Units Specification for X3D

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Summary of Web3D Consortium Comments and Responses (1)

- Necessity of units definition
  - Default unit of meter only limits X3D functionality and usage
- Location of unit node
  - Below the scene node, referenced once in an X3D file (multiple definitions in a file need to be incorporated as one to avoid complexity)
- Difference between units definition and Transform nodes
  - Units: definition of physical properties per single base file
  - Transform nodes: traditional graphics transformation

Summary of Web3D Consortium Comments and Responses (2)

- Units nodes and Metadata nodes
  - Using Metadata has problems similar to using Transform nodes
  - Browsers must recognize and interpret the semantics of all metadata contents
- Compatibility with existing X3D functionality
  - Defines a schema extension and passes schema validation without affecting the original X3D schema
  - Schema validation: Eclipse and X3D-Edit

Summary of Web3D Consortium Comments and Responses (4)

- Specified units interpretation (length)
  - For length units, default is meter
  - Note that a single X3D object file is displayed the same with or without units defined
  - When two X3D object files are read into a scene consecutively, the second object is scaled according to what is defined for the first object
    - E.g. if the first one defines meter, and the second one defines millimeter, then the second one is scaled by 1/1000

Key Points (1)

- Units specification
  - Defines all types of physical property measurements
  - Uses SI units (International System of Units)
  - Follows the EDCS unit dictionary and the unit scale dictionary (ISO/IEC 18025 Environment Data Coding Specification)
- Units location
  - Defined below a scene node once per X3D file
- Effects of length units on display
  - No difference in the case of a single X3D file
  - Scaled by the first object's X3D unit in the case of multiple X3D files

Key Points (2)

- Other SI units besides length units
  - Defined in order to transfer physical properties between applications or graphics tools
  - Examples
    - Medical data may need sound (dB) as well as visualization
    - GIS data may need temperature (K) as well as visualization
    - CAD data may need mass (kg) or luminous intensity (cd)
  - SI units required to transfer precise measurements between applications
- Need for a common interface for browsers

Key Points (3)

- Schema extension
  - A schema extension is necessary in order to include the physical node
  - A Physical element is added by extending the SceneGraphStructureNode Type, and then redefining the X3D schema
  - No change to the original X3D schema
    - Allows the Physical element to be the first element of the scene
  - http://www.web3d.kr/mwlee/x3d-3.1-ext.xml
- Schema validation
  - Validated by Eclipse and X3D-Edit

Schema Extension for Units (partial)

- **FULL Schema Extension: http://www.web3d.kr/mwlee/x3d-3.1-ext.xsd**

```
<!-- Public and private schema extension mechanisms -->
<xs:redefine schemaLocation="x3d-3.1.xsd">
        <xs:annotation>
                        <xs:documentation>Insert Physical element into SceneGraphStructureNodeType
                        </xs:documentation>
        </xs:annotation>
        <xs:complexType name="SceneGraphStructureNodeType" abstract="false" mixed="false">
                        <xs:complexContent>
                                        <xs:extension base="SceneGraphStructureNodeType">
                                                <xs:sequence>
        <xs:element name="Physical" type="PhysicalUnitType" minOccurs="0" maxOccurs="1"/>
                                                </xs:sequence>
                                        </xs:extension>
                        </xs:complexContent>
        </xs:complexType>
</xs:redefine>
```

```xml
<xs:complexType name="PhysicalUnitType">
<xs:choice>
                              <xs:element name="Length" type="LengthType" minOccurs="0" maxOccurs="1"/>
<!--
                              <xs:element name="Area" type="tns:AreaType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Volume" type="tns:VolumeType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Mass" type="tns:MassType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Time" type="tns:TimeType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Current" type="tns:CurrentType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Temperature" type="tns:TemperatureType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Substance" type="tns:SubstanceType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Luminous" type="tns:LuminousType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="SoundPressure" type="tns:SoundPressureType" minOccurs="0"
    maxOccurs="1"/>
-->
            </xs:choice>
    </xs:complexType>
```

```xml
<xs:complexType name="PhysicalUnitType">
<xs:choice>
                              <xs:element name="Length" type="LengthType" minOccurs="0" maxOccurs="1"/>
<!--
                              <xs:element name="Area" type="tns:AreaType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Volume" type="tns:VolumeType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Mass" type="tns:MassType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Time" type="tns:TimeType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Current" type="tns:CurrentType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Temperature" type="tns:TemperatureType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Substance" type="tns:SubstanceType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="Luminous" type="tns:LuminousType" minOccurs="0" maxOccurs="1"/>
                              <xs:element name="SoundPressure" type="tns:SoundPressureType" minOccurs="0"
    maxOccurs="1"/>
 -->
            </xs:choice>
    </xs:complexType>
```
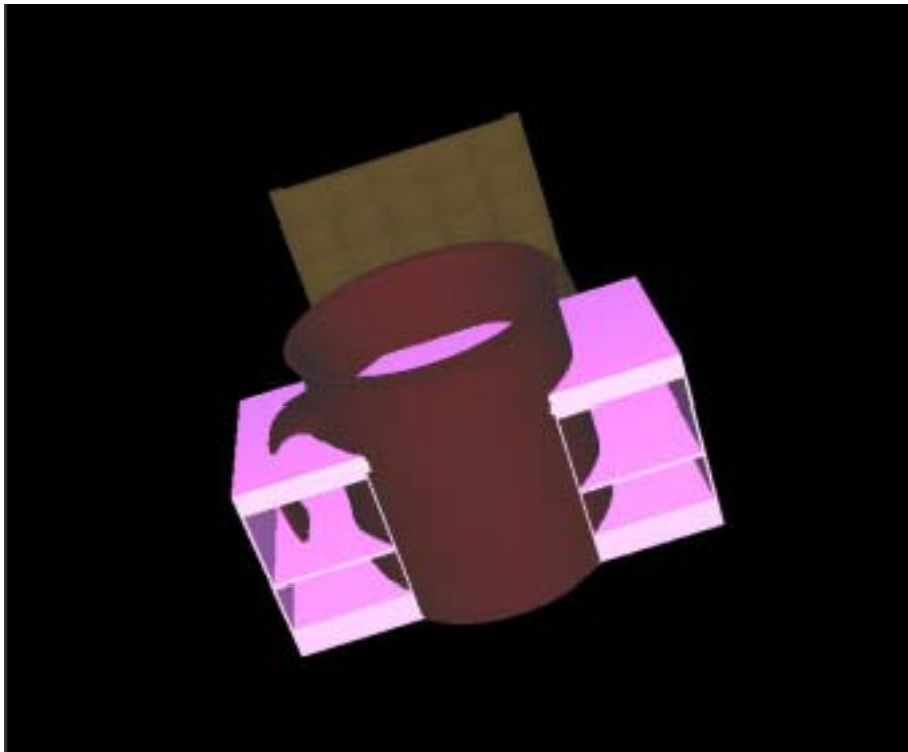
```
<xs:complexType name="LengthType">
<xs:attribute name="unit" type="unitType" use="optional" default="UNI"/>
<xs:attribute name="basis" type="basisType" use="optional" default="1"/>
<xs:attribute name="numeral" type="numeralType" use="optional" default="DEC"/>
</xs:complexType>

<xs:simpleType name="unitType">
        <xs:annotation>
                        <xs:documentation>values for unit attribute. default is "UNI" </xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:string">
                        <xs:pattern
value="YOTTA|ZETTA|EXA|PETA|TERA|GIGA|MEGA|KILO|HECTO|DECA|UNI|DECI|CENTI|MILLI|MICRO|NANO|P
ICO|FEMTO|ATTO|ZEPTO|YOCTO|INCH|LINK|FT|YD|RD|CHAIN|FL|MILE|LG|MIL|AU|LY|PC|KPC|NMILE|ANG|USE
R"/>
        </xs:restriction>
</xs:simpleType>
<xs:simpleType name="basisType">
```
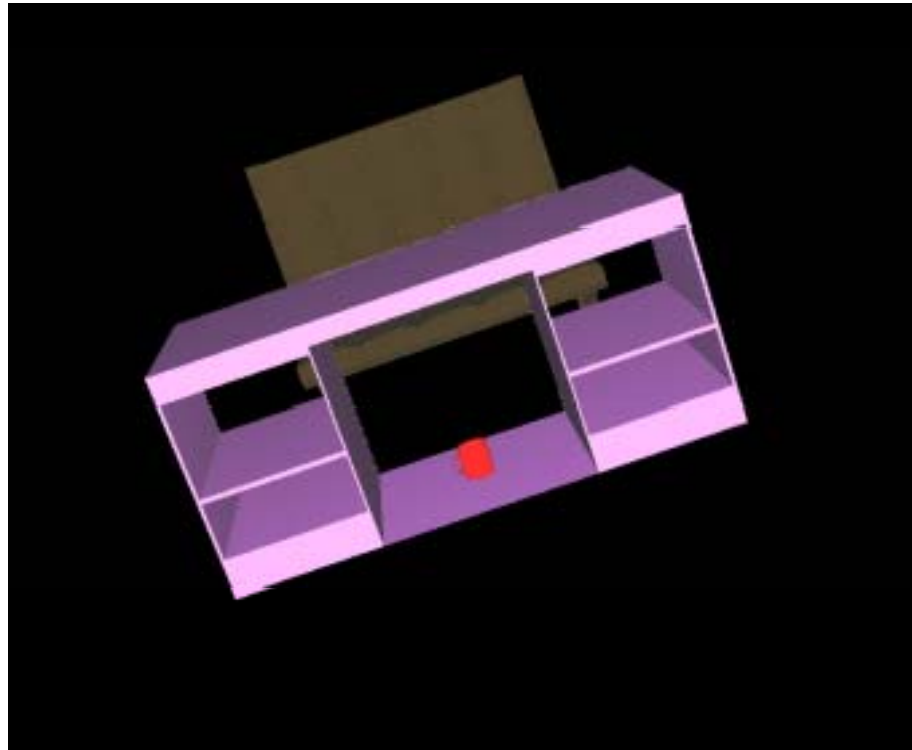
…

Unit X3D Example (1)

- Before units specification

Unit X3D Example (1)

- After units specification

Unit X3D Example (1): chair.x3d

```
<?xml version="1.0" encoding="UTF-8"?>
<X3D version="3.1" profile="Immersive"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:noNamespaceSchemaLocation="http://www.web3d.kr/mwlee/x3d-3.1-ext.xsd">

 <Scene>
    <physical>
            <length unit="CENTI" basis="1" numeral="DEC"/>
    </physical>

<Viewpoint position="0.0 0.0 1.0" description="1M view"/>
<NavigationInfo type="'EXAMINE" "ANY'"/>
<Background groundColor="0.05 0.1 0.3" skyColor="0.05 0.1 0.3 "/>
  <Transform scale="0.3415 0.3415 0.3415" translation="300 -700 300">
    <Shape>
```

Unit X3D Example (1): cup.x3d

```
<?xml version="1.0" encoding="UTF-8"?>
<X3D version="3.1" profile="Immersive"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:noNamespaceSchemaLocation="http://www.web3d.kr/mwlee/x3d-3.1-ext.xsd">

 <Scene>
    <physical>
            <length unit="MILLI" basis="1" numeral="DEC"/>
    </physical>


<Viewpoint position="0.0 0.0 1.0" description="1M view"/>
<NavigationInfo type="'EXAMINE" "ANY'"/>
<Background groundColor="0.05 0.1 0.3" skyColor="0.05 0.1 0.3 "/>
  <Transform scale="3.415 3.415 3.415" translation ="420 -190 200" rotation="0 0 0 0">
    <Shape>
      <Appearance>
```

Unit X3D Example (1): table.x3d

```
<?xml version="1.0" encoding="UTF-8"?>
<X3D version="3.1" profile="Immersive"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:noNamespaceSchemaLocation="http://www.web3d.kr/mwlee/x3d-3.1-ext.xsd">

 <Scene>
    <physical>
             <length unit="CENTI" basis="1" numeral="DEC"/>
    </physical>


 <Viewpoint position="0.0 0.0 1.0" description="1M view"/>
 <NavigationInfo type="'EXAMINE" "ANY"'/>
 <Background groundColor="0.05 0.1 0.3" skyColor="0.05 0.1 0.3 "/>
  <Transform scale="0.3415 0.3415 0.3415" rotation="0 0 0 0" translation="420 -190 200">
    <Shape>
      <Appearance>
```
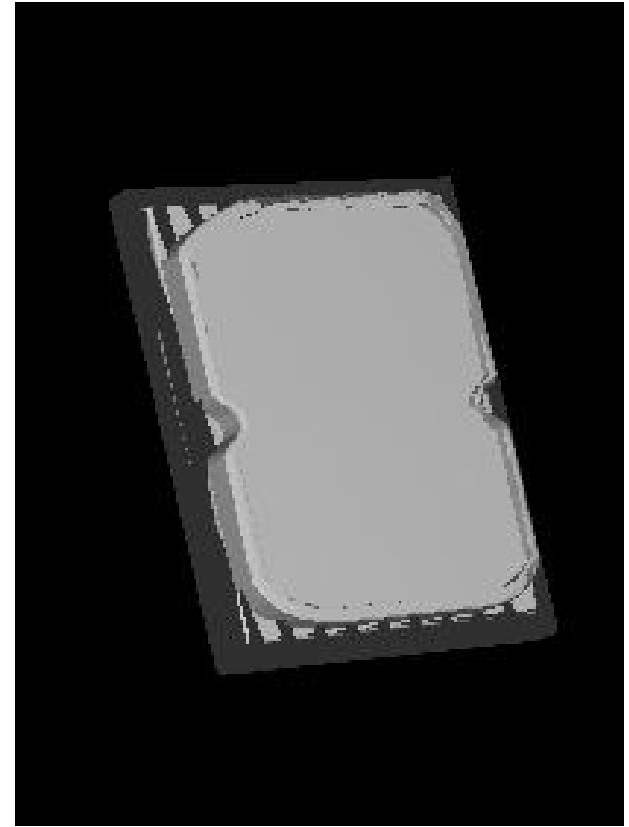
Unit X3D Example (2): Disk

```
<Scene>

  <Viewpoint position="0.0 0.0 1.0"
         description="1M view"/>

  <NavigationInfo type="'"EXAMINE" "ANY"'"/>

  <Background groundColor="0.05 0.1 0.3"
                   skyColor="0.05 0.1 0.3 "/>

  <Transform scale="0.9904 0.9904 1.125"
         rotation="-1 0 0 -1.571"
         translation="-0.07915 -5.106 11.65">

    <Shape>

        [ . . . . . . . . . ]

    </Shape>
```

Unit X3D Example (2): Monitor

```
<Scene>

 <Viewpoint position="0.0 0.0 1.0"
          description="1M view"/>

 <NavigationInfo type="'"EXAMINE" "ANY"'/>

 <Background groundColor="0.05 0.1 0.3"
                  skyColor="0.05 0.1 0.3 "/>

 <Transform scale="1 0.6061 1"
          rotation="-1 0 0 -1.571"
          translation="150.695 13.57 0">

   <Shape>

       [ . . . . . . . . . ]

   </Shape>
```

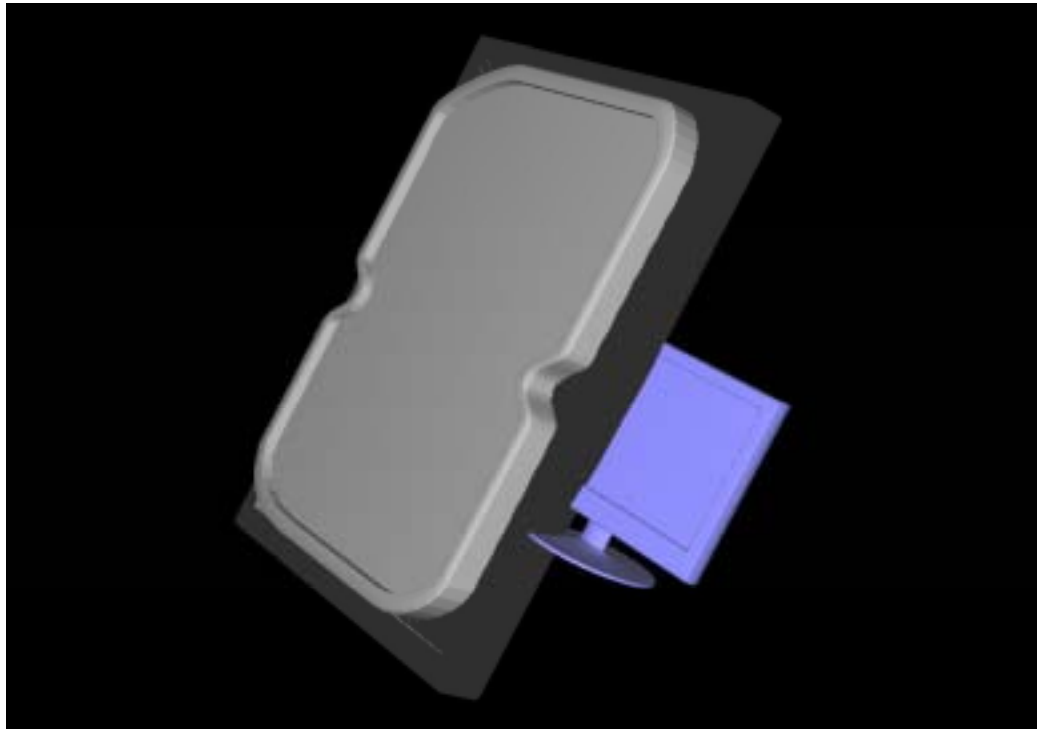# Unit X3D Example (2)

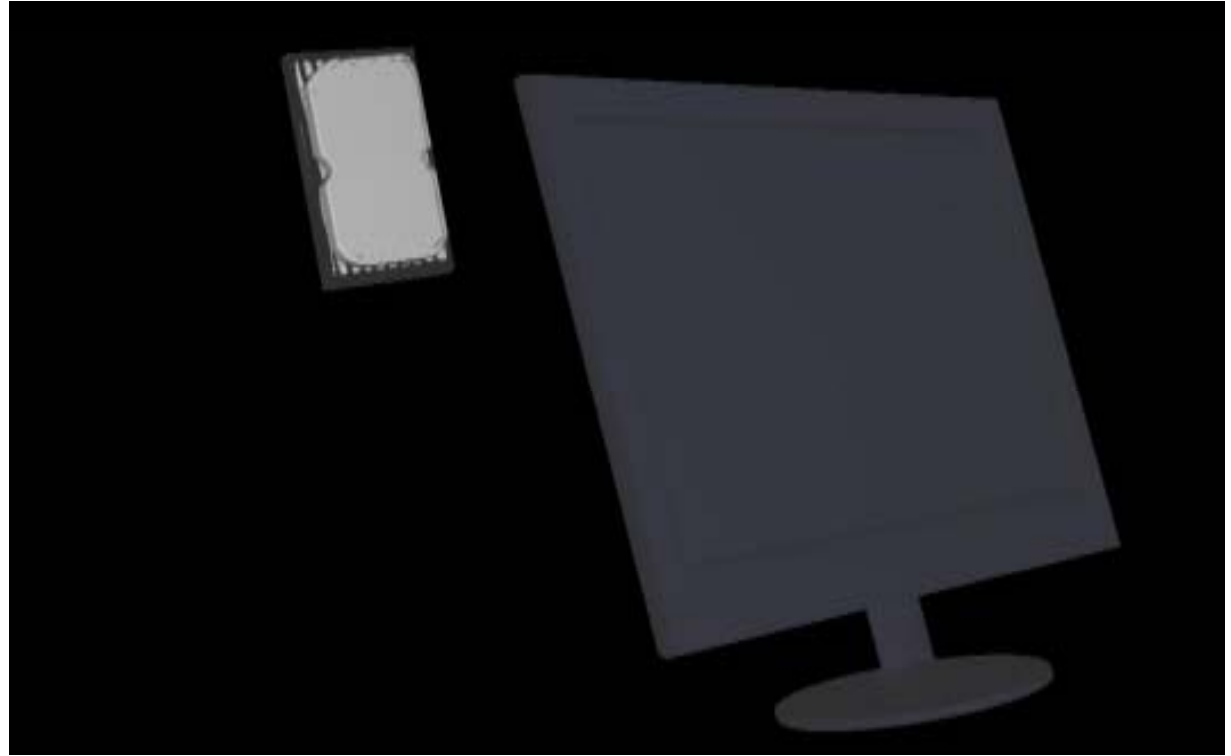- Before units specification

Unit X3D Example (2)

- After units specification

- ➢ disk: millimeter
- ➢ Monitor: centi

```
<physical>
   <length unit="MILLI" basis="1" numeral="DEC"/>
</physical>
```

```
<physical>
   <length unit="CENTI" basis="1" numeral="DEC"/>
</physical>
```

Unit X3D Example (2)

```
<Scene>

<physical>
<length unit="MILLI" basis="1"
numeral="DEC"/>
</physical>

<Viewpoint position="0.0 0.0 1.0"
        description="1M view"/>

<NavigationInfo type="'EXAMINE' 'ANY'"/>

<Background groundColor="0.05 0.1 0.3"
                skyColor="0.05 0.1 0.3 "/>

<Transform scale="0.9904 0.9904 1.125"
        rotation="-1 0 0 -1.571"
        translation="-0.07915 -5.106 11.65">

    <Shape>
        [ . . . . . . . . . ]
    </Shape>
```

```
<Scene>

<physical>
<length unit="CENTI" basis="1"
numeral="DEC"/>
</physical>

<Viewpoint position="0.0 0.0 1.0"
        description="1M view"/>

<NavigationInfo type="'EXAMINE' 'ANY'"/>

<Background groundColor="0.05 0.1 0.3"
                skyColor="0.05 0.1 0.3 "/>

<Transform scale="1 0.6061 1"
        rotation="-1 0 0 -1.571"
        translation="150.695 13.57 0">

    <Shape>
        [ . . . . . . . . . ]
    </Shape>
```

Unit X3D Browser