

Long Term Archiving with 3D PDF

3D PDF Consortium

- Jerry McFeeters – Executive Director
- Phil Spreier – Technical Director

GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2015



ELYSIUM

Parker Aerospace

NORTHROP GRUMMAN

BOEING

ELYSIUM

Parker Aerospace

NORTHROP GRUMMAN

BOEING

3D PDF Consortium

Global Product Data Interoperability Summit | 2015

A community dedicated to driving adoption of 3D PDF enabled solutions through:

- Defining industry needs and priorities
- Creating reference implementations and other resources
- Providing input to the standards process
- Raising awareness

A worldwide, non-profit, member organization

Open to all companies

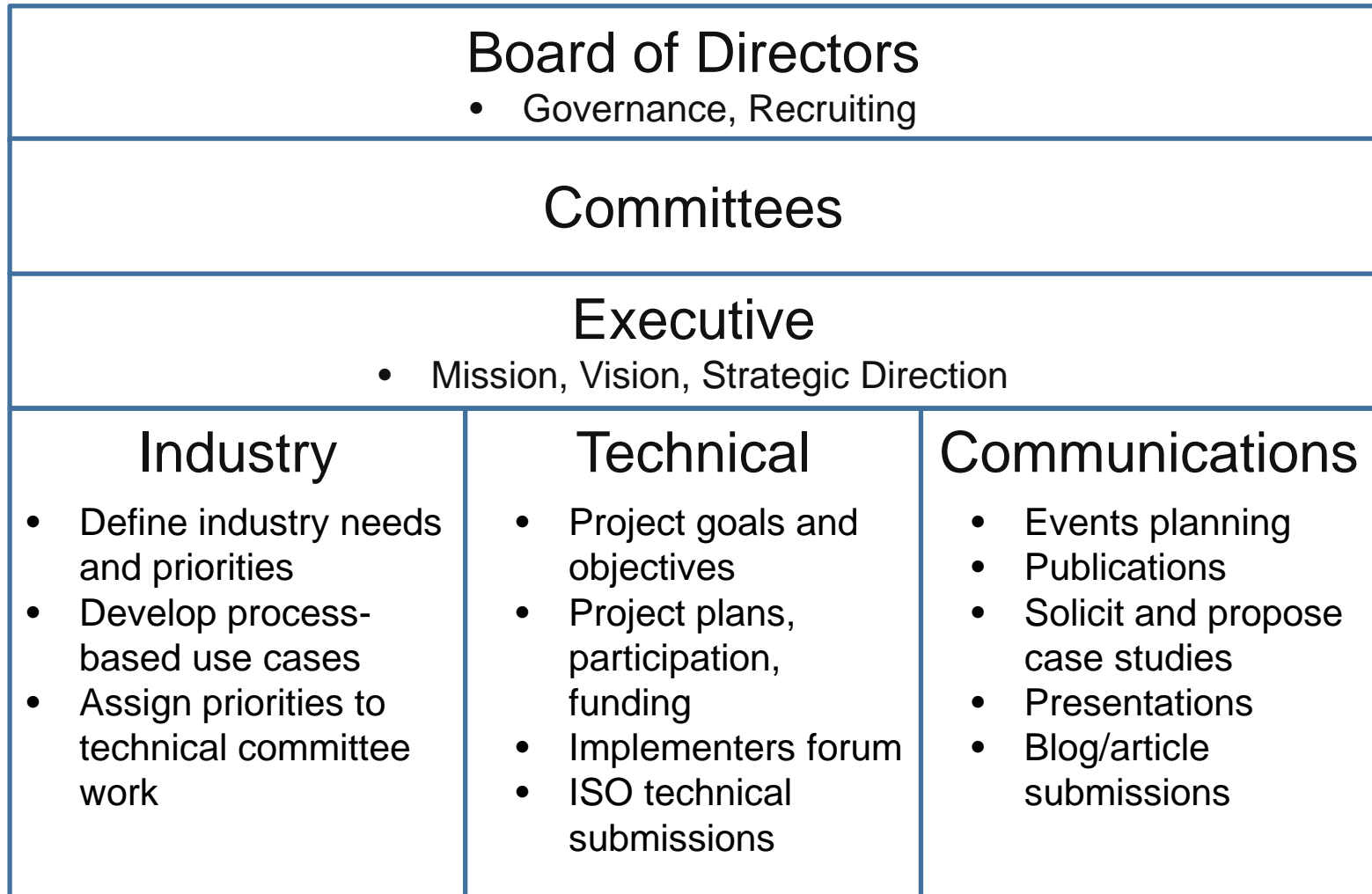
3D PDF Consortium - Members

Global Product Data Interoperability Summit | 2015



3D PDF Consortium - Organization

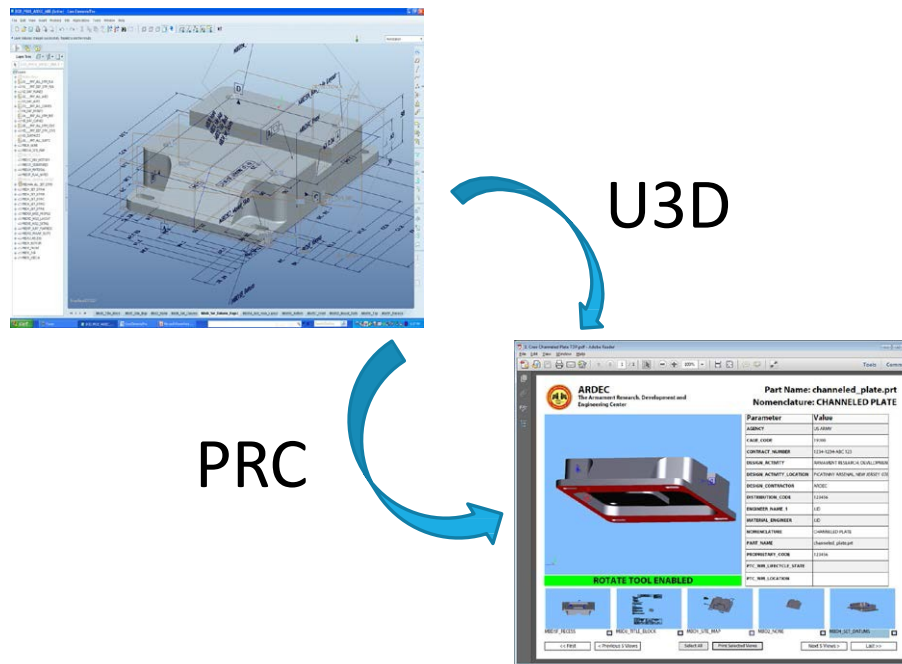
Global Product Data Interoperability Summit | 2015



What is 3D PDF?

Global Product Data Interoperability Summit | 2015

Any PDF file containing data defined in either Universal 3D (U3D), or Product Representation Compact (PRC) formats



PDF – 3D Content

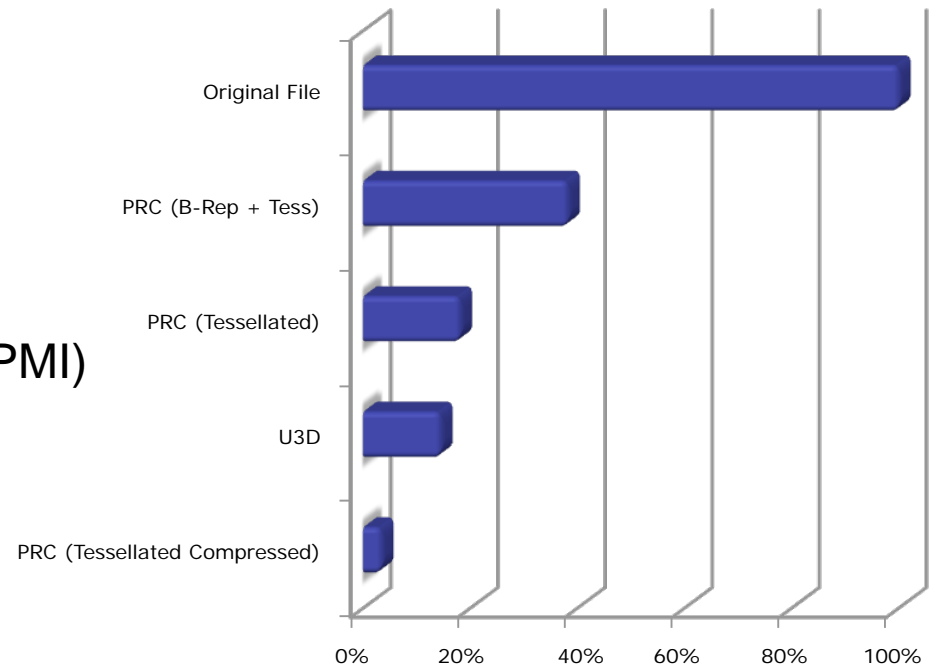
Global Product Data Interoperability Summit | 2015

PRC

- **Engineering Format**
 - Product Structure
 - Tessellation
 - Precise B-Rep
 - Product and Manufacturing Information (PMI)
 - Highly compact

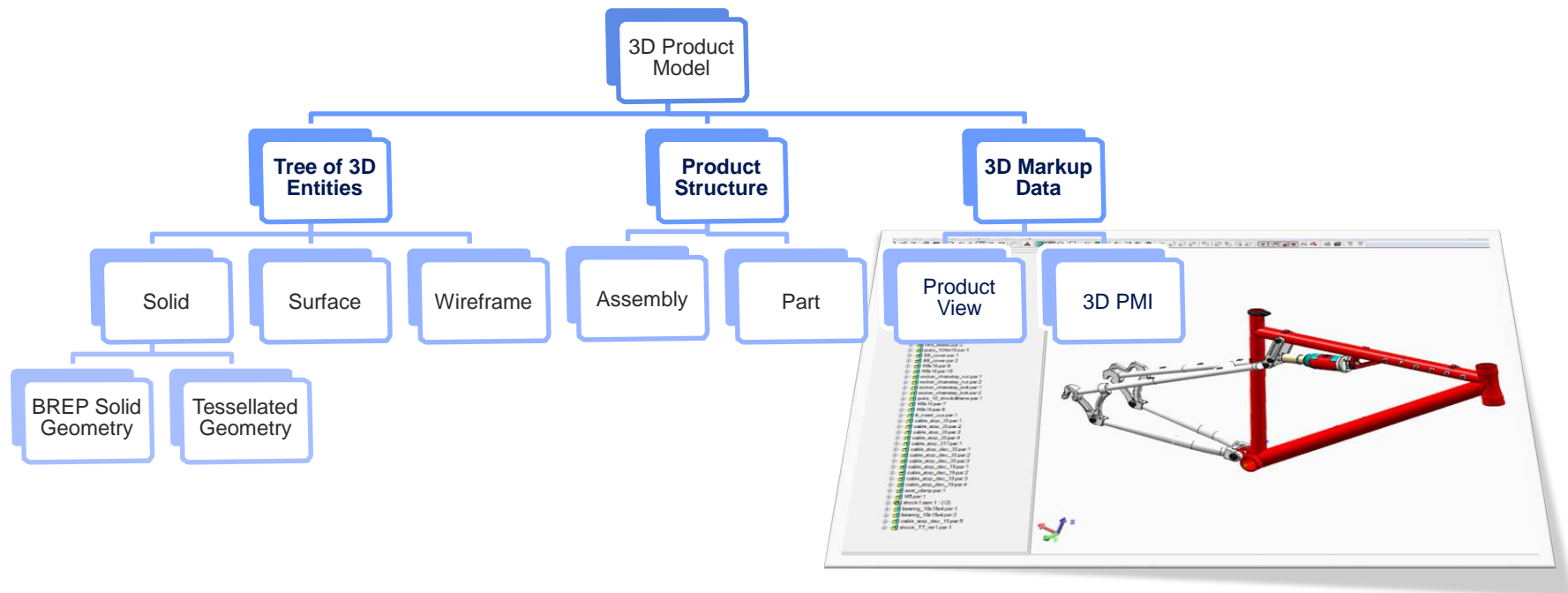
U3D

- **Presentation Format**
 - ECMA standard (ECMA 363-3)
 - Only supports tessellated data
 - No longer actively developed



What is “Product Structure?”

Global Product Data Interoperability Summit | 2015



PRC Content - Physical

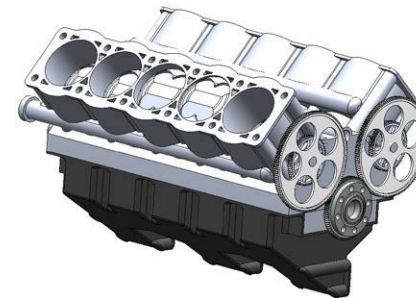
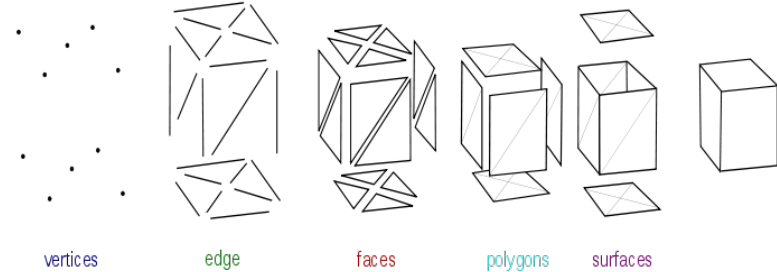
Global Product Data Interoperability Summit | 2015

Topology

- Complete topological description

Geometry

- Designed to represent geometry from ALL CAD systems
- Points, coordinate systems, polyhedra, curves, surfaces
- Maintains period and parametric definitions of curves and surfaces

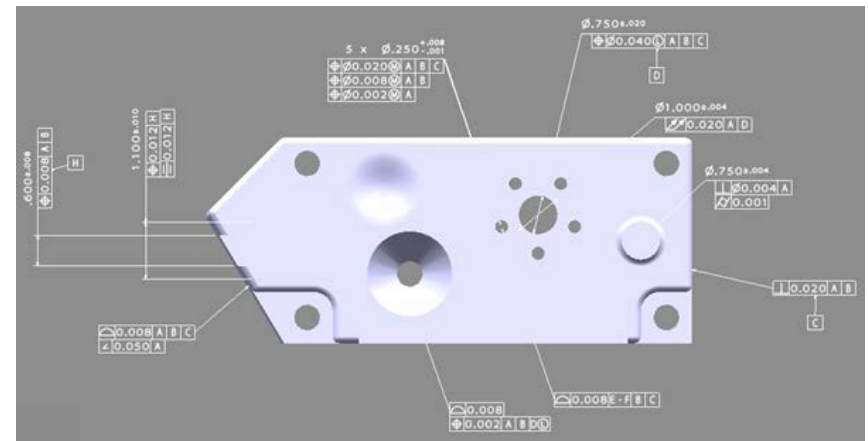


PRC Content - PMI

Global Product Data Interoperability Summit | 2015

Full visual PMI

- Annotations and symbols
- Can be associated to 3D elements



PRC Content - Metadata

Global Product Data Interoperability Summit | 2015

Name

- Key value pairs representing attributes (i.e. author, creation date, release date)

Persistent ID

- Two types of unique identification

Style

- Transparency, rendering mode, materials

Layer

- Logical grouping of elements

Show/hide

- Enables visibility

Coordinate systems

- Part based or local based

Stored as XML

- Ease of access

PDF Structure with 3D

Global Product Data Interoperability Summit | 2015

```
20: (14) [156 0 R] /T:Annot /S:Widget
21: (14) [157 0 R] /T:Annot /S:Widget
22: (11) [158 0 R] /T:Annot /S:3D
30A: (2)
30D: (6) [124 0 R] /T:3D /S:PRC
  AN: (4) [170 0 R] /T:3DAnimatorStyle /S:Linear
    Length: 1945587
    OnInstanceState: (2) [125 0 R]
      Subtypes: PRC
      Type: 3D
    VA: (12) [171 0 R]
      O: (7) [172 0 R] /T:3DView
        C2W: (12)
          CO: 7184.52002
          DN: 8c6effb7-2262-49b5-a8c0-a276cfd5fad7
          MS: M
          P: (4) [357 0 R] /S:O
            Type: 3DView
            XN: Left
          1: (7) [173 0 R] /T:3DView
          2: (7) [174 0 R] /T:3DView
          3: (7) [175 0 R] /T:3DView
          4: (7) [176 0 R] /T:3DView
          5: (7) [177 0 R] /T:3DView
          6: (12) [178 0 R] /T:3DView
          7: (12) [179 0 R] /T:3DView
          8: (12) [180 0 R] /T:3DView
          9: (12) [181 0 R] /T:3DView
          10: (12) [182 0 R] /T:3DView
          11: (12) [183 0 R] /T:3DView
        C2W: (12)
          CO: 9291.66016
          DN: 20d8e30d75_9b4fe59c974ff1e2abe04d5b463517d602e00ecf8eb28e5720be863dcf7ec6a29b405030
          LS: (2) [184 0 R] /T:3DLightingScheme /S:Headlamp
            MS: M
          NA: (4)
          O: (6) [189 0 R] /T:3DNode
            M: (12)
            N: FDRBK21V02524A0_1_32(2).3D.PML.ecf8eb28e5720be863dcf7ec6a29b405030
              O: 1.0
            RM: (2) [195 0 R] /T:3DRenderMode /S:Solid
              Type: 3DNode
              V: false
          1: (6) [189 0 R] /T:3DNode
          2: (6) [190 0 R] /T:3DNode
          3: (6) [191 0 R] /T:3DNode
```

3D data is a stream within the PDF

Geometry data is sequential binary; other data is XML and accessible

Tools exist to do the conversion from authoring system and placement in PDF file

Data binding

Global Product Data Interoperability Summit | 2015

```
<?xml version="1.0" encoding="UTF-8" ?>
- <tns:Request xmlns:tns="http://www.example.org/VW_EGVZ">
  <tns:requestNumber>987659</tns:requestNumber>
  <tns:description />
  <tns:dateOfRFQ>18.03.2009</tns:dateOfRFQ>
  <tns:closingDate>31.03.2009</tns:closingDate>
  <tns:dateOfReceipt />
  <tns:packagingTerms />
  <tns:deliveryTerms />
  <tns:paymentTerms />
  <tns:currency />
  <tns:reasonOfRefusal />
  <tns:noOfferPlanned />
  <tns:isFormFilled>0</tns:isFormFilled>
  <tns:pageCount>1</tns:pageCount>
- <tns:masterData>
  <tns:company>Global World Company</tns:company>
  <tns:unit>Versuchsbau</tns:unit>
  <tns:project>GWC001</tns:project>
- <tns:address>
  <tns:street>Industriepark</tns:street>
  <tns:no>1</tns:no>
  <tns:zip>11111</tns:zip>
  <tns:city>Globus</tns:city>
  <tns:country>Germany</tns:country>
</tns:address>
+ <tns:disponent>
+ <tns:technicalContact>
+ <tns:financialContact>
</tns:masterData>
- <tns:vendor>
  <tns:vendorId>10006</tns:vendorId>
  <tns:company>Max Maschinenbau</tns:company>
- <tns:address>
  <tns:street>Teichstr.</tns:street>
  <tns:no>57</tns:no>
  <tns:zip>22222</tns:zip>
  <tns:city>Entenhausen</tns:city>
  <tns:country>Germany</tns:country>
</tns:address>
- <tns:contact>
  <tns:forename>Max</tns:forename>
  <tns:surname>Mustermann</tns:surname>
  <tns:email>max.musterman@mm.max</tns:email>
```

Connection of field objects with data from different external sources

An intelligent 3DPDF document integrates XML data from backend systems with form field which can act together with embedded 3D geometries

Templates

Global Product Data Interoperability Summit | 2015

Predetermines layout

- Where objects are placed
- How data binding is realized
- How objects behave

Visible content

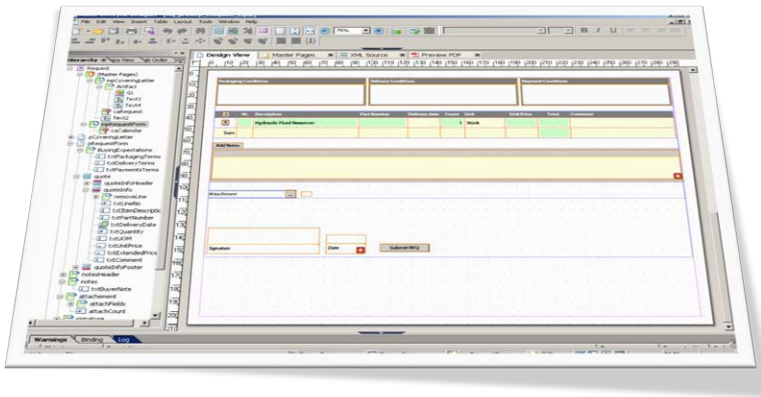
- Text
- 2D and 3D
- Form objects (editable)
- Control elements (buttons, lists)

Data content

- XML data

Control logic

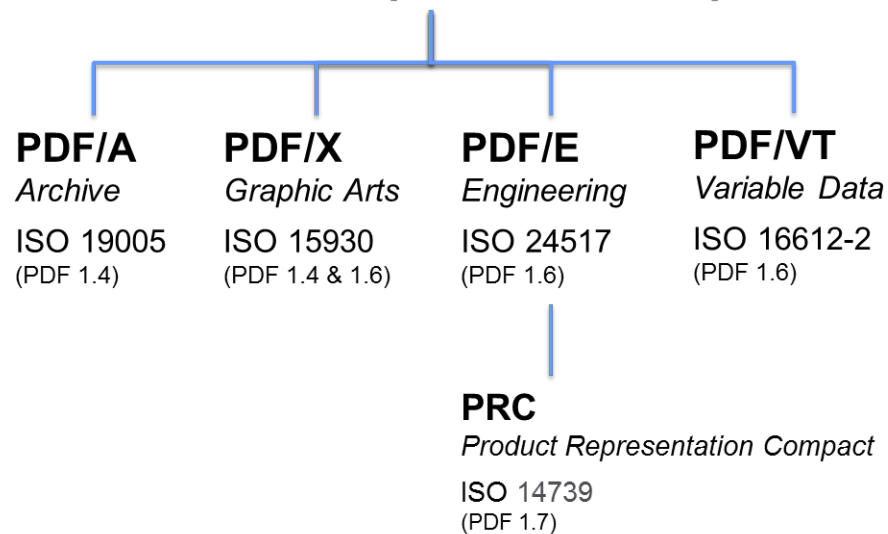
- JavaScript
- FormCalc
- Flash apps



PDF standards

Global Product Data Interoperability Summit | 2015

PDF 1.7 (ISO-32000)



What is PDF/E?

Global Product Data Interoperability Summit | 2015

The engineering document format

The screenshot displays a PDF/E viewer window titled "Parts+Catalogs-1.pdf". The interface is divided into several sections:

- Model Tree:** A hierarchical tree view on the left showing the assembly structure. The selected part is "LATCH ASY DR RH.1", which includes sub-components like "Pawl", "Housing", "Ratchet", and "Levers".
- 3D Model:** A central 3D rendering of the latch assembly, colored in blue and green.
- Supplier Name Data:** Information for "Platform Truck Heavy", including address (1431 Spruce Street, Boulder, CO 80502, USA), phone (800-555-1212), and year (2009).
- Manufacturing Bill of Materials (BOM):** A table listing parts with their IDs and descriptions. The table has columns for ID, Part Description, and Qty.
- Shipping Instructions:** A section providing details on shipping, including "Related Programs" (F-250, F-150, Econoline Van), "Shipping Weight (lbs)" (19.3), "Cost/MSRP" (357.63), "Availability Date" (7/28/2009), "Effectivity Date" (7/15/2000), "Effectivity Rev." (5), "PPAP Date" (5/22/2009 12:00:00), "Volume" (100000), and "Inventory" (1000).
- Omega Automotive Logo:** A logo for Omega Automotive, a Division of Avtek Corp., located in the bottom right corner of the data panel.

Why develop an engineering version of PDF?

Global Product Data Interoperability Summit | 2015

Engineering today is mostly done in 3D

Multiple proprietary CAD data formats exist

- AutoCAD, CATIA, Siemens NX, PTC Creo, etc.

Tools for proprietary formats are expensive

Existing open standards for CAD data are too old (IGES) or do not have a standard viewer available (STEP, JT)

Estimated that there is up to 4 times the demand for CAD data outside the engineering department – RFI/RFQ, assembly instructions, maintenance manuals, marketing, etc.

PDF/E (ISO 24517-1:2008)

Global Product Data Interoperability Summit | 2015

Based on PDF (ISO 32000-1)

Covers 3 primary areas:

- Incorporation of complex engineering data into compact PDF (3D, object-level data, etc.)
- Accurate printing of engineering drawings
- Support for secure exchange/management of annotation and markup data

Constrained to provide predictability

- All fonts **MUST** be embedded
- No external resources; self contained
- 3D, Layers, Multimedia

The need to archive PDF/E

Global Product Data Interoperability Summit | 2015

Long life cycle products

- Airplanes
- Ships
- Automobiles
- Buildings
- Nuclear Power Plants
- Off Shore Platforms
- Etc.

Need to maintain / repair /
operate these designs
throughout their lifecycle



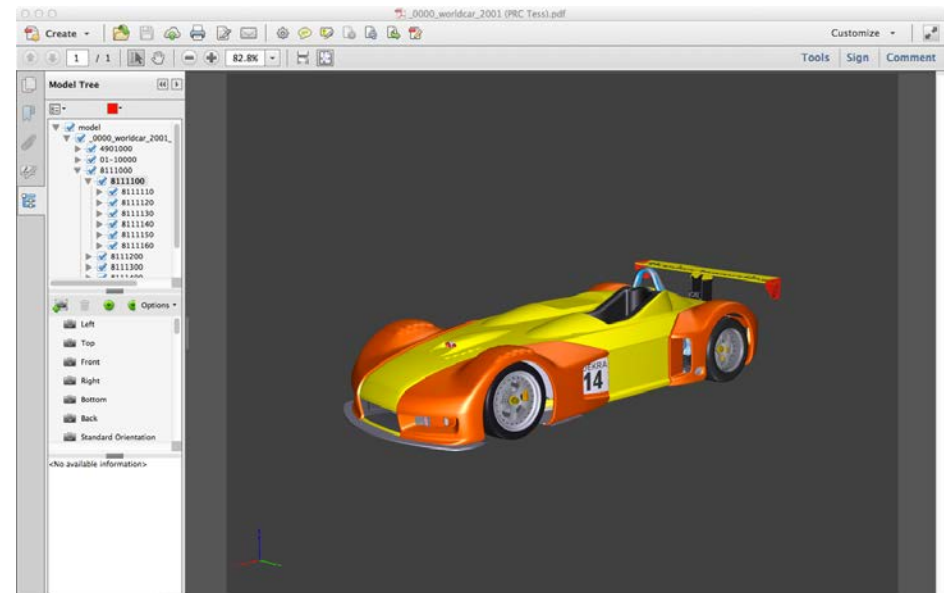
Engineering archival requirements

Global Product Data Interoperability Summit | 2015

Model has to maintain it's original form

Relationships between multiple objects must be preserved

- **Assemblies / Subassemblies / Parts**



Engineering archival requirements

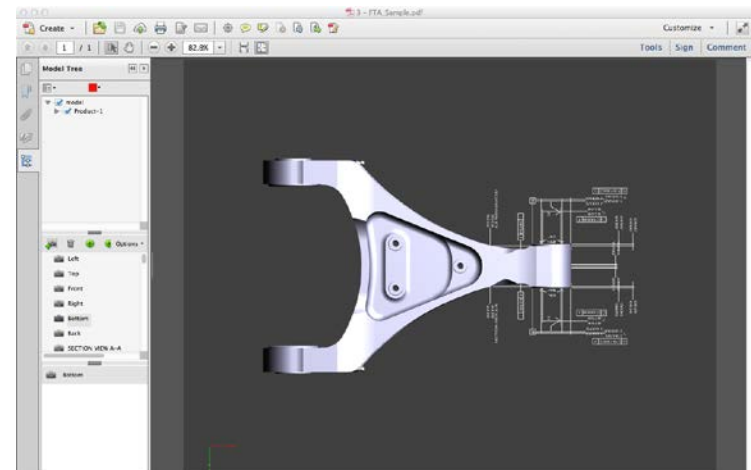
Global Product Data Interoperability Summit | 2015

Preserve attribute data that is associated to the model

- Properties – materials
- Manufacturing Information - PMI

Preserve views of the model

- Camera, Hide/Show, Sections, etc.

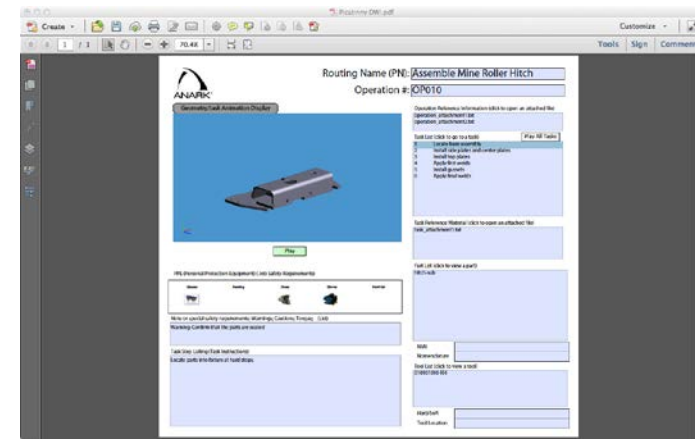


Engineering archival requirements

Global Product Data Interoperability Summit | 2015

Preserve relationships between the model and associated data

- Inspection data
- Bill of Materials (BOM)
- Animations
- Visual Response



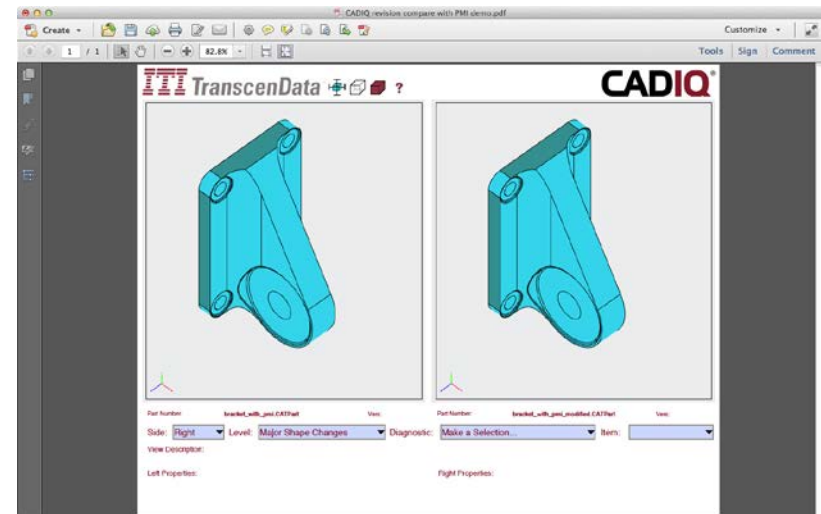
Engineering archival requirements

Global Product Data Interoperability Summit | 2015

Preserve validation information

Preserve Digital Rights (DRM)

Preserve associated business information (attachments)



PDF/E-2 (ISO 24517-2)

Global Product Data Interoperability Summit | 2015

The Engineering Archival Format

- **Aligned with ISO 32000-2 (PDF 2.0) for engineering features**
- **PRC (ISO 14739-1)**
 - Compact, precise engineering data
- **Geospatial (GIS)**
- **2D & 3D Measurements**
- **3D JavaScript**

Currently under development

Benefits of the PDF Platform

Global Product Data Interoperability Summit | 2015

Access

- through Acrobat Reader

Multi-type

- 3D, 2D, image, text, audio, video, enterprise data

Fit for purpose

- JavaScript support, templates, forms, portfolios

Infrastructure

- existing systems and resources already support PDF

Neutrality

- Investment protection

Value

- Low investment threshold with high payback

PDF/A vs PDF/E:2

Global Product Data Interoperability Summit | 2015

PDF/A

- Multiple versions (1 – 4)
- Each version less restrictive
- Developed for archivist community
- No 3D

PDF/E:2

- Developed as archival standard for engineering PDF
- Confusing name

ISO Standards

Global Product Data Interoperability Summit | 2015

Portable Document Format - Engineering
PDF/E

ISO 24517:2 Started in 2002

- **Content**
 - 3D (precise and tessellated)
 - Product Structure
 - PMI
- **Use Cases**
 - MBD
 - 3D Visualization
 - Archiving
- **Increasing usage in Model Based Enterprise**

Jupiter Technology
JT

ISO Started in 1990

- **Content**
 - 3D (precise and tessellated)
 - Product Structure
 - PMI
- **Use Cases**
 - 3D Visualization
 - DMU
 - Archiving
- **Increasing usage in Engineering**

Standard for the Exchange of Product data
STEP

ISO 10303 Started in 1984

- **Content**
 - 2D/3D (precise)
 - Product Structure
 - PMI
 - Additional life cycle data
- **Use Cases**
 - CAD/PLM Data Exchange
 - Various AP
 - LOTAR
- **High usage and wide dissemination**

STEP - Strengths / Weaknesses

Global Product Data Interoperability Summit | 2015

Strengths

- **LOTAR**
- **Designed to be the “digital thread” for engineering**
 - Process automation
- **Wide adoption by engineering applications**

Weaknesses

- **No visualization data**
- **Few viewers available**
- **File size**
- **No document capabilities**

JT- Strengths / Weaknesses

Global Product Data Interoperability Summit | 2015

Strengths

- **Siemens / Teamcenter**
- **Visualization**
- **Compressable**

Weaknesses

- **No adoption by some major engineering software developers**
- **No standardized geometry representation**
- **Weak document capabilities**

PDF:E - Strengths / Weaknesses

Global Product Data Interoperability Summit | 2015

Strengths

- Designed to archive documents, not just data
- Forms / Templates
- Scripting
- Audio / Video
- Drawings
- Highly Compressed

Weaknesses

- Geometry not read by engineering applications
- Weak process automation capabilities

Complementary Archiving Standards

Global Product Data Interoperability Summit | 2015

Use strengths of one format to offset weaknesses of another

STEP + PDF

- **PDF used as containing document**
 - Visualization
 - Documentation
- **STEP file attachment**
 - Geometry
 - Process automation