Aerospace Structures Simulation Analysis Process and Data Management

Kenneth K. Dang

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Presenters Bio

Kenneth K. Dang is currently the Digital Transformation Simulation-Analysis Lead Engineer and Product Owner for Boeing Commercial Airplane Digital Engineering Organization with focus in Structural Analysis/Simulation, Analysis Process Data Management (APDM) and Product Lifecycle Management. Kenneth is subject matter expert in the area: 3DExperience, Structures Analysis and Simulation, Model-Based Engineering that encompass charting and developing a processes/tools/business process guides/design practices to support enterprise new airplane product introduction, future airplane program and existing legacy product..

Kenneth is also Airframe Instructor – Boeing Ed-Wells Program (Kenneth develop and teach Introduction to Structural Analysis of Airplane Components).
Kenneth holds a B.S from Rensselaer Polytechnic Institute, and M.S from University of California-Los Angeles. Professional Engineer license within California Board of Professional Engineer.

Department of Consumer Affairs
Board for Professional Engineers, Land Surveyors, and Geologists

Situation-Target-Proposal (STP)

Situation:

- Boeing Commercial Airplanes (BCA) has multiple engineering disciplines that are required to perform analysis to ensure the safety and quality of its product
- BCA relies on Product Lifecyle Management (PLM) systems to manage both the product design definition (PDD) as well as associated analysis data
- Traceability of a variety of analysis artifacts is required for not only regulatory purposes but for production and fleet support needs
- Boeing is considering using the Dassault-Systemes 3DExperience (3DX) tool for a future airplane program's CAD authoring and PLM system

Target:

- Leverage a common set of tools and processes to store and manage analysis data and documentation
- Utilize workflow automation tools to standardize execution of engineering analysis processes that maximize re-use and repeatability
- Have a common methodology for integrating Boeing proprietary analysis within Commercial Off-The-Shelf (COTS) software offerings

Proposal:

- Consider a BCA lifecycle state where an airplane's general configuration is defined (i.e. Work Breakdown Structure established)
- Evaluate 3DX's ability to trace analysis data to and from product design definition based on part number, assembly, line number or other criteria
- Develop a set of guidance and tool instructions for adopting airplane programs to utilize 3DX to manage generic engineering analysis data
- Demonstrate efficiency and data quality improvements for some typical Boeing use cases including: airframe structures, interior stress, and fleet support

AGENDA

❑ Typical As-Is Process for Analysis Data Management

- AS-IS Process
- Issues of current practices

❑ Proposed To-Be Process: Analysis Process Data Management (APDM) with 3DX Overview

- Background – purpose of development
- Concept of using APDM in airplane lifecycle stages
  - Utilization of APDM in Product Development – Production – Product Sustainment

❑ Deployment and Implementation of APDM – Pathfinder DEMO

- Scalability / Pathfinder Deployment & Implementation – Working video demo
- Interiors Responsibility Center (IRC) statement of work and demo – IDEAAS video thread
- IRC Integration with 3DX and digital thread demo in 3DX APDM

❑ Summary – Values and Benefits

❑ Q&A

Typical As-Is Process for Analysis Workflow and Document Management

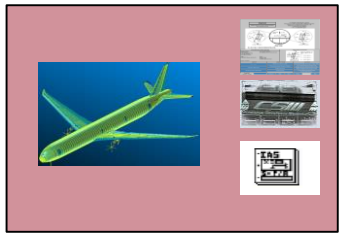
➢ **Potential Use Case: Strength Check Notes (SCN) analysis workflow and documentation.**

Pre-Processing

Analysis Input Files

CATIA

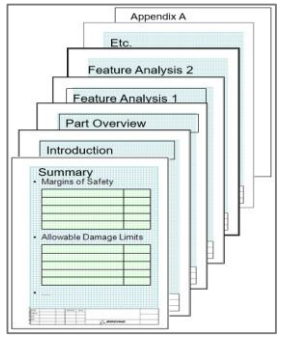
Design CAD Models



Analysis Solver

Analysis (Margins Calculation)

Structural Workstation Software (SWS)



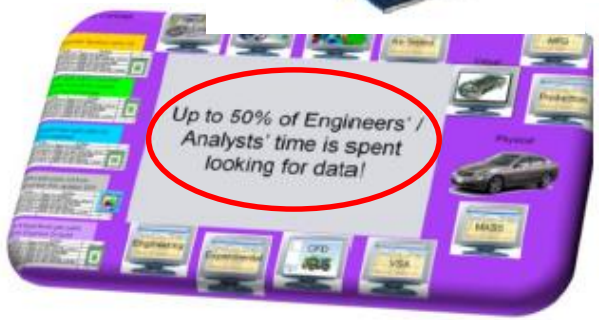
Post-Processing / Document Summary

Analysis Reports (SCN)

Typical Number of SCNs for Airplane Program

- Fuselage
- Wing
- Empennage
- Systems/Interiors

>> **Thousands of SCNs** for an Airplane Program

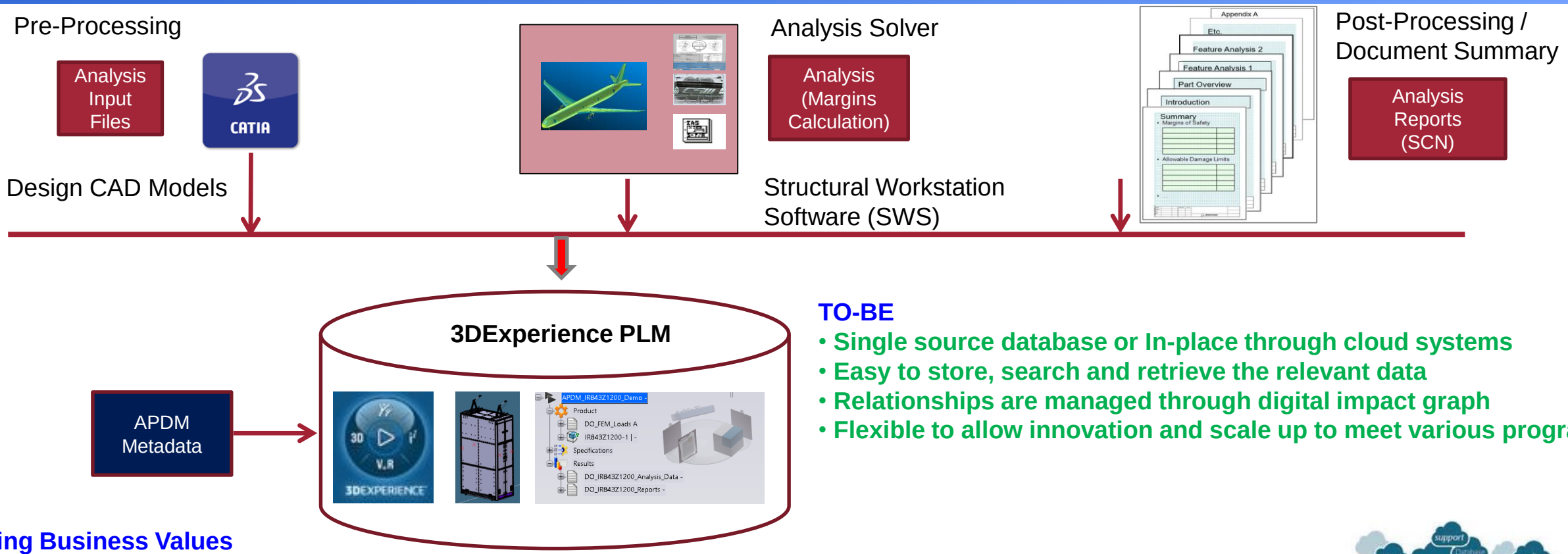


Issues and/or Challenges (As-Is)

• Difficult to access the particular SCN without much of labor intensive search.
• Difficult to connect to affected part SCN from the baseline SCN.
• Difficult to handle large data-files and the large amount of analysis data generated.
• Missing digital thread: not able to visualize the information supporting the development of SCN and no capability to do data synchronization.
• No traceability of input data, difficult to replicate the results, lead to rework, long and costly product development.

Need for centralized product lifecycle database with simple/easy access

Proposed Capability: Analysis Process and Data Management (APDM) in 3DX



TO-BE

- **Single source database or In-place through cloud systems**
- **Easy to store, search and retrieve the relevant data**
- **Relationships are managed through digital impact graph**
- **Flexible to allow innovation and scale up to meet various program**

Resulting Business Values

- Increase the traceability/data synchronization of APDM, reduce rework & increase quality
- Retrieve (analysis margins, reports, documents etc.) information quickly to help decision making reduce product development time &cost
- Make it easier to trace relevant data/visualization/search/retrieve for Validation & Verification
- Manage large amount analysis data through clouds based server / enable access data through any internet operated device
- Enable the interactive collaboration from different engineering function/disciplines (i.e. Flight Sciences, Digital Liaison)

Objectives, Key Drivers and Business Values for APDM

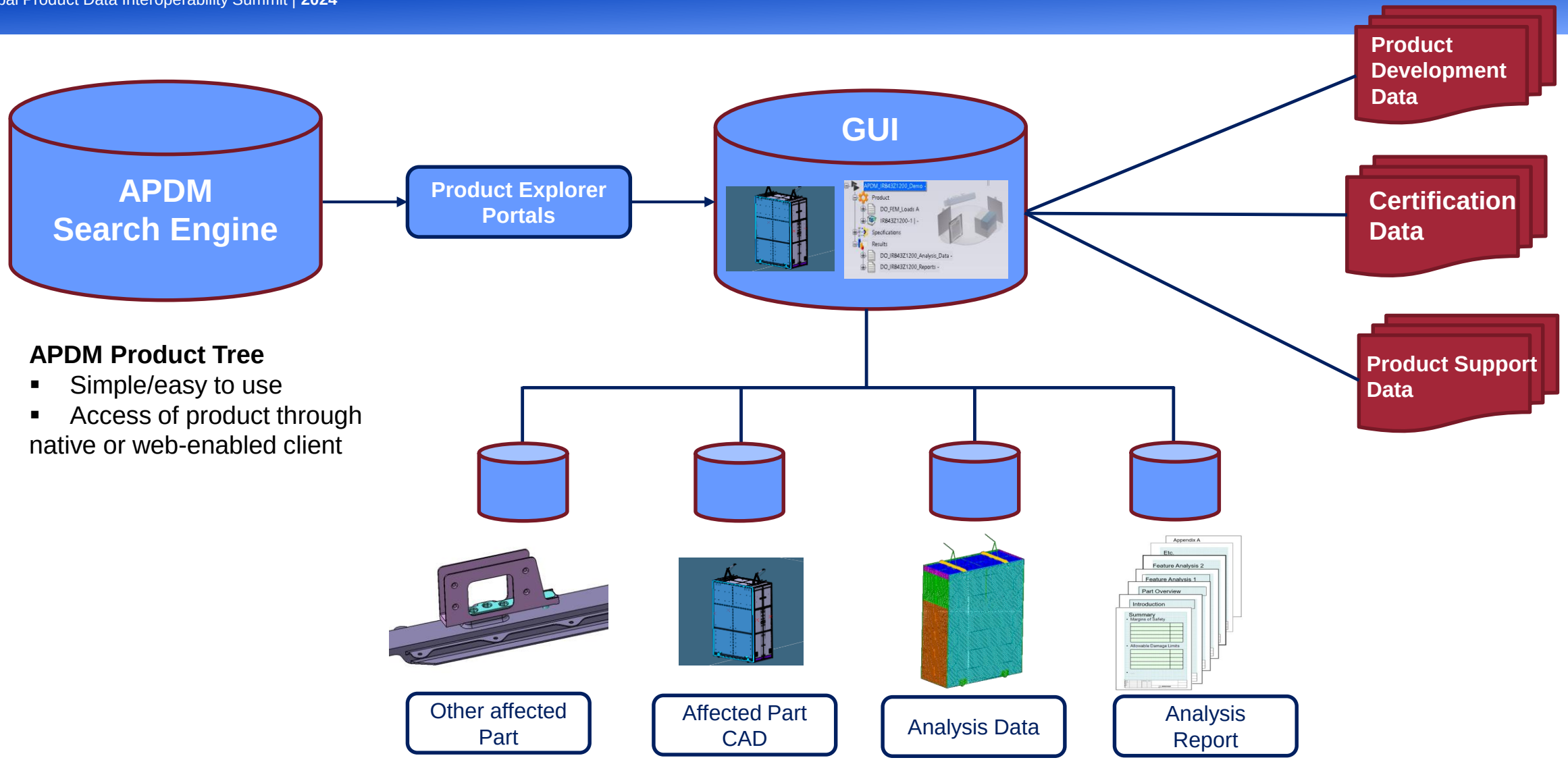
Managed APDM Will Drive Down Boeing Product Development Time/Cost

- Traceability of analysis artifacts for airplane certification
- Faster Access to Right Information
  - Significantly reduce the time for engineers to locate the right data.
- Capture and Reuse Analysis Data and Results
  - Reduce unnecessary analyses through review the same or similar analyses (no rework)
  - Apply the best practices and knowledge

Managed APDM Will Improve Boeing Product Quality

- Ensure data consistency, traceability and workflow management
- Avoid data/knowledge loss and IP loss
- Make global collaboration and data protection easier
- Deliver results in time to influence change
- Allow more analysis/simulation to be done in time

APDM Management Approach – Centralized Data Management System to Manage Data In Place

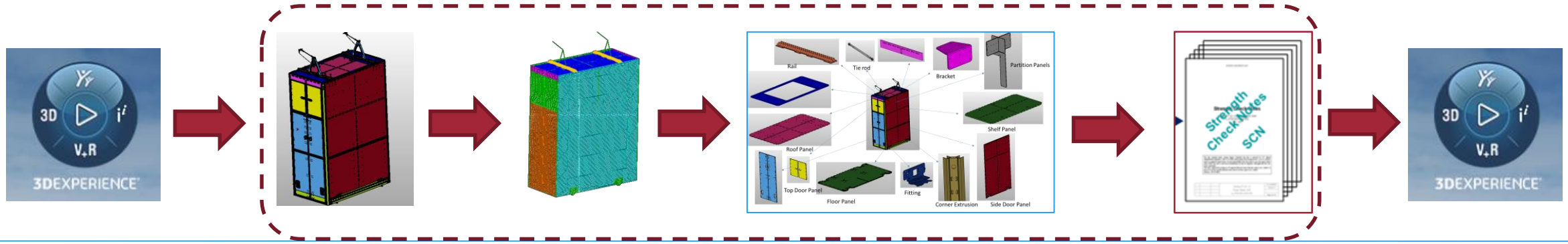


Analysis Data Accessible Through Native and Cloud

Integration of Structural Analysis Software with 3DExperience (3DX) Platform

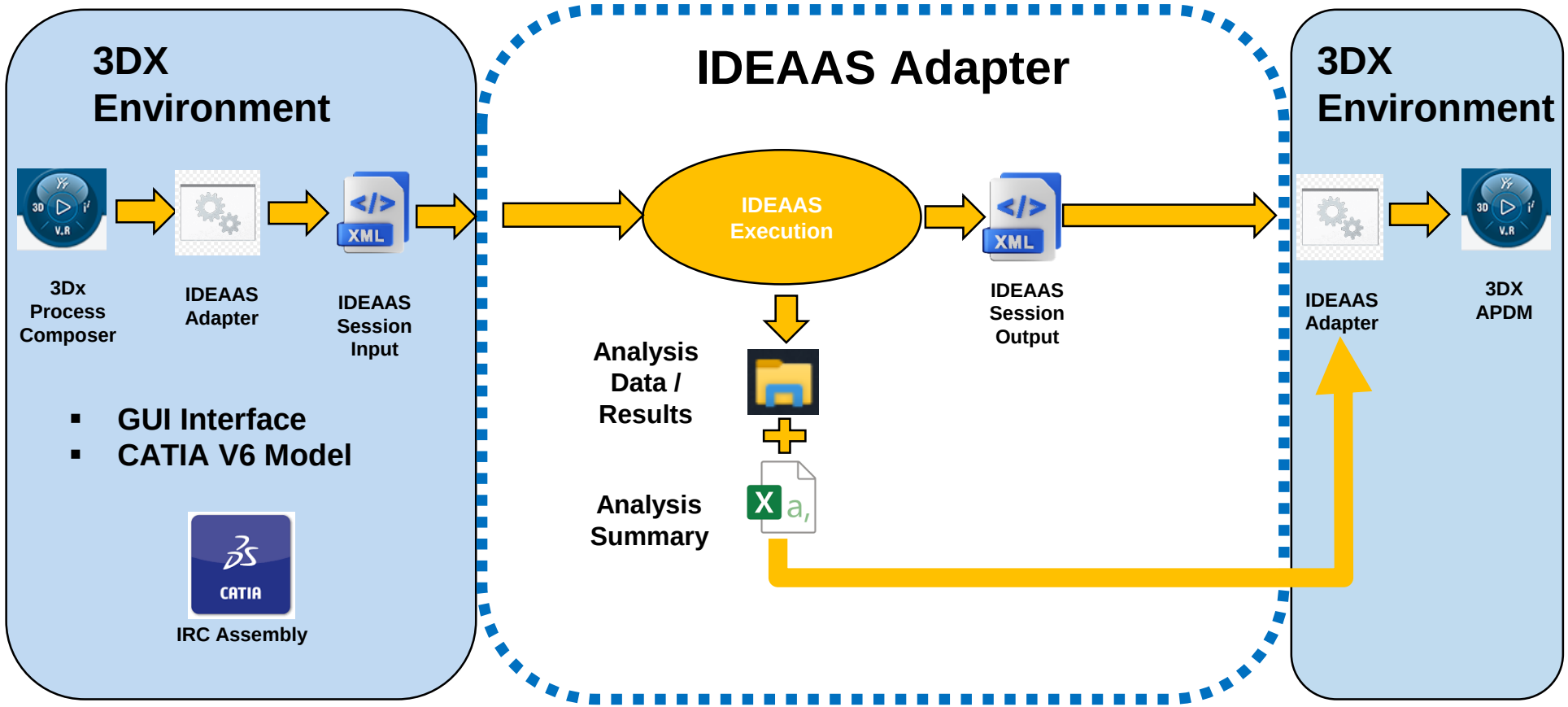
- Integrated Design Engineering And Analysis System (**IDEAAS)** is a comprehensive Model Based Engineering (MBE) structural analysis platform which integrates design and structural analysis tools, automates analysis tasks, generates analysis documentation.

- An adaptor for **IDEAAS** is developed in **3DX** process composer which links **IDEAAS** to **3DX** database. This adaptor provides the front and back end connectivity from **IDEAAS** to **3DX** product lifecycle management enabling full digital thread of the entire product lifecycle.



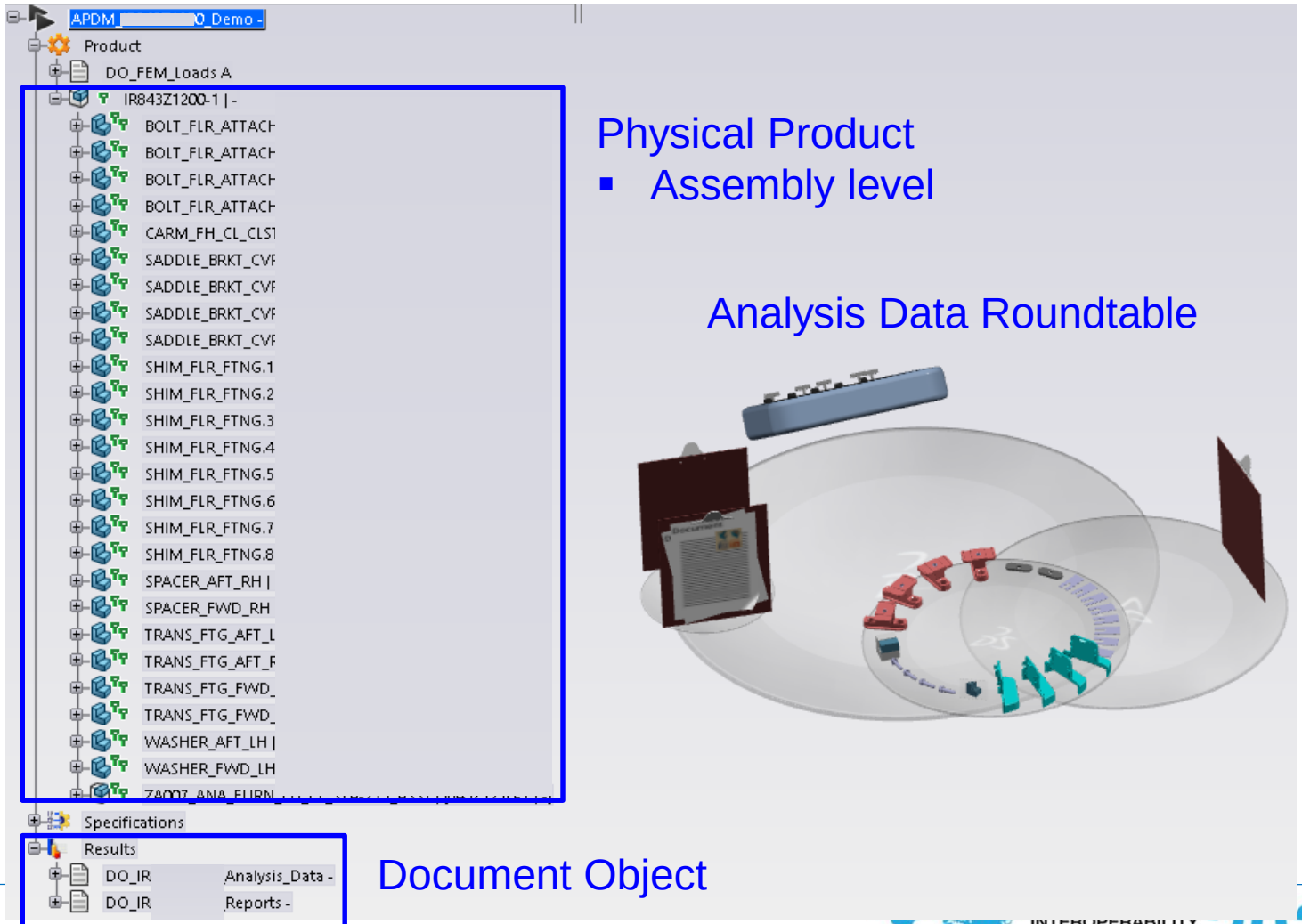
Potential Application of APDM to Interior Responsibility Center (IRC): Integration of 3DX to IRC Workbench

Integrated Design Engineering Analysis And System (IDEAAS) Integration with 3DX
High Level Process Overview



Analysis Process Data Management in 3DX

1. Analysis Process Data Management (APDM): Engineering Analysis Data Portal



Physical Product
- Assembly level

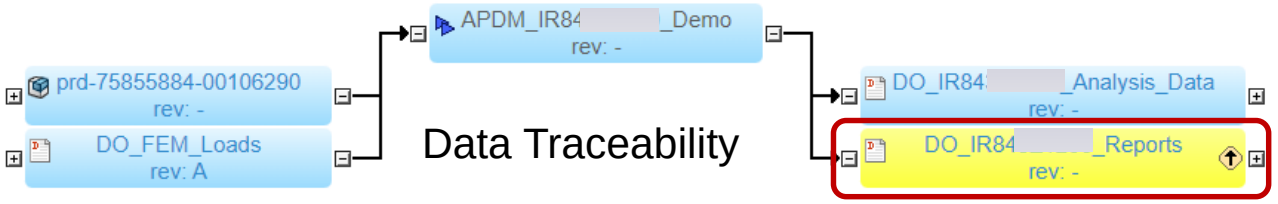
Analysis Data Roundtable

Document Object

APDM Exploration

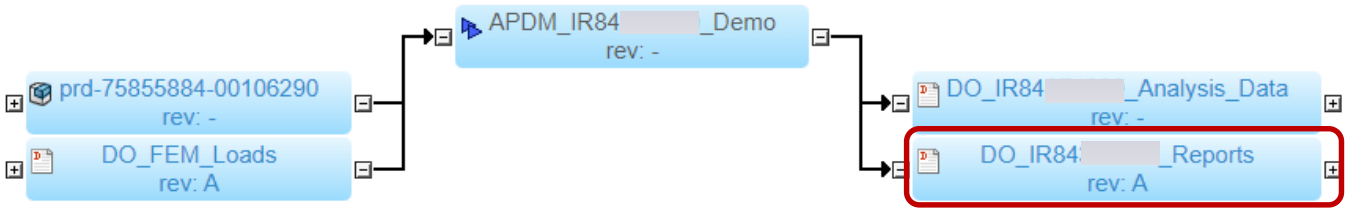
- ❑ **Physical Product**
  - Module
  - Assembly
  - Parts
- ❑ **Document Object**
  - Upload/Download Analysis Artifacts (e.g., Analysis Results, Margins Summary)
- ❑ **Analysis Data Roundtable**
  - Easy access/view to all APDM data
  - Friendly graphical user interface
    - Physical Product (CATIA)
    - Document Object (Analysis Artifacts)

2. Analysis Process Data Management (APDM): Impact Graph – Data Traceability/Synchronization



Data Traceability

Data Synchronization



Physical Product

Metadata

- Owner
- Drawing Number
- Definition
- Internal Loads & FEA Model

Document Object

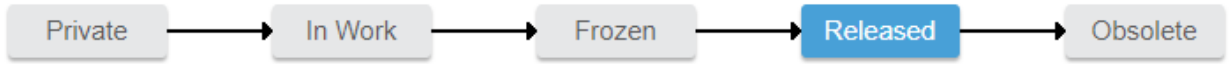
Metadata

- Analysis Artifacts (hyperlink)
- Owner
- Access to documents (reports, doc, pdf, zip files)
- **Change management**
  - Sign-off/Approval
  - Releases
  - Version controlled
- Lifecycle history

Data Synchronization

- Color legend of impact graph shows different revisions exist
- Impact graph shows up to date with latest revisions captured

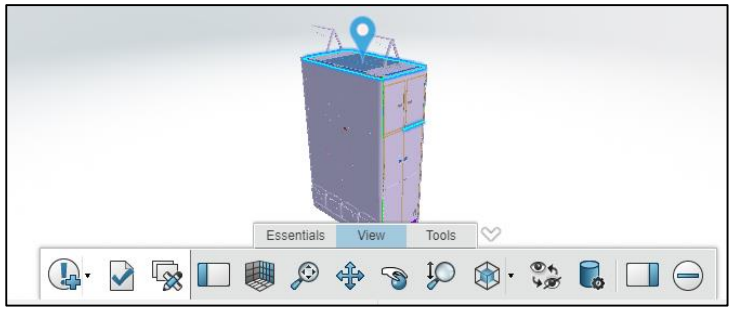
Lifecycle



3. Analysis Process Data Management (APDM): Product Support / Sustainment

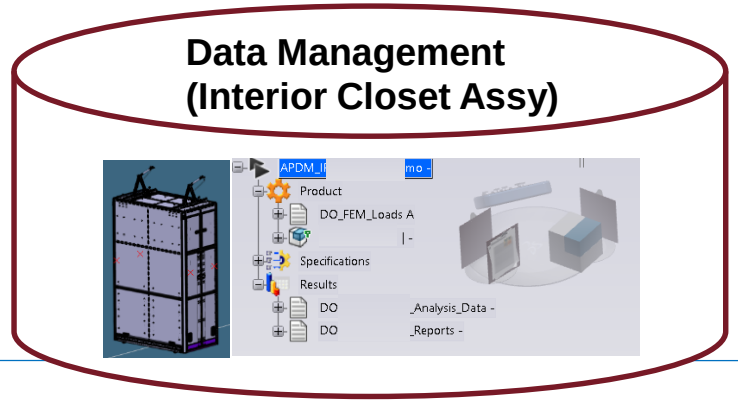
Issue Captured

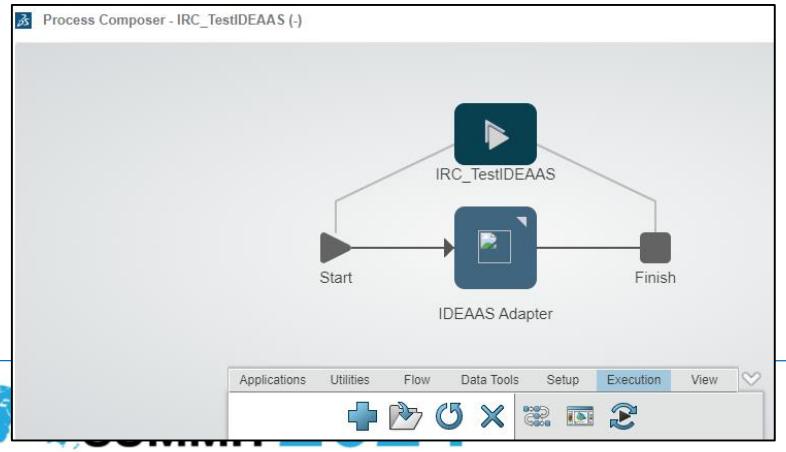
- Non-conformance (NCR)
- Service Request (SR)



Issue Management

- Affected location
- Description/issue references
- Assigning members





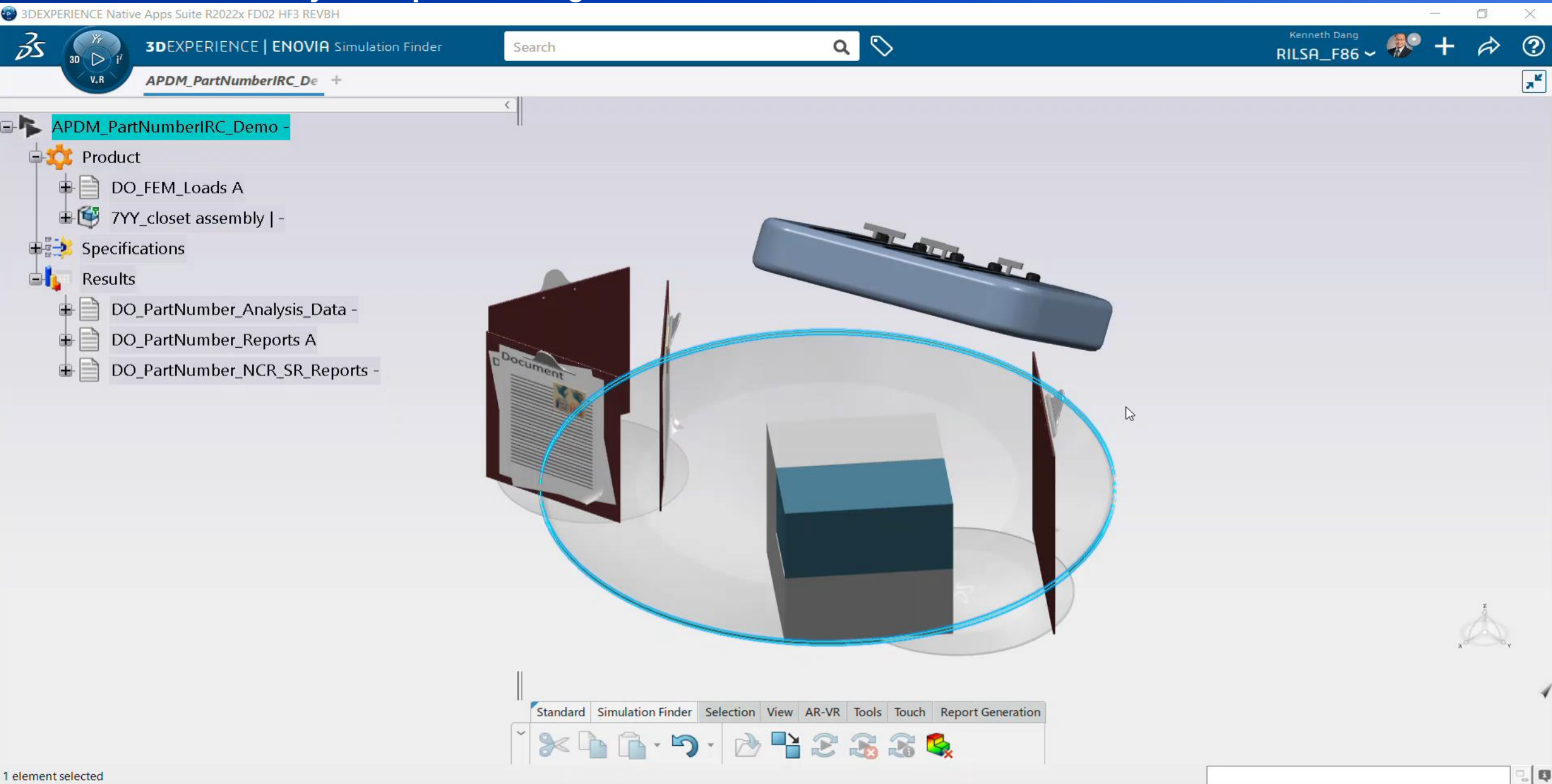
Process Composer Widget

- Execute and run analysis (ex: IDEAAS)
- Resolve issues and upload analysis results

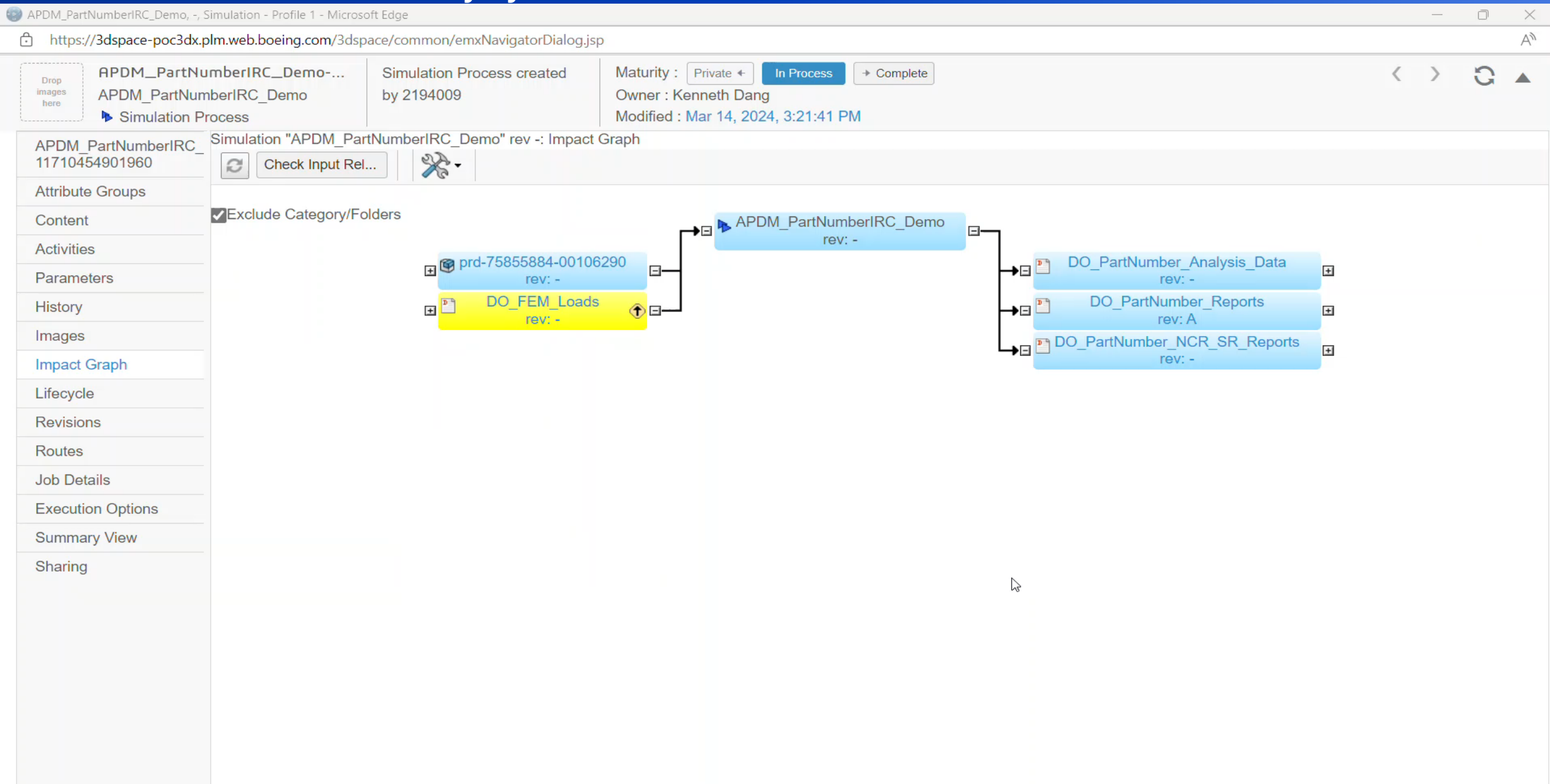
Deployment and Implementation – Pathfinder DEMO

- **Demo (3DX Analysis Process Data Management)**
  - Centralize Data Portal: Ability to upload/download analysis report and connectivity to physical product
  - Impact Graph showing the digital thread traceability/synchronization of analysis data from web-client
  - Ability to perform service issues/non-conformance issues as product support from web-client

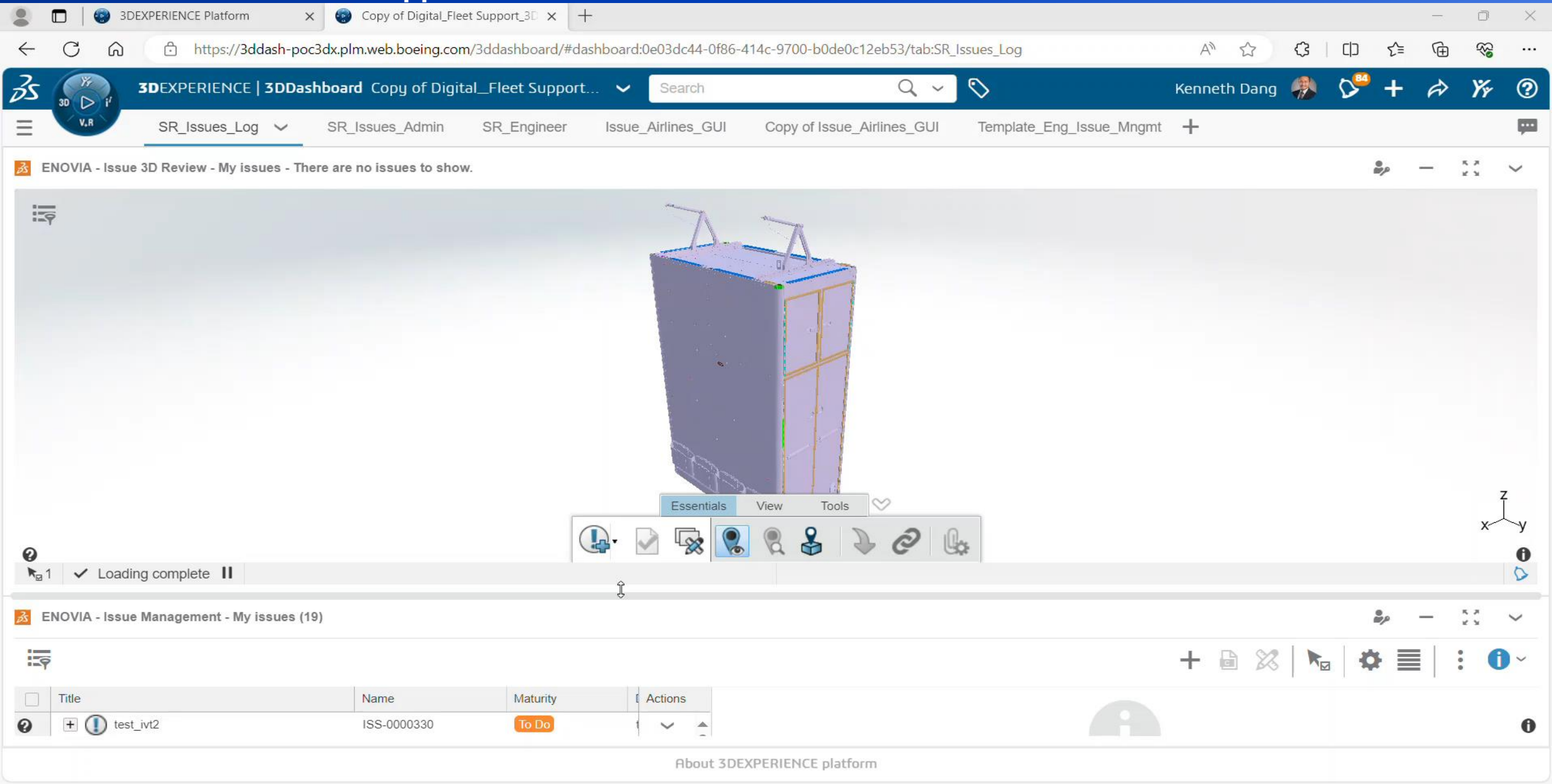
APDM Demo: Analysis Reports Management Central Portal



APDM Demo: Data Traceability/Synchronization



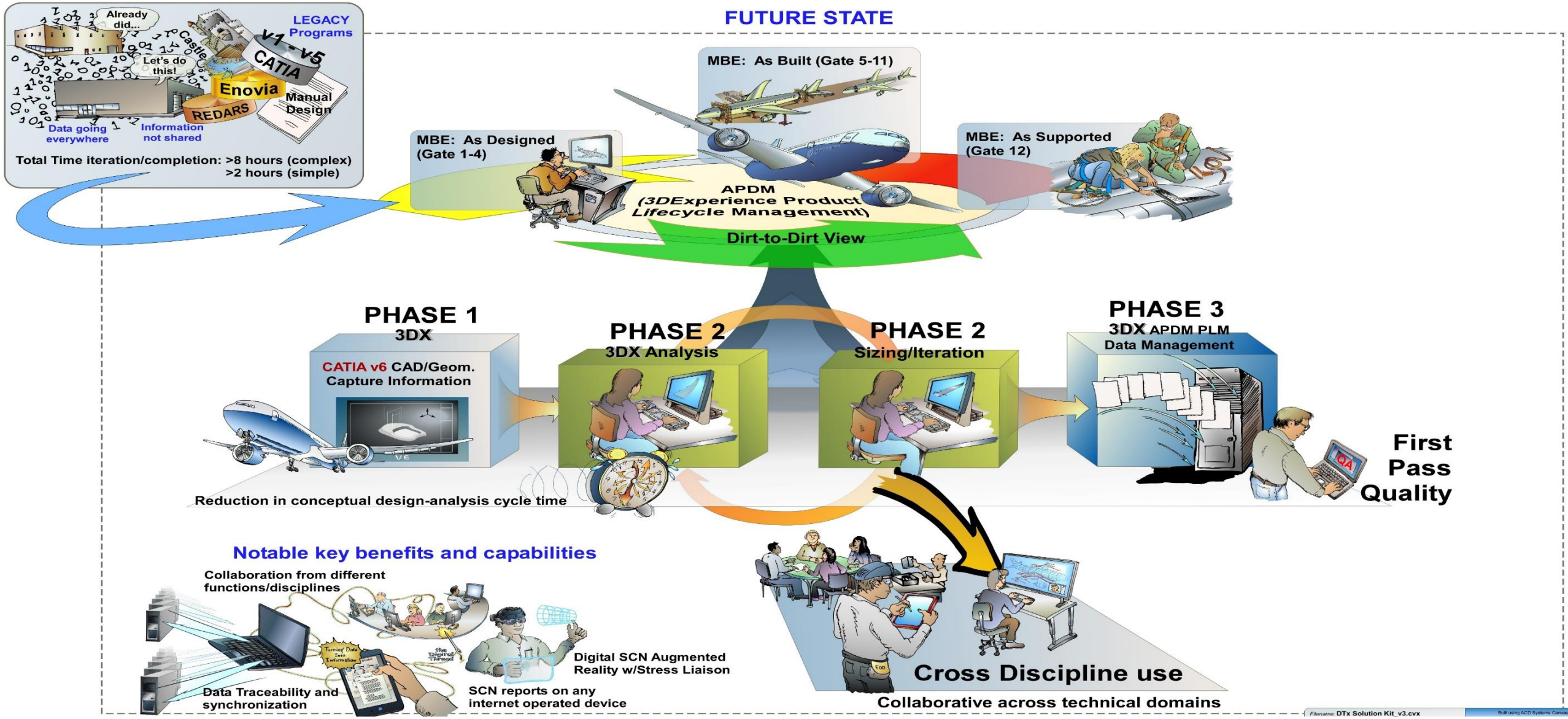
APDM Demo: Product Support



Key Benefits of a Proposed 3DX Analysis Process Data Management to Enterprise Programs

BCA Product Development ▪ Enable the traceability of certification artifacts across the product lifecycle ▪ Enable faster turnaround time study for producibility, feasibility and weight optimization ▪ Easy access and time save for engineers to look up supplemental center of excellence (i.e., Body of Knowledge, community of practices, design criteria, requirements, design practices)	➢ Reduction in work-cycle time (months to weeks) ➢ Cost saving benefits
Interior Responsibility Center (IRC) ▪ Enable the traceability of certification artifacts across the product lifecycle ▪ Easy access to full data of and reduction in analysis cycle time from preliminary to final sizing ▪ Enable engineers to formulate/simulate in a single platform the entire product design lifecycle from design-analysis-report generation-managing report (full digital thread)	➢ Reduction in work-cycle time (days to hours) ➢ Cost saving benefits
Customer Aviation Services ▪ Enable the traceability of certification artifacts across the product lifecycle ▪ Time savings of looking up search query of analysis database to support Service Request (SR) issues ▪ Easy access Service Requests (SR) database, base-line SCN analysis, and backup notes data to support (SR) disposition	➢ Reduction in work-cycle time ➢ Significant cost saving benefits for fleet product support ➢ Reduction in time to find relevant data

Envisioneer Graphic: Analysis Process Data Management



3DExperience: Analysis Process and Data Management (APDM) Development Team Acknowledgement

APDM Core Team

- John J. Dong (STF Chair of Enterprise Analysis Simulation Integration – Technical Board)
- Kevin P. Fallon (ATF Mechanical & Structural Engineering Solution Lead)
- David S. Paschal (Engineering Leader for Engineering Analysis and Simulation)
- John Z. Lin (TF BR&T Structures Technology)

Enterprise Programs/Business Units/IT Supports

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- Frank A. Smith
- Anthony Harrington
- Steve Baier
- Elijah Leonen
- Amritveer S. Grewal
- Ravi Udali
- Shobit Rastogi
- Vaibhav Ekbote
- Abhishek Sharma
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Thank you!

Q&A