

# QIF and the Future of Digital Metrology

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## GLOBAL PRODUCT DATA INTEROPERABILITY **SUMMIT** 2016



ELYSIUM

Parker Aerospace

NORTHROP GRUMMAN

BOEING



# Overview

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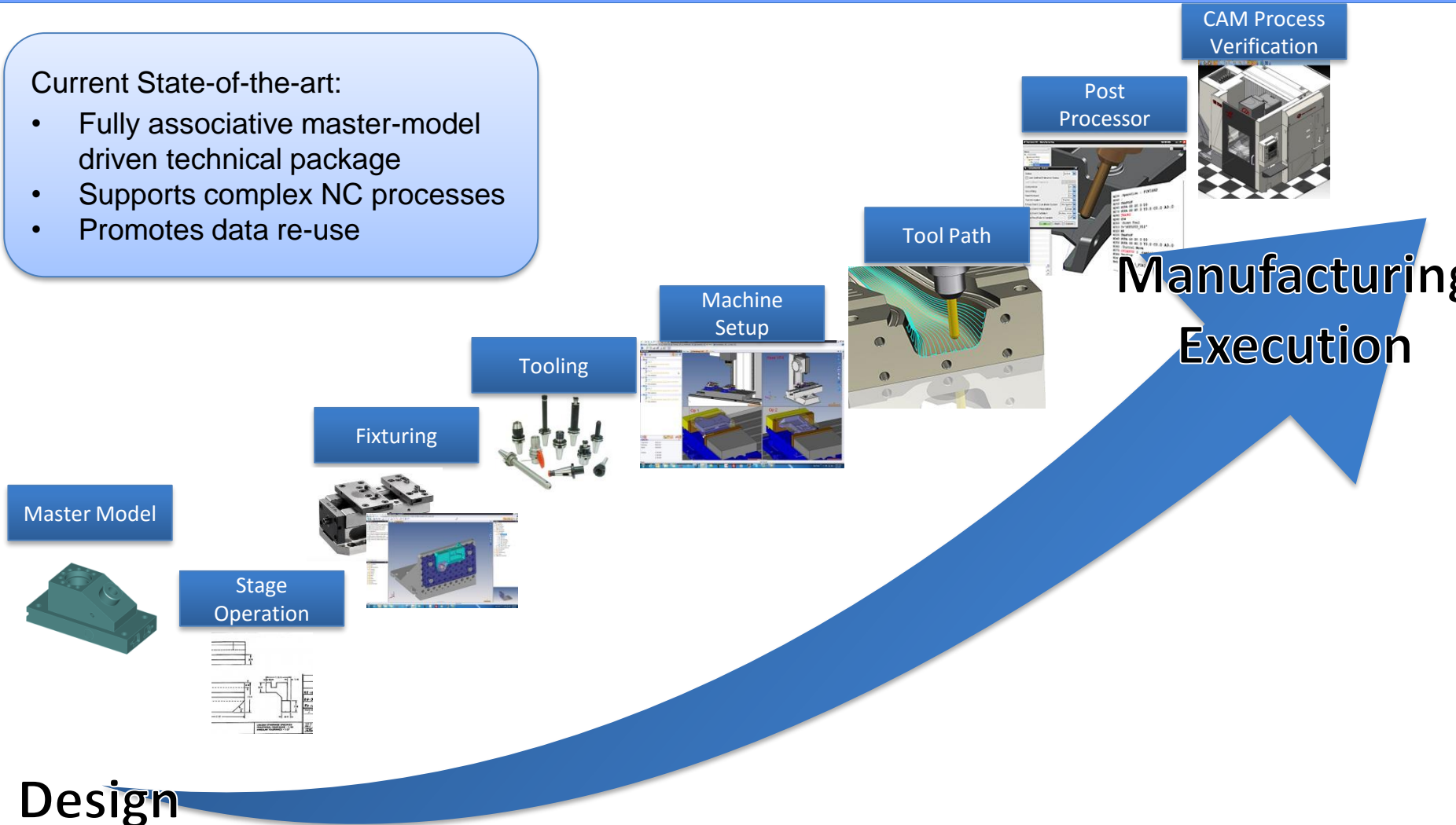
- Current metrology process
- What is QIF?
- QIF use cases
- Capvidia and QIF

# Modern Software Process: Manufacturing

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## Current State-of-the-art:

- Fully associative master-model driven technical package
- Supports complex NC processes
- Promotes data re-use



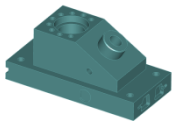
# Typical Metrology Software Process

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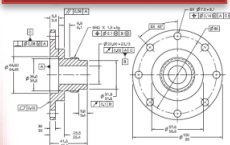
## Current State-of-the-art:

- Adequate GD&T representation not available: robust, semantic PMI required
- Downstream metrological applications exist, but lacking GD&T cannot associate back to master model

Master Model



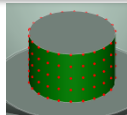
GD&T Representation



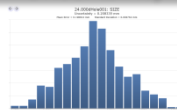
Inspection Planning



Probing Macros



Measurement Uncertainty



Measurement Resources



Fixturing



Measurement Optimization

$$F = a^T \left( w_f \int \frac{\partial F}{\partial r} \left( \frac{\partial F}{\partial r} \right)^T + w_c \int \nabla^2 F \nabla^2 F^T \right) a$$

CMM Program Generation

```

M0010  MACHINING / (CAM)
M0011  PARTNO:11111111 / (PARTNO)
M0012  T1 / (TOOL)
M0013  T1 / (TOOL)
M0014  F1000 / (FEED)
M0015  F1000 / (FEED)
M0016  F1000 / (FEED)
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```

Measurement Execution

Design

# Typical Metrology Software Process

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Even hand-written inspection reports are not uncommon

5. Char. No.	6. Reference Location	7. Characteristic Designator	8. Requirements	9. Results	10. Designated Tooling	11. Non-Conformance Number	14. Comments
1.0	1-H8		MATERIAL SHALL BE T1-6AL-4V INVESTMENT CASTING IAW AMS-T-81915, TYPE III, COMPOSITION A, ANNEALED OR IAW AMS4991, ANNEALED. ANNEAL SHALL BE IAW AMS-T-81915 OR IAW AMS4991. EXCEPTION TO AMS-T-81915 AND AMS4991 FOLLOW:	HEAT TREATED TO A TEMP. OF 1525-1575F.  Noted	N/A	200193035	HEAT TREAT: AMS 4991 PARAGRAPH 3.5.2 SPECIFIES RANGE OF 1300-1550 F. ACCEPTED ON WAIVER 200193035.

JOB NUMBER 13859		QUANTITY REJECTED			
ITEM	PARAMETER	1st PART	2nd PART	3rd PART	4th PART
1	CARGO PLATE ASSEMBLY	1.75 HR PLATE ASSEMBLY	(C. R. 1.07 IN ENCLOSED)		
2	14.4.0 ± .06	14.4.035			
3	18.00	18.008			
4	1.00 ± .05	1.175			
5	14.33 ± .06	14.365			
6					
7					

Problems:

- Transcription errors
- Weak traceability
- Data are unavailable to software

OP 作業 Operation	Workstation	Control Code Ctrl. Co.	Operation Description	作業數 PC	加工數 Act. PC	加工日 時間Start Time	完工日 時間Finish Time	操作者 Operator	放行者 Supervisor	備註 Note
0010		ZP01	ZLM504686-2 元件製做/領料 (RP)	5	5	4/1 09:00	4/1 09:00	宋達宏	王國國	
0020	打光機	ZP01	ZLM504686-2 組裝, 打印 (MA)	5	5	4/27 09:30	4/27 12:00	王國國	王國國	
0030		ZP65	ZLM504686-2 FQC	5	5	2011.4.29	2011.4.29	CFQC 025	CFQC 008	
0040		ZP99	ZLM504686-2 入庫 (WA)	5	5	2011.5.4				

Disposition results:

A first check has shown that the as-built T-test will function as designed. Test deviations are for properties which are irrelevant to this particular application. Corrective action is acceptable. Accept parts and continue processing.

Repeal Order	Classification	Identify part with modification
Repeal Order No.	Criteria	Further work
Design	Quality Control	Other Dept
Customer	OR, Author	

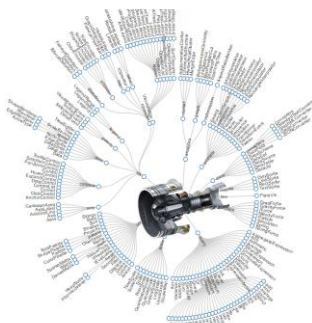
# Quality Information Framework (QIF)

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Feature-Based Ontology  
of Manufacturing Quality  
Metadata

XML Technology:  
Simple Implementation  
and Built-In Code  
Validation



Data semantically linked  
to Model for pure MBE  
implementation

# Quality Information Framework (QIF)

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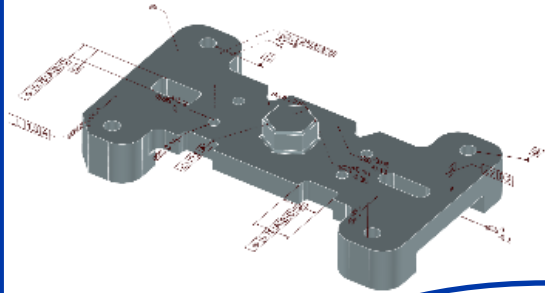


# A Simple, Unified QIF Workflow

1/5

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## Authority Model

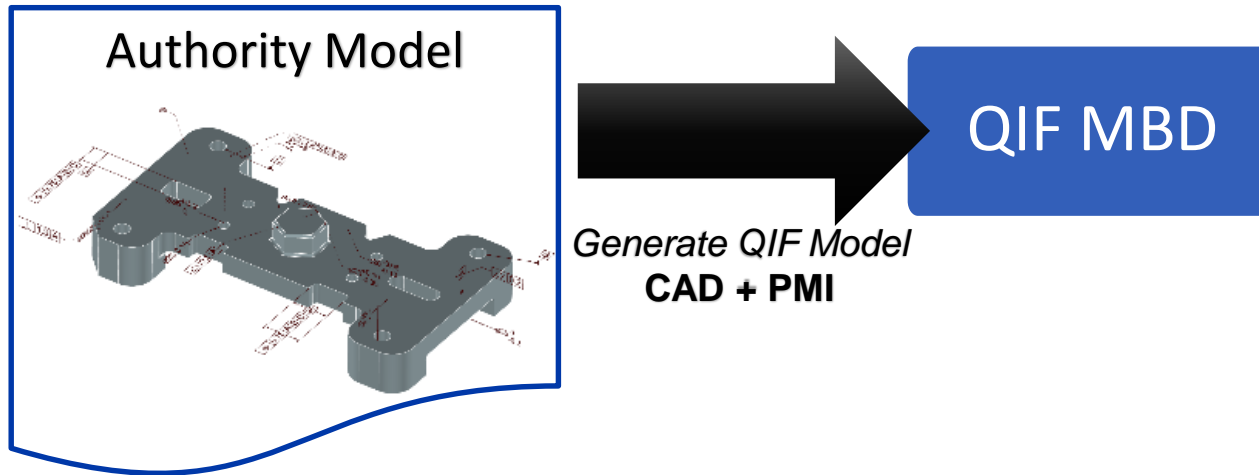




# A Simple, Unified QIF Workflow

2/5

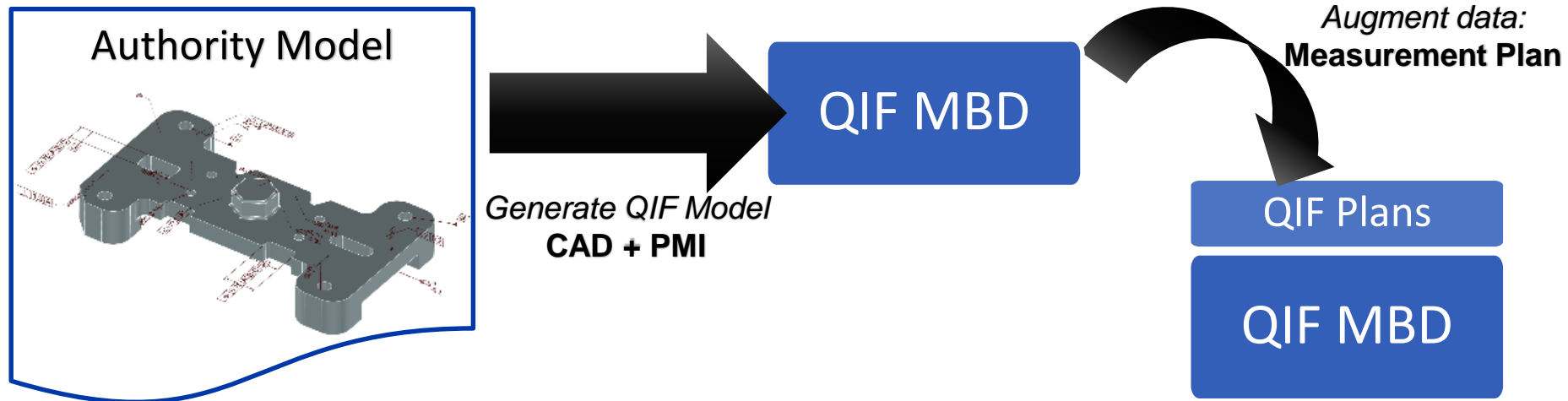
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# A Simple, Unified QIF Workflow

3/5

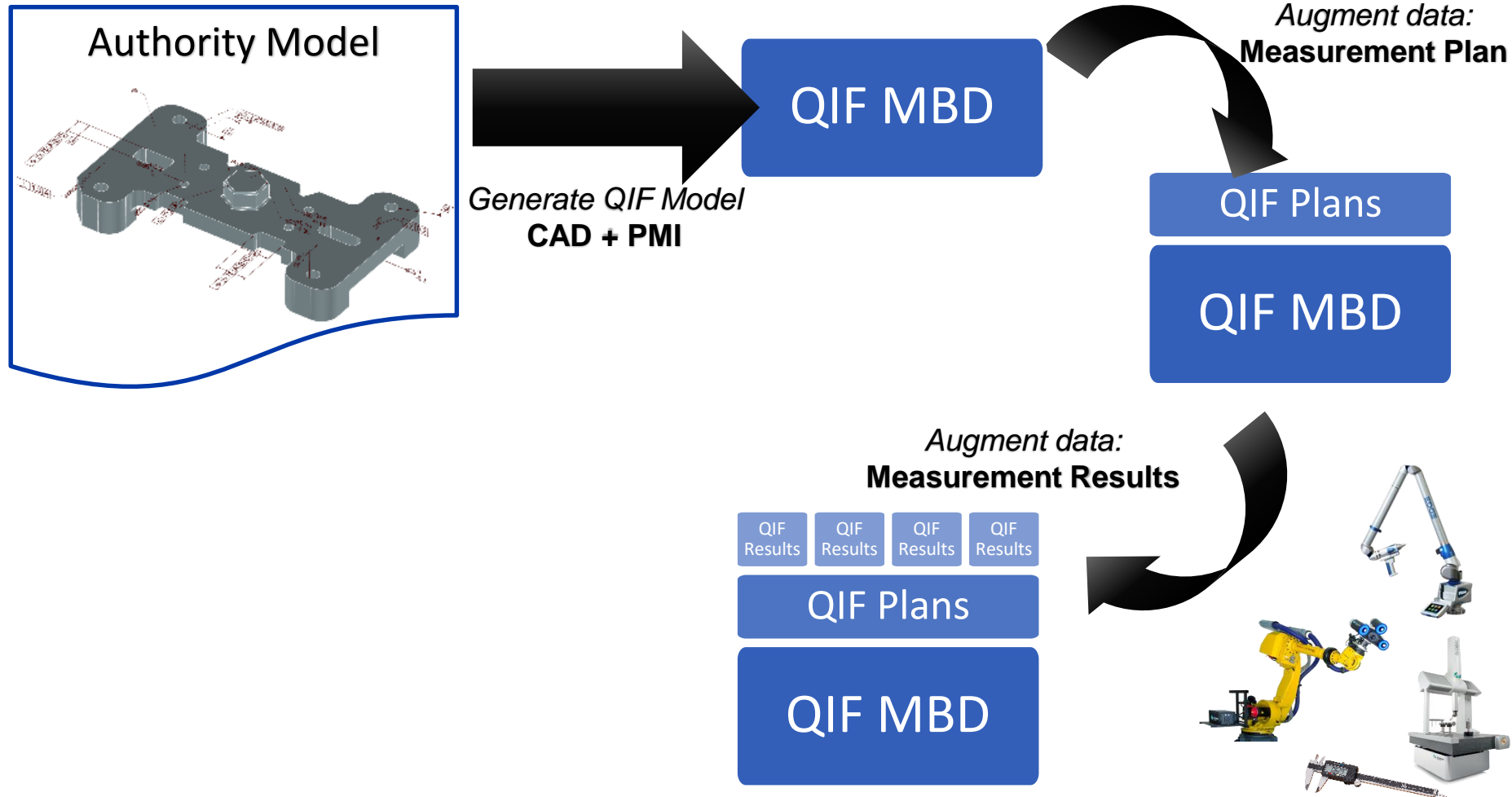
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# A Simple, Unified QIF Workflow

4/5

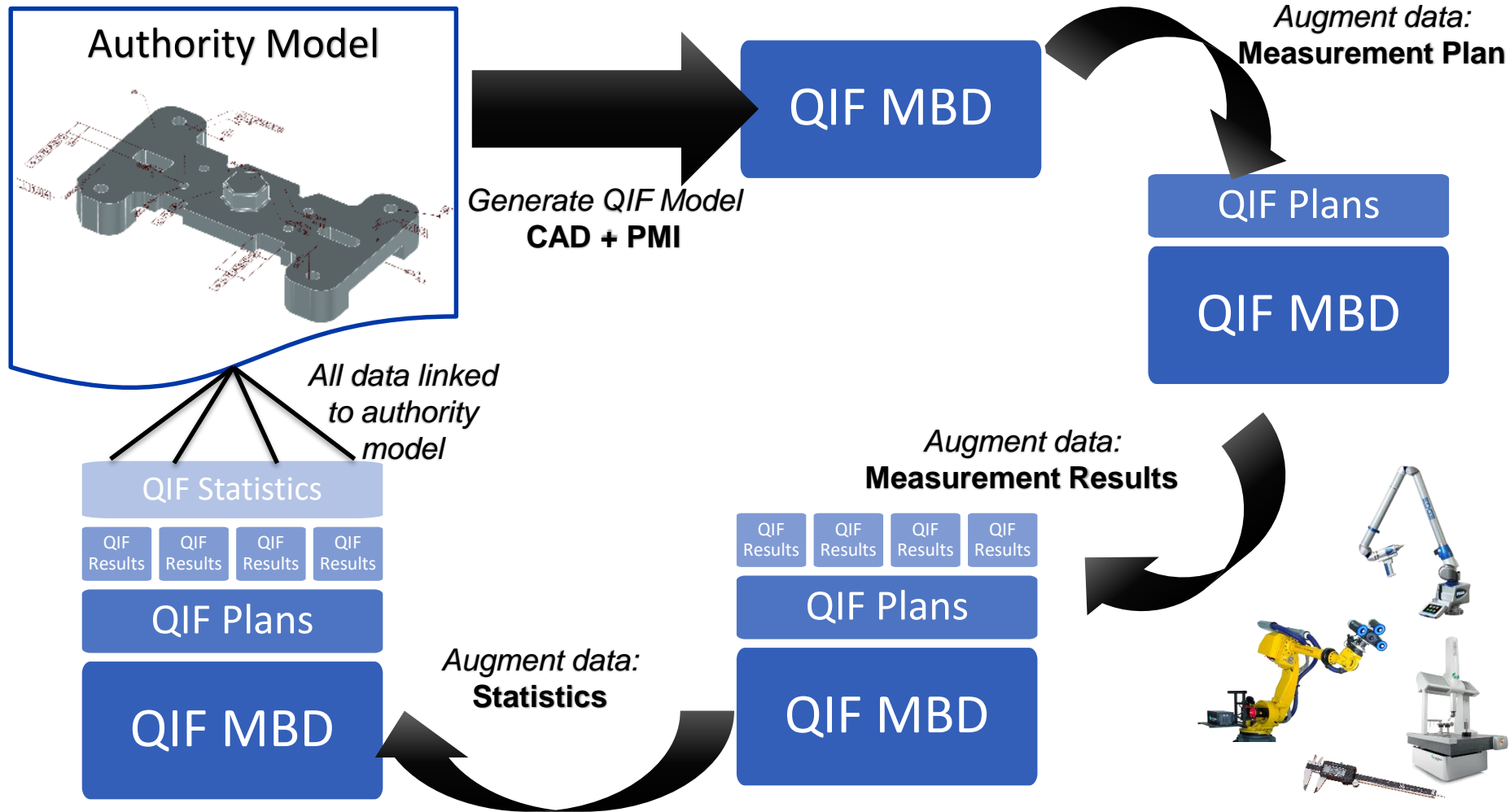
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# A Simple, Unified QIF Workflow

5/5

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# QIF Interoperability Demonstration @ IMTS 2016

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Live demonstration  
of QIF workflow  
with these software  
providers



integrated | process | improvement

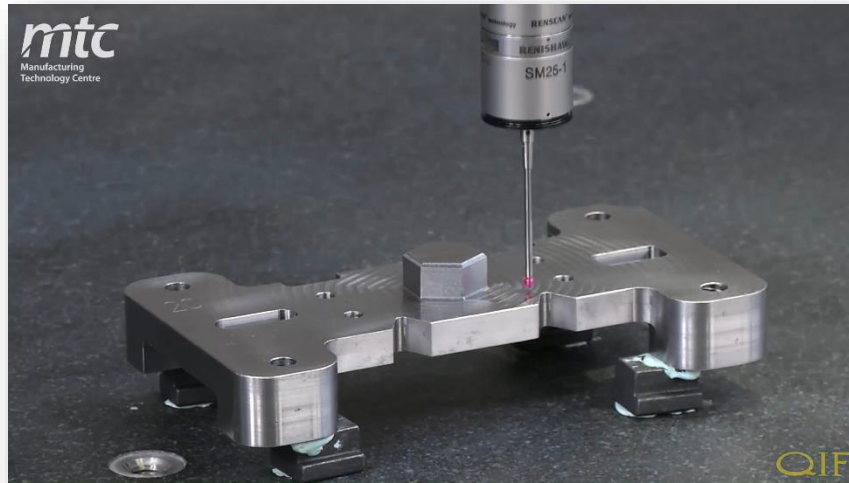
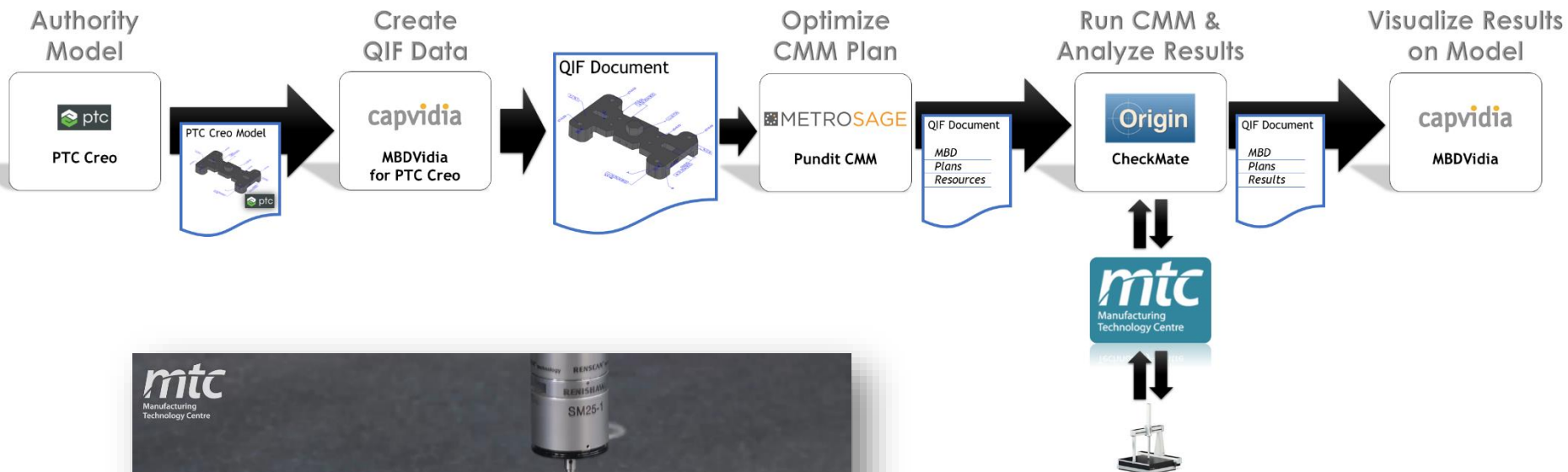


Learn More:

<http://qifstandards.org/imts-2016-qif-demonstration/>

# Example Workflow – CMM Automation and Optimization

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[Click here to watch the video](#)

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

# DMDII Project: Automatic Generation of Optimized CMM Programs on the DMC

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## DMDII

DIGITAL MANUFACTURING AND  
DESIGN INNOVATION INSTITUTE



METRO



Origin

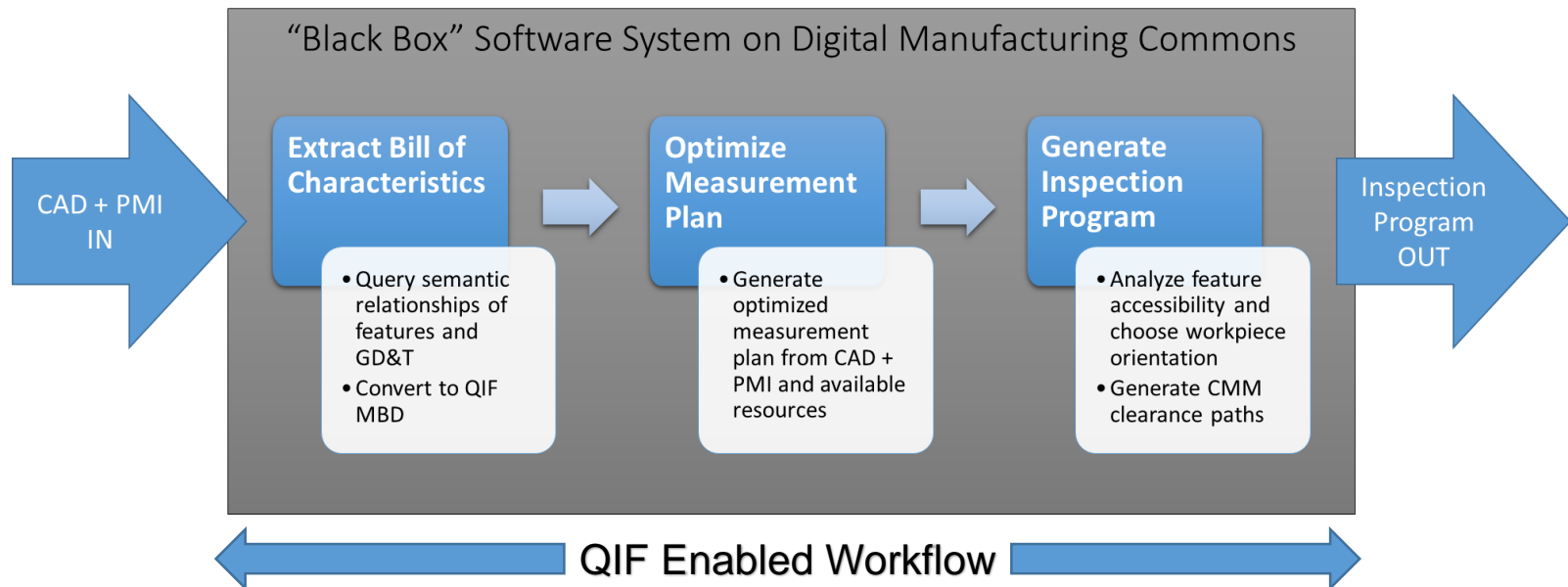
capvidia



UNC CHARLOTTE

NAV AIR

DMC + a UI LABS Collaboration



# Example Workflow – Supply Chain Control

1/5

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## Technical Data Package

- Native Model
- ...
- Certified QIF MBD
- QIF Plans (BOC)

OEM

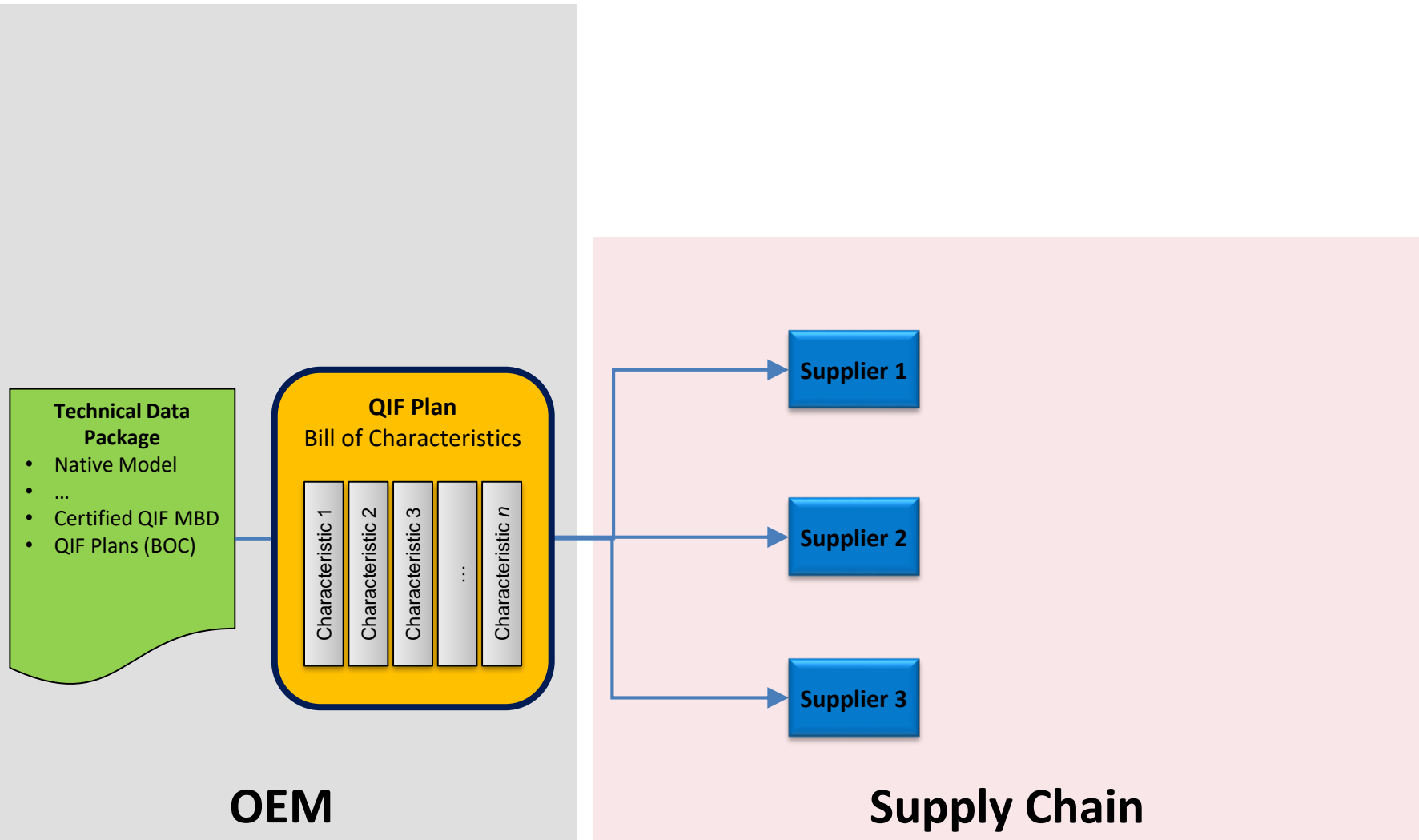
Supply Chain



# Example Workflow – Supply Chain Control

2/5

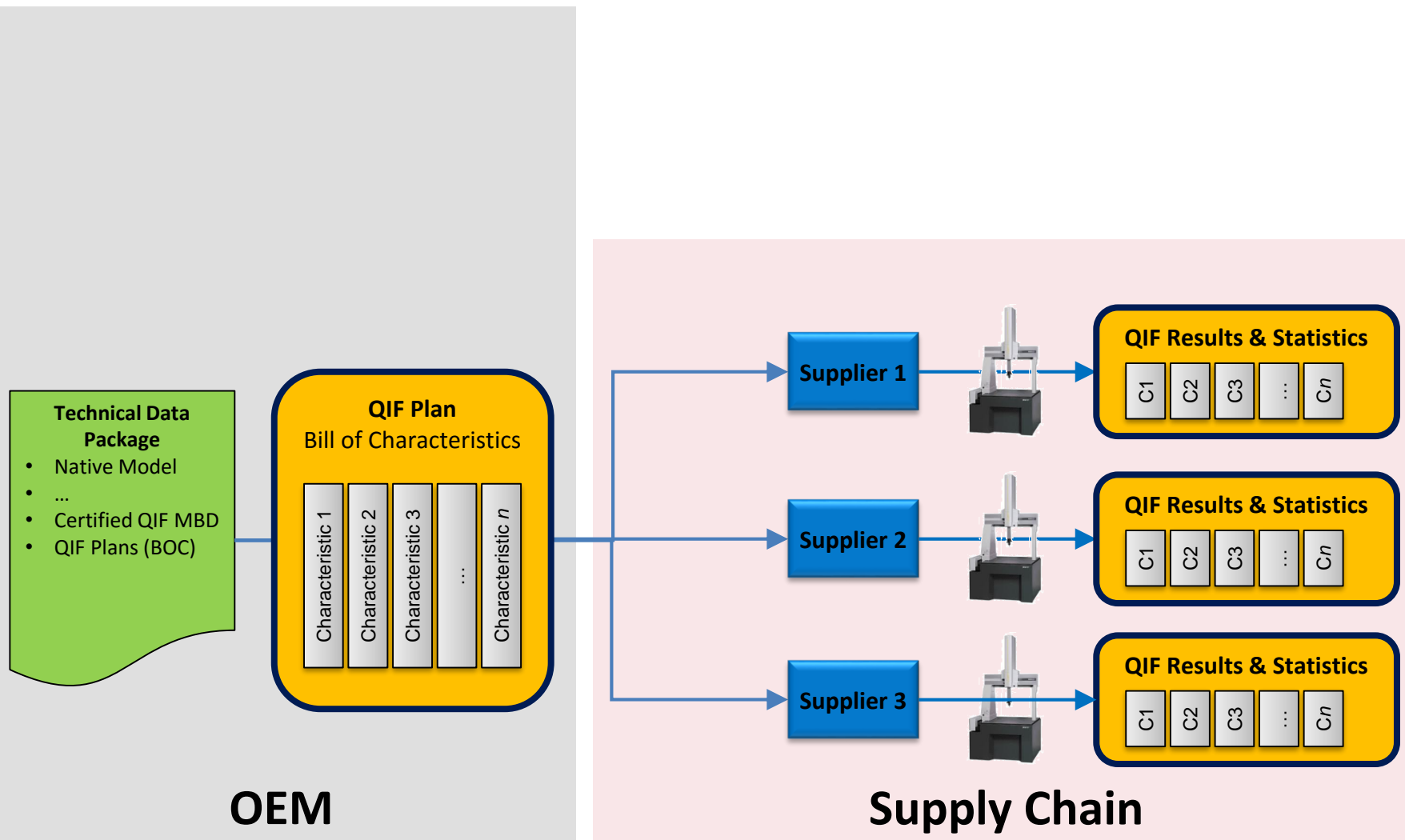
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# Example Workflow – Supply Chain Control

3/5

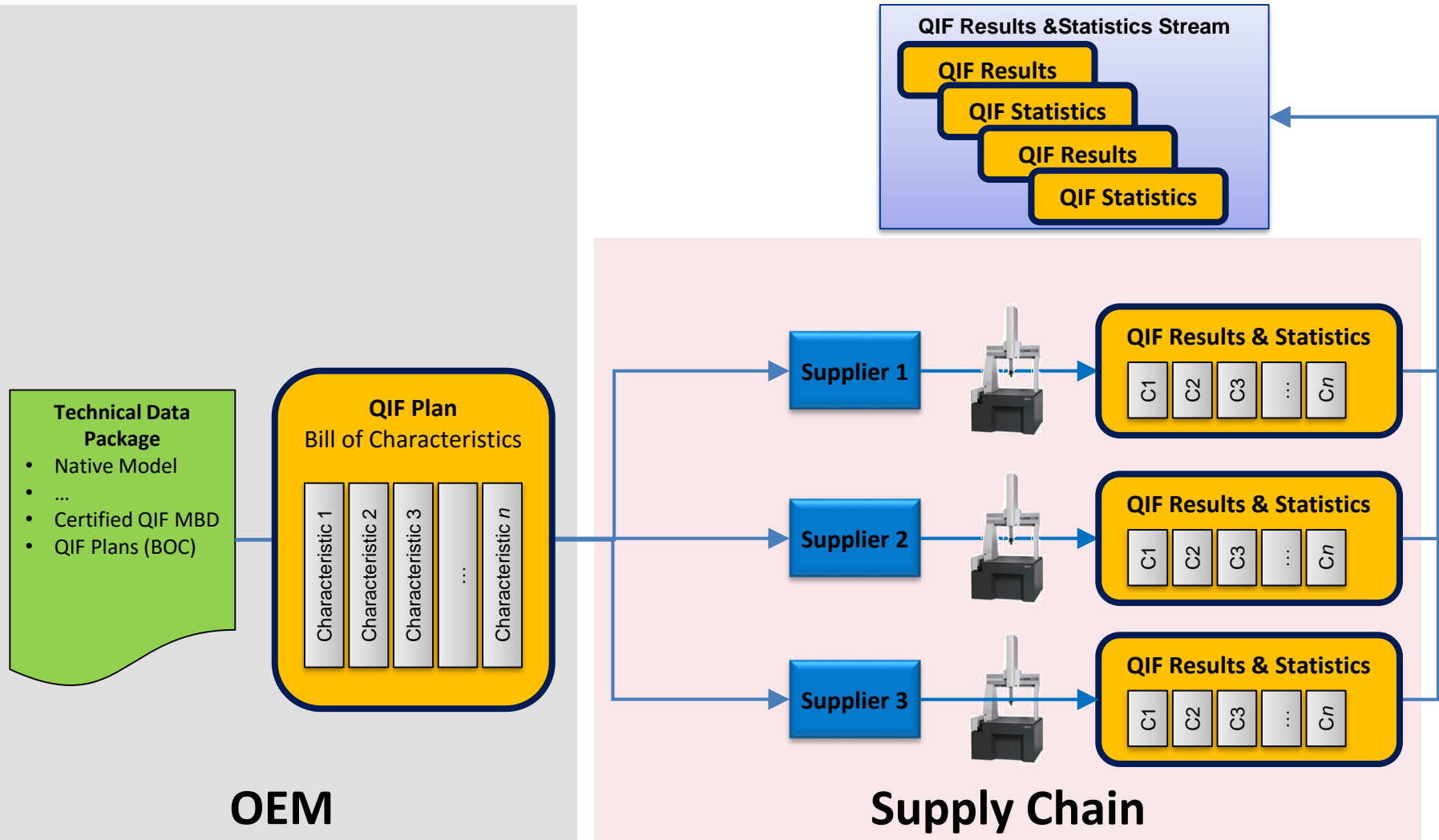
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# Example Workflow – Supply Chain Control

4/5

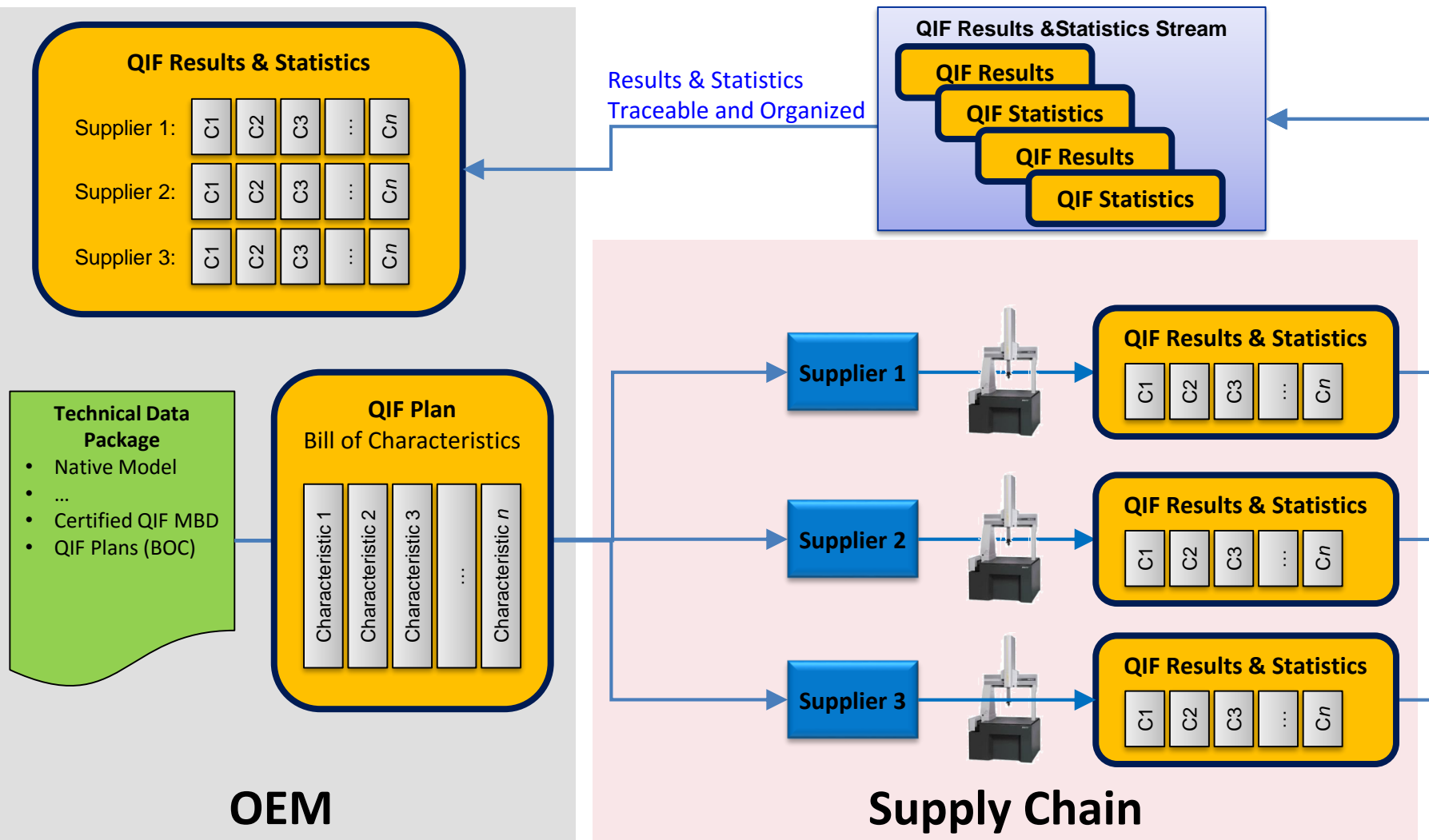
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# Example Workflow – Supply Chain Control

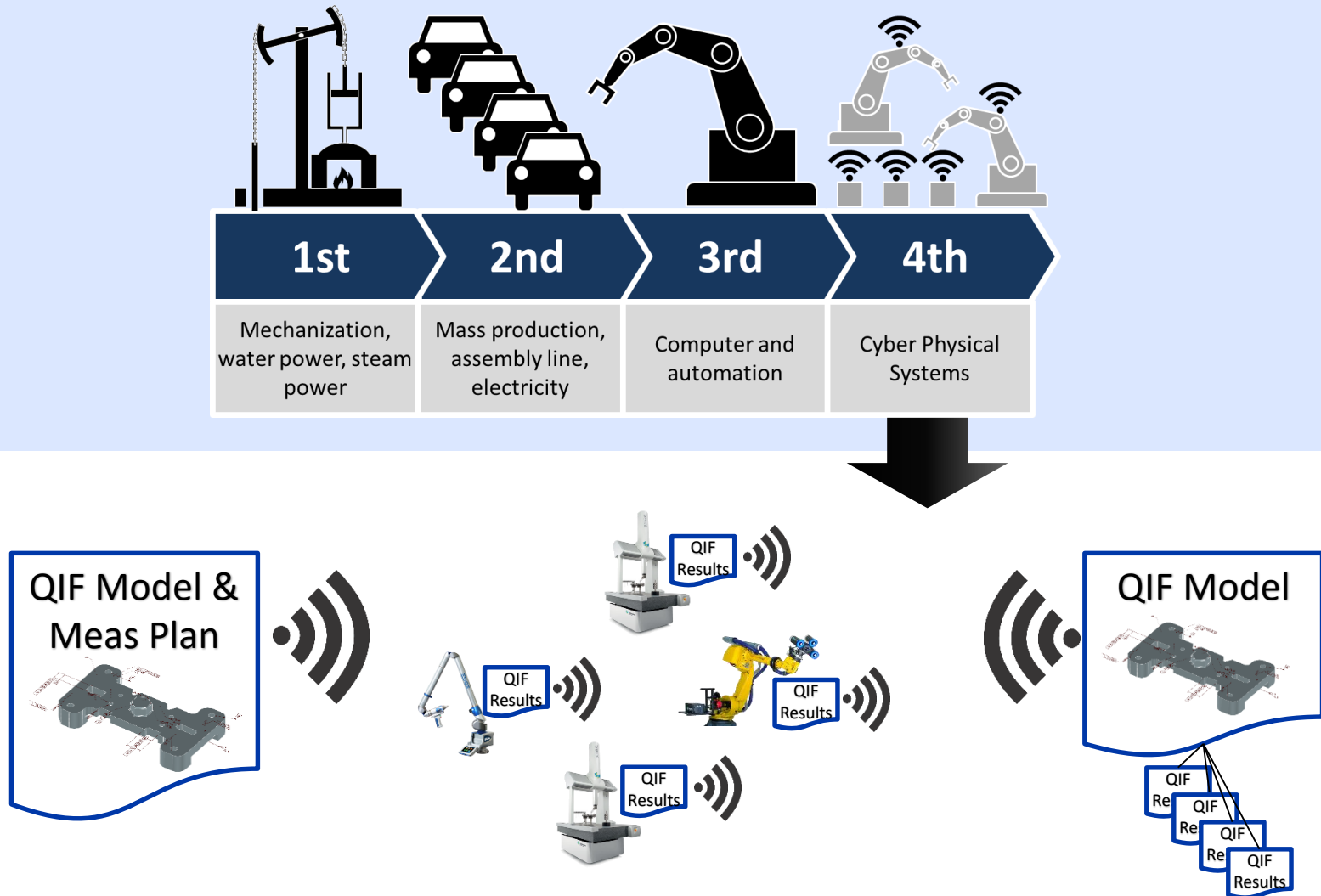
5/5

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# QIF Workflow – IoT & Industry 4.0

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# MTC Core Research Project: Digital Twin

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*Digital Twin Research:*  
The QIF format as a  
backbone for data  
transmission and  
storage in support of  
the Digital Twin  
concept



# Capvidia, QIF, and Digital Metrology

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ANSI QIF

## Capvidia QIF-Enabled Technology

### MBE Workflows

Automated  
2D Drawing  
to 3D PMI  
Conversion

Derivative  
model  
validation

Ballooning  
and  
FAI/PPAP

GD&T  
check and  
verification

Measurement  
Device  
Performance  
Testing

Organizational  
Measurement  
Rules/Macros/  
Templates

Assign  
Measurement  
Tools to  
Characteristics

In-process  
Inspection

Inspection  
Process  
Feedback

Statistical  
Process  
Control

Link to  
authority  
model

Drawing  
View  
Generation

Assembly  
Tolerance  
stack up  
analysis

Measurement  
Systems  
Analysis/  
Gage R&R

Measurement  
Uncertainty  
Calculation &  
Optimization

Non-  
Destructive  
Testing  
Processes

Part  
Fixturing  
in CMM

Point Cloud  
GD&T  
Evaluation

Failure Mode  
and Effects  
Analysis  
(FMEA)

Digitally  
Signed  
Documents

Technical  
Data Package  
(TDP)  
Generation

FEA and  
Simulation

Tolerance  
Guardbanding

Other-than-  
CMM offline  
programming

CMM Path  
Generation  
& Collision  
Avoidance

Reverse  
Engineering

LOTAR

Lightweight  
Model Viewing

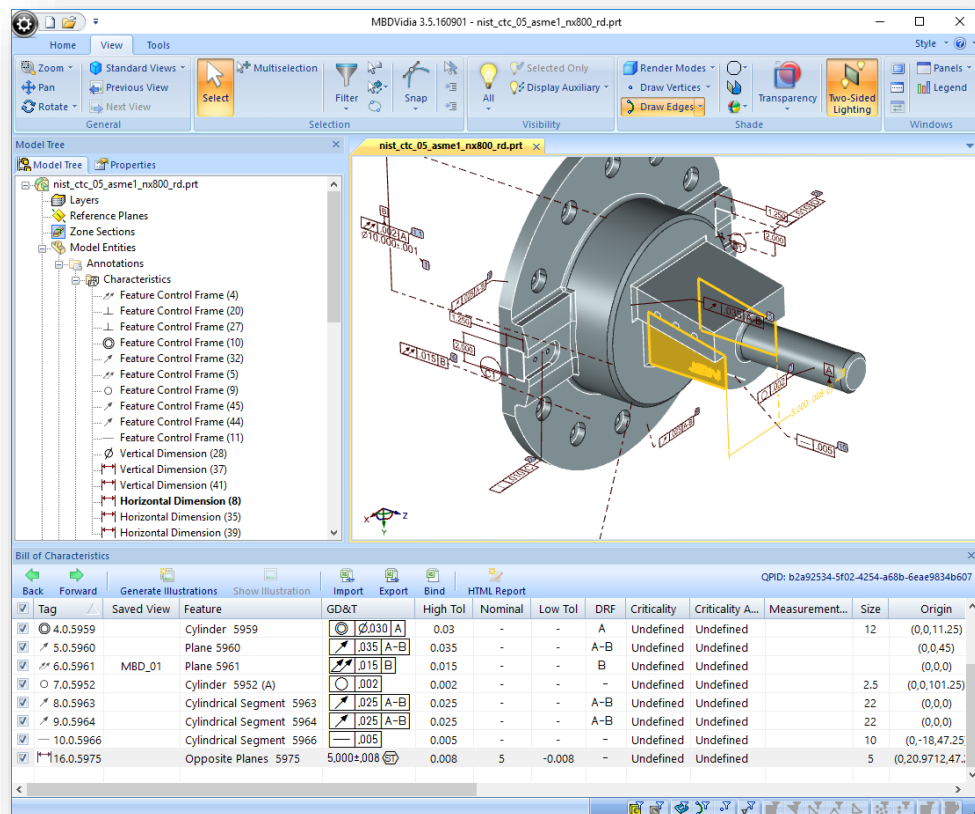
Shop Floor  
Optimization

DMIS Program  
Generation  
and Execution



# GPDIS 2016

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Questions?  
Please contact us:

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