
X3D Unit Specification Updates

Myeong Won Lee
The University of Suwon

Units Specification

- ISO_IEC_19775_1_2_WDAM2_PhysicalUnits
- UNIT statement
 - Defined in Core component
 - UNIT statements may only be contained in X3D worlds created for X3D version 3.3 or later
- Definition of UNIT statement
 - UNIT <category> <name> <conversion_factor>

Standard Units

Category	Initial base unit
acceleration	newton
angle	radian
angular_rate	radians/second
area	metres ²
force	metres/second ²
length	metre
mass	kilogram
speed	metres/second

Schema Extension for Units (partial)

```
<xs:element name="head">
  <xs:complexType>
    <xs:complexContent>
      <xs:extension base="SceneGraphStructureNodeType">
        <xs:sequence>
          <xs:element ref="component" minOccurs="0" maxOccurs="unbounded"/>
          <xs:element ref="unit" minOccurs="0" maxOccurs="unbounded"/>
          <xs:element ref="meta" minOccurs="0" maxOccurs="unbounded"/>
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
</xs:element>
```

```

<xs:element name="unit">
  <xs:annotation>
    <xs:appinfo/>
    <xs:documentation source="http://www.web3d.org/specifications/ISO-IEC-
19776.../Part01/core.html#UNITStatement"/>
  </xs:annotation>
  <xs:complexType mixed="false">
    <xs:complexContent mixed="false">
      <xs:extension base="SceneGraphStructureNodeType">
        <xs:attribute name="category" type="UnitCategoryType" use="required"/>
        <xs:attribute name="name" type="UnitNameType" use="required"/>
        <xs:attribute name="conversion_factor" type="SFDouble" use="optional" default="1"/>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
</xs:element>
<xs:simpleType name="UnitCategoryType">
  <xs:annotation>
    <xs:documentation>defines a set of values of the unit category attribute</xs:documentation>
  </xs:annotation>

```

```

<xs:restriction base="SFString">
    <xs:pattern value="acceleration|angle|angular_rate|area|force|length|mass|speed|time"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="UnitNameType">
    <xs:annotation>
        <xs:documentation>defines a set of values of the unit name attribute</xs:documentation>
    </xs:annotation>
    <xs:restriction base="SFString">
        <xs:pattern
            value="metres/second2|yottametres/second2|zettametres/second2|exametres/second2|petametres/second2|
            terametres/second2|gigametres/second2|megametres/second2|kilometres/second2|hectometres/second2|deka
            metres/second2|
            decimetres/second2|centimetres/second2|millimetres/second2|micrometres/second2|nanometres/second2|pic
            ometres/second2|
            femtometres/second2|attometres/second2|zeptometres/second2|yoctometres/second2"/> <!-- for
            acceleration unit -->
        <xs:pattern value="radian"/> <!-- for angle unit -->
        <xs:pattern value="radians/second"/> <!-- for angular rate unit -->
    </xs:restriction>
    <xs:pattern
        value="metres2|yottametres2|zettametres2|exametres2|petametres2|terametres2|gigametres2|megametres2
        |kilometres2|hectometres2|dekametres2|decimetres2|centimetres2|millimetres2|micrometres2|nanometres2
        |picometres2|femtometres2|attometres2|zeptometres2|yoctometres2"/> <!-- for area unit -->
    <xs:pattern value="newton"/> <!-- for force unit -->

```

```

<xs:pattern
  value="metre|yottametre|zettametre|exametre|petametre|terametre|gigametre|megametre|kilometre|hectometre
        |dekametre|
decimetre|centimetre|millimetre|micrometre|nanometre|picometre|femtometre|attometre
        |zeptometre|yoctometre"/> <!-- for length unit -->

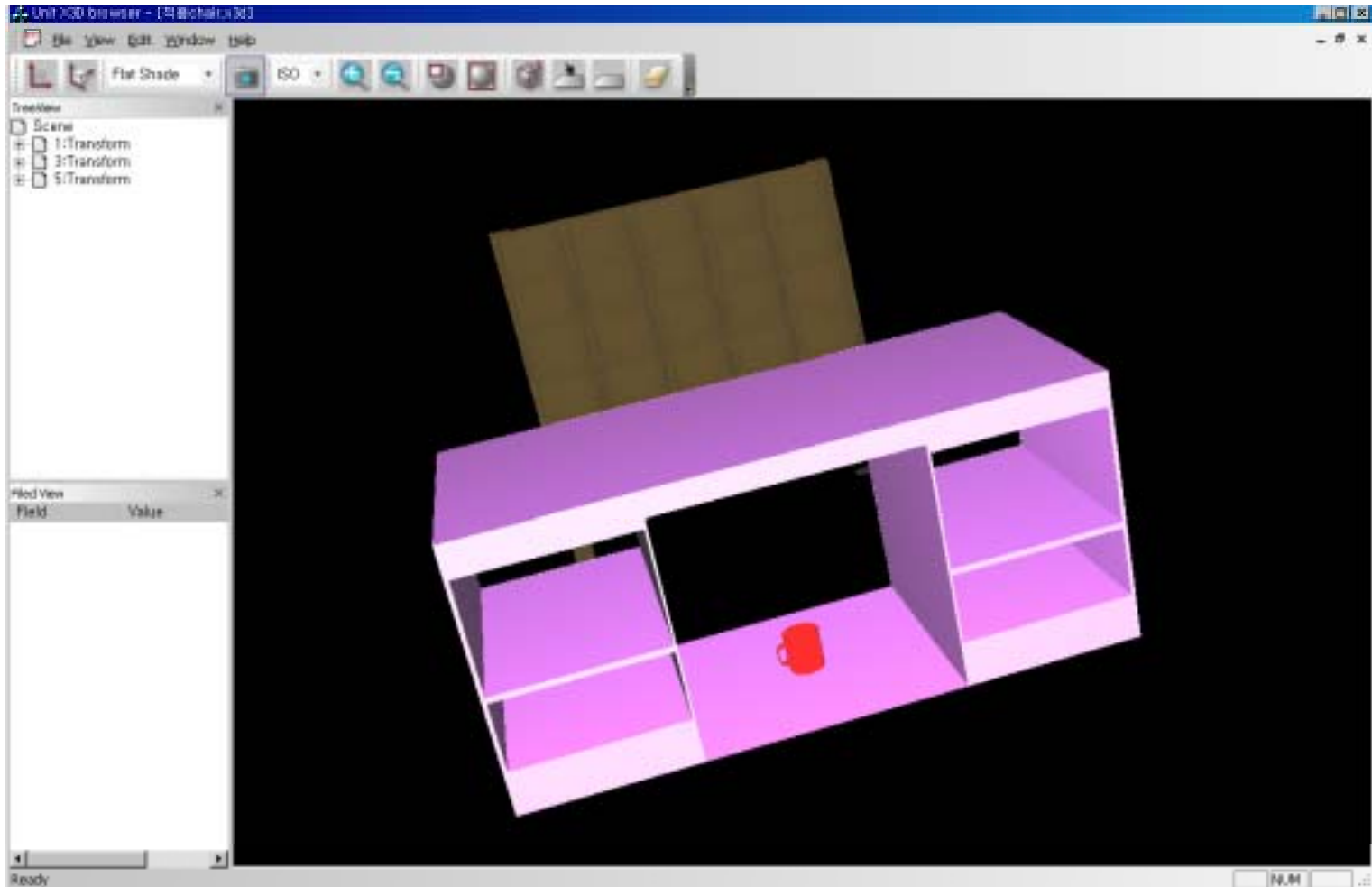
<xs:pattern
  value="kilogram|yottagram|zettagram|exagram|petagram|teragram|gigagram|megagram|hectogram|dekagram

|decigram|centigram|milligram|microgram|nanogram|picogram|femtogram|attogram|zeptogram|yoctogram"/>
  <!-- for mass unit -->

<xs:pattern
  value="metre/second|yottametre/second|zettametre/second|exametre/second|petametre/second|terametre/second
|gigametre/second|megametre/second|kilometre/second|hectometre/second|dekametre/second|decimetre/second
        |centimetre/second|millimetre/second|micrometre/second|nanometre/second|picometre/second|
        femtometre/second|attometre/second|zeptometre/second|yoctometre/second"/> <!-- for speed unit
-->
<xs:pattern value="second"/> <!-- for time unit -->
</xs:restriction>
</xs:simpleType>

```

Unit X3D Browser

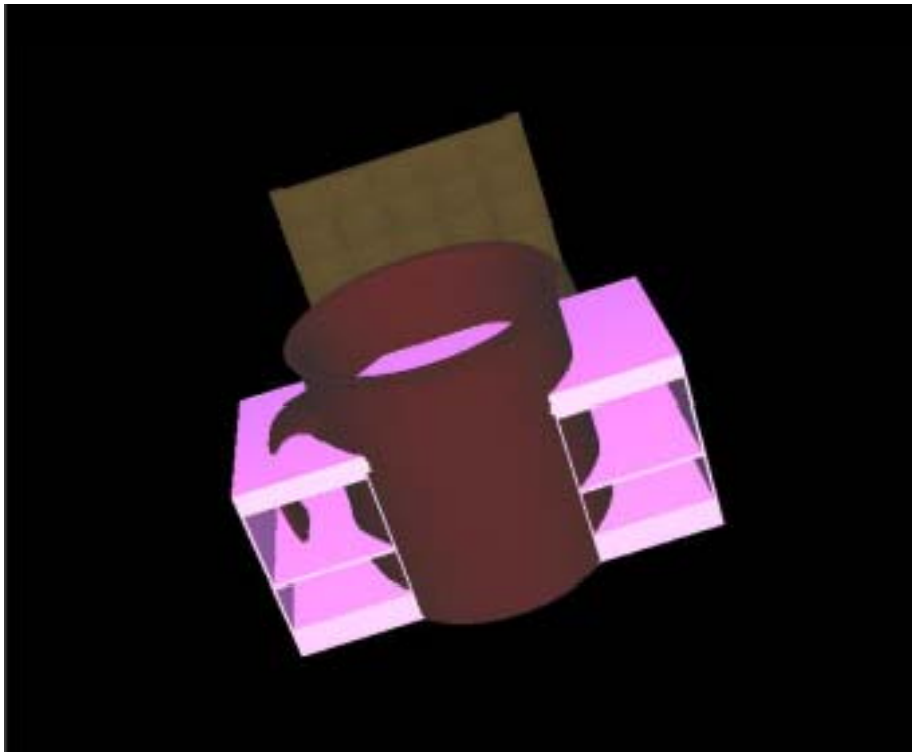


Unit X3D Example (1)

Desk-Chair-Cup

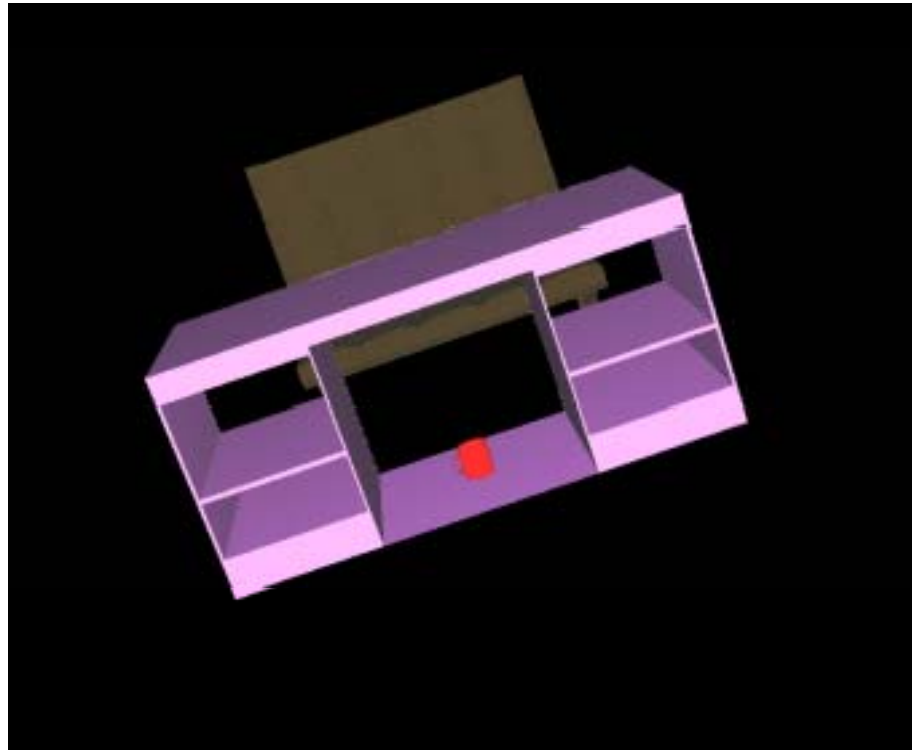
Unit X3D Example (1)

- Before length units specification



Unit X3D Example (1)

- After length units specification



Unit X3D Example (1): desk.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">

  <head>
    <unit category="length" name="CENTI" conversion_factor="0.01"/>
  </head>

  <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="0.3415 0.3415 0.3415" rotation="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">

  <head>
    <unit category="length" name="CENTI" conversion_factor="0.01"/>
  </head>

  <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="0.3415 0.3415 0.3415" translation="300 -700 300">
      <Shape>
        <Appearance>
```

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">

  <head>
    <unit category="length" name="MILLI" conversion_factor="0.001"/>
  </head>

  <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="3.415 3.415 3.415" translation="420 -190 200" rotation="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"/>

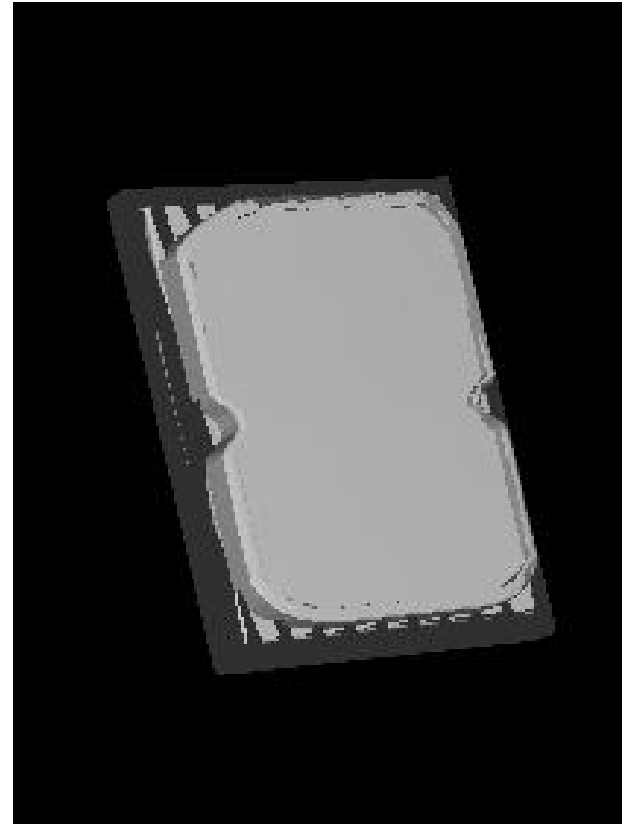
<Background groundColor="0.05 0.1 0.3"
skyColor="0.05 0.1 0.3 "/>

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

<Shape>

[.]

</Shape>



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>

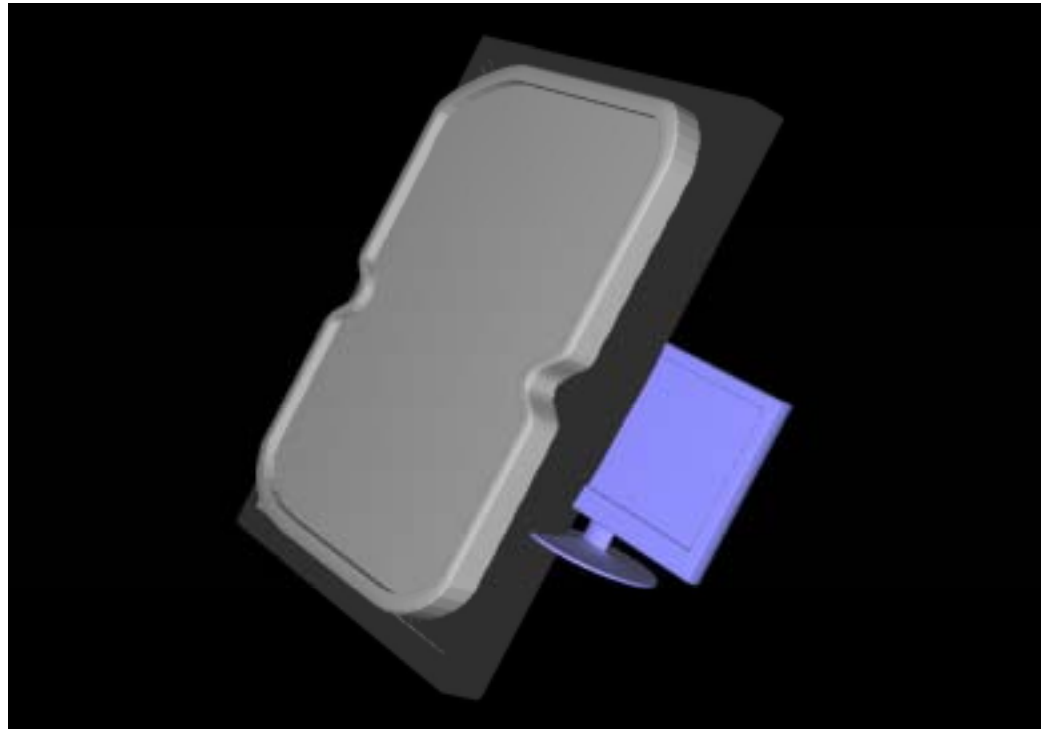
[.....]

</Shape>



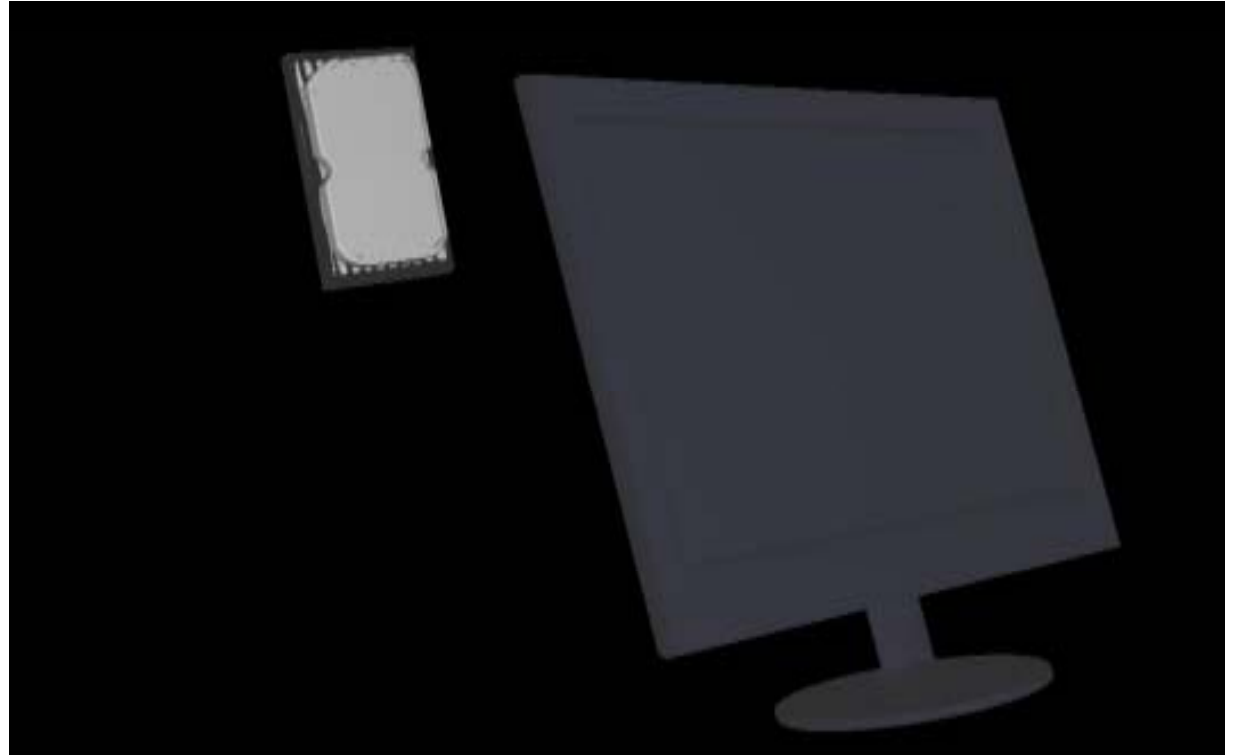
Unit X3D Example (2)

- Before length units specification



Unit X3D Example (2)

- After length units specification



- disk: millimeter
- monitor: centimeter

```
<head>  
  <unit category="length" name="MILLI"  
    conversion_factor="0.001"/>  
</head>
```

```
<head>  
  <unit category="length" name="CENTI"  
    conversion_factor="0.01"/>  
</head>
```

Unit X3D Example (2)

```
<head>  
  <unit category="length" name="MILLI"  
    conversion_factor="0.001"/>
```

```
</head>
```

```
<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>
```

```
<head>  
  <unit category="length" name="CENTI"  
    conversion_factor="0.01"/>
```

```
</head>
```

```
<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 (3)

**Microorganism:
Chlamydomonas-Bacterium**

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 "/>
```

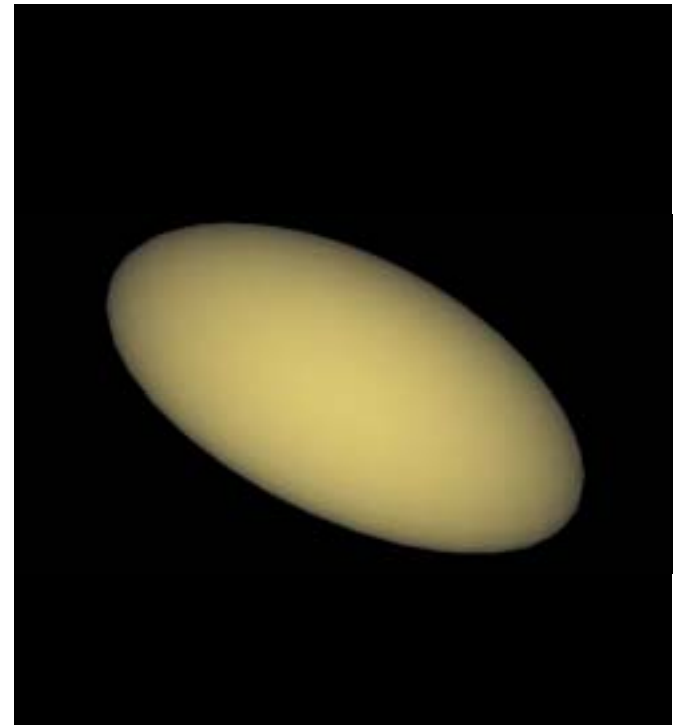
```
<Transform scale="1 1 1.827"  
  translation="-100.047 0 -0.277">
```

```
<Shape>
```

```
[ . . . . . ]
```

```
</Shape>
```

Clamidomonas : 10-30 micrometer
→ 0.01-0.03 millimeter



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 "/>

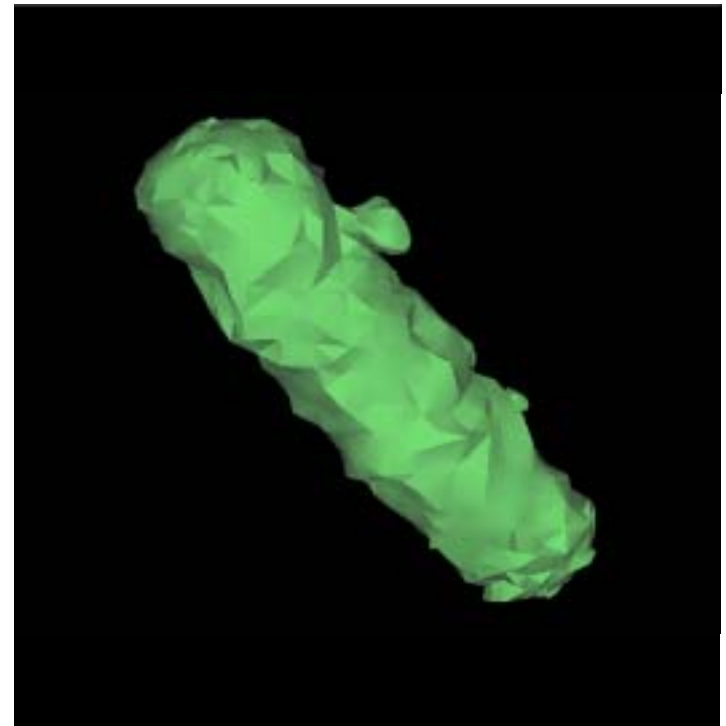
<Transform scale="-1 0 0 -1.571"
translation="30.277 1.385 0"/>

<Shape>

[.]

</Shape>

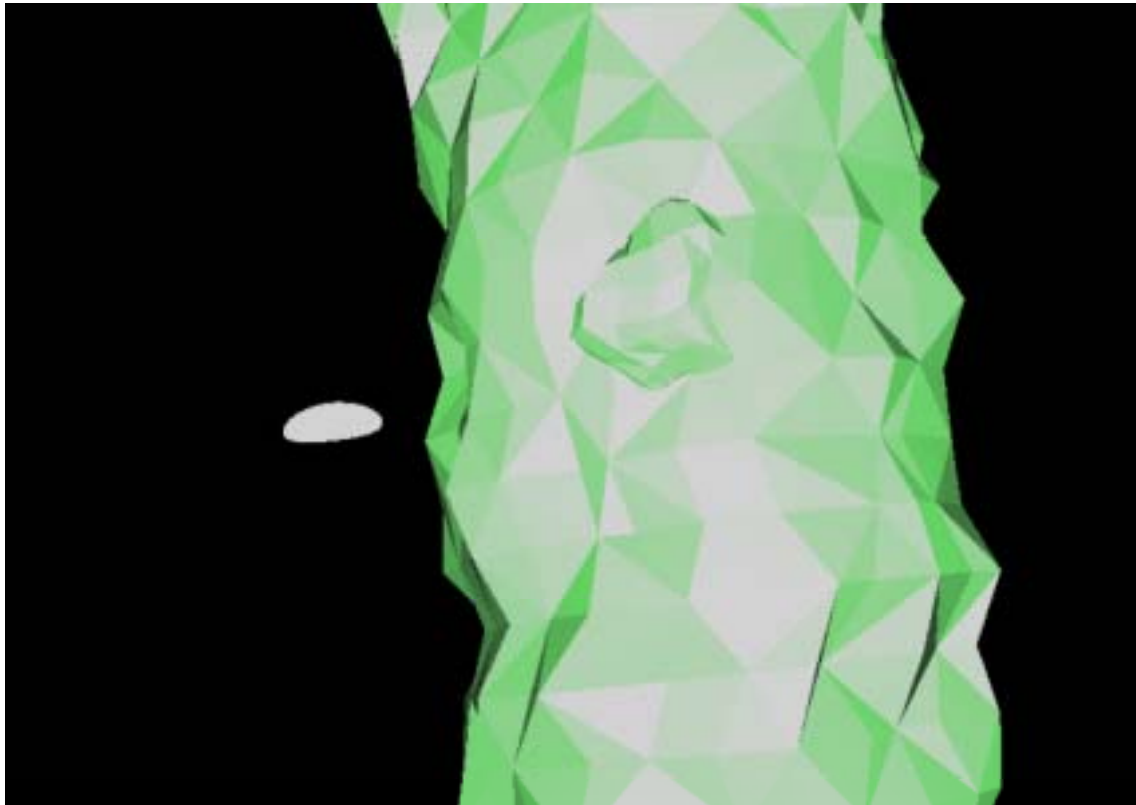
Bacterium : 0.4~1 micrometer



Microorganism: Bacterium

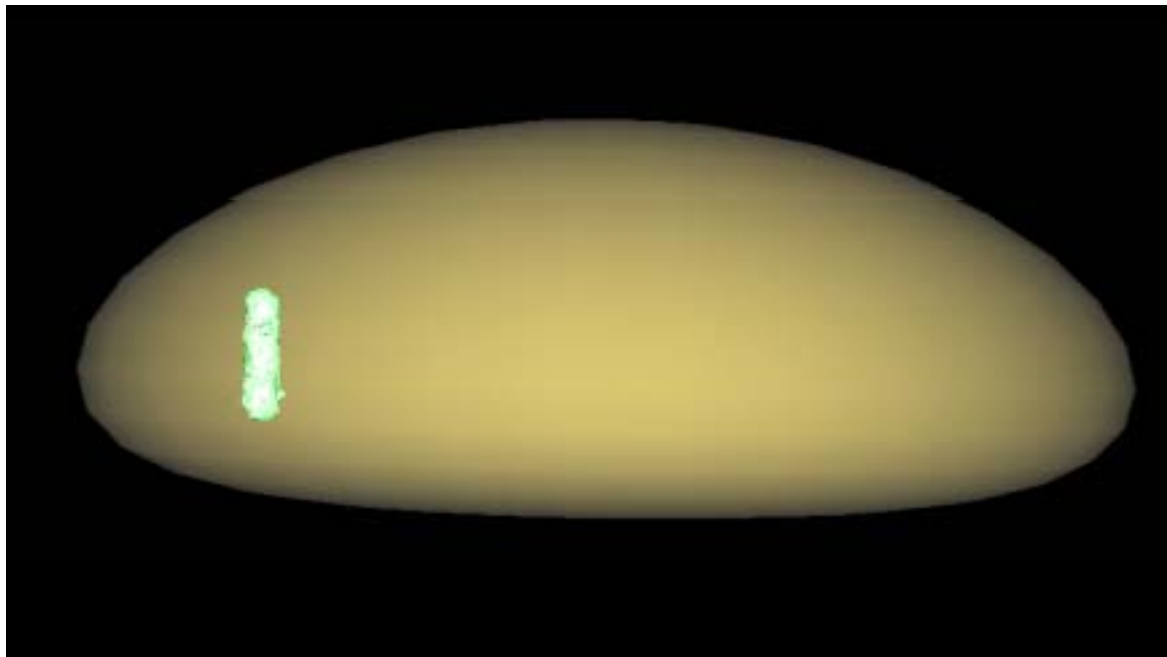
Unit X3D Example (3)

- Before length units specification



Unit X3D Example (3)

- After length units specification



Unit X3D Example (3)

```
<head>
  <unit category="length" name="MILLI"
        conversion_factor="0.001"/>
</head>

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

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

```
<head>
  <unit category="length" name="MICRO"
        conversion_factor="0.00001"/>
</head>

<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="0.001 0.001 0.00182"
    translation="-0.24 0 -0.2887"/>

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

Unit X3D Example (4)

**Planet:
Uranus-Saturn**

Unit X3D Example (4)

```
<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>
```

Uranus: 250,000 hecto meter



Unit X3D Example (4)

<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>

Saturn: 60000 km



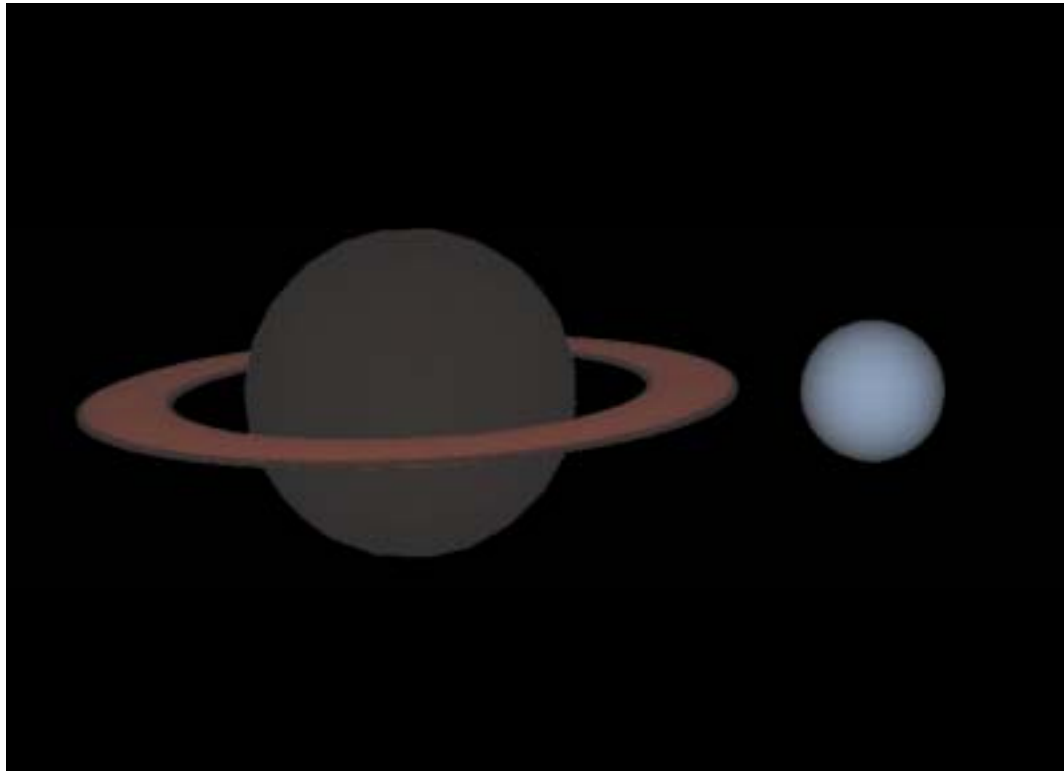
Unit X3D Example (4)

- Before length units specification



Unit X3D Example (4)

- After length units specification



Unit X3D Example (4)

```
<head>
  <unit category="length" name="HECTO"
        conversion_factor="100"/>
</head>

<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="1.261 1.261 1.261"
    translation="1430.493 0 -1.939">

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

```
<head>
  <unit category="length" name="KILO"
        conversion_factor="1000"/>
</head>

<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>
```

Real Length Definition

- Problem
 - If unit is specified, we are able to know relative size between two objects.
 - However, we are not able to know the real length of an object if only length unit is used in an X3D file.
- Solution
 - Define the measurement value of real length.
 - Define the real length of an object's bounding box.

Real Area Definition

- Problem
 - If unit specified, we are able to know relative size between two objects.
 - However, we are not able to know the real area of an object if only area unit is used in an X3D file.
- Solution
 - Define the measurement value of real area
 - Define the real areas projected to xy, yz and zx planes for an object

Conclusions

- Next work for physical units
 - Define real length and real area measurement values in an X3D file
 - Represent real length and real area for an object in a 3D scene