Expanding the MBPLE method from marketing to design within the aircraft interior sector : digital threat between ALM, PLM and ERP

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AGENDA

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Chapter 01

PRELUDE

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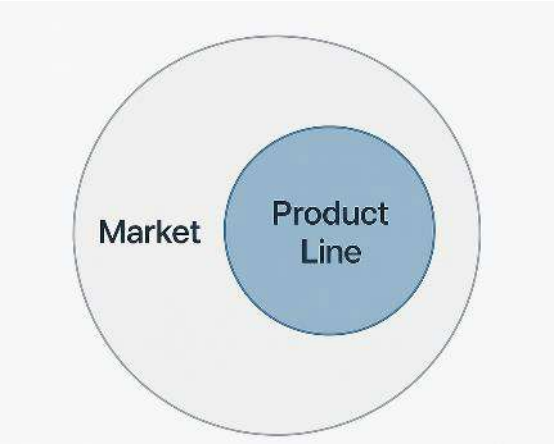
What are the main reasons that drive a company to adopt a PLE approach

- **Principal Reasons**
  - Reduce costs
  - Reduce time-to-market
- **Some others Reason**
  - Propose flexibility and customization
  - Simplify industrialization
  - Improve standardization and quality
- **Key success factor:**
  - Align all the organization of the same KPI for RC and NRC costs?
- **Attention Points**
  - Manage the loss of break even of the PLE in the early phase of the PLE (3 projects)



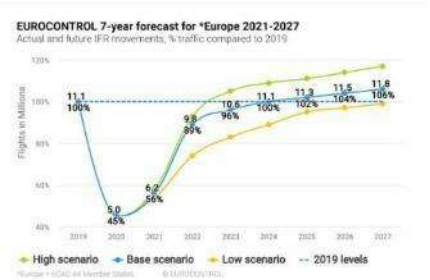
A successful product line should be tailored to a well-defined market segment to guarantee a favorable return on investment.

A universal product line that suits everyone remains an idealistic notion (PLE perimeter)

Chapter 02

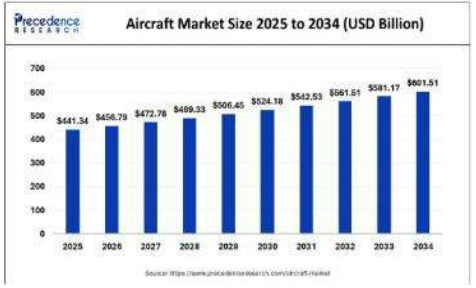
WHY PLE APPROACH MAKES SENSE FOR AIRCRAFT INTERIORS?

Market Overview and Context

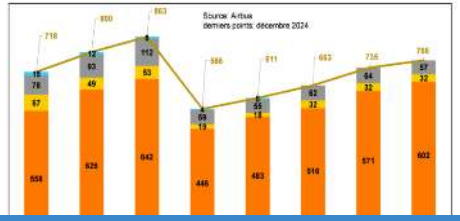


Source : New EUROCONTROL 2021-2027 forecast expects traffic recovery to 2019 levels by the end of 2023

Source : Graphique: Transport aérien : vers un record de passagers en 2024 ? | Statista



Source : Aircraft Market Size to Hit Around USD 601.51 Billion By 2034



8.5 millions new seats over the next decade

The market, encompassing Head of Version and Retrofit Aircraft, is expanding, with new technologies enabling novel aircraft applications that drive demand for innovative interior designs.

Aircraft interiors are a major factor that distinguishes airlines, serving as a reflection of the brand's identity.

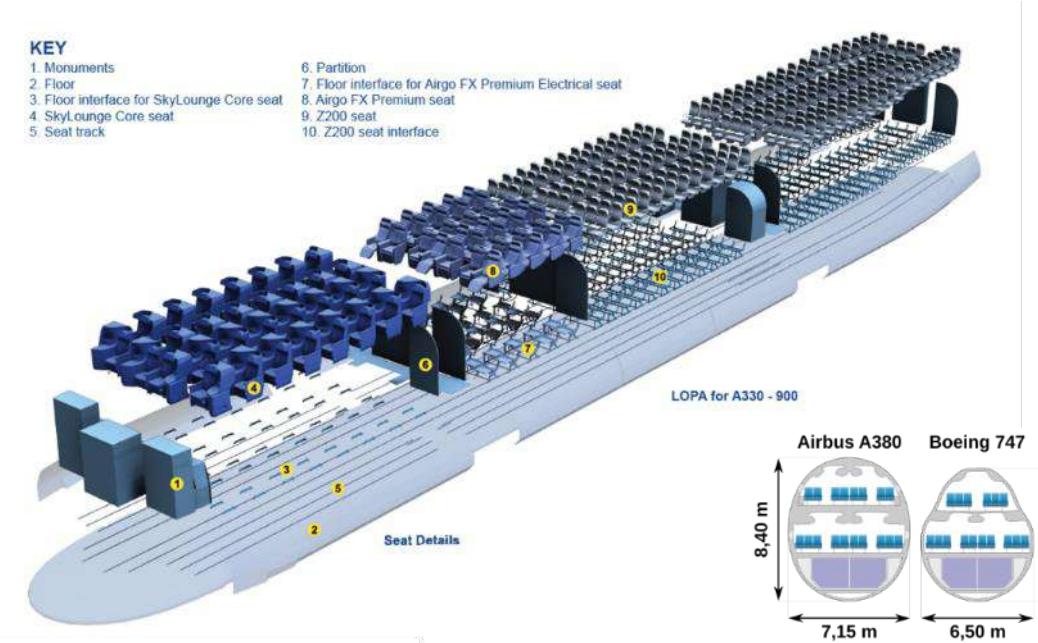


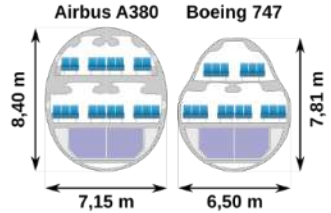



SAFRAN SEATS Portafolio - From Market Needs to Product Line Strategy

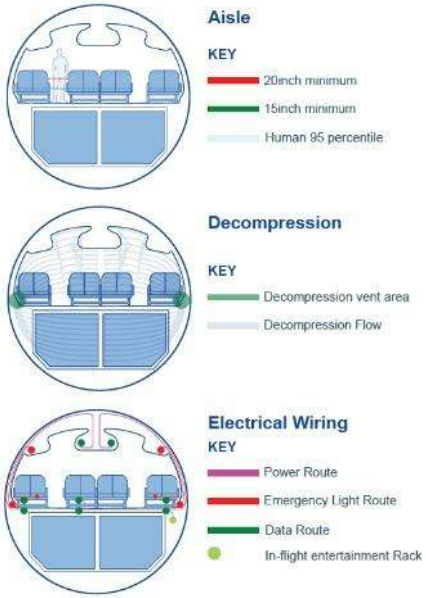
Engineering to Order <- Configuration to Order

How the Layout of Passenger Accommodation (LOPA) is considered





Source : Avion à fuselage large — Wikipédia



Variability is influenced by both the type of aircraft and its integration.

Produce everywhere or Industrial footprint Impact

2025

8

Production units in Europe, Américas, Africa

Economy class seats
Business/First class seats
Economy & Business class seats

Shells
Components

A strong presence worldwide through our factories

Chapter 03

STRATEGIES FOR VARIABILITY MANAGEMENT

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The Transition from ALM to ERP within the PLM: Exploring the Conceptual Boundary

Application Lifecycle Management (ALM) is responsible for managing the upstream elements of system definition.

Product Lifecycle Management (PLM), on the other hand, governs the downstream technical realization. It manages.

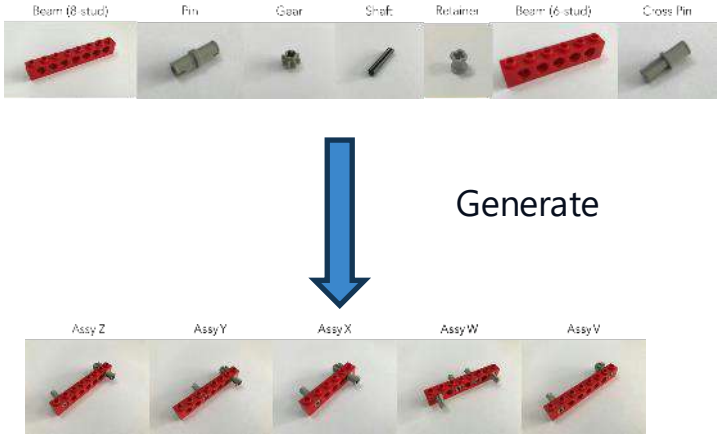
Enterprise Resource Planning (ERP), in turn, manages the industrial and operational execution of the product once it moves from engineering to production and service. This includes.

- **Assets and points of variability are widespread throughout the system and organization**
- **Having a unified tool remains an ideal goal: maintaining clear boundaries between ALM and PLM is key for consistency in a MBPLE approach.**
- **Within a Model-Based Product Line Engineering (MBPLE) framework, clearly differentiating between ALM, PLM, and ERP systems is crucial to maintain alignment between the intended functionality and its physical implementation.**

The variability and the PLE are manage into the extended PLM

How the design driver distributes information throughout the system : Give to Caesar what belongs to Caesar.

- **A robust configuration management implemented within an PLM system enables the handling of a vast number of design solutions alternatives.**
- **Numerous industrial examples have proven this capability.**
  - PLM systems manage product variant
  - They facilitate the visualization and creation of all possible assembly combinations.
- **Nonetheless, we focus the PLM to manage the approved configuration instead to explore the catalogue capability : PLM system isn't intended to be a space for creativity, also if the tools allows this features**
- **Controlling variability within the PLM may result in unrealistic outcomes.**



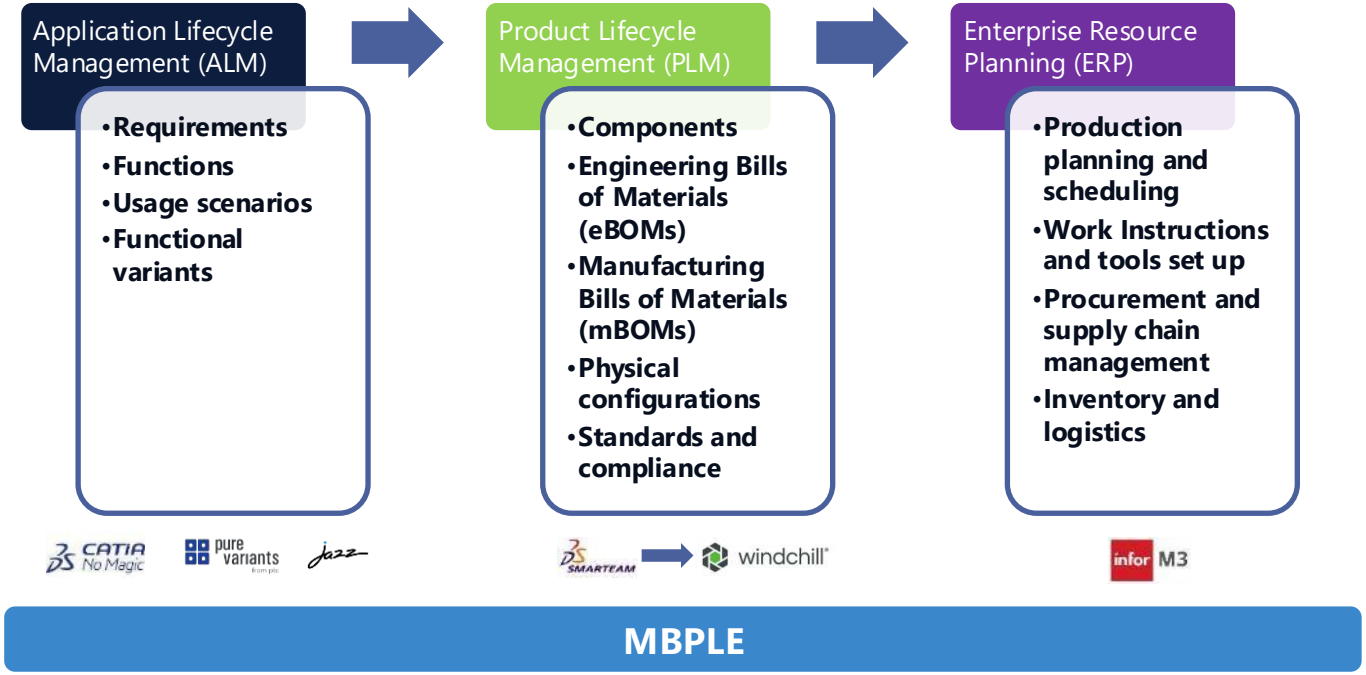
The conventional PLM plays a role within variability management.

How the PLE driver distributes information throughout the system : how we can share the variability model

- **Additional hypotheses:**
  - There is no tool capable of managing all aspects comprehensively.
  - Gradual Change - Rome was not built in a single day.
    - Begin by shifting from 2D tools to N-dimensional variability tools.
- **Some trade off criteria:**
  - Abstraction Level – Impacted artefact
  - Nature of the variability (feature, technical, industrial,..)
  - Certification impacts and rules
  - Frequency of change

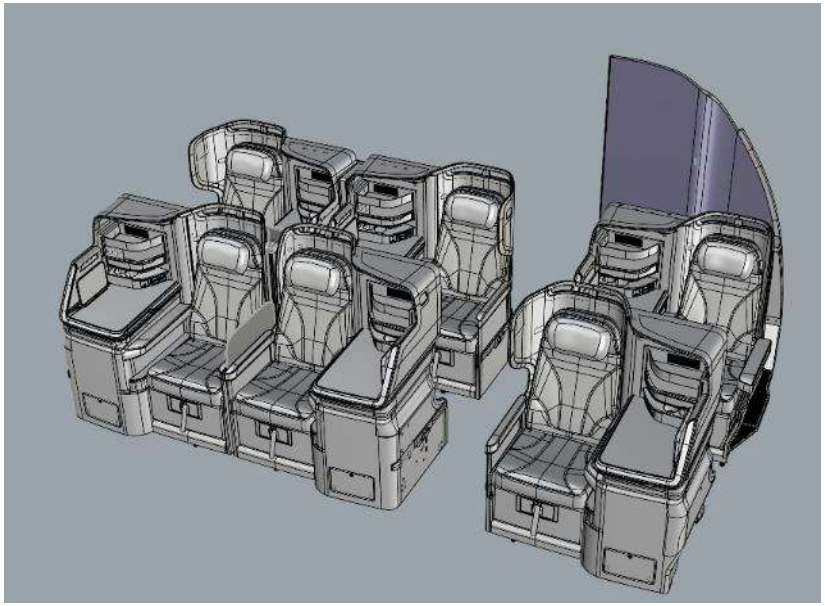
No single definitive solution exists for MBPLE; an effective model is one that aligns well with the intended modelling objectives.

From ALM to ERP : Conceptual frontier



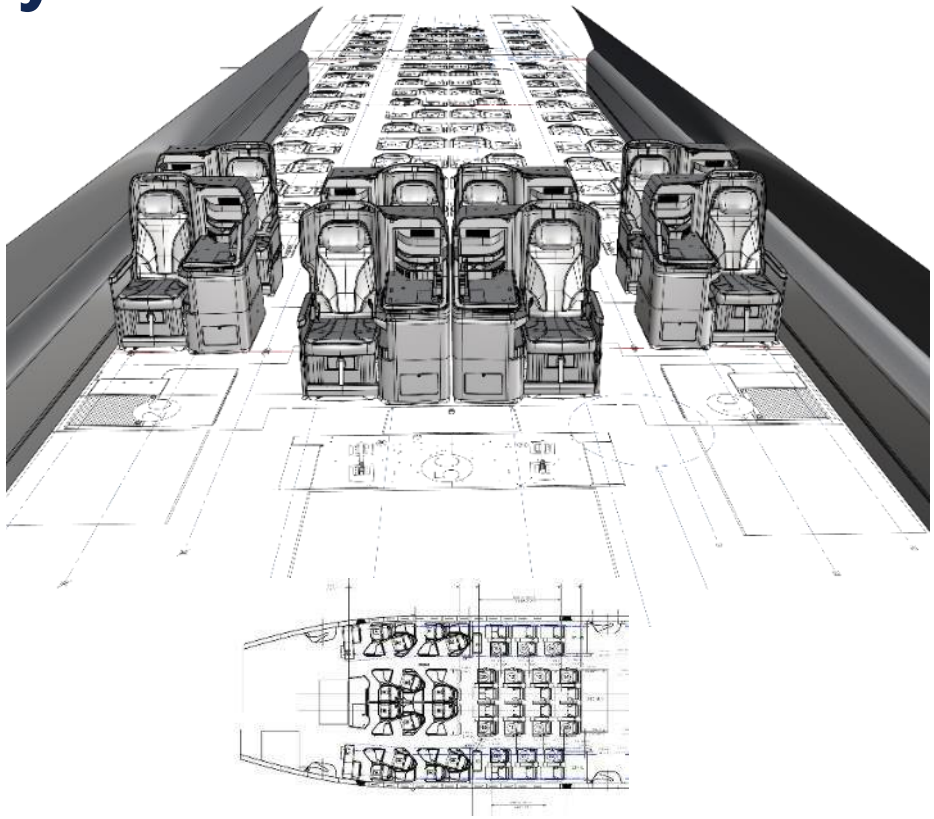
Application Lifecycle Management (functional configuration) : used to manage the functional variability

- **In the ALM, the focus is on managing only the options that Airlines can select:**
  - Product Line / BeSpoke Configuration
  - Double Bed
  - Minibar
  - Massage System
  - Window Shade
  - Headset
  - Wireless Charger
  - Seat size
  - Trim and Finish exclusively for the Customize to Order product
- **Based on this catalogue, there are only 2 or 3 functional configurations available in the LOPA**



Product Lifecycle Management (technical configuration) : used to manage the technical variability

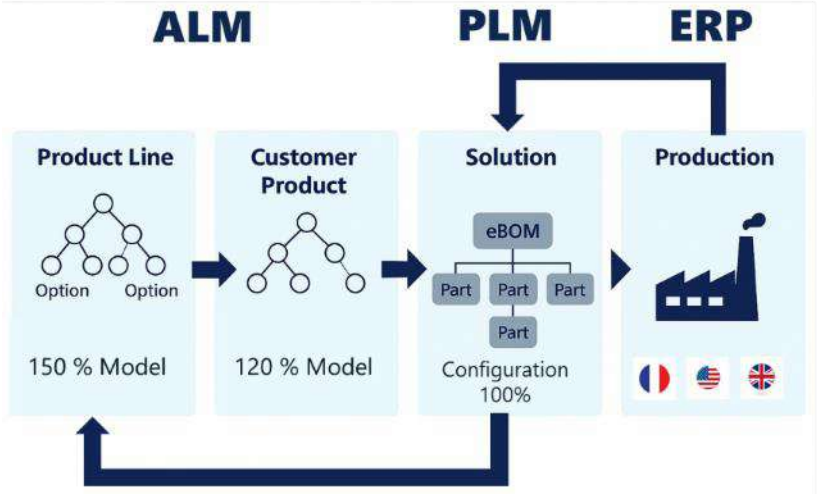
- **Within the PLM, the focus is on managing solely the technical configuration**
  - Catalogue of existing parts
  - Configuration Items (CIs)
  - Change Management
  - Right or Left Hand Item
  - LOPA variations - Sidewall adjustment
  - Certification requirements (such as color and foam)
  - Trim and Finish considerations for Engineering to Order
- **Currently, integration variability may account for the majority of overall variability (18-20)**



Enterprise Resource Planning, the customized solution for manufacturing processes

- **Within the ERP system, the objective is to oversee all components related to the assembly line location**
  - Alternative components (such as harnesses, Velcro, etc.)
  - Parametric design elements (e.g., meal table dimensions)
  - Assembly-related placards
  - Unpainted parts solely for logistics purposes: T&F is included as part of the certification process
- **Currently, variability in production is "limited" by the certification rules: a design is certified**

From theory to legacy world into SoS world



In a theoretical framework, the process flows from Requirement to Product Delivery

However, since the product often predates system engineering, the product line should be supplemented with legacy information.

Re-enforce the Configuration Management

- **If we focus more on system engineering topics : the configuration management should be focus on 3 assets becoming key for PLE deployment**
  - Requirement
  - MBSE
  - Variability Model (Feature Models, Asset Model)

- **Open Questions:**
  - Have a confederate model allowing to manage all the variability/diversity in a single place ?
  - Respect the MBPLE Modeling Language Requirement and Semantics Rules?

Chapter 04

DIGITAL THREAT EXAMPLES

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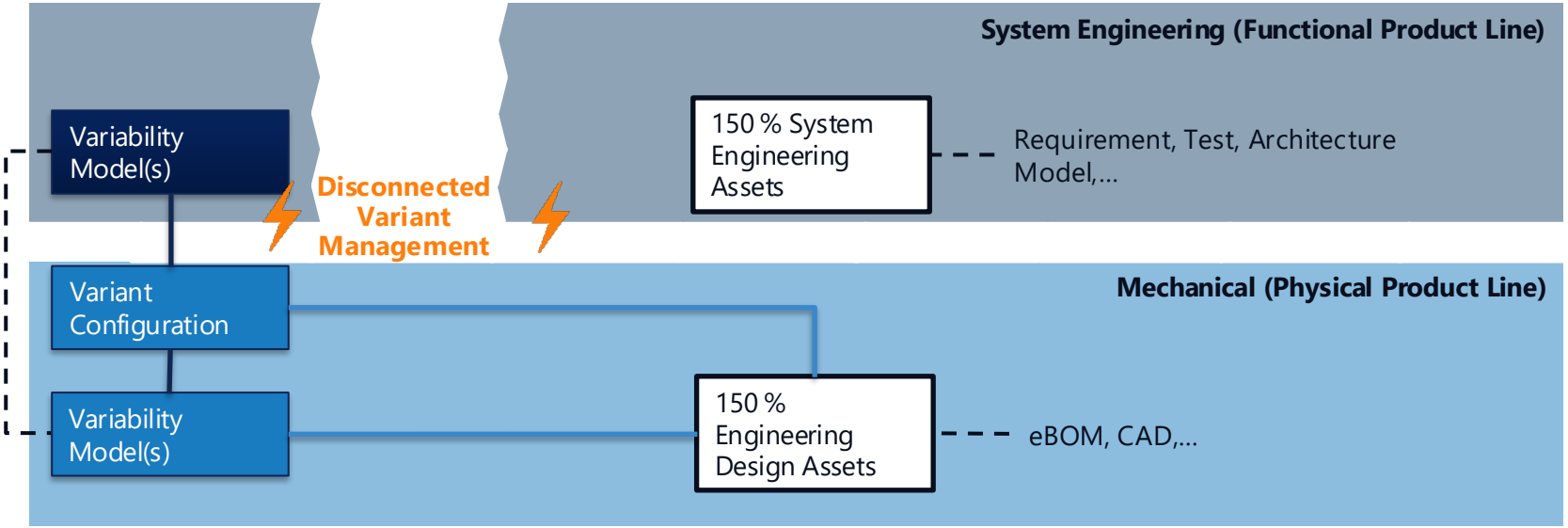
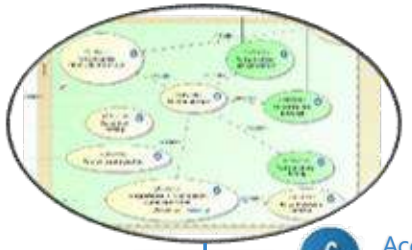
Digital Disruption in the tools for MBPLE



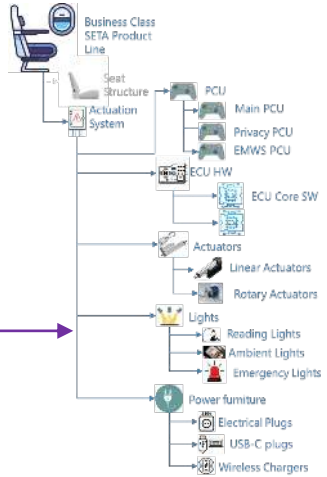
From Customer Requirements to Product Lifecycle Management (PLM)

PLE Top-Down Approach

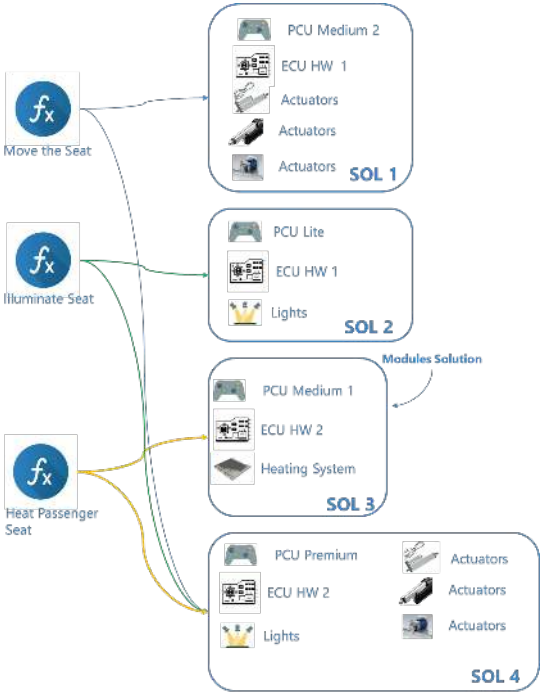


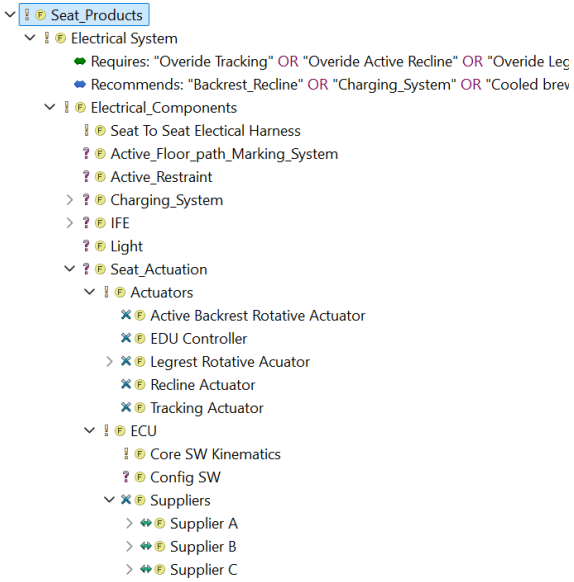
Use Cases Customer Oriented with Features Variability

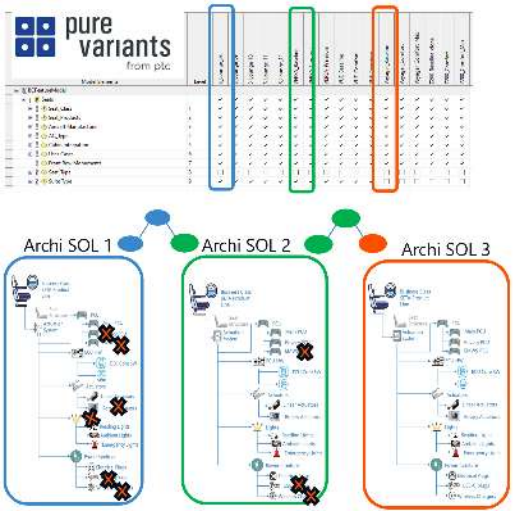
- Accommodate passenger
- Move the Seat
- Illuminate the Suite
- Heat Passenger Seat



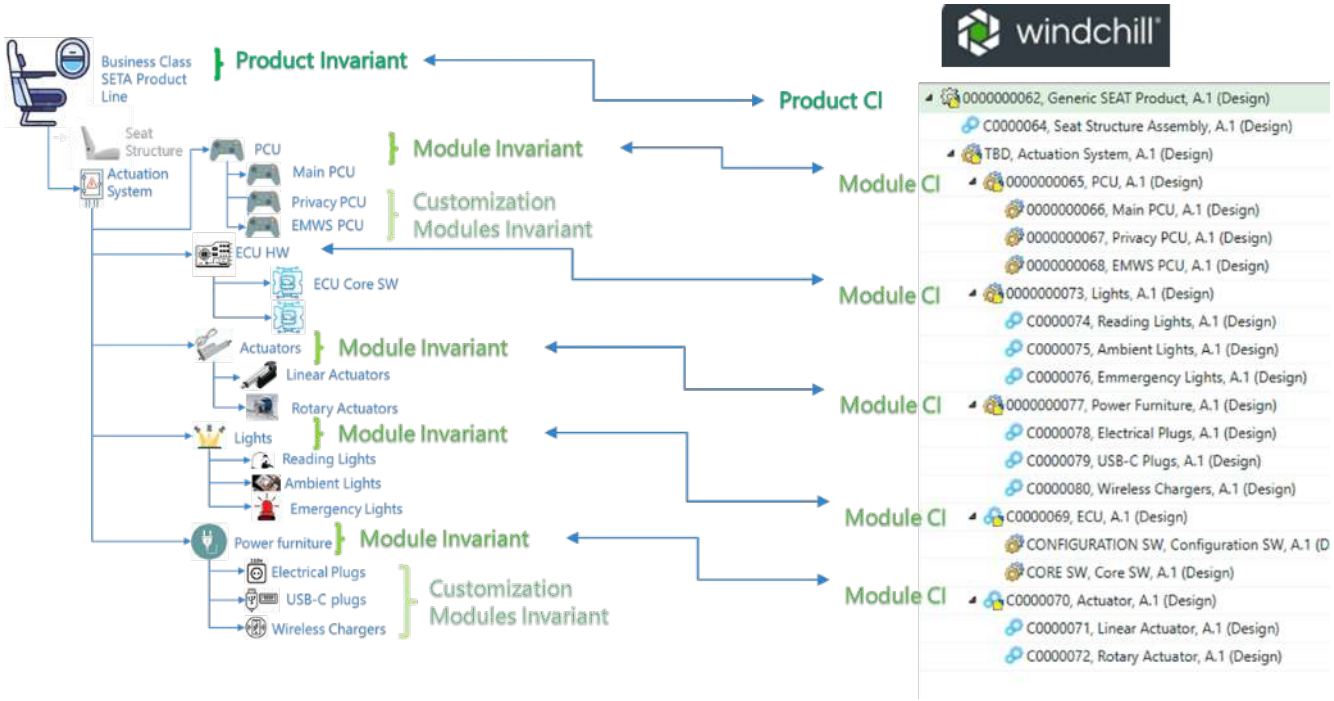
A highway route during the initial stage of MBPLE management



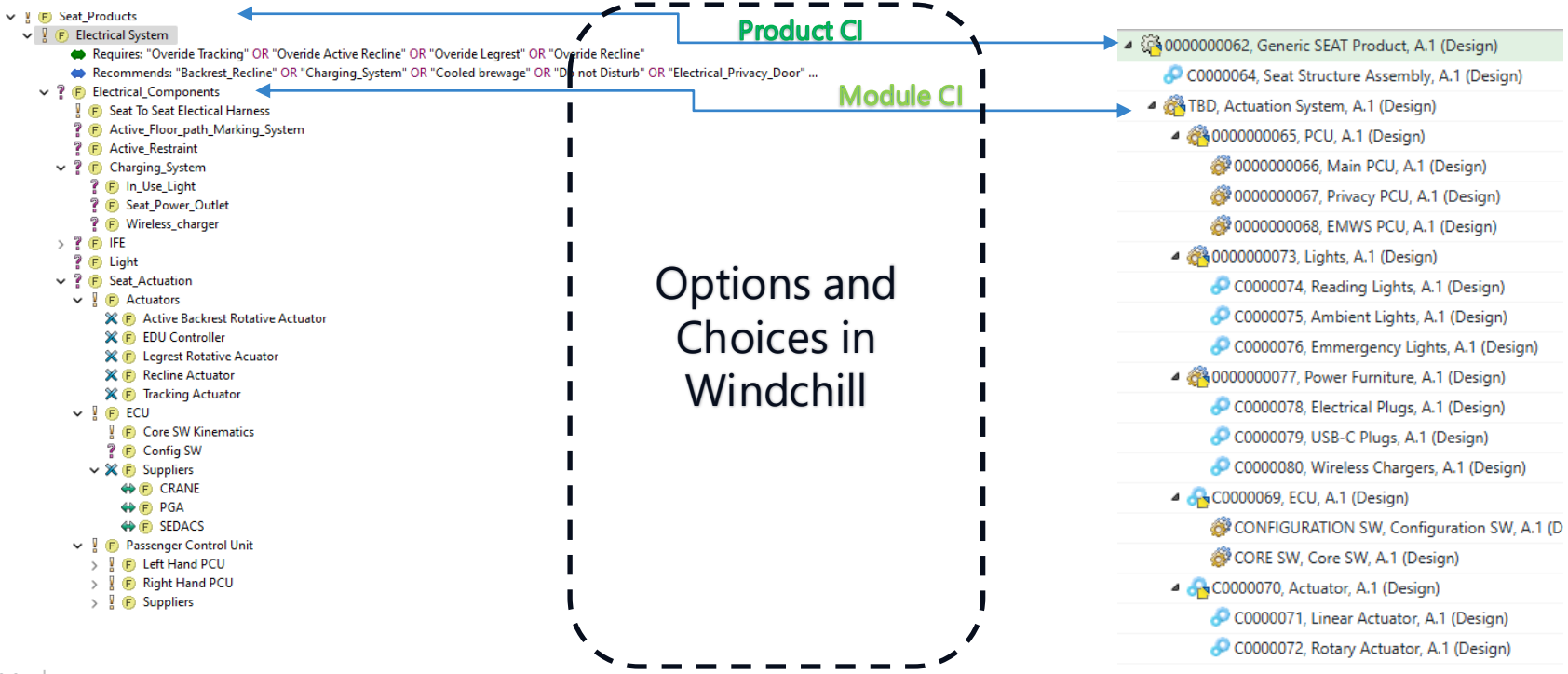




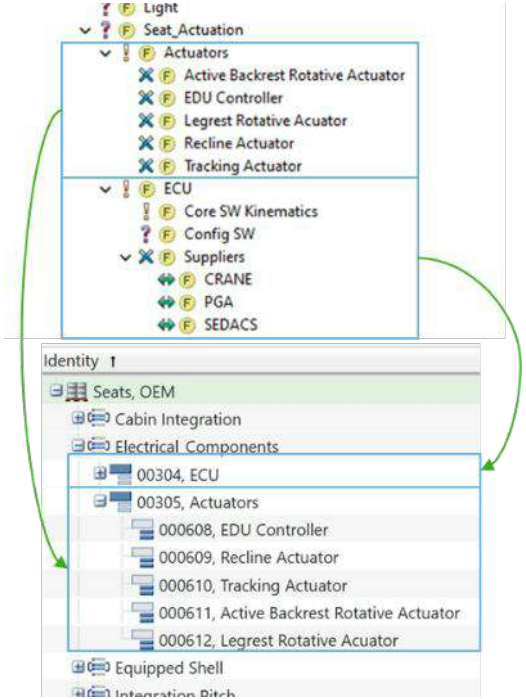
How to avoid that the PLM PBS will be the CAD BOM structure?



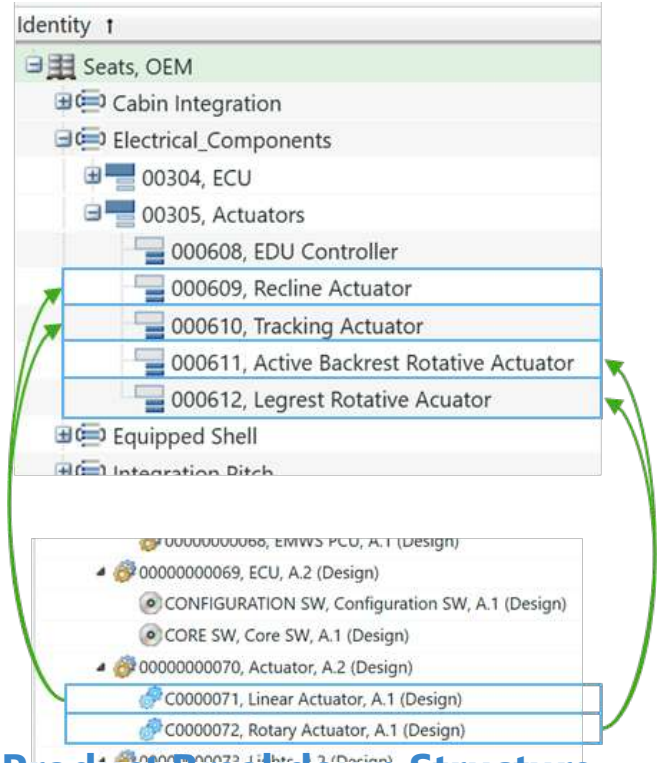
A rural path as we confront the digital challenges arising between ALM and PLM.



A two-step guide to a road trip between ALM and PLM



Feature Model translated into the PLM system's variability language



Product Breakdown Structure easily connected to Variability inside the PLM

Coordination among cost management, quotation, and design-to-cost processes

Design

Agreement

Quotation

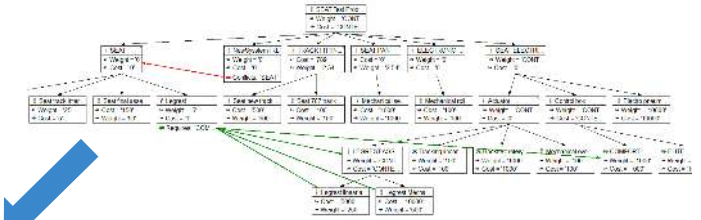
Quotation Request

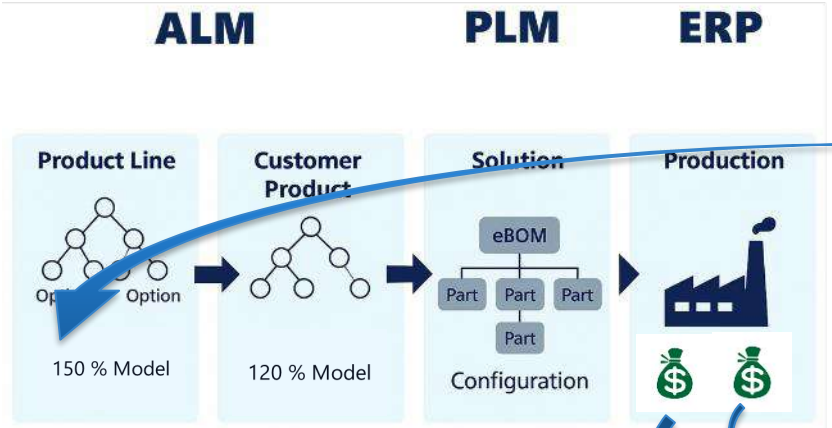
ALM	PLM	ERP
Product Line: Option, Option — 150 % Model	Customer Product — 120 % Model	Solution: eBOM, Part, Part, Part, Part — Configuration	Production

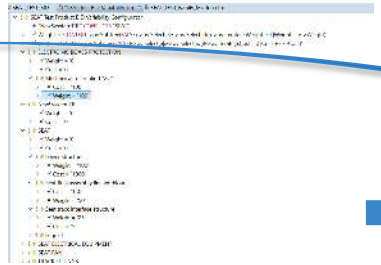
How to retrieve and utilize parts and project costs along with the built catalogue containing cost details

- Every project within the ERP features a unique PBS structure, resulting in a distinct module cost structure.

- Product Line – PBS

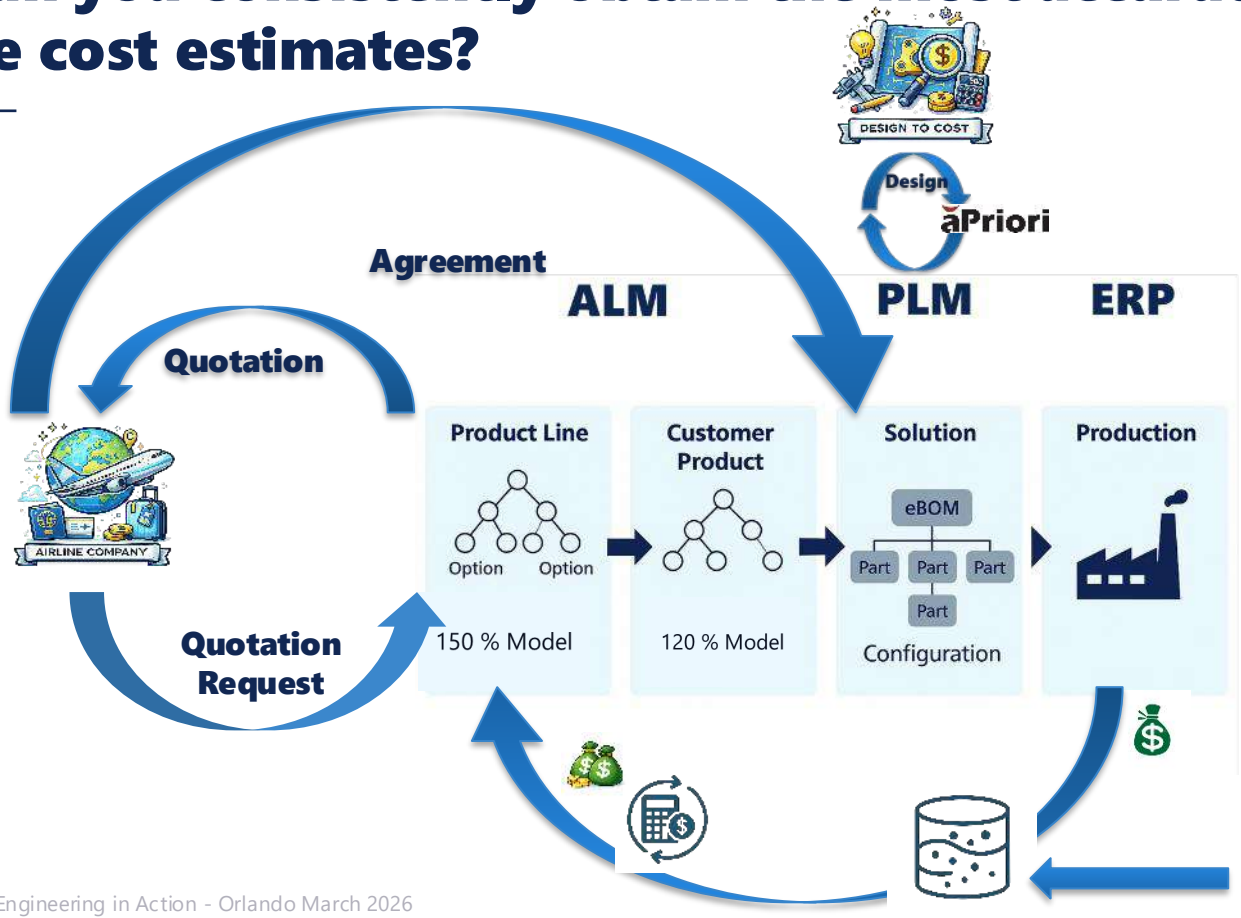






Human activities involved in extracting and synthesizing data can introduce errors and generally has few value.

How can you consistently obtain the most accurate and up-to-date cost estimates?



ERP provides data on past costs that need to be revised based on the current trade market conditions

Chapter 05

ORGANISATIONAL OPPORTUNITIES, CHALLENGES AND CULTARAL CHANGES

How to convert the opportunity

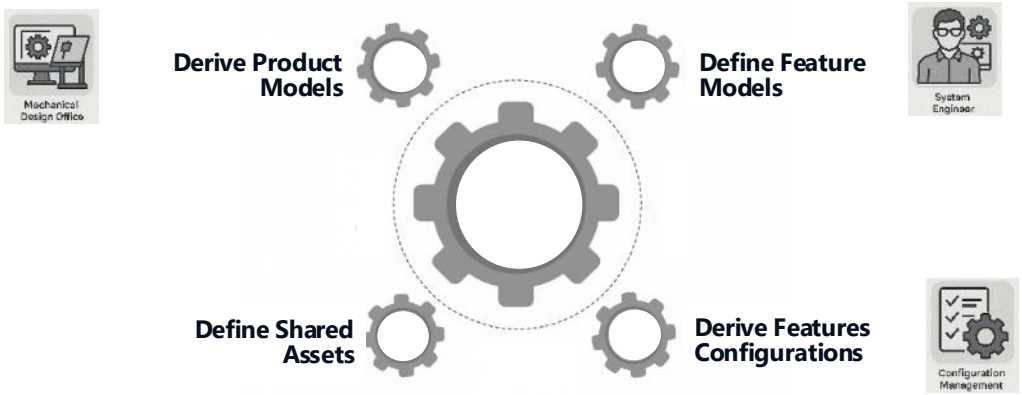
- **Product line deployment is not solely an engineering strategy**
- **According to current best practices, governance and financial oversight are critical factors for successful product line transformation**
- **From an engineering perspective, the "maturity grid" proposed by [1] can be utilized**

Without organization change and variability strategy is possible to manage product variant, but not a PLE

[1] Model-Based Product Line Engineering (MBPLE) : Forlinghieri & all

Cultural change shift for MPLE paradigm

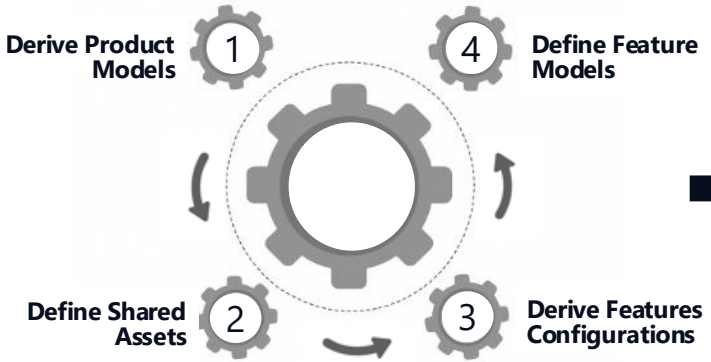
PEOPLE FROM DIFFERENT PERSPECTIVES



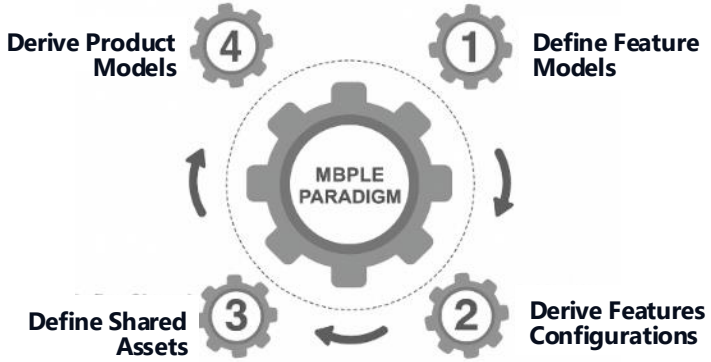
Sources :
ISO/IEC 26580:2021 : Ingénierie du logiciel et des systèmes - Méthodes et outils pour l'approche basée sur les caractéristiques dans l'ingénierie de lignes de produits logiciels et systèmes
Model-Based Product Line Engineering (MBPLE) : Forlinghieri & all

Cultural change shift for MBPLE paradigm

NATURAL ENGINEERING METHODOLOGY



MBPLE PARADIGM



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Model-Based Product Line Engineering (MBPLE) : Forlinghieri & all

Chapter 06

SUMMARY AND FUTURE ACTIONS

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NEXT STEPS

- **PLM and ALM Integration (tomorrow presentation)**
  - ALM and PLM to share platform definition, logic and rules for variability
- **Skills Assessment and Enterprise Architecture**
  - Extension of the INCOSE Competency Framework for the product line with INCOSE PLE WG
  - The automotive sector has widely embraced and implemented practices associated with the customize-to-order model.
  - In contrast, instances of the engineering-to-order approach are relatively rare and generally confined to aerospace firms.
  - We are interested in collaborating with INCOSE or a small team to develop engineering-to-order best practices.

TAKE AWAY AND PROSPECTIVES

- **Overview of the aircraft's interior market leading to the intention to deploy PLE**
  - Customers and Partners needs
- **Strategy for handling variability among various systems**
- **2 examples of MBPLE lack of digital threat**
- **Organizational viewpoints regarding the implementation of the PLE methodology**
- **Collaborations with tool vendors are underway to realize our vision within the tool suite**

POWERED BY TRUST

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