

Model Based Definition(MBD)을 활용한 설계 및 제조 프로세스의 통합

2025. 10. 23

(주) 솔루션랩



Computer Aided Design (CAD)



THE HISTORY OF CAD

In less than a century, engineering and design have moved from basic, 2D drawings to full-scale, holographic models, in large part thanks to computer-aided design (CAD). Learn how CAD developed over the past century and how it has moved designers from pencil and paper to lifelike models.



DAC
Design Automated by Computer
Dr. Patrick J. Hanratty, General Motors, and IBM
Dr. Patrick J. Hanratty, General Motors, and IBM partnered to create DAC, an early graphic CAD system. Computer scientist Douglas T. Ross coined the name CAD (computer-aided design).



CADAM
Computer-graphics Augmented Design and Manufacturing
IBM/Lockheed
CADAM introduced CAD to aerospace design.



CADD
Computer-Aided Design & Drafting
McDonnell Douglas (now merged with Boeing)
McDonnell Douglas and other manufacturers started releasing internal CAD systems like CADD, which was used for parts layouts and geometry work.



PDGS
Product Design Graphics System
Ford
Ford developed an internal CAD system called PDGS.

1957

PRONTO
Dr. Patrick J. Hanratty (the "Father of CAD")
PRONTO was the first commercial, numerical-control programming system. It sparked everything that is CAD.

1963

Sketchpad
Ivan Sutherland
Sketchpad was one of the first design systems to use a graphic user interface. Using a light pen on a CRT display, users could constrain properties in a drawing. Sketchpad also created the use of "objects" and "instances."

1965

Digigraphics
Itek
Itek released Digigraphics, one of the first commercial CAD systems. The system cost \$500,000.

1966

Computervision now under PTC
Philippe Villers and Martin Allen
Computervision sold one of the first commercial CAD systems to Xerox.

1967

1969



IGES
Initial Graphics Exchange Specification
U.S. National Bureau of Standards
IGES is a neutral CAD format that lets users transfer their 3D designs between different CAD software programs. Once STEP was released, IGES was no longer updated, but it is still accepted in many places.

1980

GEOMOD
SDRC (Structural Dynamics Research Corporation)
SDRC developed GEOMOD, their geometric modeling product. Featuring NURBS (Non-Uniform Rational B-Splines), this model generator was based on precision and accuracy.

1981

Autodesk/AutoCAD
John Walker
John Walker founded the company Autodesk, which released AutoCAD. AutoCAD was the first CAD software made for PCs instead of mainframe computers.

1982

Radar CH later ArchiCAD
Gábor Bojár
This was the first BIM software available for personal computers.

1984

MiniCAD now Vectorworks, Inc.
Richard Diehl/Diehl Graphsoft
MiniCAD was the best selling CAD software for Mac computers.

1985

AutoCAD 3D
Autodesk
Autodesk started offering 3D modeling systems.

1988

Pro/Engineer now PTC Creo
PTC
This was the first mainstream CAD program that brought the ideas of Sketchpad (interactive, easy to use, fast) to life. Based on solid models, history-based features, and the use of constraints, it transformed the CAD industry. It was written in LINUX's X-Windows, making it faster and more user-friendly.

1992

CADENAS
Juergen Heimbach
Founded originally as an engineering firm, CADENAS realized the potential of the engineering IT age. This eventually gave way to eCATALOG solutions.

1993

Building Design Advisor
Lawrence Berkeley National Laboratory
This BIM system could perform simulations to determine how buildings and components function and give feedback to design teams.

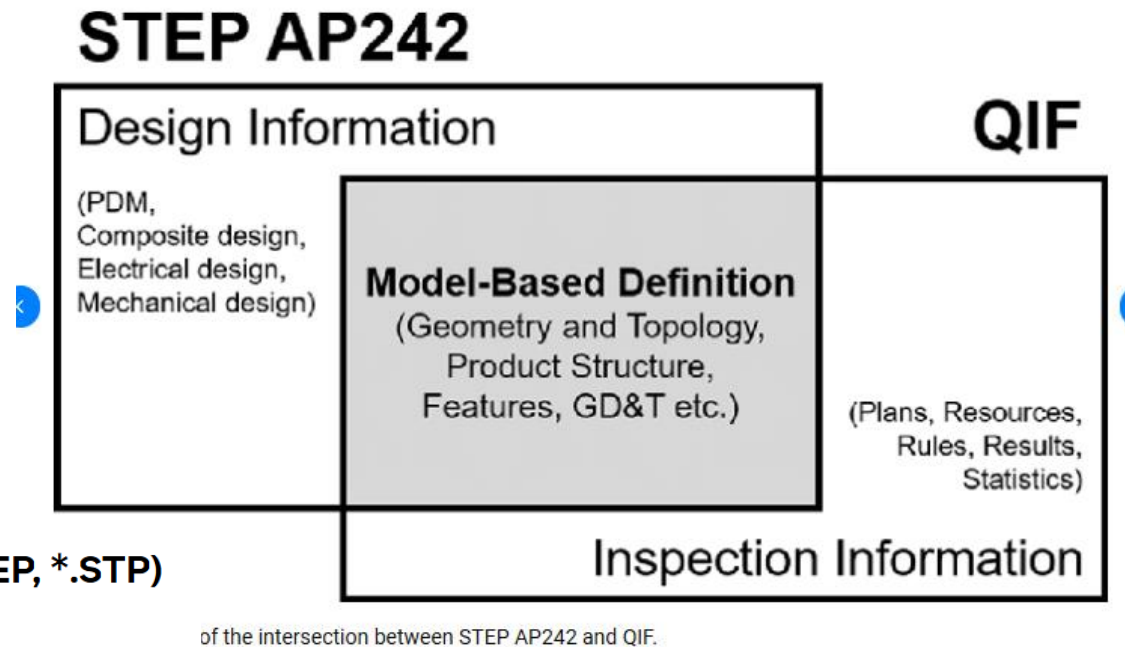
1994

AutoCAD R13
Autodesk
This version made AutoCAD 3D compatible.

1994

STEP Standard for the Exchange of Product Data
ISO (the International Standards Organization)
STEP took over from IGES as the new format to use when transferring 3D models. The initial 1994 release of STEP made it an international standard for models, and it's still the most used format today.

New Standard



1. STEP (File Extension: *.STEP, *.STP)

- Year Introduced: 1994, Last Update: 2022.
- Standard: [ISO 10303-242:2022](#)
- Representation: B-rep (precise) & Vis-rep (approximation)
- Organization: International Organization for Standardization and PDES Inc.

STEP files are the most widely used & accepted neutral CAD format today, making it a standard across multiple industries.

Most CAD software supports importing & exporting STEP files, allowing it to be interoperable between different systems, including CAM (computer-aided manufacturing), CAI (computer-aided inspection), and CAE (computer-aided engineering).

2. QIF (File Extension: *.QIF)



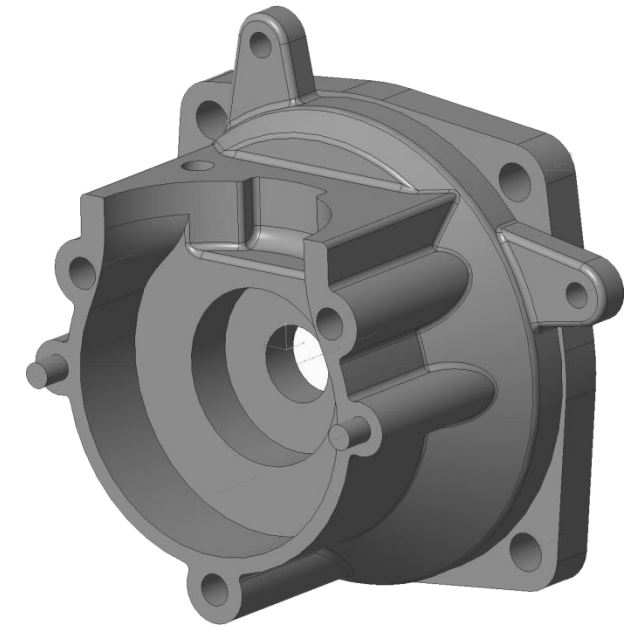
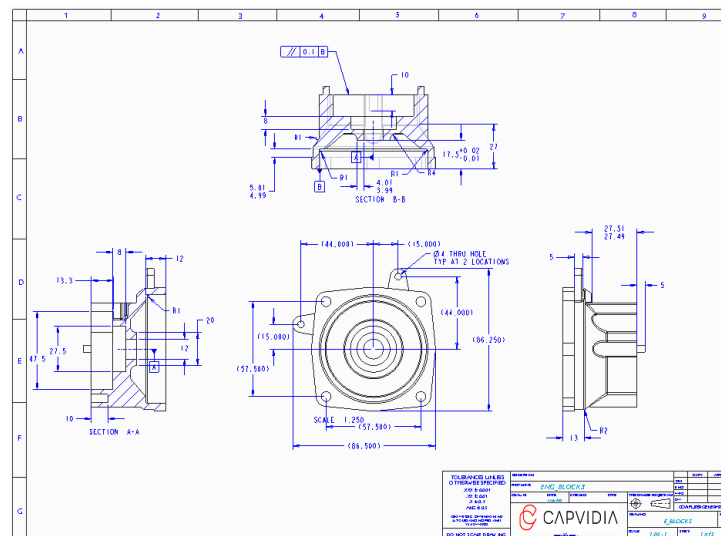
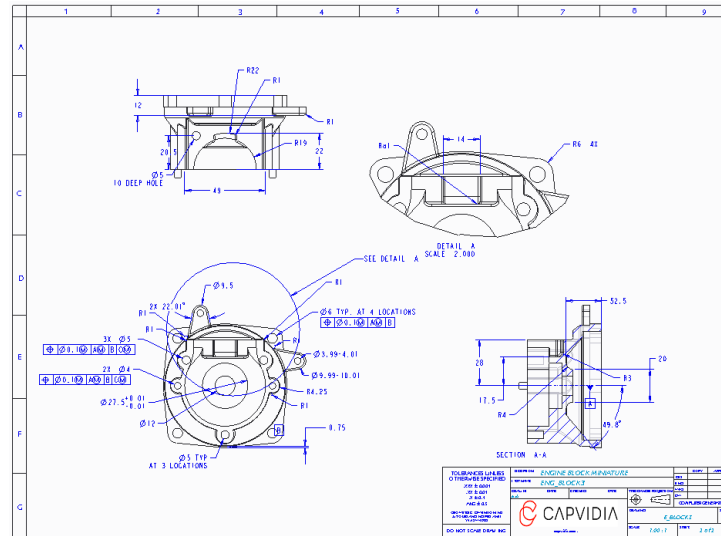
- Year Introduced: 2013, Last Updated: 2020
- Standard: [ISO 23952:2020](#)
- Representation: B-rep (precise) & Vis-rep (approximation)
- Organization: DMSC (Digital Metrology Standards Consortium)

QIF (Quality Information Framework) files are made for digital manufacturing in the 21st century. It optimizes for **semantic PMI**, which allows for human & machine-readable CAD leading to two main things: interoperability & traceability downstream.

3D MBD Models Based on 2D Drawing

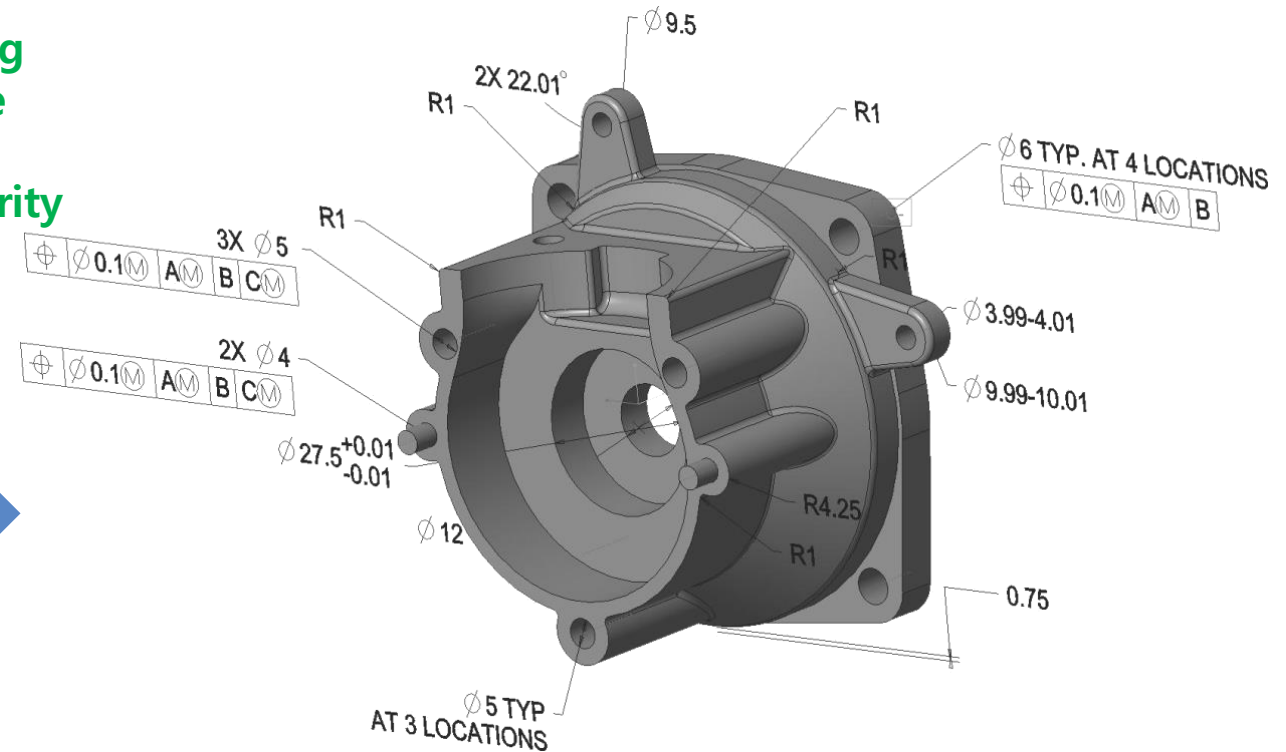
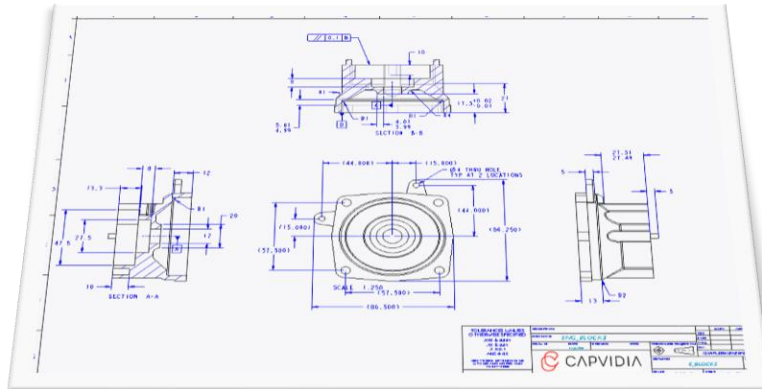
Challenge

- 2D Drawing is the **master document** and contains all annotations
- Over 90% of 3D models have no annotations
- Manual conversion is expensive and error prone



Annotated 3D MBD models

Model-based definition is an approach to creating 3D models so that they effectively contain all the data needed to define a product. With MBD, the model becomes the source authority that drives all engineering activities.



2D drawing

- 2D Drawing is the master document and contains all annotations
- Over 90% of 3D models have no annotations
- Manual conversion is expensive and error prone

3D MBD annotated model

- Fully **semantic, machine-readable PMI**
- Complete MBD definition (MBD ready data)
- Validated model quality

Industry 4.0 – digital transformation in engineering

Automation

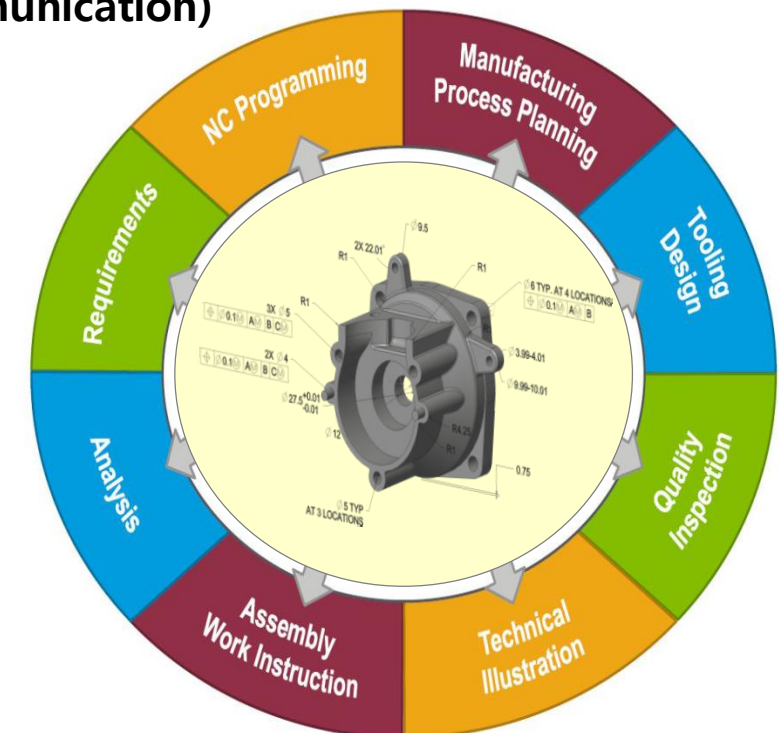
- **Lower costs (more competitive)**
- **Better products (quality demanded by the market)**

Requirements

- Engineering information must be **Machine Readable** (M2M communication)
- Replace traditional 2D drawings with Annotated 3D MBD models
- **Reuse** of existing information through product life-cycle

Benefits

- **Elimination of human interaction (source of errors/expertise)**
- **Better process control**
- **Reuse of existing information (3D MBD)**
- **Lower cost**
- **Better products**



MBD 적용 사례: GPT-4o

• 보잉(Boeing)

- 보잉은 항공기 설계 및 제조에 MBD를 도입하여 설계와 제조 간의 **일관성**을 높였습니다. MBD를 통해 3D 모델에 모든 제품 및 제조 정보를 포함시켜, 도면 없이도 제조 및 조립이 가능하도록 했습니다. 이를 통해 오류를 줄이고, 설계 변경 시의 반영 속도를 높였습니다.

• 록히드 마틴(Lockheed Martin)

- 록히드 마틴은 F-35 전투기 프로그램에서 MBD를 활용했습니다. MBD를 통해 설계 데이터를 디지털 방식으로 관리하고, 제조 및 조립 과정에서의 **정확성**을 높였습니다. 이로 인해 생산 **효율성**이 향상되고, 비용 절감 효과를 얻었습니다.

• 제너럴 일렉트릭(GE)

- GE는 항공 엔진 부문에서 MBD를 도입하여 설계와 제조 프로세스를 통합했습니다. MBD를 통해 엔진 부품의 설계 정보를 3D 모델에 포함시켜, 제조 과정에서의 오류를 줄이고 **품질**을 향상시켰습니다.

• 포드(Ford)

- 포드는 자동차 설계 및 제조에 MBD를 적용하여, 설계 변경 시의 반영 속도를 높이고, 부품 간의 간섭 문제를 사전에 해결할 수 있었습니다. 이를 통해 **제품 개발 주기**를 단축하고, 생산 비용을 절감했습니다.

• 애플(Apple)

- 애플은 제품 설계와 제조에 MBD를 활용하여, **제품 개발 주기**를 단축하고 품질을 향상시켰습니다. MBD를 통해 설계 데이터를 통합 관리하고, 제조 파트너와의 협업을 강화하여 생산 **효율성**을 높였습니다.

• 인텔(Intel)

- 인텔은 반도체 설계 및 제조에 MBD를 도입하여, 설계와 제조 간의 데이터 **일관성**을 유지하고, 오류를 줄였습니다. MBD를 통해 복잡한 반도체 설계의 **정확성**을 높이고, 생산 공정의 최적화를 이루었습니다.

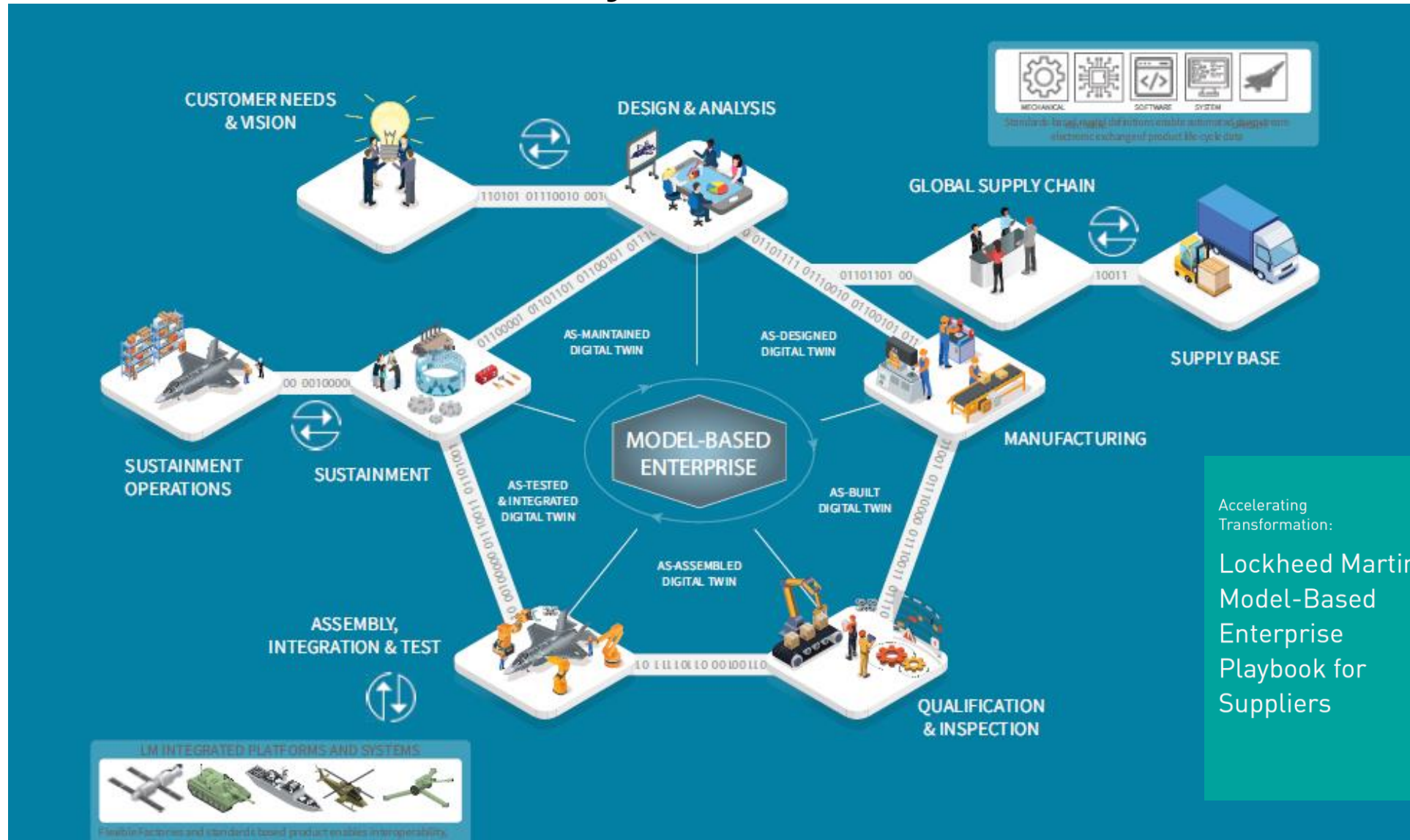
• 지멘스(Siemens)

- 지멘스는 산업 자동화 및 디지털화 솔루션에 MBD를 적용하여, 설계와 제조 프로세스를 통합했습니다. 이를 통해 제품 개발의 **효율성**을 높이고, 고객 맞춤형 솔루션을 제공할 수 있었습니다.

• 소니(Sony)

- 소니는 전자제품 설계에 MBD를 활용하여, 제품의 복잡성을 관리하고, 설계 변경 시의 반영 속도를 높였습니다. MBD를 통해 설계와 제조 간의 협업을 강화하고, **제품 품질**을 향상시켰습니다.

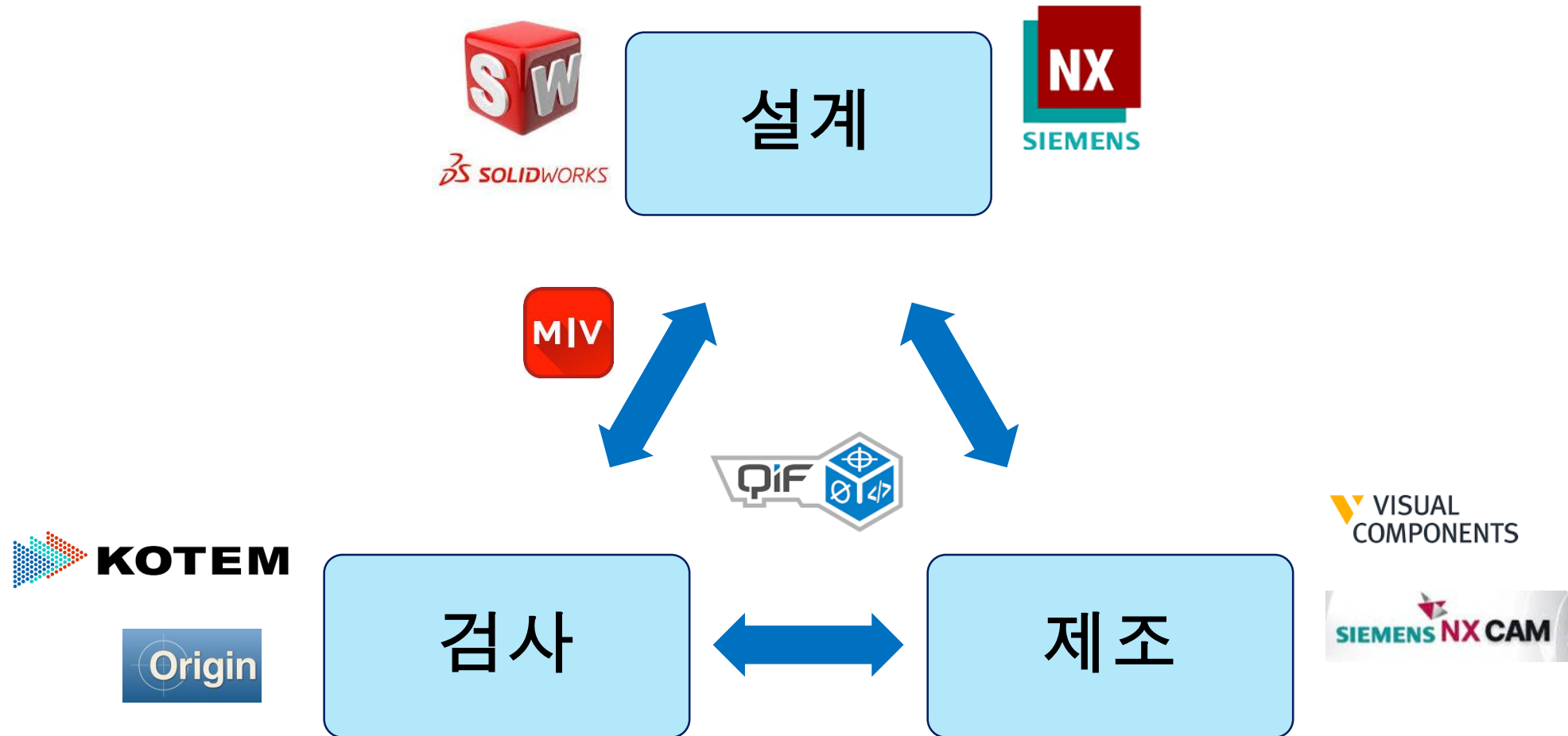
Lockheed Martine MBE Playbook



Accelerating Transformation:

Lockheed Martin's Model-Based Enterprise Playbook for Suppliers

MBD 작업 흐름도



MBDVidia

Access, explore, share, and
organize your MBD data



Model Based Definition: Current Challenges

Typical Problems with MBD Workflows

Access to MBD

- Requires costly CAD seat
- Bad data means loss of design intent
- MBD requires access to real data

Inspection Planning

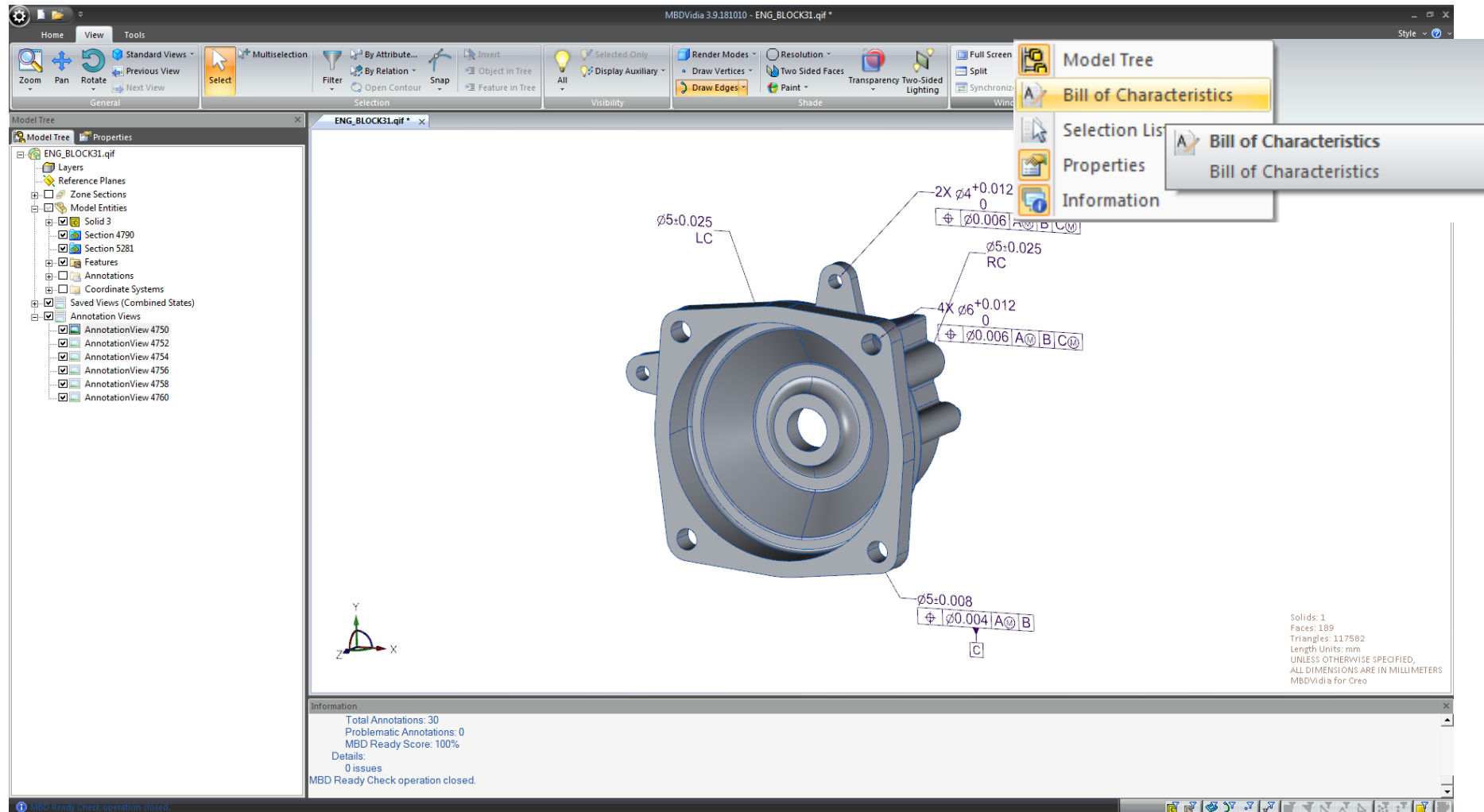
- Characteristic ballooning and generation of FAI & inspection reporting forms is a time-consuming process
- Paper-based formats are antiquated

Scattered Results

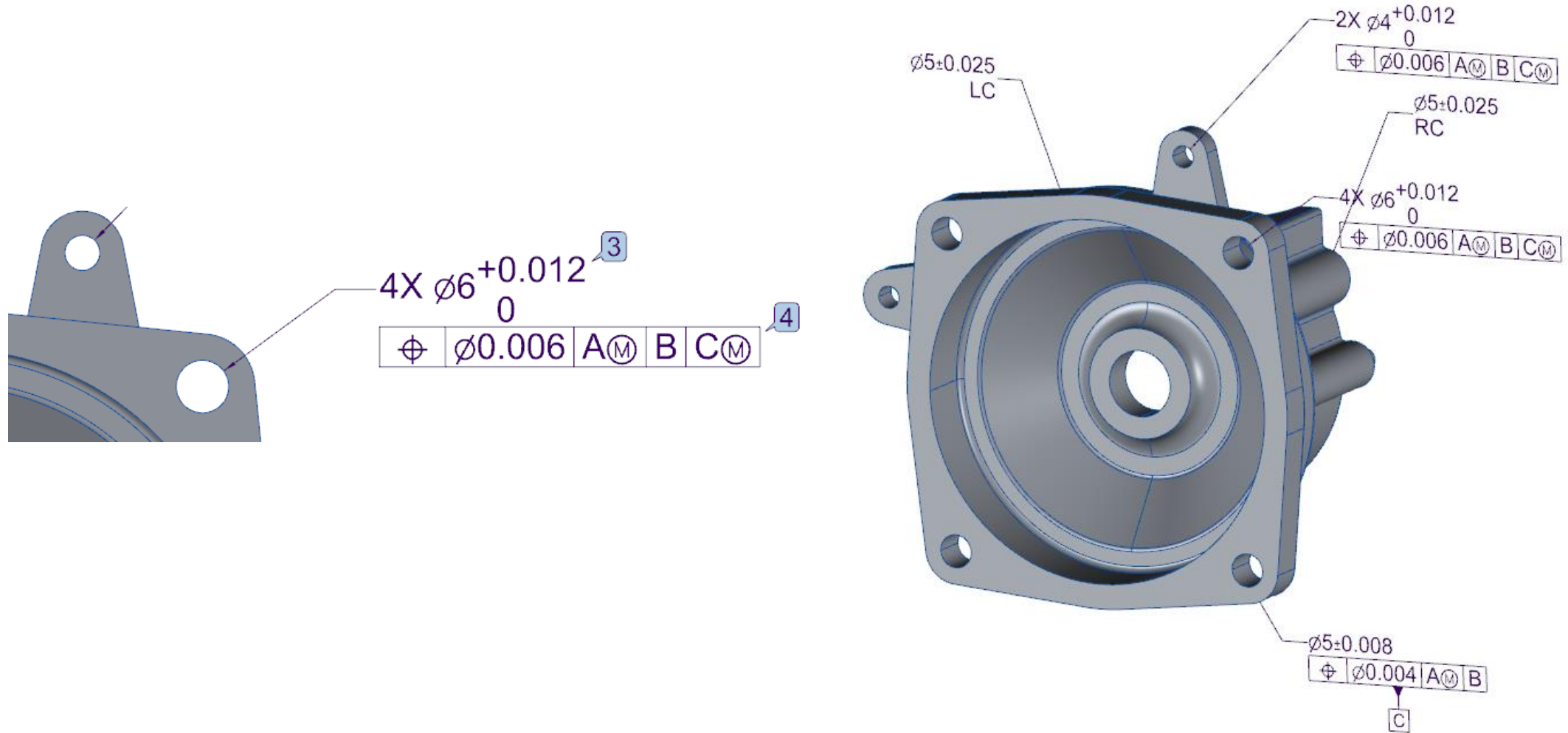
- Measurement results in various formats
- Lack of result format interoperability prohibits all-encompassing analytics
- Results are not traceable to the authority MBD model

First Article Inspection (FAI) Preparation

FAI Data Preparation



Ballooning



HTML Export



Bill of Characteristics

MBDVidia 2024.4.2412.27

CAD_modelDefault.qif

General Information

QPID

da88cdb8-43d5-4439-92ef-1ef0748d6212

Modification Date

07.03.2025

Source System

Part Number

Revision

Description

Units

mm



Tag	Saved View	Feature Name	Annotation Name	GD&T	(-)	/	(+)	DRF
1	*우측면	Plane 5097 [3304] - Plane 5132 [3304]	TXD4	7 ±0.50	-0.50	7	0.50	-
2	*우측면	Plane 5087 [3304] - Plane 5124 [3304]	TXD3	7 ±0.50	-0.50	7	0.50	-
3	*우측면	Plane 5067 [3304] - Plane 5108 [3304]	TXD1	7 ±0.50	-0.50	7	0.50	-
4	*우측면	Plane 5077 [3304] - Plane 5116 [3304]	TXD2	7 ±0.50	-0.50	7	0.50	-
5.1	*정면	Plane 5068 [3304]	도면화 항목3	 0.50 A	-	-	0.50	A
5.2	*정면	Plane 5065 [3304]	도면화 항목3	 0.50 A	-	-	0.50	A
5.3	*정면	Plane 5067 [3304]	도면화 항목3	 0.50 A	-	-	0.50	A

Measurement Results Management

Traceability (Binding with CAD Data)

Measurement Results Management

First Article Inspection Report

- Input Measurement Results
 - Manually fill in measurement results
 - Import from CSVExcel File

ENG_BLOCK31.xls [Compatibility Mode] - Microsoft Excel

FileHomeInsertPage LayoutFormulasDataReviewViewAcrobatTeam

Clipboard

Font

Alignment

Number

General

Styles

Cell Styles

Cells

Editing

Conditional FormattingFormat as TableInsertDeleteFormatFillClearSort & Find & FilterAutoSum

R24C20

123456789101112131415171819

1SAE AS9102 First Article Inspection (Rev. B)

2Form 3: Characteristic Accountability, Verification, and Compatibility

3Evaluation

4Sheet 3 of 13

51. Part Number

6440011

73. Serial Number

8N/A

94. FAI Report

10N/A

11Characteristic Accountability

12Inspection / Test Results

135. Char. Num.

146. Reference Location

157. Characteristic Designator

168. Requirement

179. Results

18Accept

19Reject

2010. Designed Tooling/Gauging used to accept product

2111. Non-Conformance Number

2214. Comments Related To This Requirement Or Result

231

24FRONT_VIEW

25Major

26Ø4 +0.012 0

274.874332323

28N/A

29N/A

301

31FRONT_VIEW

32Major

33Ø4 +0.012 0

344.313620228

35N/A

36N/A

372

38FRONT_VIEW

39Major

40⊕ Ø0.006 A(M) B C(M)

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42N/A

43N/A

443

45FRONT_VIEW

46Major

47⊕ Ø0.006 A(M) B C(M)

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49N/A

50N/A

514

52FRONT_VIEW

53Major

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56N/A

57N/A

585

59FRONT_VIEW

60Major

61Ø6 +0.012 0

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63N/A

64N/A

656

66FRONT_VIEW

67Major

68Ø6 +0.012 0

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71N/A

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74Major

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81Major

82⊕ Ø0.006 A(M) B C(M)

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85N/A

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92N/A

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99N/A

1011

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1013Major

1014⊕ Ø0.006 A(M) B C(M)

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1016N/A

1017N/A

101812

1019LEFT_VIEW

1020Minor

102121 ±0.015

102221.15540721

1023N/A

1024N/A

102513

1026LEFT_VIEW

1027Major

102812 ±0.012

102912.15540721

1030N/A

1031N/A

103214

1033LEFT_VIEW

1034Minor

1035Ø66 ±0.025 -0.015

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1037N/A

1038N/A

103915

1040LEFT_VIEW

1041Major

1042Ø12 ±0.008

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1044N/A

1045N/A

104616

1047LEFT_VIEW

1048Major

1049⊙ Ø0.007 A

10500.007651987

1051N/A

1052N/A

105317

1054LEFT_VIEW

1055Minor

105610 ±0.10

105710.7646203

1058N/A

1059N/A

106018

1061LEFT_VIEW

1062Major

106313 ±0.012

106412.90796496

1065N/A

1066N/A

106719

1068REAR_VIEW

1069Critical

107014 ±0.008

107113.07977431

1072N/A

1073N/A

107420

1075REAR_VIEW

1076Major

1077Ø5 ±0.025 L C

10785.079774309

1079N/A

1080N/A

108121

1082REAR_VIEW

1083Minor

108420.00° ±0.25°

108520.64948523

1086N/A

1087N/A

108822

1089REAR_VIEW

1090Major

109157.500 ±0.030

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1094N/A

109523

1096REAR_VIEW

1097Major

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1100N/A

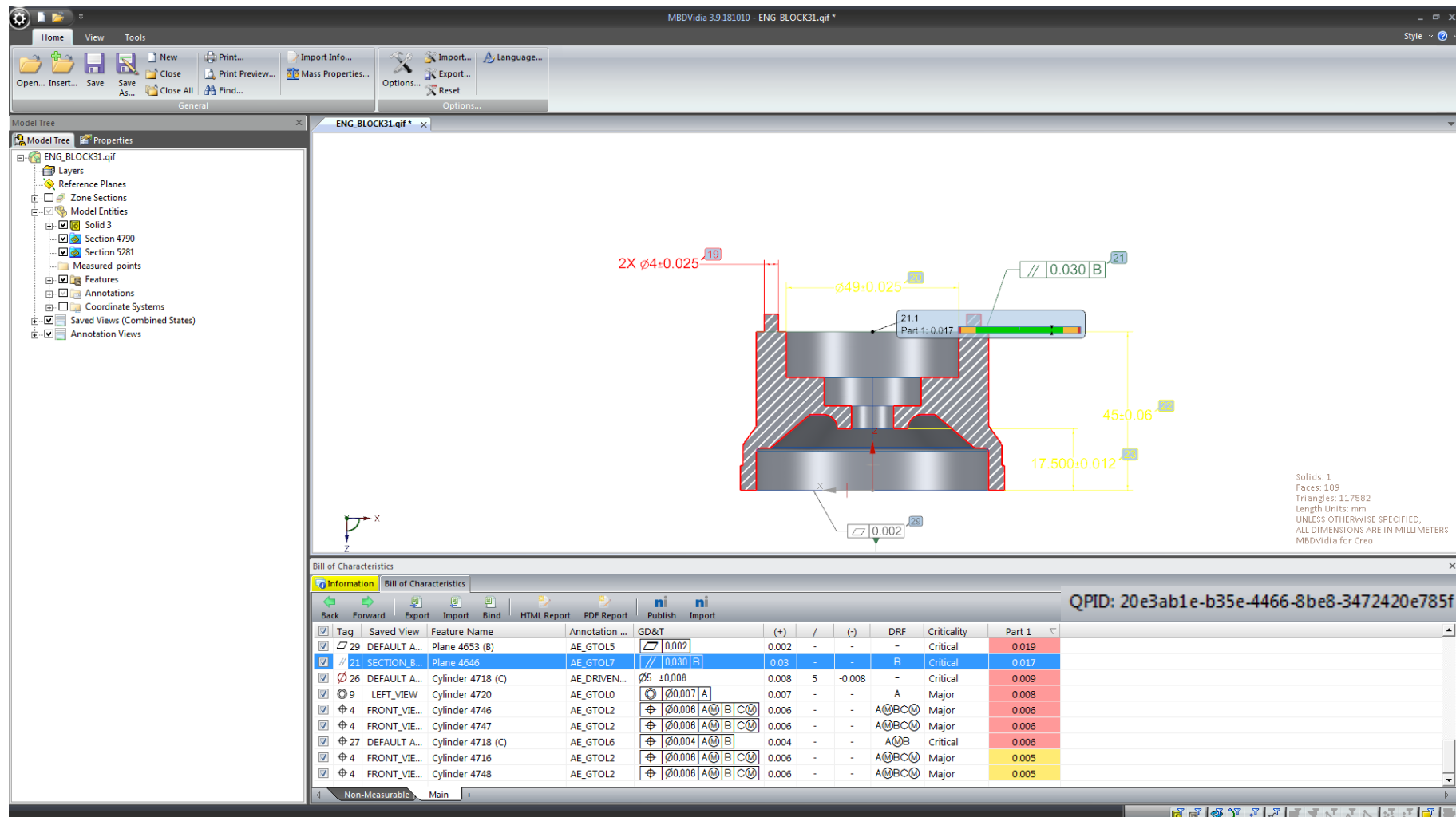
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AS9102 Form 1AS9102 Form 2AS9102 Form 3Model ViewDefault View2DEFAULT_ALL~2DEFAULT_ALL~3FRONT_V1

ReadyScroll Lock100%



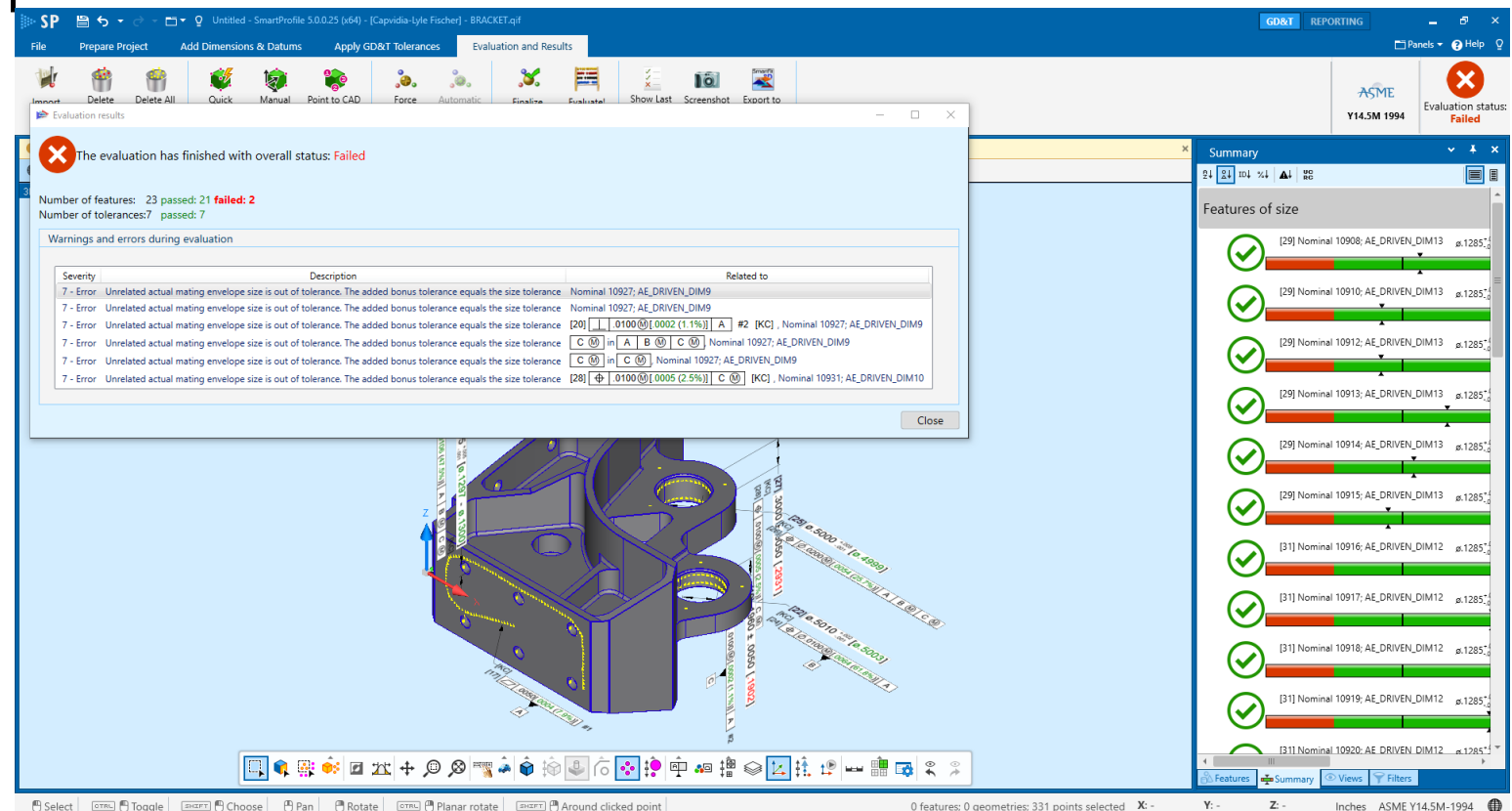
Traceability



QIF Based Workflow with CMM Programs

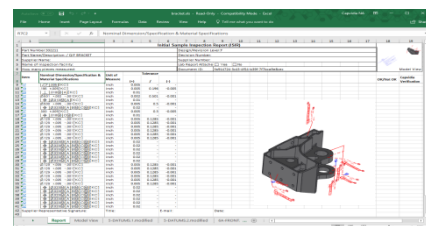
Inspection Results Analysis with Smart Profile

- QIF (3D +PMI) import into Kotem Smart Profile
- Import measurement points
- Evaluate
- Get Results

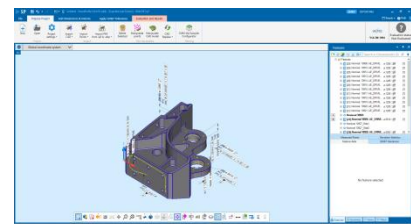


Gather Measurement Results

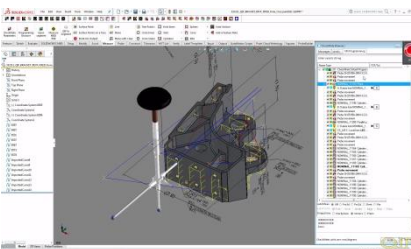
- Standard Format
- Traceable to MBD
- Enables Data Mining & Analytics



Results



Results



Results

