Sustaining 3D CAD - The Aerospace Experience

Sean Barker FBCS CEng

Sean Barker - Background

Career
- Radar Designer - Marconi 1976
- CAD Software Research - PCL & Brunel 1986
- BAE Systems 1990 onwards
  - CAD software development - team lead
  - Product data management - architect
  - Enterprise engineering - researcher
  - STEP/PLCS - data modeller

Currently: Independent Consultant

Long term archiving - relevant experience
- CAD model exchange
- PDM exchange for Eurofighter
- LOTAR - team member
- PDES Inc.- technical advisory board
- BSI ACE/1 Technical Specialist on Design Archiving
- Repository Access Services - project lead
- 4C Curation Costs - advisory board

Contents

What is LOTAR?

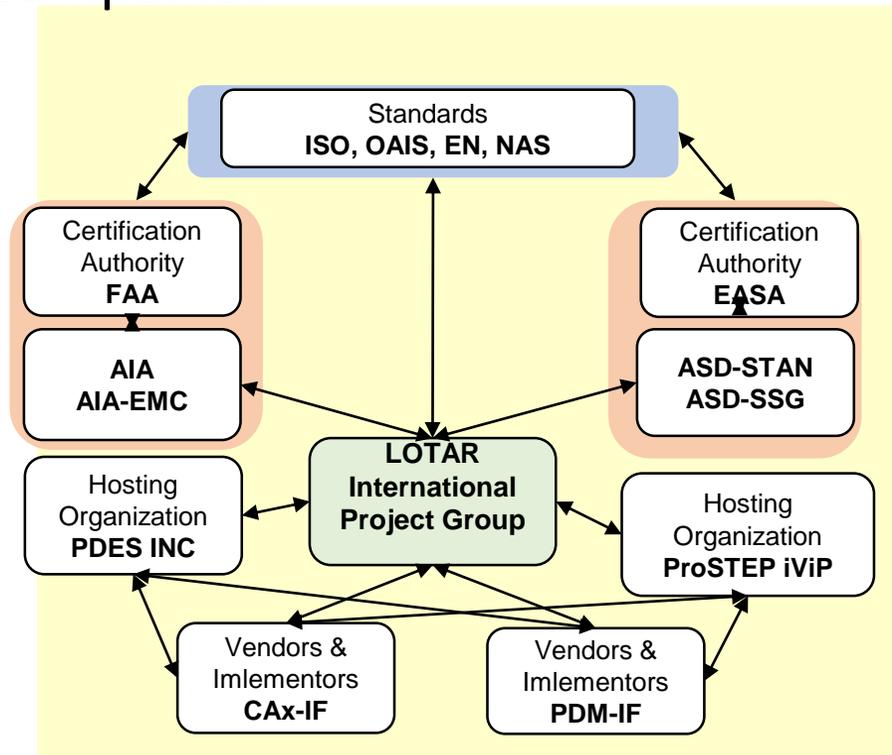**Peculiarities of CAD**

How LOTAR deals with CAD
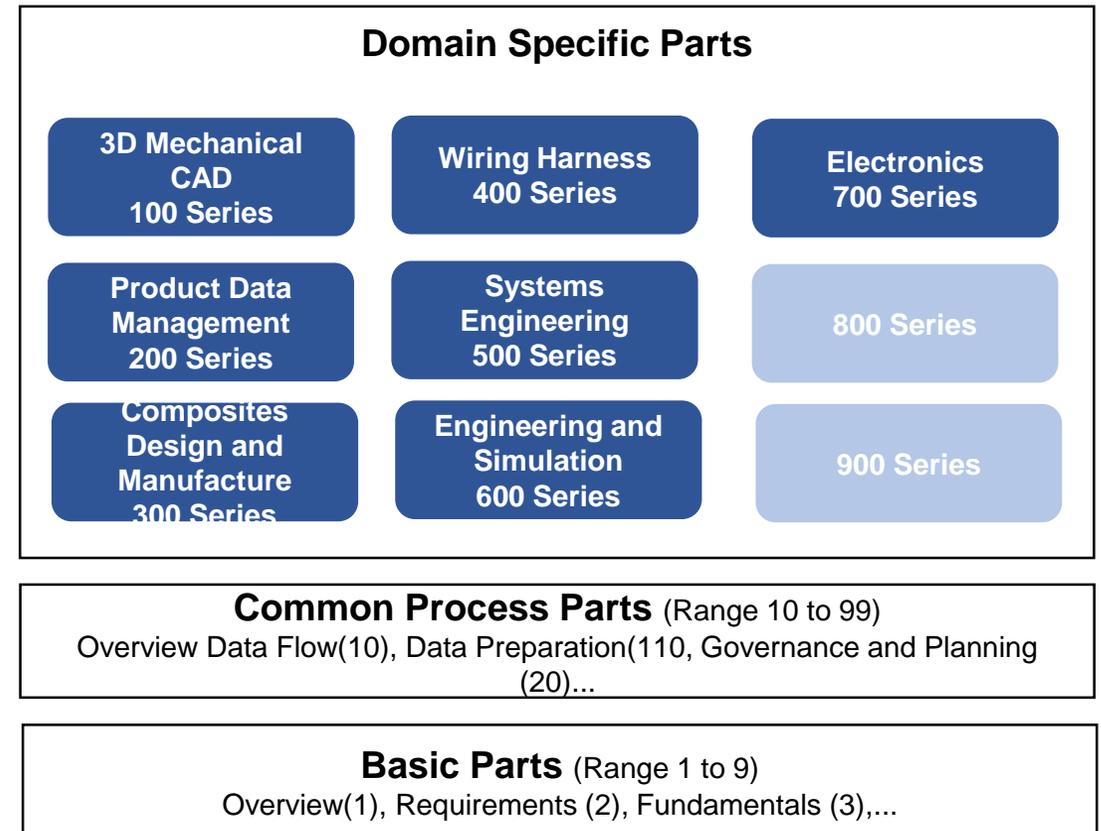
Aerospace - Why is CAD a concern?
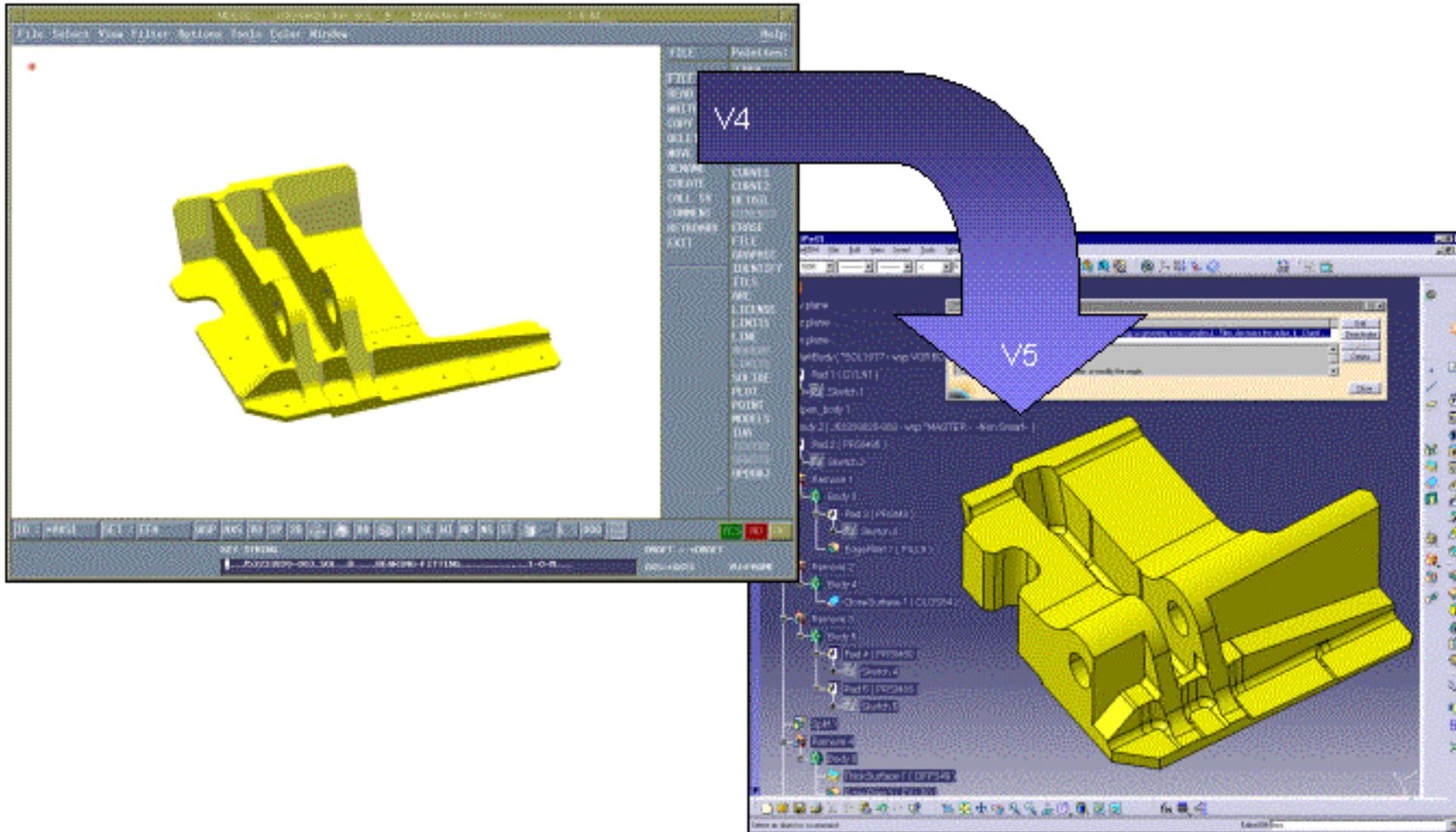
What is LOTAR?

LOTAR - The Project and the Standard

The project: A dozen Aerospace companies plus supporting organisations and specialist companies

Standard NAS/EN 9300
Published in many parts

Standards
ISO, OAIS, EN, NAS

Certification Authority
FAA

**AIA
AIA-EMC**

Certification Authority
EASA

**ASD-STAN
ASD-SSG**

Hosting Organization
PDES INC

LOTAR International Project Group

Hosting Organization
ProSTEP iViP

Vendors & Imlementors
CAx-IF

Vendors & Imlementors
PDM-IF

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Domain Specific Parts

3D Mechanical CAD 100 Series	Wiring Harness 400 Series	Electronics 700 Series
Product Data Management 200 Series	Systems Engineering 500 Series	800 Series
Composites Design and Manufacture 300 Series	Engineering and Simulation 600 Series	900 Series

Common Process Parts (Range 10 to 99)
Overview Data Flow(10), Data Preparation(110, Governance and Planning (20)...

Basic Parts (Range 1 to 9)
Overview(1), Requirements (2), Fundamentals (3),...

LOTAR - Aerospace Requirements

1: Certification

2: Product Liability

3: Reuse

4: Product Support

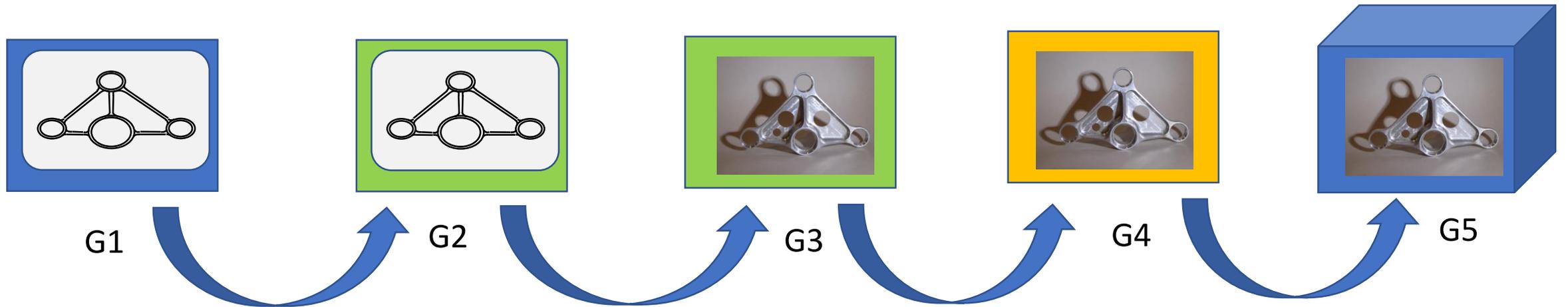Aircraft Lifecyle - typically 70 years

Assumption:
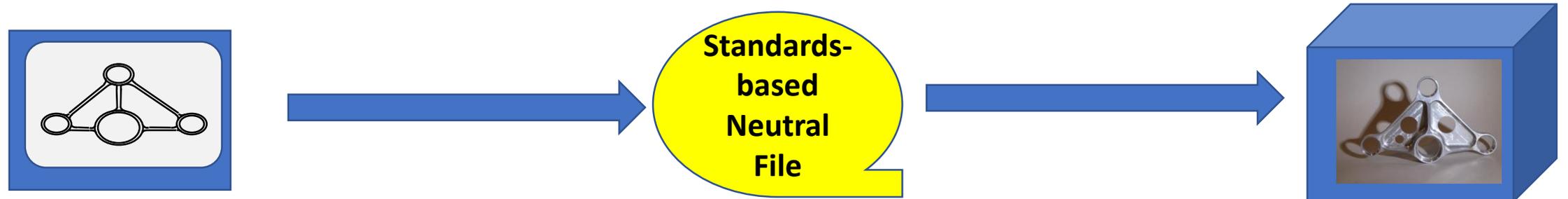Even if we could archive the original software and the computers it runs on
We can't archive the original engineers
        therefore, we need to archive for the CAD systems that future engineers will use

LOTAR Approach - Preservation Chains

G1   G2   G3   G4   G5

Either migrate through every CAD software generation - LOTAR not recommended
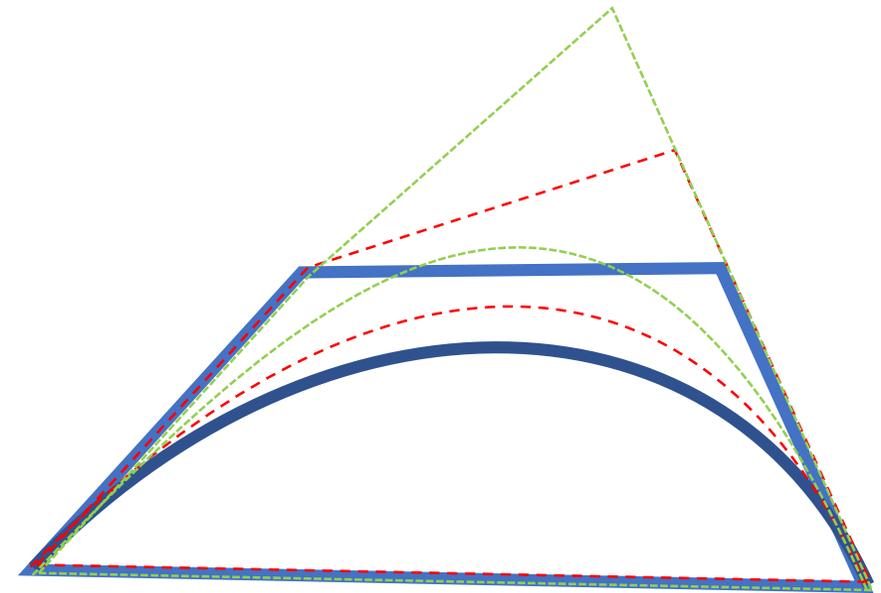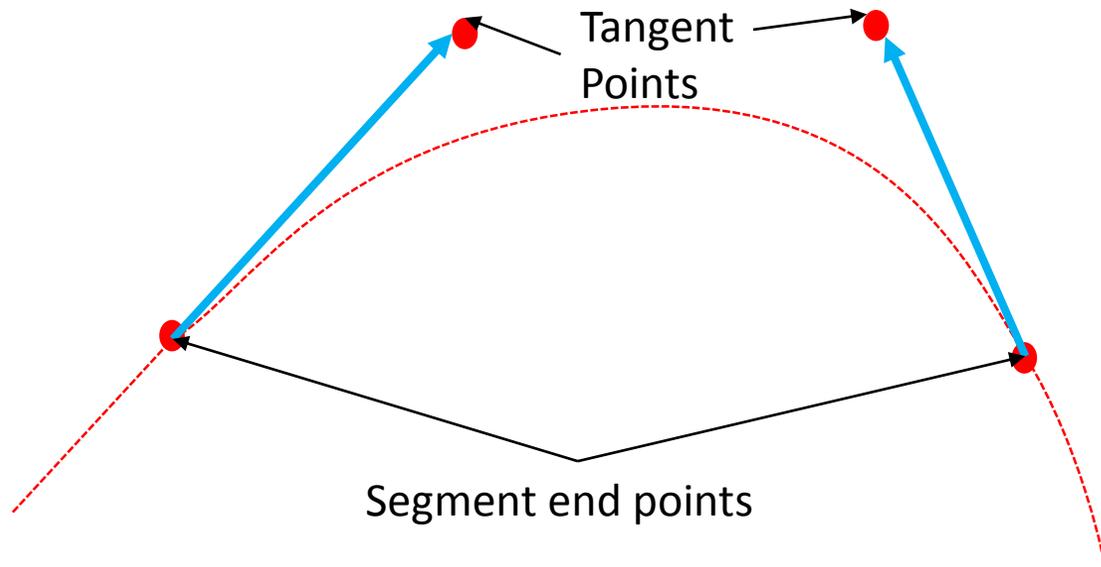
G1

Standards-based Neutral File

G5

OR save in standards-based neutral format   - **LOTAR preferred method**

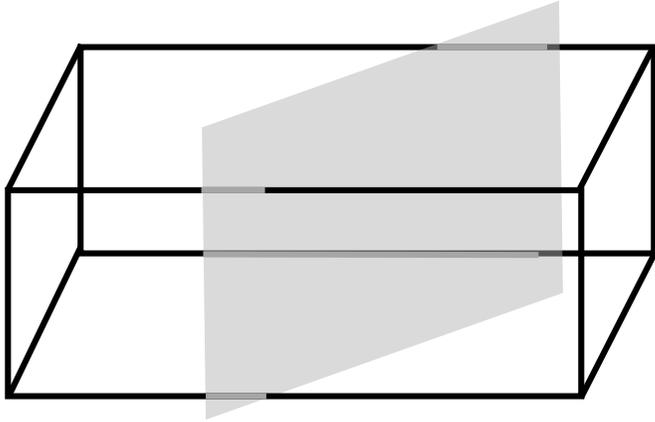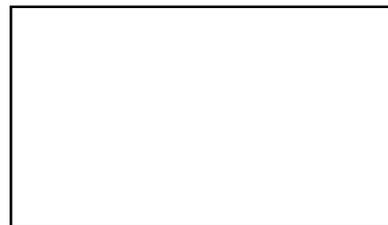# The Peculiarities of CAD

CAD - Ingredients and Recipes not Cakes
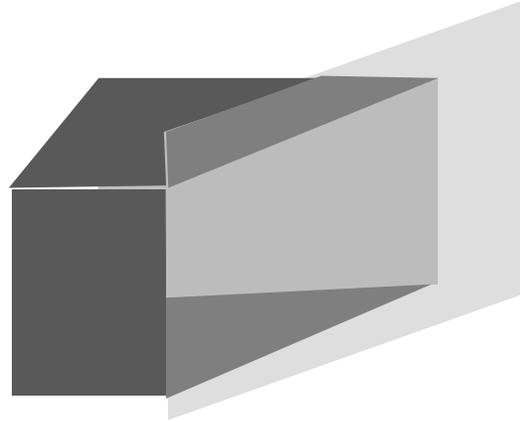

Tangent Points

Segment end points

©SAE International - source see slide 19

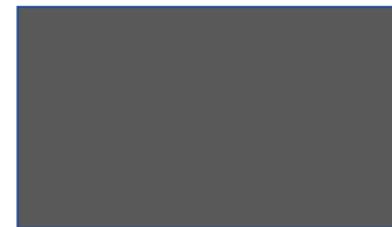Aim: Fit a smooth curve through a series of points

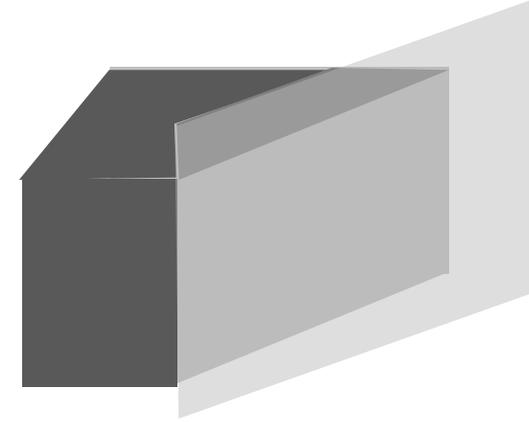# CAD - Types of Solid Modeller

Wire frame

Surface Model
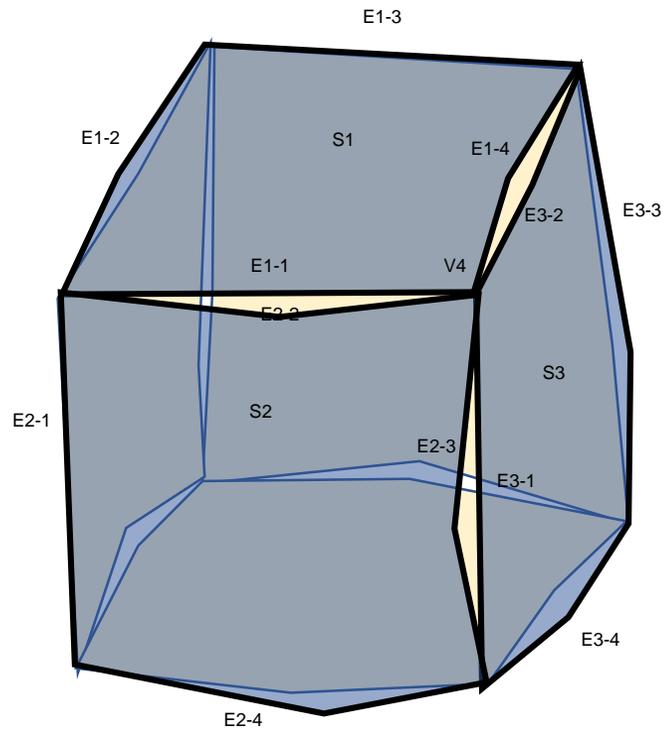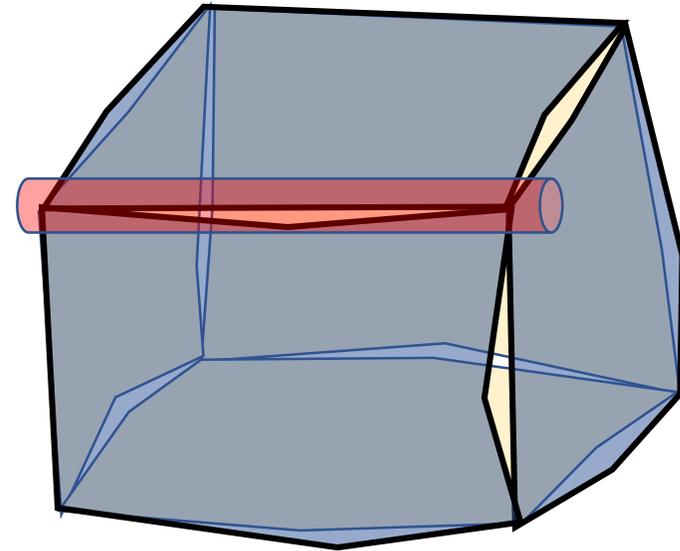
Solid Model

CAD - Modelling errors

A Badly Constructed Box


Edge Gap Tolerance Test

CAD - Product Manufacturing Information

PMI - Dimensions, manufacturing tolerances, etc

Appears as annotation to the model
- PMI as presentation
    - only the shapes of the letters recorded
    - hard to validate without OCR
- PMI representation
    - Numerical properties linked to the model
    - PMI validation properties

STEP AP 203 and 214 include only limited PMI
STEP AP 242 developed to meet LOTAR requirements on PMI
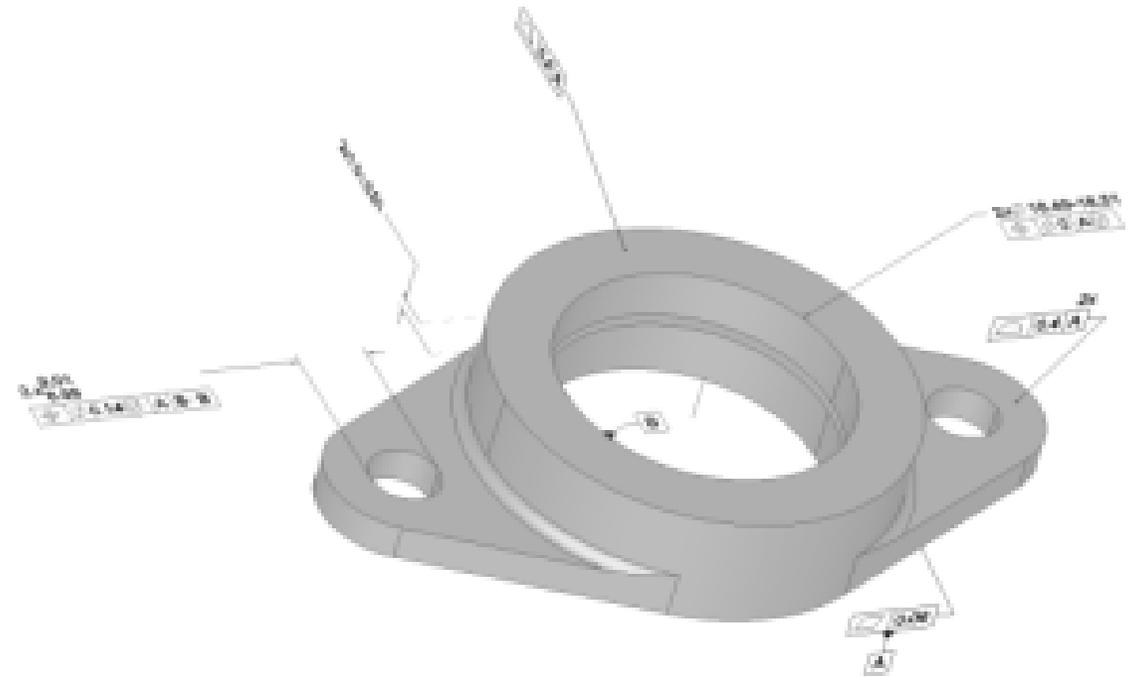
How LOTAR deals with CAD

LOTAR - Verification and Validation

Verify the model **stored** is archive **quality**
test on the data stored

Validate the model **recovered** is **unchanged**
test on the algorithms

LOTAR - Verification Rules

Is the data fit to archive?

SASIG Code	Rule Content	Comment/Recommended Threshold
G-CU-LG	Large Segment Gap	≥ 0.001 mm
G-CU-NT	Non-Tangent Segments	≥ 75 degrees
G-LO-LG	Large Edge Gap	≥ 1.0 mm
G-SH-FR	Free Edge	Not valid for a solid body
G-SU-NM	Over-used Edge	≥ 3 (count)
G-SU-FG	Fragmented Surface	≥ 2500 patches
-	Empty Model	No solid or surface geometry

LOTAR - Validation Properties

Is the model unchanged in the new software?

Geometry	Validation Test
Exact Solid	Volume, Centre of Gravity, Area
Exact Independent surface/open shell	Centre of Gravity, Area
Exact independent curve	Independent Curve Length Independent Curve Centroid
Tessellated solid	Surface area, Centroid
Tessellated surface	Surface area, Centroid
Tessellated curve	Total Length, Centroid

Checks that the software follows the recipe

Summary

Archiving is a **Business** issue, not one IT suppliers help with
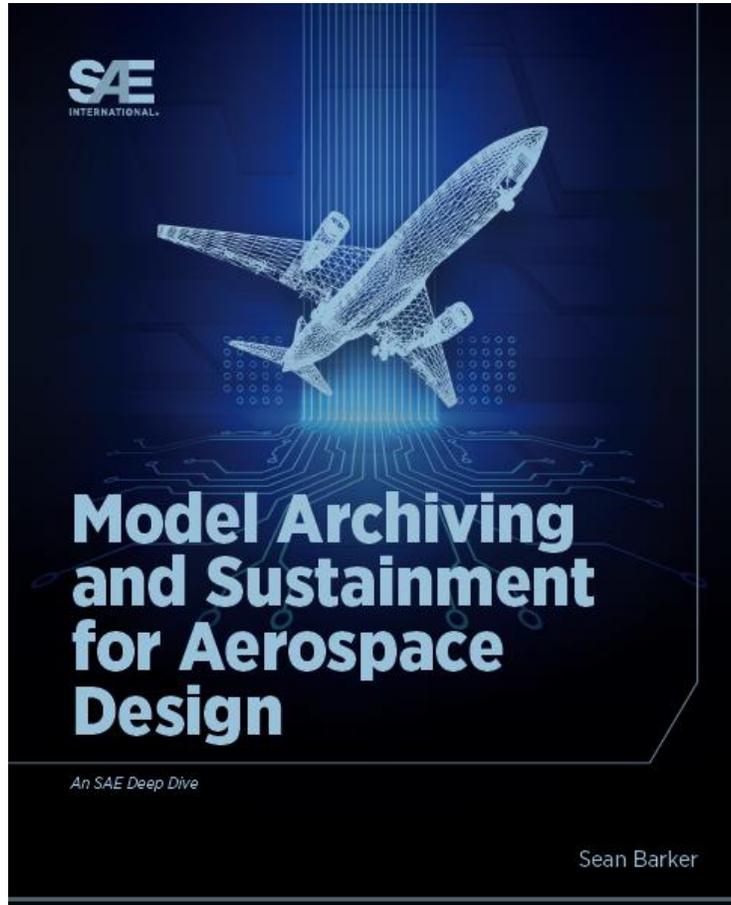
Archiving must meet **Business requirements**

If CAD models are cakes, the **ingredients** are the **model files**, which use software **recipes** to recreate the design

LOTAR recommends storage in a **neutral format**

LOTAR adds **verification** rules and **validation** properties

Standards rely on **users** to **input** their requirements

Now buy the book

Model Archiving and Sustainment for Aerospace Design
Sean Barker
SAE International -Warrendale PA, USA 2020
Available soon at books.sae.org

Contents
1. Introduction
2. Aerospace Requirement
3. OAIS
4. Service Architectures
5. LOTAR Basics
6. Governance and Planning
7. Basic of CAD
8. Preserving CAD
9. Signposts for Other Models
10. Basics of PDM
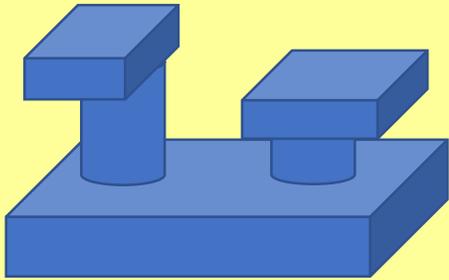11. How to Archive an Aircraft
12. Summary

Knowledge
This presentation - 30 minutes
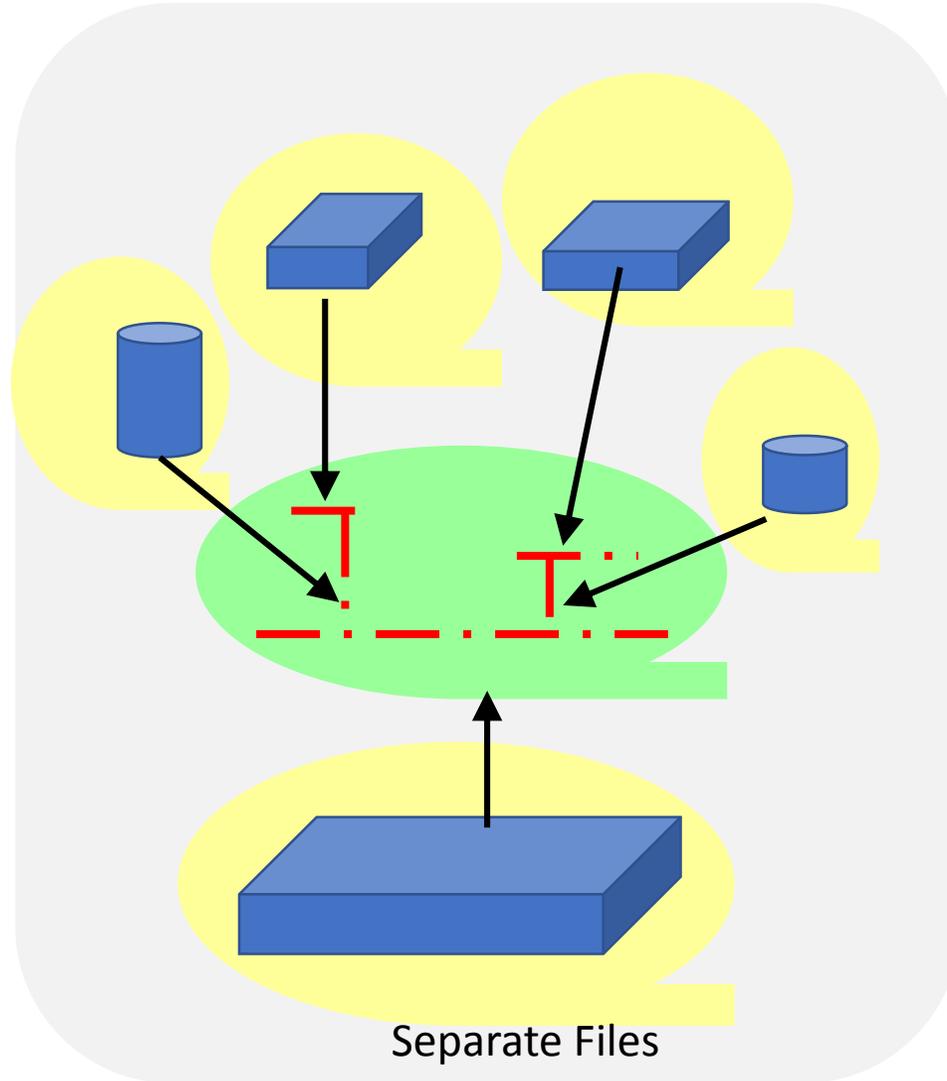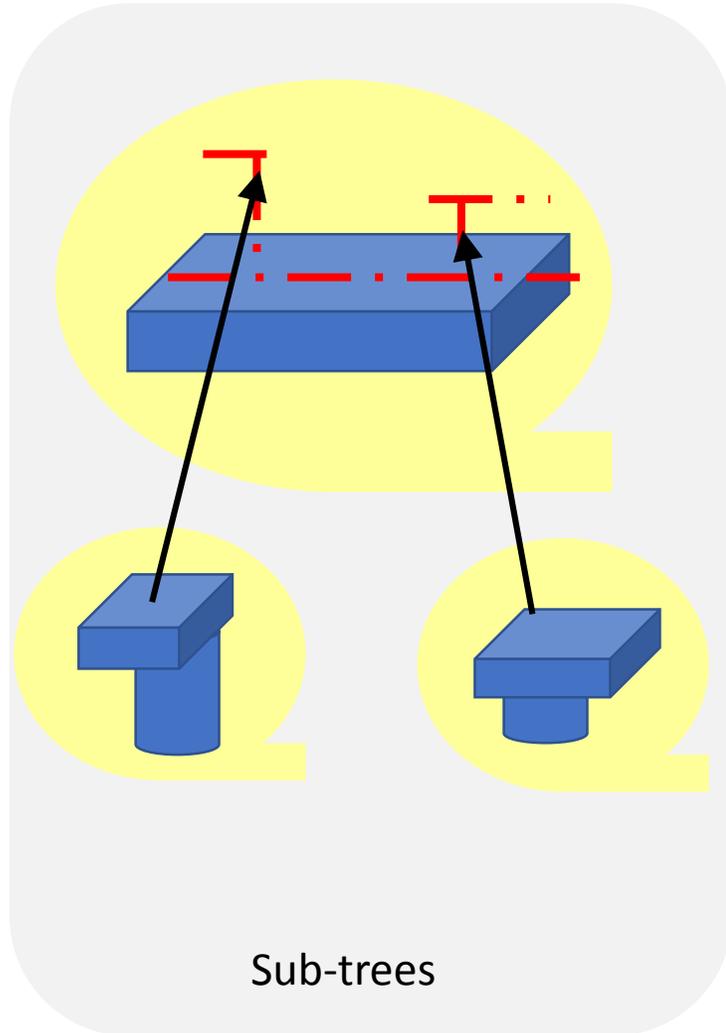The book - 4 to 5 hours
Basic texts - 4 to 5 months

CAD Assemblies

One File

Separate Files

Sub-trees