

**Proposal for ISO/IEC SC24 Technical Report:**  
**CAD-to-X3D Conversion for Product Structure,  
Geometry Representation and Metadata**

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**Web3D Korea Chapter / Web3D CAD Working Group**  
**2018. 1. 13.**



# Introduction

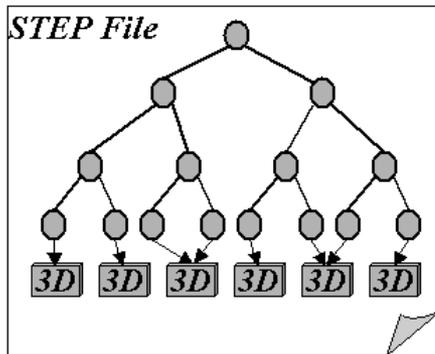
- CAD-to-X3D Conversion
  - Conversion of CAD data into X3D representation for lightweight 3D visualization
  - ISO TC 184/SC4 STEP based approach
  
- Purpose
  - To provide a guide on the conversion of a CAD assembly data into X3D representation for lightweight visualization
  - To improve X3D specification for better representation of CAD data if necessary
  - To identify a basis for further cooperative work by ISO standards groups
  
- Scope of CAD-to-X3D includes
  - Product Structure (PS)
  - Geometry
  - Product Manufacturing Information (PMI)

**PS**

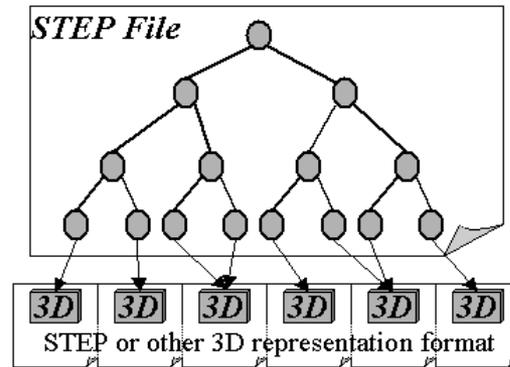
**PRODUCT STRUCTURE**

# Representation of PS in STEP\*

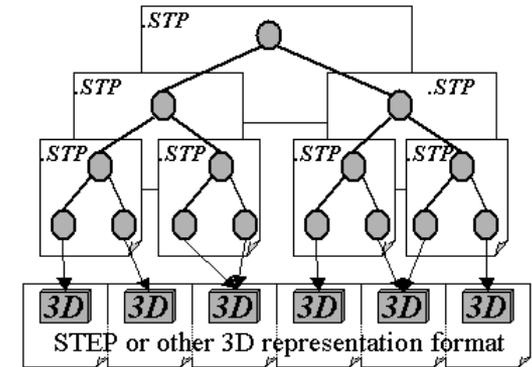
- Representation of PS in an assembly with external reference
  - Assembly and part geometries in the same file
  - An assembly file with external reference to geometry files => **external reference**
  - An assembly file with externally referenced sub-assemblies and geometry files => **nested external reference**



Assembly and part geometries in the same file



Assembly with external reference to 3D geometry file (in STEP or other format)

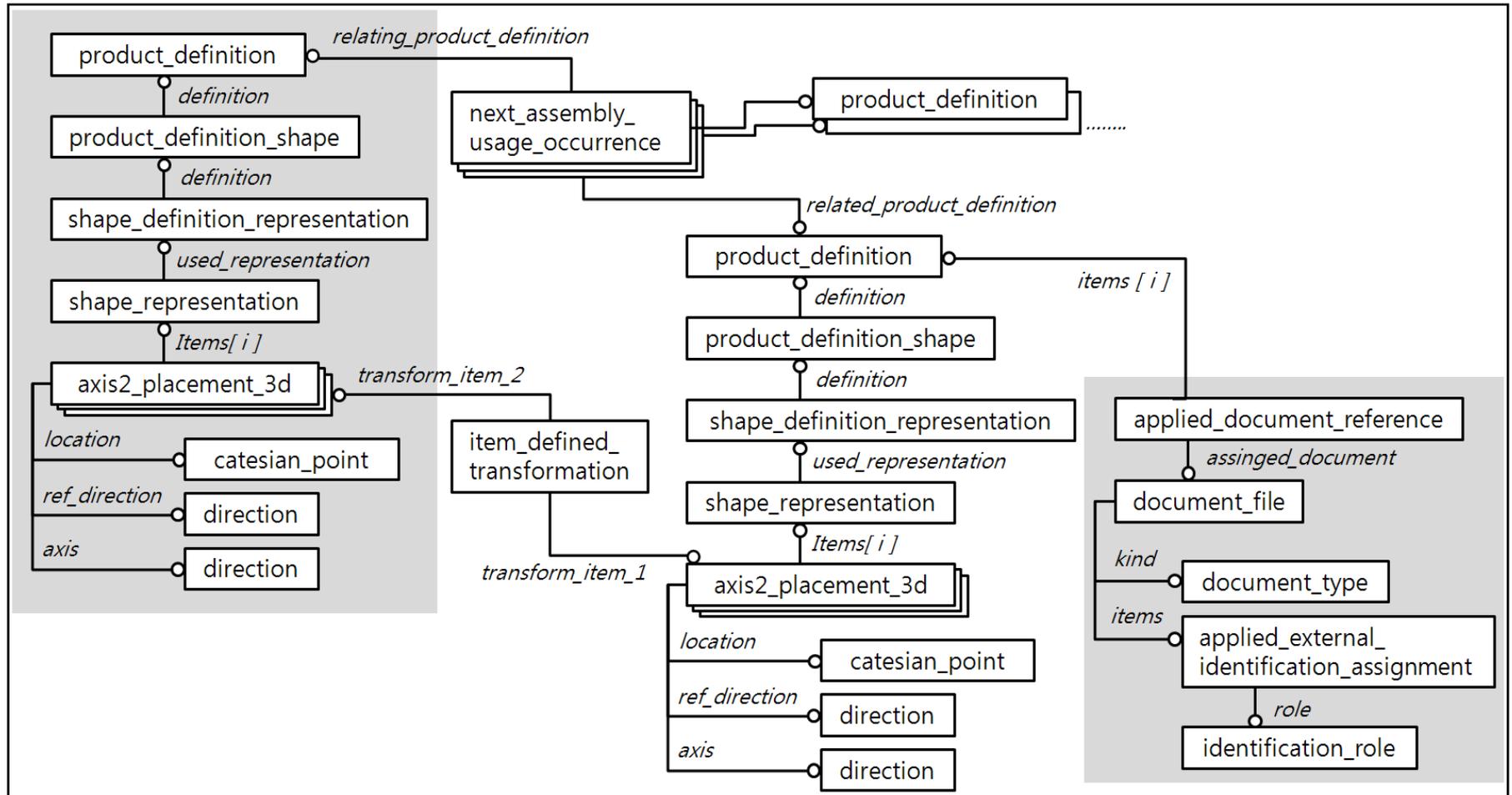


Nested assembly

\* STEP AP242 Project, <http://www.ap242.org/geometry-assembly-pmi-interoperability>

# Extraction of PS Information

- STEP\*-based approach for extraction of PS information\*\*



STEP AP203ed2 instance diagram for PS

\* ISO 10303 STEP (Standard for the Exchange of Product) Model Data

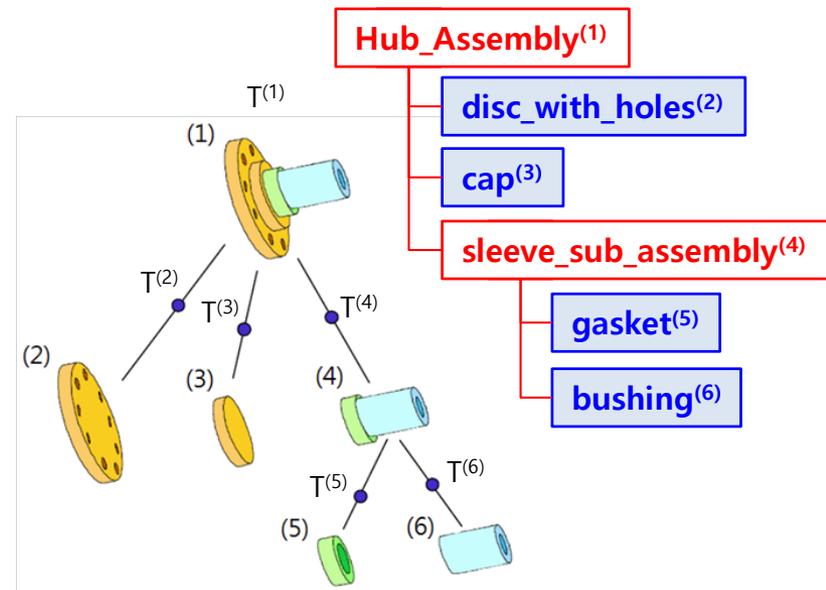
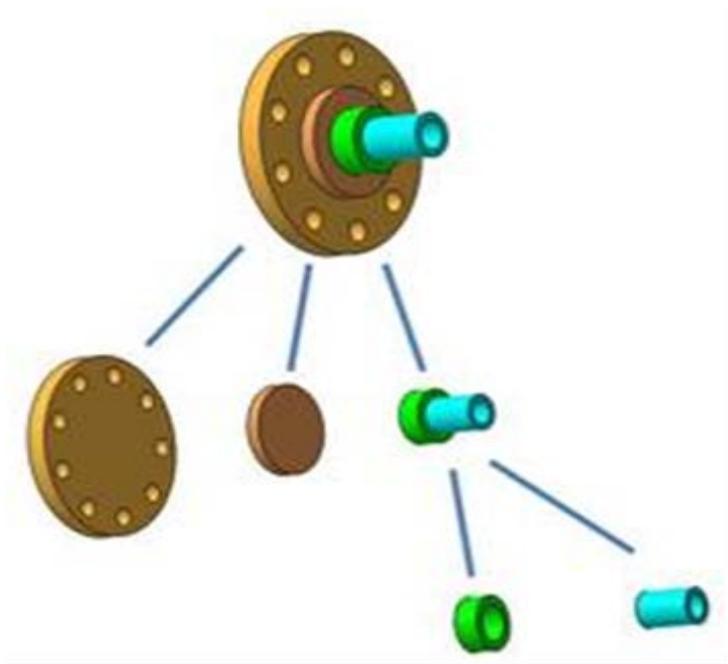
\*\* Cho, G., Hwang, J., and Kim, Y., "Translation of 3D CAD Data to X3D Dataset Maintaining the Geometry and Structure Information of a Product." *The Transactions of the Korea Information Processing Society*, VOL. 18-A, NO. 03, PP. 0081~0092, June 2011.



# Representation of PS in X3D

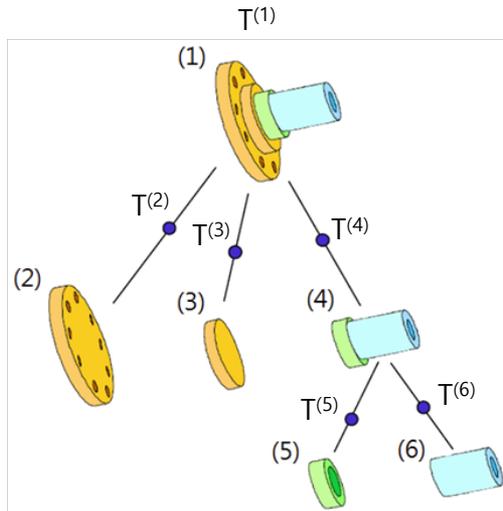
- X3D nodes for PS
  - CADLayer / CADAssembly / CADPart / CADFace: parent-child relations
  - Transform / ClipPlane : transform and reveal geometric information
  - Inline : external referencing to a data file
- Methods for representing PS in X3D
  - A : assembly and part geometries in the same file
  - B : external reference
  - C : nested external reference

# Hub assembly PS



CATIA\* Hub Assembly  
(6 Files)

- **A** : assembly and part geometries in the same file



## CatiaHubAssembly.X3D

```
<Transform DEF="T(1)">
```

```
<CADAssembly name="Hub_Assembly">
```

```
<Transform DEF="T(2)">
```

```
<CADAssembly name="disc_with_holes">
```

```
<CADPart name="disc_with_holes" ...>
```

```
<CADFace> ... </CADFace>
```

```
</CADPart>
```

```
</CADAssembly>
```

```
</Transform>
```



```
<Transform DEF="T(3)">
```

```
<CADAssembly name="cap">
```

```
<CADPart name="cap" ...>
```

```
<CADFace> ... </CADFace>
```

```
</CADPart>
```

```
</CADAssembly>
```

```
</Transform>
```



```
<Transform DEF="T(4)">
```

```
<CADAssembly name="sleeve_sub_assembly">
```

```
<Transform DEF="T(5)">
```

```
<CADAssembly name="gasket">
```

```
<CADPart name="gasket" ...>
```

```
<CADFace> ... </CADFace>
```

```
</CADPart>
```

```
</CADAssembly>
```

```
</Transform>
```



```
<Transform DEF="T(6)">
```

```
<CADAssembly name="bushing">
```

```
<CADPart name="bushing" ...>
```

```
<CADFace> ... </CADFace>
```

```
</CADPart>
```

```
</CADAssembly>
```

```
</Transform>
```



```
</CADAssembly>
```

```
</Transform>
```

```
</CADAssembly>
```

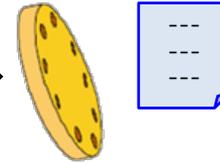
```
</Transform>
```

# CatiaHubAssemblyInline.X3D

```
<Transform DEF="T(1)">  
  <CADAssembly name="Hub_Assembly">  
    <Transform DEF="T(2)">  
      <CADAssembly name="disc_with_holes">  
        <Inline url="CatiaHubDiscWithHoles.x3d" />  
      </CADAssembly>  
    </Transform>  
    <Transform DEF="T(3)">  
      <CADAssembly name="cap">  
        <Inline url="CatiaHubCap.x3d" />  
      </CADAssembly>  
    </Transform>  
    <Transform DEF="T(4)">  
      <CADAssembly name="sleeve_sub_assembly">  
        <Transform DEF="T(5)">  
          <CADAssembly name="gasket">  
            <Inline url="CatiaHubGasket.x3d" />  
          </CADAssembly>  
        </Transform>  
        <Transform DEF="T(6)">  
          <CADAssembly name="bushing">  
            <Inline url="CatiaHubBushing.x3d" />  
          </CADAssembly>  
        </Transform>  
      </CADAssembly>  
    </Transform>  
  </CADAssembly>  
</Transform>
```

## Reusable geometry files

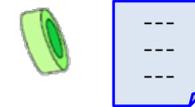
CatiaHubDiscWithHoles.x3d



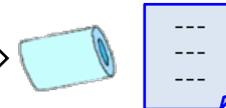
CatiaHubCap.x3d



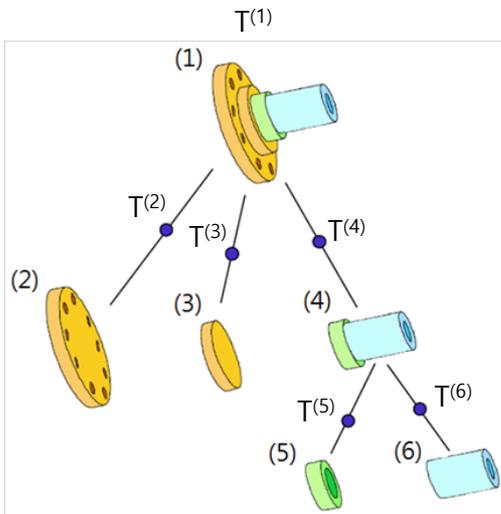
CatiaHubGasket.x3d



CatiaHubBushing.x3d

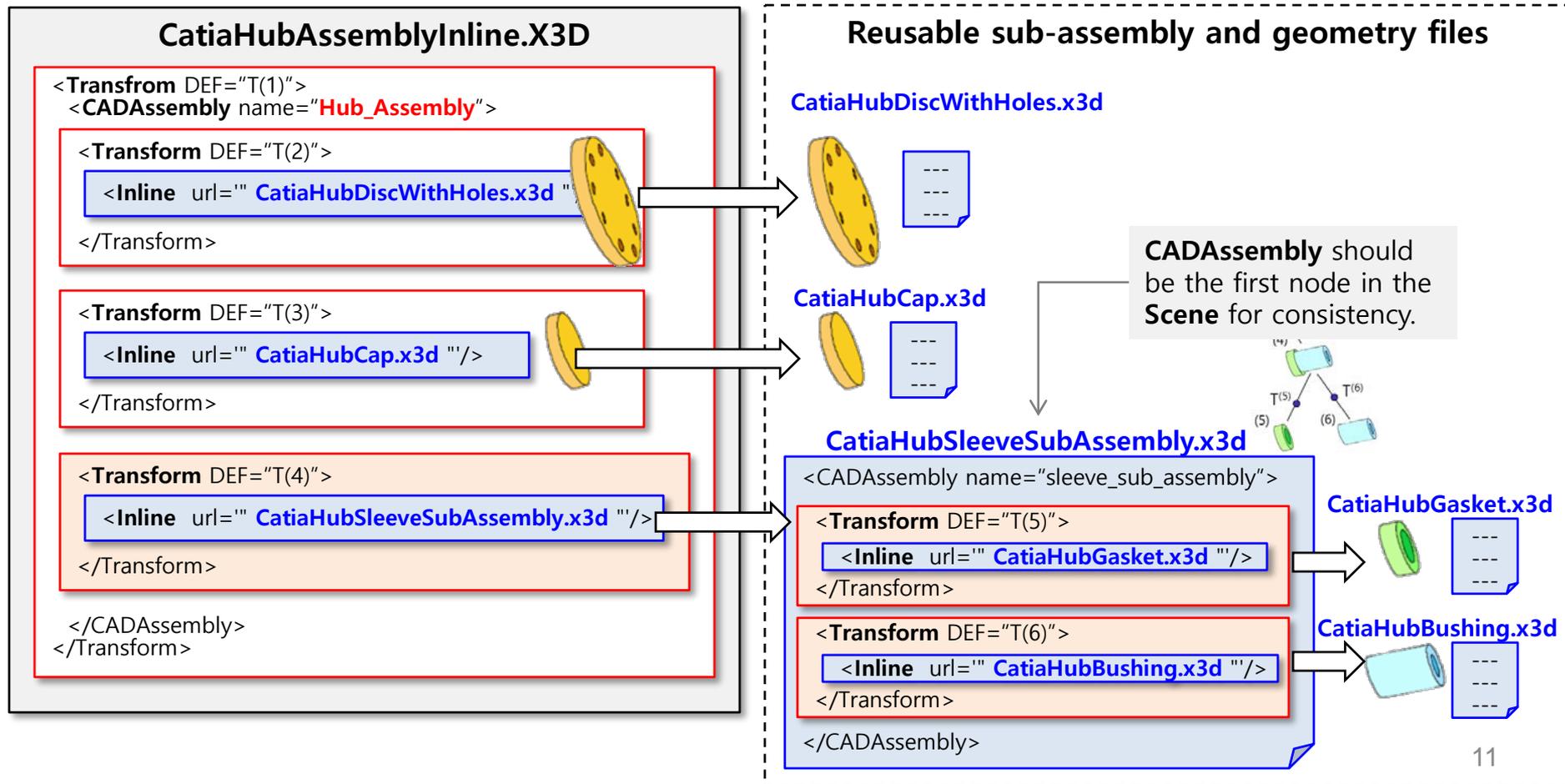


- **B** : external reference



# Methods for Representing PS in X3D

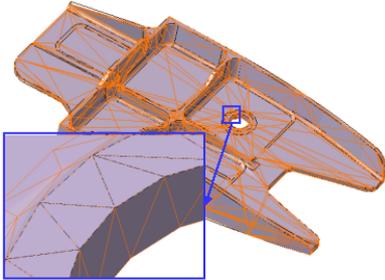
- C : nested external reference



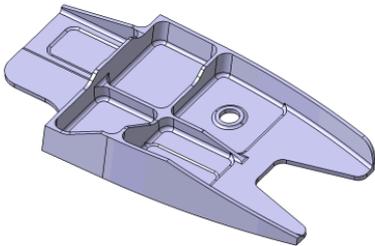
# **GEOMETRY**



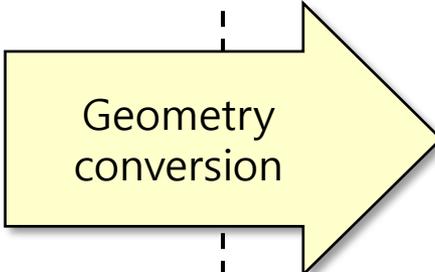
### 3D tessellated explicit geometry



### 3D exact explicit geometry



### 3D parametric & constr. History



- Polygon-based representation
  - [Indexed]Triangle[Fan|Strip]Set
  - IndexedFaceSet
  - [Indexed]QuadSet
- Surface-based representation
  - Primitives
  - Extrusion
  - NURBS component

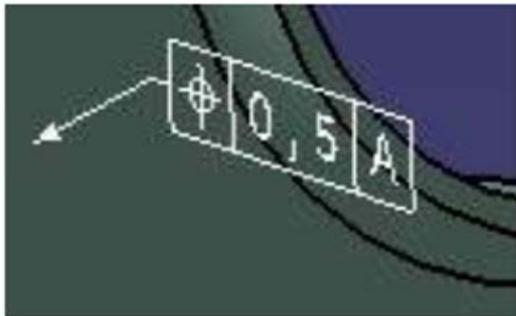
Mapping of STEP vocabularies to existing parametric X3D nodes

**PMI**

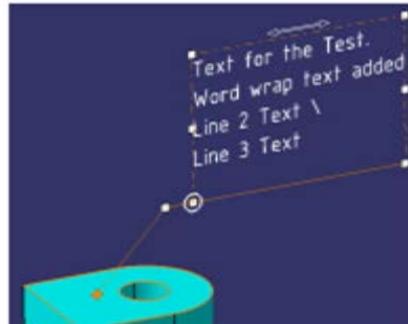
**PRODUCT MANUFACTURING INFORMATION**

# PMI representation in STEP\* and LOTAR\*\*

- Product Manufacturing Information
  - Geometry Dimension & Tolerance(GD&T) / annotations / symbols



3D GD&T



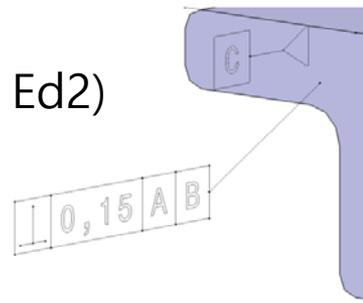
3D annotations



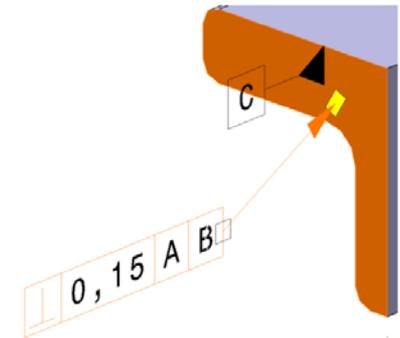
3D symbols

- Graphic representation
  - STEP geometric entities
    - polylines (AP 214 / AP 203 Ed2)
    - tessellated (AP 242)
- Semantic representation
  - PMI semantic entities

Graphic presentation



Semantic representation

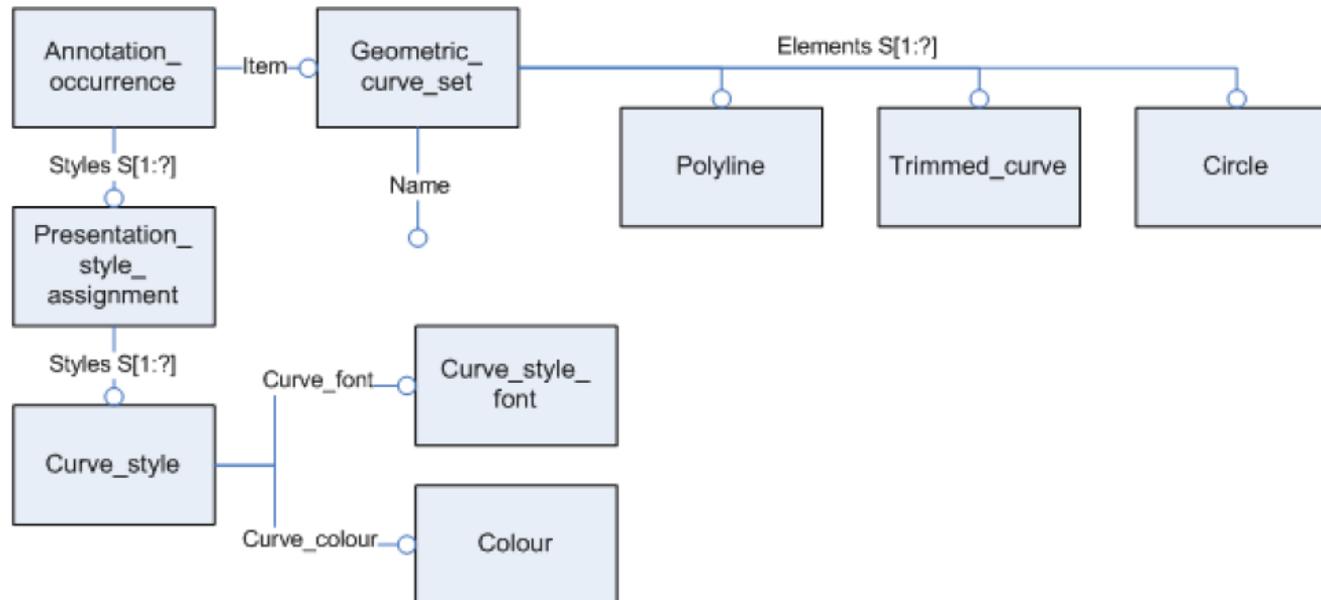


\* STEP AP242 Project, <http://www.ap242.org/geometry-assembly-pmi-interoperability>

\*\* Long Term Archiving and Retrieval, <http://www.lotar-international.org/>

# PMI Representation in STEP\*

- Presentation of 3D PMI as polylines (AP 214 / AP 203 Ed2)\*
  - A `geometric_curve_set` of polylines, circles and trimmed\_curves
  - Tessellated presentation and semantic presentation currently under test by CAX-IF\*\*
- Styling of the annotation
  - Graphic characteristics (colour, line type and width)
  - Optional attributes (types of annotation, layer)



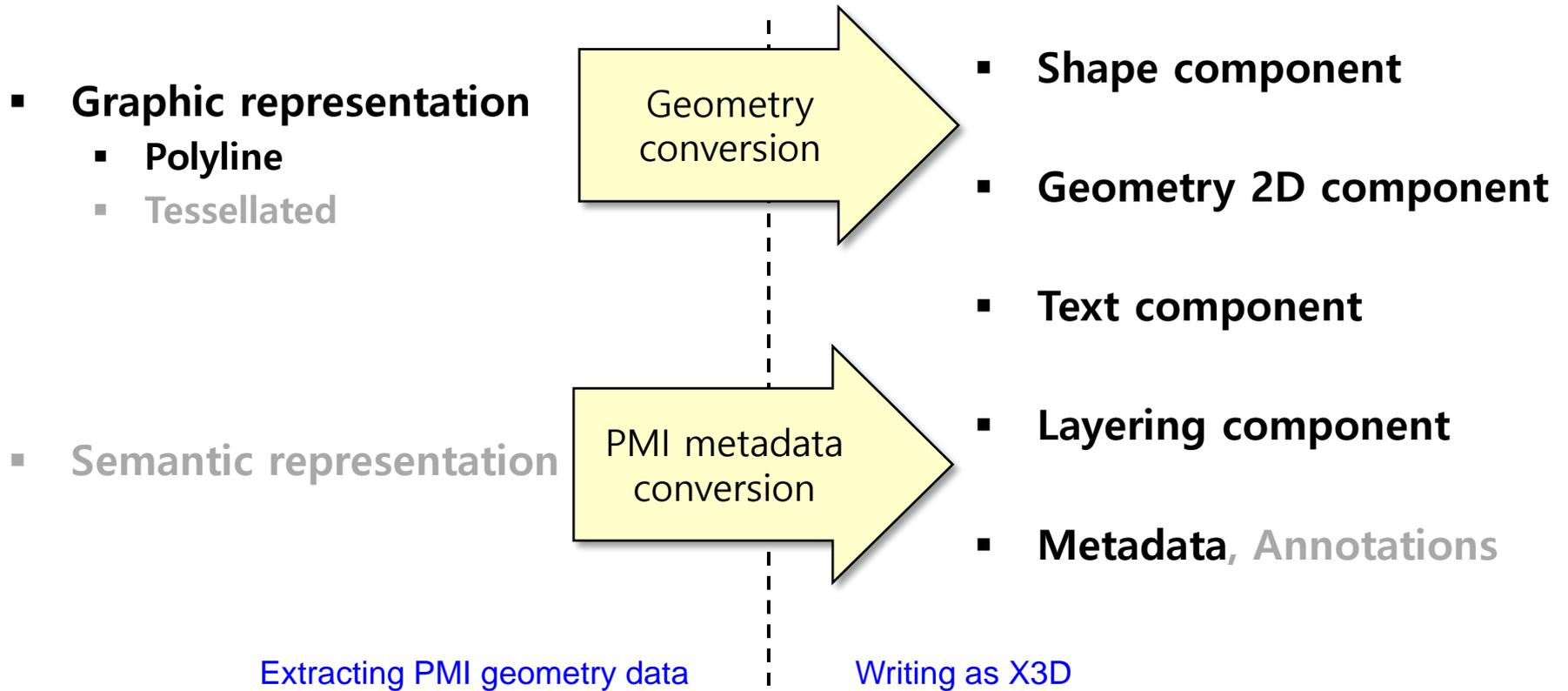
\* Recommended Practices for Geometric Dimensions & Tolerances (GD&T) "Polyline Presentation", Release 1.0, CAX-IF & LOTAR, June 16, 2008.

\*\* Test Suite for the CAX Implementor Forum Round 34J April-September 2014, Release 1.0, CAX-IF, June 30, 2014.

# Representing PMI in X3D

- A rich set of X3D metadata capabilities exist which might capture all relevant PMI when exporting X3D models
- Part 1: Architecture and base components
  - 7 Core component
    - MetadataSet, typed Metadata nodes
  - 12 Shape component
    - Appearance / FillProperties / LineProperties / Material / TwoSided Material / ...
  - 14 Geometry2D component
    - Arc2D / Circle2D / Polyline2D / Rectangle2D / ...
  - 15 Text component
    - FontStyle / Text
  - 35 Layering component
    - Layer / LayerSet / ...
  - X. Annotation component (extension proposal for X3D version 3.4)

# Conversion of STEP 3D PMI into X3D



# Thank you!

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