CAD2X3D Conversion for Product Structure Viewer

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Outline

- Background & motivation
- Problem definition
- Solution
- Implementation environment
- Results & applications
- Summary & conclusion

Background & motivation

- Sharing 3D CAD model product information
  - To apply 3D CAD data created in the design stage of product life cycle to various applications of the other stages in related industries

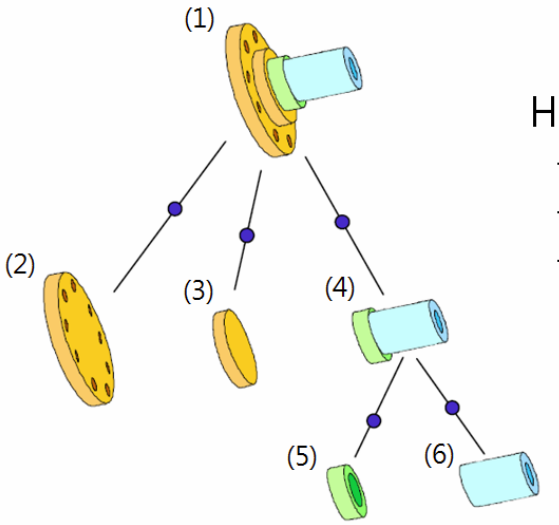
- Difficulties of sharing 3D CAD models
  - Too complex and heavyweight to be shared for distributed collaboration such as in a Web-based environment
  - Security problems of CAD design information
  - Various 3D CAD systems and viewers, and licenses problems

  → Lightweight formats
  > 3D-XML, COLLADA, JT, U3D, **X3D**, HSF, XVL, …

1) SC4N2465 Report on Visualization Candidate Format Assessment
2) Inho Song and Sungchong Chung, "Data Format and Browser of Lightweight CAD files for Dimensional Verification over the Internet", Journal of Mechanical Science and Technology, vol.23, pp.1278-1288, 2009.
3) Manjula Patel, Alexander Ball, and Lian Ding, "Strategies for the Curation of CAD Engineering Models", The International Journal of Digital Curation, vol.4, pp.84-97, 2009.

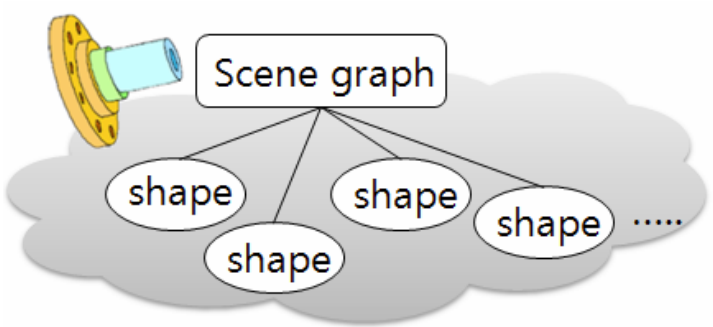
Problems of the CATIA VRML exporter

- Problems when using the CATIA VRML exporter
  - Geometry information exported to a single VRML file
  - Product structure information lost
  - Still heavy for Web-based application



Hub Assembly(1)
- disc with holes(2)
- cap(3)
- sleeve sub-assembly(4)
  - gasket(5)
  - cylinder(6)

export

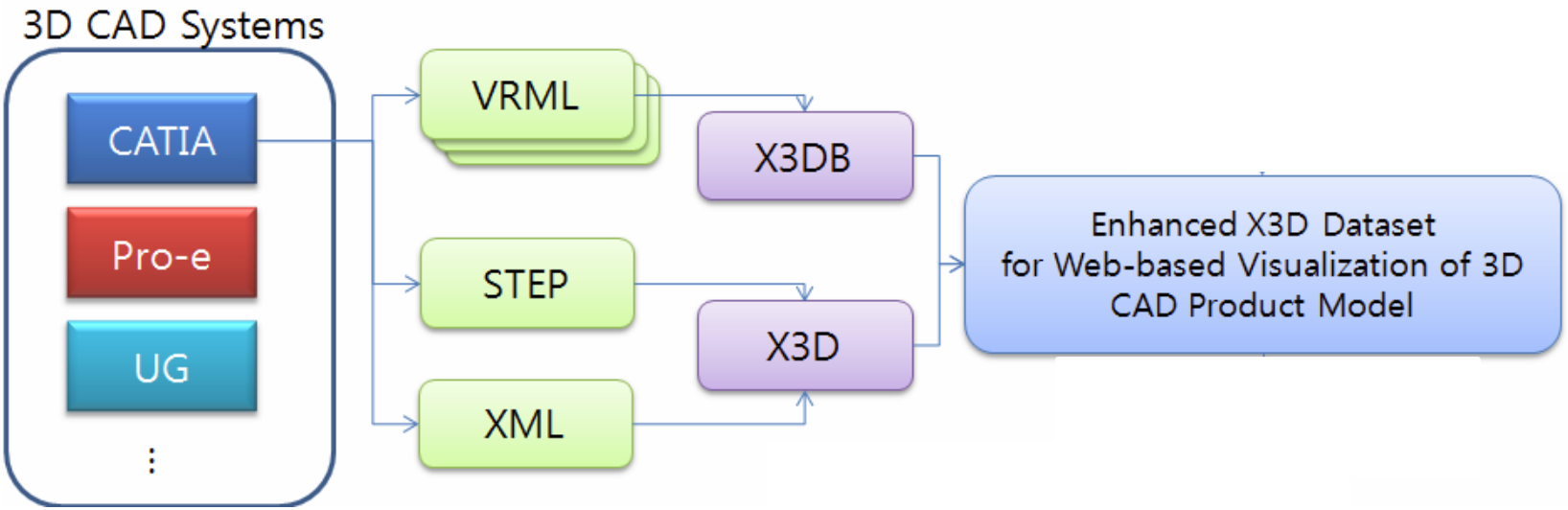


CATIA Hub Assembly

VRML Hub Scene graph

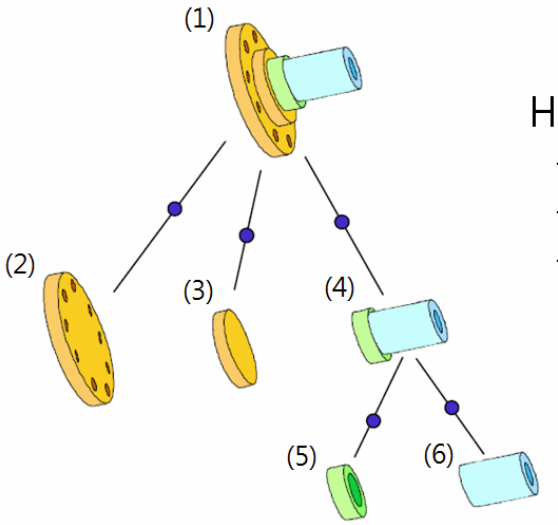
Solution : CATIA2X3D conversion

- CATIA2X3D conversion including product structure information
  - Geometry information of each part file is exported by using the CATIA VRML exporting API, and then converted to X3D by VRML2X3D converter
  - Product structure information is extracted by using STEP(the STandard for the Exchange of Product model data).
  - Filtering each X3D file which has geometry information of a part.



Guimok Cho, "Translation of 3D CAD Data to X3D Dataset Maintaining Product Structure for Web-based Visualization", Master Thesis, Chungnam National Univ., Feb. 2011.

Solution : CATIA2X3D conversion



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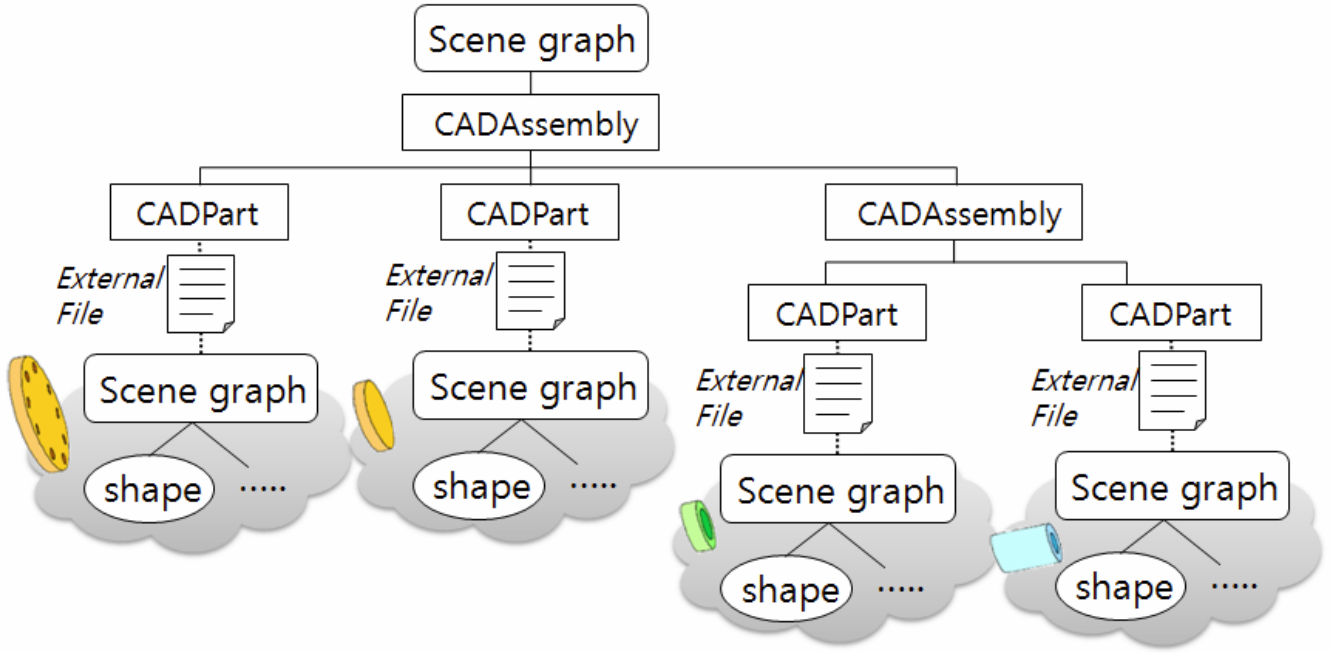

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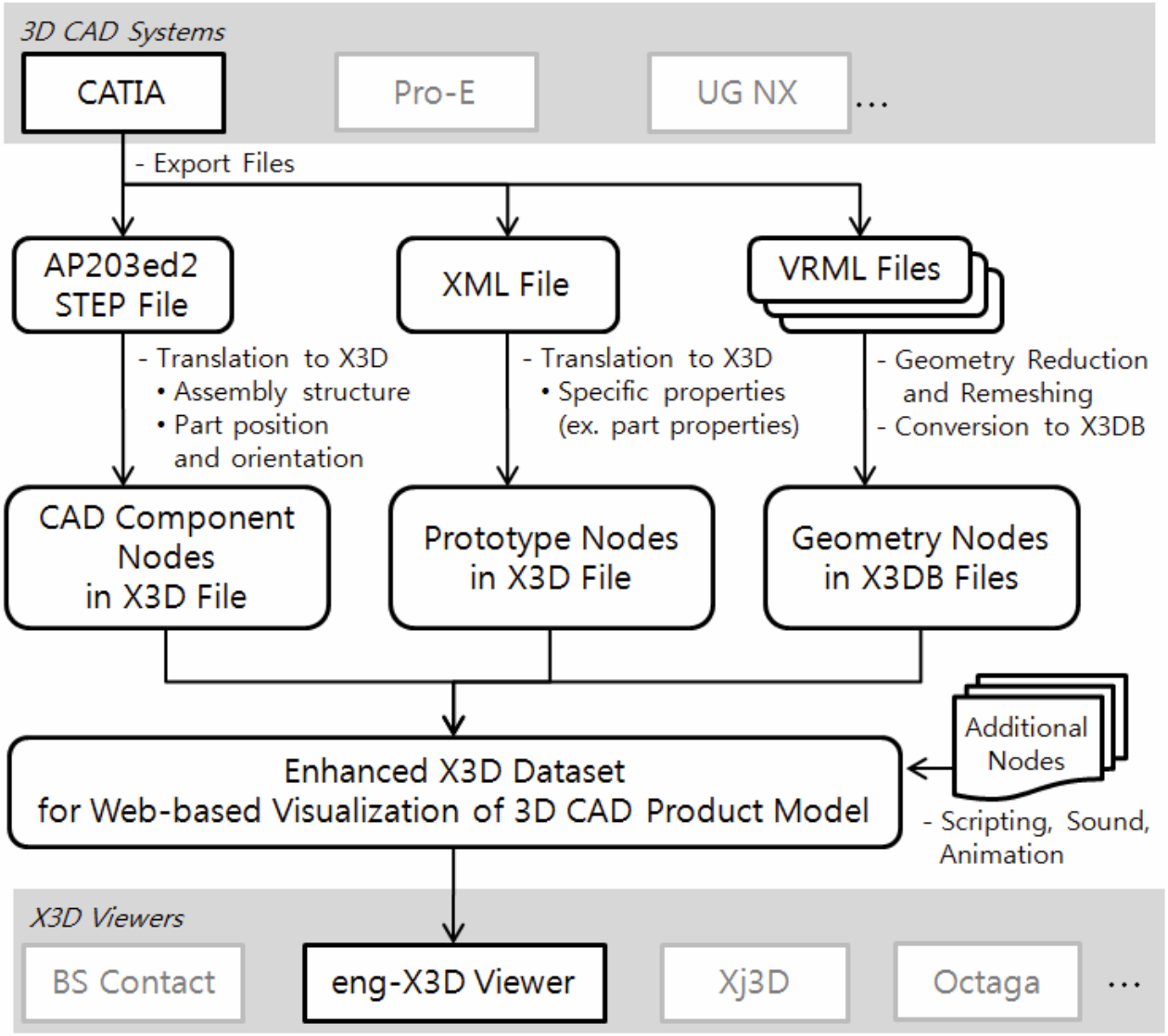
CATIA2X3D conversion



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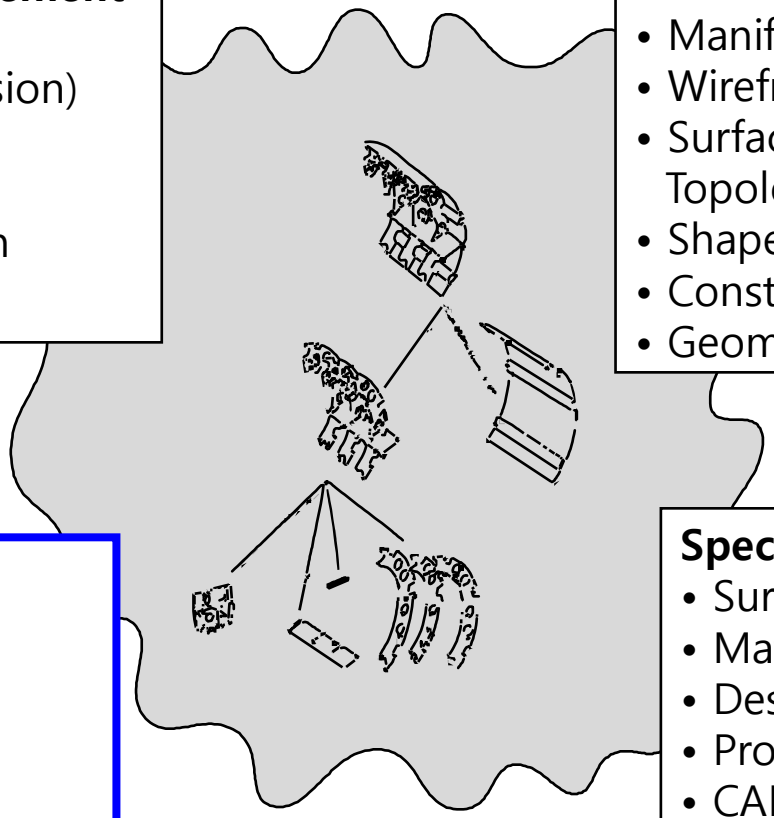
AP203 Configuration Controlled Design

Configuration Management
- Authorization
- Control(Version/Revision)
- Effectivity
- Release Status
- Security Classification
- Supplier

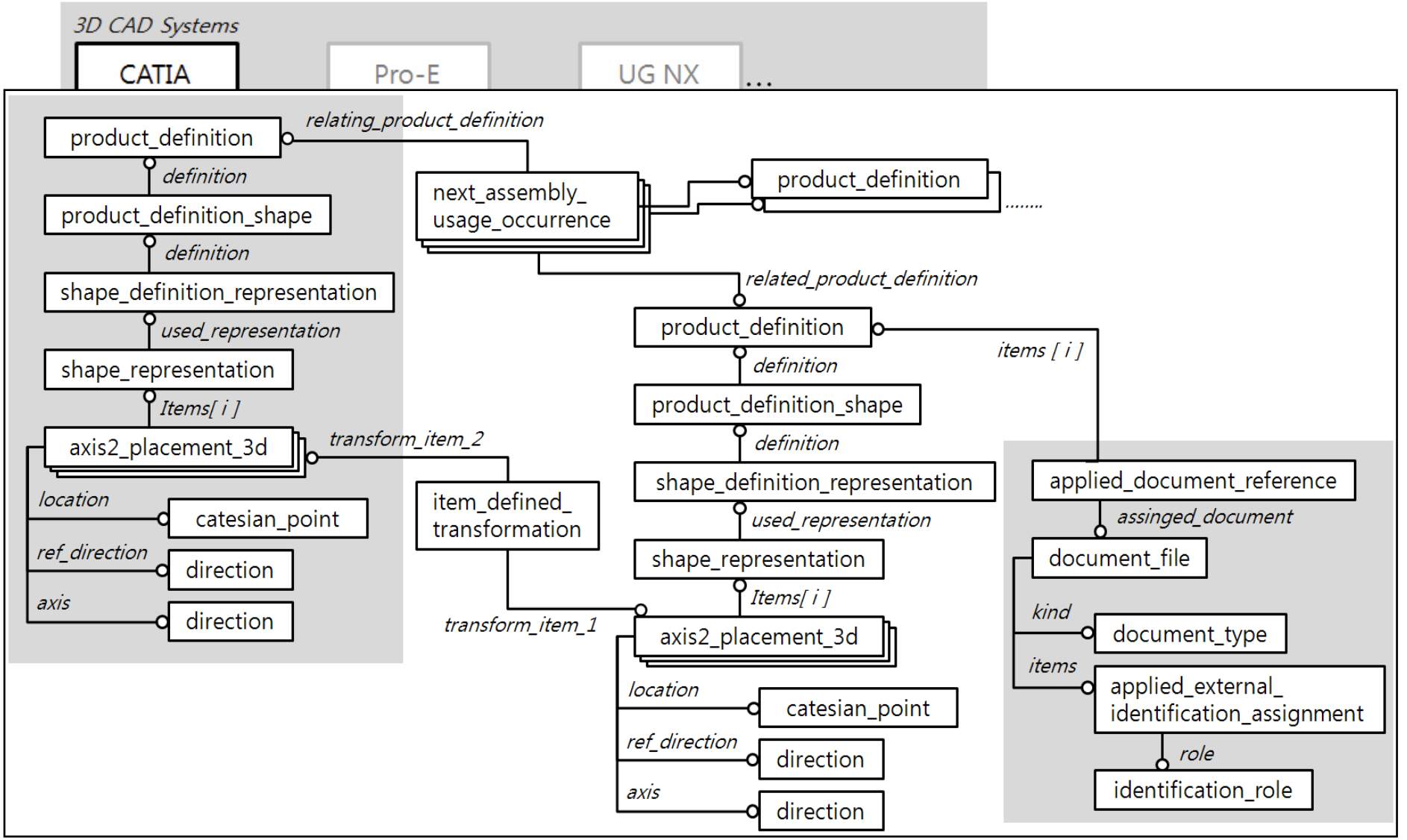
Geometric Shapes
- Advanced BREP Solids
- Faceted BREP Solids
- Manifold Surfaces with Topology
- Wireframe with Topology
- Surfaces and Wireframe without Topology
- Shape Appearance/Layers
- Constructive Solid Geometry
- Geometric Validation Properties



Product Structure
- Assemblies
- Bill of Materials
- Part
- Substitute Part
- Alternate Part

Specifications
- Surface Finish
- Material
- Design
- Process
- CAD File Reference

STEP AP203ed2 instance diagram related to product structure



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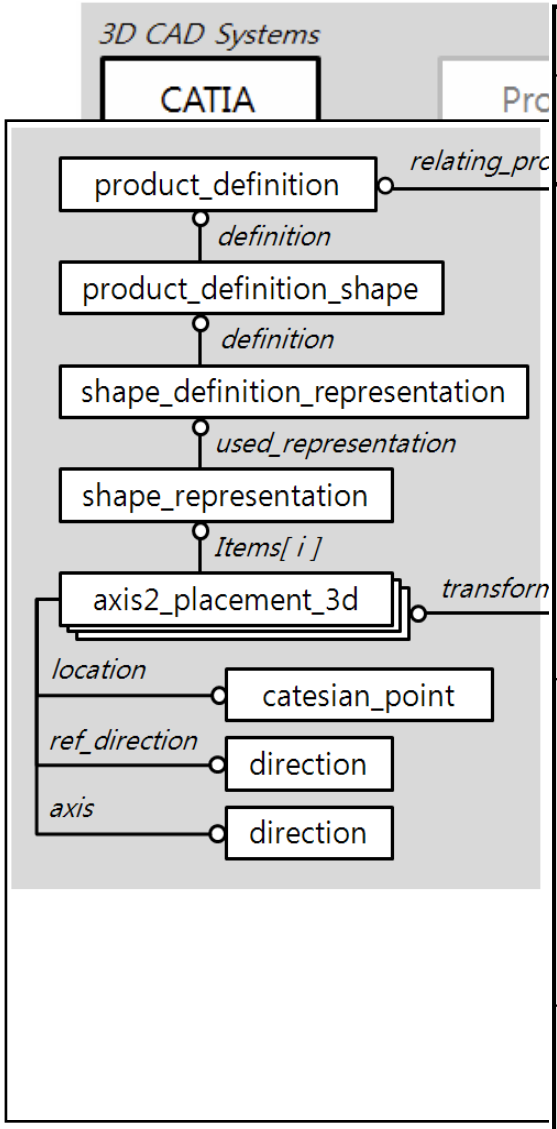
Mapping b/w STEP AP203ed2 entity & X3D node



STEP AP203ed2				X3D	
Entity	Relation	Related Entity	Attribute	Node	Field
next_assembly_usage_occurrence	relating_product_definition	product_definition	persistent_label	CADProperty Prototype	referenceId
				CADAssembly	DEF
			id		name
	related_product_definition	product_definition	persistent_label	CADProperty Prototype	referenceId
				CADPart	DEF
			id		name
axis2_placement_3d	location	catesian_point	coordinates	CADPart	translation rotation scale
	ref_direction	direction	direction_ratios		
	axis	direction	direction_ratios		
applied_document_reference	assigned_document	document_file	assigned_id	CADProperty Prototype	geometryUrl

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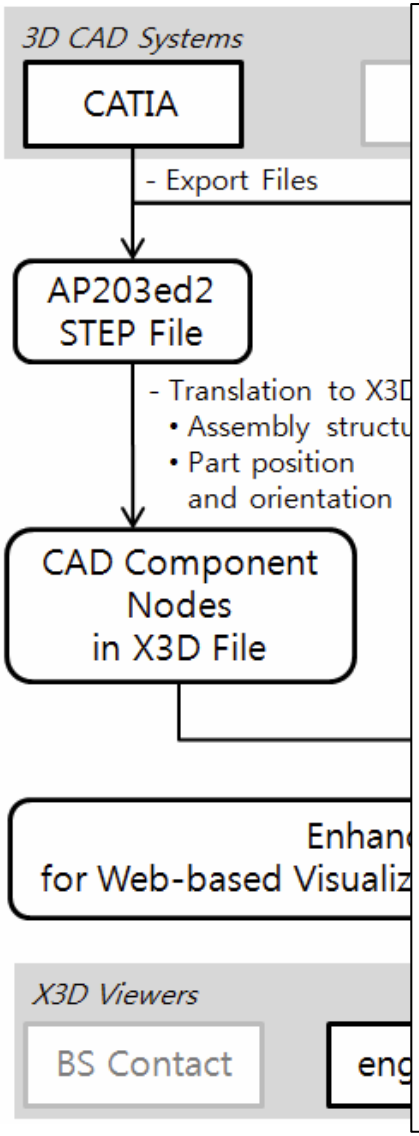
CADProperty node




```
<ProtoDeclare name="CADProperty">
  <ProtoInterface>
    <field accessType="inputOutput" name="referenceID" type="MFString" />
    <field accessType="inputOutput" name="geometryUrl" type="SFString" />
    <field accessType="inputOutput" name="propertyName" type="MFString" />
    <field accessType="inputOutput" name="propertyValue" type="MFString" />
    <field accessType="inputOutput" name="children" type="MFNode" />
    <field accessType="inputOnly" name="addChildren" type="MFNode" />
    <field accessType="inputOnly" name="removeChildren" type="MFNode" />
  </ProtoInterface>
  <ProtoBody>
    <Transform>
      <IS>
        <connect nodeField="children" protoField="children" />
        <connect nodeField="addChildren" protoField="addChildren" />
        <connect nodeField="removeChildren" protoField="removeChildren" />
      </IS>
    </Transform>
  </ProtoBody>
</ProtoDeclare>
```

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STEP Data : PS(Product Structure) + Part position

```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION(('CATIA V5 STEP'),'2;1');

FILE_NAME('D:\\@Test\\CATIA_Data\\Lanborghini\\Lanborghini_203ed2_extLink.stp','2010-09-04T07:

FILE_SCHEMA(('CONFIGURATION-CONTROL-3D-DESIGN-MIM-LF { 1 0 10303 403 1 1 4}'));

ENDSEC;
/* file written by CATIA V5R16 */
DATA;
#17=PRODUCT_DEFINITION('Lanborghini',' ',#6,#3) ;
#31=PRODUCT_DEFINITION('Low_Frame',' ',#30,#3) ;
#68=PRODUCT_DEFINITION('High_Frame',' ',#67,#3) ;
#105=PRODUCT_DEFINITION('Middle_Frame',' ',#104,#3) ;
#142=PRODUCT_DEFINITION('F_Frame',' ',#141,#3) ;
#179=PRODUCT_DEFINITION('Front_Bumper',' ',#178,#3) ;
#185=PRODUCT_DEFINITION('F_Bumper',' ',#184,#3) ;
#222=PRODUCT_DEFINITION('F_Bumper_Grill',' ',#221,#3) ;
#259=PRODUCT_DEFINITION('F_Blinker',' ',#258,#3) ;
#311=PRODUCT_DEFINITION('Rear_Bumper',' ',#310,#3) ;
#317=PRODUCT_DEFINITION('R_Bumper',' ',#316,#3) ;
#354=PRODUCT_DEFINITION('R_Bumper_Gril',' ',#353,#3) ;
#406=PRODUCT_DEFINITION('L_Fender',' ',#405,#3) ;
#443=PRODUCT_DEFINITION('R_Fender',' ',#442,#3) ;
#480=PRODUCT_DEFINITION('L_Side_Panel',' ',#479,#3) ;
#517=PRODUCT_DEFINITION('R_Side_Panel',' ',#516,#3) ;
#554=PRODUCT_DEFINITION('Trunk',' ',#553,#3) ;
#591=PRODUCT_DEFINITION('Trunk_Panel',' ',#590,#3) ;
#628=PRODUCT_DEFINITION('Roof_Panel',' ',#627,#3) ;
#665=PRODUCT_DEFINITION('L_Door',' ',#664,#3) ;
#671=PRODUCT_DEFINITION('L_Door_Panel',' ',#670,#3) ;
#708=PRODUCT_DEFINITION('L_Door_inside',' ',#707,#3) ;
```

XML Data : Part specification

```
    <PropertySet id="Trunk_Panel.1">
      <Property propertyName="번호" propertyValue="1" />
      <Property propertyName="설명" propertyValue="엔진후드" />
      <Property propertyName="보증" propertyValue="M8X23" />
      <Property propertyName="수량" propertyValue="1" />
      <Property propertyName="부품번호" propertyValue="M8X24-TP" />
      <Property propertyName="가격" propertyValue="$500.02" />
    </PropertySet>
    <PropertySet id="Tire_FR">
      <Property propertyName="번호" propertyValue="2" />
      <Property propertyName="설명" propertyValue="타이어" />
      <Property propertyName="보증" propertyValue="Dunlop SP Sport" />
      <Property propertyName="수량" propertyValue="4" />
      <Property propertyName="부품번호" propertyValue="DSST-RSC" />
      <Property propertyName="가격" propertyValue="$251.95" />
    </PropertySet>
    <PropertySet id="R_Door_Panel">
      <Property propertyName="번호" propertyValue="2" />
      <Property propertyName="설명" propertyValue="Front Door" />
      <Property propertyName="보증" propertyValue="ISA M6X14" />
      <Property propertyName="수량" propertyValue="2" />
      <Property propertyName="부품번호" propertyValue="M6X14-FD" />
      <Property propertyName="가격" propertyValue="$365.84" />
    </PropertySet>
```

X3D Data : PS, Part position & specification

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.2//EN" "http://www.web3d.org/specifications/x3d-3.2.dtd">
<X3D profile="Full" version="3.2">
  <head>
    <meta content="Extensional CAD Component" name="title" />
  </head>
  <Scene>
    <ProtoDeclare name="CADProperty ">
      <!-- omissions -->
    </ProtoDeclare>
    <CADAssembly DEF="Lanborghini" name="Lanborghini">
      <CADPart DEF="Low_Frame.1" name="Low_Frame" rotation="-1 0 0 1.571" translation="0.0 -0.33658 1.94522" />
      <CADAssembly DEF="Reel&amp;Tire_RL.1" name="Reel&amp;Tire_RL">
        <CADPart DEF="Tire_R" name="Tire_R" rotation="-1 0 0 1.571" translation="-0.95 -0.15658 1.29699" />
        <CADPart DEF="Wheel_R" name="Wheel_R" rotation="-1 0 0 1.571" translation="-0.95 -0.15658 1.29699" />
      </CADAssembly>
      <!-- omissions -->
    </CADAssembly>
    <ProtoInstance DEF="CADPropertyInfosation" name="CADProperty">
      <ProtoInstance name="CADProperty">
        <fieldValue name="referenceID" value="&amp;quot:Tire_R&amp;quot:" />
        <fieldValue name="geometryUrl" value="partmodels/Tire_R.x3db" />
        <fieldValue name="propertyName" value="&amp;quot:설명&amp;quot: &amp;quot:부품번호&amp;quot: &amp;quot:가격&amp;quot:" />
        <fieldValue name="propertyValue" value="&amp;quot:DSST-RSC&amp;quot: &amp;quot:3610&amp;quot: &amp;quot:$251&amp;quot:" />
      </ProtoInstance>
      <!-- omissions -->
    </ProtoInstance>
  </Scene>
</X3D>
```

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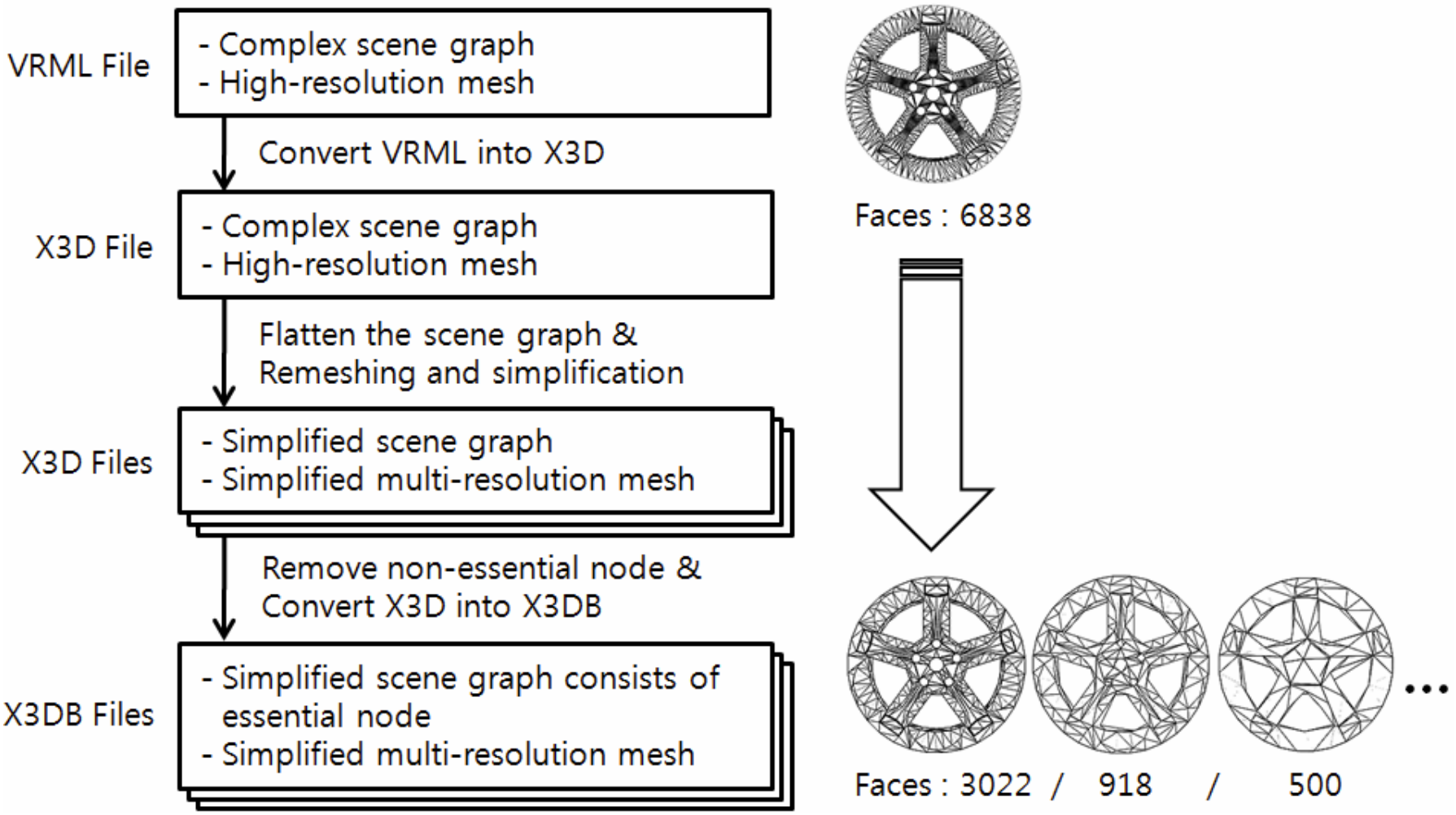
VRML2X3D conversion and filtering process



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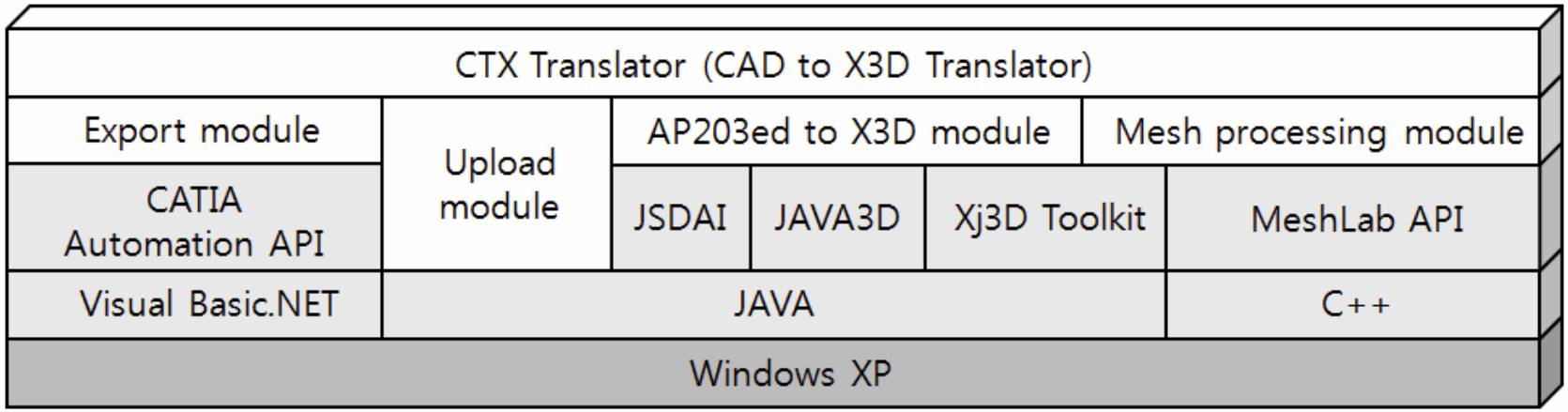
Implementation environment



H/W	CPU	Intel Core2 Duo 2.6GHz
	RAM	4GB
	VGA	Nvidia Quadro FX 5500
S/W	OS	Windows XP (32bit)
	3D CAD System	CATIA V5R16
	VRML & X3D Viewer	Customized Xj3D Viewer plug-in for IE 8

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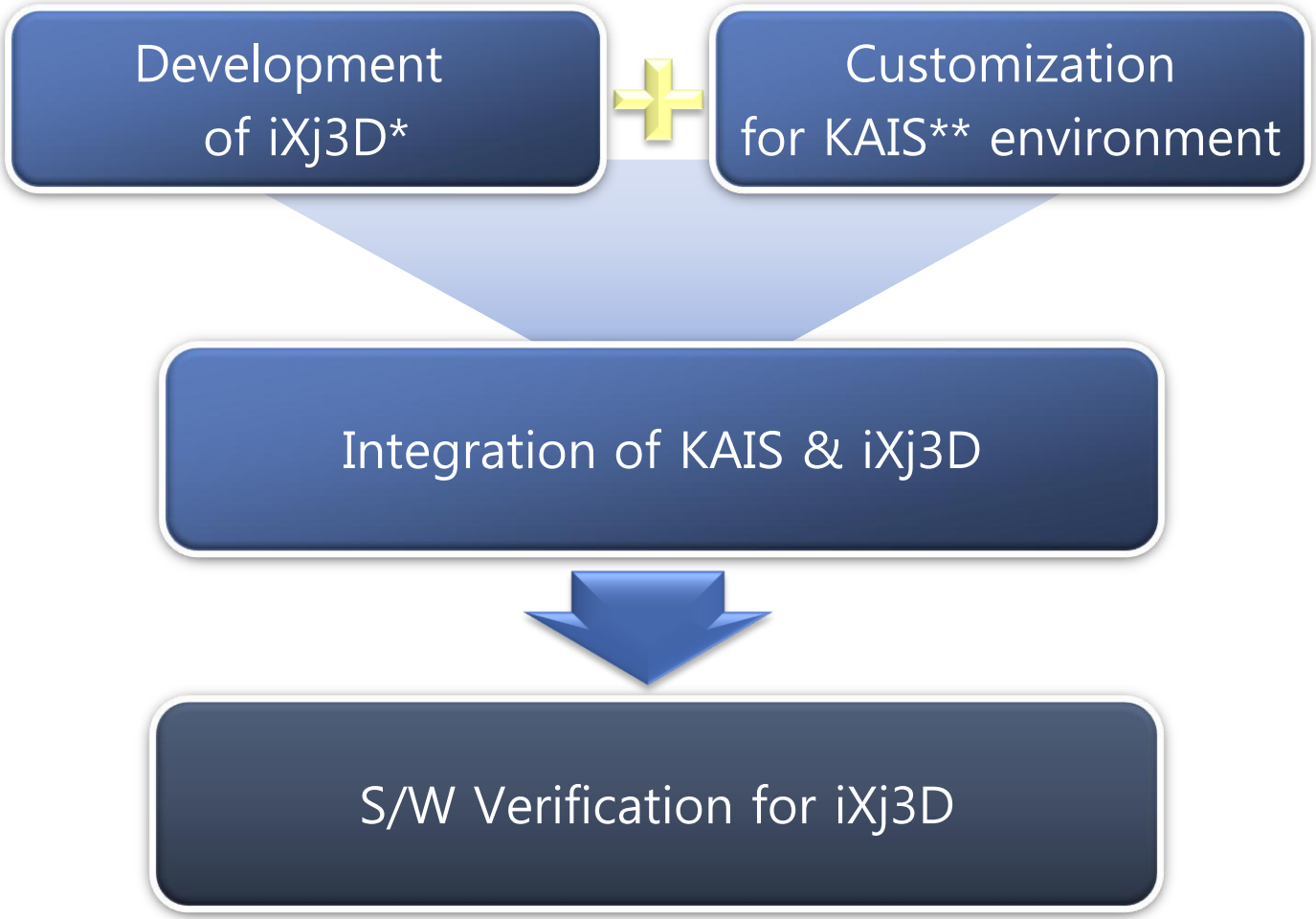
Results & Applications

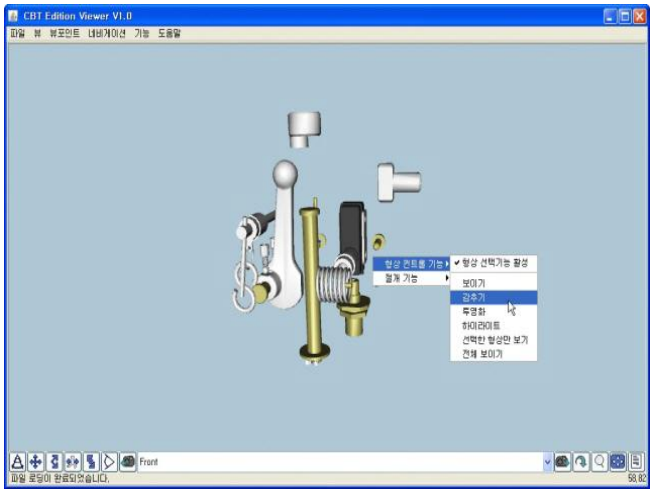
- **Integration of X3D-based viewer into KAIS (Korean Army's IETM tool)**
- **CBT (Computer-Based Training)**
- **PSV (Product Structure Viewer)**

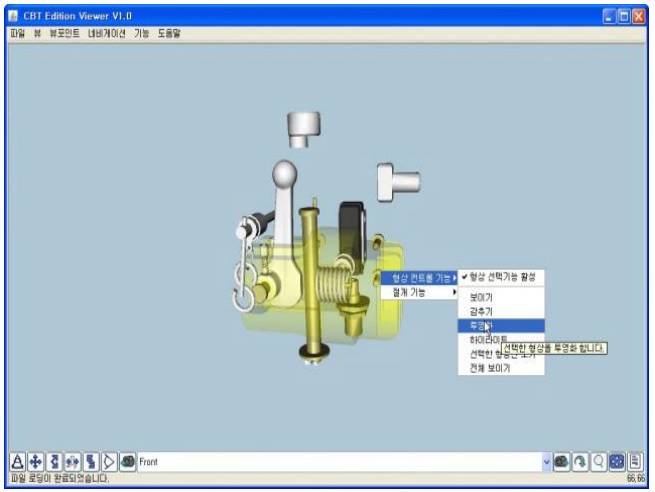
Integration of X3D-based viewer into KAIS



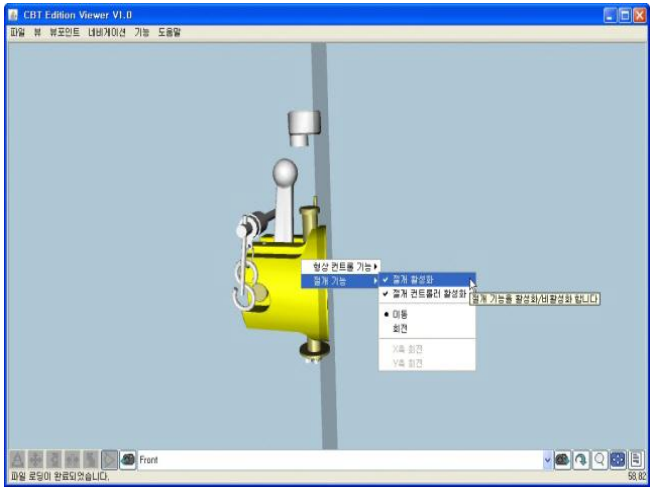
* iXj3D : X3D-based viewer customized from Xj3D
** KAIS: Korean Army's IETM tool

Visualization effects (show/hide, highlight, transparent)

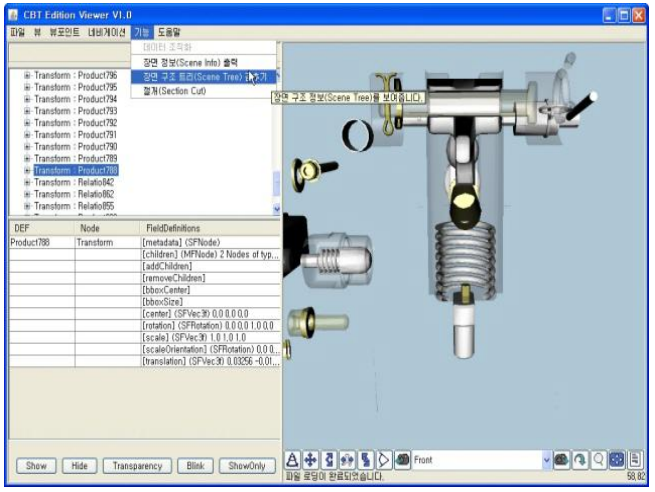




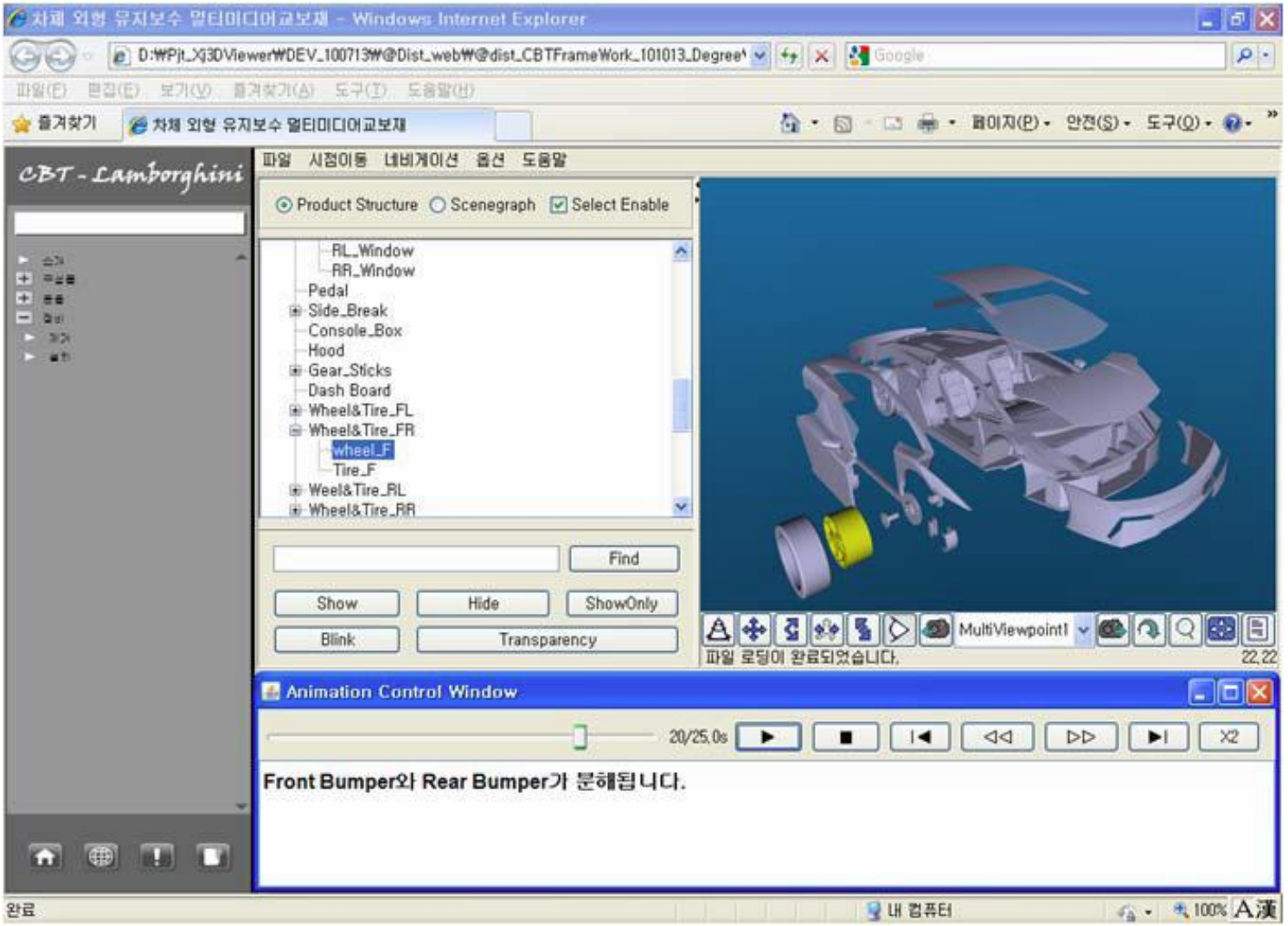
Arbitrary section cut



Explicit scene tree information



CBT (Computer-Based Training)



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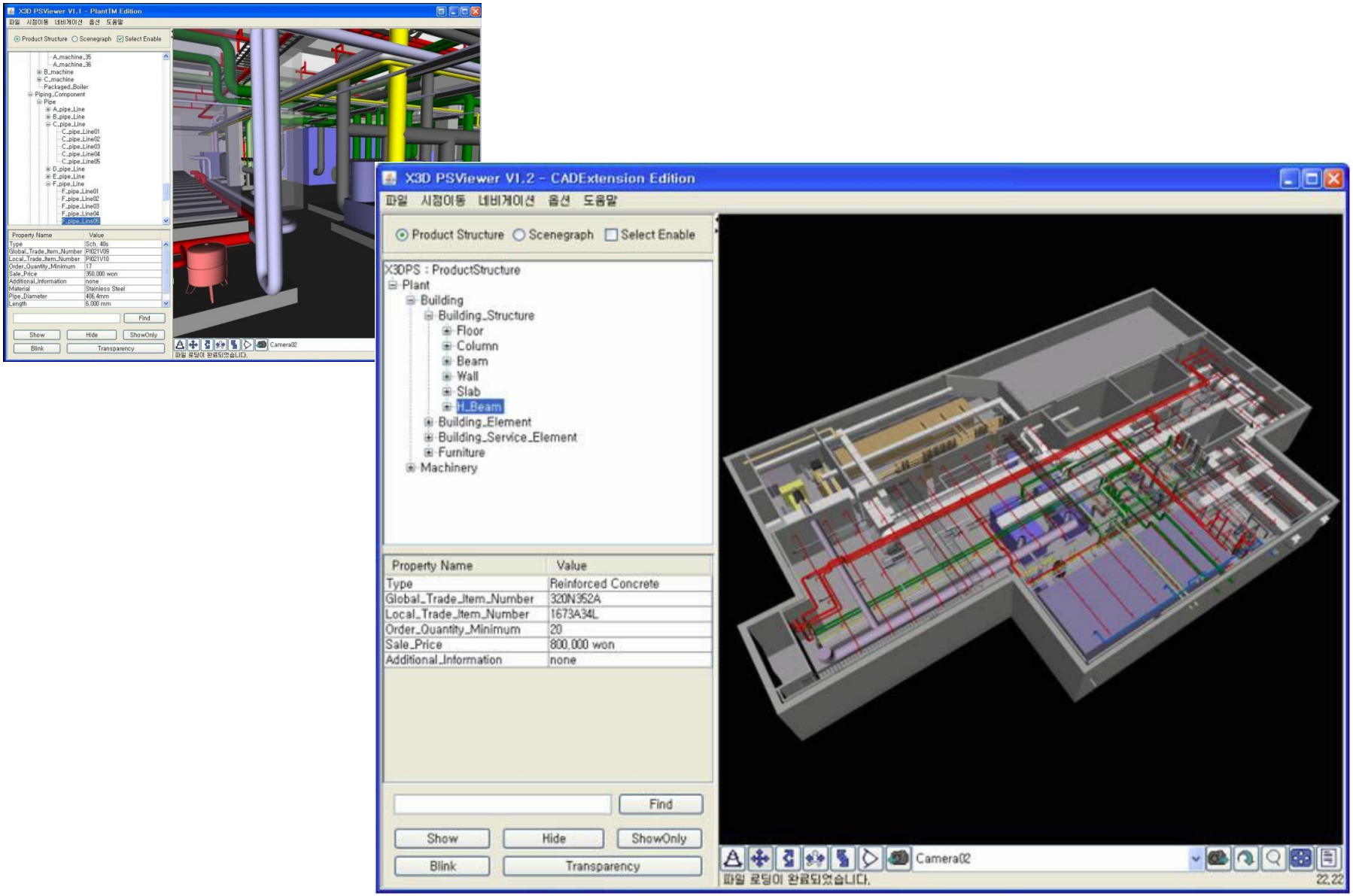
PSV (Product Structure Viewer)



Summary & conclusion

- CATIA2X3D conversion including Product Structure information
- Enhanced X3D dataset and customized viewer
  - Web-based visualization of 3D CAD product model
- Future work
  - Improving the CATIA2X3D conversion and filtering process
  - STEP-based geometry information conversion

Thank you!

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