

NAVAIR Non Contact In-Process Inspection

Gabe Draguicevich N42 FRC-SW NAVAIR NI Aug 25th, 2015





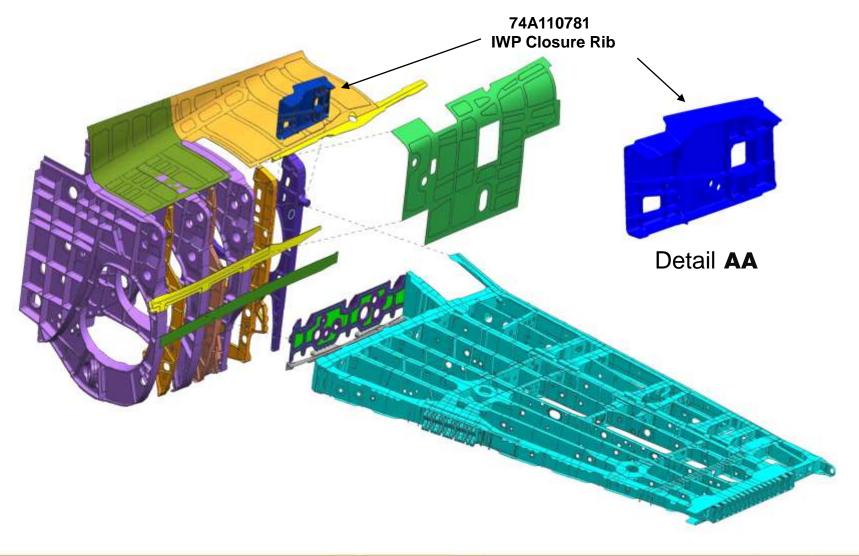
Overview

- Background on Navy 3D Model Status
 - (3MS / MBD)
- Proposed System Examples
- Definition of Digital Product Definition and Model-Based Definition (MBD)
- Model-Based GD&T for Inspection
- Challenges
- Resources





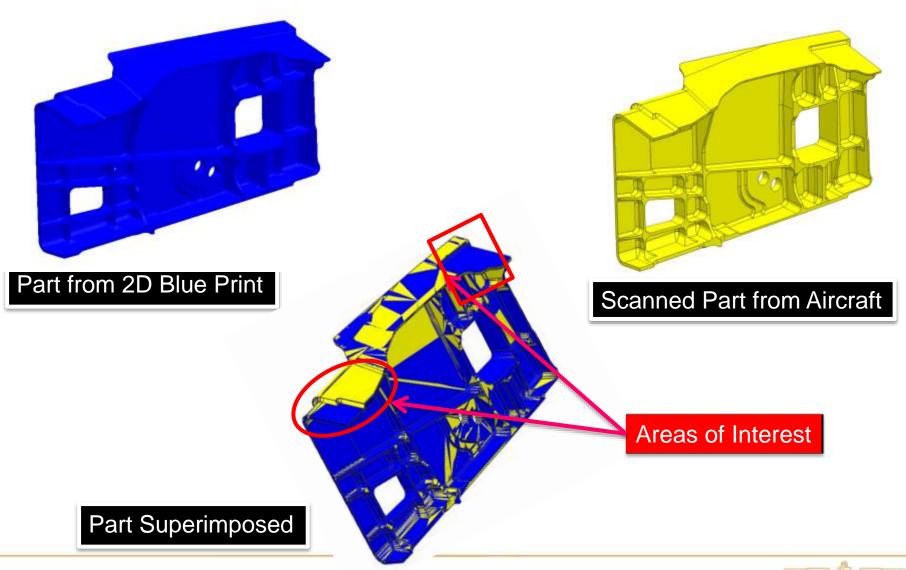
F/A-18 IWP CLOSURE RIB







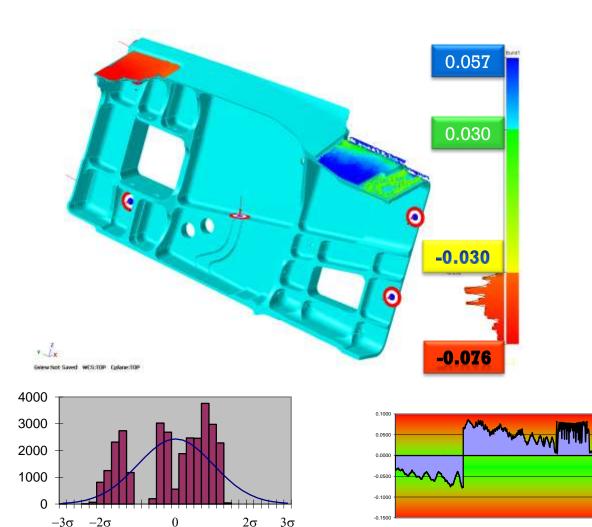
CLOSURE RIB COMPARAISON





CLOSURE RIB ADVANCED MEASUREMENT

Model Deviation Graph



Bell Curve 6o



Verisurf Build

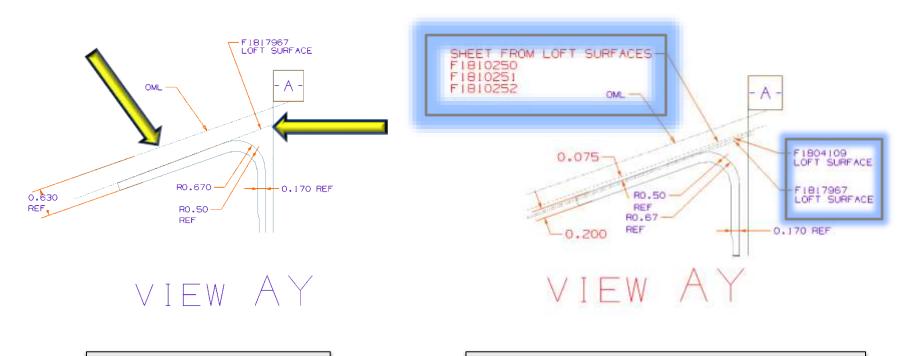


FaroArm®





CLOSURE RIB ML DEFININTION PER B/P



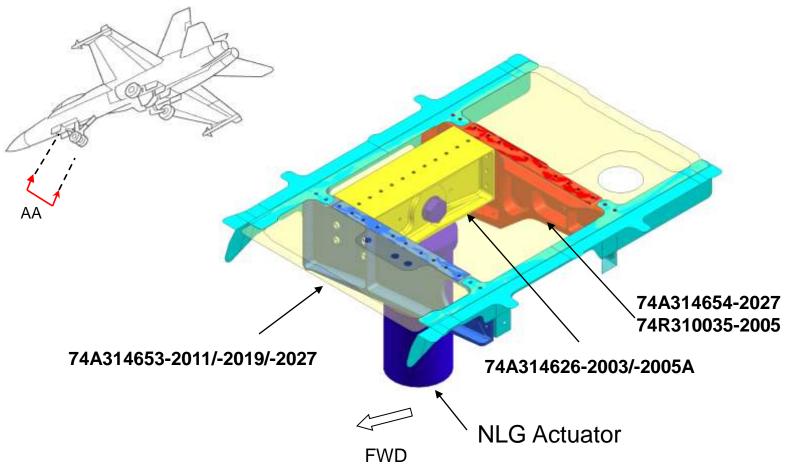
Part Drafted per B/P

Modified the B/P To Reflect the Part





NLG ACTUATOR SUPPORTS



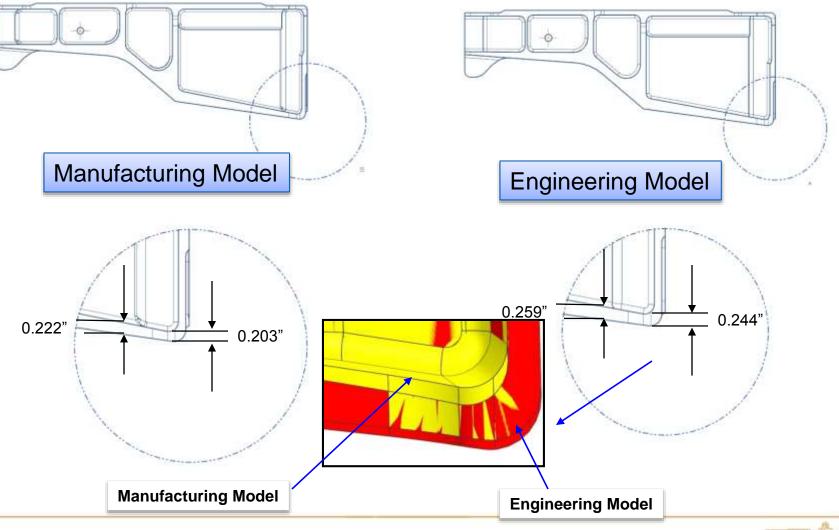




Comparing Manufacturing & Engineering 3D CAD Models 74R310035-2005 74R310035-2005 Manufacturing Model **Engineering Model** 74A310035-2005 Superimposed **Critical Spot 2: Critical Spot 1: Smaller Radius Smaller Thickness ∆=0.040**"



Differences between Manufacturing & Engineering Critical Spot #1 74R310035-2005

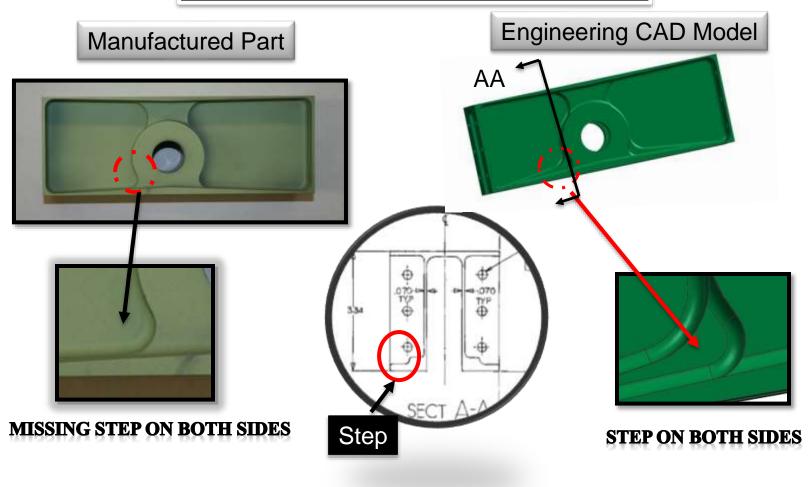






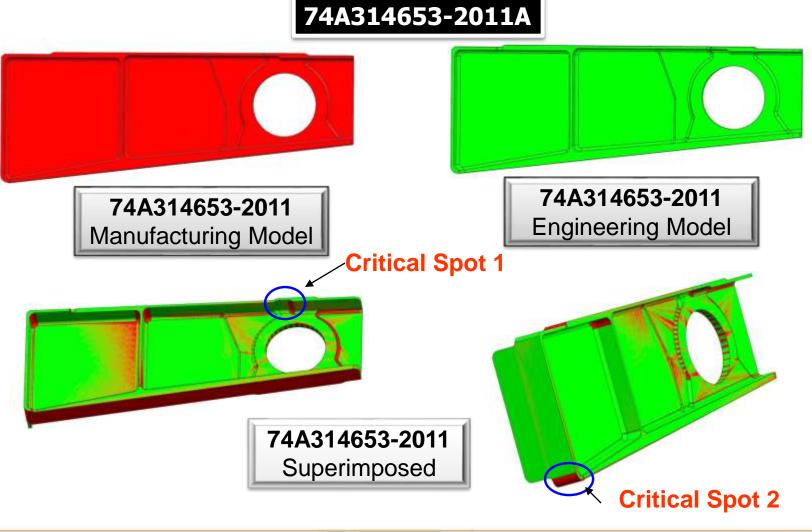
Manufactured Parts Do Not Conform to B/P

74A314626-2003/74A314626-2005A





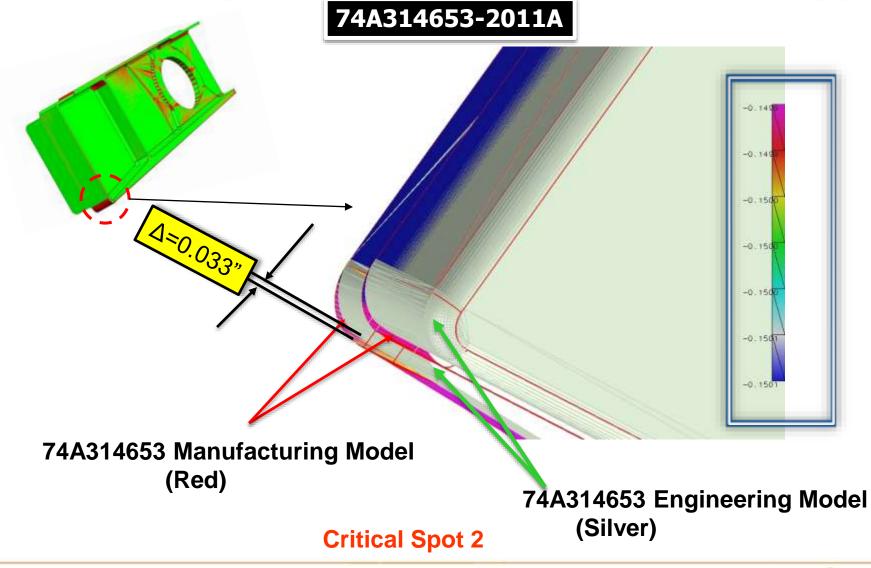
Comparing Manufacturing & Engineering 3D Models







Manufacturing & Engineering 3D Models Overlapping





Traditional CMM's Approach

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Characteristic Accountability						Inspection / Test Results			
6, Char No.	6. Reference Location	7. Characteristic Designator	8. Requirement	Sa. UoN	85. Upper Limit	8c. Lower Limit	9. Results	10. Designed Tooling	11. Nar Canfor Mumbe
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2	pg.1, zone 2.A	LINEAR	.750±.020	in .	0.770	0.730	0.74	CMM	1
3	pg.1, zone 2.B	LINEAR	.680±.020	in	0.700	0.000	0.001	CNM	1
4	pg.1, zone 2.B	LINEAR	.618±.020	in	0.638	0.598	0.62	CMM	1
5	pg-1, zone 2.B	ANGULAR	.325±.020	in	0.345	0.305	0.32	Digital Calipera	
8	pg.1, zone 2.C	PROFILE OF A SURFACE	48.56°	deg	49.56	47.58	49.54	Digital Calipers	
7	pg.1, zone 2.C	RADIAL	020 A B C	'n			0.017	CMM	1
8	pg.1, zone 2.D	PERPENDICUL	R.125	\$1	0.130	0.120	0.119	Digital Calipers	1
9	pg 1, zone 2.D	LINEAR	.010 A B	in .	0.01	0.01	0.01	Digital Calipers	
10	pg.1, zone 3.C	LINEAR	2.875±.020	in	2.895	2.866	2.89	Cigital Calipera	
11	pg.1, zone 3.C	LINEAR	3.206+.003	in	3.209	3.202	3.205	Digital Calipers	
12	pg. 1, 2016 5.C	PERPENDICULAR	3.503 3.496	.in	3.505	3.496	3.6	Digital Calipers	









Capital Improvement Project (CIP)

- Approx \$36M total investment across three fleet readiness centers
 - FRC-SW San Diego, CA
 - FRC-SE Jacksonville, FL
 - FRC-E New Bern, NC
- In Process Inspection System
 - \$800K Y16 / Y17 Project





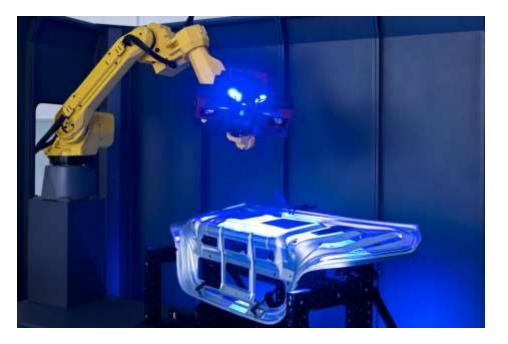
Measuring Large Structure Manufacturing Parts







ATOS Scanbox







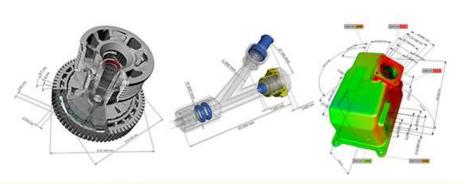




Cognitens 360 SIMS



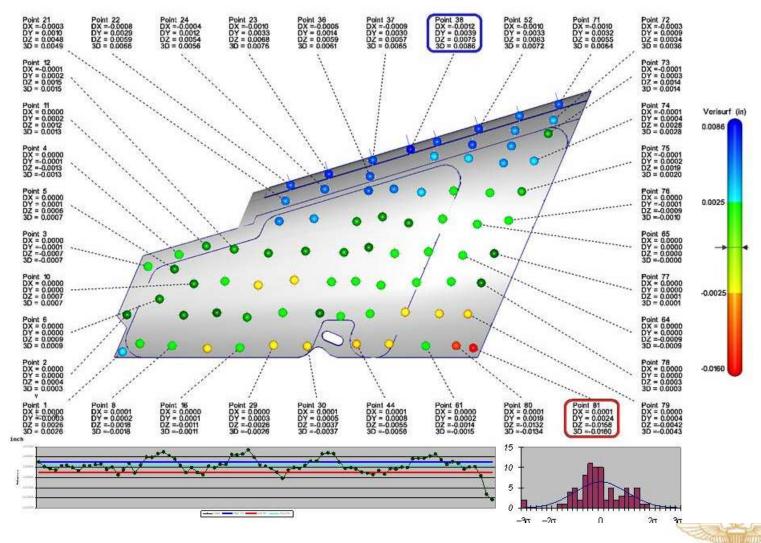








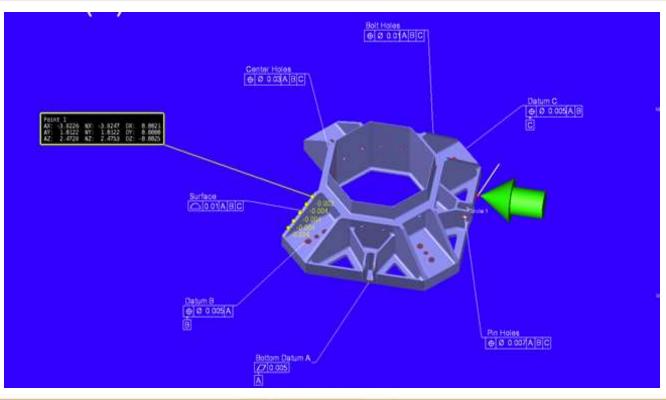
Model-Based Inspection Solutions QA Reporting to MBD





WHAT IS A MBD?

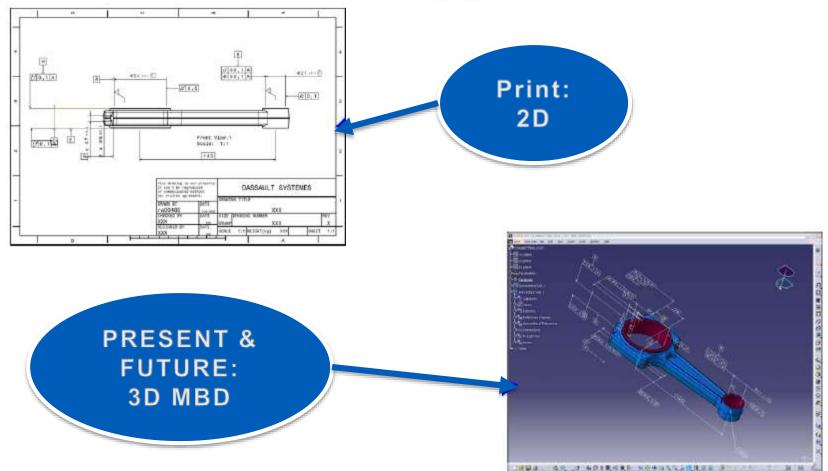
Model Based Definition, MBD is Using the Native CAD Model as the Sole Data Authority







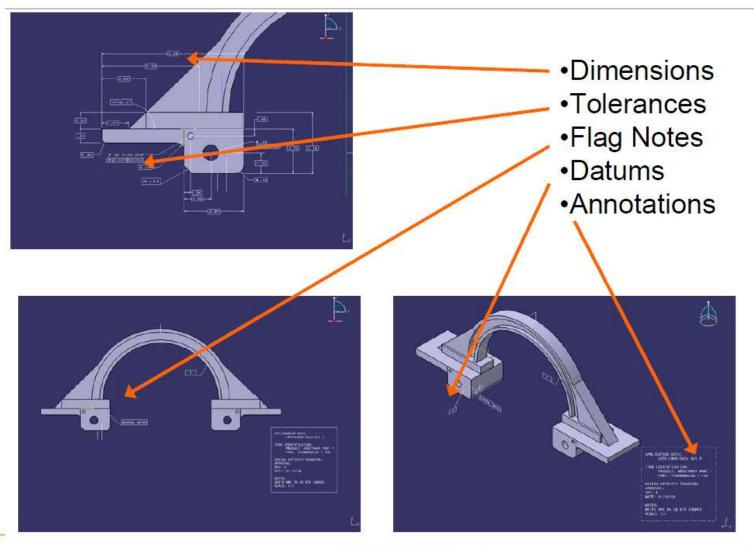
MODEL BASED DEFINITION MBD







3D SOLID MODEL BASE DEFINITION





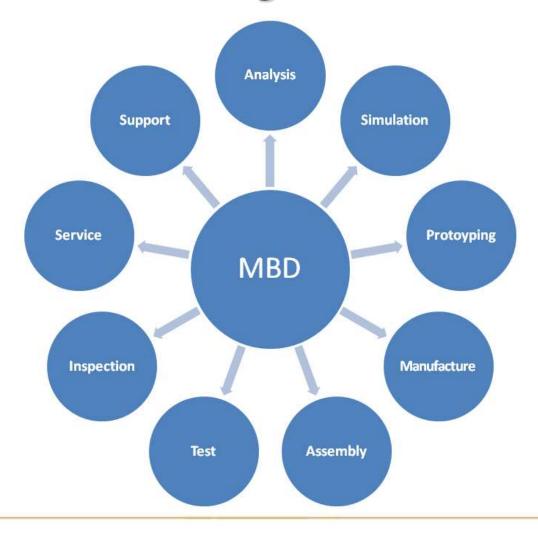


• The Model Based Enterprise (MBE) is made up of many related processes. At its core is the product definition which we refer to as the Model Based Definition (MBD). Another way to define MBD is an annotated 3D CAD Model that contains all the information needed to define a product. This annotated model replaces a traditional drawing. Thus, a drawing is created by exception not as a standard process.





MBD at the center of Product Lifecycle Management







Value of MBD

- With authority bestowed on the model, MBD will:
 - Eliminate errors that result from referencing an incorrect source.
 - Make processes more efficient—no more searching to determine correct revision levels.
 - Eliminate outdated drawings floating around the manufacturing floor.
 - Eliminate discrepancy between the CAD model and 2D documentation.





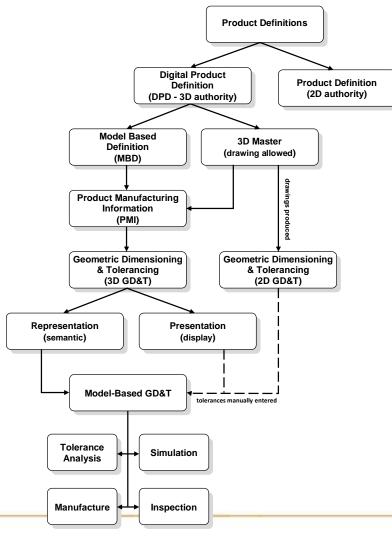
Where MBD Is Best Applied

- Complex surface profiles
- Complex products with large bills of materials
- Mission critical components with high liability
- Long product lives
- Global supply chains
- Stringent regulatory requirements





Product Structure in a MBD Environment







Model-Based GD&T Annotations

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Model-Based Enterprise Broken

Model Based Definition

- 3D Solid Models
- CAD Intelligence Utilized
- Automated Digital Processes

Model Based Definition Broken

- •Productivity Barrier
- •Quality Data Loop Broken
- Statistical Improvement Impeded

Drawing Based Definition

- 2D Drawings
- CAD Intelligence Lost
- Manual Analog Hand Tools





Model-Based Enterprise Applied

Model Based Definition

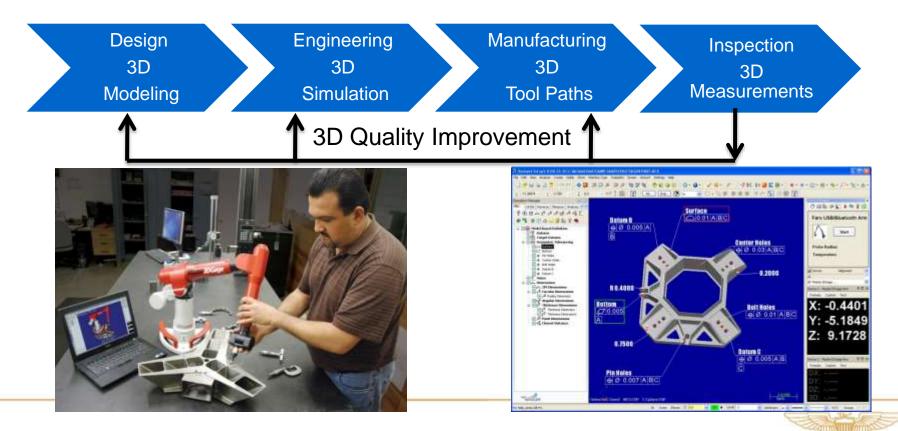
- 3D Solid Models
- CAD Intelligence Utilized
- Automated Digital Processes

Model Based Definition Extended

- Productivity Improved
- •No 2D Drawing Waste
- •3D Quality Data Loop Closed

Model Based Inspection

- 3D Profile with Tolerances
- CAD Intelligence Utilized
- Automated Digital Process





Benefits of Model-Based Measurement and Inspection

- No 2D Drawings
 - Cost and time eliminated
 - Contradictions removed
- Automated inspection planning
- Automated report formatting
- Accuracy
 - All features included in plan
 - No interpretation errors
 - GD&T rule checking
 - No data entry errors
- Prompted inspection procedures

- Live, graphical measurement display
- Automated reporting
 - No data entry
 - No manual calculations
- Only basic skills needed
- Eliminate CMM overhead (PCMM)
 - No fixtures
 - No part set-up
 - No programming
 - No manual data recording



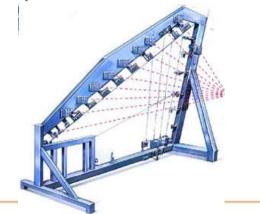


Model-Based Large Volume Measurement Applications

Tooling Fabrication and Validation



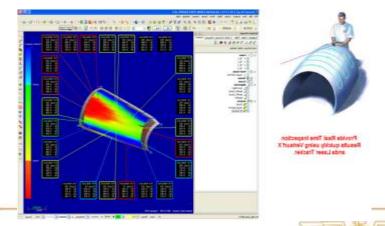
Automated high precision inspection and R&R studies



Large volume Inspection



Real time Model-Based Inspections





Model-Based Inspection Solutions Import 3D CAD & MBD

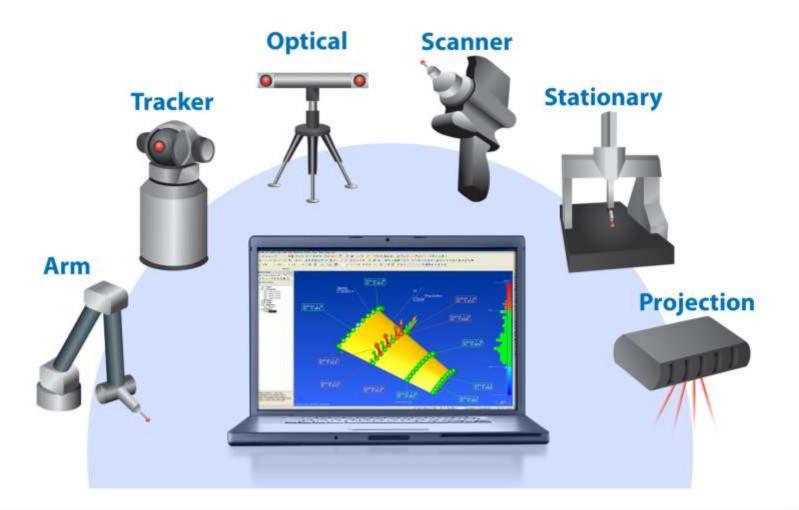
- CATIA Dassault
- UG Siemens
- Pro/ENGINEER PTC
- SolidWorks Dassault
- Inventor Autodesk
- SolidEdge Siemens

Autodesk SolidWorks NX UNIGRAPHICS

Mastercam V8 Files (*.MC8) All Mastercam Files (*.MCX;*.EMCX;*.MC9;*.MC8) IGES Files (*.IGS;*.IGES) AutoCAD Files (*.DWG;*.DXF;*.DWF) Parasolid Files (*.X_T;*.X_B;*.XMT_TXT) Pro/E Files (*.PRT;*.ASM;*.PRT.*;*.ASM.*) ACIS Kernel SAT Files (*.SAT;*.SAB) STEP Files (*.STP;*.STEP) VDA Files (*.VDA) Rhino 3D Files (*.3DM) SolidWorks Files (*.SLDPRT;*.SLDASM) SolidWorks Drawing Files (*.SLDDRW) Solid Edge Files (*.PAR;*.PSM;*.ASM) Autodesk Inventor Files (*.IPT;*.IAM) Autodesk Inventor Drawing Files (*.IDW) KeyCreator Files (*.CKD) ASCII Files (*.TXT;*.CSV;*.DOC) StereoLithography Files (*.STL) Catia V4 Files (*.MODEL;*.EXP) Catia V5 Files (*.CATPART;*.CATProduct) SpaceClaim Files (*.SCDOC) Alibre Design Files (*.AD_PRT;*.AD_SMP) HPGL Plotter files (*.PLT) Cadkey CDL Files (*.CDL) PostScript Files (*.EPS;*.Al;*.PS) Catia V4 Files (Moldplus) (*.model; *.exp) Catia V5 Files (Moldplus) (*.CATPart; *.CATProduct) Verisurf STL files (*.STL) Unigraphics NX (*.PRT) All Files (*.*)



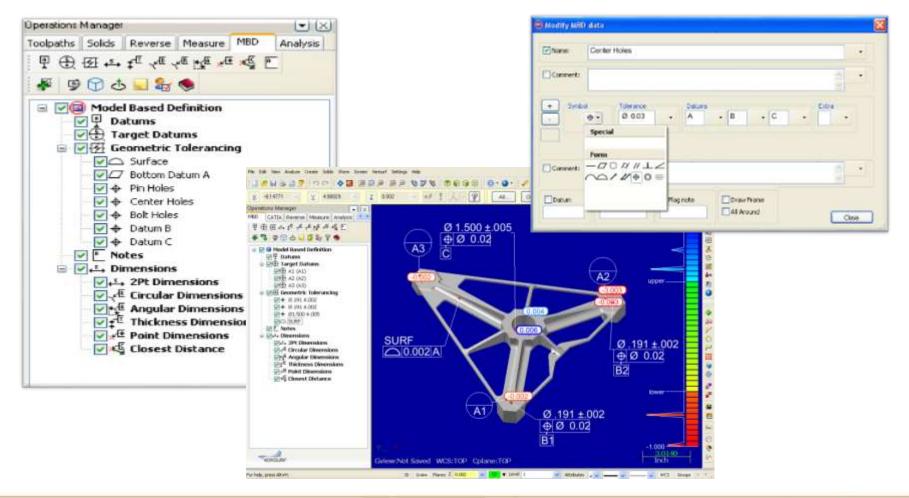
Model-Based Inspection Solutions Connect To Metrology Devices







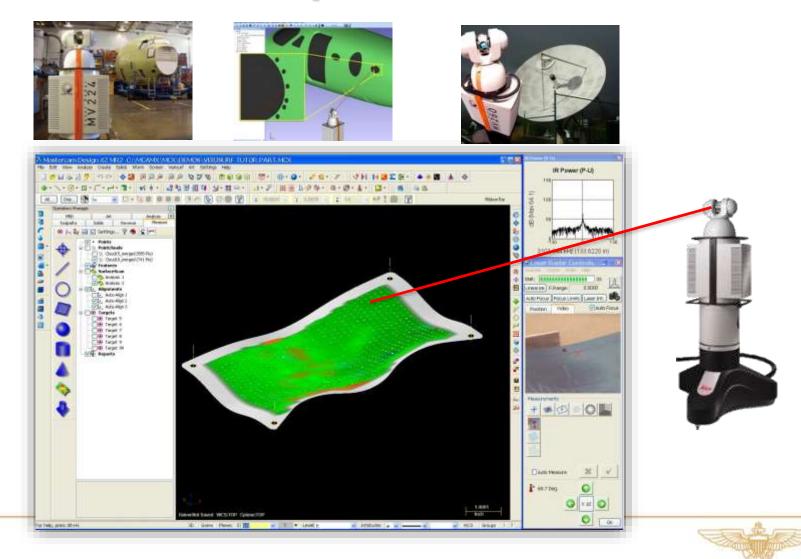
Model-Based Inspection Solutions Create MBD







Model-Based Inspection Solutions Automated Inspection Plans to MBD





Model-Based Inspection Solutions Analyze & Display Inspection Data

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MBD Implementation Levels

Level 0	Drawing Centric Disconnected Manufacturing - Disconnected Enterprise Primary D eliverable: 2D Drawing
Level 1	Model Centric Il eutral Model CAM - Disconnected Enterprise Primary Deliverable: 2D Drawing and Neutral CAD Model
Level 2	Model Centric In ative Model CAM - Disconnected Enterprise Primary Deliverable: 2D drawing and Native CAD Model
Level 3	Model Based Definition It ative Model CAM - Disconnected Enterprise Primary Deliverable: 3D Annotated Model and LightWeight viewable
Level 4	Model Based Definition Integrated Manufacturing - Disconnected Enterprise Primary Deliverable: 3D Annotated Model and LightWeight viewable via PLM
Level 5	Model Based Enterprise Integrated Manufacturing - Integrated Internal Enterprise Primary Deliverable: Digital Product Definition Package and TDP
Level 6	Model Based Enterprise Integrated Manufacturing - Integrated Extended Enterprise Primary Deliverable: Digital Product Definition Package and TDP via the web

Courtesy of Model Based Enterprise



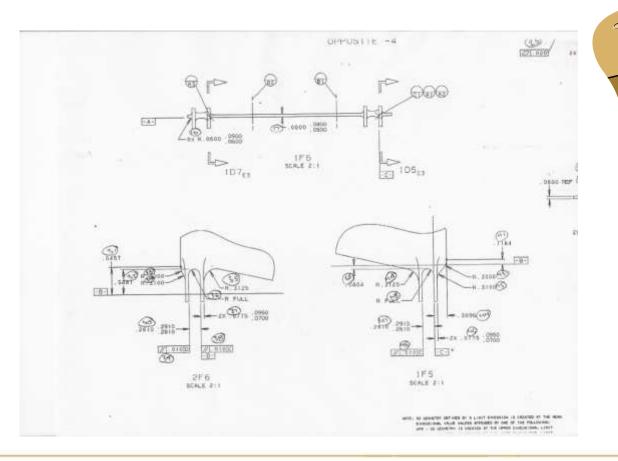
Challenges Interoperability

- CATIA Dassault
- UG Siemens
- Pro/ENGINEER PTC
- SolidWorks Dassault
- Inventor Autodesk
- SolidEdge Siemens

Autodesk SolidWorks NX UNIGRAPHICS Mastercam V8 Files (*.MC8) All Mastercam Files (*.MCX;*.EMCX;*.MC9;*.MC8) IGES Files (*.IGS;*.IGES) AutoCAD Files (*.DWG;*.DXF;*.DWF) Parasolid Files (*.X_T;*.X_B;*.XMT_TXT) Pro/E Files (*.PRT;*.ASM;*.PRT.*;*.ASM.*) ACIS Kernel SAT Files (*.SAT;*.SAB) STEP Files (*.STP;*.STEP) VDA Files (*.VDA) Rhino 3D Files (*.3DM) SolidWorks Files (*.SLDPRT;*.SLDASM) SolidWorks Drawing Files (*.SLDDRW) Solid Edge Files (*.PAR;*.PSM;*.ASM) Autodesk Inventor Files (*.IPT;*.IAM) Autodesk Inventor Drawing Files (*.IDW) KeyCreator Files (*.CKD) ASCII Files (*.TXT;*.CSV;*.DOC) StereoLithography Files (*.STL) Catia V4 Files (*.MODEL;*.EXP) Catia V5 Files (*.CATPART;*.CATProduct) SpaceClaim Files (*.SCDOC) Alibre Design Files (*.AD_PRT;*.AD_SMP) HPGL Plotter files (*.PLT) Cadkey CDL Files (*.CDL) PostScript Files (*.EPS;*.AI;*.PS) Catia V4 Files (Moldplus) (*.model; *.exp) Catia V5 Files (Moldplus) (*.CATPart; *.CATProduct) Verisurf STL files (*.STL) Unigraphics NX (*.PRT) All Files (*.*)



Challenges *Eliminating Drawings*

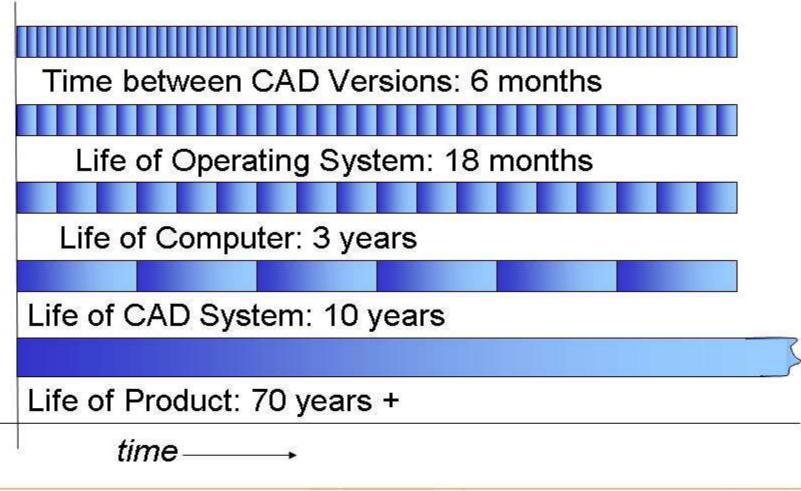


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Challenges Legacy Data







Challenges CAD Translation & Validation

When Boeing DPD data containing 3D geometry is received in translated format (e.g., IGES, STEP), the supplier must verify their translation of each dataset or have a process to verify and validate translation software (per Section 3.), in order to maintain authority status.





Boeing Standard D6-51991

QUALITY ASSURANCE STANDARD FOR DIGITAL PRODUCT DEFINITION AT BOEING SUPPLIERS, D6-51991, REV J, September 17, 2010

9.2 Translations - Suppliers are responsible for all dataset translations used for manufacturing and inspection, and must have a clear documented process for each. The documented process must include a method to verify the accuracy of translations. (See definitions for description of "translation".)

9.2.1. Acceptance criteria for accuracy of translated surface profile/geometry, (tolerance) must be determined by the supplier, and must ensure the end product will be within engineering tolerance/specification. Objective evidence of translation validation must be retained. (Typical allowable deviation tolerance is .0001 to .001 inch)

9.2.2. Suppliers must be able to demonstrate the CAD translation process, including verification/interrogation methods used, and the ability to identify known discrepancies.

9.2.3. The verification process for translation of datasets containing 3D annotation, i.e. feature control frames, dimensions, text, and/or surface geometry must ensure that all intended entities are accounted for in the translated dataset.





Inspection 2D Drawings

Challenges Changing Process

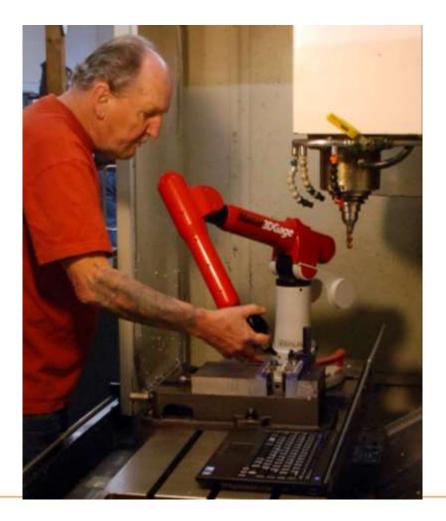


Engineering 3D Simulation Manufacturing 3D Tool Paths





Challenges Changing People















Predictions

- 3D Global Supply Chains
- Elimination of 2D Drawings
- STEP AP242 Will Enhance Interoperability
- Increased Noncontact Inspection & 3D Scanning
- Cloud Based Inspection Databases
- SPC of Key Characteristics
- 3D Maintenance Repair Overhaul





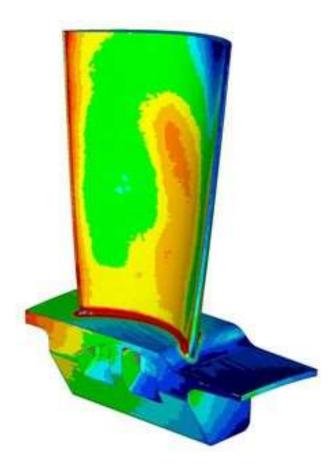
Additional Information

- <u>STEP AP242 Managed Model Based 3D</u>
 <u>Engineering</u>
- ISO 10303 STEP Standard for the Exchange of Product model data
- Quality Information Framework (QIF)
- <u>Aerospace Industries Association (AIA)</u>
 <u>Engineering Data Interoperability Group (EDIG)</u>
- Automotive Industry Action Group (AIAG)
- Model Based Enterprise





Thank You!









Reverse Engineering, 3D Scanning & Tolerancing

Review & Wrap-Up

25 August 2015





Next JTEG Technology Forum

Cold Spray Repair

29 September 2015