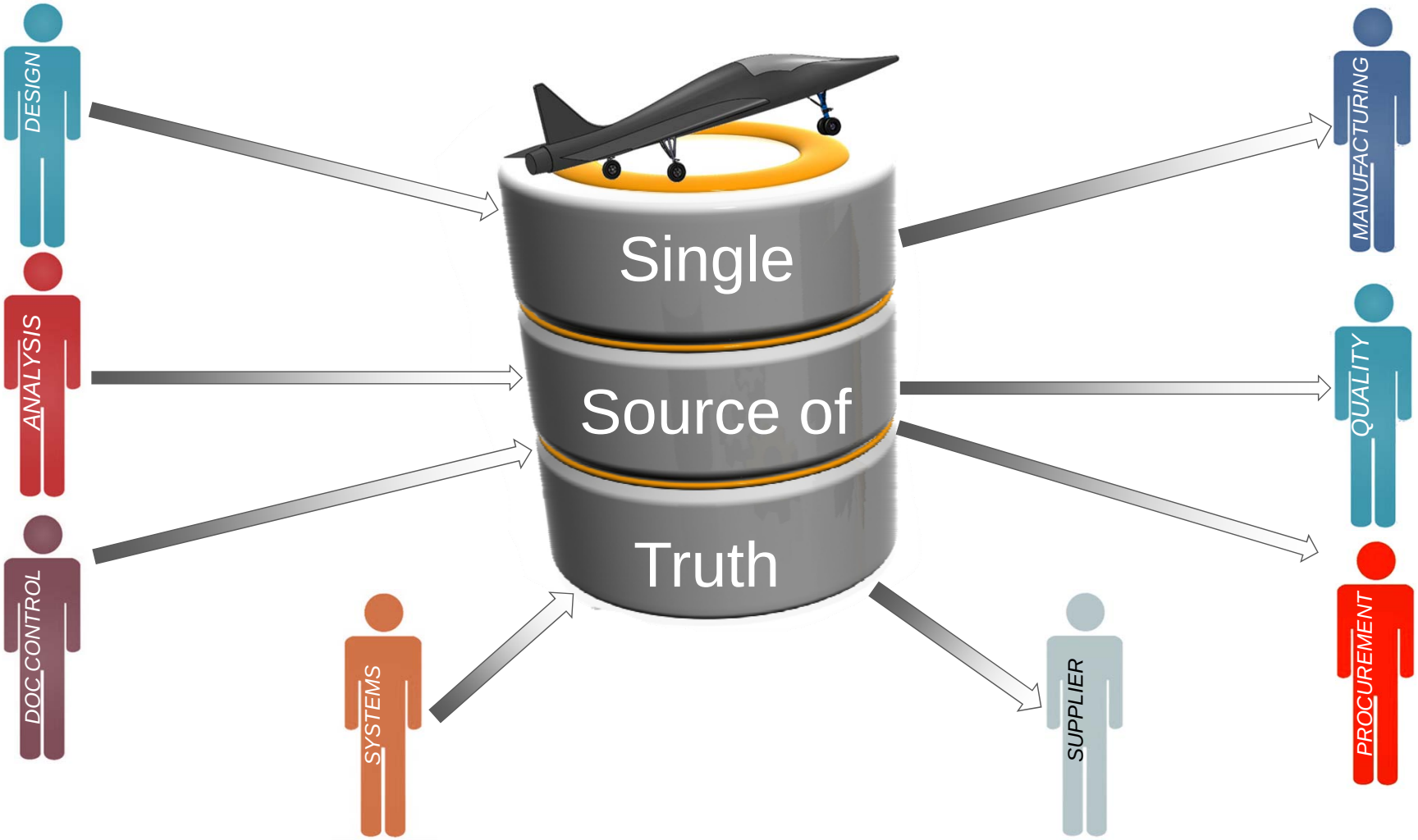
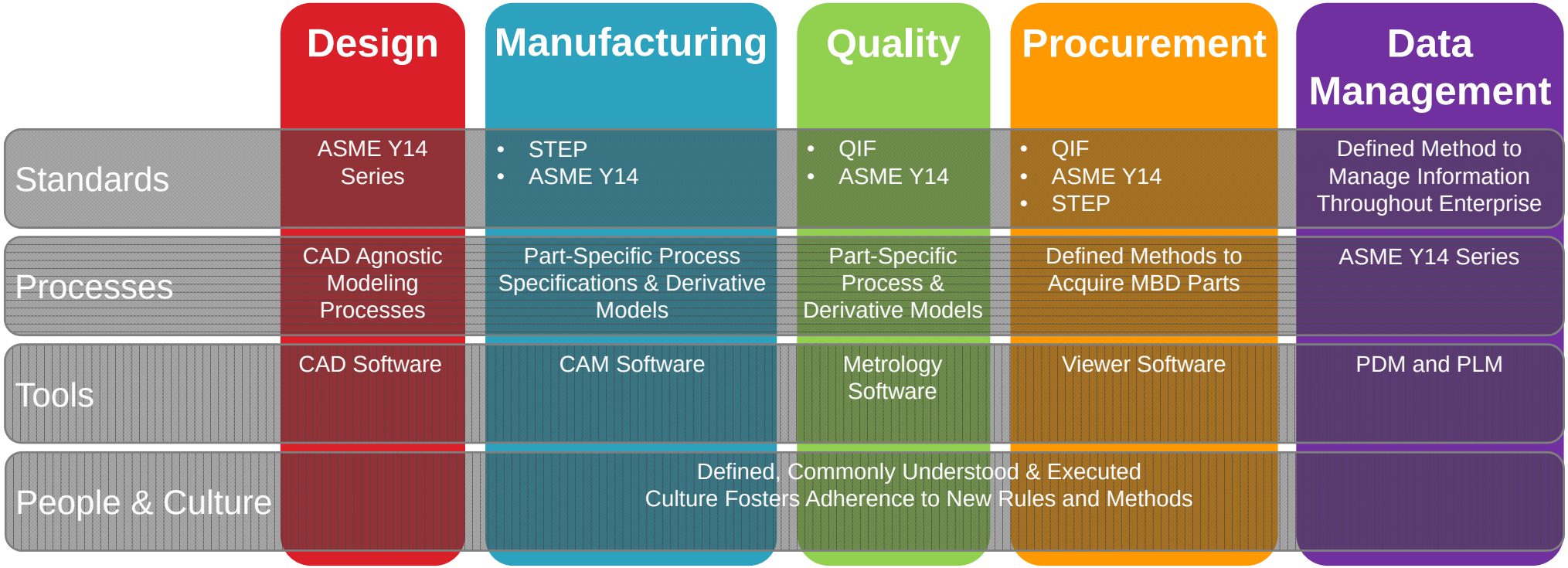
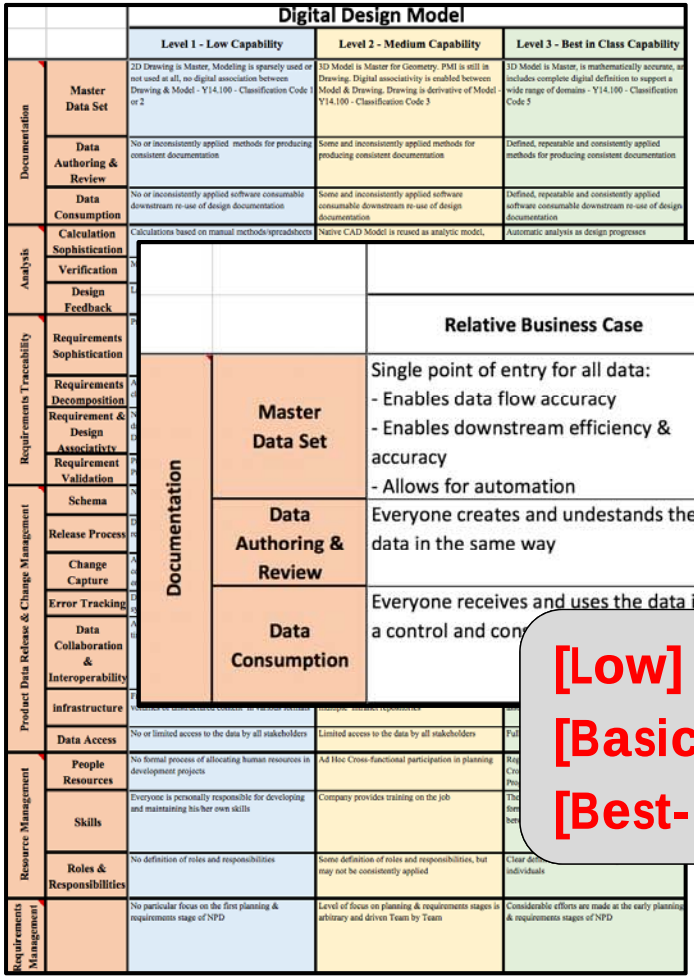
What does a fully integrated digital enterprise look like?



Success with Digital Data Requires the Entire Enterprise



Organizational Readiness: Evaluate Current & Target States



		Digital Design Model		
		Level 1 - Low Capability	Level 2 - Medium Capability	Level 3 - Best in Class Capability
Documentation	Master Data Set	2D Drawing is Master, Modeling is sparsely used or not used at all, no digital association between Drawing & Model - Y14.100 - Classification Code 1 or 2	3D Model is Master for Geometry. PMI is still in Drawing. Digital associativity is enabled between Model & Drawing. Drawing is derivative of Model - Y14.100 - Classification Code 3	3D Model is Master, is mathematically accurate, and includes complete digital definition to support a wide range of domains - Y14.100 - Classification Code 5
	Data Authoring & Review	No or inconsistently applied methods for producing consistent documentation	Some and inconsistently applied methods for producing consistent documentation	Defined, repeatable and consistently applied methods for producing consistent documentation
	Data Consumption	No or inconsistently applied software consumable downstream re-use of design documentation	Some and inconsistently applied software consumable downstream re-use of design documentation	Defined, repeatable and consistently applied software consumable downstream re-use of design documentation
Analysis	Calculation Sophistication	Calculations based on manual methods/spreadsheets	Native CAD Model is reused as analytic model,	Automatic analysis as design progresses
	Verification			
	Design Feedback			
Requirements Traceability	Requirements Sophistication			
	Requirements Decomposition			
	Requirement & Design Associativity			
	Requirement Validation			
Product Data Release & Change Management	Schema			
	Release Process			
	Change Capture			
	Error Tracking			
	Data Collaboration & Interoperability			
	infrastructure			
	Data Access	No or limited access to the data by all stakeholders	Limited access to the data by all stakeholders	
Resource Management	People Resources	No formal process of allocating human resources in development projects	Ad Hoc Cross-functional participation in planning	
	Skills	Everyone is personally responsible for developing and maintaining his/her own skills	Company provides training on the job	
	Roles & Responsibilities	No definition of roles and responsibilities	Some definition of roles and responsibilities, but may not be consistently applied	
Requirements Management		No particular focus on the first planning & requirements stage of NPD	Level of focus on planning & requirements stages is arbitrary and driven Team by Team	Considerable efforts are made at the early planning & requirements stages of NPD

DETERMINE VALUE STREAM

ACHIEVE ROI

		Digital Design Model					
		Relative Business Case	Level 1 - Low Capability	Level 2 - Medium Capability	Level 3 - Best in Class Capability	SCORE Current State	SCORE Target State
Documentation	Master Data Set	Single point of entry for all data: - Enables data flow accuracy - Enables downstream efficiency & accuracy - Allows for automation	2D Drawing is Master, Modeling is sparsely used or not used at all, no digital association between Drawing & Model - Y14.100 - Classification Code 1 or 2	3D Model is Master for Geometry. PMI is still in Drawing. Digital associativity is enabled between Model & Drawing. Drawing is derivative of Model - Y14.100 - Classification Code 3	3D Model is Master, is mathematically accurate, and includes complete digital definition to support a wide range of domains - Y14.100 - Classification Code 5	Level 2-MEDIUM	Level 3-BEST IN CLASS
	Data Authoring & Review	Everyone creates and undestands the data in the same way	No or inconsistently applied methods for producing consistent documentation	Some and inconsistently applied methods for producing consistent documentation	Defined, repeatable and consistently applied methods for producing consistent documentation	Level 1-LOW	Level 3-BEST IN CLASS
	Data Consumption	Everyone receives and uses the data in a control and con	No or inconsistently applied software	Some and inconsistently applied	Defined, repeatable and consistently	M	Level 3-BEST IN CLASS

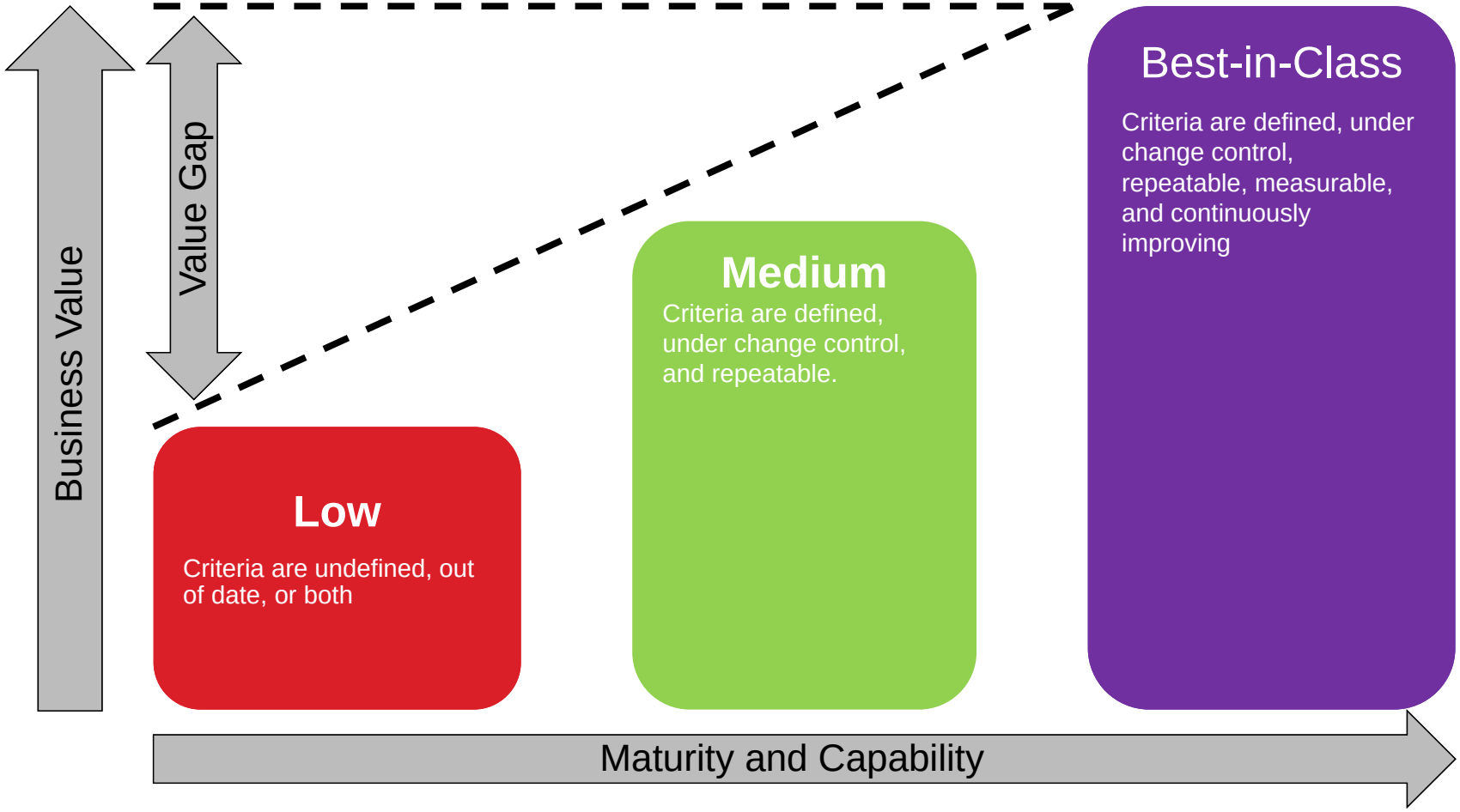
[Low] ***Undefined & Out-of-date***

[Basic] ***Defined & Repeatable***

[Best-in-Class] ***Measured & Continuously Improving***

REFERENCE: Digital Thread Capability & Maturity Model, Action Engineering, LLC & DSA

The Value Add of MBE Maturity



Top 3 Focus Areas… and Why

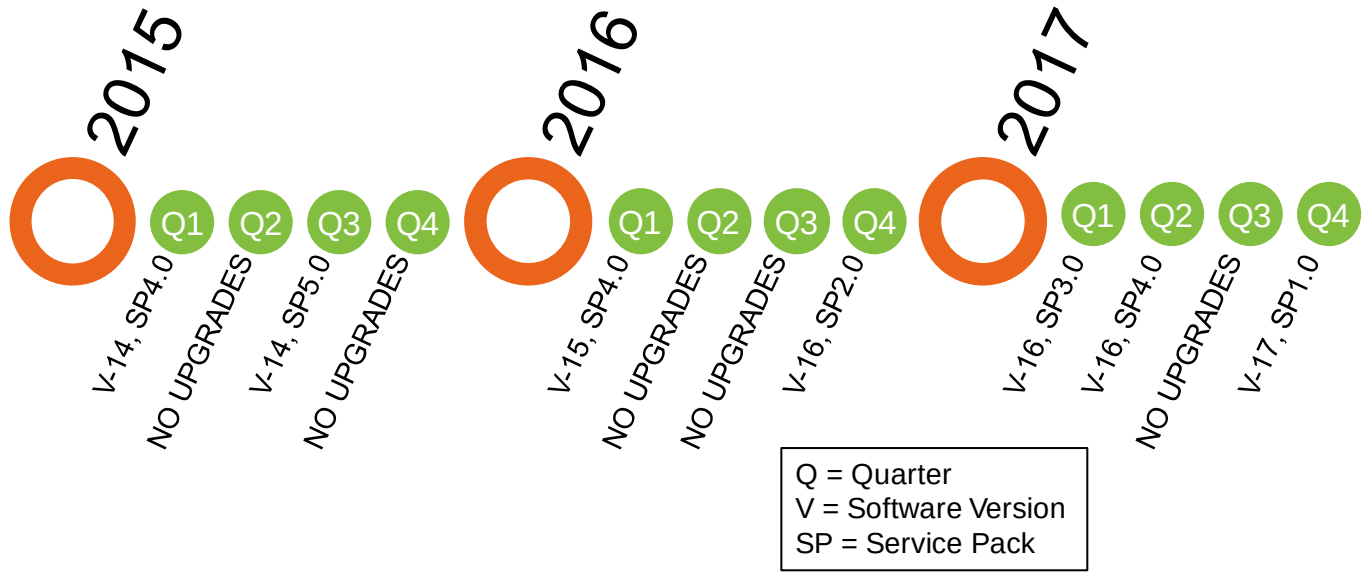
Software Tools and Maintenance

Define and Execute Consistently

Robust CAD Source, Derivative and Interoperability Strategy

Software Tools & Maintenance

- Research
- Select
- Test
- Deploy
- Maintain
  - It is critical to “KEEP UP”

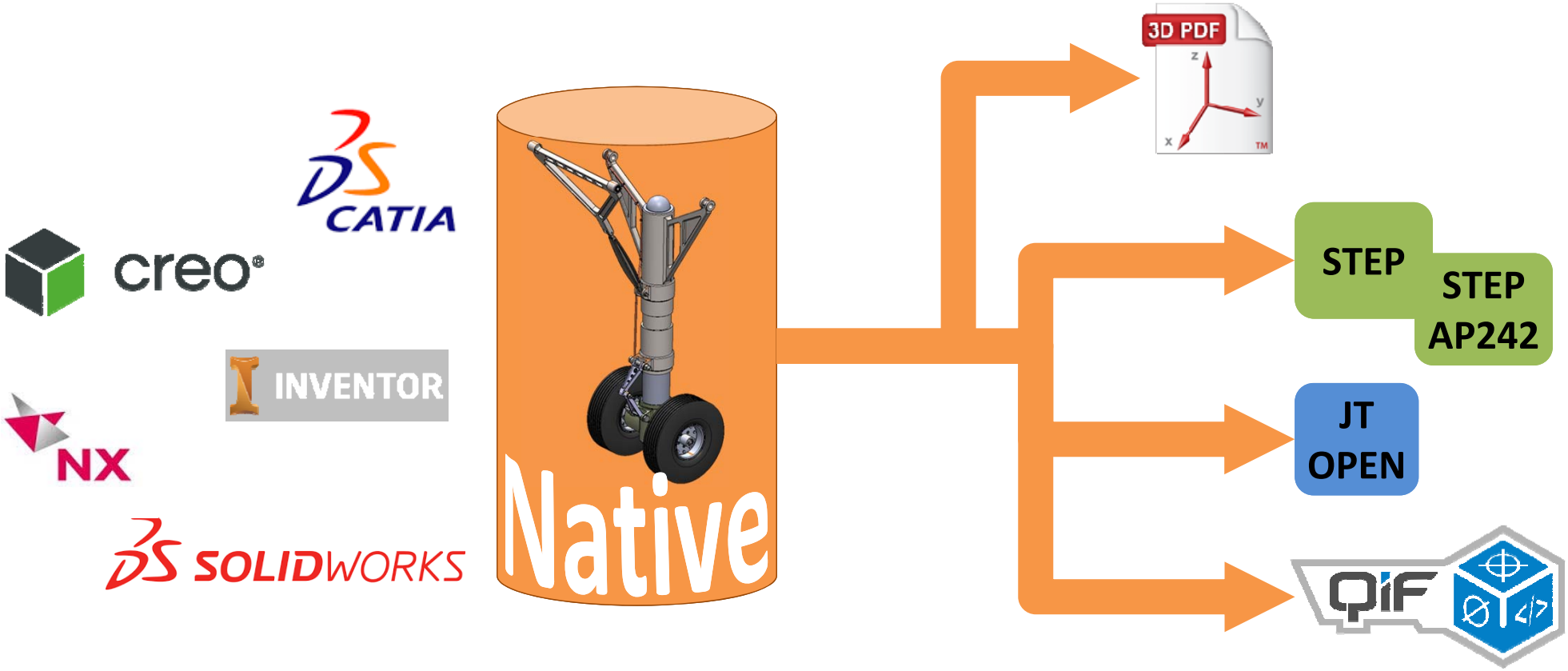


REFERENCE: http://www.action-engineering.com/blog/2015/12/cad-maintenance-flavors

Define and Execute Consistently

- Road Map for Implementation
  - Include all stakeholders: Design, Manufacturing, Quality, Data & Change Management, Procurement, Product Lifecycle Management, People & Culture
- 3D Product Definition
  - 3D modeling standard
  - Sophisticated understanding of GD&T
  - Sophisticated approach to inspection criteria
  - CAD agnostic processes for MBD
- Stakeholder Engagement
  - It's all about the people!
    - Make jobs less frustrating
    - Improving the quality of the end product
    - Build loyalty

Robust CAD Source, Derivative and Interoperability Strategy



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What about Suppliers and Manufacturing/Quality?

Manufacturing & Quality Readiness

- Internal Suppliers
- External Suppliers

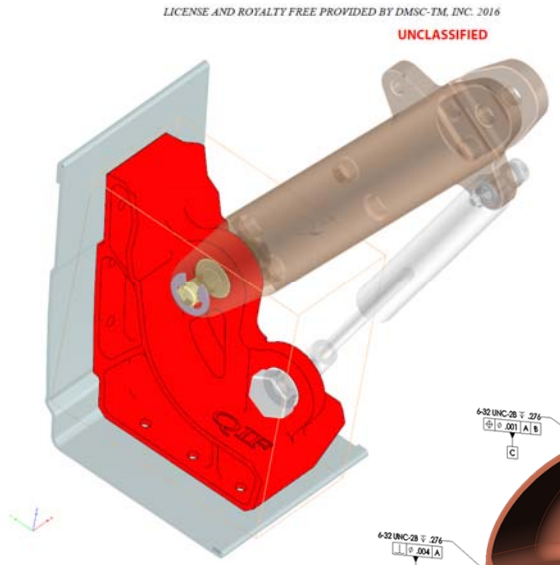
MBE Summit Manufacturing & Quality Track

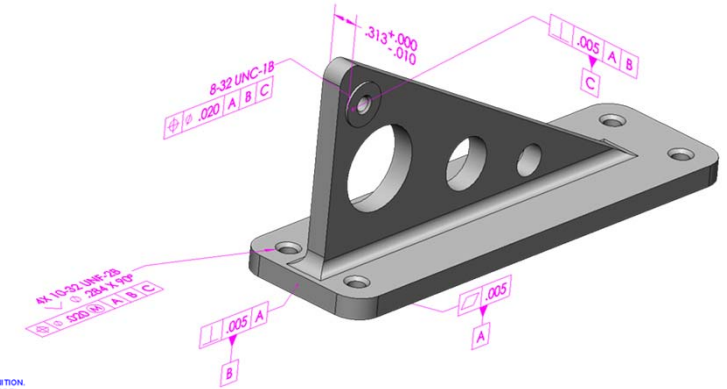
MBD Supplier Readiness

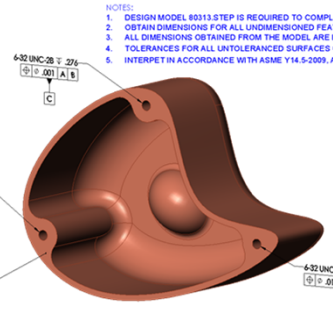
Tuesday, April 5, 2017 4:20-4:40 pm

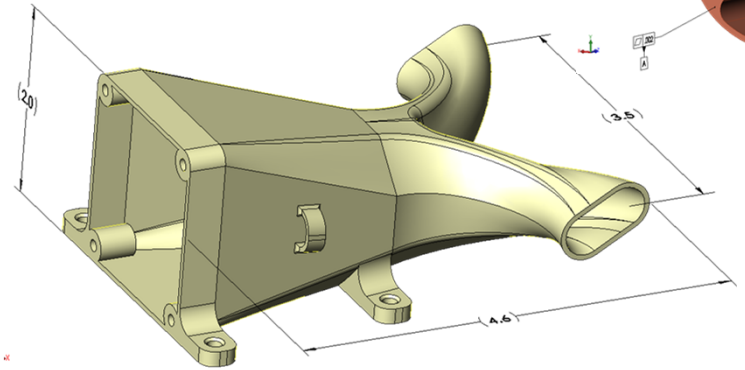
What did you learn?

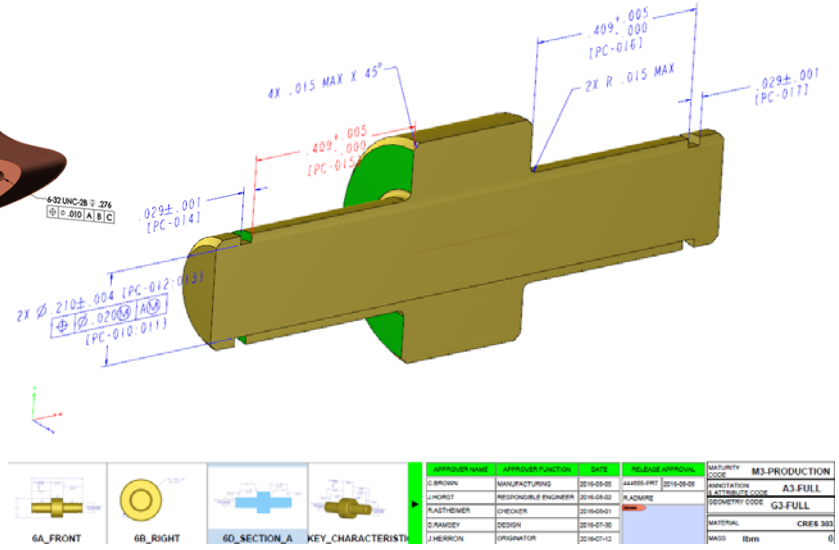
PARTS LIST		
PART NUMBER	PART DESCRIPTION	PART QUANTITY
122333	BULKHEAD MOUNT	1
332211	QIF BRACKET	1
444555	QIF SHAFT	1
667788	QIF STRUT	2
60355K861	BALL BEARING	1
4170T211	CORROSION RESISTANT	1
97431A300	SIDE_MOUNT_EXTERNAL	2
NAS620-8	WASHER	2
91259A163	ALLOY STEEL SHOULDER	1
MS21043_06	HEXAGON_NUT	1
456987	BEARING_SHAFT	1
97431A270	SIDE-MOUNT_EXTERNAL	1











Find Out More…

Re-Use Your CAD™

Model-Based Business Process Coaching & Planning

- Model-Based Engineering & Enterprise (MBE) Planning
- PDM & PLM Process Implementation
- Tailor Business Practices and PDM/PLM Workflows to include 3D CAD
- Apply Configuration Management Directly to 3D Model Data Sets
- Strategies to Create and Consume MBD Models

Model-Based Training and Education

- Basic Training is CAD Agnostic and Focuses on MBE Philosophy
- Intermediate and Advanced Training is Software-Specific and Customized to Your Organization
- Understanding Model-Based Definition (MBD) and Technical Data Packages (TDP), per ASME Y14.41 and MIL-STD-31000A
- CAD Modeling Best Practice for MBE

CAD, PDM, PLM Software Selection Consulting

- Software Beta Testing
- User-Based Feedback and Improvement for Software Tools
- Assess and Recommend Software Tools for Compatibility with 3D Model-Based Engineering (MBE)

CAD Agnostic Course Listings

MBD/MBE EDUCATION	Course Number	Suggested Format
Model Based Enterprise (MBE) Overview – What, Benefits, How	101	Live or Online
Introduction to MBD – What, GD&T, How	102	Live or Online
PLANNING		
MBE Implementation	103	Live or Online
MBE Planning and Roadmap Building	104	Live
IMPLEMENTING		
Model Schema and Organization – CAD Agnostic	105	Live or Online
How to Write a Modeling Guide – CAD Agnostic	106	Live or Online
Reading, Commenting and Publishing 3D PDFs	107	Live or Online

CAD Specific Course Listings

CAD & PDM IMPLEMENTATION: SOLIDWORKS	Course Number	Suggested Format
Using SOLIDWORKS MBD	201	Live or Online
Administration, Set-up, and Best Practices for SOLIDWORKS and Enterprise PDM for MBD	202	Live or Online
Model Checking Automation for MBD	203	Live or Online
Reading, Viewing, and Reviewing MBD in SOLIDWORKS and eDrawings	204	Live or Online
CAD IMPLEMENTATION: Creo	**Course Number**	**Suggested Format**
Using Creo MBD	301	Live or Online
Model Checking Automation for MBD – ModelCHECK Administration and Best Practice	303	Live or Online
Reading, Viewing, and Reviewing MBD in Creo and CreoView	304	Live or Online
CAD IMPLEMENTATION: NX	**Course Number**	**Suggested Format**
Using NX MBD	401	Live or Online

Courses listed are not official SOLIDWORKS, DASSAULT, PTC, or SIEMENS sanctioned courses.

Contact Action Engineering

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Re-Use Your CAD

Online Resources

- Blogs
  - www.action-engineering.com/blog
  - blog.grabcad.com
  - MCADCafé.com
- LinkedIn Groups
  - Model Based Enterprise
  - Model Based Definition
- Events
  - 3D CIC + QIF Summit
    October 3-5, 2017, Golden, CO

Part Layout Example

QIF BRACKET
PART NO: 332211

REVISION: G
REVISION DATE: 2016-08-23
REVISION HISTORY: UPDATED PARAMETERS TO MATCH INDUSTRY STANDARD

NOTES:
1. INTERPET IN ACCORDANCE WITH ASME Y14.5-2009, ASME Y14.41-2012 AND ASME Y14.100-2013.

2. DESIGN MODEL 332211.PRT or 332211.QIF IS REQUIRED TO COMPLETE PRODUCT DEFINITION.

3. UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

4. SCALE AND SIZE ARE NOT APPLICABLE.

5. ALL DIMENSIONS OBTAINED FROM THE MODEL ARE BASIC UNLESS OTHERWISE SPECIFIED.

6. TOLERANCES FOR ALL UNTOLERANCED SURFACES = ⌓ .020 A B C AND INSPECTION IS NOT REQUIRED.

7. KEY CHARACTERISTICS (PC) SHALL BE VALIDATED PER AS9102B AND QIF 2.1 AND ARE IDENTIFIED AS: [PC-###].

8. ALL BOTTOM FILLETS ARE MAX R 0.031.

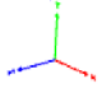
9. UNLESS OTHERWISE SPECIFIED, MAXIMUM SURFACE ROUGHNESS FOR ALL MACHINED SURFACES SHALL BE 125 MICROINCHES.

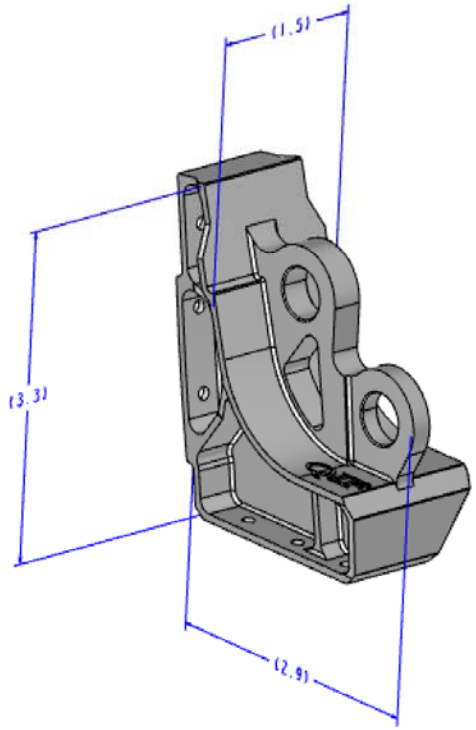
MATERIAL: AL 6061-T6
MASS: 0.221 lbm
MATURITY CODE: M3-PRODUCTION
ANNOTATION & ATTRIBUTE CODE: A2-PARTIAL
GEOMETRY CODE: G3-FULL

RELEASE APPROVAL
R.ADMIRE 2016-06-30

APPROVALS

FUNCTION	NAME	DATE
DESIGN	D.RAMSEY	2016-07-26
CHECKER	R.ASTHEIMER	2016-07-27
RESPONSIBLE ENGINEERING	J.HORST	2016-07-27
MANUFACTURING	C.BROWN	2016-07-30



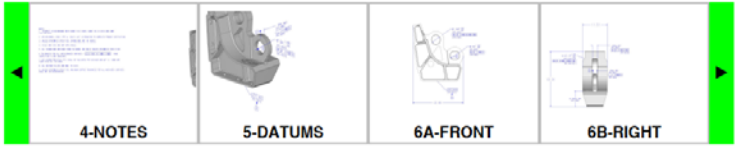


QIF DMSC ANARK

REV	REV DESCRIPTION	
G	UPDATED PARAMETERS TO MATCH INDUSTRY STANDARD	2016-08-23

COMMENTS (ENTERED IN PDF ONLY)

PROJECT NUMBER QIF101



APPROVER NAME	APPROVER FUNCTION	DATE
C.BROWN	MANUFACTURING	2016-07-30
J.HORST	RESPONSIBLE ENGINEER	2016-07-27
R.ASTHEIMER	CHECKER	2016-07-27
D.RAMSEY	DESIGN	2016-07-26
J.HERRON	ORIGINATOR	2016-06-22

RELEASE APPROVAL	
332211-PRT	2016-06-30
R.ADMIRE	
JennifrHerron	Digitally signed by JennifrHerron Date: 2016.06.23 18:47:42 -06'00'

MATURITY CODE	M3-PRODUCTION
ANNOTATION & ATTRIBUTE CODE	A2-PARTIAL
GEOMETRY CODE	G3-FULL
MATERIAL	AL 6061-T6
MASS	lbm 0.221307

ACTION ENGINEERING, LLC
2269 S ELLIS CT
LAKEWOOD, CO 80228

CAGE CODE 3TKH2

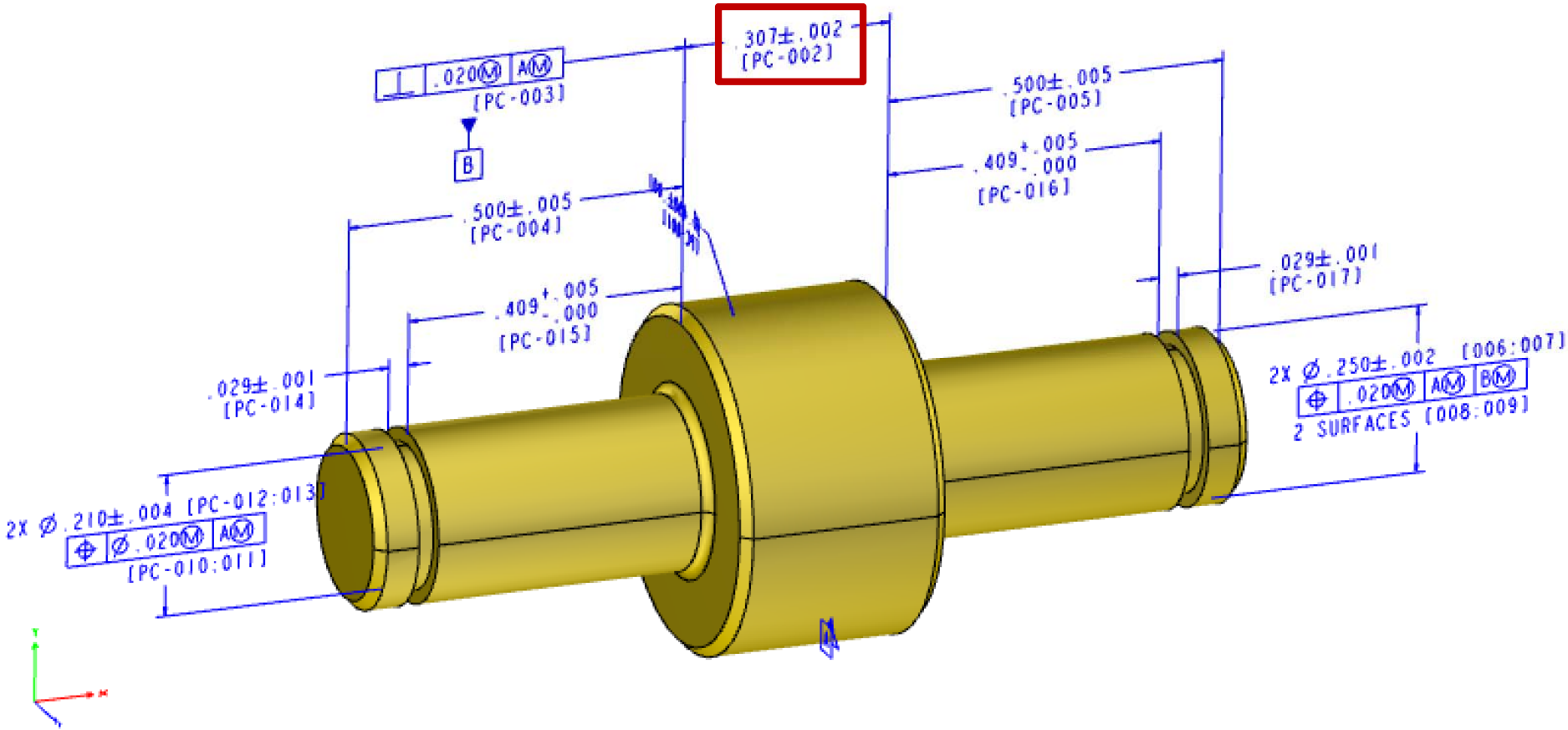
DESCRIPTION
QIF BRACKET

NUMBER 332211

REVISION G

Identifying Product Characteristics with MBD

7. PRODUCT CHARACTERISTICS (PC) SHALL BE VALIDATED PER AS9102B AND QIF 2.1 AND ARE IDENTIFIED AS: [PC-###].



Creating a Data Package (DP)