Collaboration Among Original Equipment Manufacturers (OEMs)

Romarx Bonicillo - Boeing
Bernd Feldvoss - Airbus

Presenters Bio

 **Romarx Bonicillo** **Boeing Commercial Airplanes** **System Engineering Integration Team** **Project Engineer – Supply Chain & Fabrication Domain** **The Boeing Company**	Romarx joined Boeing in 1997 and worked in Liaison Engineering supporting all widebody airplanes. More recently he supported product development working on projects to enable model-based engineering with supply base. Prior to that he was on the 787 program developing the configuration management plan and worked with the program partners to establish data, process and tool standards. Romarx studied Mechanical Engineering at the University of Washington and received his MBA from Seattle Pacific University.

Presenters Bio

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PLM Interoperability Standards Specialist

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Roadmap for Enabling Global Collaboration

Agenda

- **AD PAG Project Team**
- **AD PAG Global Collaboration Project History**
- **AD PAG Collaboration Guidelines & Pilots**
- **Phase 3 This Release 3.0 defines the requirements to enable global collaboration and builds from Releases 2.0/2.1 and the Collaboration Management System (CMS) Research Report**
- **Collaboration Guidelines**
- **Accomplishment Summary and Go Forward Plan**
- **Q&A**

Global Collaboration - Timeline

2025+ Timeline

2015 | 2016 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025

PHASE 1
Research Report

Research resulted in characterization of currently practiced PLM Collaboration and a taxonomy of product development collaboration.

PHASE 2
Research Report

Research resulted in assumption of three collaboration entities and five collaboration purposes identified as offering the highest potential of improvement in global collaboration

PHASE 3 Position Paper

Improving Collaboration in the A&D Design Chain

PowerPoint describing Phase 3 deliverables

Edition 1 - As-Is State of Data Exchange

Position paper explores the need for frictionless operation (OEM & Suppliers).
PLM Global Collaboration position paper addressed multiple current state use cases as well as a Go Forward Plan, were described

Edition 2 - To-Be State of Global Collaboration

Offers objectives, a description of the desired state, and expected business impacts

Global Collaboration Feasibility App. Study
Develop a standard prototype and have it tested by new collaborative relationships

Publish Edition 2 - To-Be State of Global Collaboration

Offers objectives, a description of the desired state, and expected business impacts

Global Collaboration Feasibility App. Study
Develop a standard prototype and have it tested by new collaborative relationships

Collaborative Standards Application

Provide a standard interactive application for how OEM / Supplier collaborations can be managed.

Start Preparing for Edition 3 - Requirements for Global Collaboration

Pilot Concepts from Edition 2 and the CMS Paper

Study how the checklist/CMS may have enhanced the collaboration on existing programs. Incorporate the pilot results in future editions. This will offer specific recommendations and requirements to help the A&D industry reach its goal of simplified PLM global collaboration

Edition 3 - Requirements for Global Collaboration

As the AD PAG's research continues, will offer specific recommendations and requirements to help the A&D industry reach its goal of simplified PLM global collaboration

Publish Edition 3 and start planning for Phase 4

PHASE 4 *
Continuous Global Collaboration (open ended)

Collaboration team will meet monthly to capture potential new technologies, new standards, new Vendor software enhancements and the adaption of the 8-Step guidelines highlighting savings and success with a goal to update the Collaboration Paper at least bi-annually.

*pending leadership approval

Global Collaboration - Mandate Update

- **Monthly meetings to maintain the momentum of the team**
- **A new paper just containing the Edition 3: Requirements for Global Collaboration will be started and maintained with regular updates.**
- **The new mandate will have two components resulting in potential updates to the Global Collaboration Paper.**
  - To capture adaption of the 8-Step guidelines highlighting savings and success.
  - New Technology, Standards updates and new standards that impact the Global Collaboration Paper.
- **The goal would be to update the paper annually or every other year depending on inputs from items 1 and 2 above.**

Aerospace & Defense PLM Action Group founded in February 2014

Mission

An association of aerospace & 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
- 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 member-prioritized industry and technology topics

Website: www.ad-pag.com

Members

AIRBUS

BOEING

EATON

GE Aerospace

Gulfstream
A GENERAL DYNAMICS COMPANY

PRATT & WHITNEY
DEPENDABLE ENGINES

Rolls-Royce

SAFRAN

SPIRIT AEROSYSTEMS

A&D PLM Global Collaboration - Abstract (1 of 2)

- Collaboration among Original Equipment Manufacturers (OEMs) and their product design and manufacturing engineering partners and suppliers is **key to any major aerospace and defense (A&D) program**.

- Process analysis by an A&D PLM Action Group (AD PAG) project team has shown that the exchange of product data, such as 3D-MBD, Bill of Materials (BOM), and Model-Based Engineering (MBE), **between multiple OEMs and suppliers presents a challenge** within the industry.

- Currently, the exchange methods for long-term collaboration between OEMs and suppliers are independent and utilize exclusive environments and protocols, each unique and complex. **Improving the consistency and efficiency of establishing and managing OEM-supplier collaboration can significantly improve cost, schedule, and quality across all phases of the product lifecycle.**

A&D PLM Global Collaboration - Abstract (2 of 2)

- This presentation offers the **“Desired State”** for OEM-supplier collaboration through the application of and **adherence to a set of guidelines** defined by the project team.

- The A&D PLM Collaboration Guidelines defined **eight standard and repeatable steps for establishing and managing** the environment where OEMs and suppliers collaborate which were mapped to an ISO standard approach. To facilitate the adoption of the A&D PLM Collaboration Guidelines, the project team has developed an **open-service Collaboration Management System (CMS) web application.**

- In Phase 3 the team worked on the **requirements** towards the systems and how to cover whole product life cycle

A&D PLM Global Collaboration - Ontology

- **The original use cases and collaborative concepts were evaluated in the development of desired collaboration framework.**

- **To better understand the context of collaboration framework, the key terms that the team considered are identified in a word cloud.**

- **A collaborative community is two or more people from different groups or companies working jointly on a project.**
- **As shown in the following figure, a collaborative community's main objective is to efficiently design, manufacture, and support components throughout their lifecycle.**

Figure 1 - Collaboration Community Along a Lifecycle

- **Collaborative communities must support collaboration, brainstorming, and innovation in real-time.**
- **As stated in the Overview of the Desired Interactions between Business Entities section, collaborative community participants must also respect to reach program milestones.**

A&D PLM Global Collaboration - Evolution

SUPPLIER AGREEMENTS

NEED TO EVOLVE INTO FLEXIBLE CONTRACTS SUPPORTING MODEL-BASED DEVELOPMENT WITH ADVANCED COLLABORATION METHODS

DOCUMENT BASED DEFINITION of product with limited distribution and delayed communication through (paper, mail, scan/fax)

ELECTRONIC DEFINITION of product disrupted decades of industry standard practice with data transfer

CONNECTIVITY TECHNOLOGY, DATA FORMAT, intellectual property, and level of detail quickly rose as inhibitors to electronic data definition and transfer

COLLABORATION IS NEEDED during all phases of program lifecycle. Levels of frequency and volumes will vary at each phase, which will determine the level of interconnectivity and interoperability.

Evolution

A&D Collaboration Guidelines

1a. Prepare Recommended Collaboration for the Data Exchange Process

1b Assess Supplier Capabilities (4)

2. Commercial, Contractual and Legal Relationship

Done in parallel and can be done multiple times

3. Set up Governance (5)

4. Project management (1)

5. Set up Interfaces & organization (3)

6. Setup Collaboration Environment for Program Life

7. Program Review Process

8. End State (8) LoTAR

Objectives

- To optimize Collaboration supporting aerospace the A&D team developed and defined Aerospace Collaboration guidelines in Edition 2 paper
- These Guidelines evolved into a checklist which has been digitized into a web application Collaboration Management System (CMS)

Appendix A: A&D Collaboration Guidelines Checklist

Step	Global Collaboration Team Guidelines for A&D	Status
1	**Prepare for Collaboration and Data Exchange**	
1.1	Define Type and Scope of Data	
1.2	Define Recommended Way of Collaboration	
1.3	Define Recommended Project Management Terminology and Tool Set	
1.4	Define IP-Compliant Process	
1.5	Assess Collaboration Capability	
1.6	Supplier Selection Announced	
1.7	Data Collaboration Agreement	
1.8	Audit and Follow-Up	
2	**Establish Commercial, Contractual, and Legal Relationships**	
2.1	Define Data Exchange Rules and Processes	
2.2	Define Project Management Terms	
2.3	Monitor and Manage Contract Execution and Contractual Coverage of	
2.4	Anticipate and Mitigate Contractual Risks	
2.5	Amend the Contract	
3	**Set Up Governance**	
3.1	Establish Import/Export Guidelines	
3.2	Determine Intellectual Property (IP)	
3.3	Implement Security Protocol(s)	
3.4	Protect Personal Identifiable Information	
3.5	Conduct Collaboration Platform Review(s)	
4	**Establish Project Management**	
4.1	Supply Chain Management	
4.2	Authority Delegation	
4.3	Planning and Measuring	
4.4	Risk Analysis	
5	**Set Up Interfaces and Organization**	
5.1	Nominate Focal Points	
5.2	Provide Access	
5.3	Define a Support System	
6	**Set Up Collaboration Environment for Program Life**	
6.1	Preparation	
6.2	Initialization	
6.3	Operation	
7	**Conduct the Program Review(s)**	
7.1	Prepare the Optimized Program Review	
7.2	Conduct the Program Review	
7.3	Follow Up and Close the Program Review	
8	**Perform End State Tasks**	
8.1	Review Data for Archiving	
8.2	Archive the Data	
8.3	Decommission the Program/Project Collaboration Space	
8.4	Manage the Contract Expiration and Close and Terminate the Contract	

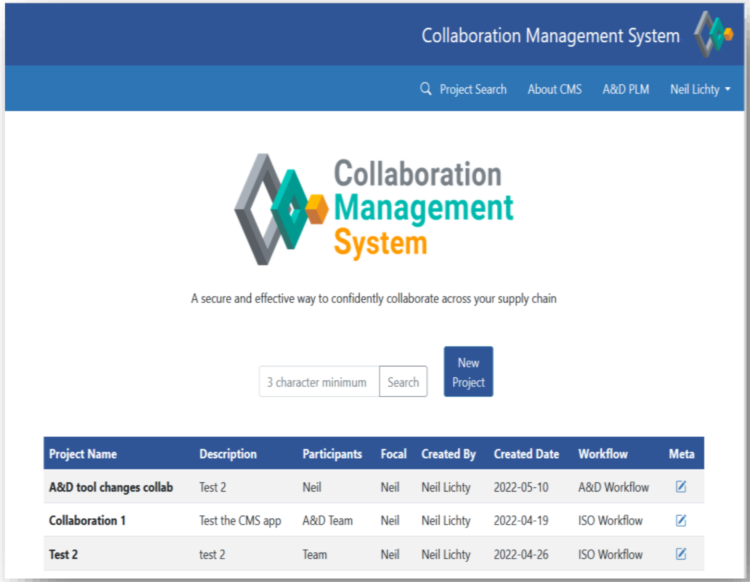
AD PAG Collaboration Guidelines - Eight steps with sub-steps

Step 1. Prepare for Collaboration and Data Exchange	1.1 Define Type and Scope of Data	1.2 Define Recommended Way of Collaboration	1.3 Define Recommended Project Management Terminology and Tool Set	1.4 Define IP-Compliant Process	1.5 Assess Collaboration Capability	1.6 Supplier Selection Announced	1.7 Data Collaboration Agreement	1.8 Audit and Follow-Up
Step 2. Establish Commercial, Contractual, and Legal Relationships	2.1 Define Data exchange rules & process	2.2 Define Project management terms	* 2.3 Monitor and Manage Contract Execution and Contractual Coverage of Evolution Requests	* 2.4 Anticipate and Mitigate Contractual Risks	* 2.5 Amend Contract	* 2.6 Manage the Contract Expiration and Close and Terminate the Contract		
***Step 3.** Set up Governance	3.1 Establish Import/Export Guidelines	3.2 Determine Intellectual Property (IP)	3.3 Implement Security Protocol(s)	3.4 Protect Personal Identifiable Information	3.5 Conduct Collaboration Platform Review(s)			
*** Step 4.** Establish Project Management	4.1 Supply Chain Management	4.2 Authority Delegation	4.3 Planning & Measuring	4.4 Risk Analysis				
*** Step 5.** Set up Organization & Interfaces organization	5.1 Nominate Focal Points	5.2 Provide Access	5.3 Define Support System					
*** Step 6.** Setup Collaboration Environment for Program Life	6.1 Preparation	6.2 Initialization	6.3 Operation					
*** Step 7.** Conduct the Program Review(s)	7.1 Prepare the Optimized Program Review	7.2 Conduct the Program Review	7.3 Follow-Up and Close the Product Review					
Step 8. Perform End State Tasks	8.1 Review data for archiving	8.2 Archive Data	8.3 Decommission Collaboration Platform	8.4 Manage Contract Expiry, Close and Terminate Contract				

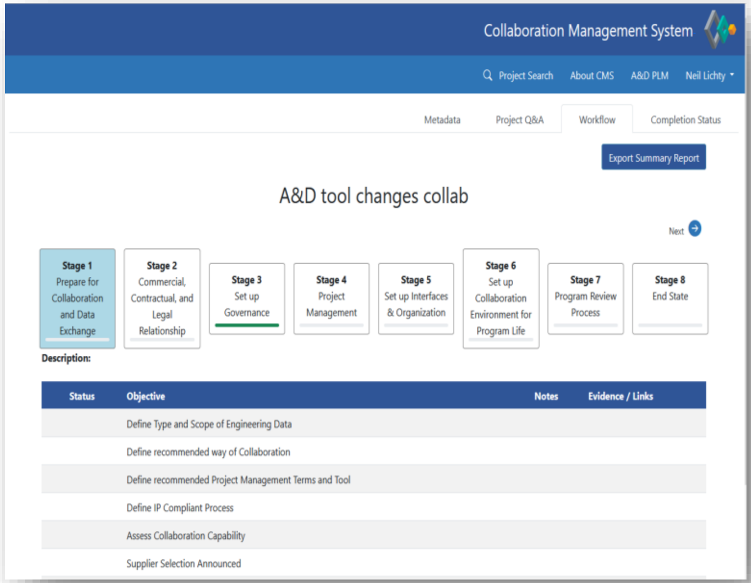
** Can be done in parallel and can be done multiple times*

Link to Paper

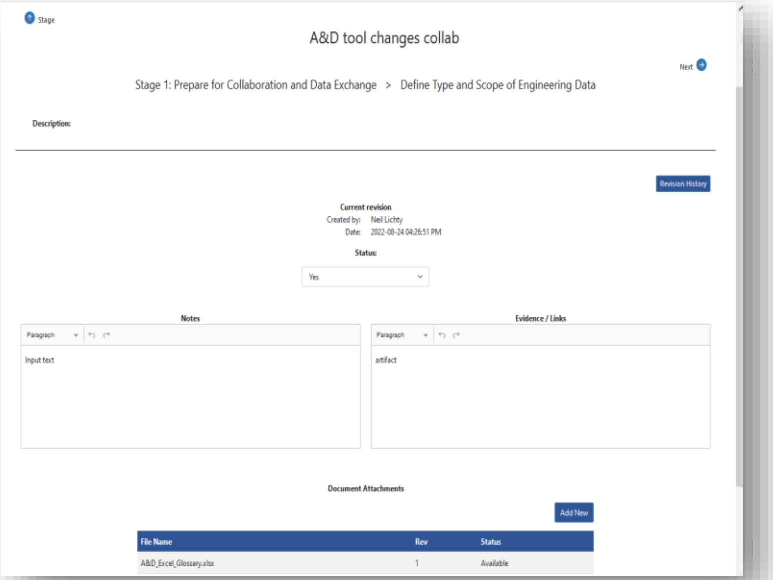
Collaboration Management System (CMS) Application - Embedding collaboration guidelines in a web-based application



Project work queue
(initial window upon login)



Collaboration status view showing progression of project stages



Individual collaboration objectives showing evaluation details including notes, deliverables and attachments

Images courtesy of Talisen Technologies

Collaboration Management System (CMS) Application - Video

Collaboration
Management
System

Collaboration Management System

CMS (Collaboration Management System) is a productivity aide with a workflow based on the A&D PLM Collaboration Guidelines and ISO 44001 strategic lifecycle framework. Utilizing a common Industry approach for data exchange greatly enhances communication across your networked community and supports compliance with industry standard collaboration practices.

CMS utilizes the A&D PLM collaboration methodology and the ISO 44001 standard which contains licensed materials from the ISO organization.

Availability & System Requirements

CMS is available as a cloud solution hosted here on My Supplier Net, or can be deployed locally on premise. If you're interested in setting up a local instance on premise here are the IT minimum requirements:

- Small Linux application server (physical or virtual machine)
- Local or network Database (i.e., MySQL, Oracle)
- Disc or network storage for file attachments
- A local authentication/access service

Virtual Tour (video)

https://www.mysuppliernet.com/assets/videos/CMS.mp4

Collaboration Management System (CMS)
Pilot Results and Feedback

Pilot Activity:

- **CMS Pilot Completed April 2024**

Positive feedback:

- **Tool/methodology provides guidance and rigor for collaboration**
- **Tool gives better understanding of SOW developed, which could have been established in earlier phases of project**
- **The CMS framework enabled further discussion around specifics such as IT infrastructure, data IP rules, supplier agreements, and data/project archival**

Opportunities:

- **Beginning of CMS framework could further address discussion around exploratory technology**
- **Difficult for team to address program review questions within steps as a few did not apply**
- **There were questions around validation of answers, how do we know if answers to the framework were fulfilled?.**
- **It would be useful to integrate a partnership between CMS and other data exchange tools**

Global Collaboration - Phase 3

Culture Change to Optimize Collaboration
- Culture Change within the Organization
- Change Management
- User Interface Between Human and Machine

Importance of Supplier Engagement Levels

Collaboration-Supporting AD PAG Initiatives
- Model-Based Enterprise (MBE)
- Model-Based System Engineering (MBSE)
- Digital Twin / Digital Thread (DTw / DTh)

Standards applicable to collaboration

Enabling Digital Transformation through Collaboration
- Digital Innovation Shaping the Industry
- Enabling Global Collaboration
- Industry Data Standards Supporting Transformation

PLM Collaboration Solutions
- PLM Synchronous Systems (Application Layer)
- PLM Asynchronous Systems (Application Layer)
- PLM Engineering Data Interoperability (Product Lifecycle)

Vendor Software Evolution to Support Global Collaboration

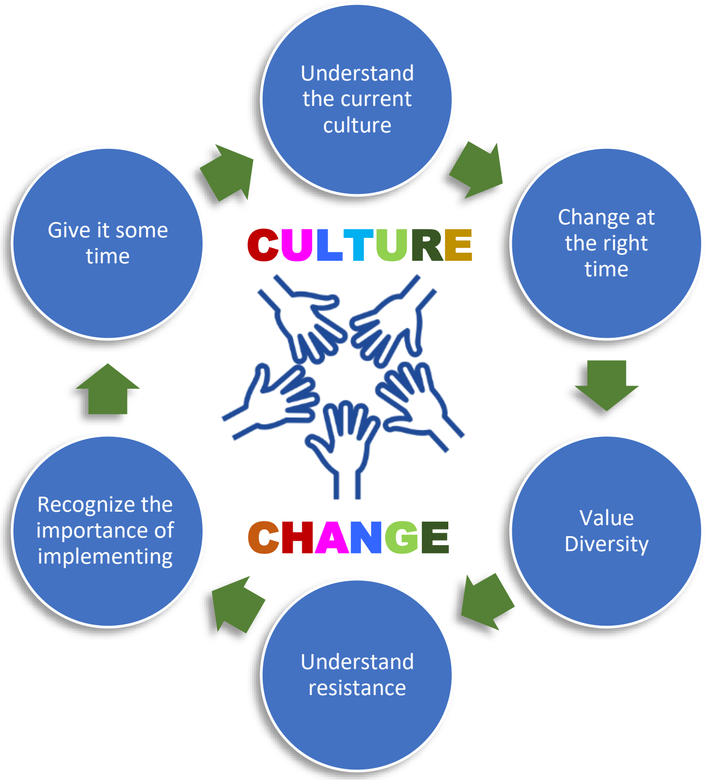
Summary

Culture Change within the Organization

Implementing new PLM or other equivalent tools may require re-engineering the processes and reconstructing the organization to support the new tools and capabilities. **Organizational Change Management** (OCM) must be engaged throughout the process. OCM typically includes four key components: communications, training, resistance management, and culture change. It is defined by **ISO/TS 10020**:2022 Quality Management Systems Organizational Change Management Processes.

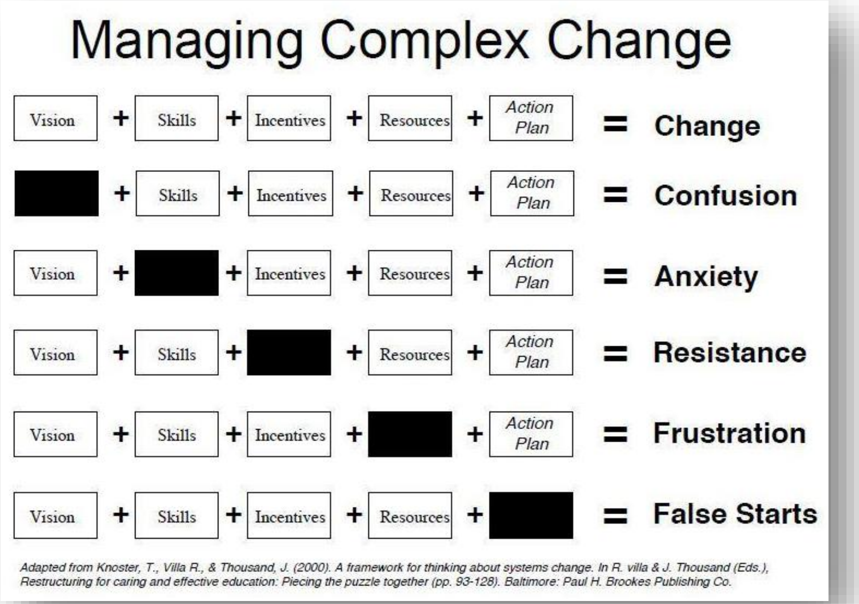
Implementation of a new PLM or other collaboration tool requires revaluating existing processes and considering potential changes to optimize the organization. Before implementing any new collaboration tools, it is necessary to involve management and stakeholders to ensure that they understand and will communicate the planned capabilities and potential impacts to the organization. Commitment of management and stakeholders is critical to ensure implementation of the enhanced processes, which are not necessarily new processes, but current processes adapted and improved with the new collaboration tool capability.

Leaders must be invested in the change and actively champion the change. This means clearly communicating the desired culture, modeling the behaviors, and holding the teams accountable.



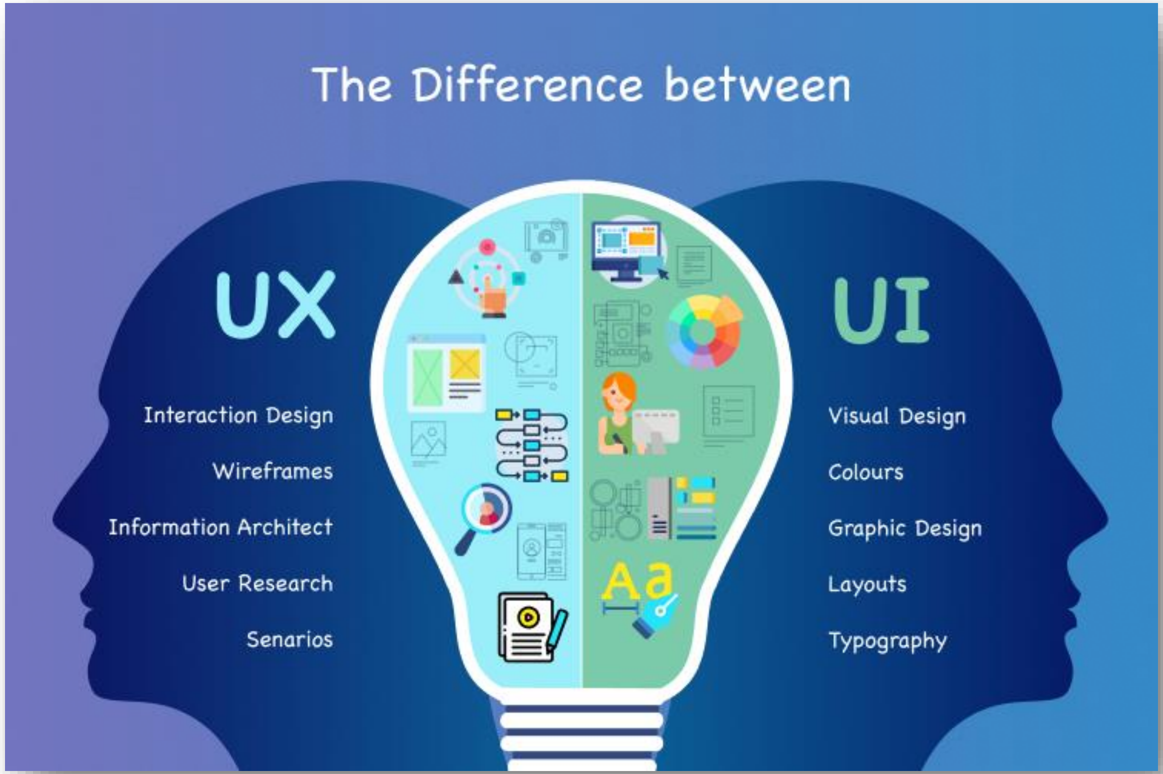
Change Management

- Develop a clear vision defining what success looks like and its benefits to the company
- Assess collaboration effectiveness and adjust approaches as required
- Select a panel of key users representative of different generations, categories, adaptability, etc.
- Integrate the key users into the study, development, and testing of the new tool
- Identify the blocking points and work with the software provider (vendor) to find a solution(s)
- Communicate transparently via the OCM team throughout the process about the results—successes, failures, and blocking points—explaining why some processes and organization changes are required
- Note: This necessitates some flexibility from not only the software vendor but the software, which must be easily configurable and must not require adaptations or specific interfaces that would have to be redone in the event of software changes



User Interface Between Human and Machine

To facilitate adoption of new collaboration tools or other equivalent tools by operators, the interface between human and machine must be **easy and intuitive**, and the navigation menus must be explicit. It is also useful to have integrated multi-lingual user guides configured by the administrators

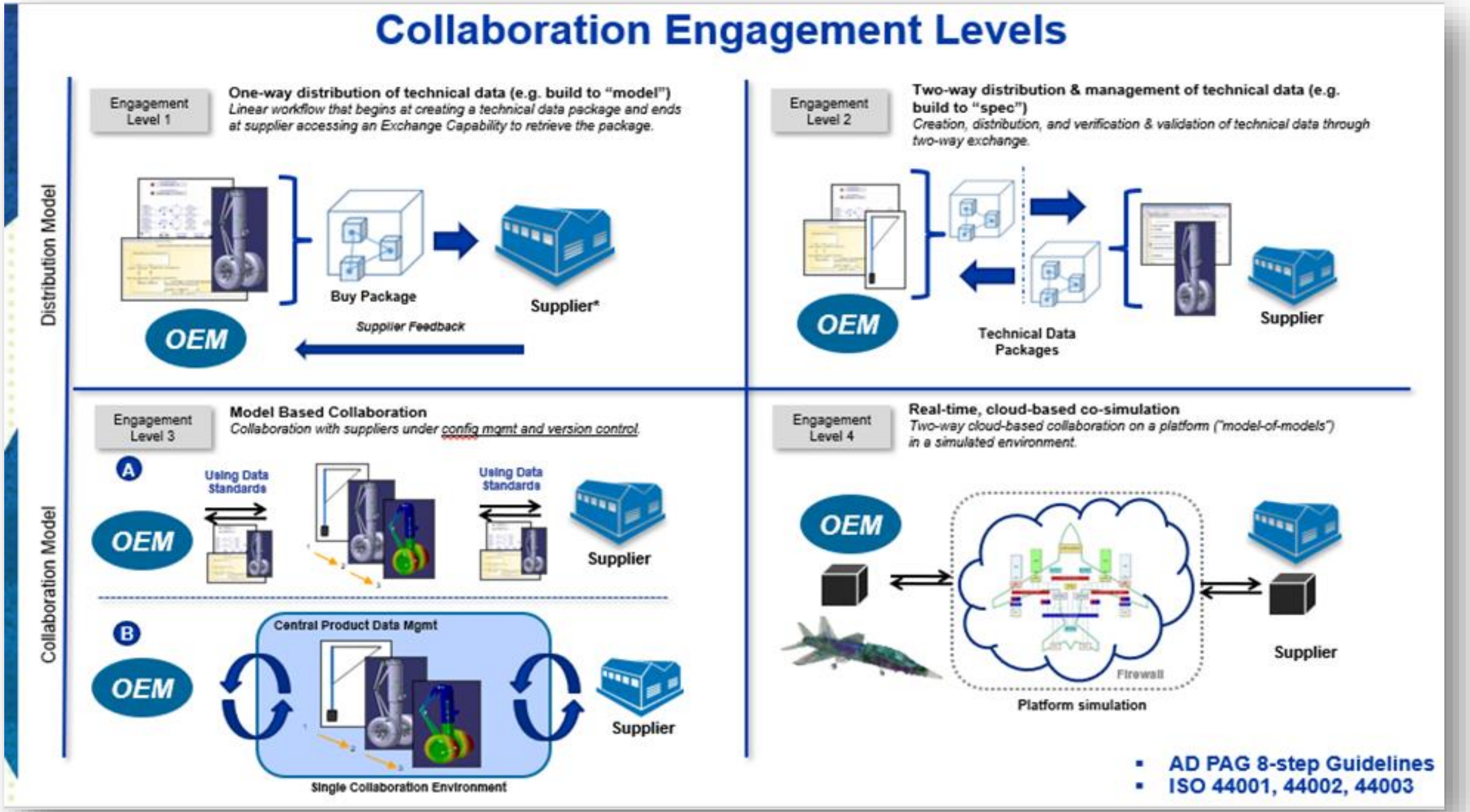


Source: Google

Supplier Engagement Levels

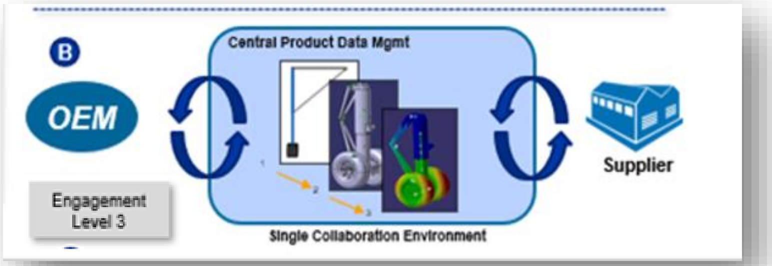
- Engagement Level 1 – One-way distribution of technical data (e.g., build to “model”); linear workflow that begins at creating a TDP and ends at the supplier accessing an exchange capability to retrieve the package
- Engagement Level 2 – Two-way distribution and management of technical data (e.g., build to “spec”); creation, distribution, and verification and validation (V&V) of technical data through two-way exchange
- Engagement Level 3 – A model-based collaboration service enables co-design with suppliers; digital metadata enables interoperability; collaboration with suppliers under configuration management and version control
- Engagement Level 4 – Real-time, cloud-based co-simulation; two-way cloud-based collaboration on a platform (“model-of-models”) in a simulated environment

Supplier Engagement Levels



PLM Asynchronous Systems (Application Layer)

- The OEM provides an on-premises or cloud-based collaboration space to which the OEM–PLM workflow links to the source data content in a separate PLM. Once data is available, the solution notifies the supplier of availability and updates. Again, this approach offers bi-directional collaboration such that any format of source data from the supplier could be used to trigger a notification to the OEM. This use case can be reversed where the OEM has the source data and suppliers have a link to it from their PLM. This example's applicable Engagement Level is EL3b shown in the Importance of Supplier Engagement Levels section.



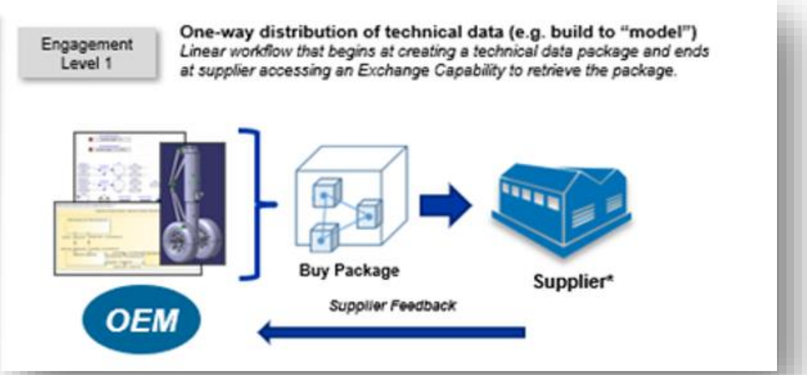
- The PLM infrastructure allows one collaborative workspace for multiple communities or projects. This approach requires a network connection to the PLM environment, which can be challenging depending on the policies and procedures of the OEM and/or supplier. In this use case the OEM and the supplier share a common PLM environment where source data is hosted.

PLM Synchronous Systems (Application Layer)

The asynchronous type of global collaboration supports the following examples of data exchange:

- Consider a supplier (i.e., one that is manufacturing the product in accordance with the OEM's engineering data and specifications). This is sometimes known as the make-to-print model. The engineering data is the drawing or model, and it references multiple specifications and standards to enable compliant manufacture. This example's applicable Engagement Level is EL1 shown in the Importance of Supplier Engagement Levels section 3.6.

- The combination of engineering data, specifications, models, standards, and extended content must also be managed across the collaboration solution and the product definition. Manufacture of the product in this scenario is typically by a design supplier where collaboration occurs between primes and sub-tiers, with primes off-loading partial content to the sub-tiers. This approach offers bi-directional data movement from OEM to supplier and from supplier to OEM, which is particularly useful during early product development when considering producibility.



Collaboration-Supporting AD PAG Initiatives

Within the AD PAG working groups teams are focusing on initiatives involving MBE, MBSE, and the Digital Twin/Digital Thread, Digital Engineering. These teams are helping describe methods for collaboration and digital transformation across the aerospace industry.

A summary of the activities these teams are pursuing follows. Please refer to the links for more detailed information about each of the teams e.g. MBSE, Digital Twins Digital Threads etc. ⇒ AD PAG

The concepts and requirements proposed by these working groups are addressed through this team's AD PAG Global Collaboration 8-Steps Guidelines.

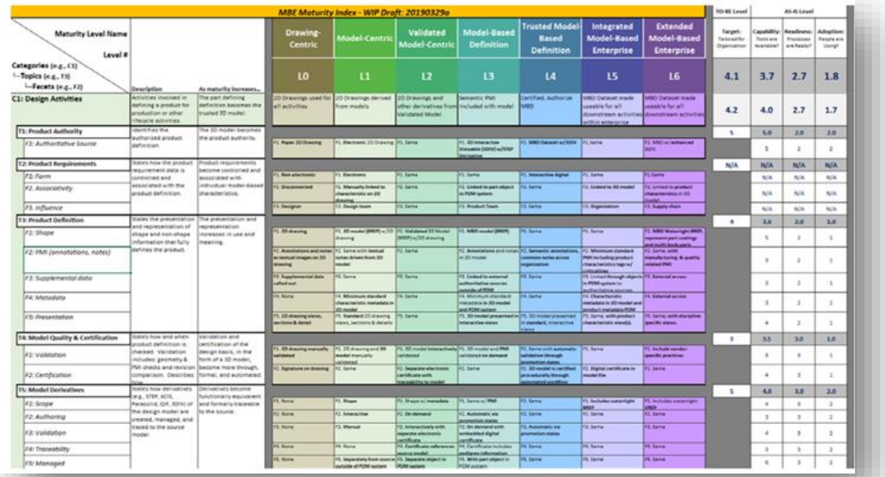
Legacy collaboration methods started with the exchange of drawings, engineering changes, and bill of materials usually by mail.

Once exchange systems became available, electronic 2D data was started, and it eventually changed into 3D geometry.

As digital exchange environments became more common, the type of data exchange became a superset of digital collaboration data. (Refer to the MBE Maturity Index figure.)

The collaboration platforms continue to evolve to allow processing of the enhanced MBE collaborative requirements.

Sandia National Laboratories has published a **Model-Based Enterprise** (MBE) Maturity Level Index, which is available at https://www.sandia.gov/app/uploads/sites/171/2022/06/NSE_MBE_Maturity_Index_UUR_B.3.xlsm.



Model-Based Systems Engineering (MBSE)

Although **Model Based Systems Engineering** (MBSE) is not a core component of a federated or synchronized system, a bi-directional link must be established to ensure that all requirements are fully captured for the complete supply chain. Significant content has been provided by the AD PAG MBSE team:

- MBSE Data Interoperability - Specification Report - Research Report from 9th December 2020
- MBSE Data Interoperability - Architecture Model Exchange Solutions - Presentation from 16th November 2020
- Model-Based Systems Engineering (MBSE) Data Interoperability - Position Paper from 24th January 2019
- Additional work is underway supporting model-based OEM/supplier collaboration needs in the Aviation Industry Driving Toolchain Requirements and Tool Provider Selection areas
- Additional external resources supporting this team are under applied architecture frameworks like the Unified Architecture Framework (UAF) or Department of Defense Architecture Framework (DoDAF); The British Ministry of Defence Architecture Framework (MODAF) replaced by the North Atlantic Treaty Organization (NATO) Architecture Framework needs mapping to a universal methodology to enable collaboration

Refer to the following link to download the AD PAG MBSE team's publications: AD PAG MBSE
The AD PAG MBSE team continues to refine collaboration methodologies, including the comparison of direct interfaces or integration between platforms.

The benefits of using a neutral standard for collaboration should be considered. The supplier collaboration scenarios and methods are outlined as part of the AD PAG 8-Step Guidelines and supplier engagement levels

Digital Twin / Digital Thread (DTw / DTh)

Digital Twin Digital Thread standards are necessitating greater attention by standards organizations that support the A&D industry. This includes the recognition and willingness to address the continuity of the digital twin across the product life cycle. The AD PAG Digital Twin/Thread team has noted that the following should be considered in the maturation of digital twin/thread standards:

- Revised definition and alignment of the digital twin/thread construct will continue as technology aligns with the functional and operational digital twin requirements.
- Interoperability between and composition of digital twins will require new standard types to be defined within the digital thread.
- Digital Product Authoritative Source is an emergent attribute of the digital thread. The digital thread will be required to support non-persistent and long-term data storage requirements.

The concept of digital twin/thread standards introduces the need for broad standardization of complex and rapidly changing business processes, system definition, and IT. This standardization will be needed to ensure that digital twin/thread data interoperability and data utilization complexities are minimized.

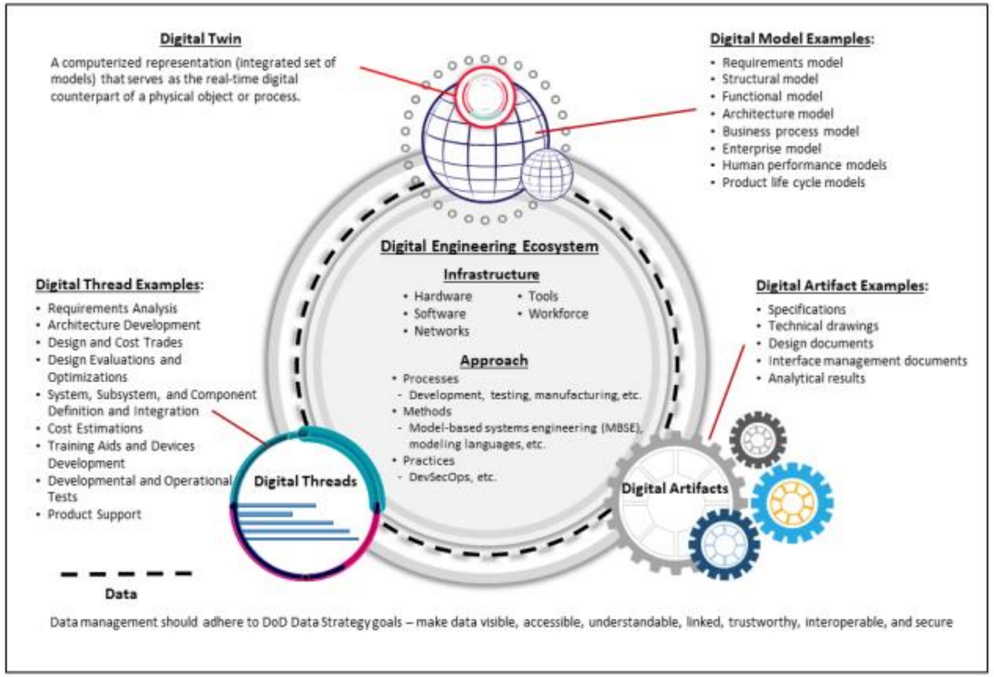
The emerging content provided by the AD PAG Digital Twin/Thread team can be downloaded at the following link: https://www.cimdata.com/en/aerospace-and-defense/publications/digtaltwin-digitalthread.

Digital Engineering

US DoD Directive 5000.97 from 21st December 2023

https://www.cto.mil/news/digital-engineering-practice/

Digital Engineering Framework

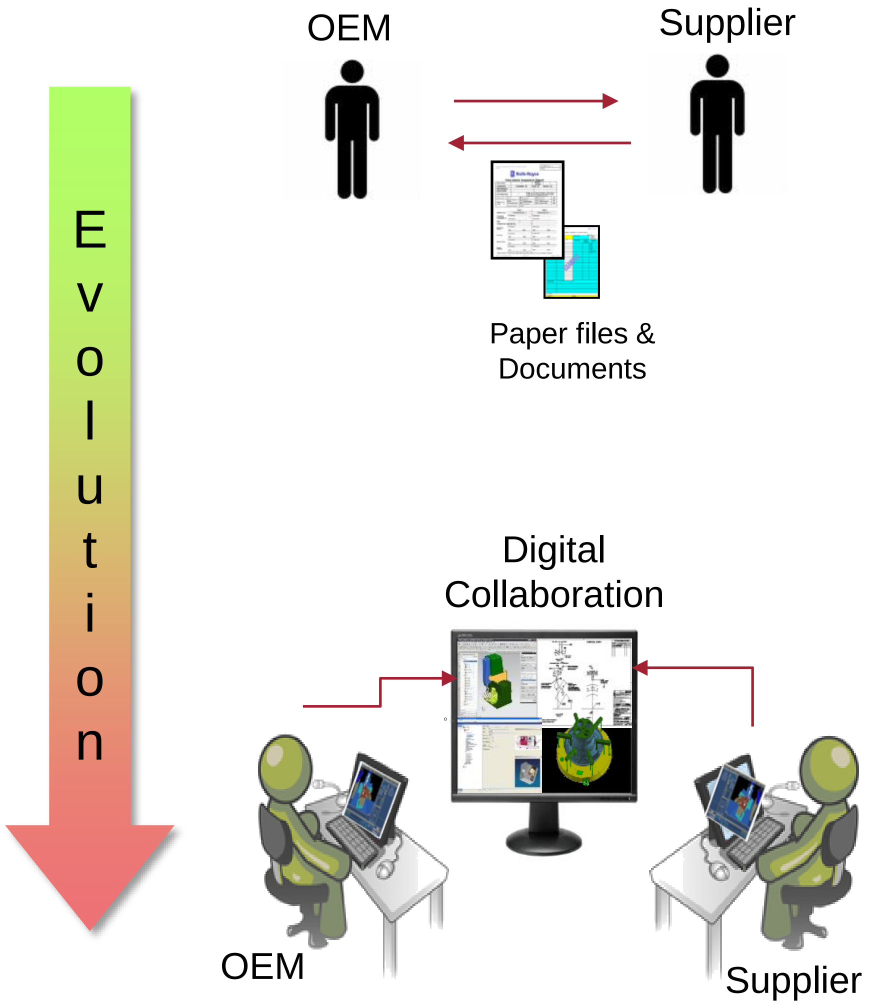


Enabling Digital Transformation through Collaboration

Years ago, most companies started to replace 2D drawings with 3D models, but this was only the first step. For a complete data-centric way of working, not only 3D models but other data such as the following needed to included:

- MBSE (Requirements, Functional, Logical, and Physical (RFLP), logical and functional, behavioral model, V&V, etc.)
- Configurations, documentation, change management, IP, export control
- Dummy parts (IP and export control compliant model)
- Modeling and simulation (weights, loads, finite element method (FEM); light, acoustic noise, Computational Fluid Dynamics (CFD), thermal, etc.)
- Electric (logic, form board for manufacturing, etc.)
- Electronic (printed boards, chips, etc.)
- Software (product line engineering, source code, libraries, open source, etc.)
- Quality (first article inspection, statistical qualification, 3D measurement etc.)
- Customer technical publication (maintenance manuals, illustrated parts catalogue (IPC), spare parts, etc.)
- PMI (tolerances, material, surface requirements, quality standards, etc.)
- Archiving and retrieval (LOTAR)

Only with full interoperability and traceability across company borders can efficient collaboration that ensures IP protection, export control, etc. be enabled. (3D geometry envelopes, shrink wraps or similar could be an appropriate solution).



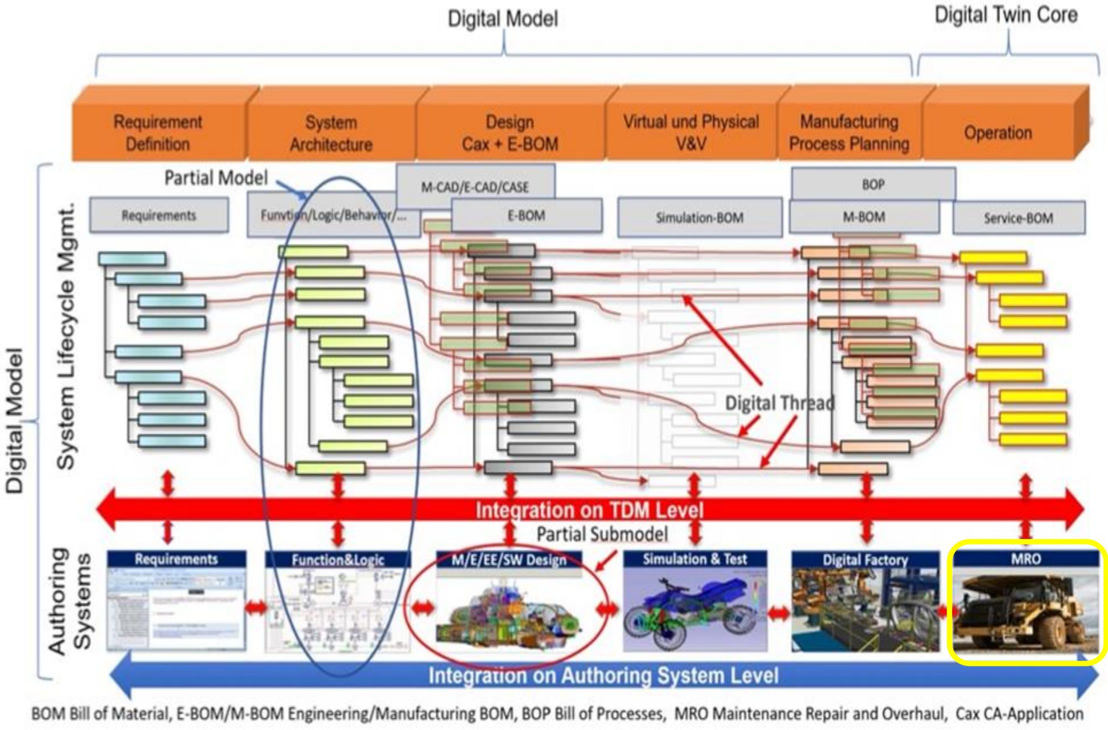
⇒ Data is the new gold!

Digital Innovation Shaping the Industry

Digital innovation is reshaping the way most industries and businesses are functioning today. By 2030, current and legacy data, data collection, and analysis will be the basis of all future service offerings and business models. Robotics, augmented/virtual reality, sensor technology, internet of things (IoT), building information modeling systems, and other disruptive technologies are on the increase and must be considered.

In the future, digital information/data including tools/systems needs to be connected (i.e., to cover the whole lifecycle). Also, digital information needs to be clarified to support in-service aircraft data. This data requires regular updates supporting Maintenance, Repair, and Overhaul (MRO) or other in-service activities (e.g., derivative product creation). Existing data needs to be better structured and of good quality to reach these goals. A data-centric and model-based way of working is the enabler for a digital twin and for continuous data flow between different tools and across company borders and is essential for efficient collaboration.

Enhancing current and new disciplines must be taken into consideration (e.g., architecture/building information, jigs and tools, infrastructure, cranes, robots, power, water and waste, etc.) to establish a digital twin covering the entire lifecycle. The digital twin/thread should be a byproduct of a global collaboration effort supported by continuous data streams. And the source data shared across organizations should be made available in a standard interoperable format to minimize data translation, re-creation, manipulation, and scanning.



Industry Data Standards Supporting Transformation

Open standards (e.g., STEP, JT, FMI, SSP, SysML) would enable, reaching the goal of digital transformation. In addition to that, close collaboration with several associations (e.g., PDES, prostep ivip, IDTA, IDSA, NAFEMS, INCOSE) should be improved, and close cooperation with standardization development organizations like ISO, IEC, OMG, Modelica, and SAE required. For more information about the standards, refer to Table 3 for the AD PAG Standards team's publications.

Associated AD PAG Sub-Teams and Publications

Table 3 – AD PAG Sub-Teams and Publications

Sub-Team's Name	Publications Link
Digital Twin Digital Thread	https://www.cimdata.com/en/aerospace-and-defense/publications/digtaltwin-digitalthread
Global Collaboration	https://www.cimdata.com/en/aerospace-and-defense/publications/global-collaboration
Model-Based Definition and BOM Definition	https://www.cimdata.com/en/aerospace-and-defense/publications/mbd-bom
Model-Based System Engineering	https://www.cimdata.com/en/aerospace-and-defense/publications/mbd-bom
Multi-View Bill of Materials	https://www.cimdata.com/en/aerospace-and-defense/publications/mv-bom
PLM Technology/Obsolescence Management	https://www.cimdata.com/en/aerospace-and-defense/publications/obsolescence-management
Standards	https://www.cimdata.com/en/aerospace-and-defense/publications/standards

Vendor Software Evolution to Support Global Collaboration

- Systems must provide a change management service for reviewing, scheduling, tracking, incorporating, and ensuring visibility of customer enhancement requests
- Systems must allow access and synchronization with other PLM systems and with other connected systems
- Systems Application Program Interfaces (APIs) must support integration with other systems and facilitate collaboration
- Systems must provide user-friendly and customizable interfaces
- Systems must provide for industry standard neutral file interoperability
- Systems utilizing industry neutral file interoperability must show support of the capability of V&V between the source and the neutral format
- Systems must work to incorporate and adhere to the latest industry standards as soon as practical
- Systems must support the collaboration standards. Refer to Table 2 in the Collaboration Standards section
- Systems must support a data-centric approach to ensure traceability and digital continuity
- Systems must support libraries containing additional meta data. (i.e., standard part, material specifications, mass properties, IP, etc.)
- Software providers must ensure compatibility between releases
- When a new version of software is issued, the vendors must implement the process that updates all the shared data

Enabling Global Collaboration
Summary

- The digital transformation must allow innovation with tools that are able to integrate the benefits of these innovations to optimize global collaboration

- To enable global collaboration, systems need to be connected and a strategy for the use of data defined. The data should be in easy-to-use formats with traceability between several systems and from requirements to behavioral models.

- The tools must not be a barrier to collaboration; each partner must be able to use their own PLM or CAD system and be able to integrate data or models from another system with minimum conversion and validation (e.g., CATIA model versus Unigraphics/NX model or between two different PLM software systems, such as ENOVIA and Teamcenter

- Processes and tools for validation conversion (CAD, Data base, meta data, Units, PMI, etc.) must be available and agreed upon for each collaboration program
- Engagement with software providers must occur to develop a process that allows automatic updates of shared data

Enabling Global Collaboration Summary - Continued

- Going forward, RFLP, 3D models, BOM, Engineering Change Number (ECN), software and electronics, etc. must be considered. Examples of systems to manage this type of data include but are not limited to requirement management systems, MBSE, Application Lifecycle Management (ALM), PLM, and Enterprise Resource Planning (ERP).

- No redundant copies are generated and only references to centralized standard part libraries within the collaborating systems

- Part definition is becoming more than 3D data and drawings; new data types/formats are required by the new evolving initiatives, such as MBD, MBE, digital twin, digital thread, MBSE, and quality assurance, and must be supported to ensure end-to-end collaboration

- Specifications and reporting of the impacts of changes to the processes and/or definition must be fluid, transparent, and traceable; feedback loops must be available to be capture, document, and communicate lessons learned

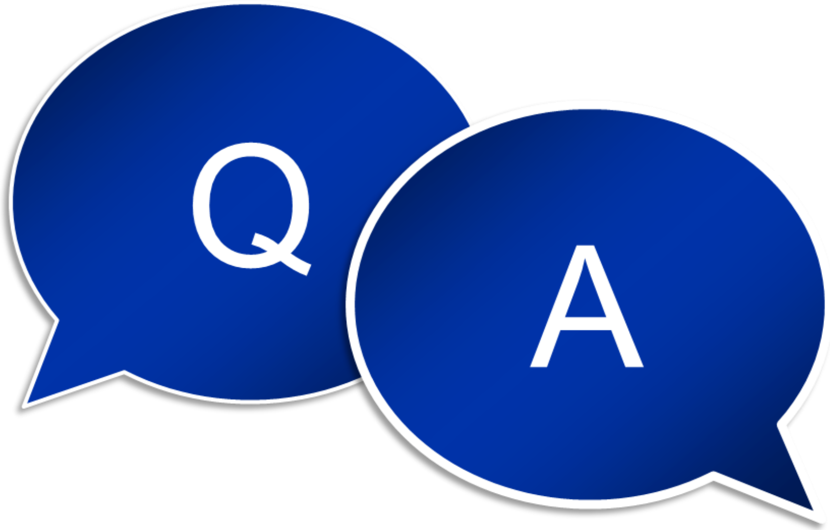
- Consistent adoption and implementation of common, agreed upon standards used specifically with each collaboration project/program

- Promote Standard Numbering System (SNS) numbering identification to facilitate data management from requirements to maintenance manuals

- Coordination amongst AD PAG teams should be increased

A&D PLM Global Collaboration - Q&A

Many thanks for your attention!



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