Designing the Future Landscape: Digital Architecture, Design and Engineering Assets

Library of Congress
Architect of the Capitol
National Gallery of Art

Phil Rosche – ACCR for Rick Zuray – The Boeing Company
16 November 2017
Records Information Management
- What data to archive?
- How long to archive?
- Who owns archived data and systems?
- What are the operational requirements on systems?
- Governance & Planning Process

- Model Based Environment impacts IT systems and design processes

Transition to a Model Centric Approach for structured digital data.
Complex Products
# Evolution of the Design Process

<table>
<thead>
<tr>
<th>Product</th>
<th>767</th>
<th>747-400</th>
<th>777</th>
<th>787</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media</td>
<td>Paper Drawings</td>
<td>2D CAD</td>
<td>3D CAD w/ 2D Dwgs</td>
<td>3D MBD</td>
</tr>
<tr>
<td>Parts per airplane</td>
<td>3,100,000</td>
<td>10,000,000</td>
<td>3,000,000</td>
<td>2,300,000</td>
</tr>
<tr>
<td>Data volume (GB)</td>
<td>354.6</td>
<td>1143.8</td>
<td>343.1</td>
<td>4401.5</td>
</tr>
</tbody>
</table>

Built/Delivered (as of Sept, 2017)

| Airplane Fleet         | 1,034        | 1,536        | 1,518          | 600            |
| Data volume (GB)       | 366,656.4    | 1,675,366.3  | 353,393.0      | 154,052.6      |

25.5 petabytes of data – Boeing widebody airplanes
Evolving Technologies: Early Data Exchange Example

Rosetta Stone

Hieroglyphics

Demotic Script

Greek
Evolving Technologies: The Product Definition Example

Product Definition Data (PDD) creation, storage and distribution has significantly changed in the past 50 years. PDD is the source for “Type Design” as defined by the FAA.

- **2D Only Creation**: 2D Authority
- **Hybrid 2D / 3D Creation**: 2D Authority
- **3D Only Creation**: 3D Authority

Model Based Definition (MBD)
## Technology Evolution: Processes Can Be Tool Independent

<table>
<thead>
<tr>
<th>How parts are controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Configuration Management</strong></td>
</tr>
<tr>
<td>- Paper-based</td>
</tr>
<tr>
<td>- Master controlled by the originator (desk drawer)</td>
</tr>
<tr>
<td>- Engineering intent defined in multiple locations</td>
</tr>
</tbody>
</table>

### 1st Generation

![1st Generation Image](image1.png)

### 2nd Generation

![2nd Generation Image](image2.png)

### 3rd Generation

![3rd Generation Image](image3.png)
Program lifecycles are lengthening and technology lifecycles are compressing. There will be 260+ software upgrades over the B-52's lifetime.
Global Collaboration Environment - 787

- Common processes, computing applications, and training materials accessible by over 100 partners and thousands of suppliers worldwide.
- Data compatibility
- Standard design language
- Global Design resource
- 24 hour workday

Single instance of PDM at the Boeing Puget Sound Data Center.
How are we going to manage this complex data over its 70+ year lifecycle?
Addressing the Challenge
Mission Statement
The project objective is to develop, publish and maintain standards designed to provide the capability to archive and retrieve digital product and technical information, including 3D CAD and PDM data, in a standard neutral form that can be read and reused throughout the product lifecycle. The standards are published as NAS 9300 US, (EN9300 Europe), series and cover both the information content as well as the processes required to ingest, store, administer, manage and access the information.

Key Team Members:
Team Leaders and Represented Companies:
- Rick Zuray: US Chair
- Jeff Holmlund: US Coordinator
- Jean-Yves Delaunay: EU Chair
- Jochen Boy: EU Coordinator
- Phil Rosche: CAx-IF Chair
- Mike Jahadi: PDES President
Information Lifecycle Planning

Driving Questions

- What data should we archive?
- Why are we archiving the data?
- What is the final format the data is to be archived in?
- What is the retention period of the data?
- What is the current data format?
- How frequent do we access the data?
LOTAR Timeline

Late 1990s:

2000
- Start of the PDES, Inc. LTDR Project (US) coord w/AIA LTDR

2002
- Start of the ASD Stan – ProSTEP iViP LOTAR Project (Europe)
- IAQG* approved charter for AIA/ASD Stan Joint Project
- AIA LTDR Published ARP9034

2003
- First joint team meeting of the international AIA - ASD-Stan LOTAR effort under the mgt of the IAQG* (MoU: AIA/ASD-Stan)

2004
- Launch of the 3D CAD and PDM Workgroups

2005
- First Publication of LOTAR Basic Parts

2006
- First Publication of LOTAR Common Process Parts

2009
- Creation of the joint LOTAR International consortium (AIA / ASD-Stan / PDES, Inc. / ProSTEP iViP)
- Launch of the Composites WG

2012
- First Publication of LOTAR Domain Specific Parts (3D CAD)
- Launch of the Workgroups for Electric Harness, Meta Data for Archive Packages, and 3D Visualization

2014
Kicked off LOTAR Eng Analysis & Sim Workgroup Sept 2014

2015:
- Launch of the LOTAR Additive Manufacturing WG

2017:
- Evaluation of Model Based System Engineering Requirements
LOTAR Standard Foundation
ISO 14721:2012 (OAIS)

- "Open Archive Information System" (OAIS) Reference Model is basis for LOTAR processes
- Developed by Aerospace and Defense Industry
- Extended to meet the specific requirements of LOTAR

- As neutral data format for the archives, ISO 10303 (STEP) has been chosen since it is the most advanced open format.
LOTAR Working Groups

Engineering Analysis and Simulation
EN/NAS 9300-6xx series
ISO STEP AP209 ed2
2014 launch

Wiring Harness
EN/NAS 9300-4xx series
STEP AP242 ed2
2012 launch

Meta Data for Archive Packages
EN/NAS 9300-21
STEP AP239 ed3
STEP AP 242 ed2
2012 launch

Composites and Advanced Manufacturing
EN/NAS 9300-3xx series
STEP AP203 ed2
STEP AP242 ed1
2009 launch

Mechanical 3D CAD with Product and Manufacturing Information (PMI)
EN/NAS 9300-1xx series
STEP AP203 ed2
STEP AP214 ed3
STEP AP242 ed1
2004 launch

3D Visualization
Requirements and Compliance Documents
2012 launch

Product Data Management (PDM)
EN/NAS 9300-2xx series
STEP AP239
STEP AP242 ed1
2004 launch
Process Domain Technical Working Groups

- ISO Information Models
  - AP242 E1&2
  - AP239 AP242
  - AP203 AP242 E1&2
  - AP242 E2 Target
  - AP233 Target
  - AP209 E2 Target
  - AP210 E2 Target

- Process & Use Cases (LOTAR Work Groups)
  - CAD Mechanical 3D Geometry with PMI & Assy
  - Product Management Data
  - Composite Design & Manufacturing
  - Electrical Harness
  - Systems Engineering (in-work)
  - Engineering Analysis & Simulation
  - Electronics (Not Started)

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LOTAR Homepage:
www.lotar-international.org

Why LOTAR?
- Mission, Objectives & Scope
- Legal & Business Motivation
- Technical & IT Background
- Goals & Benefits

LOTAR Organization
- External View
- Internal View
- Working Together
- Fundamentals & Processes
- Member Companies

LOTAR Workgroups
- 3D CAD with PMI
- PDM
- Composites
- Electrical Harness
- 3D Visualization
- Meta-Data for Archival
- Simulation & Analysis

Communication
- Public Presentation
- Progress Reports

LOTAR Standard
- Overview on Parts
- Industry Use

News
Links
Contact
Interoperability Impact

- Digital data interoperability is costing A&D Industry $5B annually.

- Digital data interoperability is critical to exchanging and managing informational across the Supply Chain as well as across your company’s infrastructure.

- There are huge saving opportunities by moving to open neutral data formats and enables a more efficient long term retention strategy over the lifecycle of your data.

*NIST/RTI Survey*

*2008 design and manufacturing survey findings revealed: “Unique CAD requirements added 20 % or more to the cost of doing business”.*
Expected benefits of the use of LOTAR standards

• Process security achieved through implementation of archival systems compliant to international accepted standards

• Aerospace and Defense authorities accept workflow due to intense collaboration during standards creation

• Applicable archiving workflow supported by STEP interfaces & functionalities

• By solving the challenges of long term data retention, issues of data exchange are addressed

*Development and use of LOTAR standards by the A&D industries allow for decreasing the costs and risks of LT archiving of aerospace product data*
Any questions?

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Model Based Definition

**3D Model Based Definition** – Model Based Definition (MBD) is a set of concepts, processes, and tools that allow the creation of an annotated 3D product definition based on a 3D solid model. The MBD dataset includes all Engineering Intent requirements (including 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 constitutes an authoritative, single source of master product definition data that does not include or depend upon traditional 2D drawings. The MBD dataset 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.
A Model-Base Enterprise is an environment that leverages the full benefits of Model-Based Definition/Design (MBD) dataset usage, translation, format management, archival, retrieval, and other uses relative to company processes and requirements. Discussion of issues related to using model-based product definition in the workflow. Following CAD data and its derivatives throughout company processes, addressing various tasks and how the data is used (i.e. CAD → NC, CAD → CMS etc.). Discussion of data use and translation requirements within design (CAD to CAD, CAD to CAE, CAD to neutral format, etc.), between design and downstream processes (manufacturing, inspection, assembly, service, clients, etc.). Discussion of addressing compliance issues with regulatory agencies, auditors, etc., long-term data archival issues, data management, data integrity, and data quality, data validation and verification strategies and tools is included.
Requirements

- Meeting the legal and business requirements of the aerospace and defense industry:
  - EN/NAS 9300 considers requirements coming from:
    - Legal and certification rules
    - Regulations on long term archiving of technical documentation
    - Reuse
    - Support in operation
  - Additional to legal demands, there are industry established standards, company specific rules and recommendations.
  - The standard defines architecture, processes and data formats to fulfill these requirements.