Minimum Model-Based Definition (MBD) for Type Design Certification

Problem Statement, with Use Cases, and Go Forward Plan

Release 1.0

August 2019

AEROSPACE & DEFENSE PLM ACTION GROUP
Abstract

Minimum Model-Based Definition (MBD) for Type Design Certification is an important topic within the Aerospace and Defense (A&D) industry because the use of multiple and ever-changing engineering and manufacturing software tools to design and produce aircraft components adds time and cost by requiring management of the changing data representations to maintain a current definition of the aircraft over its long lifecycle. Previous work by the A&D PLM Action Group (AD PAG) project team identified an initial minimum set of part types and data elements to support type design certification.

Developing the use cases included in this paper captures the attributes required to perform tasks necessary to develop, build, and certify the various part types and optimizes the minimum MBD. As each use case is developed, questions about each part type are discovered and resolved. This discovery process helps the A&D industry in general, and the AD PAG member companies in particular, gain a better understanding of required minimum data for each part type. Future editions of this paper will refine and expand on the use cases for currently cataloged and any as yet unidentified part types.
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## Revision Record

<table>
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<tr>
<th>Release</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>August 2019</td>
<td>Initial Release (Edition 1)</td>
</tr>
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</table>
Minimum MBD for Type Design Certification

Executive Summary

The Aerospace and Defense Product Lifecycle Management Action Group (AD PAG) is an association of aerospace Original Equipment Manufacturers (OEMs) and aircraft engine providers within CIMdata’s globally recognized PLM Community Program, which functions as a PLM advocacy group. One of the key business issues identified by this industry group is that collaboration within a large, global, distributed supply chain of design and development partners is seriously hindered by relying on traditional, document-based development processes. As such, one of the key business challenges identified by this group is achieving OEM and supply chain collaboration through bi-directional exchange of technical data packages via digital tools and model-based processes.

In response, a project team of domain experts from the AD PAG member companies has been established to evaluate current data interoperability standards, enabling a Model-Based Definition (MBD) set of concepts, processes, and tools that allow the creation of a semantically annotated 3D product definition that is linked to a Bill of Materials (BOM) system. The MBD dataset includes all Engineering Intent requirements (e.g., Process Specifications, Geometric Dimensioning and Tolerancing (GD&T), Product and Manufacturing Information (PMI), and other required information). Combined with Product Lifecycle Management (PLM) attributes, a parts list, and general notes, this product dataset constitutes an authoritative, single source of master product definition data that does not include or depend upon traditional 2D drawings. The MBD dataset also defines complete requirements for a product in its nominal condition, as well as permissible limits of variation and other acceptance criteria, providing all the data needed to plan, fabricate, and validate an article of product hardware.

The research activity on which this position paper is based was to assess the feasibility of exchanging digital data requirements and systems architecture models instead of documents within a collaborative product development activity. Phase 1, which has been completed with the publication of a position paper in December 2017, identified a gap in the capability of MBD and BOM authoring tools to support data exchange out-of-the-box.

The current, recommended Phase 2 short-term solution is to evaluate, validate, and employ the use of third-party MBD and BOM interoperability software tools that support data exchange and product interoperability for the life of the product. That means the recommendation is to use a neutral interface of third-party vendors, such as Core Technology, Elysium, or TSystems, in addition to neutral interfaces of the COTS editor (e.g., Dassault Systèmes, Siemens Software). In the longer term for Phase 3, the AD PAG strongly desires to see the data and model interoperability requirements be incorporated with a long-term data retention system.
Introduction

In March 2016, executives from the AD PAG member companies–Airbus, Boeing, Embraer, Gulfstream, and Rolls-Royce–met with the intent that informal discussions of PLM-related issues would lead to agreement on common objectives, requirements, and plans for remediation of their common PLM pain points. This discussion resulted in agreement of the member executives to jointly sponsor and staff a select set of projects, each chartered to define objectives, requirements, and roadmaps for eliminating or significantly reducing a key inhibitor to the value potential of PLM. The topic addressed by this particular special project, which was initiated in 2017, is Minimum Model-Based Definition (MBD) for Type Design Certification. The scope of the team’s activity has been to agree on the minimum content required in a full 3D MBD definition needed for certification and to agree on a set of recommended standards for representation of that information.

Since the initial agreement in 2016, AD PAG membership has increased from five to eleven OEMs, including Bombardier, Dassault Aviation, GE Aviation, Mitsubishi Regional Jet, Pratt & Whitney, and Safran, and this project team has added subject matter experts (SMEs) from many of them.

Drawings Versus Model-Based Definition Content

Drawings have been the descriptive engineering foundation of component design, assembly, and installation since the beginning of the A&D industry. The drawings captured diverse information supported by several pictorial views of the item(s), such as a drawing or part number, dimensions, datums, tolerances, flag notes, general notes, etc. Drafting standards, including the ANSI/ASME Y14 family and the ISO 1101 family, have been supporting the industry’s drawings definition for decades. The drawings were, and in some cases still are, then consumed or repurposed downstream to enable aircraft planning, manufacturing, and servicing.

The rise of 3D CAD (Computer Aided Design) modelers in the late 1980s and 3D As Master in the early- to mid-1990s ushered in the beginning of MBD in the 1990s. To improve design cycle time and cost, MBD use led to the development of processes and tools that have helped the A&D industry move away from creating 2D drawings and toward 3D models as the data of record.

Industry leaders worked with PLM vendors to define what is known today as Model-Based Definition or Model-Based Enterprise (MBE). This new approach and its continuous innovation have advanced from the basic transfer of all detailed information from 2D drawings to 3D model Geometric Dimension and Tolerances (GD&T) with annotation—known as Product and Manufacturing Information (PMI)—to a recognizable, semantic, fully-dimensioned 3D model to minimum dimensioning with intelligent features, parameters, and more. These continuous advancements are not only improving the global strategy but are also expanding the gap between industry knowledge, existing standards, and available solutions proposed by PLM software providers.

Problem Statement

This section of the position paper first establishes the context within which product development occurs and then identifies, through four current state use cases, the common roadblocks that slow current product development processes that rely on the exchange of model data between stakeholders. Each use case is presented as a user story in table format. Business consequences and the root causes of the problem are noted for each.

Context

As noted earlier, with the advancement of technology and the maturity of CAD tools, the past decades have seen an increase in the transition from 2D drawing-based designs to 3D MBD designs within the A&D community. Today, A&D companies are seeing active CAD data as an asset that is continuously versioning. The available neutral formats, such as ISO STEP AP242, are keeping up at a constant pace, but the scope is also expanding to more and more data types.

A common objective of the AD PAG is to evaluate the minimum digital thread of MBD data elements required to fulfill type design certification requirements set forth by the global regulatory bodies. The team evaluated the certification requirements, the collective part types currently certified by the A&D industry, and various open data standards such as, but not limited to, ISO 10303-242 (STEP AP242), ISO14306 (JT), and ISO32000/14739 (PRC for 3D PDF) to support data exchange and interoperability requirements for existing MBD design processes.

![Generic, High-Level Process Flow for 3D MBD Parts](image)

The AD PAG’s goal is to cover the minimum semantic of the different categories of parts used by the A&D industry. The AD PAG supports the following:

- Communication between OEM and the Engineering suppliers during the design phase of product development.
- Communication to downstream processes between Engineering and Manufacturing with computer-readable semantic data for
  - Preparation of 3D NC machining programming,
– Preparation of 3D NC quality control, and
– Input for simulation of manufacturing processes (specific to each category of part type).
• Communication between Design Engineering and upstream processes, including
  – FEM simulation of structural parts,
  – Electromagnetic Interference (EMI) simulation of electrical wiring harnesses, and
  – Pressure simulation for tubing systems (pumps, etc.).

As a result of this support, the group defined a minimum list of required 3D MBD data items organized by the category of parts. This list was first described in the AD PAG’s published position paper, titled *Minimum Model-Based Definition (MBD) and Bill of Material (BOM) Definition with STEP AP242*, which is available at [www.ad-pag.com](http://www.ad-pag.com) under the link for Position Papers named *Model-Based Definition (MBD) and Bill of Material (BOM) Definition – Position Paper*. The file will download with filename ad-pag-mbd-bom-pp-4.0.pdf. Two additional part types—Deformable and AM - Additive Manufacturing and ALM - Additive Layer Manufacturing—have been added since that paper’s publication. The group is actively researching the following 17 part types.

**Table 1 – List of 17 Actively Researched Part Types by the AD PAG**

<table>
<thead>
<tr>
<th>PART TYPE</th>
<th>PART TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite - Detail - Core Stiffened Bond</td>
<td>Composite - Detail - Co-Cured/Co-Bonded</td>
</tr>
<tr>
<td>Casting</td>
<td>Forging</td>
</tr>
<tr>
<td>Sheet Metal</td>
<td>Machined</td>
</tr>
<tr>
<td>Wire Harness</td>
<td>Tube Assembly - Flexible</td>
</tr>
<tr>
<td>Tube Assembly - Rigid</td>
<td>Ducting - Metallic - Mechanically Fastened</td>
</tr>
<tr>
<td>Installation</td>
<td>Standard Part - Mechanical</td>
</tr>
<tr>
<td>Standard Part - Electrical (Connector, Back Shell, etc.)</td>
<td>Supplied Part - Mechanical Systems (Pump, Actuator, etc.)</td>
</tr>
<tr>
<td>Supplied Part - E/E Systems (Battery, LRU, etc.)</td>
<td>Deformable</td>
</tr>
<tr>
<td>AM - Additive Manufacturing and ALM - Additive Layer Manufacturing</td>
<td></td>
</tr>
</tbody>
</table>
Use Cases Introduced

This initial edition of the MBD Type Design Certification project identifies four current As Is use cases that include the generation of 3D MBD data. Each use case starts on a separate page for easy reference and offers a description of the process, the issues that arise, and the business consequences of their impact.

- Use Case 1: Visual Interpretation and Visual Consumption
- Use Case 2: Feature-based Machining/Manufacturing
- Use Case 3: OEM Submission of Technical Data Package to Authority for Certification
- Use Case 4: Statistical Process Control
Use Case 1: Visual Interpretation and Visual Consumption

Manufacturing has historically relied on visual interpretation of the dimensions, tolerances, and other technical data, such as notes and specifications, to plan and program the fabrication of parts and facilitate inspection, quality, etc. This has been done with 2D drawings for many years. With MBD, the same information (dimensions, tolerances, etc.) is conveyed in 3D space with MBD views. This is done by applying PMI on the 3D geometry.

Visual consumption can be directly from the native CAD system or through a neutral format viewer, such as Adobe with 3D PDF. The ability to visualize the MBD product definition is the most basic and critical use case. Prior to the release of a product definition, many business functions (i.e., manufacturing, quality, assembly) must visualize and approve the design. These functions may not have access to native CAD data; hence, they must use a simplified neutral format with a simple visualization tool (e.g., Adobe 3D PDF).

Production Planners must be able to visualize the dimensions to plan the manufacturing sequences. Numerical Control (NC) and Coordinate Measuring Machine (CMM) Programmers must visualize dimensions and tolerances in conjunction with the 3D geometry to program the NC machine and inspection machine operations, respectively. Any loss of visual data can lead to manufacturing defects.

Regardless of the neutral format used—ISO STEP, ISO JT, or ISO 3D PDF—the visualization tools must quickly and reliably display the 3D model with PMI content.

Difficulties arise immediately whenever the native CAD solution or the neutral format in use does not yet support the MBD display of all necessary data items used in downstream functions.

EPIC: Minimum MBD for Type Design Certification

Feature: Visual Interpretation and Visual Consumption

User Story:

As a: Manufacturing Process Planner
I want to: define the sequence of steps to manufacture the product
So that I can: inform factory floor production staff,
Given: a 3D model-based view of the product.
When: manufacturing process planning is done,
Then: manufacturing planning is complete, and production can start.
Table 2 - Visual Interpretation and Visual Consumption Use Case

<table>
<thead>
<tr>
<th>EPIC</th>
<th>Feature/Sub-Process</th>
<th>CFP</th>
<th>ID</th>
<th>Created by</th>
<th>User Story</th>
</tr>
</thead>
<tbody>
<tr>
<td>As a Manufacturing Process Planner</td>
<td>I want to define the sequence of steps to manufacture the product</td>
<td>So that I can inform factory floor production staff,</td>
<td>Given a 3D model-based view of the product.</td>
<td>When manufacturing process planning is done,</td>
<td>Then manufacturing planning is complete, and production can start.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tools/Apps</th>
<th>Predecessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D data model with PMI Display Viewer</td>
<td>2D drawings</td>
</tr>
</tbody>
</table>

**Business Consequences of Use Case 1**
When downstream NC Programmers or CMM Programmers cannot visualize a needed dimension or other part manufacturing data item, they are left either to interrupt the overall process by requesting clarification from the design organization or to make an assumption. If the programmer’s assumption proves incorrect, time and money are lost in order to correct the problem. In severe cases, the overall product schedule may slip and the company could miss market opportunities.

**Causal Analysis of Use Case 1**
The predominant cause of missing visual data can often be traced to the lack of capability, either in the CAD solution itself or in a lagging definition within a standard format. In addition, even if the capability is supported, the designer may not realize a particular dimension or tolerance is needed downstream and, as a result, may fail to add it to the 3D MBD view.

One current concern is based on the fact that there are not many different viewers that can accurately display standard data. Development of an application-independent format (or standard) allows suppliers and manufacturers to develop solutions that can significantly reduce their cost of business.
Use Case 2: Feature-Based Machining/Manufacturing

Within MBD, features capture the engineering intent of a 3D model (Product Definition) and serve as significant support for Computer Integrated Manufacturing (CIM). Feature-based design systems typically act as interpretive processors between Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) environment actions. These systems can enable feature-based product definition systems, geometry-based process planning, automatic feature recognition, and design-by-feature systems.

Integrating such technologies is a major concern within current engineering practices and has been a high priority topic for research and development activities. In various engineering and manufacturing domains, the design-by-feature model is a main tenet in the CAD/CAM integration effort. The most preferred system architecture for a feature-based system is a blend of the aforementioned approaches. The approaches used for automatic feature-recognition systems are becoming more mature and are being used in Advanced Manufacturing practices.

The more the A&D industry can utilize Advanced Manufacturing and feature-based capabilities, the more able the industry will be to predict the quality of products coming off the machine tool. This will allow companies to provide to their regulatory agencies better, more accurate data in support of certification and compliance.

Certification of Feature-Based Machining/Manufacturing systems that produce data used for verification and validation, as well as for inspection purposes, must be accredited and approved for use in compliance with regulatory requirements.

EPIC: Minimum MBD for Type Design Certification

Feature: Feature-Based Machining/Manufacturing

User Story:

As a: Manufacturing Employee (Machinist)
I want to: manufacture a machined part from model data
So that I can: meet the OEM requirements/schema,
Given: the data is in an easily-readable format that contains the minimum necessary information and requirements to machine/manufacture the part.
When: the part data has been consumed and the requirements have been met,
Then: the OEM job is complete, and the part can be delivered.
Table 3 - Feature-Based Machining/Manufacturing Use Case

<table>
<thead>
<tr>
<th>EPIC</th>
<th>Feature/Sub-Process</th>
<th>CFP</th>
<th>ID</th>
<th>Created by</th>
<th>User Story</th>
</tr>
</thead>
<tbody>
<tr>
<td>As a Manufacturing Employee (Machinist)</td>
<td>I want to manufacture a machined part from model data</td>
<td>So that I can meet the OEM requirements/schema,</td>
<td>Given that the data is in an easily-readable format that contains the minimum necessary information and requirements to machine/manufacture the part.</td>
<td>When the part data has been consumed and the requirements have been met,</td>
<td>Then the OEM job is complete, and the part can be delivered.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tools/Apps</th>
<th>Predecessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intellectual Property (IP)-protected CAD model w/PMI</td>
<td>2D drawing</td>
</tr>
<tr>
<td>Agnostic 3D visualization</td>
<td>STL model</td>
</tr>
<tr>
<td>ISO neutral formats STEP, JT, 3D PDF, etc.</td>
<td>IGES</td>
</tr>
<tr>
<td>LOng Term Archiving and Retrieval methods (LOTAR)</td>
<td>Paper, Velum, Mylar, Linen, Microfiche, etc.</td>
</tr>
</tbody>
</table>

Business Consequences of Use Case 2

Today, parts for manufacturing are contracted to suppliers in a variety of formats, with varying degrees of requirements. With ever changing software tools, this puts a lot of pressure on suppliers to meet the requirements and keep up with the software.

On programs that had to transition from CATIA V4 to CATIA V5, suppliers were required to read and interpret data from both Version 4 and Version 5 models.
Causal Analysis of Use Case 2
The cost of making changes to a company’s infrastructure impacts its ability to compete. If the company is well established and has sufficient capital in reserves to pay for these changes, there is still an impact on the schedule and delivery of goods. This may lead to a search for additional suppliers to help meet the schedule, and there is an added cost of review, certification, and contracts associated with potential new suppliers.
Use Case 3: OEM Submission of Technical Data Package to Certification Authority

With the emergence of digital data-based processes, including MBD, requirements were identified that predicate the need for a long-term data retention solution(s) to meet the regulatory and business requirements. Traditional legacy retention and retrieval methods do not support complex digital product definition data.

Prior to MBD, the authorized type design process output was 2D drawings. Certification was performed by providing access to those drawings. In MBD, the design is an annotated 3D model, in which certification can be performed by giving access to the 3D data in a format compatible with the certification authorities. This is a requirement for LOTAR of product and technical data, as defined by the EN/NAS 9300-xxx LOTAR standards.

Those LOTAR standards include the following:

- EN/NAS 9300-001-009 – Basic Fundamentals & Concepts
- EN/NAS 9300-010-030 – Common Process for Data Preparation, Management, Archive and Storage
- EN/NAS 9300-1xx through 7xx – Domain Specific Type Preservation (Mechanical, PMI, Composites etc.):
  - EN/NAS 9300-1xx: LT Archiving and Retrieval of Mechanical Information
  - EN/NAS 9300-2xx: LT Archiving and Retrieval of Product Management Data
  - EN/NAS 9300-3xx: LT Archiving and Retrieval of Advanced Manufacturing Data (Composite, Additive Manufacturing, etc.)
  - EN/NAS 9300-4xx: LT Archiving and Retrieval of Electrical Information
  - EN/NAS 9300-5xx: LT Archiving and Retrieval of Model-Based System Engineering
  - EN/NAS 9300-6xx: LT Archiving and Retrieval of Engineering Analysis and Simulation
  - EN/NAS 9300-7xx: LT Archiving and Retrieval of Electronics Information

Currently with MBD, the certification authorities are given access to the 3D data, according to three types of solutions based on:

- Lightweight format (3D PDF, ISO 14306 JT, etc.),
- CAD neutral data format (ISO 10303, AP242\(^2\)), or
- Native CAD model.

This puts the burden of interpreting the native CAD model on the certification body that may be certifying multiple OEMs with different CAD systems. Additionally, a native CAD model often contains IP beyond the final design, and the OEM may not wish to expose that IP (e.g., construction methods, constraints, and relationships) to the certification body. OEMs may want to strip out or mask that data before providing a minimum product definition package to the certification body or restrict access via thin client architectures, such as CITRIX.

\(^2\) AP203 and AP214 have been merged in AP242.
**EPIC:** Minimum MBD for Type Design Certification

**Feature:** OEM Submission of Technical Data Package to Certification Authority

**User Story:**

As an: OEM Supplier  

I want to: provide access to a graphic presentation of my product definition  

So that I can: show proof of complete product design and definition to the government/regulatory body,  

Given: the data is in a readily consumable format containing the minimum necessary information and/or requirements to effectively satisfy the government/regulatory body.  

When: the government body is able to access and understand the content of a product definition,  

Then: the standard documentation of design is accepted as valid, compliant, and complete.

<table>
<thead>
<tr>
<th>EPIC</th>
<th>Feature/Sub-Process</th>
<th>CFP</th>
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<th>Created by</th>
<th>User Story</th>
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</thead>
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<tr>
<td>As an OEM</td>
<td>I want to provide access to a graphic presentation of my product definition</td>
<td>So that I can show proof of complete product design and definition to the government/regulatory body,</td>
<td>Given the data is in a readily consumable format containing the minimum necessary information and/or requirements to effectively satisfy the government/regulatory body.</td>
<td>When the government body is able to access and understand the content of the product definition,</td>
<td>Then the standard documentation of design is accepted as valid, compliant, and complete.</td>
</tr>
<tr>
<td>Supplier</td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>Tools/Apps</th>
<th>Predecessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D CAD model</td>
<td>Hand Drawings</td>
</tr>
<tr>
<td>(drawing)</td>
<td></td>
</tr>
<tr>
<td>3D CAD model</td>
<td>Physical Mockups</td>
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<tr>
<td>digital mockups</td>
<td></td>
</tr>
<tr>
<td>Enhanced 3D model</td>
<td></td>
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<tr>
<td>with PMI</td>
<td></td>
</tr>
<tr>
<td>Agnostic 3D</td>
<td>STL model</td>
</tr>
<tr>
<td>visualization</td>
<td></td>
</tr>
<tr>
<td>Tools/Apps</td>
<td>Predecessor</td>
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<td>--------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>ISO Neutral Formats</td>
<td>IGES</td>
</tr>
<tr>
<td>(STEP, JT, 3D PDF, etc.)</td>
<td></td>
</tr>
<tr>
<td>LOTAR</td>
<td>Paper, Velum, Mylar, Linen Microfiche, etc.</td>
</tr>
</tbody>
</table>

**Business Consequences of Use Case 3**

Evolving software tools may render certain applications and data formats inaccessible. Inadequate access control and protocols (Intellectual Property Export Control (IPEC)) and internal People and Organization (PNO) requirements create the risk of unauthorized transfer, manipulation, and export of data.

The impact of technology readiness and differences on concurrent collaboration among partners and suppliers may affect the schedule and quality of the product. Failure to keep pace with the evolution of delivery and consumption media creates processes and tools that become isolated and ineligible for further migration. Misinterpretation of product definition may lead to quality issues and loss of design intent.

**Causal Analysis of Use Case 3**

Restricted information flow and misinterpretation of definition, quality issues, and loss of design intent will lead to the potential loss of type data and inability to recreate it as well as exposure to data manipulation. This presents a potential for compromised Unauthorized Data Export IP which may lead to a loss of confidence from the regulatory authorities.
Use Case 4: Statistical Process Control

Statistical Process Control (SPC) is a data-driven methodology for analysis and an improvement methodology for measuring and controlling quality during the manufacturing process. Quality data in the form of product or process measurements is obtained in real-time during manufacturing.

This data is then plotted on a graph with pre-determined control limits. Control limits are determined by the capability of the process; whereas, specification limits are determined by the customer. Data that falls within the control limits indicates that everything is operating as expected. Data outside the control limits indicates that the cause is likely the source of process variation, and something within the process should be changed to resolve the issue before defects occur.

**EPIC**: Minimum MBD for Type Design Certification

**Feature**: Statistical Process Control

**User Story**:  

**As a**: Quality Assurance Employee  
**I want to**: collect and analyze SPC data points from manufactured product data  
**So that I can**: meet the OEM design requirements/schema,  
**Given**: the data is in an easily readable format that contains the minimum necessary information and requirements to machine/manufacture the part.  
**When**: the part data has been consumed and the requirements have been met,  
**Then**: the job is complete, and the part can be delivered.

| Table 5 - Statistical Process Control (SPC) Use Case |
|---|---|---|---|---|---|---|
| EPIC | Feature/Sub-Process | CFP | ID | Created by | User Story |
| **As a Quality Assurance Employee** | **I want to** collect and analyze SPC data points from manufactured product data | **So that I can** meet the OEM design requirements/schema, | **Given** the data is in an easily readable format that contains the minimum necessary information and requirements to machine/manufacture the part. | **When** the part data has been consumed and the requirements have been met, | **Then** the job is complete, and the part can be delivered. |

<table>
<thead>
<tr>
<th>Tools/Apps</th>
<th>Predecessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Mite, SPC sensors</td>
<td>2D drawings, manual measurement</td>
</tr>
</tbody>
</table>
**Business Consequences of Use Case 4**

- This new process requires new software, integrated with internal software structures and machine tools, along with new processes to capture data. In addition, testing, training, restructuring, and maintenance of these new systems must be in place.
- Implementing an SPC process on machine tools and in quality management policies will impact current operating processes and affect scheduled delivery of the product.

**Causal Analysis of Use Case 4**

- Restricted information flow
- Difficulty absorbing (i.e., interpreting) information
- Loss of confidence by the regulatory authorities due to poor quality

**Go Forward Plan**

This paper is staged in three editions. This current Edition 1 of the projected, full position paper addresses the current context and offers As Is use cases with their associated negative business impacts. Research will continue.

Edition 2 of the position paper will offer objectives, a description of the desired state, and To Be use cases. Edition 3 will provide specific recommendations and requirements to help the A&D industry reach its goal of agreement on the minimum content required in a full 3D MBD and BOM definition needed for certification, and agreement on a set of recommended standards for representation of that information.

The AD PAG will evaluate and recommend short-term solutions to abate the current barriers using existing 2019 technology, as well as provide a clear, step-by-step five-year action plan that can be achieved within the A&D industry to enact those recommended short-term solutions.
About A&D PLM Action Group

The Aerospace & Defense PLM Action Group ([www.ad-pag.com](http://www.ad-pag.com)) is an association of aerospace and defense companies within CIMdata’s globally recognized PLM Community Program, which functions as a **PLM advocacy group** to:

- Set the direction for the aerospace & defense industry on PLM-related topics that matter to members (including promoting, not duplicating, the work of standards bodies)
- Promote common industry PLM processes and practices
- Define requirements for common interest PLM-related capabilities
- Communicate with a unified voice to PLM solution providers
- Sponsor collaborative PLM research on prioritized industry and technology topics

CIMdata administers Group operations, coordinates research, and manages the progression of policy formulation.

About CIMdata

CIMdata, a leading independent worldwide firm, provides strategic management consulting to maximize an enterprise’s ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. Since its founding over thirty years ago, CIMdata has delivered world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM-enabling technologies.

CIMdata works with both industrial organizations and providers of technologies and services seeking competitive advantage in the global economy. CIMdata helps industrial organizations establish effective PLM strategies, assists in the identification of requirements and selection of PLM technologies, helps organizations optimize their operational structure and processes to implement solutions, and assists in the deployment of these solutions. For PLM solution providers, CIMdata helps define business and market strategies, delivers worldwide market information and analyses, provides education and support for internal sales and marketing teams, as well as overall support at all stages of business and product programs to make them optimally effective in their markets.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through PLM certification programs, seminars, and conferences worldwide. CIMdata serves clients around the world from offices in North America, Europe, and Asia-Pacific.

To learn more about CIMdata’s services, visit our website at [www.CIMdata.com](http://www.CIMdata.com) or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 734.668.9922. Fax: +1 734.668.1957; or at Oogststraat 20, 6004 CV Weert, The Netherlands. Tel: +31 (0) 495.533.666.