X3D Units Examples

Myeong Won Lee

The University of Suwon

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
    - In the case of a single unit specification, astronomical or microbiological objects are displayed as before without scaling
  - Relatively scaled by the first object's X3D unit in the case of multiple X3D files with different units

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>
```
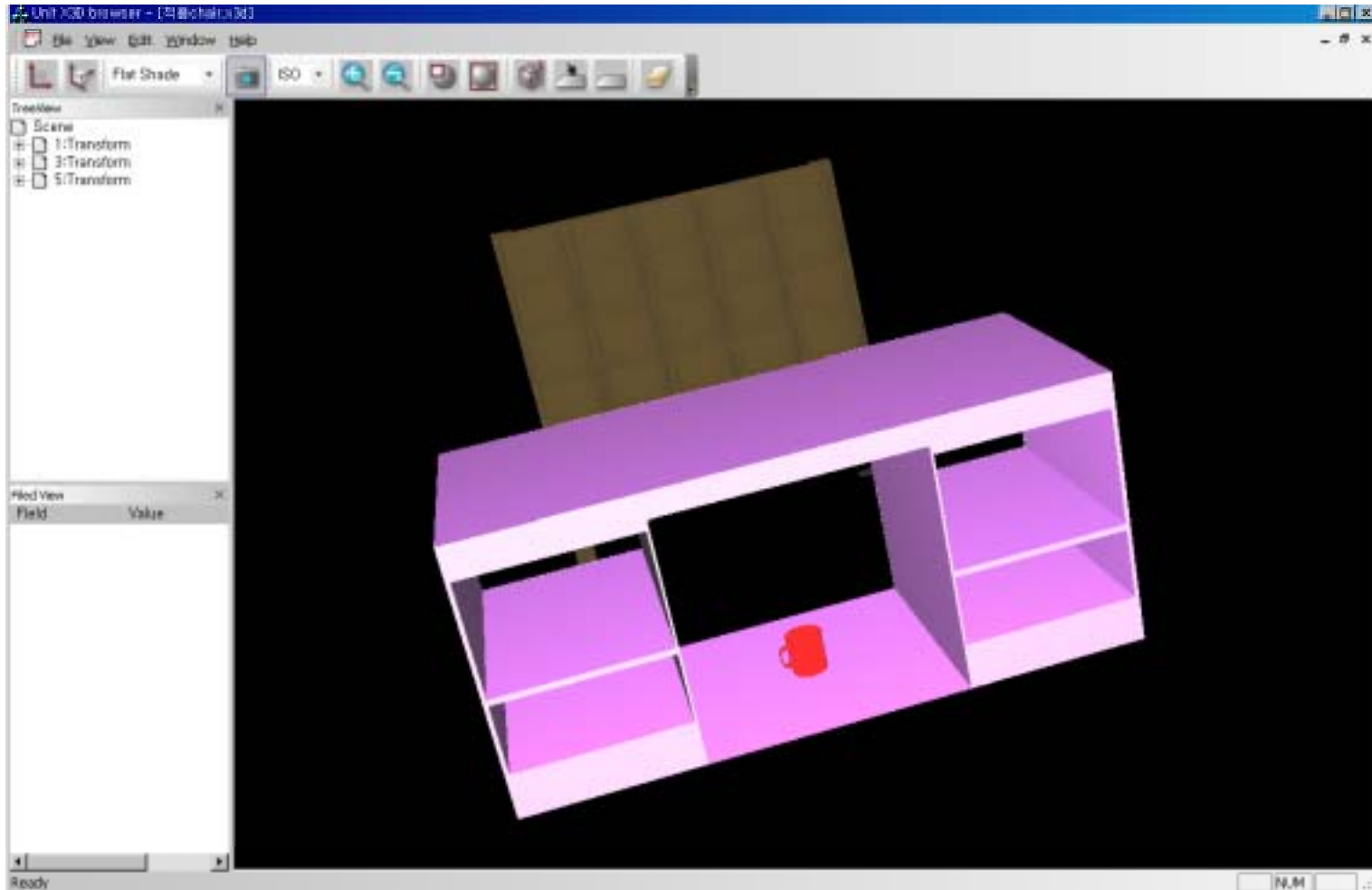
```
<xs:complexType name="LengthType">
<xs:attribute name="unit" type="unitType" use="optional" default="UNI"/>
<xs:attribute name="basis" type="basisType" use="optional" default="1"/>
<xs:attribute name="numeral" type="numeralType" use="optional" default="DEC"/>
</xs:complexType>

<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">
```
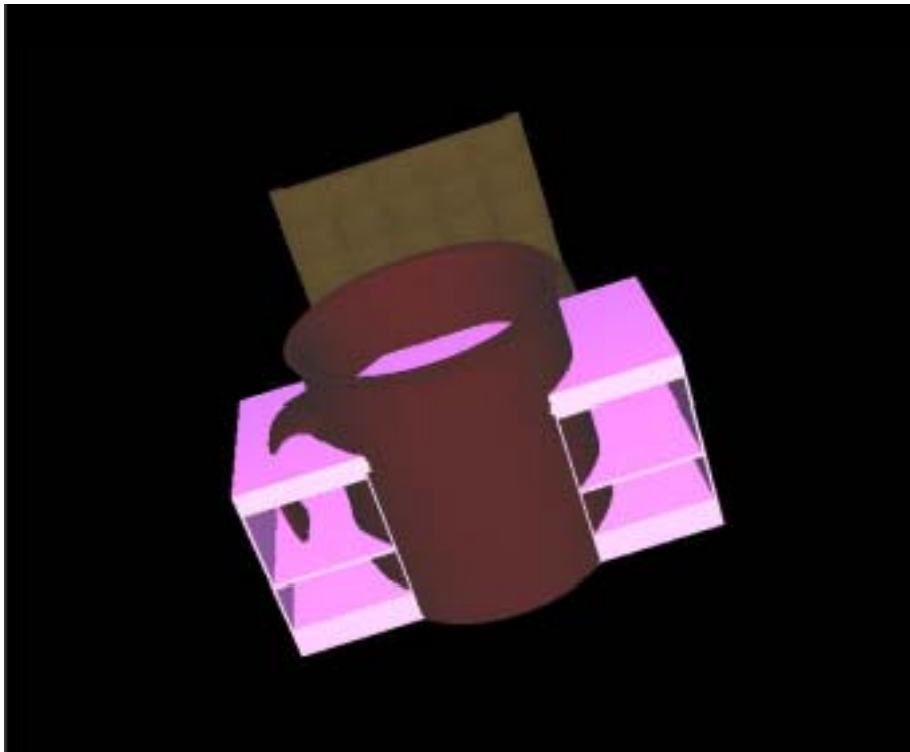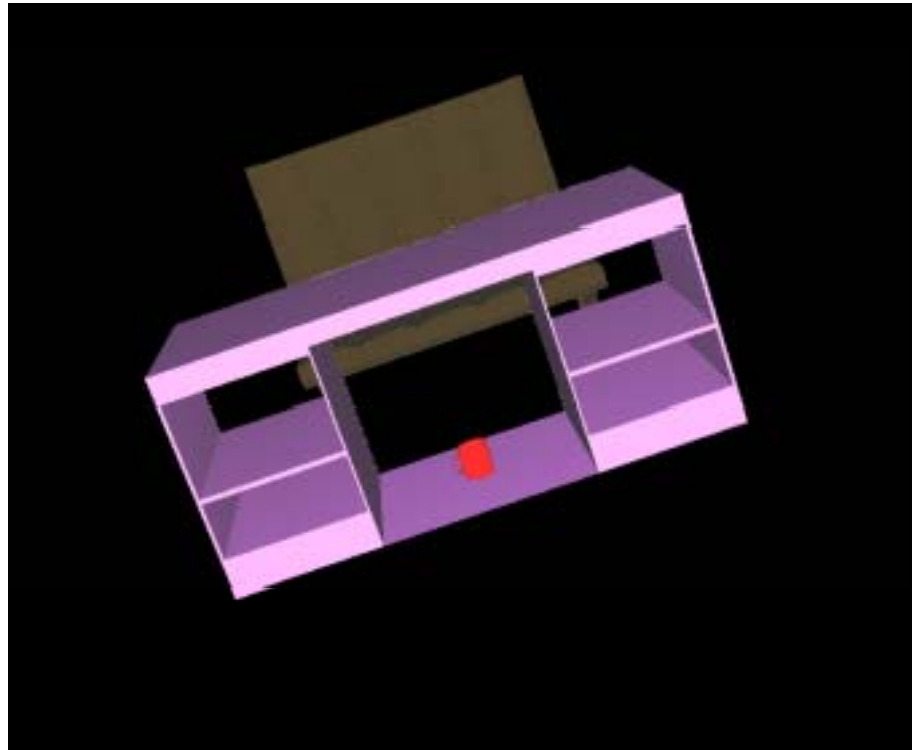
…

Unit X3D Browser

Unit X3D Example (1)

Table-Chair-Cup

Unit X3D Example (1)

- Before length units specification

Unit X3D Example (1)

- After length units specification

Unit X3D Example (1): table.x3d

```xml
<?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 (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
<?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 (2)

Monitor-Hard Disk

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>

</Shape>
```
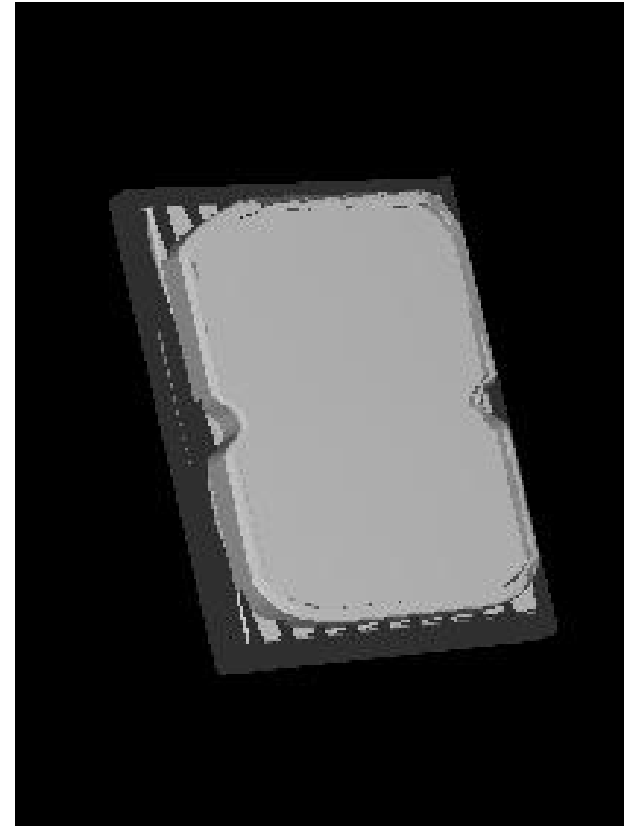
Unit X3D Example (2): Monitor

```
<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>
```
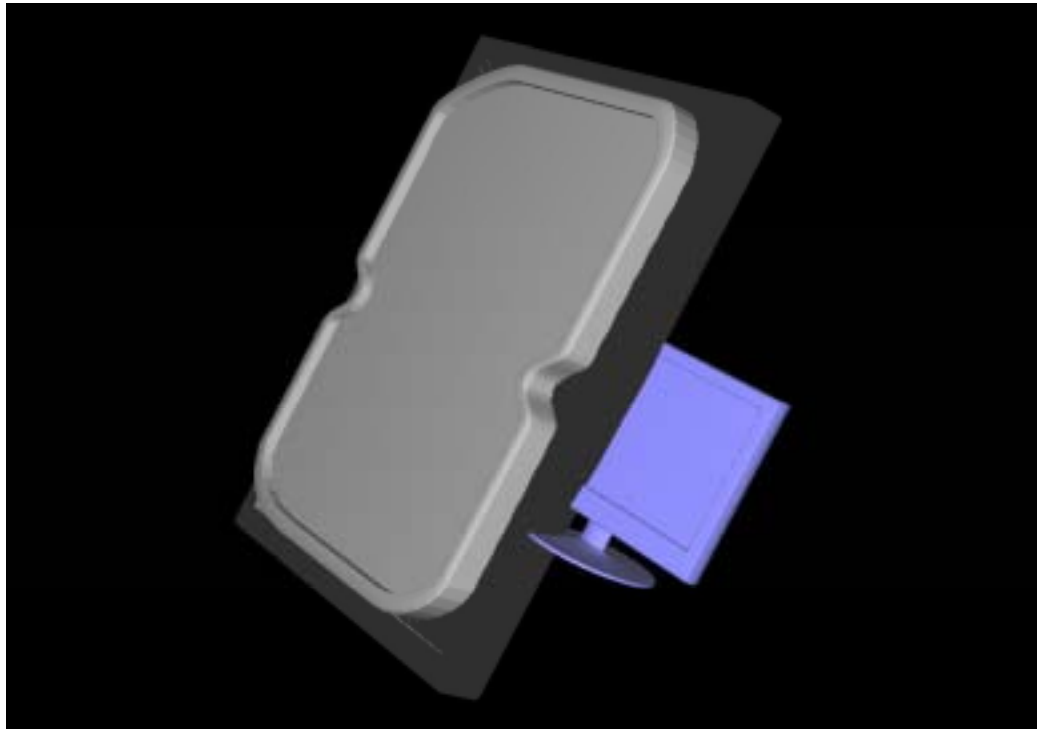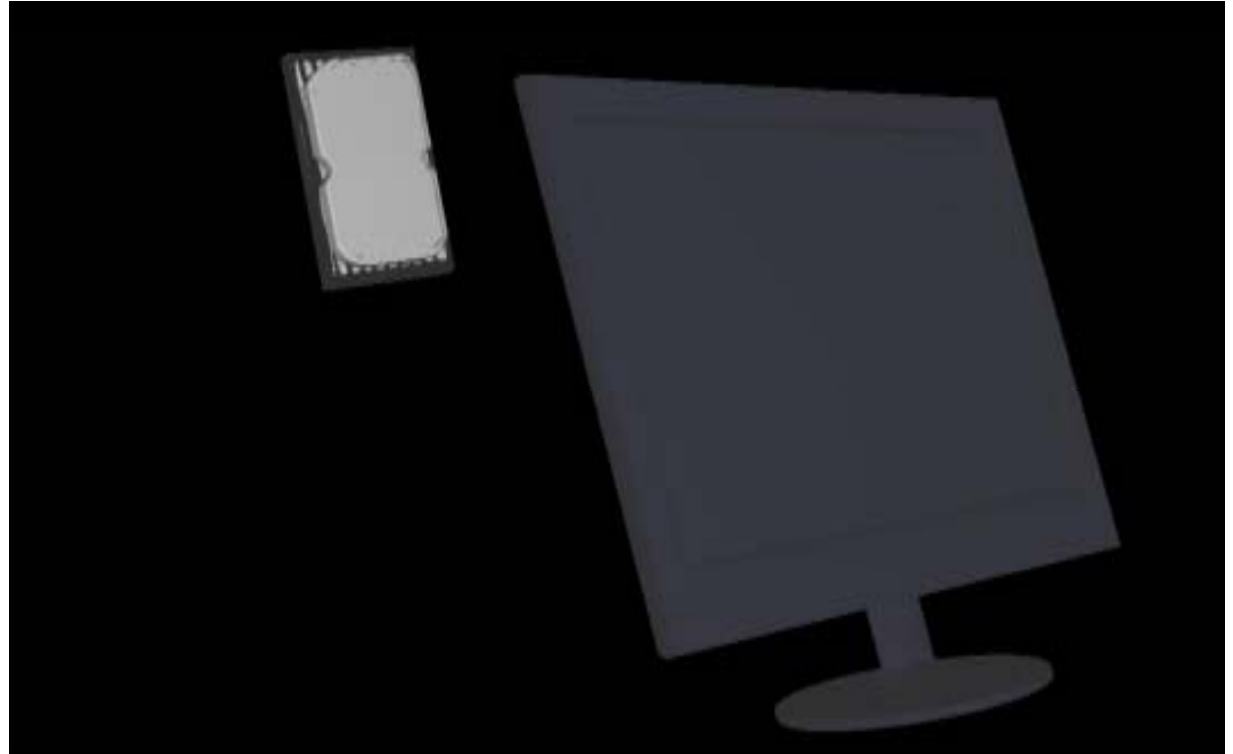
Unit X3D Example (2)

- Before length units specification

- After length units specification

➢ disk: millimeter
➢ monitor: centimeter

```
<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>
```
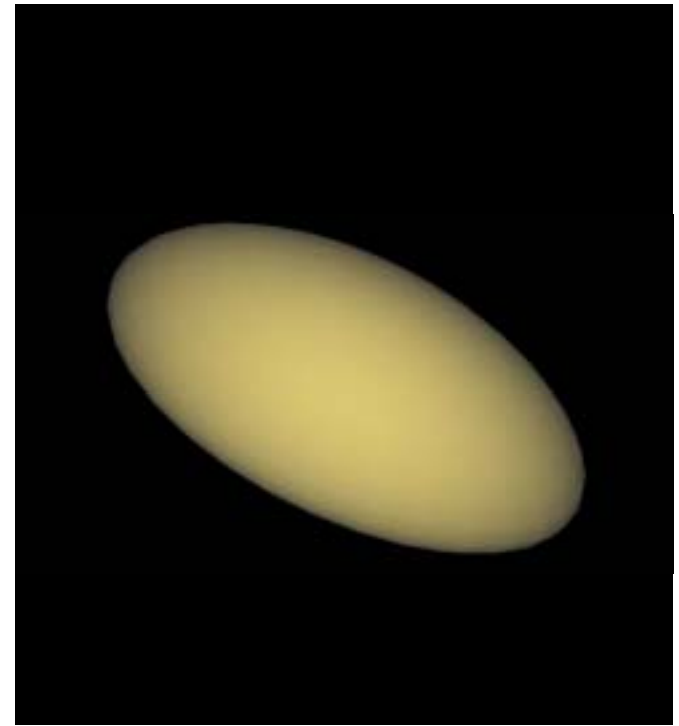
```
<Scene>

 <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 Example (3)

Microorganism:
Clamidomonas-Bacterium

Unit X3D Example (3)

Clamidomonas : 10-30 micrometer
➔ 0.01-0.03 millimeter

```
<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 1 1.827"
         translation="-100.047 0 -0.277">

      <Shape>

         [ . . . . . . . . . ]

      </Shape>
```


Monad: Clamidomonas

Unit X3D Example (3)

```
<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 0 -1.571"
        translation="30.277 1.385 0">

    <Shape>

        [ . . . . . . . . . ]

    </Shape>
```
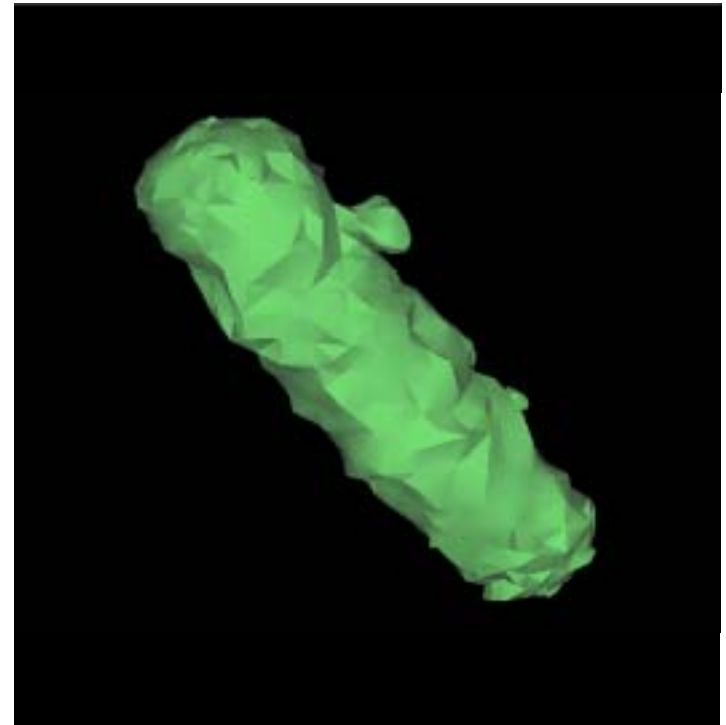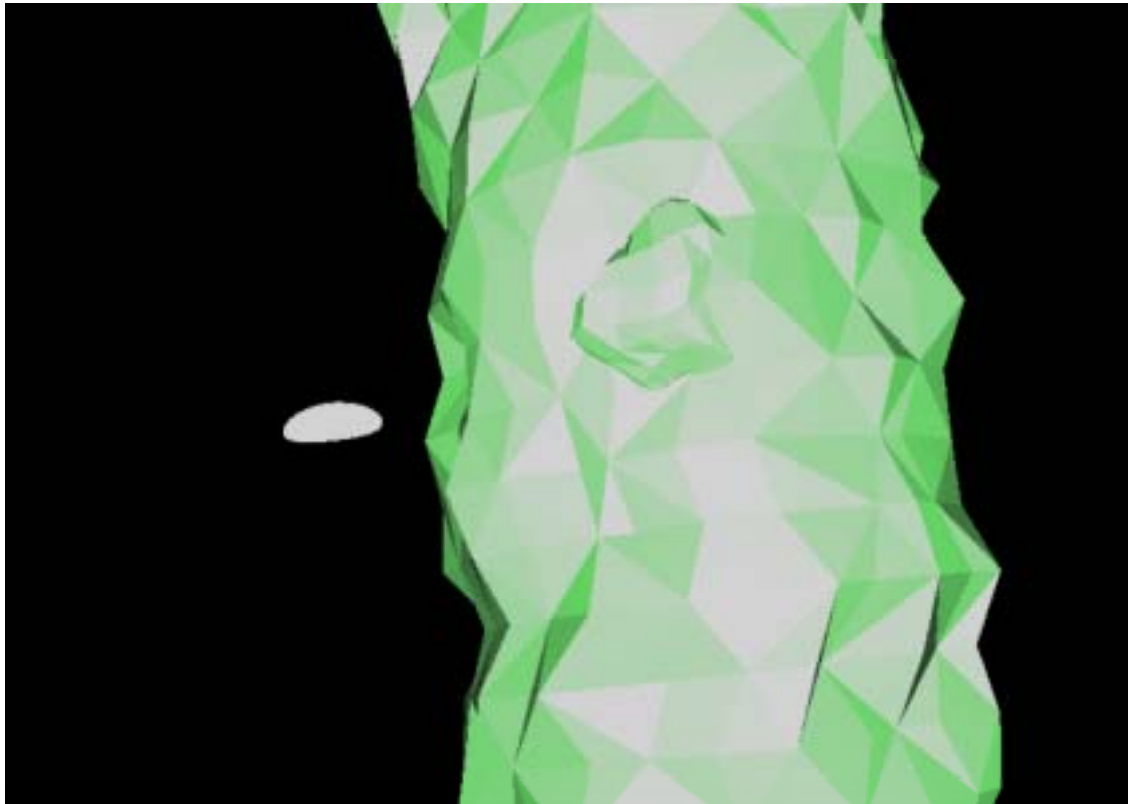
Bacterium : 0.4~1 micrometer

Microorganism: Becterium

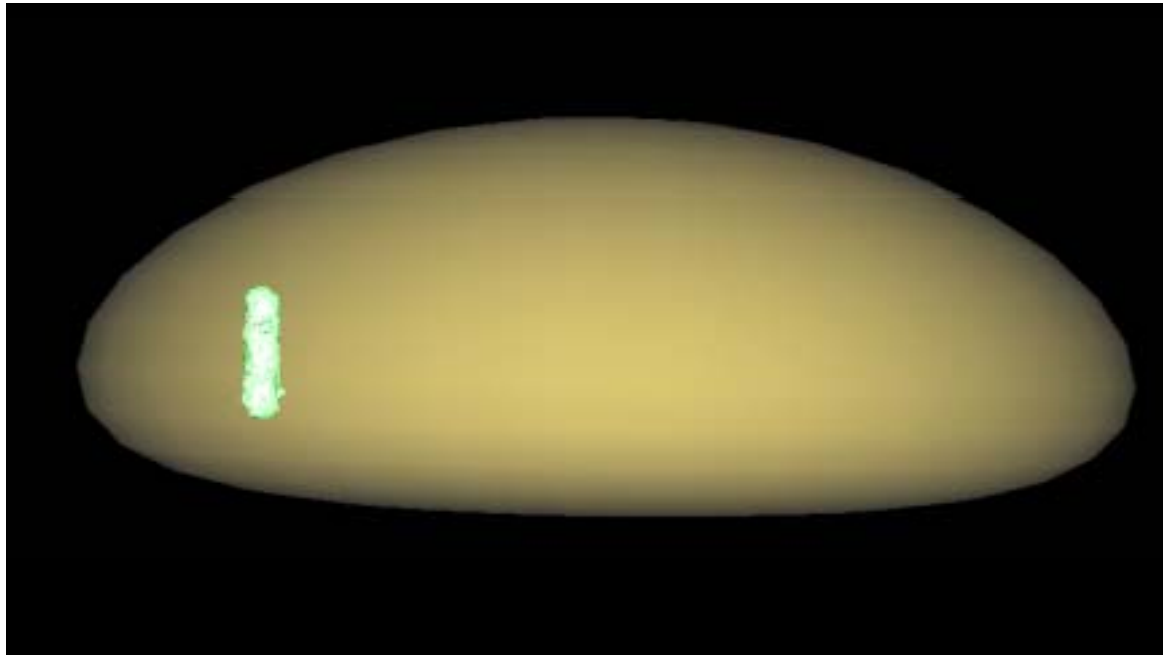# Unit X3D Example (3)

- Before length units specification

Unit X3D Example (3)

- After length units specification

Unit X3D Example (3)

```
<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="0.3121 0.3121 0.3121"
          translation="20.12 1.385 0.7341">

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

```
<Scene>

 <physical>
 <length unit="MICRO" 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="0.001 0.001 0.00182"
          translation="-0.24 0 -0.2887">

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

Unit X3D Example (4)

Planet:
Uranus-Saturn

Unit X3D Example (4)

Uranus: 250,000 hecto meter

```
<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="1.174 1.174 1.174"
            translation="-1500.493 0 -1.939">

        <Shape>

            [ . . . . . . . . . ]

        </Shape>
```

Unit X3D Example (4)

Saturn: 60000 km

```
<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="1.174 1.174 1.174"
        translation="-2.493 0 -1.939">

  <Shape>

      [ . . . . . . . . . ]

  </Shape>
```

Unit X3D Example (4)

- Before length units specification

Unit X3D Example (4)

- After length units specification

Unit X3D Example (4)

```
<Scene>

 <physical>
 <length unit="HECTO" 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="1.261 1.261 1.261"
        translation="1430.493 0 -1.939">

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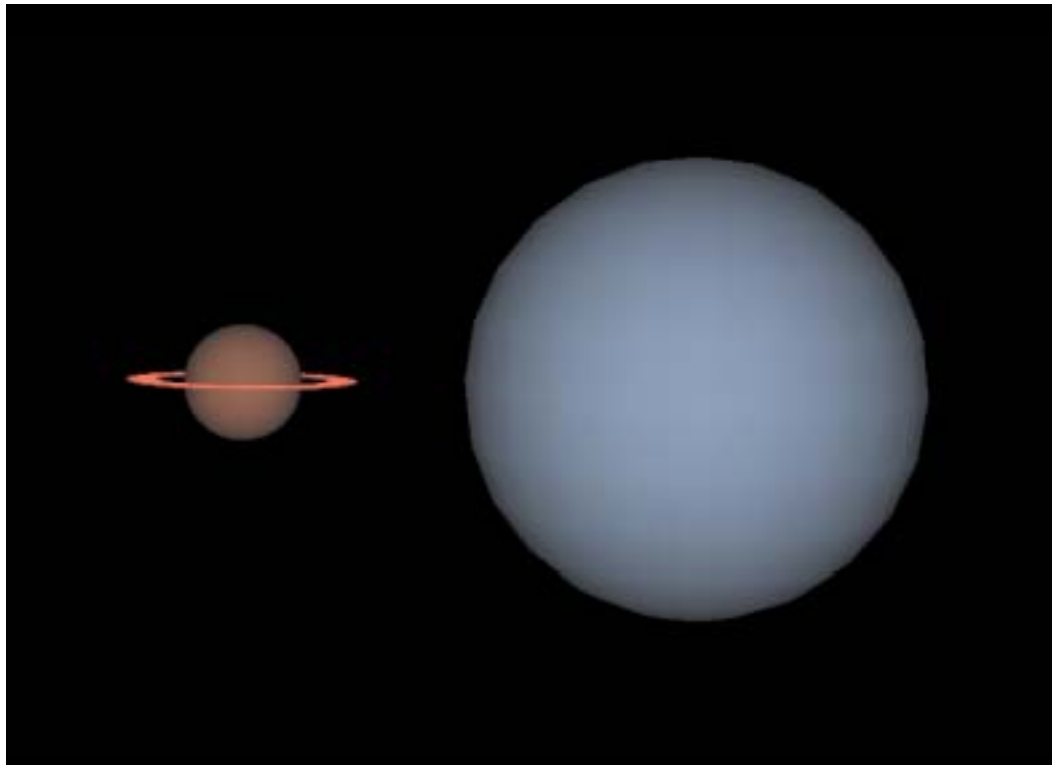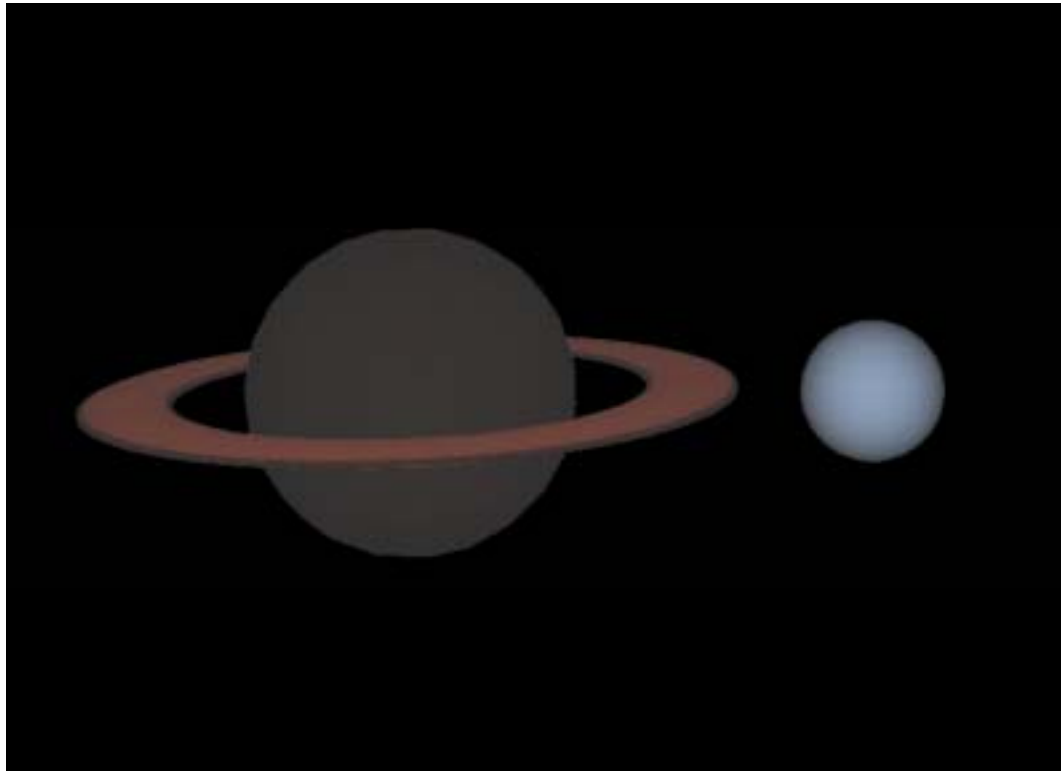
```
<Scene>

 <physical>
 <length unit="KILO" 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="1.174 1.174 1.174"
        translation="-2.493 0 -1.939">

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