Model-Based Quality enabled by Persistent Product Characteristics

Curtis W. Brown
Principal Engineer
Honeywell FM&T

The Department of Energy's National Security Campus is operated and managed by Honeywell Federal Manufacturing & Technologies, LLC under contract number DE-NA0002839

Overview

- **Introduction**
  - **Kansas City National Security Campus**
  - **Honeywell FM&T**
  - **Speaker Information**
- **Model-Based Enterprise (MBE) - The Epic Journey**
- **Model-Based Characteristics (MBC) - The Bridge**
- **Model-Based Quality (MBQ) - Our part of the Story**
  - **Trusted Product Models**
  - **Product Characteristics**
  - **Quality Information Framework**
- **IMTS 2016 Demonstration and Message**
- **The Persistent Product Characteristic Story**
- **Way Forward**

Kansas City National Security Campus

Government sponsored, multi-mission engineering and manufacturing enterprise delivering trusted national security products and government services

Core Mission – National Nuclear Security Administration

- **A large portion of the Campus is dedicated to NNSA's mission of keeping our nation's nuclear stockpile safe, secure and reliable by delivering mission-critical mechanical, electrical and engineered material components.**

Global Security – Other Government Agencies

- **Our unique expertise extends beyond the nuclear security enterprise to benefit national security and promote nonproliferation with field-ready solutions for other government agencies.**

Supply Chain Management Center – Department of Energy

- **Using our innovative strategic sourcing processes, we enable DOE and NNSA sites to leverage their annual spend to save millions each year.**

NNSA

KANSAS CITY NSC National Security Campus

Honeywell

Managed and Operated by Honeywell FM&T

Kansas City National Security Campus located in Kansas City, MO

KCNSC

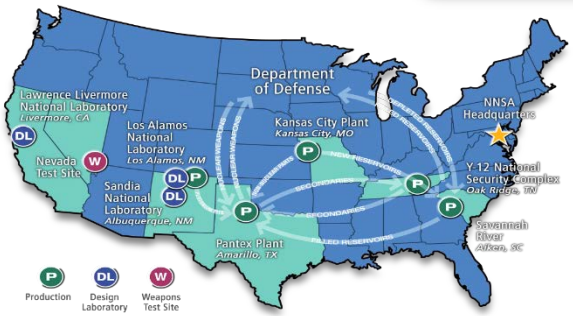
- 60 Years of Continuous Service to Department of Energy
- Relocated in 2014 as a LEED® Gold-Rated Manufacturing Facility
- ~1.5 million sq. ft. facility

Talented Work Force

- 2,700 skilled employees in MO & NM
- Engineers, skilled trades workers, and support personnel

Partners

- Sandia National Laboratories
- Los Alamos National Laboratories
- Lawrence Livermore National Laboratories



Customers

- -National Nuclear Security Administration
- -Department of Energy
- -Department of Defense
- -Other Federal Agencies

NNSA

KANSAS CITY NSC National Security Campus

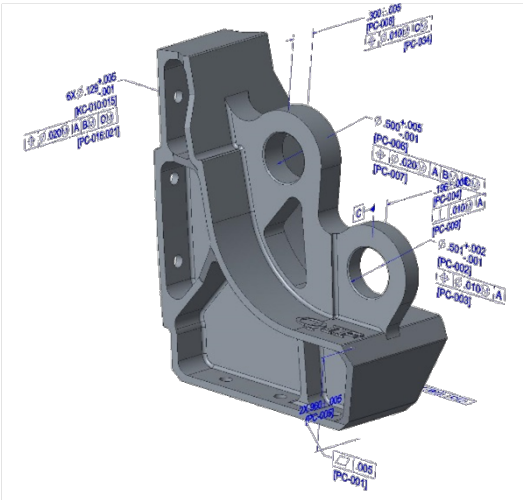
Honeywell

Speaker information

- **Curtis W. Brown**
  - Hired as a Quality Engineer support CMM product inspections
  - Currently Principle Mechanical Engineer in Design Services
  - FM&T's Focus Lead for Model-Based Enterprise
  - Technology Creator of Feature-Based Tolerancing (FBTol) Advisor
  - Volunteer President of the Dimensional Metrology Standards Consortium

What is Model-Based Enterprise (MBE)?

MBD: An 3D annotated model and its associated data elements that fully define the product definition in a manner that can be communicated and used effectively by all downstream customers without a drawing graphic sheet.

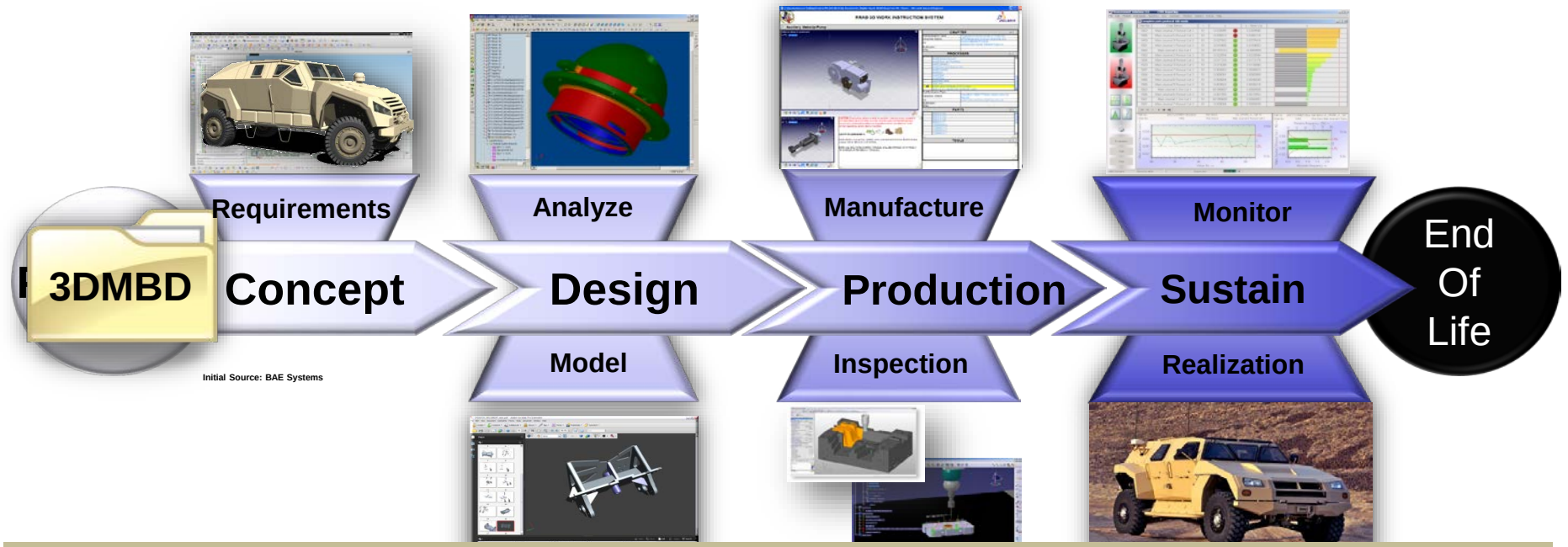


Model-Based Enterprise starts with a Trusted MBD

Curtis W. Brown, 2016

What is Model-Based Enterprise (MBE)?

MBE: A fully integrated and collaborative environment founded on a 3D MBD, validated, authorized, and shared across the enterprise to enable the realization of products from concept through sustainment.

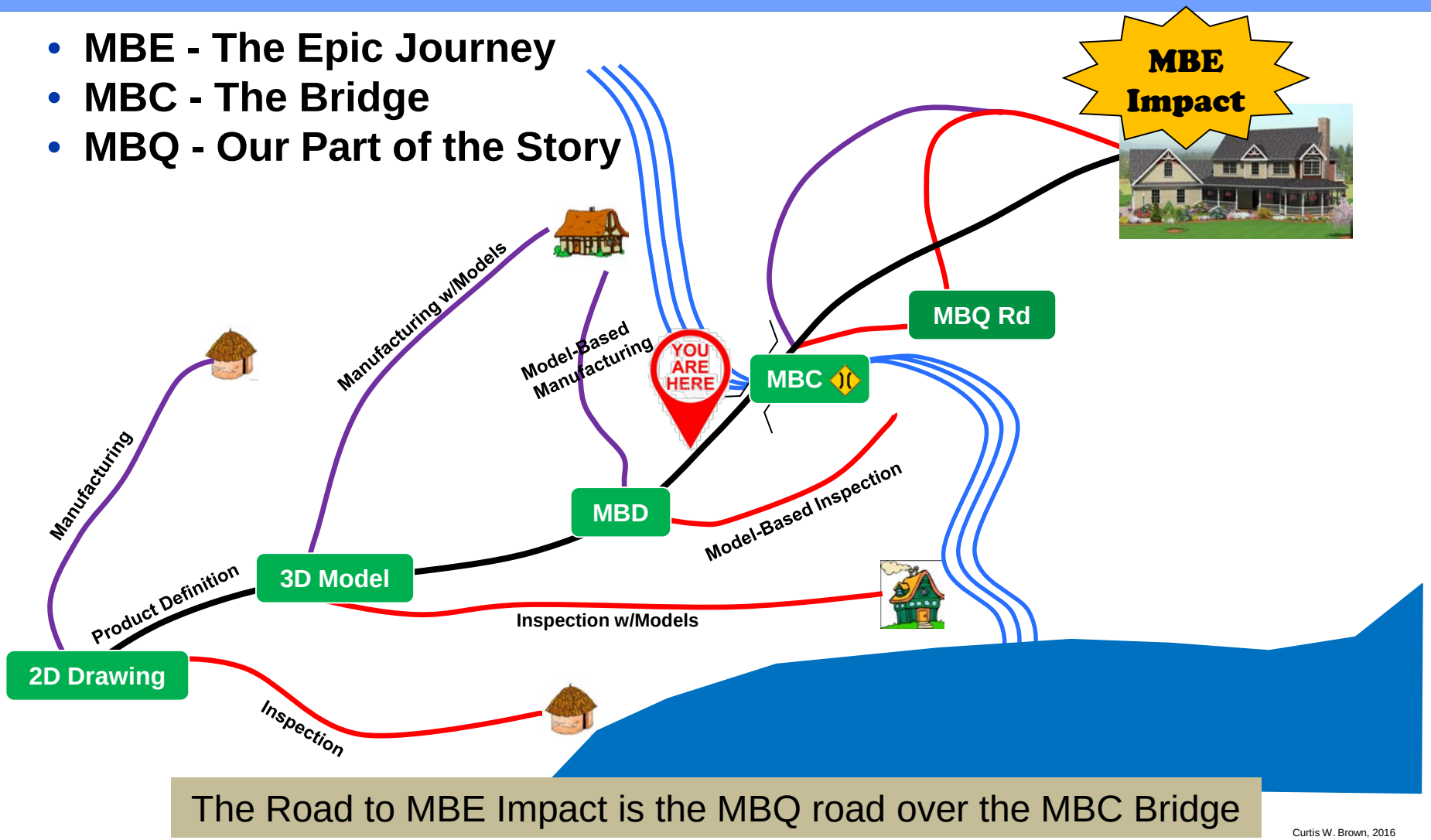


An organization that successfully reuses MBD

Curtis W. Brown, 2016

The Road to MBE Impact

- **MBE - The Epic Journey**
- **MBC - The Bridge**
- **MBQ - Our Part of the Story**



The Road to MBE Impact is the MBQ road over the MBC Bridge

Curtis W. Brown, 2016

KCNSC's Digital Product Realization Enterprise

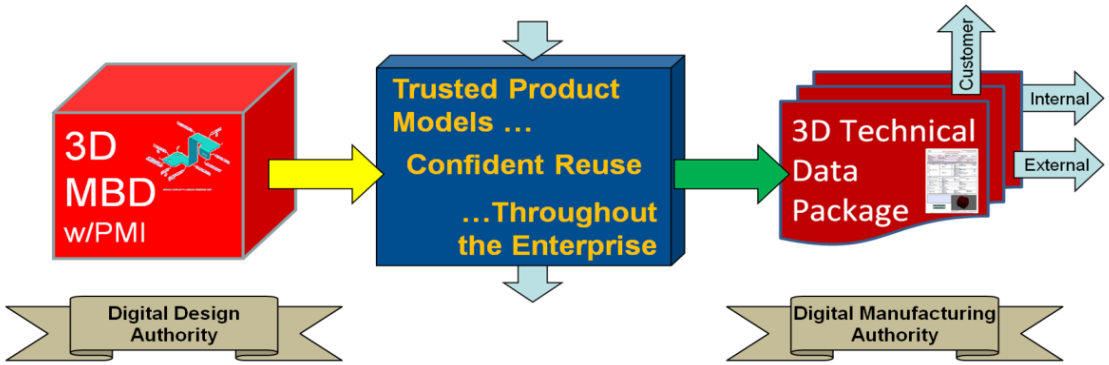
VISION

STRATEGIES

GOALS

Trusted Product Models, with Confident Reuse, Throughout Our Enterprise

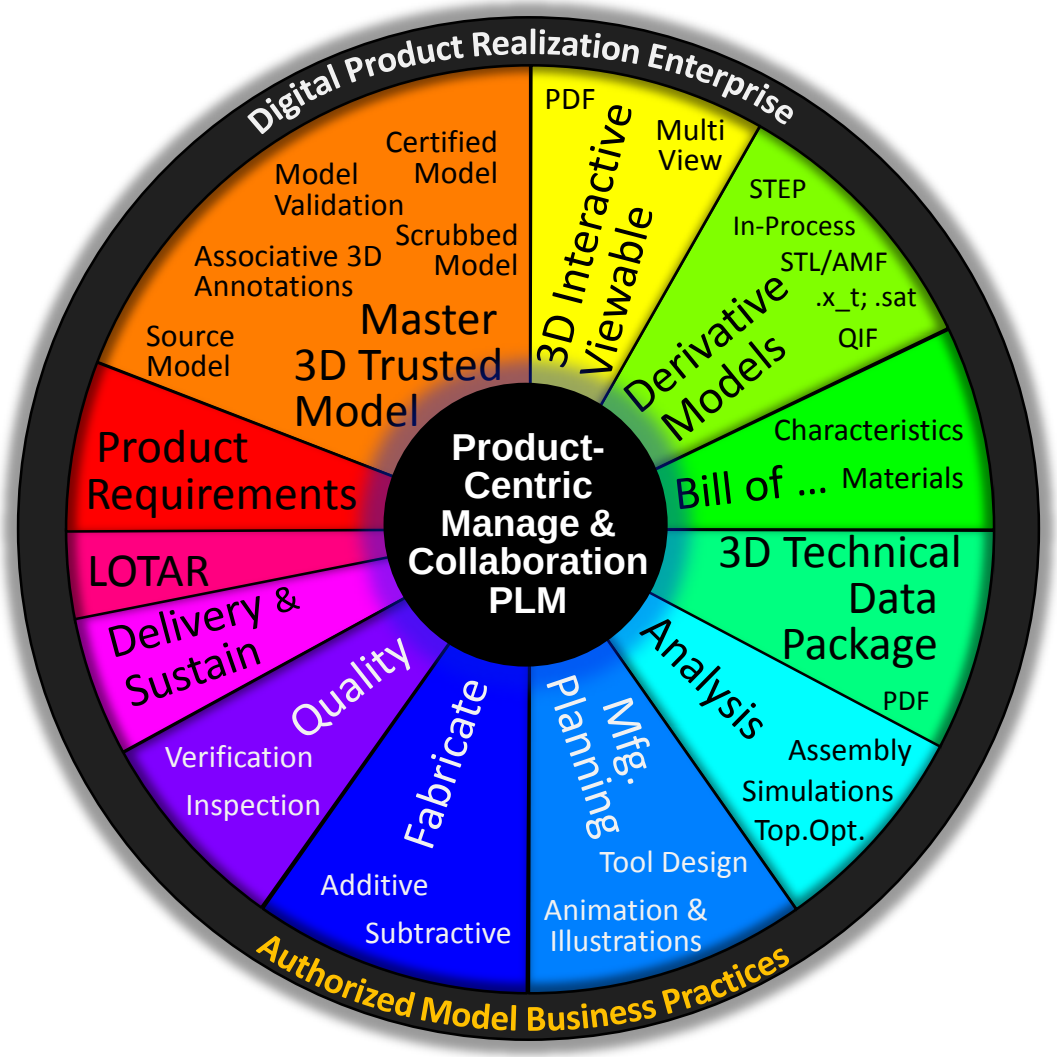
1. Establish Trusted 3D Annotated Master Models
2. Certify Equivalent Derivative Models
3. Enable Manufacturing & Quality Collaboration
4. Communicate & Release 3D Product Viewables
5. Focus on Preparing 3D Technical Data Package
6. Build "Case Law" Implementation Approach
7. Evaluate Progress against MBE Capability Roadmap



From a Trusted 3D Model-Based Definition to a 3D Technical Data Package to the Enterprise

KCNSC's Digital Product Realization Enterprise

Global Product Data Interoperability Summit | **2016**



Curtis W. Brown, 2016

Digital Product Realization Enterprise

Trusted Product Models . . .

. . . with Confident Reuse . . .

. . . Throughout our Enterprise©

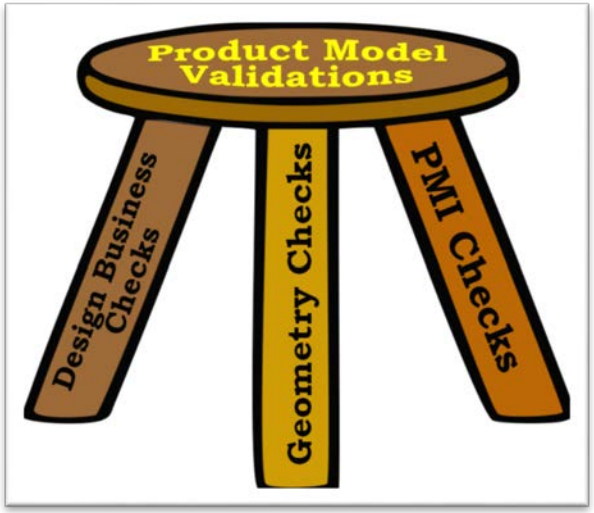
Digital Product Realization Enterprise

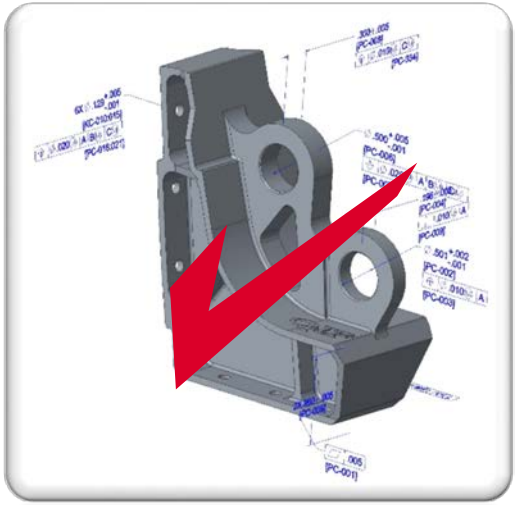
Trusted Product Models with Confident Reuse Throughout our Enterprise

Trusted Product Models . . .

- *Prepare **3D** Associative **Annotated Models***
- ***Certify Model Quality** through Validations*
- *Use FBTol to Check & Advise on Tolerancing*
- ***Authorize** Certified Product **Models** for Reuse*

If you are going to rely on your model,
it must be a reliable model… then prove it.





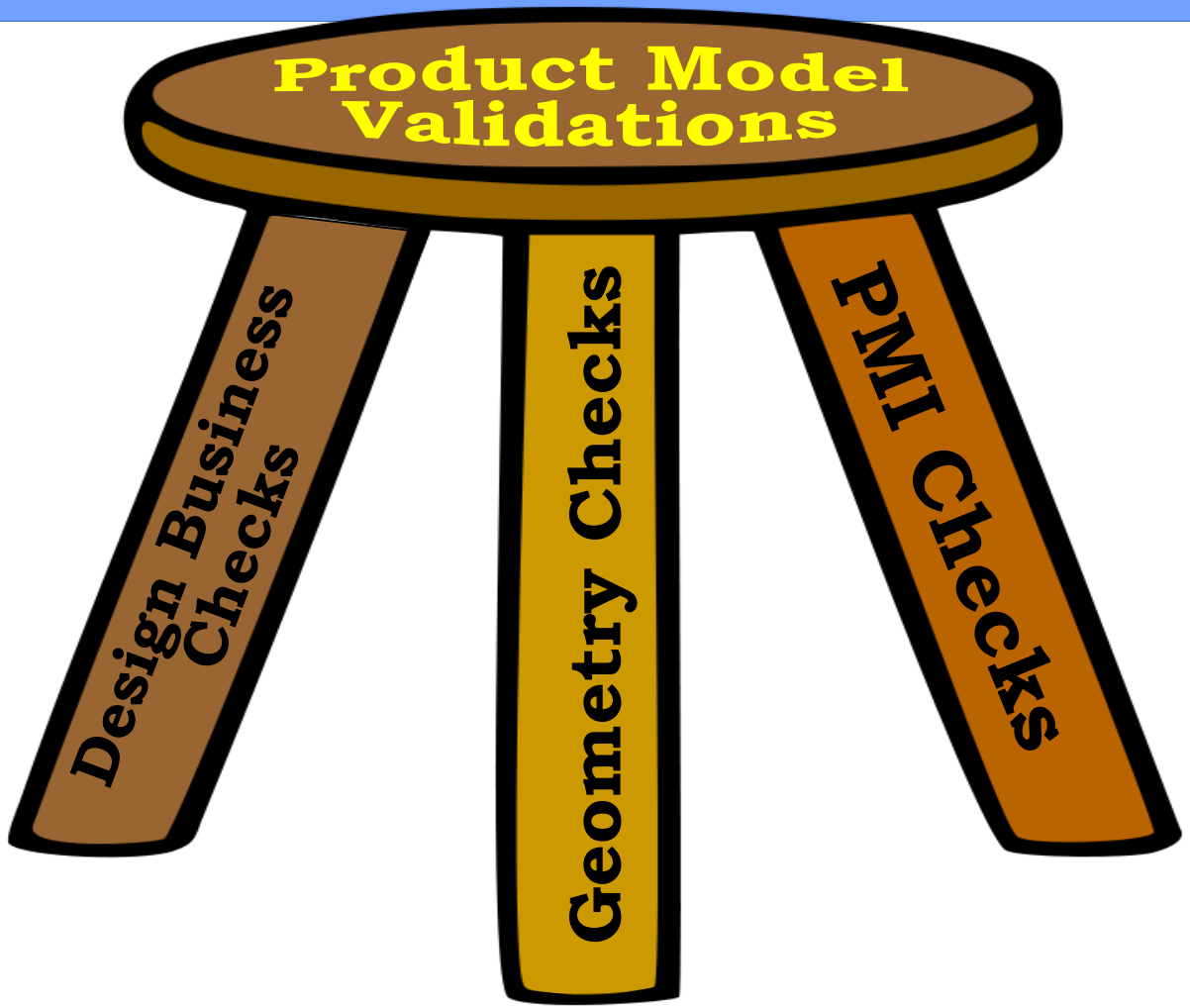
3D Product Models with
Associative Annotations

Important Terms and Definitions

- **PMI: Product and Manufacturing Information –** the annotations added to the product definition such as GD&T, notes, symbols, specifications, & tables.
- **DPD: Digital Product Definition –** the digital information needed (e.g., 3D model) to fully describe the geometry and all design requirements for the product:
  - **Geometry (both shape &** supplemental)
  - PMI (product & manufacturing information),
  - Associated metadata, and
  - Presentation states (combination states)

Curtis W. Brown, 2016

Trinity of Product Model Validations

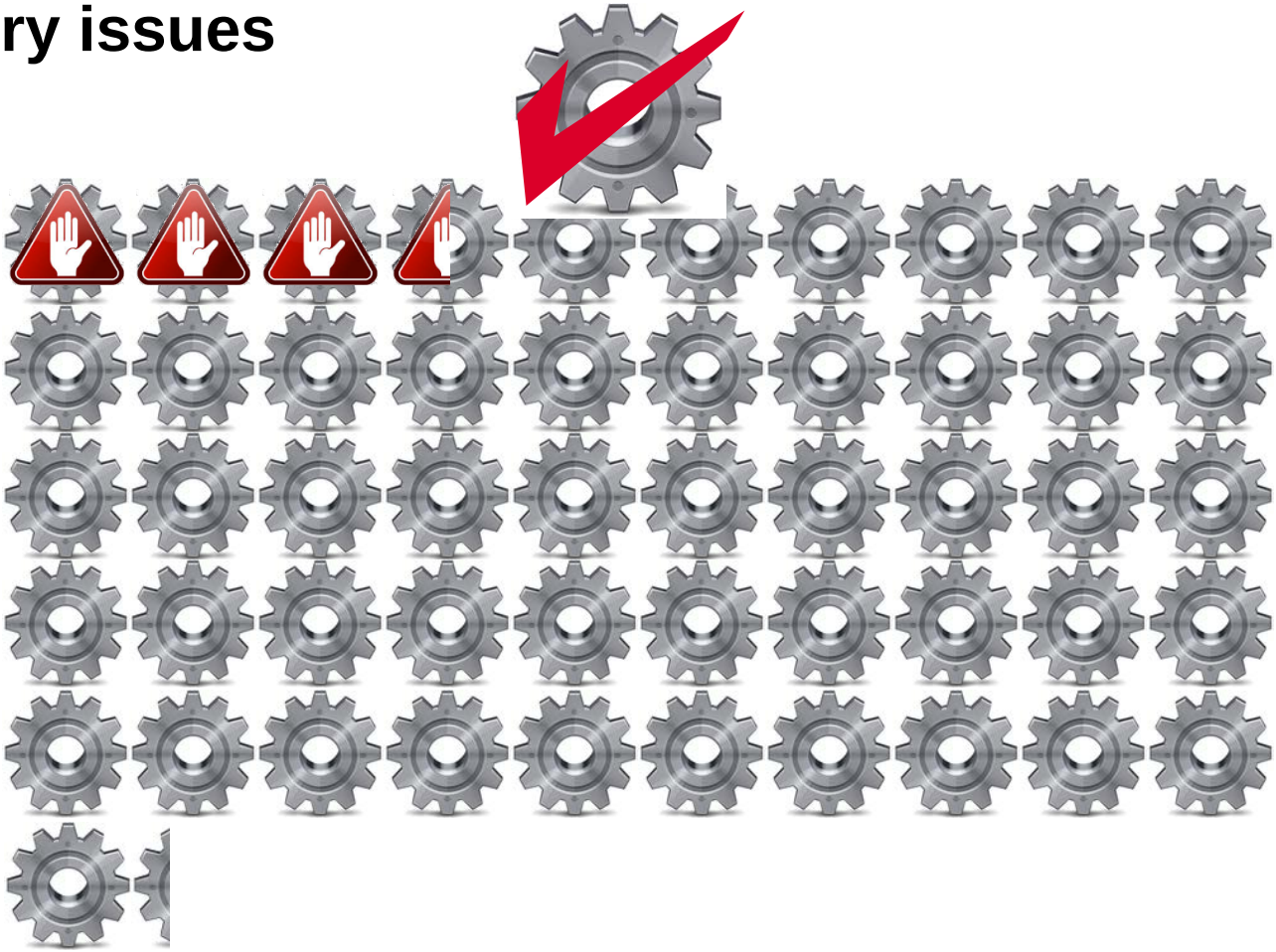


Multiple Checks for Multiple Purposes, all to gain a Certified Product Model

Curtis W. Brown, 2016

Trusted Product Models – Geometry Checks

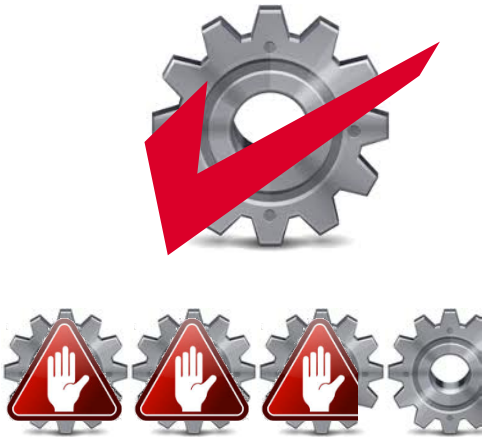
Status: 7% of the 513 model geometry checks had “hot” geometry issues



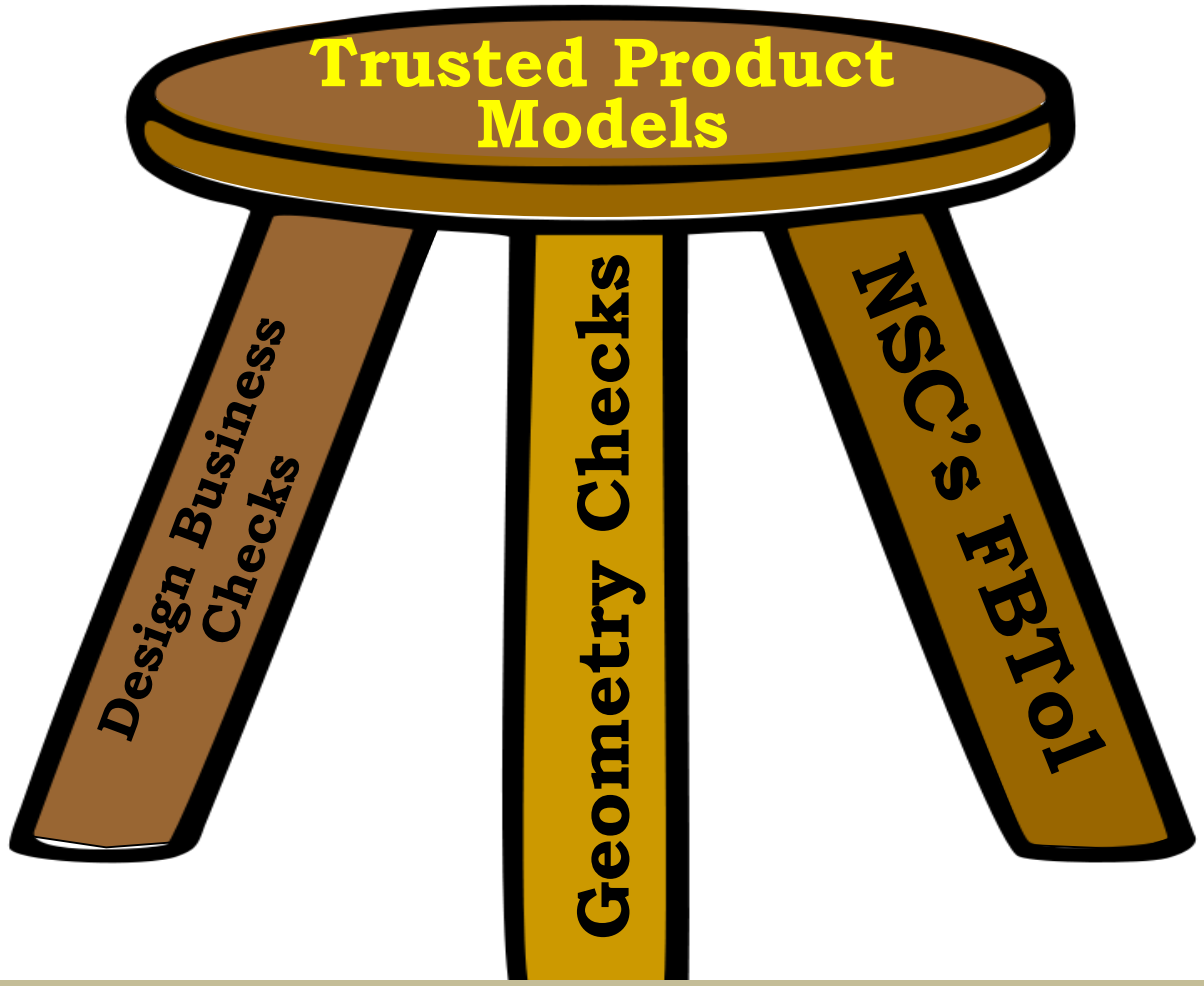
Curtis W. Brown, 2016

Trusted Product Models – Geometry Checks

Status: For parts that are “Geometry Rich”, 80% of model geometry checks identify addressable issues.



Trinity of Product Model Validations - PMI Checks



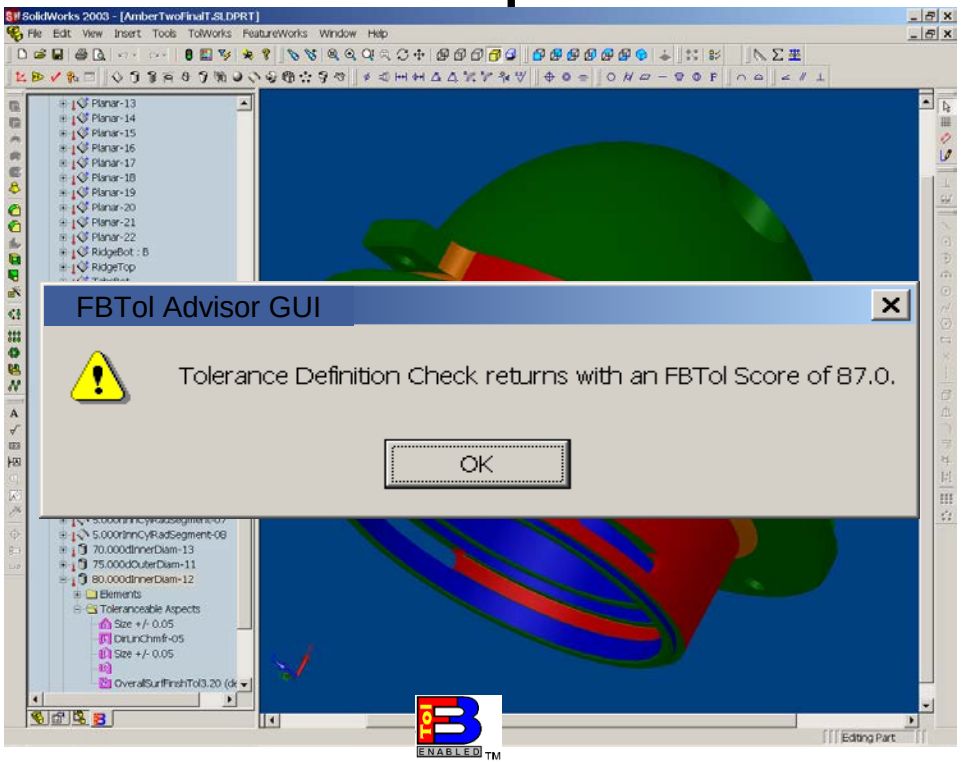
Make sure your products fit & function by communicating complete & correct PMI

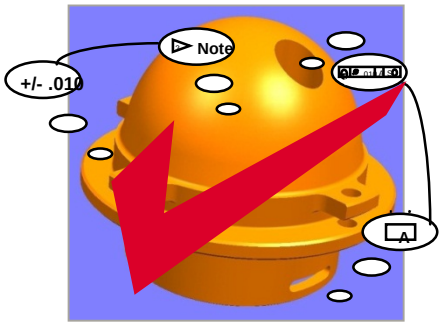
Curtis W. Brown, 2016

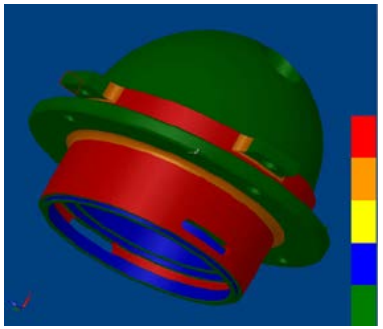
Trusted Product Models – PMI Checks

Feature-Based Tolerancing (FBTol) Advisor

- **Is your Part's tolerances complete and correct?**







Technology that Represents Fully Semantically Part Tolerances on solid models and Check for Completeness and Correctness

Curtis W. Brown, 2016

Trusted Product Model – PMI Checks

- Part Tolerance Definition Checking w/ FBTol

- Documented FBTol Tolerance Definition Analysis this period
  - 40 Analysis
  - FBTol Averages (low-high)
    - 78.2% FBTol Score (30% - 99.76%)
    - 24.1 Issues Identified (1 – 75)
  - Tolerance Definition Complexity Average (low-high)
    - 83.7 Characteristics (5 - 1199)

Curtis W. Brown, 2016

Trusted Product Model - Certified

- **Master Models: Certify Quality then Authorized for Reuse**
- **Derivative Models: Certified back to Master Model**
- **Model Certification: Certify Model Quality**
  - **Manual Certificate: via Separate Accompanying Documentation**
  - **Digital Manufacturing Certificate: Extension with Model File**
    - **Considering widely accepted X.509 Digital Certificate Standard**
    - **Investigations with NIST's Thomas Hedberg – EngrLab**

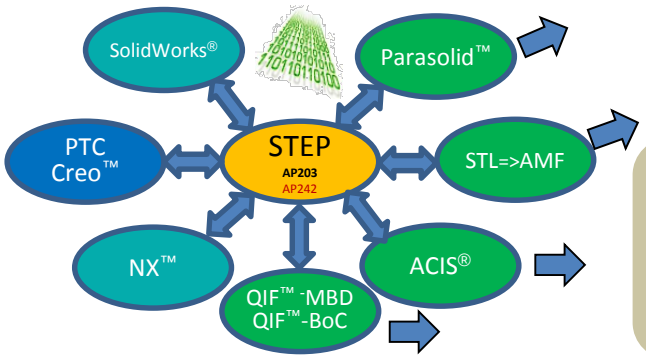
If you are going to rely on your model,
it must be a reliable model. . . and then make it known.

Curtis W. Brown, 2016

Digital Product Realization Enterprise

Trusted Product Models with Confident Reuse Throughout our Enterprise

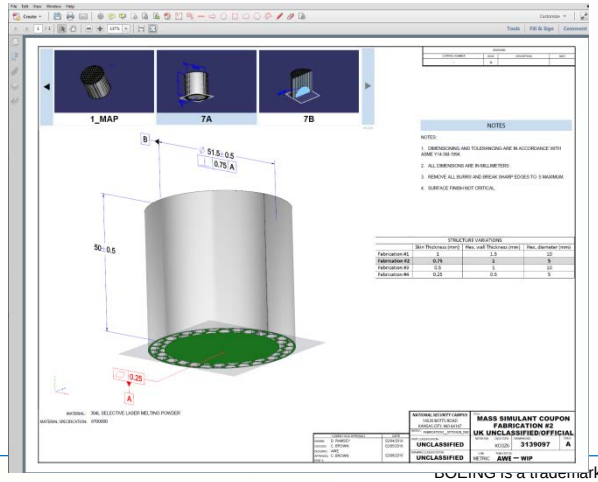
. . . with Confident Reuse . . .



Derivatives Contribute to Analysis, Manufacturing, and Verifications

- *Create **Certified Derivatives** w.r.t. the Master*
- *Generate 3D Interactive Viewables (**3DIV**)*
- *Extend **Product-Centric LifeCycle Management***

3D Interactive Viewable (3DIV) Succeeds the 2D Static Drawing as the preferred human consumption format.

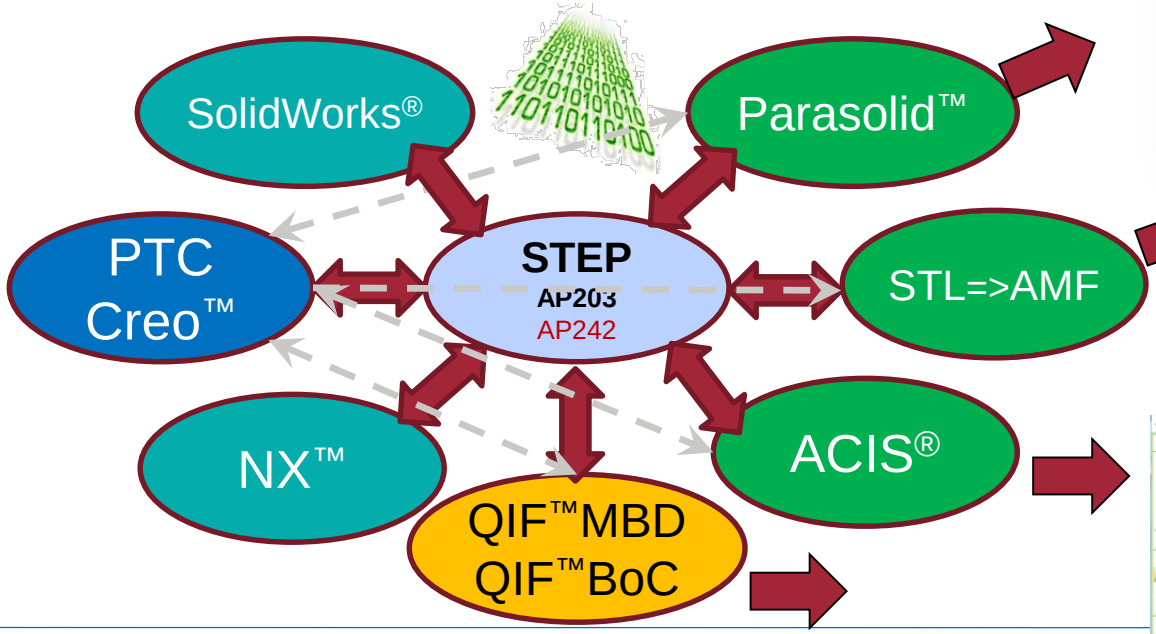


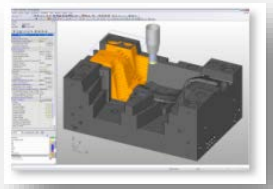
Curtis W. Brown, 2016

… with Confident Reuse …

Interoperability with Derivatives

- **Derivative Models Certified as Functionally Equivalent to Authorized Model**
- **STEP is always an *Intermediary* Derivative Model**





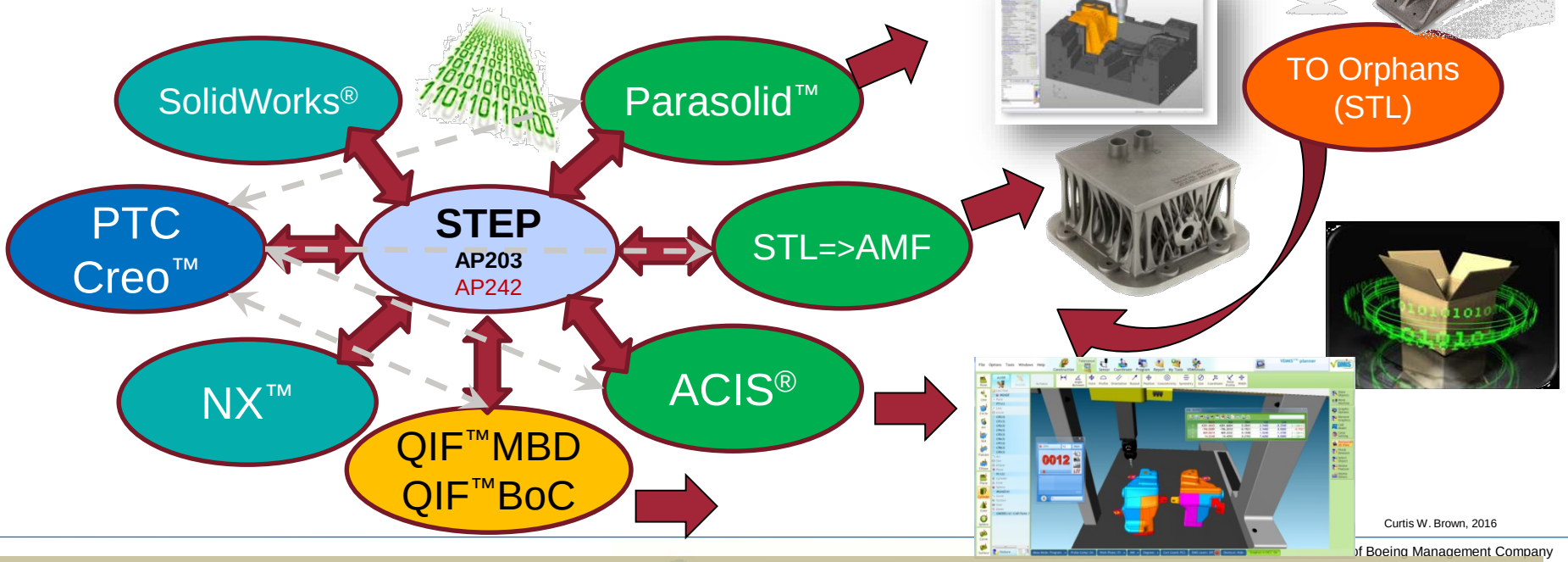
Curtis W. Brown, 2016

Downstream Applications are Enabled by Derivatives

… with Confident Reuse …

Interoperability with Derivatives

- **Derivative Models Certified as Functionally Equivalent to Authorized Model**
- **STEP is always an Intermediary Derivative Model**
- **Other Derivatives: Scrubbed Models; In-Process Models, AM Models, Physics Models**
- **Also Consider Direct Derivative Models, and prepare for:**
  - **ANSI / QIF MBD – Quality Information Framework (has PMI, Metadata, Presentation States)**
  - **ISO/ASTM 52915:2013 – Additive Manufacturing File (AMF) Format**
  - **ISO 10303-AP242 – Managed Model-Based 3D Engineering (has PMI, but modular and …)**
- **Adopting Orphaned Models back into CAD Assemblies**



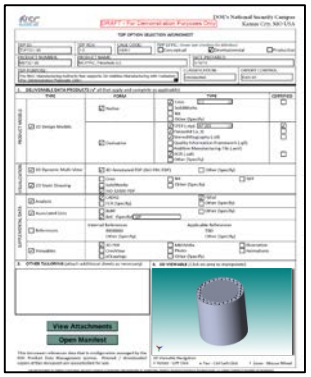
Curtis W. Brown, 2016

Downstream Applications are Enabled by Derivatives

Digital Product Realization Enterprise

Trusted Product Models with Confident Reuse Throughout our Enterprise

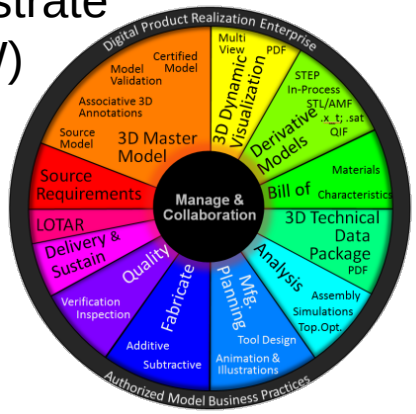
. . . Throughout our Enterprise



Digital TDP

- *Empower Manufacturing & Quality with Trusted Models*
- ***Product Characteristic** designations with criticalities*
- *Digital **Bill of Characteristics** (BoC)*
- ***QIF** Enables Quality to Digitally Contribute to the Enterprise*
- *Prepare **3D Technical Data Package (TDP)***
- *Model-Based Animations for Process Definitions*
- Measure our Progress with the **MBE Capability Index**
- **Functional Pilots** to prove-in and demonstrate
- Model-Based Business Workshop (MBBW)
- *Enable Additive Manufacturing*
- *Digital Exchange with External Suppliers*

3D TDP becomes the Manufacturing Authorization



Digital Product Realization Enterprise Architecture

Model-Based Quality (MBQ)

- **MBQ is the conformance to the requirements of the product using measurement planning, execution, and evaluating in combination with a 3D model, *PMI (characteristics)*, and associated data.**
- **MBQ is validating the quality of your product models and defining the quality process definition necessary for digital product realization**
- **MBQ takes advantage of product characteristics grouped as a Bill of Characteristics**
- **MBQ starts with a Quality Model and Results in a Quality Product**

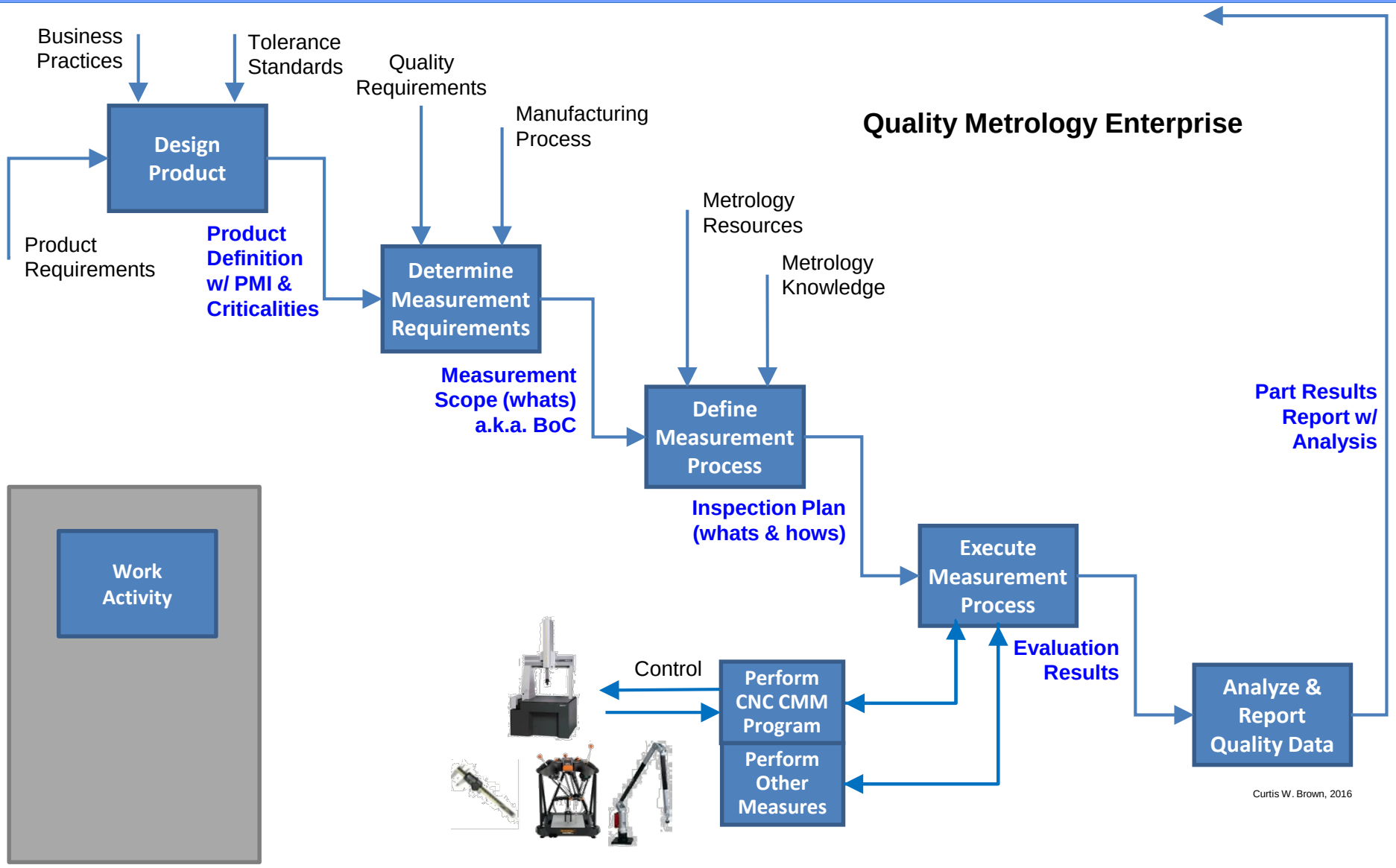
From a workSession at the 2016 MBE Summit - NIST

The Quality of your Products will Reflect the Quality of your Models

Curtis W. Brown, 2016

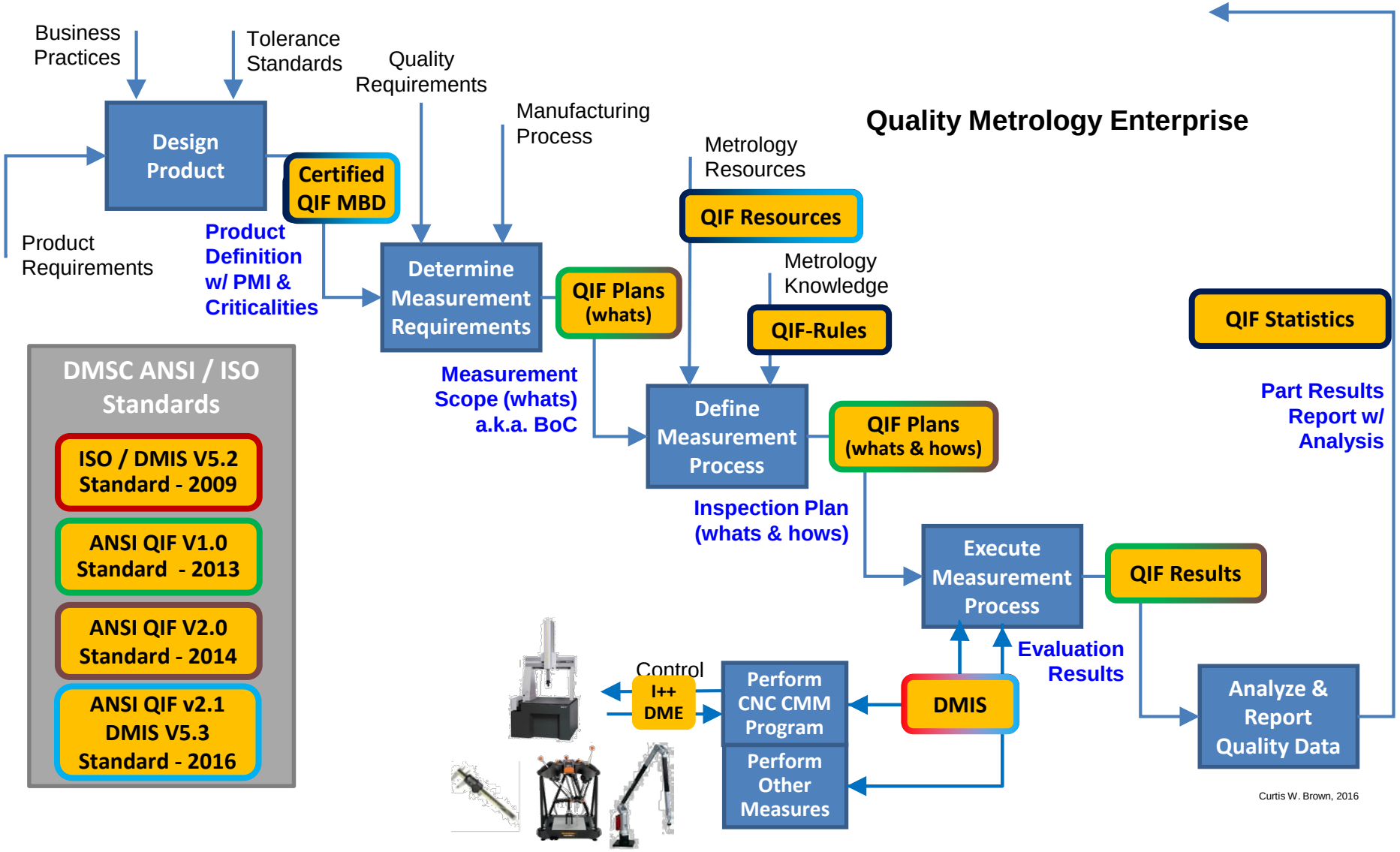
Model-Based Quality Activity Workflow

Global Product Data Interoperability Summit | **2016**



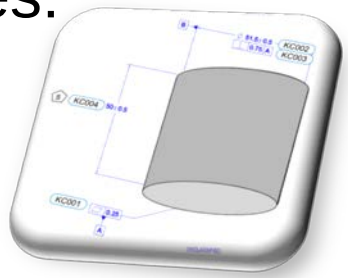
Model-Based Quality Activity Workflow

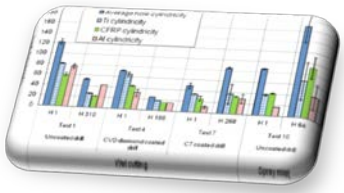
Global Product Data Interoperability Summit | **2016**



The QIF Standard – What does it do?

- *Quality Information Framework (QIF) – DMSC/QIF 2016 (v2.1)*
- *An Integrated Model for Manufacturing Quality Information*
- Defines, Constrains, and Exchanges:
  - ***Model-Based Definition***
    - *Feature-Based Semantic PMI*
  - ***Quality Planning***
    - *Bill of Characteristics (BoC)*
    - *Inspection Plan*
  - ***Measurement Execution***
    - *DMIS 5.3 w/QPIds*
  - ***Measurement Results***
    - *Piece Part*
    - *Statistical*
  - ***Enterprise Connectivity for Quality Feedback***
    - *Quality Persistent ID (QPId) (i.e., universal unique ID)*
    - 651aded1-ff04-498a-968e-044147a2506d





Curtis W. Brown, 2016

QPIds – A Persistent UUID used within the QIF

QIF Persistent Identifier (QPId) *noun* Cu·pid \ˈkyü-pəd\

- Universally Unique Identifier (UUID) (adopted by Microsoft as GUID)
  - ISO/IEC 9834-8
  - 550e8400-e29b-41d4-a716-446655440000
  - 340000000000000000000000000000000000 ($3.4x10^{38}$) possible UUIDs
- Chances of generating two that are the same within the universe are practically nil.
- Many software development libraries generate UUIDs
- Allows information to be combined later without resolving identifier conflicts
- QPIds uniquely identify
  - QIF Document
  - QIF Plan
  - QIF Result
  - QIF Rule Set
  - Feature Item
  - Characteristic Item
  - Product Item
  - Resource Item

An Important Mechanism that facilitates Lifecycle Connectivity

Curtis W. Brown, 2016

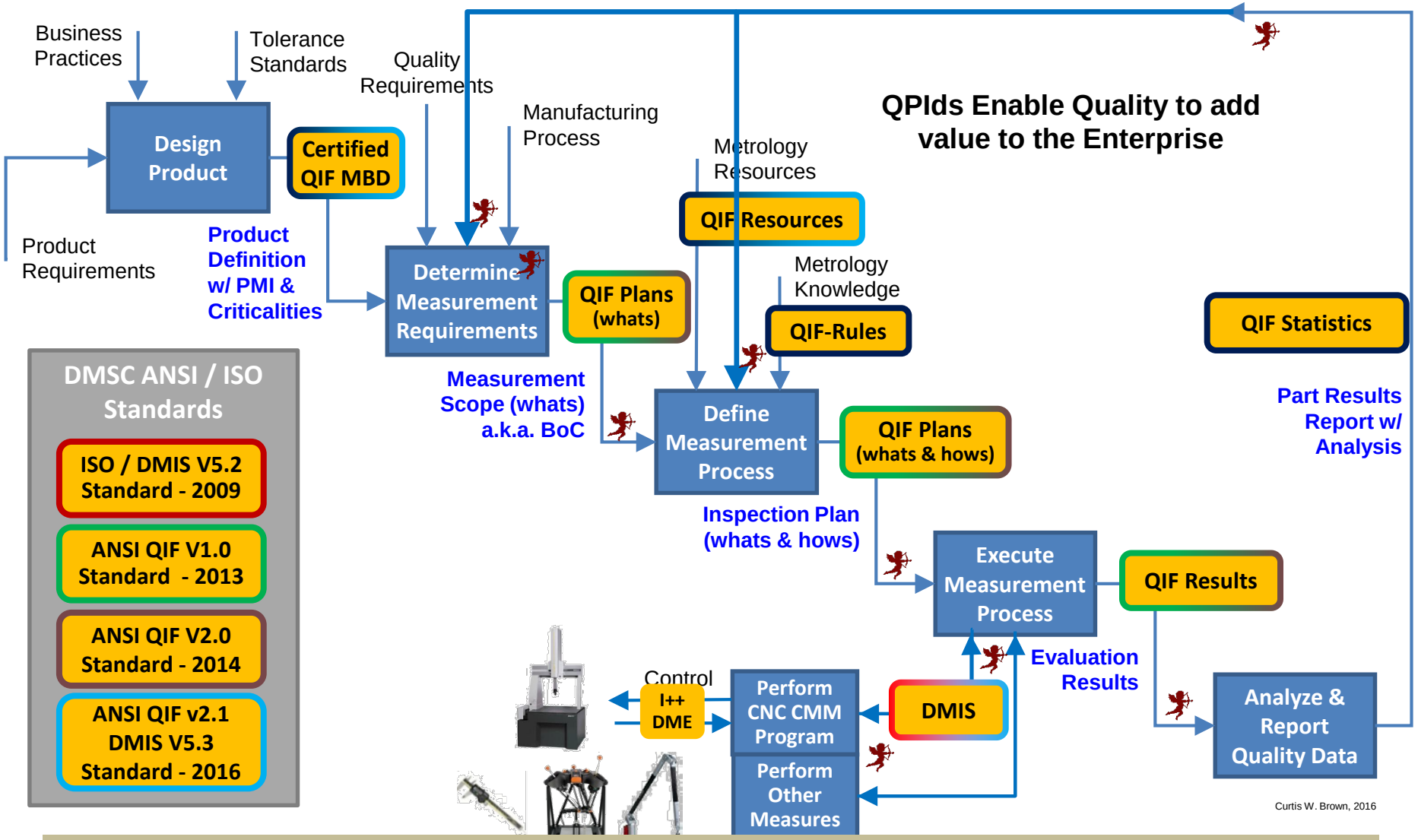
Important Terms and Definitions

- **Product Characteristic:** a tolerance or specification applied to a feature or product that requires verification. A characteristic has designation identifier(s) and may have a criticality associated with it. A product characteristic may exist because of a product requirement.
- **Bill of Characteristics (BoC):** the complete listing of characteristics required for verifying that a part meets requirements. A BoC can be represented via DMSC/QIF standard.
- **Model-Based Characteristics (MBQ):** the use of a Model-Based Definition with product characteristics designated.
- **Quality Information Framework (QIF):** a new American National Standard (ANSI) for the digital interoperability of information supporting model-based definition, manufacturing quality processes, and measurement results.

Curtis W. Brown, 2016

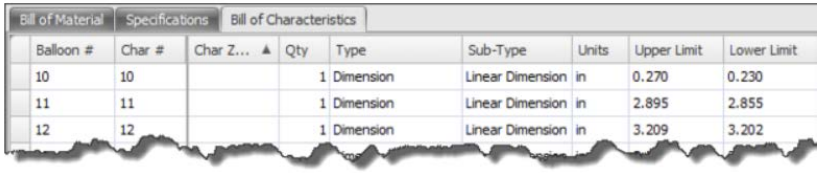
Quality Plan BoC QPId Use Case

Global Product Data Interoperability Summit | **2016**



QIF w/ QPId BoC enables Quality to add Value to the Enterprise

Bill of Characteristics



Bill of Material | Specifications | Bill of Characteristics

Balloon #	Char #	Char Z...	Qty	Type	Sub-Type	Units	Upper Limit	Lower Limit
10	10		1	Dimension	Linear Dimension	in	0.270	0.230
11	11		1	Dimension	Linear Dimension	in	2.895	2.855
12	12		1	Dimension	Linear Dimension	in	3.209	3.202

5. Char No.	*6. Reference Location*	*7. Characteristic Designator*	8. Requirement	8a. UoM	8b. Upper Limit	8c. Lower Limit
3	LOWER PLATE - A2.PDF pg.1	LINEAR	.618	in	0.638	0.598
5	LOWER PLATE - A2.PDF pg.1	LINEAR	.750	in	0.770	0.730
10	LOWER PLATE - A2.PDF pg.1	LINEAR	.250	in	0.270	0.230
11	LOWER PLATE - A2.PDF pg.1	LINEAR	2.875	in	2.895	2.855
13	LOWER PLATE - A2.PDF pg.1	LINEAR	3.503 / 3.496	in	3.503	3.496

Char No.	Criticality	Characteristic	Feature	Requirement	Plus	Minus
KC0019	Minor	Size +/- 0.1	Hole #9	12	0.1	-0.1
KC0020	Minor	Size +/- 0.1	Hole #10	12	0.1	-0.1
KC0016	Minor	Flat.005	Datum A	0	0.005	
KC0014	Minor	Prof.010wABm	Pocket 192		0.01	
KC0099	Major	Paint color	Product	JohnDeere Green		

```
<Characteristics>
 <CharacteristicDefinitions>
   <DiameterCharacteristicDefinition id="10">
    <Tolerance>
     <MaxValue>0.1</MaxValue>
     <MinValue>-0.1</MinValue>
    </Tolerance>
   </DiameterCharacteristicDefinition>
</CharacteristicDefinitions>
<CharacteristicItems>
   <DiameterCharacteristicItem id="12">
    <Name>Sized +/- 0.1</Name>
    <QPId>651aded1-ff04-498a-968e-044147a2506d</QPId>
    <KeyCharacteristic>
     <Designator>KC0019</Designator>
     <Criticality>CRITICAL</Criticality>
    </KeyCharacteristic>
    <FeatureItemIds N="1">
     <Id>9</Id>
    </FeatureItemIds>
    <CharacteristicNominalId>11</CharacteristicNominalId>
    <LocationOnDrawing>
     <DrawingId>3</DrawingId>
     <SheetNumber>NA</SheetNumber>
     <DrawingZone>NA</DrawingZone>
    </LocationOnDrawing>
   </DiameterCharacteristicItem>
```

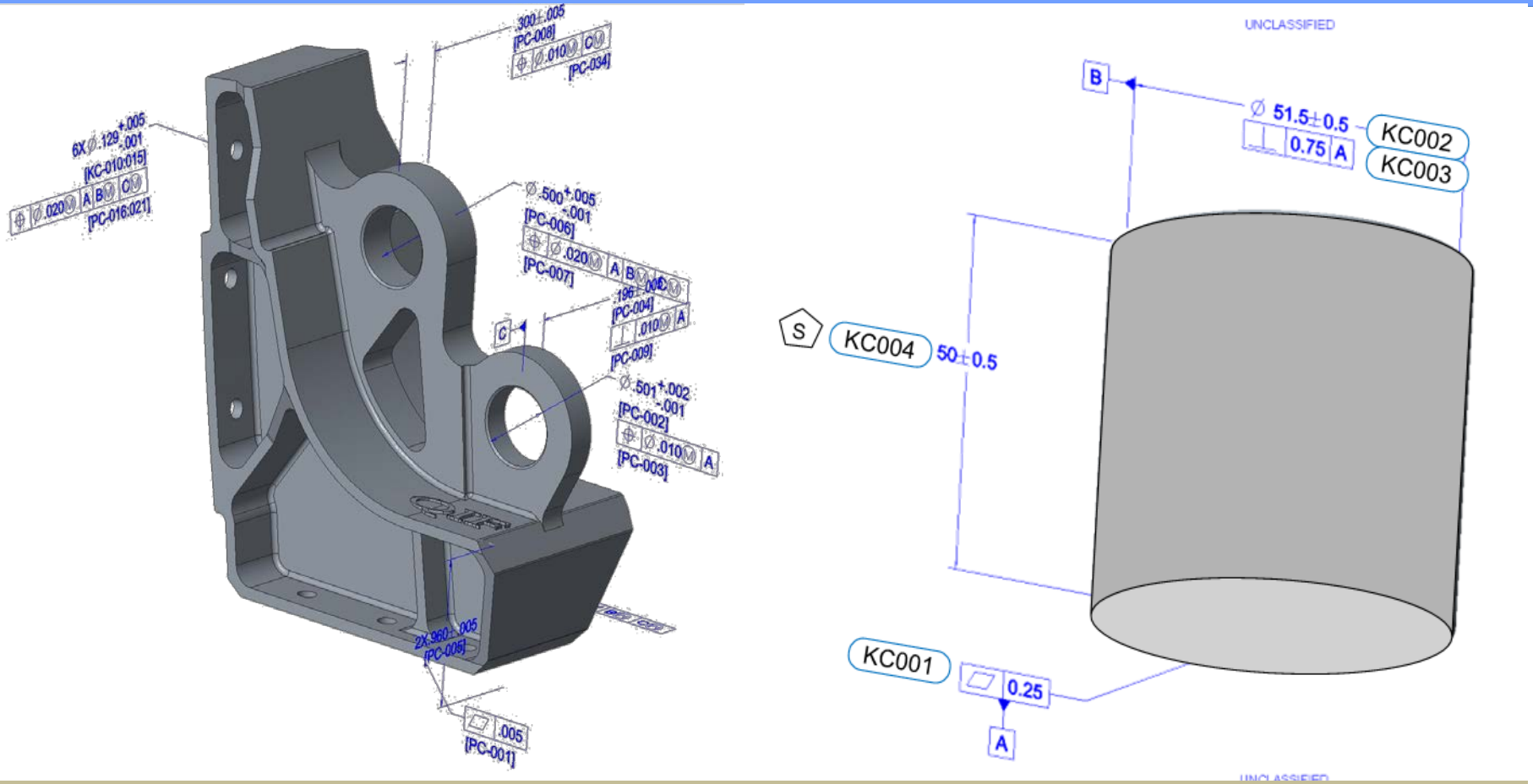
KC0019

Human-Readable BoCs

Machine-Read/Writeable QIF/BoC

DMSC/QIF ANSI Standard allow BoCs to be Digitally Consumed, Enabling Closed-Loop Automation

MBQ – MBD w/ Product Characteristics Designations

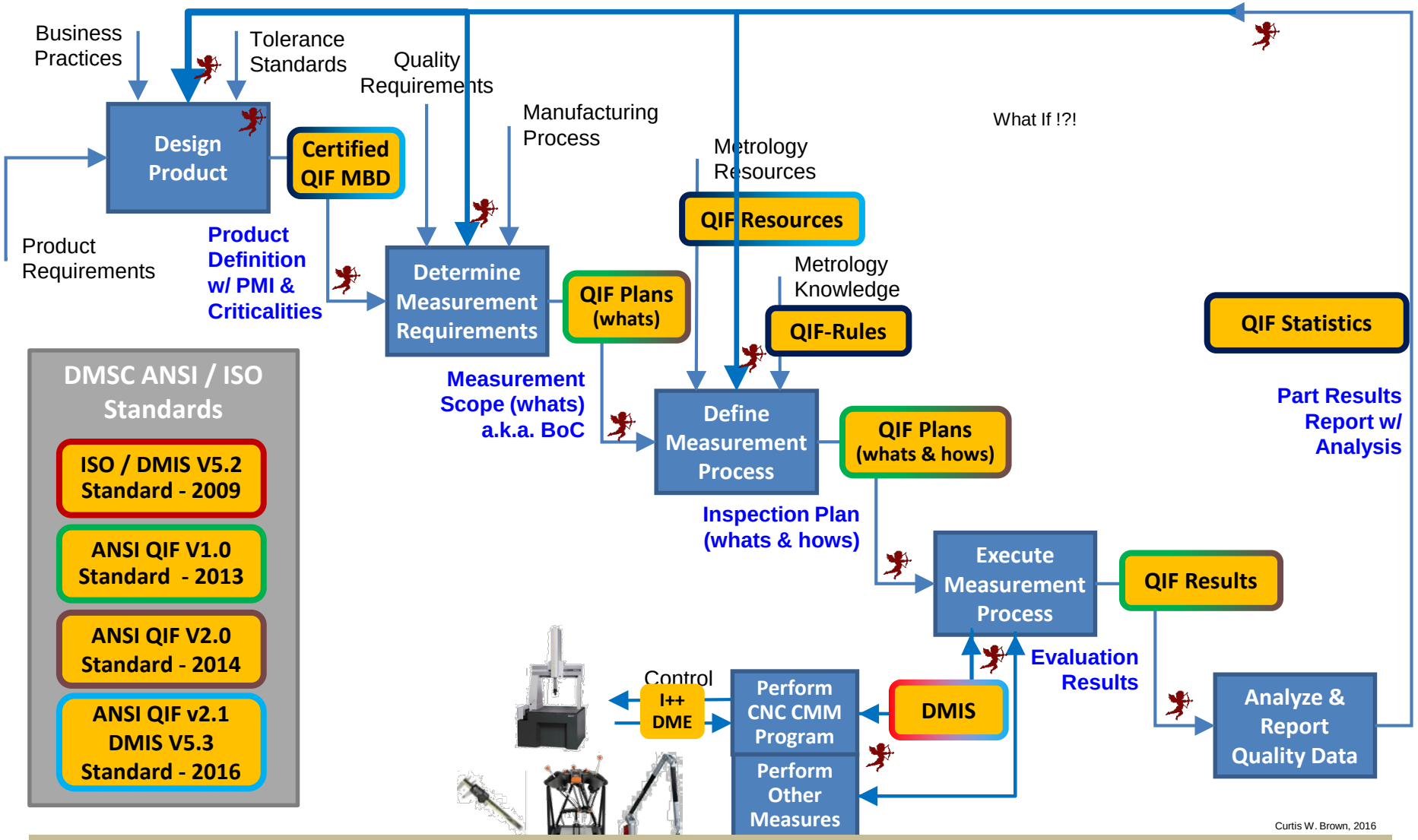


Product Characteristics can be Designated for Human Consumption And QIF Allows for Digital Consumption!

Curtis W. Brown, 2016

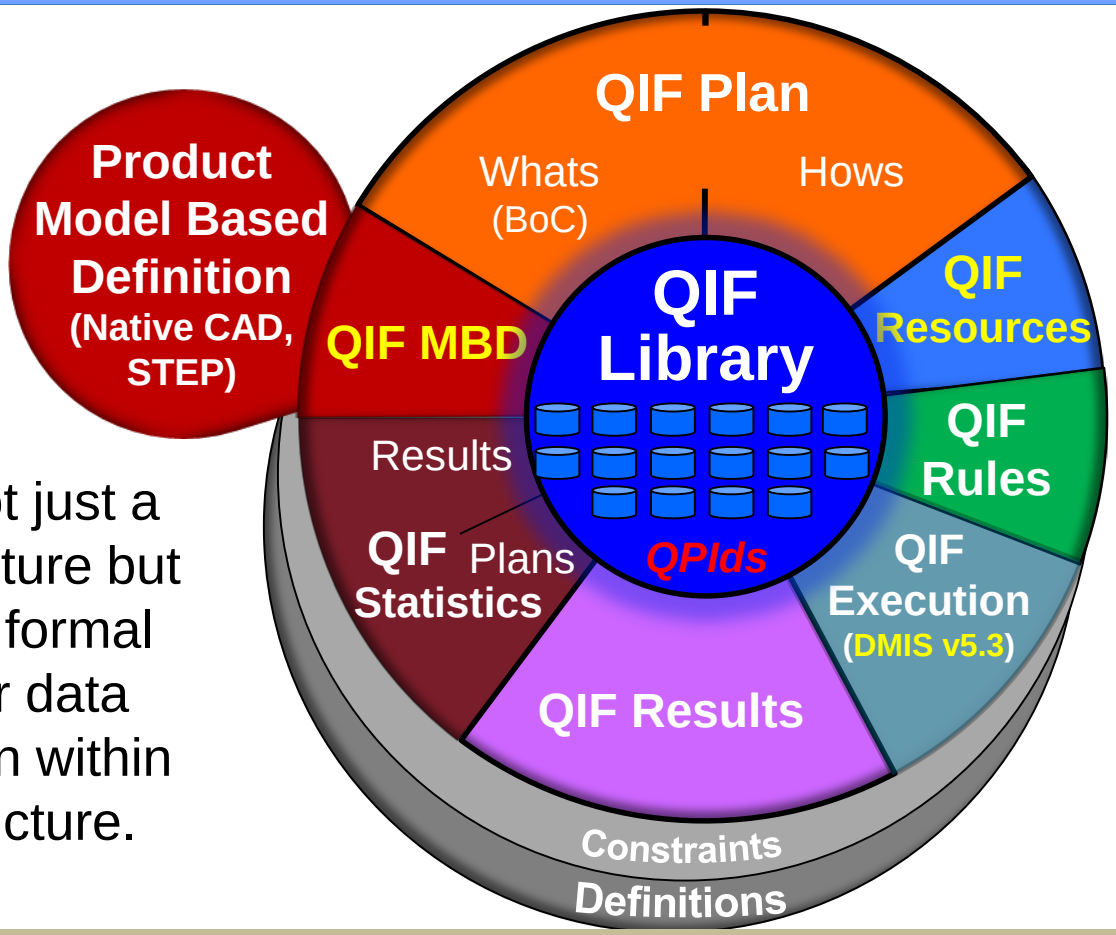
MBD BoC QPIds Use Case

Global Product Data Interoperability Summit | **2016**



QIF w/ QPIds BoC enables Quality to directly influence Product Design

QIF v2.1 Metrology 'Life Saver' Architecture

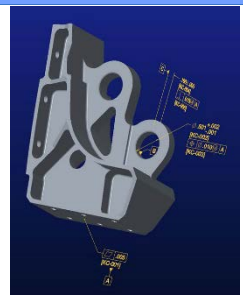


QIF is not just a data structure but includes formal rules for data interaction within that structure.

QIF standard transfers the burden of data quality from the application developer to the standard itself.

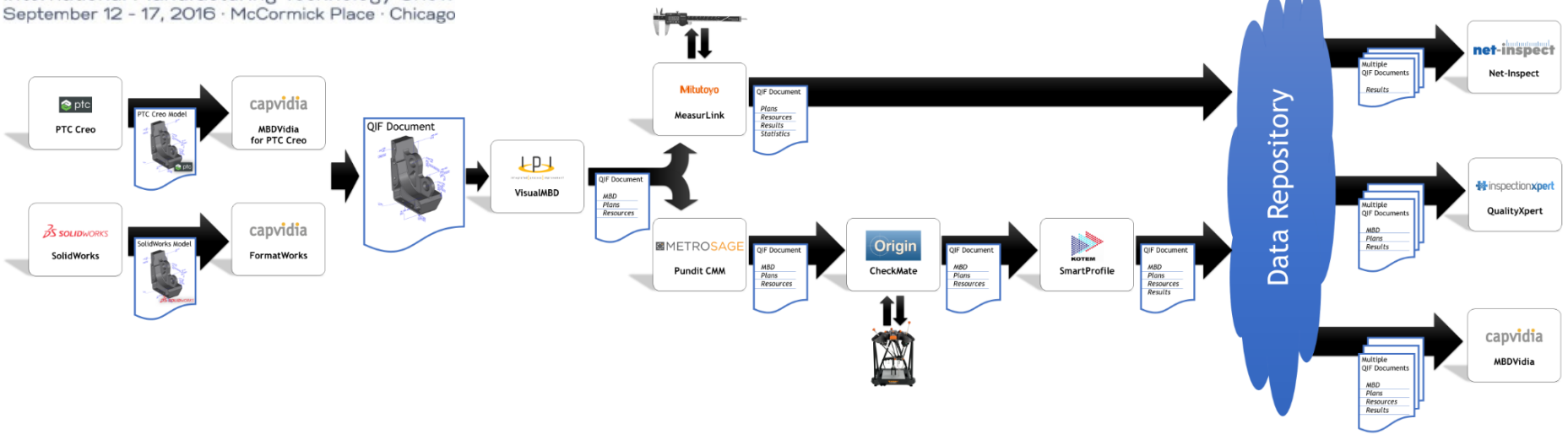
Curtis W. Brown, 2016

IMTS 2016 – ANSI QIF Interoperability Demonstration



IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago

ANSI QIF Interoperability Demonstration
IMTS 2016



Curtis W. Brown, 2016

IMTS 2016 – The Message

Quality is a Requirement .. Make if Easier with the QIF

Manufacturers want:

- **Freedom of choice** in selection of value and performance based metrology solutions.
- Quality solutions that **communicate** the **value** of their inspections back to design & manufacturing.
- **Interoperability** between current software & equipment solutions.

DMSC Announces:

- New **Business Model** for Manufacturing Quality.
- Digital information exchange standard DMSC/QIF 2.1.
- QIF is **powerful** and relatively quick and easy to implement.

IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago

Business Model:

- **Mandate** the use of **QIF** within your enterprise
- **Join the DMSC** with your preferred suppliers to progress change
- Both organizations **Reap Cost Savings.**

Curtis W. Brown, 2016

IMTS 2016 – The Message

Quality is a Requirement .. Make if Easier with the QIF

QIF offers:

- **Mature** ANSI Standard (v2.1)
- Solution providers that have **Implemented** QIF
- Results from Software Scientists and Dimensional Metrology Experts
- Reflects the **state-of-the-art**
  - Model-Based Definition
  - Feature-Based Tolerancing
  - Quality Planning with Bill of Characteristics (BoC)
  - Robust Measurement Results with Persistent IDs
  - Modern Software Development Techniques
- 500 Years of **Experience** in Metrology, GD&T, & Software Development
- **Value-Added** proposition to Manufacturing and Design
- Energized the dimensional metrology development community

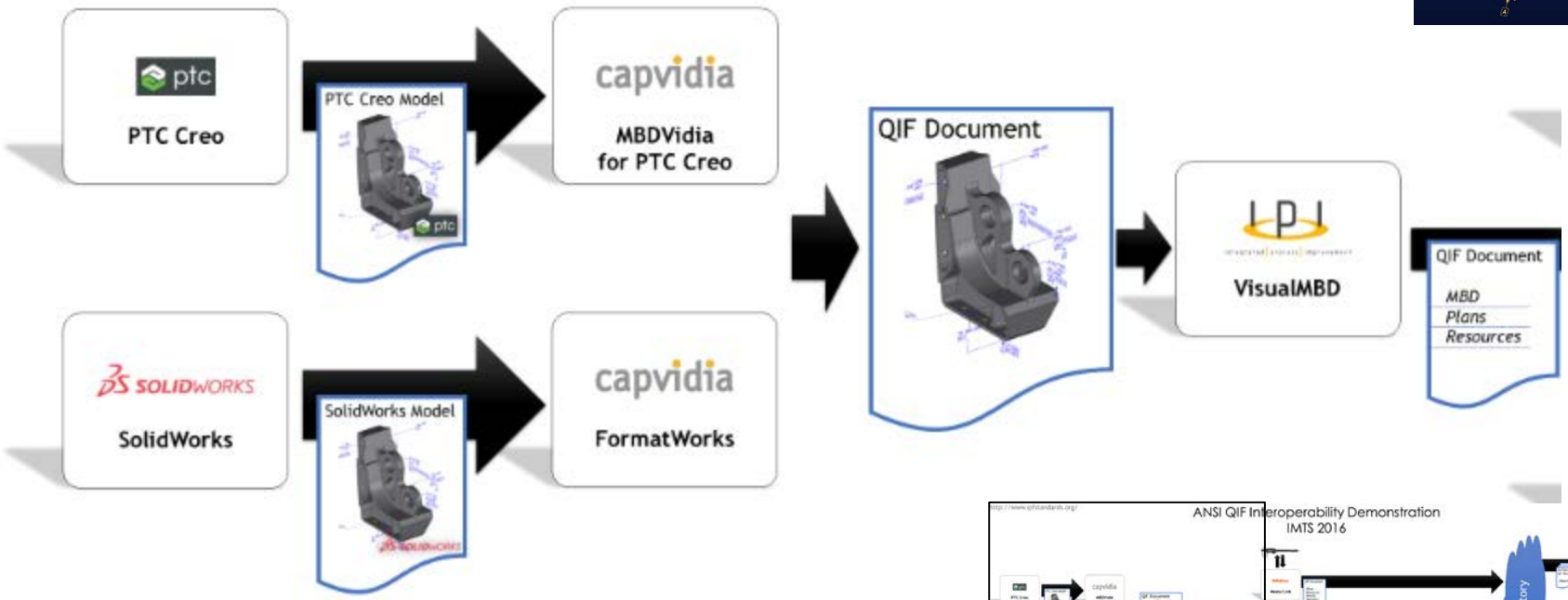
IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago

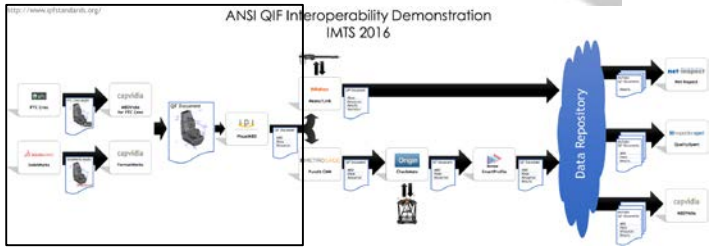
Curtis W. Brown, 2016

IMTS 2016 – ANSI QIF Interoperability Demonstration

Global Product Data Interoperability Summit | **2016**

IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago





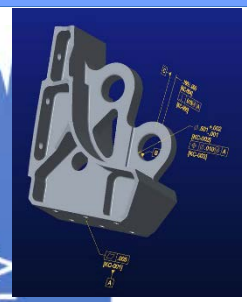
Curtis W. Brown, 2016

IMTS 2016 – ANSI QIF Interoperability Demonstration

IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago

Mitutoyo
MeasurLink

QIF Document
Plans
Resources
Results
Statistics



QIF Document
MBD
Plans
Resources

METROSAGE
Pundit CMM

QIF Document
MBD
Plans
Resources

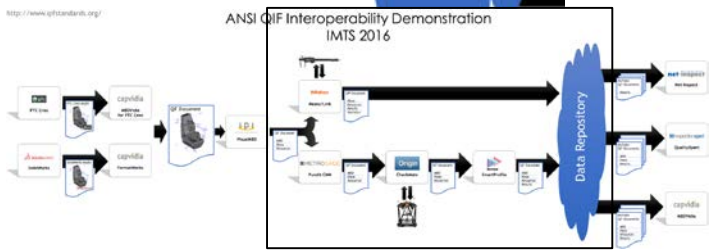
Origin
CheckMate

QIF Document
MBD
Plans
Resources

KOTEM
SmartProfile

QIF Document
MBD
Plans
Resources
Results

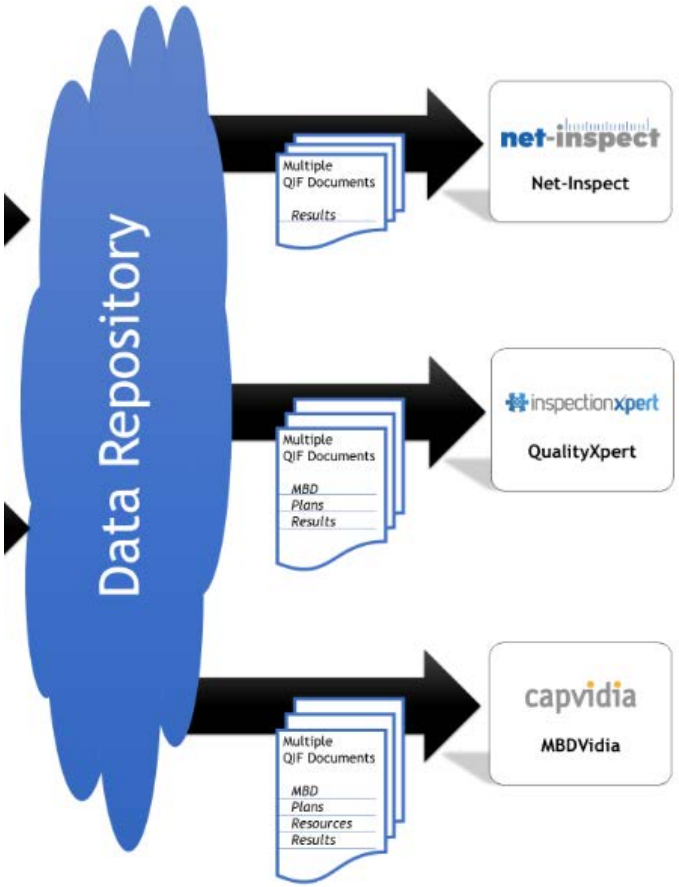
Data Repository

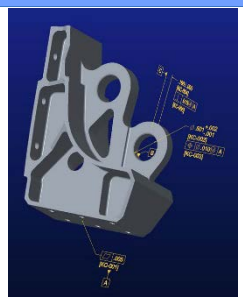


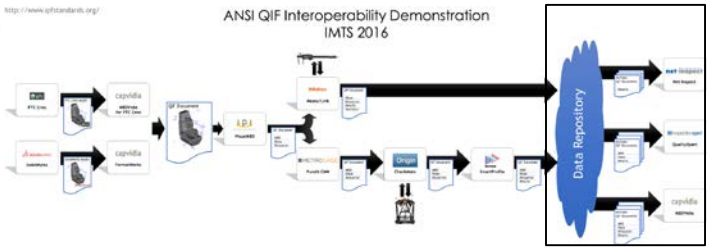
Curtis W. Brown, 2016

IMTS 2016 – ANSI QIF Interoperability Demonstration

IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago





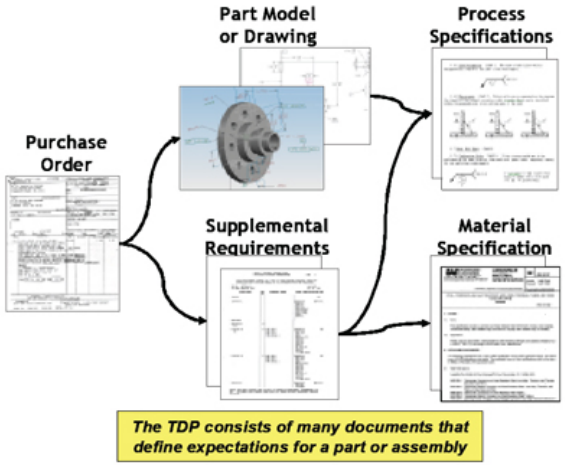


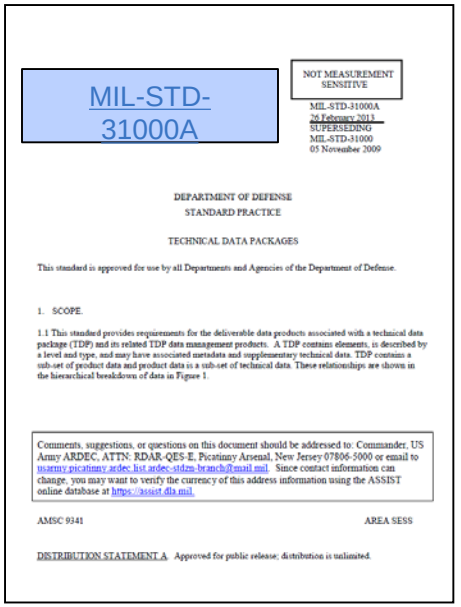
Curtis W. Brown, 2016

…Throughout our Enterprise

3D Technical Data Package (TDP)

- Recognized as the Digital Manufacturing Authority
- A collection of all product data elements needed to Acquire, Manufacture, and/or Sustain the product
- Viewed as a competitive advantage but likely to become a requirement.
- Regulated – DoD's MIL-STD-31000A




MIL-STD-31000A

NOT MEASUREMENT SENSITIVE

MIL-STD-31000A
26 February 2013
SUPERSEDING
MIL-STD-31000
05 November 2009

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

TECHNICAL DATA PACKAGES

This standard is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE.

1.1 This standard provides requirements for the deliverable data products associated with a technical data package (TDP) and its related TDP data management products. A TDP contains elements, as described by a level and type, and may have associated metadata and supplementary technical data. TDP contains a sub-set of product data and product data is a sub-set of technical data. These relationships are shown in the hierarchical breakdown of data in Figure 1.

Comments, suggestions, or questions on this document should be addressed to: Commander, US Army ARDEC, ATTN: RDAR-QES-E, Picatinny Arsenal, New Jersey 07806-5000 or email to usarmy picatinny ardec list ardec-stdzn-branch@mail.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST online database at https://assist.dla.mil.

AMSC 9341 AREA SESS

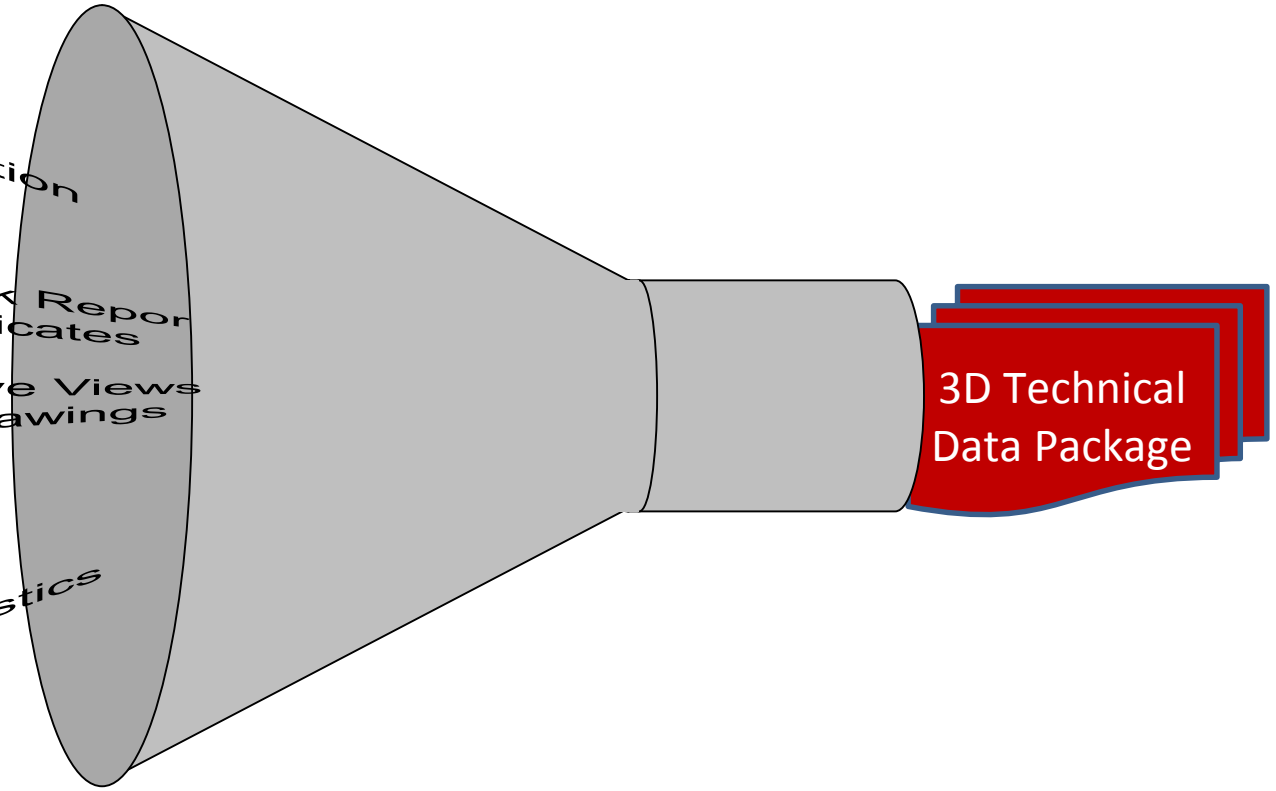
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Focus on the 3D Technical Data Package

…Throughout our Enterprise

TDP is a package containing Technical Data Elements.

- For Example:
  - Digital Product Definition
    - Models
      - Native
      - Derivatives
      - Model Check Repor
      - Model Certificates
    - Viewables
      - 3D Interactive Views
      - 2D Static Drawings
  - References
    - Included
    - Hyperlinked
    - External
  - Quality Support
    - Bill of Characteristics

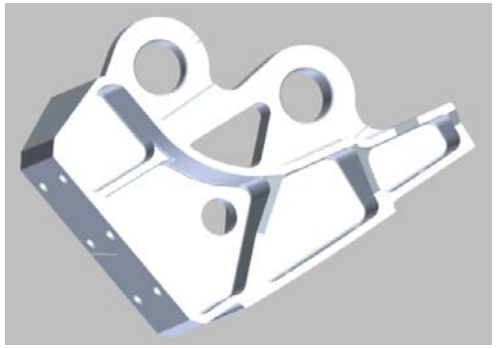


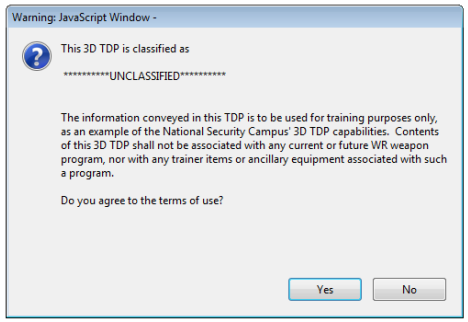
Curtis W. Brown, 2016

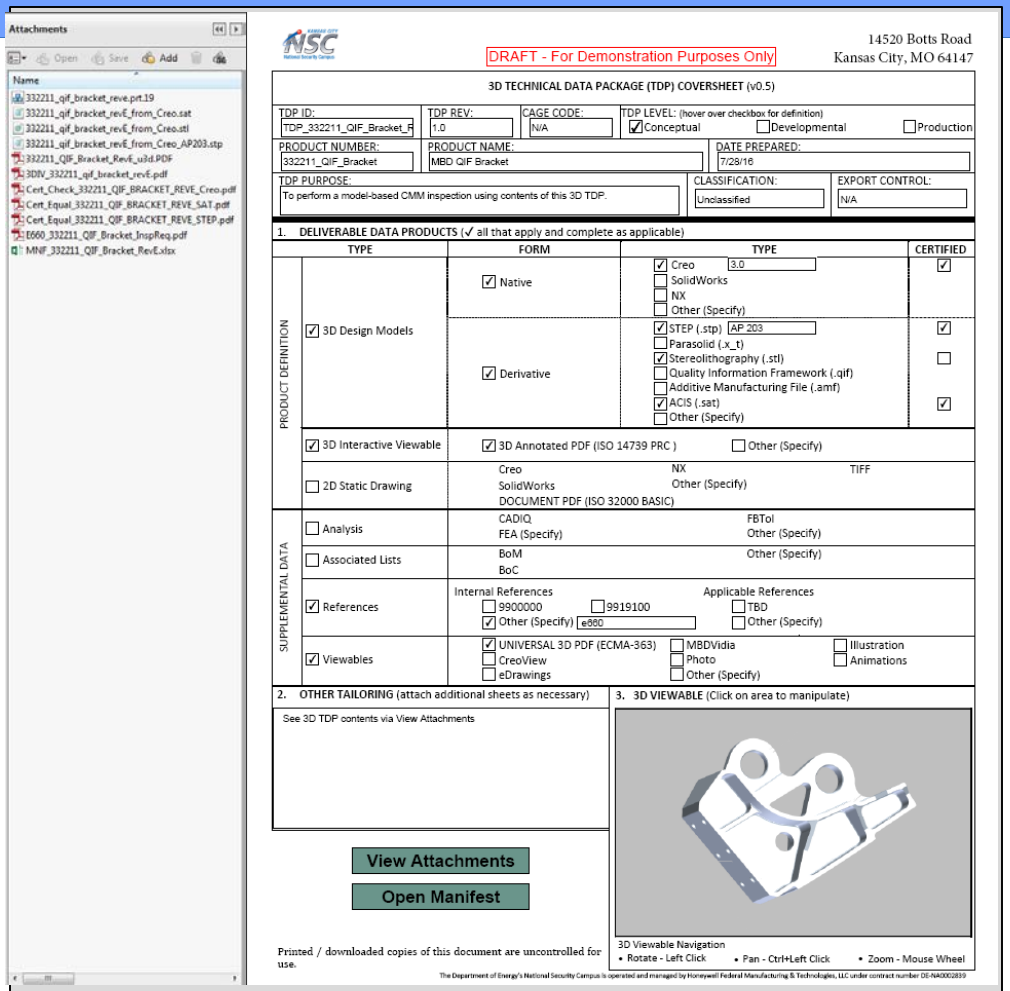
… Throughout our Enterprise

3D Technical Data Package

- **Manufacturing Authority**
- **PDF Container**







Mechanical Piece-Part for CMM Inspection

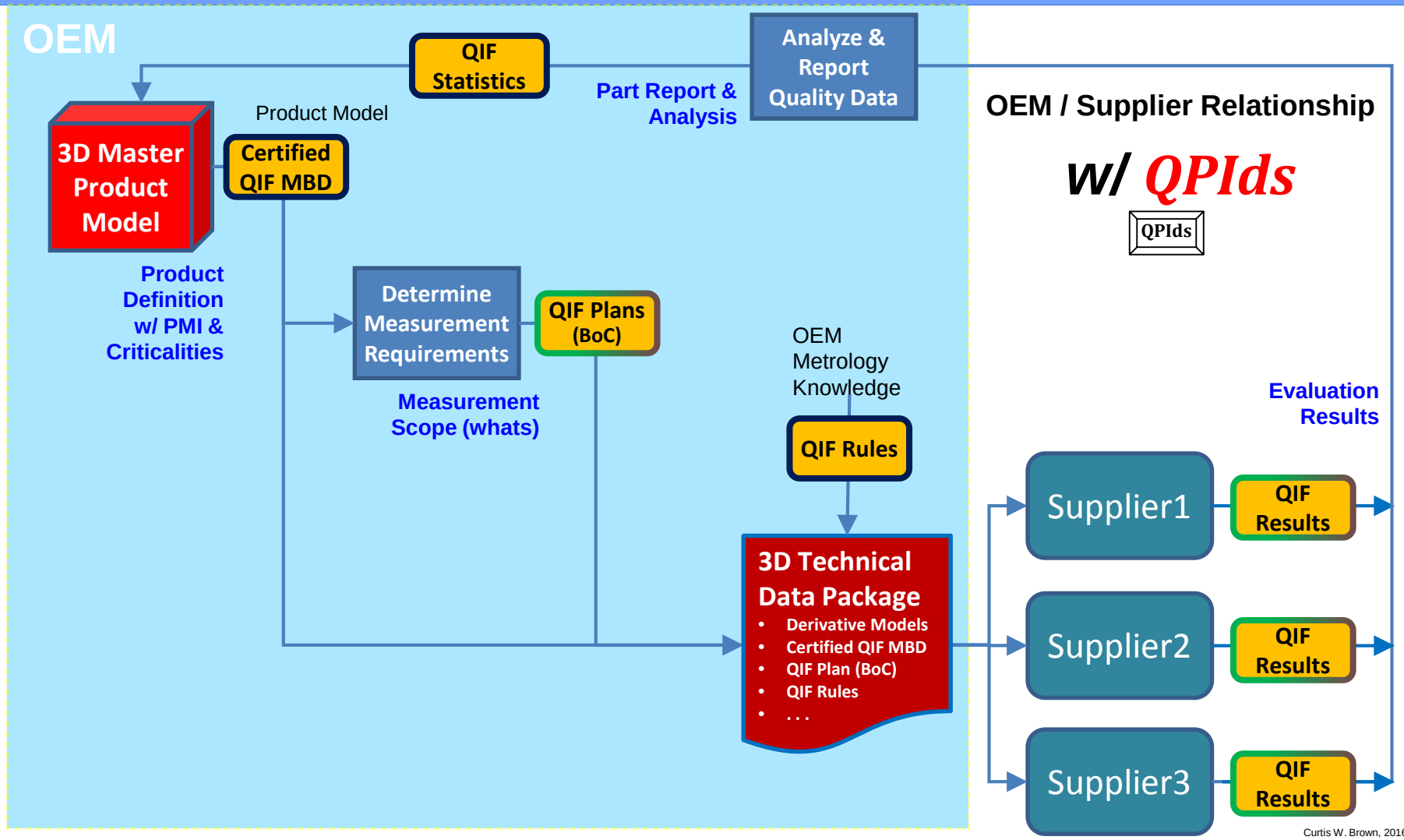
KCNSC's Inspection Request 3D Technical Data Package

Curtis W. Brown, 2016

The QIF advances the OEM/Supplier Relationship

Use Case Measurement Scope (BoC)

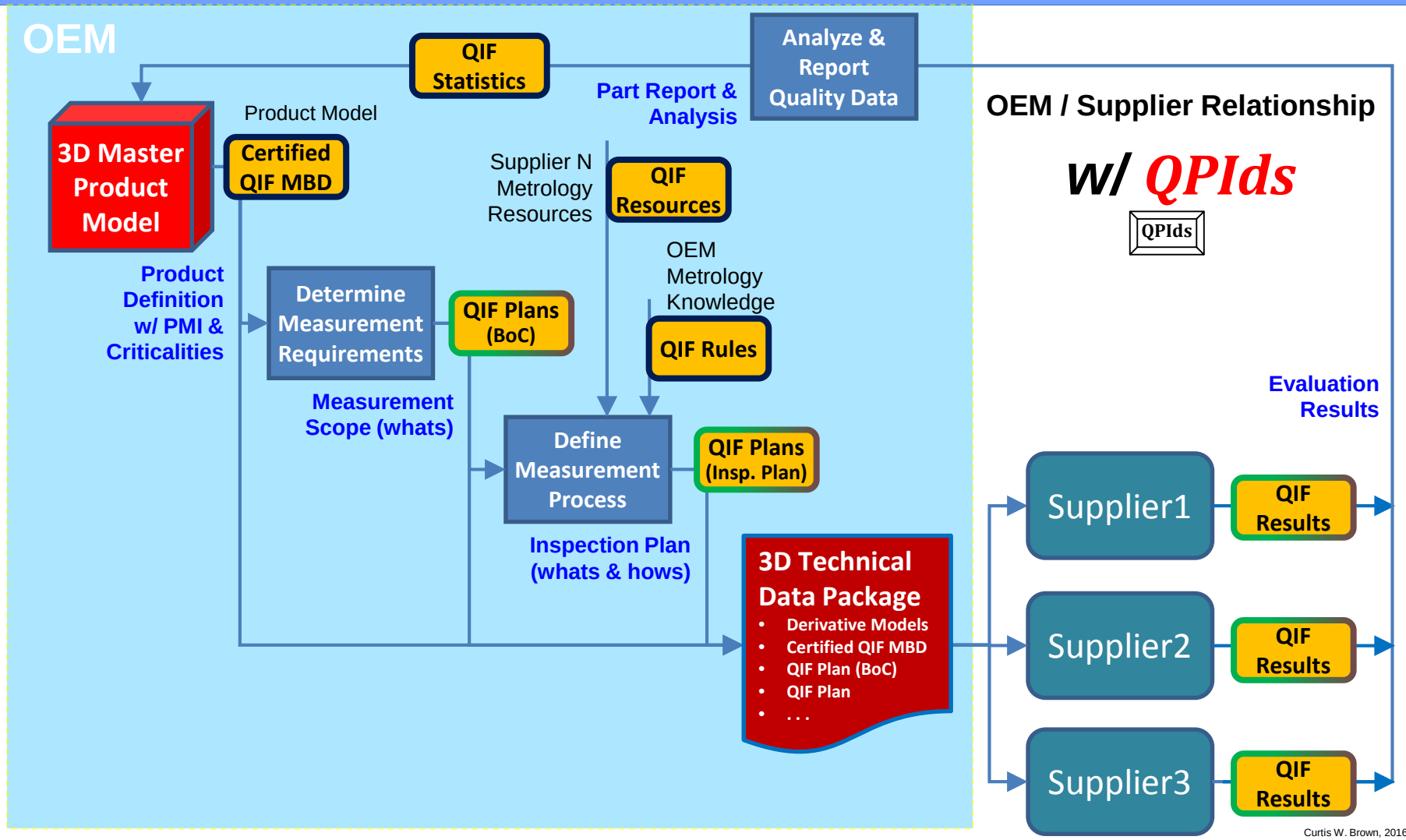
Global Product Data Interoperability Summit | **2016**



Curtis W. Brown, 2016

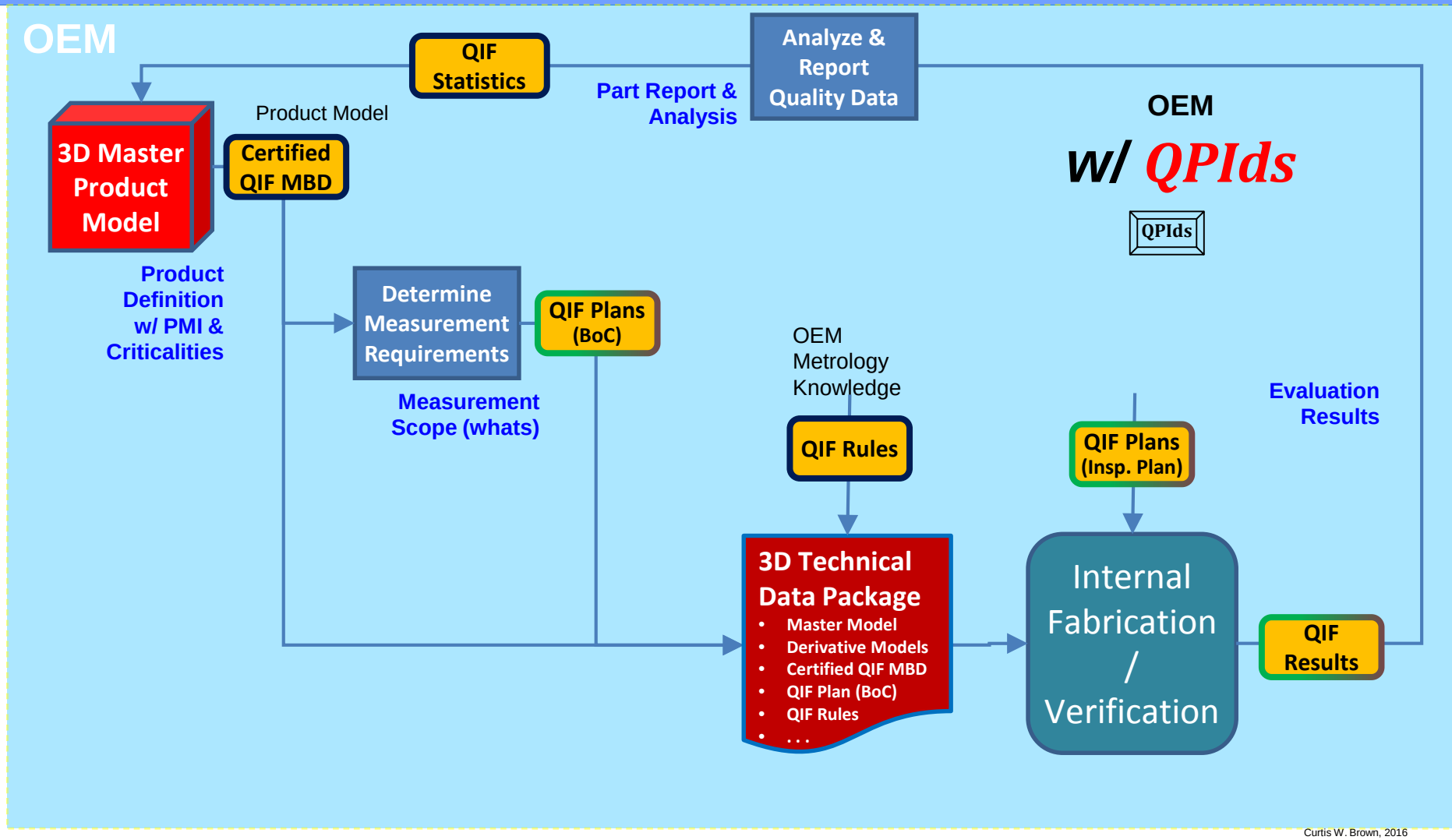
The QIF advances the OEM/Supplier Relationship

Use Case Inspection Plans



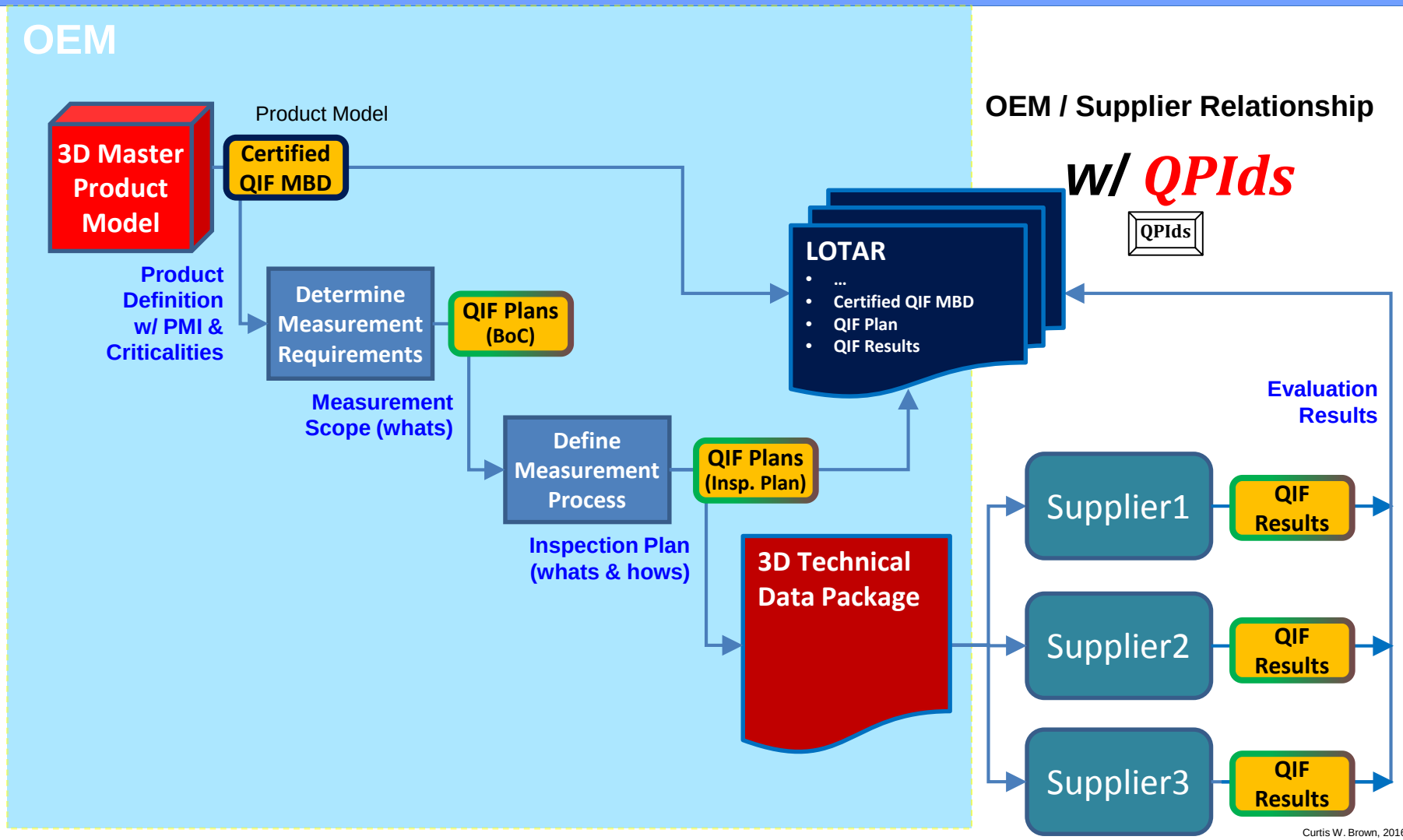
The QIF advances the OEM Fabrication

Use Case: Internal



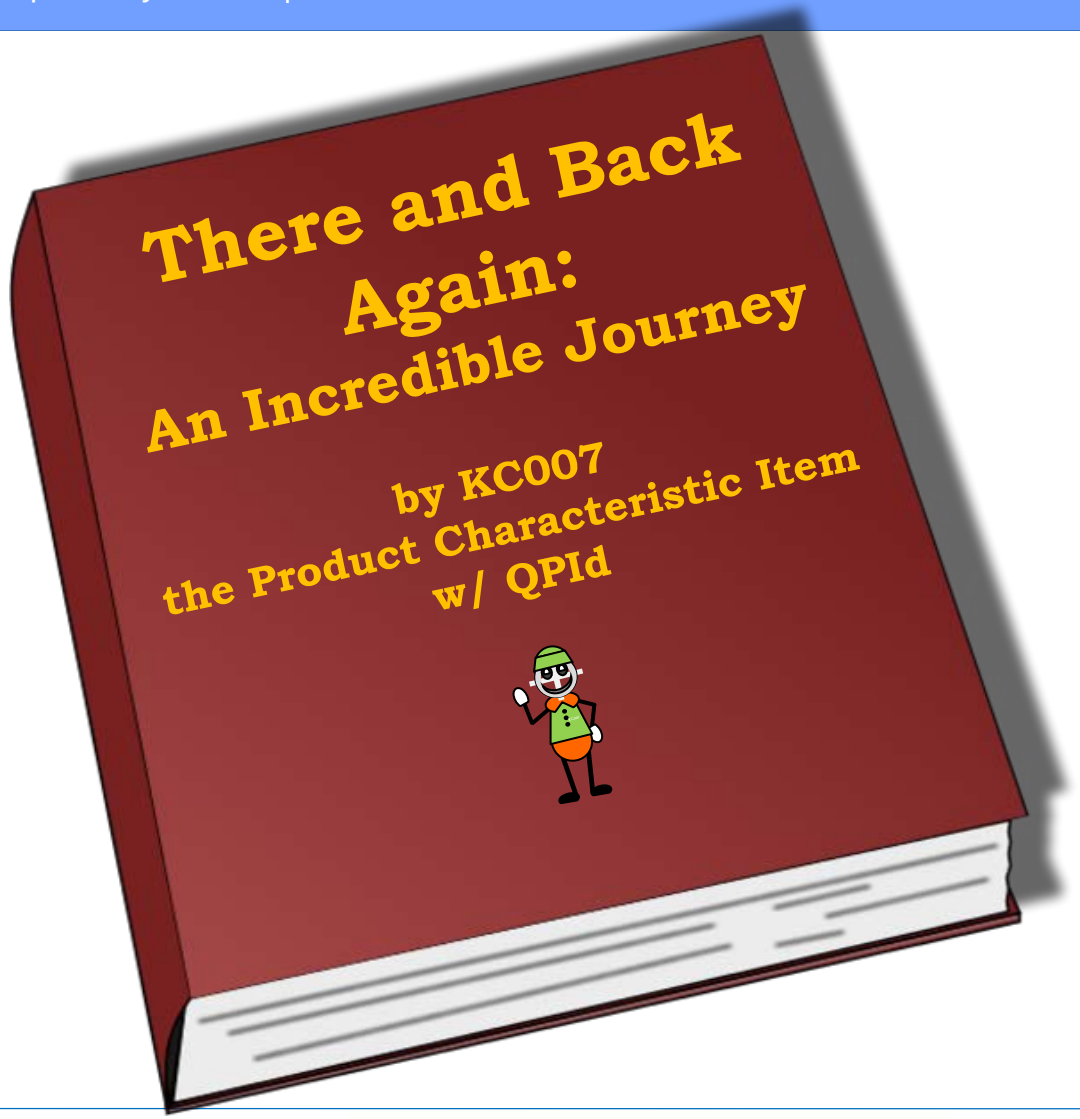
Curtis W. Brown, 2016

The QIF enriches Product Realization LOTAR



Curtis W. Brown, 2016

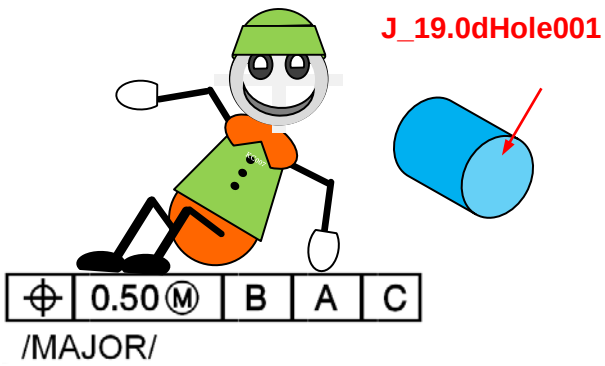
The Incredible Journey of KC007 the QPId



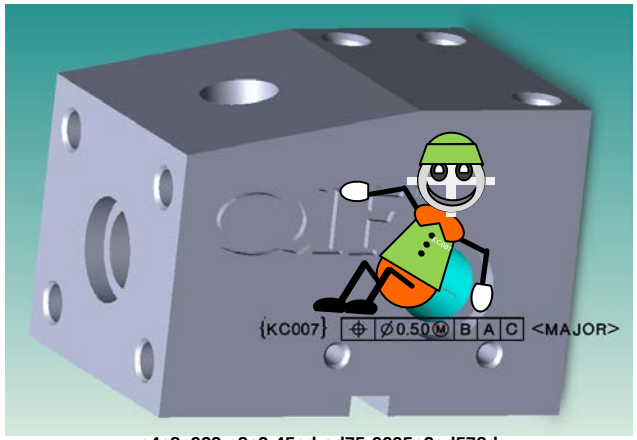
Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

A "**major**" Product Characteristic Item was conceived during a QIF process when a positional tolerance: **[Pos|0.50m|B|A|C]** was applied to the cylindrical feature: **J_19.0dHole001**.



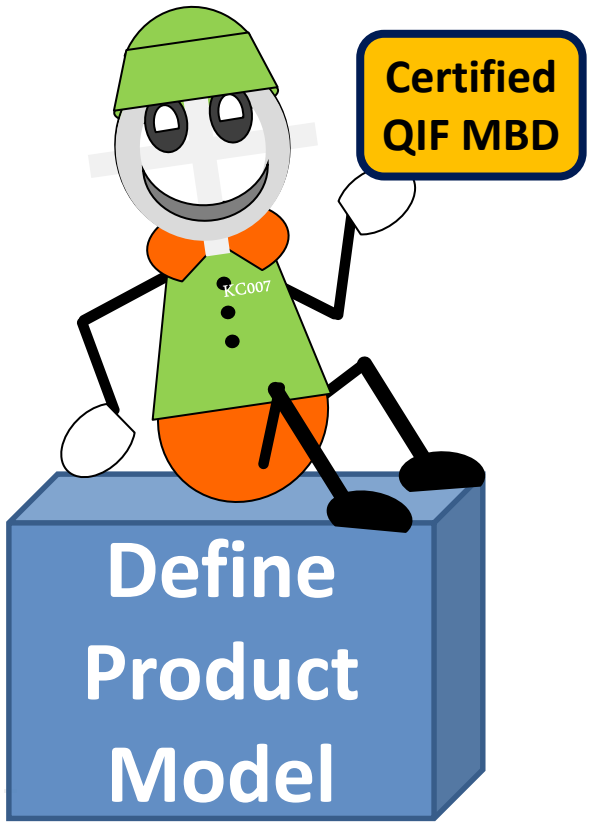
He was born on the digital product definition: QIF Widget IMTS 2014, known universally has: <QPId> **c4c8e922-e8c2-45cd-ad75-9995e2ad578d** </QPId>



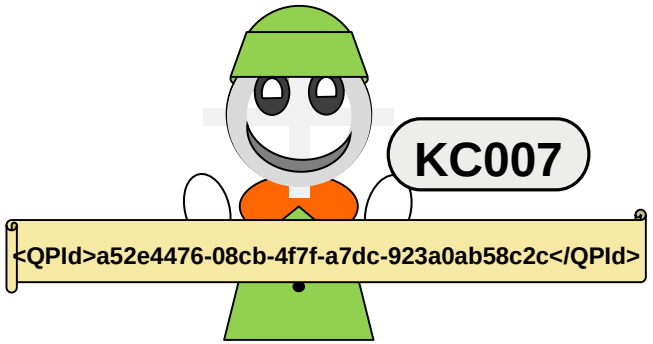
c4c8e922-e8c2-45cd-ad75-9995e2ad578d

Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

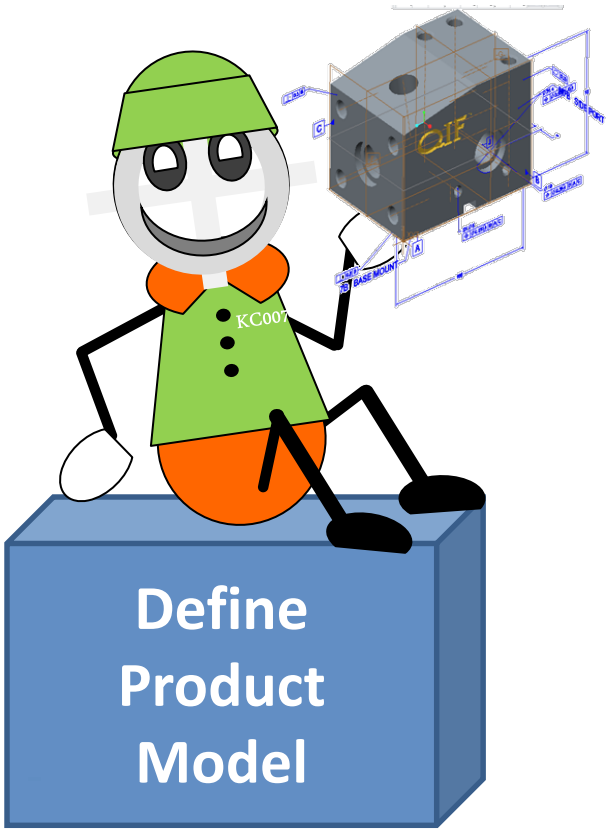


The universe gave this Product Characteristic Item the unique identity of: <QPId> **a52e4476-08cb-4f7f-a7dc-923a0ab58c2c** </QPId>.
His friends and family called him: "**KC007**".

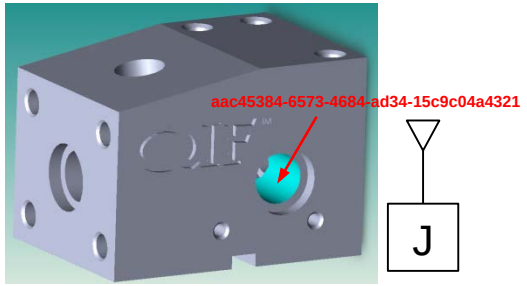


Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId



His closest friend was a Cylinder Feature Item known as **J_19.00dHole001**. This feature was known universally as: <QPId>**aac45384-6573-4684-ad34-15c9c04a4321** </QPId>.



Interestingly, this feature obtained a Datum J status and pointed to a face known within the product as: Face-15.

Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

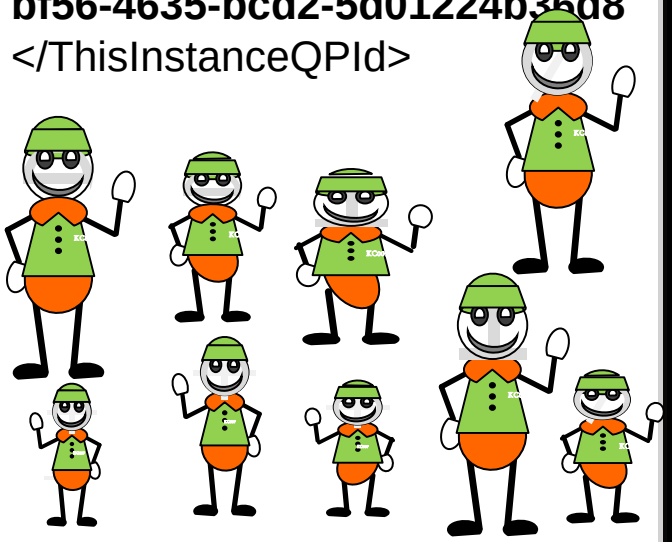
His conception in the QIF v2.0 could be written as:

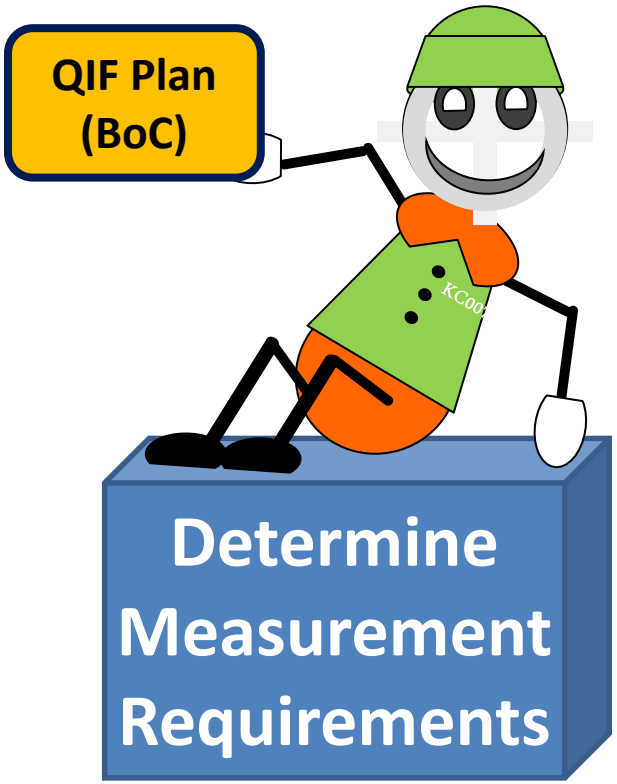
```
<PositionCharacteristicItem id="99">
    <Name>Pos0.5mBAC</Name>
    <QPId>
      a52e4476-08cb-4f7f-a7dc-923a0ab58c2c
    </QPId>
    <KeyCharacteristic>
      <Designator>KC007</Designator>
      <Criticality>MAJOR</Criticality>
     </KeyCharacteristic>
    <FeatureItemIds N="1">
      <Id>95</Id>
    </FeatureItemIds>
    <CharacteristicNominalId>
      98
    </CharacteristicNominalId>
    <LocationOnDrawing>
      <DrawingId>3</DrawingId>
    </LocationOnDrawing>
</PositionCharacteristicItem>
```

Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

Later he was collected with a group of other Product CIs and teamed together as a Bill of Characteristics (BoC). They were assigned to a QIFPlan <ThisInstanceQPId> **3dfa570f-bf56-4635-bcd2-5d01224b36d8** </ThisInstanceQPId>



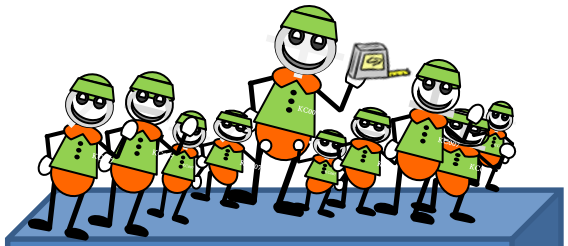


Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

Soon he was matched from a list of measurement resources with a measurement method for how he could be verified.

QIF Resources



Define Measurement Process

Then his team of BoCs was sequentially ordered as an Inspection Plan for verification by Manufacturing Quality

QIF Rules

Curtis W. Brown, 2016

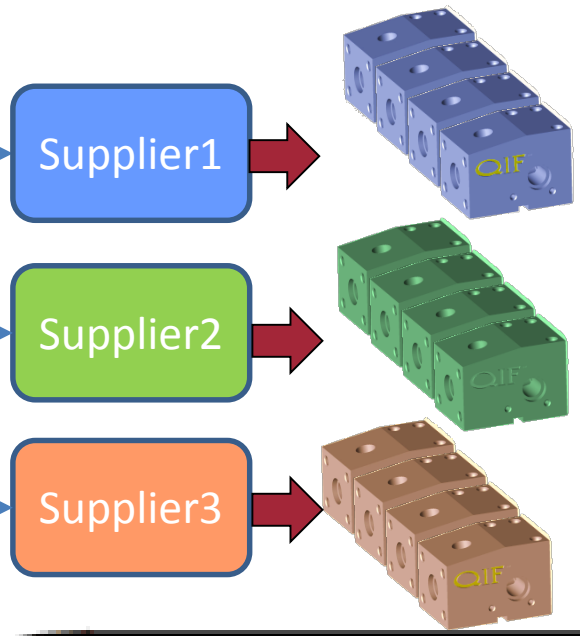
The Incredible Journey of KC007 the QPId

Interestingly, his product, QIF Widget, was to be realized by multiple suppliers at different location throughout the universe. Therefore, his BoC and Inspection Plan was packaged within a digital Technical Data Package (TDP).

3D Technical Data Package

- Master Model
- …
- Certified QIF MBD
- QIF Plan (BoC)
- QIF Plan

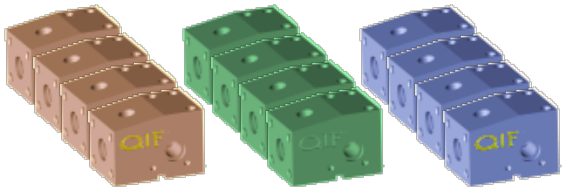
And the TDP was delivered to three suppliers. Each supplier realized a lot of QIF Widgets.



Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

After the products were realized,



they were all shipped home for verification on a coordinate measuring machine (CMM).

Execute Measurement Process

Execution of the measurement process involves the creation of a DMIS (dimensional measuring interface standard) CMM part program. With the new DMIS major word REFID for QPId reference ID.

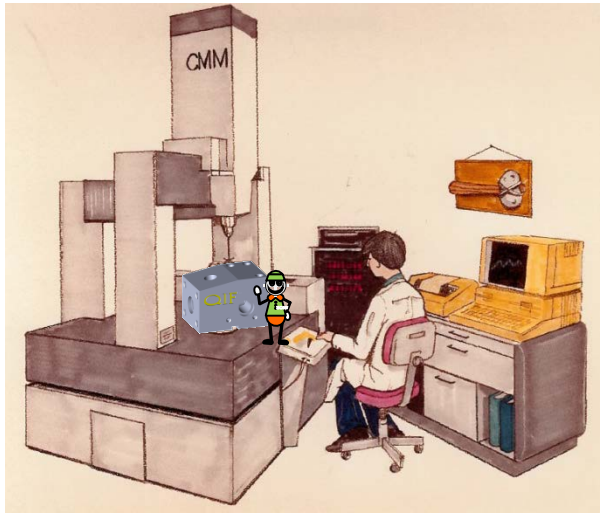
DMIS

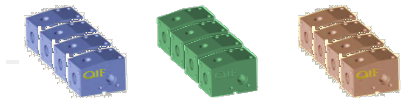
```
DMISMN/'QIF Widget', 5.3
. . .
F(FCY95) = FEAT/CYLNDR,
      INNER,CART,x,y,z,i,j,k,19.0
T(TPS99) = TOL/POS,
      3D,0.050,MMC,DAT(B),DATA),DAT(C)
KC(KC007) = KEYCHAR,F((FCY95),T(TPS99)
REFID/KC(KC007), NAME,  'QPId',
      'a52e4476-08cb-4f7f-a7dc-923a0ab58c2c'
MEAS/CYLNDR,F(FCY95),33
EVAL/KC(KC007)
. . .
ENDFIL
```

Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

Performing the CNC DME part program, verifies the KC007 for each actual part by probing the measurement feature



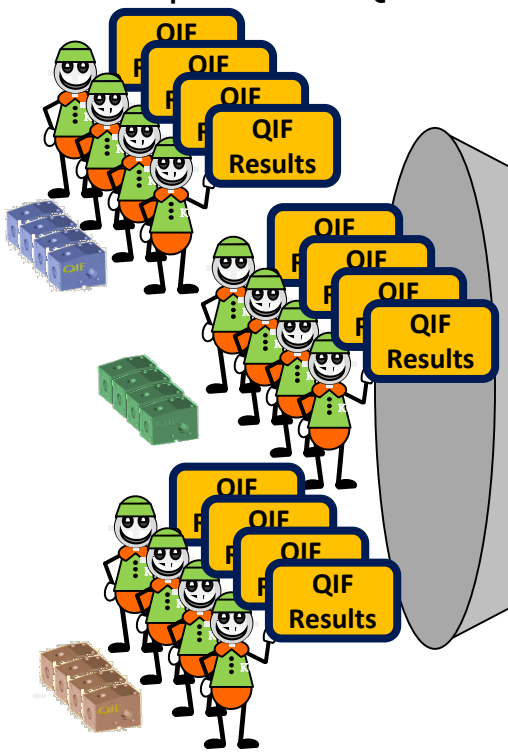


Perform CNC DME Program

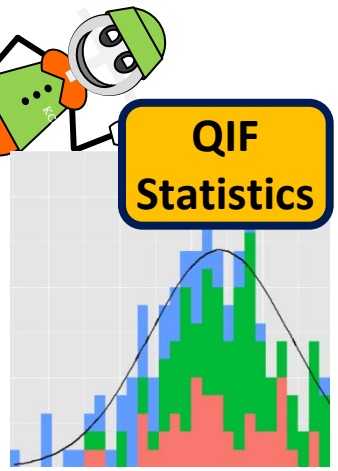
Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

Measurements from each KC007 produced QIF Results



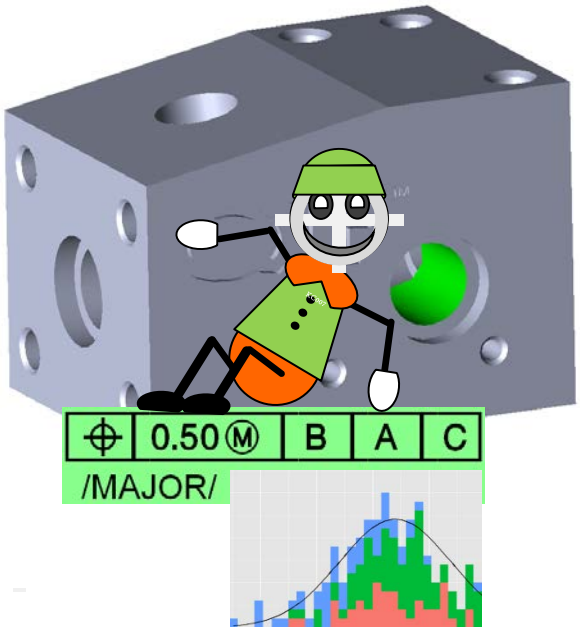
No matter where the inspection was performed, the QPId allows us to group each piece-part's KC007 and perform QIF Statistics.



Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

Returning home to KC007's digital product definition, KC007's can communicate about his actual results …



… and through QPIds, he can provide feedback on his feature relationship with J_19.0dHole001

What a incredible journey:

- from digital product definition
- to product realization,
- to product verification,
- to reporting, and
- back to digital product definition.

Curtis W. Brown, 2016

The Incredible Journey of KC007 the QPId

And it does not end there. KC007 and his digital product definition, inspection plan, and measurement actuals can be long term archived for future retrieval!

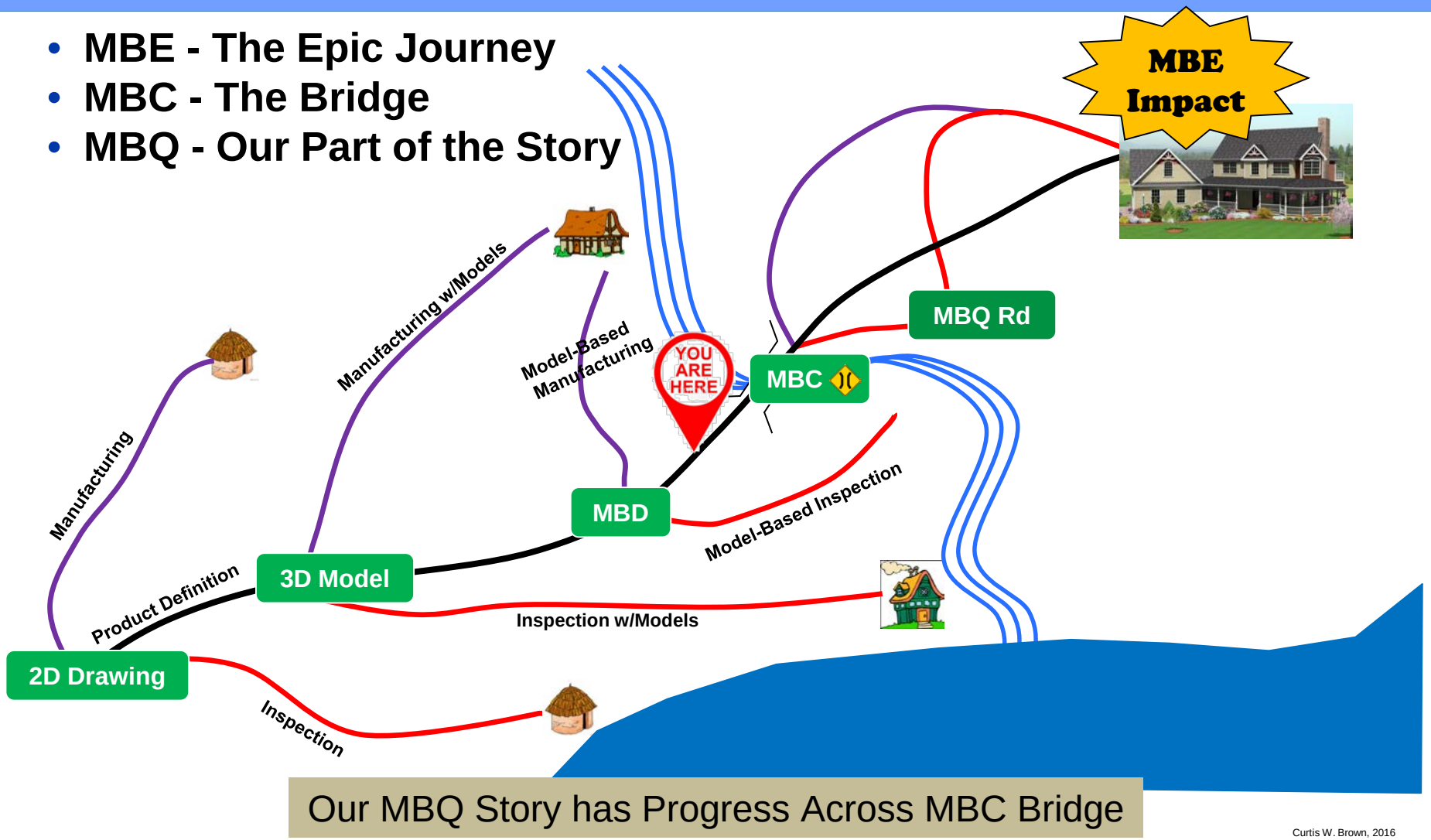
KC007, through his QPId connects, lived long and happily ever after and was remembered when called upon.

The End

Curtis W. Brown, 2016

The Road to MBE Impact

- **MBE - The Epic Journey**
- **MBC - The Bridge**
- **MBQ - Our Part of the Story**



Our MBQ Story has Progress Across MBC Bridge

Curtis W. Brown, 2016

Our Interest in the QIF

- **Quality is a customer requirement**
  It is neither free nor optional;
  However, it can be achieved
  - **Faster**
  - **Better,**
  - **Cheaper,**
  - **Smarter**

  with Innovation and Standards-Based Digital Interoperability
- **QIF is a effective standards solutions since:**
  - **Contains inherent validations for data correctness**
  - **XML-Based Implementation**
  - **Cost efficient to implement and use**
  - **Complete but extensible**
  - **Enables the Model-Based Enterprise**

QIF™
Quality Information Framework

Curtis W. Brown, 2016

- A not-for-profit, cooperative sponsorship organization with **members Large and Small**
- Focused on or relating to **Digital Dimensional Metrology**
- Dedicated to identifying, promoting, fostering, and encouraging the **Development and Interoperability of Standards** that benefit the dimensional metrology community.
- An **ANSI accredited Standards Making organization** with **ISO fast-track** international presence
- Brought you the **DMIS ISO Standard**, the most influential standard in the industry
- Developed and **ANSI standardized** the **Quality Information Framework** (QIF), a **full end-to-end** Digital Metrology Interoperability **solution**

Curtis W. Brown, 2016

Participants

- ## DMSC Consortium Members
  - **Action Engineering**
  - **Advanced Dimensional Management**
  - **Applied Automation Technologies**
  - **Capvidia**
  - **Deere & Company**
  - **Honeywell FM&T**
  - **Innovalia Metrology**
  - **InspectionXpert**
  - **Kotem Technologies**
  - **Lockheed Martin**
  - **MBD360 LLC**
  - **MetroSage LLC**
  - **Mitutoyo America Corp**
  - **Nikon Metrology**
  - **NIST**
  - **Origin International, Inc.**
  - **PAS Technology**
  - **QIF Solutions**
  - **Renishaw**
  - **Siemens PLM Software**
  - **UNC-Charlotte**

- ## Associated Organizations

Open to all who have a Direct and Material Interest

- Rolls Royce
- Pratt Whitney
- GE Aviation
- Boeing
- DISCUS Software
- Lockheed Martin
- Hexagon Metrology
- MTConnect
- Renaissance Services
- Validation Technologies
- IPI Solutions
- Manufacturing Technology Centre
- PTC
- Net-Inspect

Curtis W. Brown, 2016

We value your Involvement

- ***Encourage:***
  - ***Your Favorite Vendor to Investigate the Benefits of QIF***
  - ***Your Metrology Department to Plan for the Use of the QIF***
  - ***Your MBE Strategy Team to Plan for the Use of the QIF***
  - ***Visit the DMSC Booth at IMTS 2016***
  - ***Present or Attend the QIF Summit, 2017***
  - ***Join us, we would value your involvement!***
- **DMSC Membership (www.DMSC-Inc.com)**
  - **bsquier@dmsc-inc.com to Request an Application**
- **QIF Involvement (www.QIFStandards.org)**
  - **One or Many Working Groups**
- **Download DMSC/QIF 2016**
  - **www.QIFStandards.org/download-qif/**

Curtis W. Brown, 2016