WEB GRAPHICS WITH X3D

By Raymond Pang

What is X3D

- eXtensible 3D graphics
- Defined by Web3D Consortium (www.web3d.org)
- Successor of VRML
- An open standard for web-enabled interactive 3D content integrated with multimedia
- Defined the scene graph with tags and elements

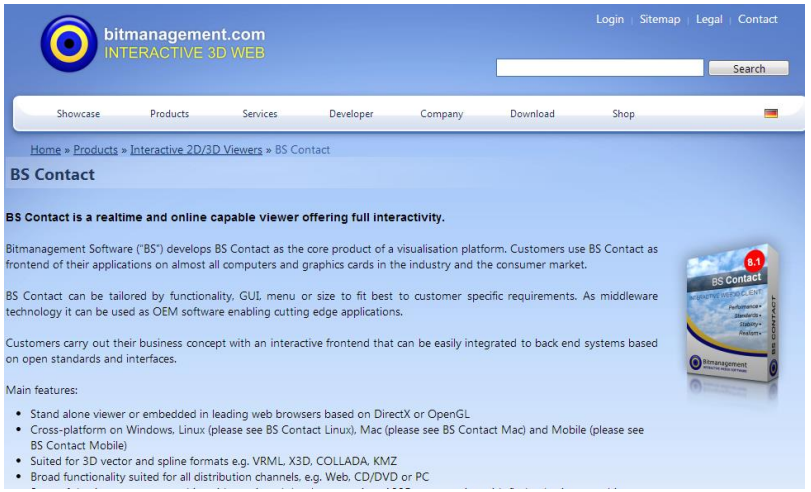
What is X3D

- X3D browsers parse (read)
- X3D scene models and
- render (draw) them
- Also provide simulation capabilities for animation and user interaction

External Viewer of X3D

There are many X3D external viewers

- BS Contact
  - http://www.bitmanagement.de/en/download
- FreeWRL/FreeX3D
  - http://www.crc.ca/FreeWRL
- InstantReality
  - http://instantreality.org
- Octaga
  - http://www.octaga.com
- Xj3D
  - http://www.xj3d.org

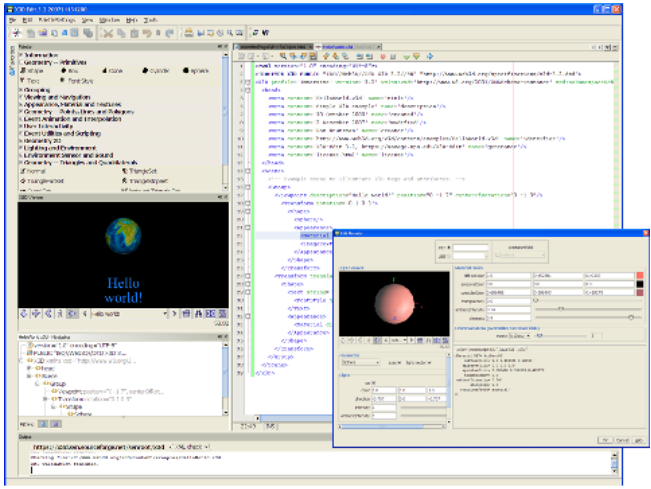


Language Encodings

- X3D has multiple file-format encodings
  - .x3d is XML based
  - .x3dv is Classic VRML syntax
  - .x3db is Compressed Binary Encoding with both
- Geometric and information compression
- X3D has multiple application program
- Interfaces (APIs) with similar structure
  - Javascript (formally known as EcmaScript)
  - Java (optionally supported)

Some Tools for X3D

- BS Editor
  - http://www.bitmanagement.de/en/products/authoring-tools/bs-editor
- X3D-Edit
  - https://savage.nps.edu/X3D-Edit/
  - Written in Java
- Blender and MeshLab
  - Generic mesh editor and viewer
  - Output X3D format



x3D-Edit

An Introduction

x3D-Edit

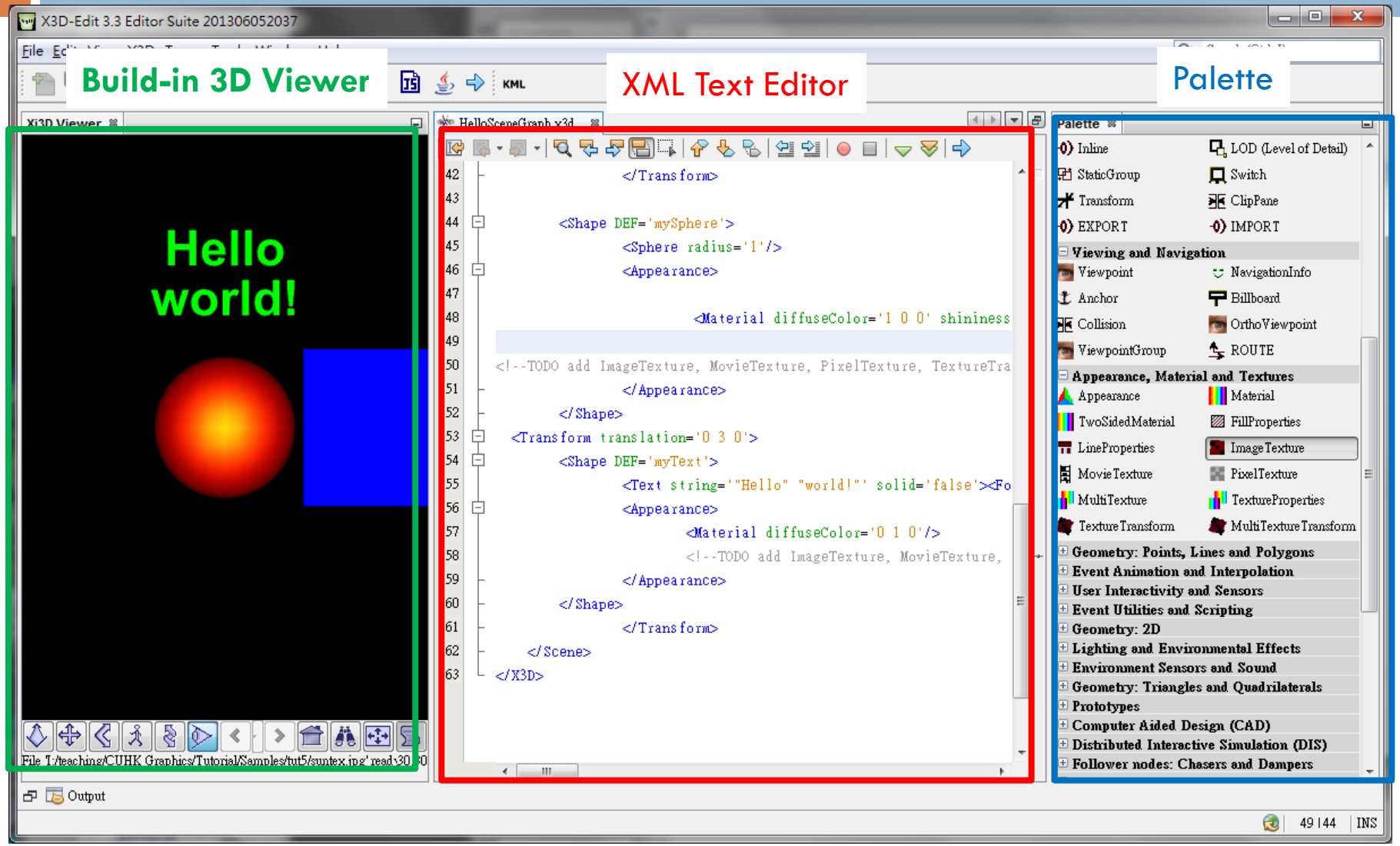
Built-in features :

- Syntax highlighting of XML source, text editing or tree navigation
- Drag-and-drop palette for adding new nodes
- Customized editors for each node, download wizard for X3D example archives
- Multiple validation, data checking and format-conversion capabilities (also online at X3D Validator)
- Extensive help system includes multilingual X3D Tooltips and X3D Specifications
- View changes using embedded Xj3D viewer, external Web browser plugin, or configurable set of selectable X3D viewers
- Open source, royalty free, cross-platform, automatic updates
- User-addable plugin

Download and Run

- Download from https://savage.nps.edu/X3D-Edit/
- X3D-Edit3.3.zip and then extract it into a new directory.
- Run X3dEditWin.bat on a Windows
- or runX3dEditMac.sh.command on a Mac

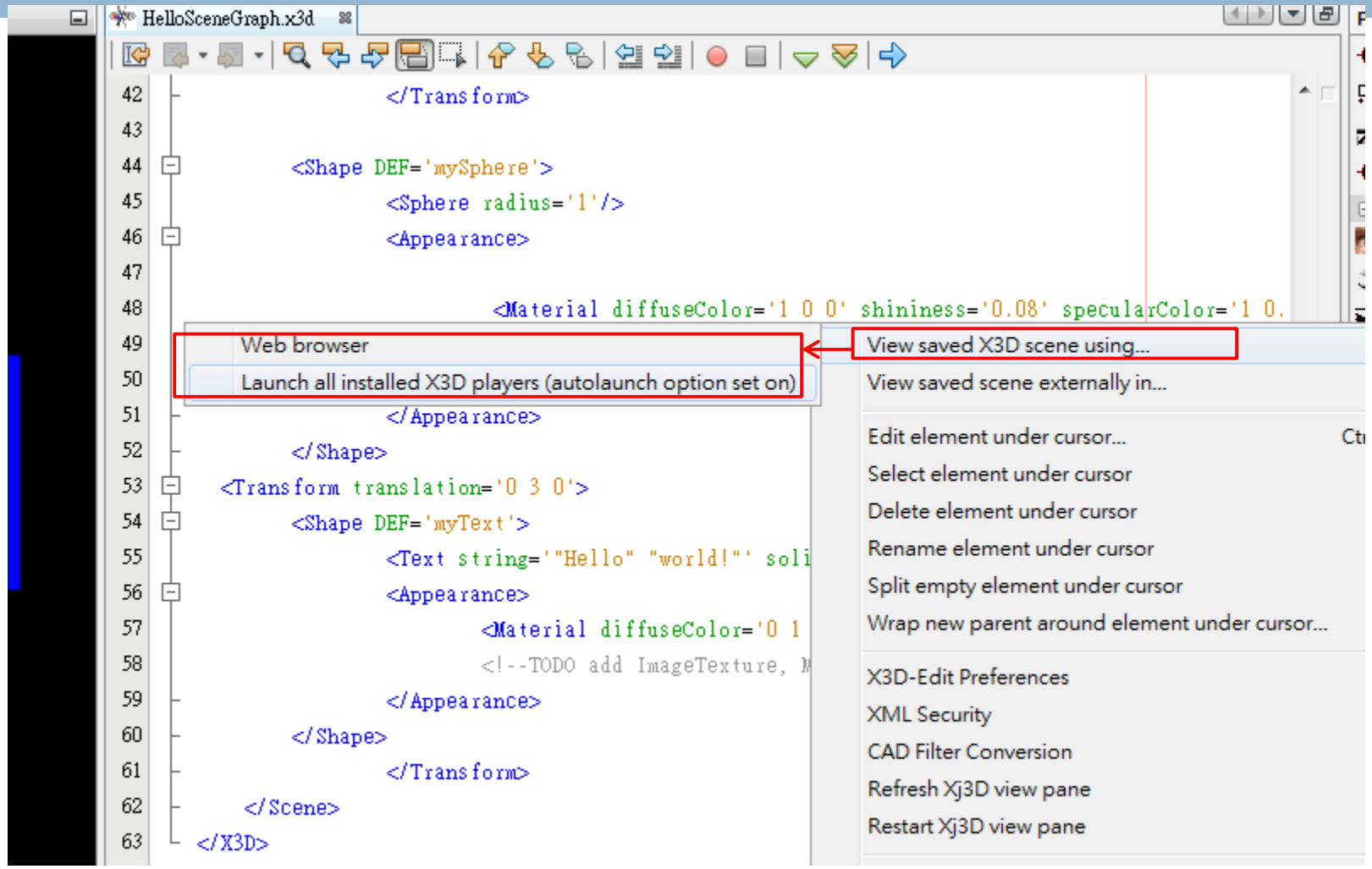
The User Interface



Viewing alternatives for X3D

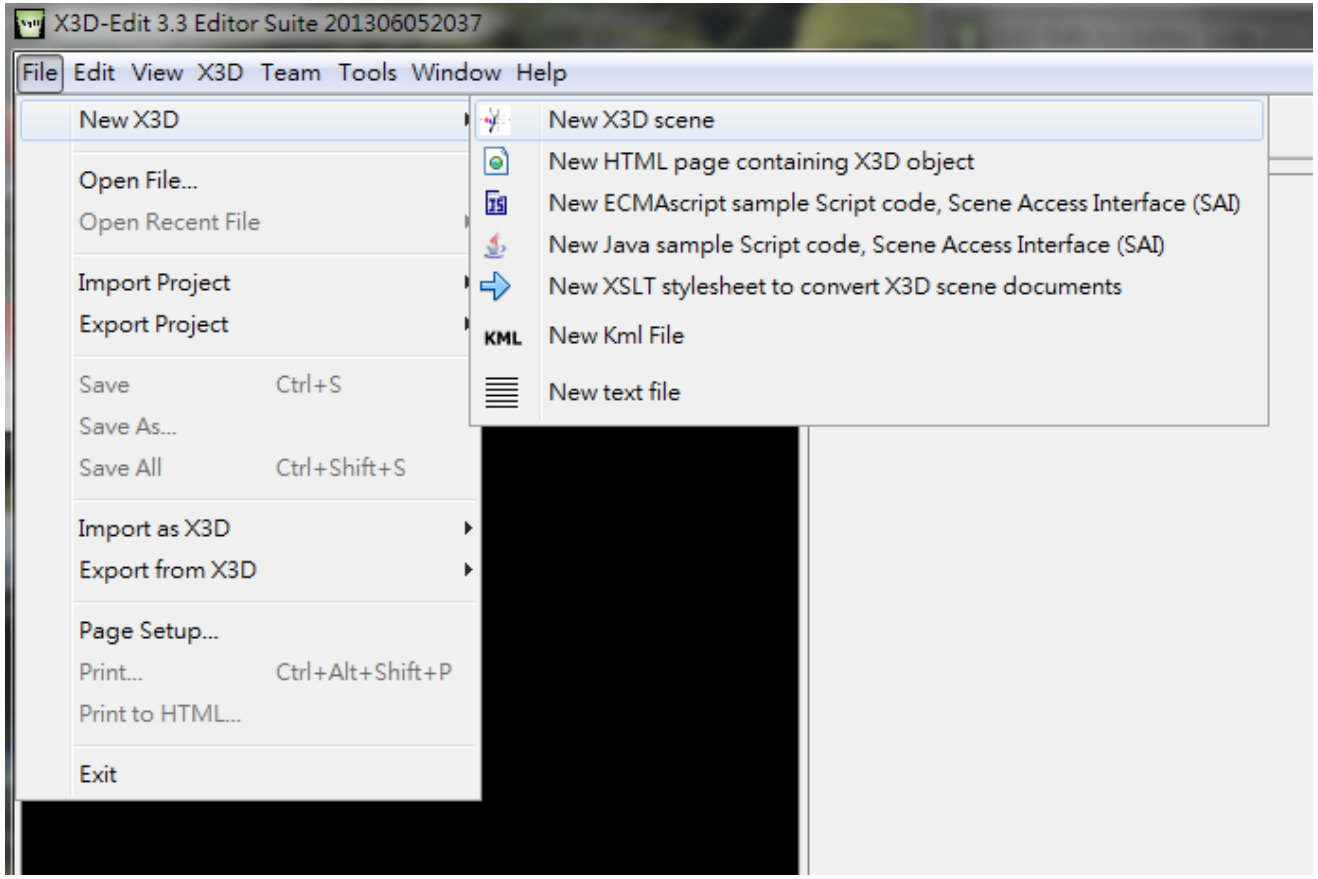
- Default built-in viewer is open-source Xj3D
  - High performance, implemented using Java OpenGL
- Can launch current scene into web browser
  - Displays using any of your installed plugins
- Can also launch into standalone applications
  - Configuration panel simplifies download, install

Launch External Players



Scene Editing

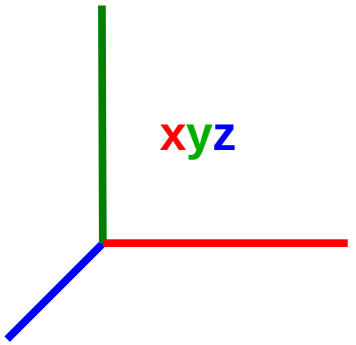
- Create a new X3D scene



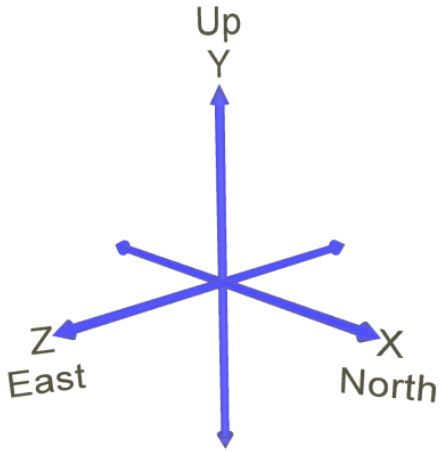
Scene Graph

- All the objects are defined within the <Scene> Tags

```
<Scene>
    ....
</Scene>
```



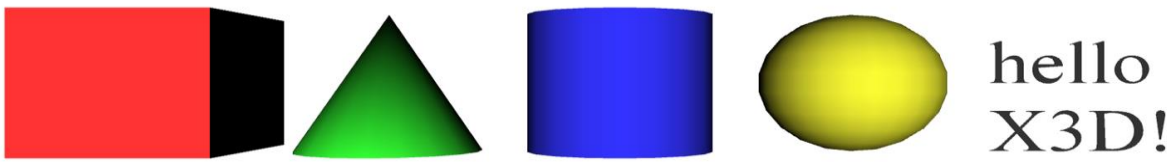
- Coordinate System of the scene
  - Right hand rule for X Y Z order
  - Y axis is up
  - Correspondence: North, Up, East



Scene Graph

- There are several simple primitive geometries available in X3D
  - Box
  - Sphere
  - Cone
  - Text and etc.

Choices from Palette



Shape

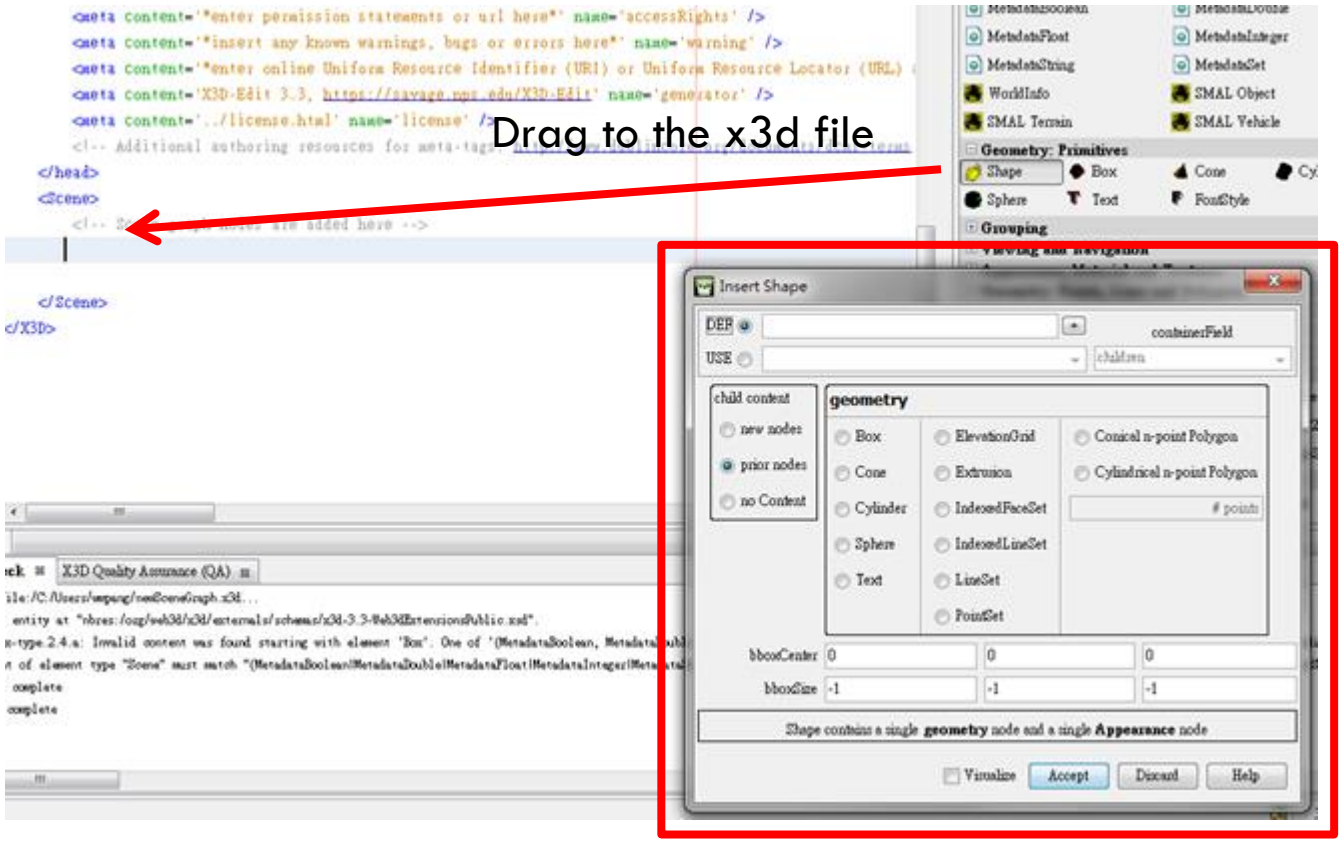
- Shape must be parent node, can only hold one geometry node

```
<Shape>
    ....
</Shape>
```

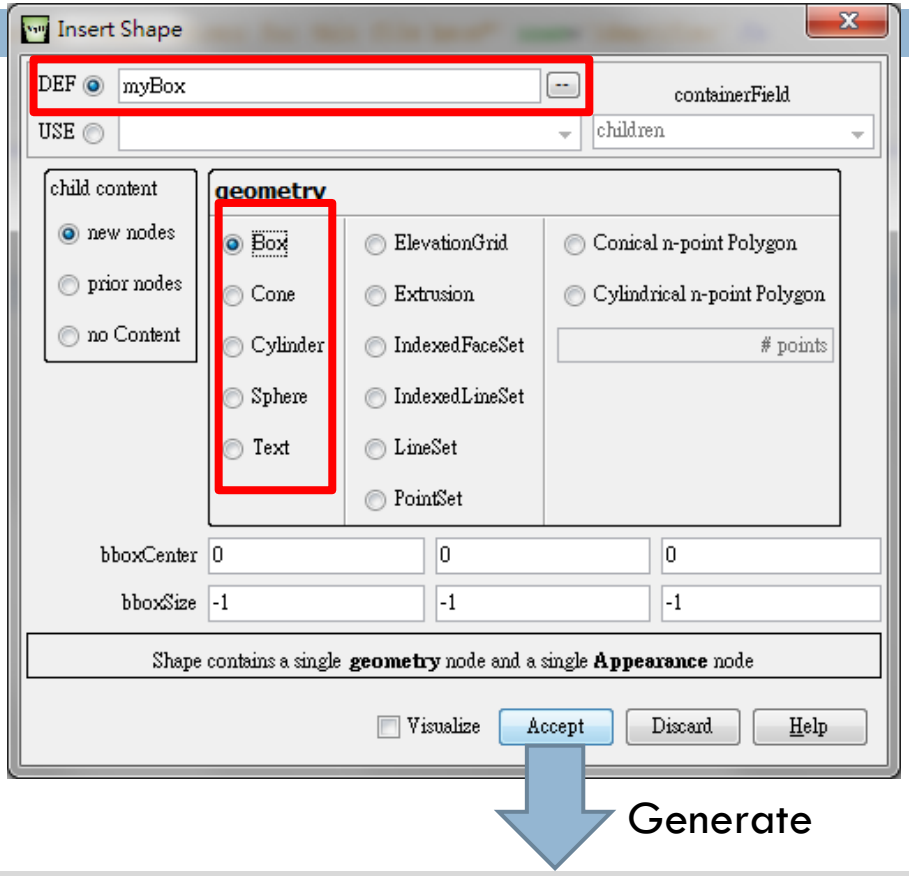
- Appearance and Material nodes define colors, transparency, etc.

Creating a box in x3D-Edit

- Drag the shape item to the edit will popup “Insert Shape Window



Creating a box in x3D-Edit



Generate

```
<Shape DEF='myBox' >
        <Box size='2 2 2'/>
        <Appearance>
                <Material diffuseColor='1 1 1'/>
</Appearance> </Shape>
```

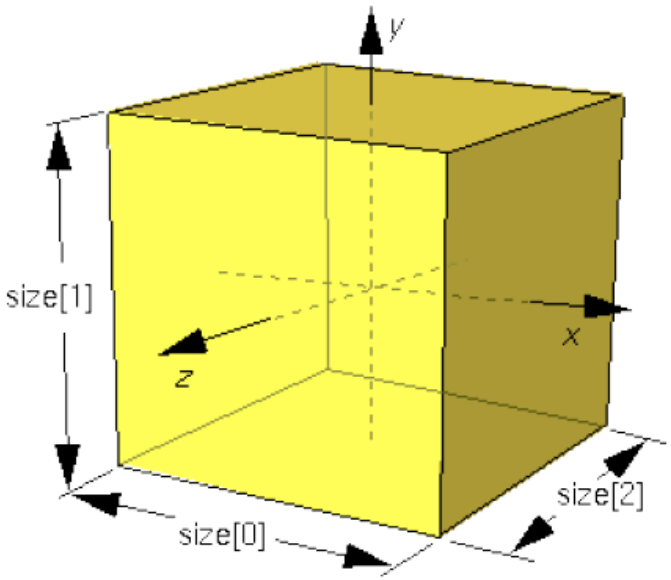
- DEF names provide a label for any node
- Choose Box geometry
  - Default to generate a box with 2x2x2 in size and white in color

Box Node

- Six-sided rectangular cube

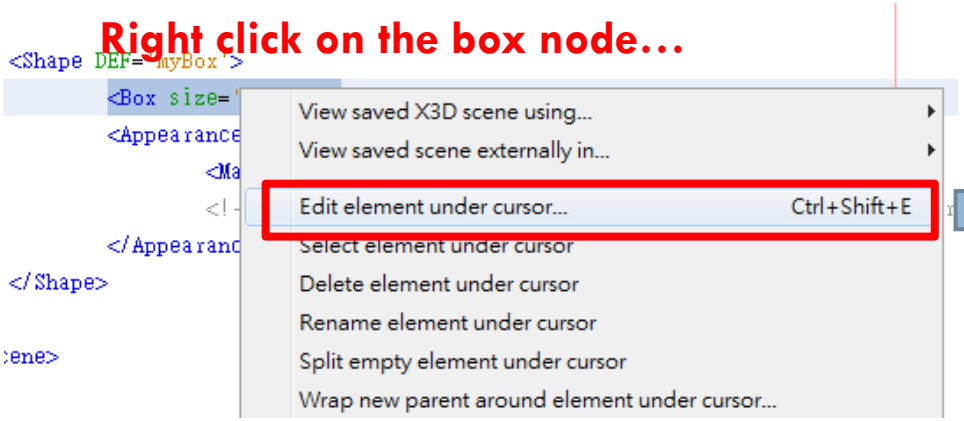
```
<Box size='2 2 2'/>
```

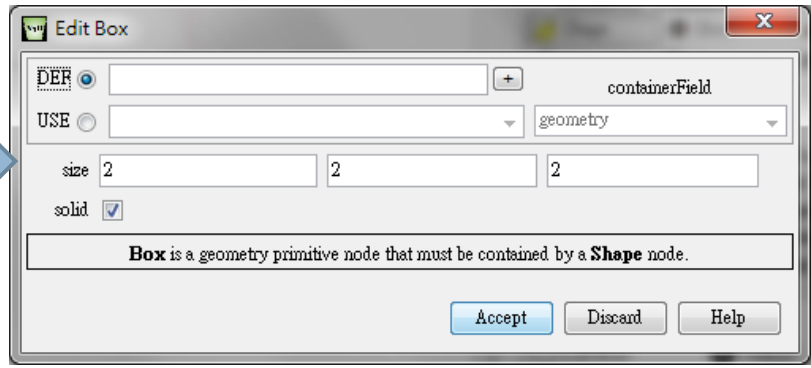
  - Define its size in x,y & z axis
  - Centered at local origin
  - All units are in meters



- Edit the box geometry in X3D-Edit:

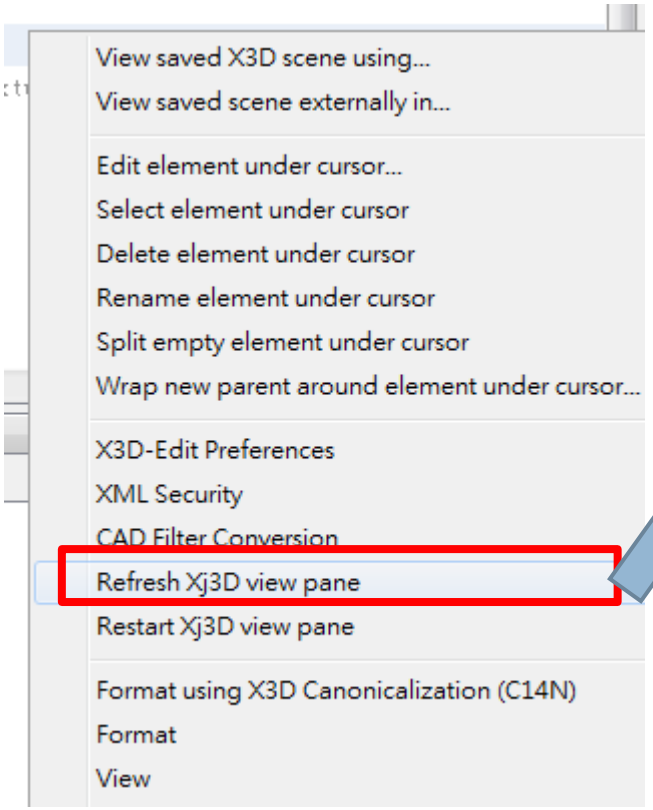
Right click on the box node…

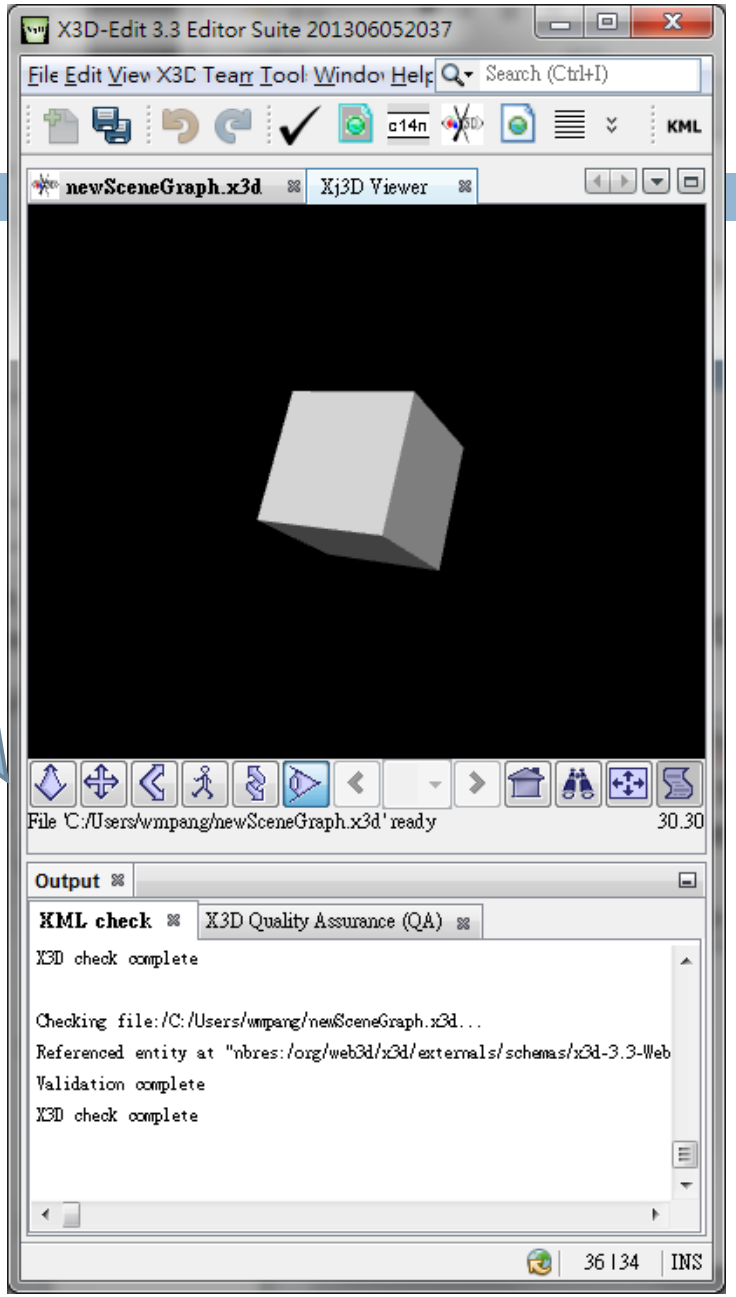




X3D Viewer

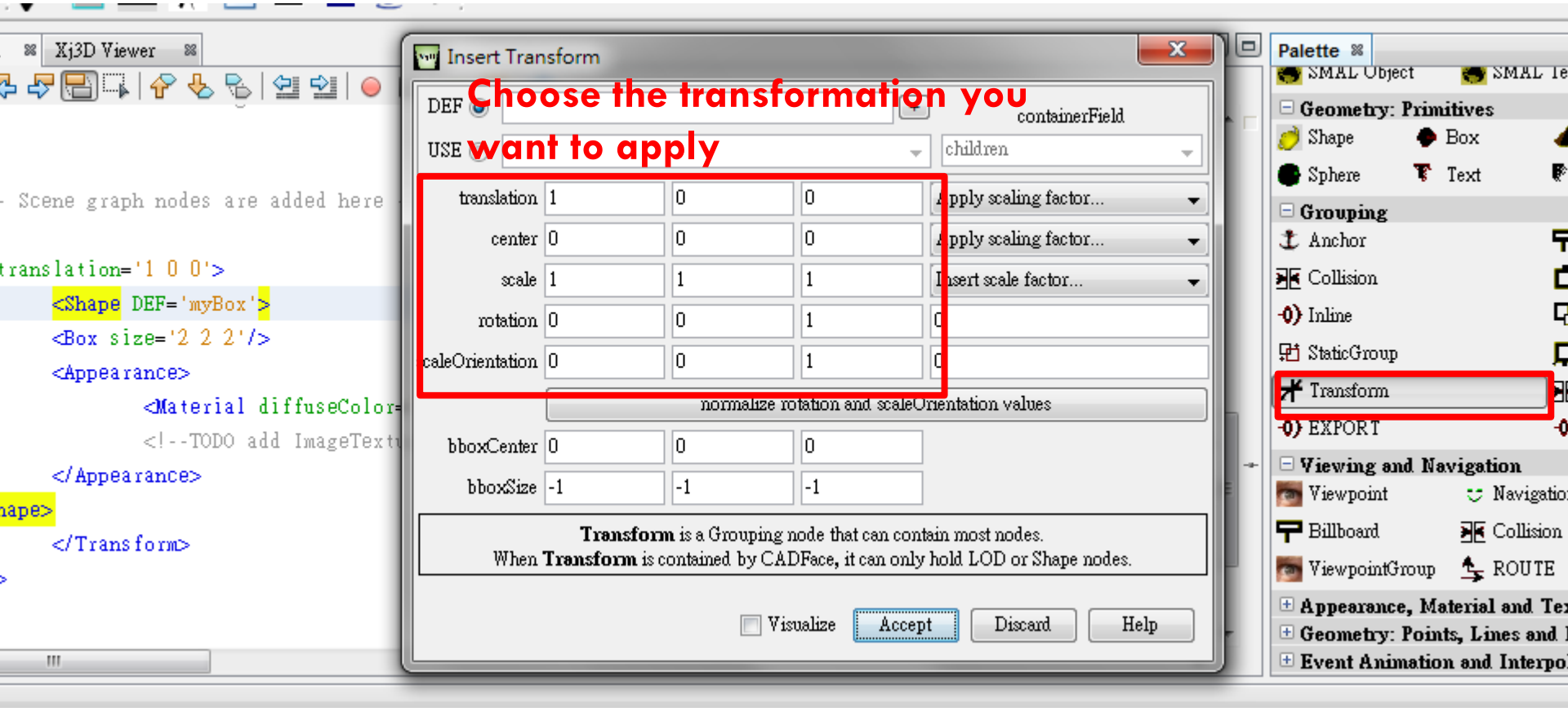
- Update the build-in X3D Viewer





Transform Node

- We can transform Shapes by the <Transform> node



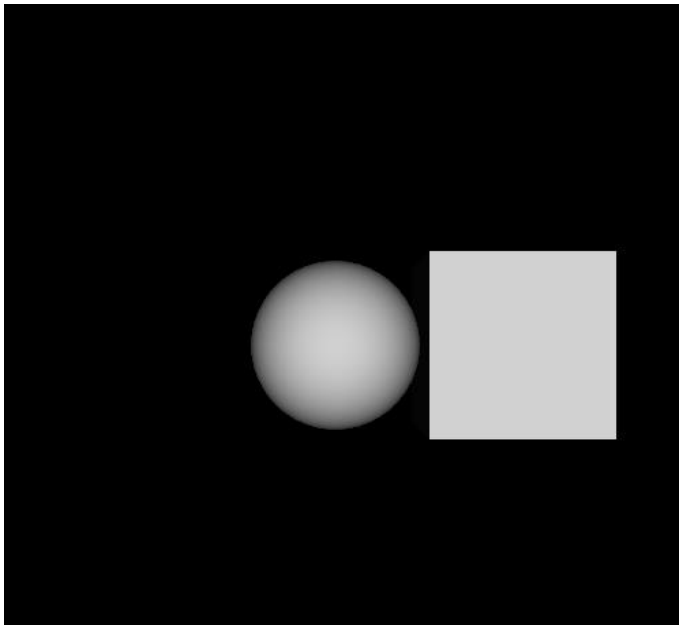
Transform Node

- Move the box in positive x direction for 2 meter

```
<Transform translation='2 0 0'>
        <Shape DEF='myBox'>
                <Box size='2 2 2'/>
                <Appearance>
                        <Material diffuseColor='1 1 1'/>
                </Appearance>
        </Shape>
</Transform>
```

Sphere Node

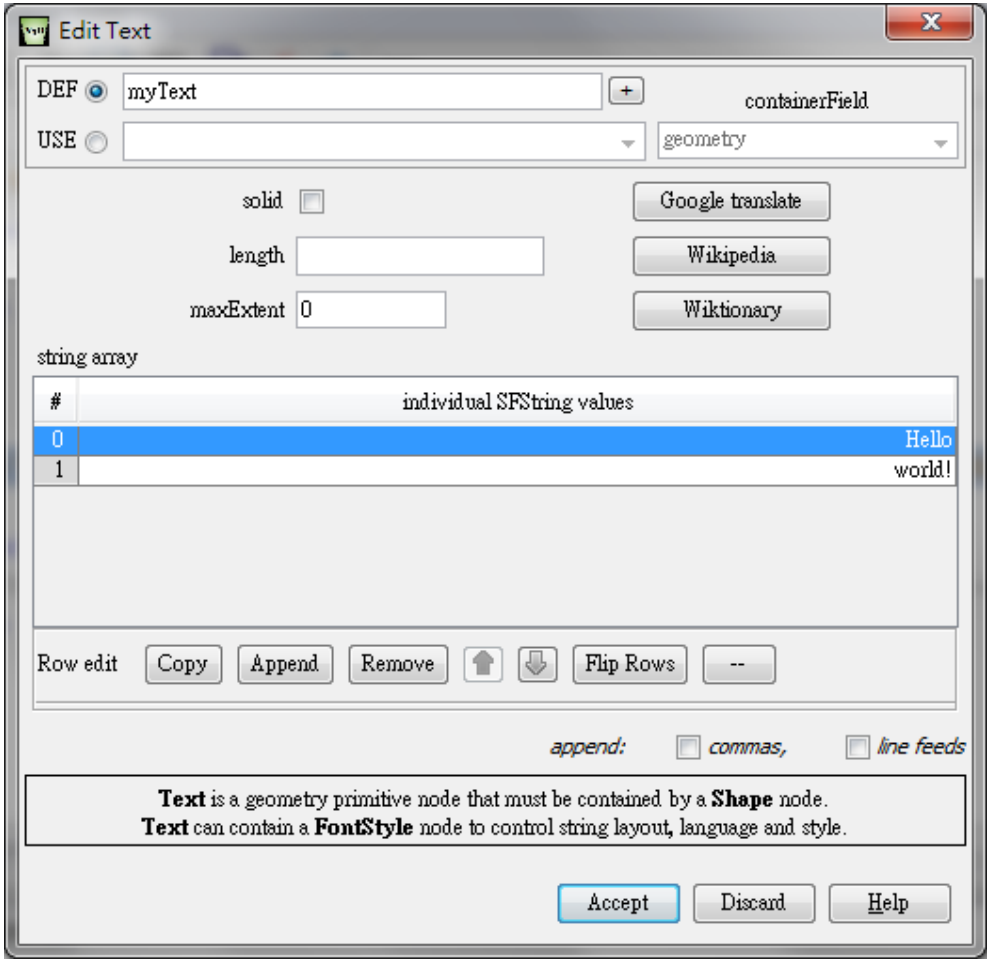
- Create a sphere is similar to what we did for the box
  - Default has radius = 1
- XML generated :



```
…
 <Shape DEF='mySphere'>
            <Sphere radius='1'/>
            <Appearance>
            <Material diffuseColor='1 1 1'/>
                        </Appearance>
</Shape>
….
```

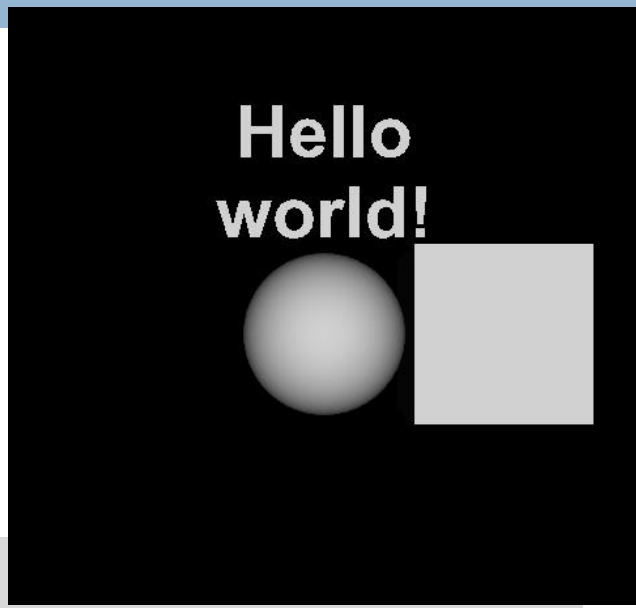
Text Node

- Produce readable flat, 2D text strings in X3D world
- By default, "Hello World!" Is displayed



Text Node

- FontStyle tag is also generated to define font used in the text tag
- We move the text to top of the scene here




```
<Transform translation='0 3 0'>
      <Shape DEF='myText'>
         <Text string='"Hello" "world!"' solid='false'>
         <FontStyle family='"SANS"' justify='"MIDDLE" "MIDDLE"'
style='BOLD'/></Text>
          <Appearance><Material diffuseColor='1 1 1'/></Appearance>
       </Shape>
 </Transform>
```

Appearance Node

- Each Shape contains a single geometry node along with a corresponding Appearance node
- Appearance is a container which may include
  - A single Material (or TwoSidedMaterial) node
  - Fill/Line/Texture Properties, single Texture node
- In our previous examples, Appearance node is generated like:

```
<Appearance>
  <Material diffuseColor='1 1 1'/>
</Appearance>
```

Material Node

- Material controls
  - Color
  - Transparency or glowing, etc.
- Surface visual properties are applied equally across all polygons making up a shape
- Material properties define how geometry visually interacts with light sources in the scene
  - Lighting and Environment will be covered in next Tutorial

Material Node

- Here we define material's diffuse color with RGB = 1,1,1

```
<Appearance>
  <Material diffuseColor='1 1 1'/>
</Appearance>
```

- All possible parameters :

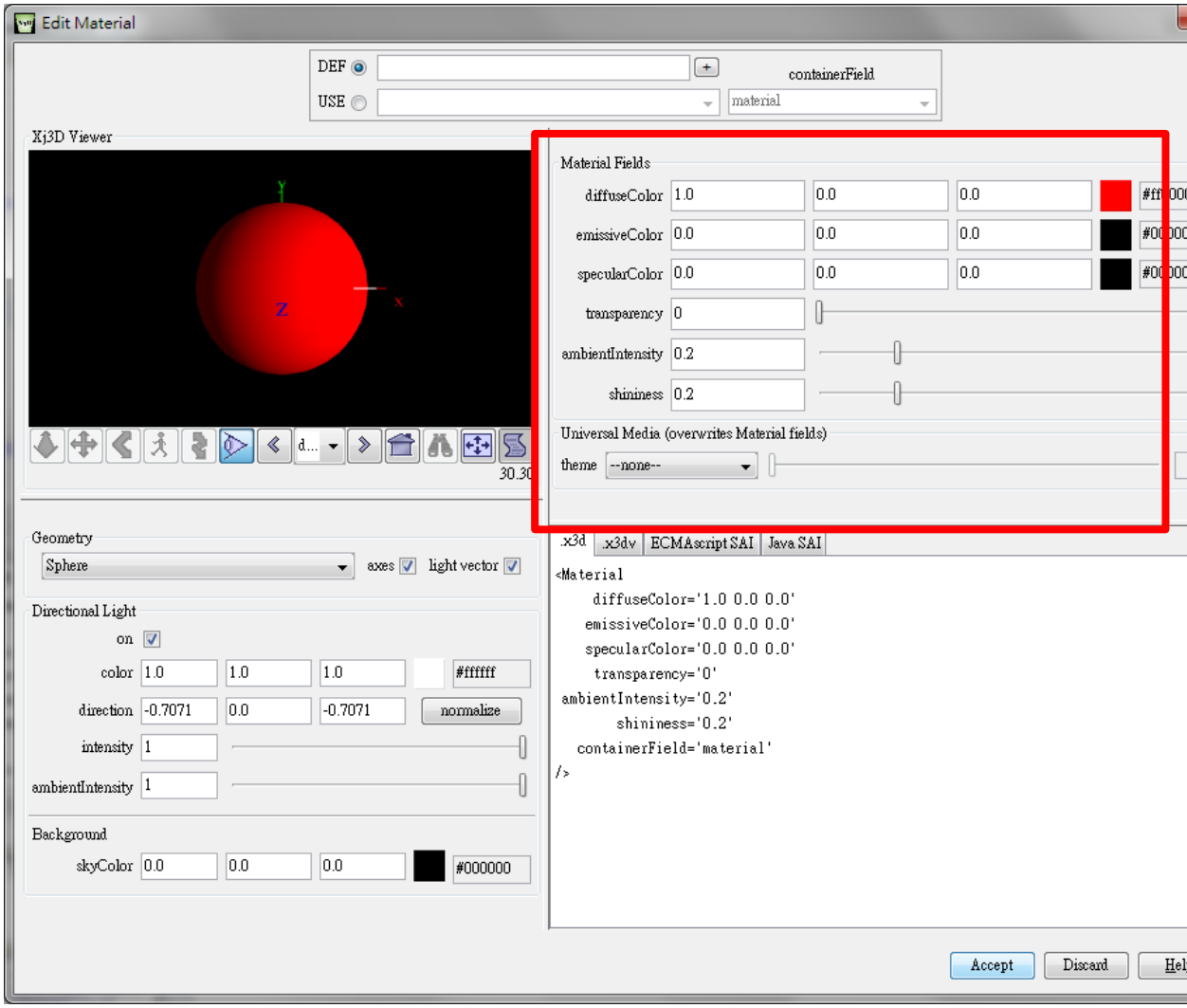
SFFloat *ambientIntensity*	0.2	[0,1]
SFColor *diffuseColor*	0.8 0.8 0.8	[0,1]
SFColor *emissiveColor*	0 0 0	[0,1]
SFFloat *shininess*	0.2	[0,1]
SFColor *specularColor*	0 0 0	[0,1]
SFFloat *transparency*	0	[0,1]

Fields in Material Node

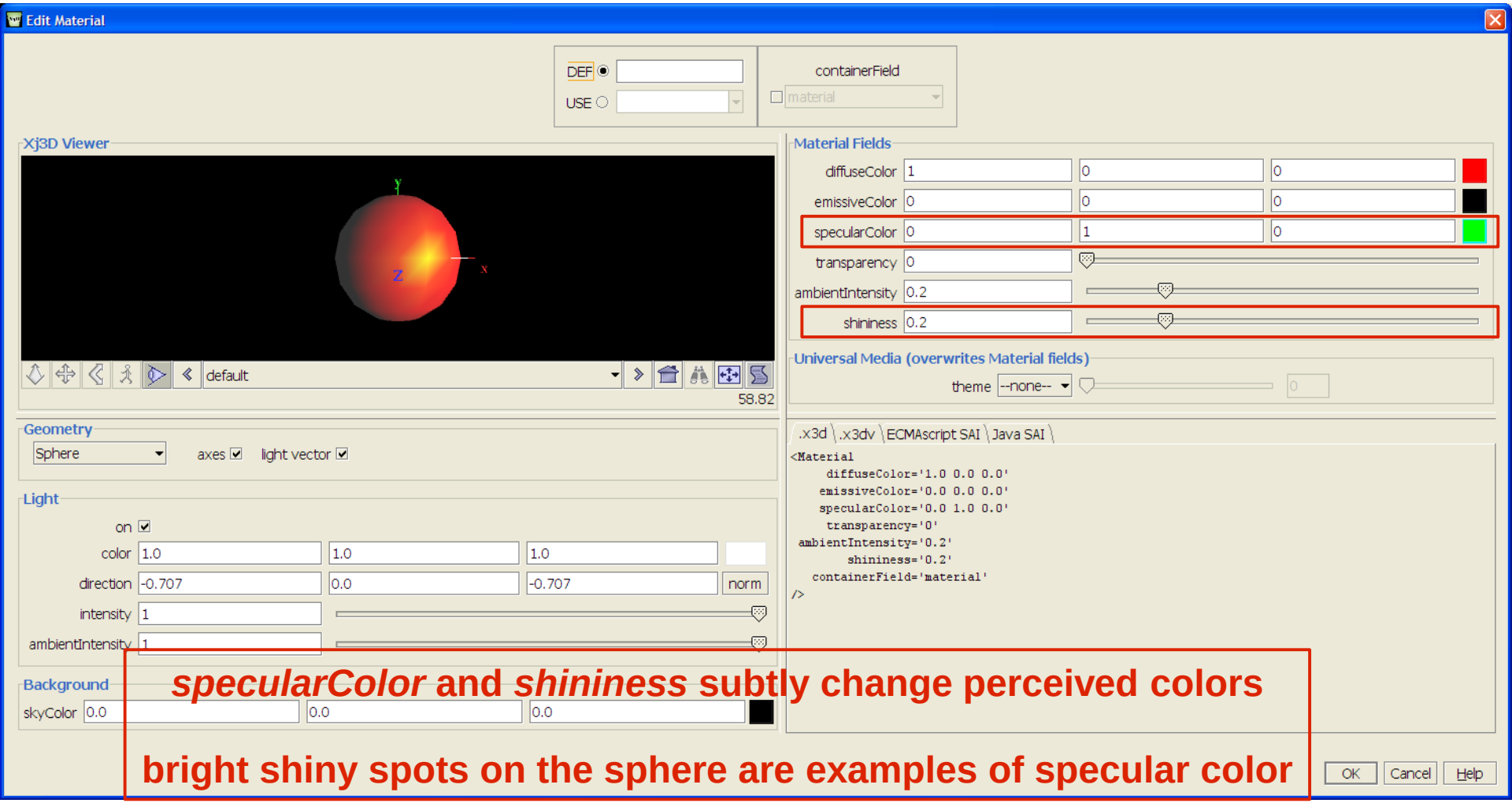
- diffuseColor
  - reflects all X3D light sources, depending on viewing angles towards each light
- ambientIntensity
  - ambient component
- emissiveColor
  - glowing component, normally off, independent of reflected light
- specularColor
  - governs reflection highlights
- shininess
  - controls specular intensity
- transparency
  - ability to see through an object: 1 is completely transparent, 0 is opaque

Edit Material in X3D-Edit

- See the effect of material instantly
- E.g. we can change material to red color
  - By setting RGB = 1,0,0

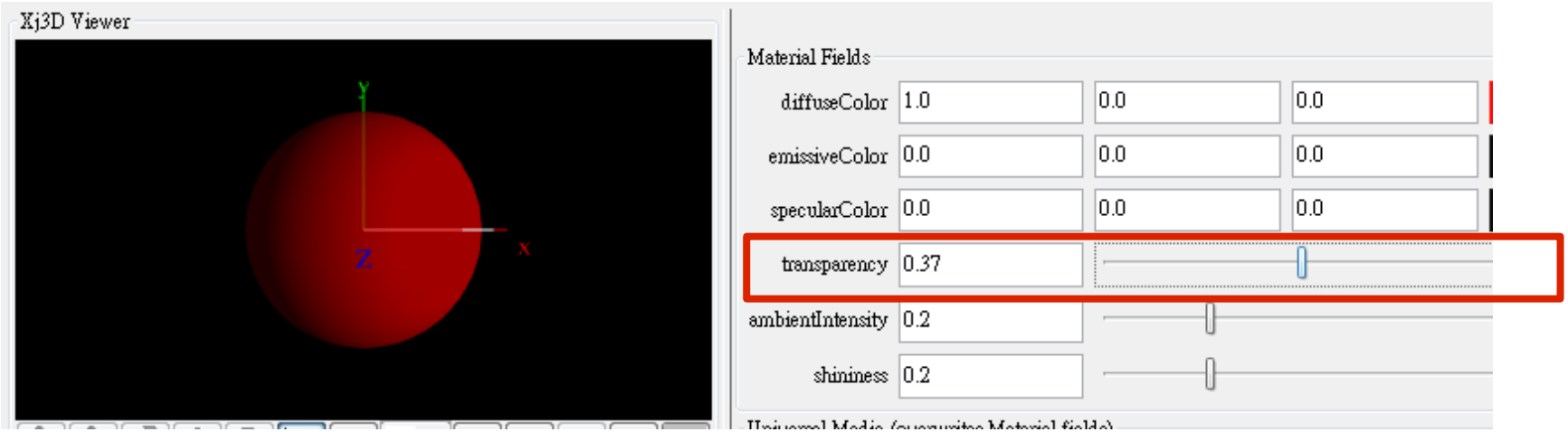


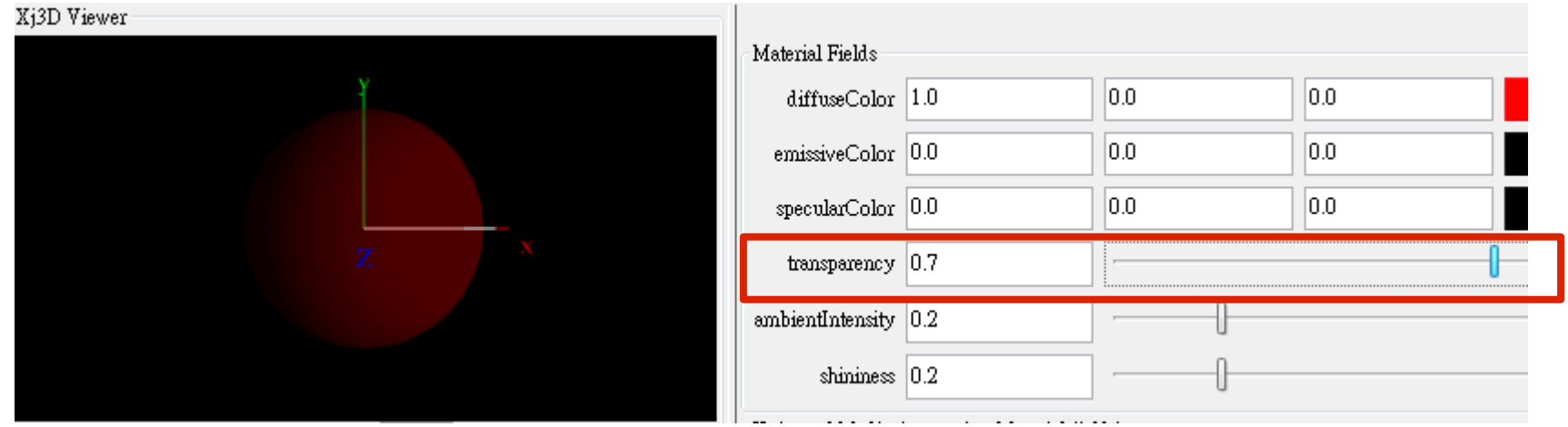
Material editor for specularColor, shininess



Transparency

- The higher the value, the more transparent it is





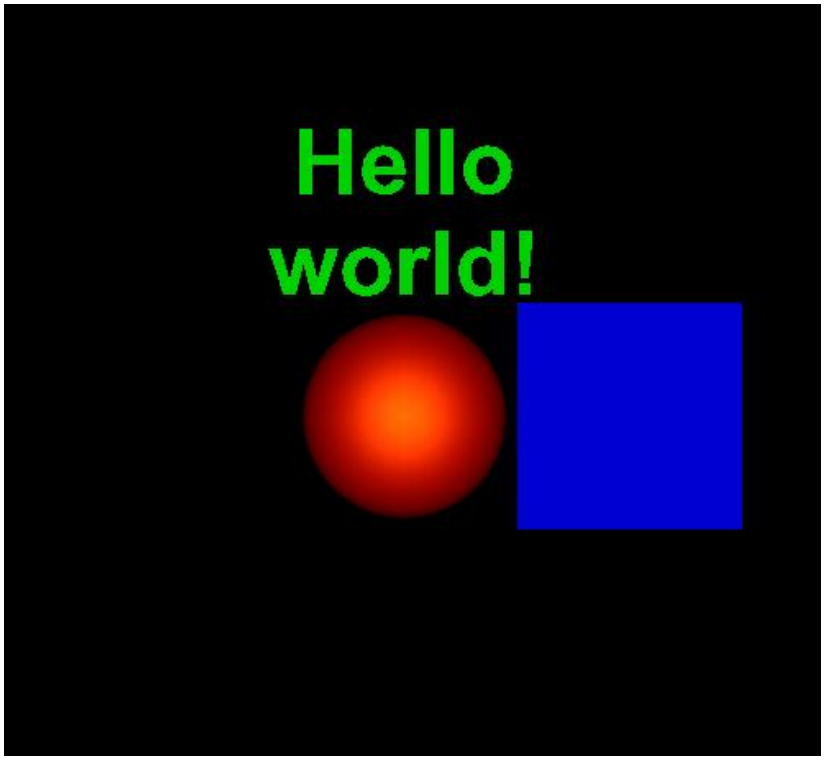
Our Example

- We modify different materials for the shapes

```
<Material diffuseColor='0 1 0'/>
```

```
<Material diffuseColor='0 0 1'/>
```

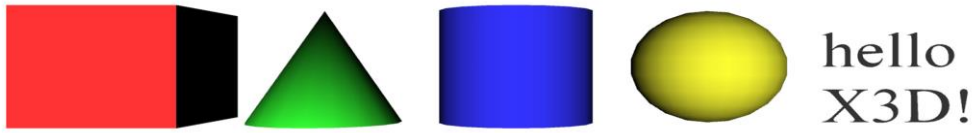
```
<Material diffuseColor='1 0 0'
shininess='0.08' specularColor='1
0.87451 0.039216'/>
```



HelloSceneGraph.x3d

C:/My Documents/X3D/X3dBook/chapters/Chapter02-GeometryPrimitives/GeometryPrimitiveNodes.x3d

<?xml version="1.0" encoding="UTF-8"?>
<! DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d-3.0.dtd">
X3D: version: 3.0, profile: Immersive, xmlns:xsd: http://www.w3.org/2001/XMLSchema-instance, xsd:noNamespaceSchemaLocation: http://www.web3d.org/specifications/x3d-3.0.xsd
head
meta: name: filename, content: GeometryPrimitiveNodes.x3d
meta: name: description, content: Geometry Primitive Nodes: Shape, Box, Cone, Cylinder, Sphere, Text, FontStyle
meta: name: creator, content: Don Brutzman
meta: name: created, content: 25 March 2005
meta: name: modified, content: 25 March 2005
meta: name: rights, content: Copyright (c) Don Brutzman and Len Daly, 2005
meta: name: identifier, content: GeometryPrimitiveNodes.x3d
meta: name: generator, content: X3D-Edit, http://www.web3d.org/x3d/conte
meta: name: license, content: ../../license.html



Scene
Transform: translation: -5 0 0
Shape: DEF: DefaultShape, bboxCenter: 0 0 0, bboxSize: -1 -1 -1, containerField: children
Box: DEF: DefaultBox, size: 2 2 2, containerField: geometry
Appearance: DEF: DefaultAppearance, containerField: appearance
Material: diffuseColor: 1 0.2 0.2
Transform: translation: -2.5 0 0
Shape
Cone: DEF: DefaultCone, height: 2, bottomRadius: 1, side: true, bottom: true, containerField: geometry
Appearance
Material: diffuseColor: 0.2 1 0.2
Transform: translation: 0 0 0
Shape
Cylinder: DEF: DefaultCylinder, height: 2, radius: 1, top: true, side: true, bottom: true, containerField: geometry
Appearance
Material: diffuseColor: 0.2 0.2 1
Transform: translation: 2.5 0 0
Shape
Sphere: DEF: DefaultSphere, radius: 1, containerField: geometry
Appearance
Material: diffuseColor: 1 1 0.2
Transform: translation: 4 0 0
Shape
Text: DEF: DefaultText, string: "hello" "X3D!", maxExtent: 0.0, containerField: geometry
FontStyle: DEF: DefaultFontStyle, family: "SERIF", style: PLAIN, justify: "BEGIN", size: 1.0, spacing: 1.0, horizontal: true, leftToRight: true, topToBottom: true, containerField: fontStyle
Appearance
Material: DEF: DefaultMaterial, diffuseColor: 0.8 0.8 0.8, emissiveColor: 0 0 0, specularColor: 0 0 0, shininess: 0.2, ambientIntensity: 0.2, transparency: 0, containerField: material

GeometryPrimitiveNodes.x3d

Texture Node

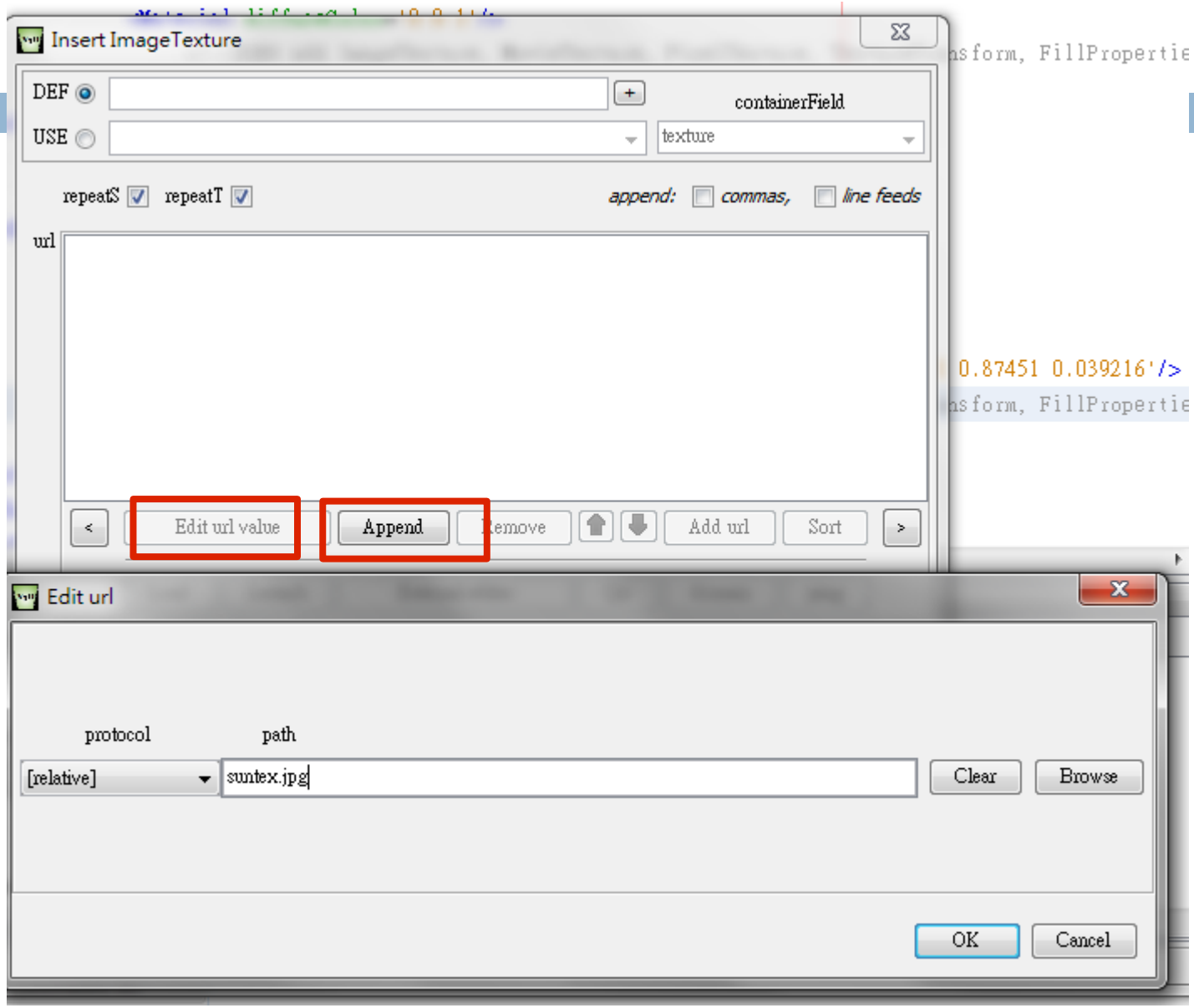
- Texture nodes read 2D image (or movie) files and apply them pixel-by-pixel to the associated geometry sharing the same Shape node
- Thus wrapping picture images around an object
- ImageTexture, PixelTexture, MovieTexture
- Can be inexpensive way to achieve high fidelity
- Texture images can be shifted, rotated, scaled
- TextureTransform, TextureCoordinate
- Thus modifying image application to geometry

ImageTexture Node

- ImageTexture retrieves a 2D image file and applies it as a texture to geometry
  - jpg and png are commonly supported

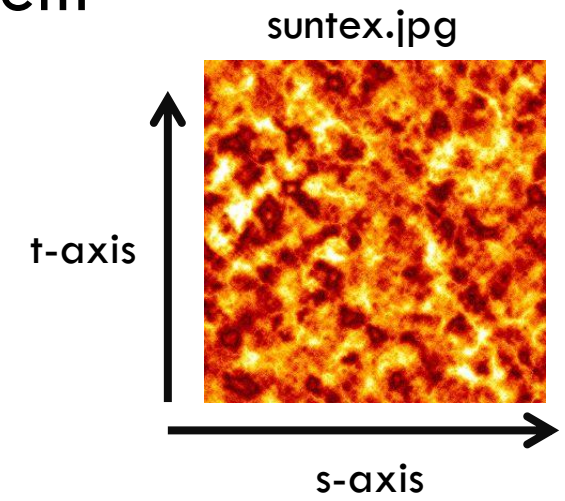
- An example node of ImageTexture

```
<ImageTexture DEF='mytex'
url='"“File name.jpg"'/>
```


Insert ImageTexture
DEF
USE
containerField
texture
repeatS
repeatT
append:
commas,
line feeds
url
Edit url value
Append
Remove
Add url
Sort
Edit url
protocol
path
[relative]
suntex.jpg
Clear
Browse
OK
Cancel

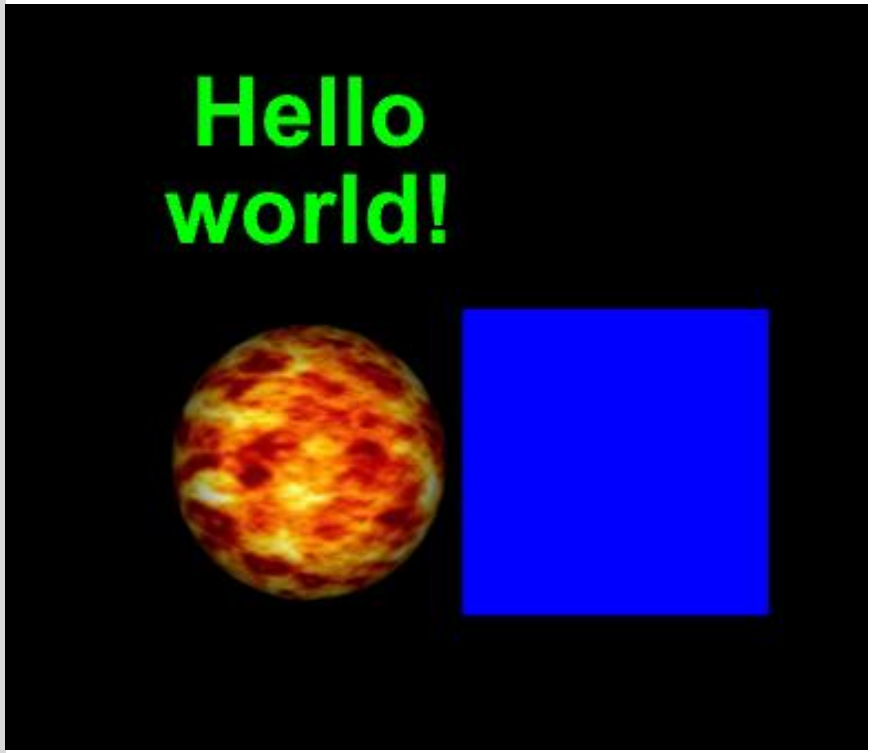
Texture Coordinate

- Defined by a 2D (s, t) coordinate system
  - Ranges from [0,1] along lateral s and vertical t axes
  - Bottom edge of image is s-axis (t=0)
  - Left edge of image is t-axis (s=0)
  - Top-right corner is (s, t) = (1, 1)
- repeatS and repeatT
  - These boolean fields indicate whether the texture image is repeated along a given axis once used
  - Default is to use once along each axis, mapping the texture image once from coordinates (0,0) to (1,1)



Texture Mapping

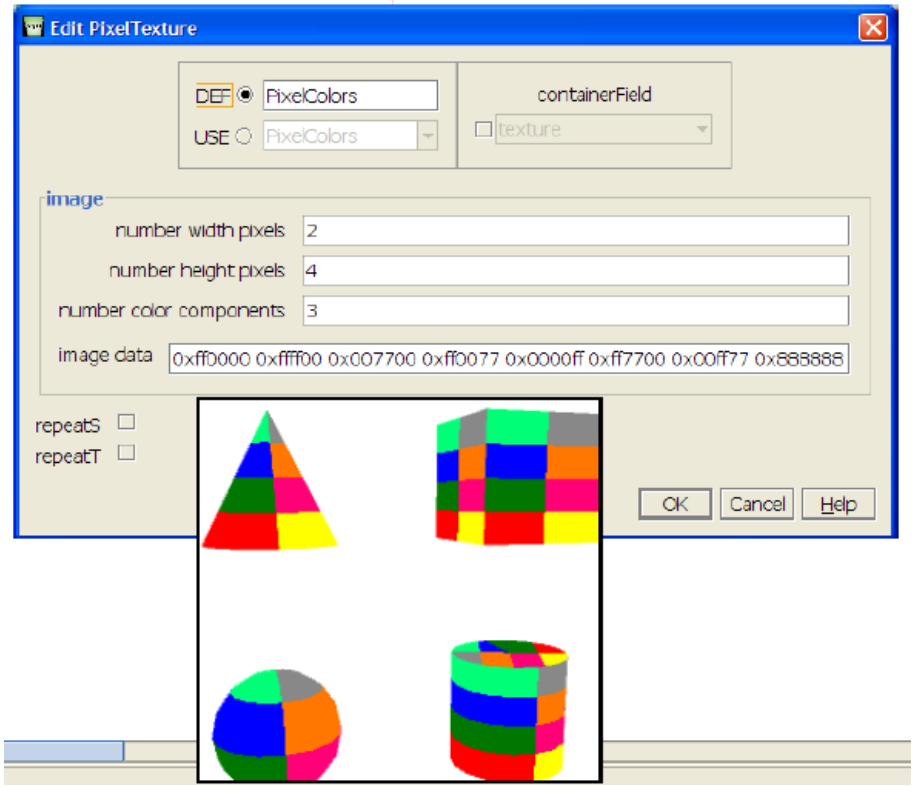
```
<Shape DEF='mySphere'>
  <Sphere radius='1'/>
  <Appearance>
   <Material diffuseColor='1 0 0'
shininess='0.08' specularColor='1
0.87451 0.039216'/>
    <ImageTexture DEF='mytex'
url='"suntex.jpg"'/>
   </Appearance>
</Shape>
```



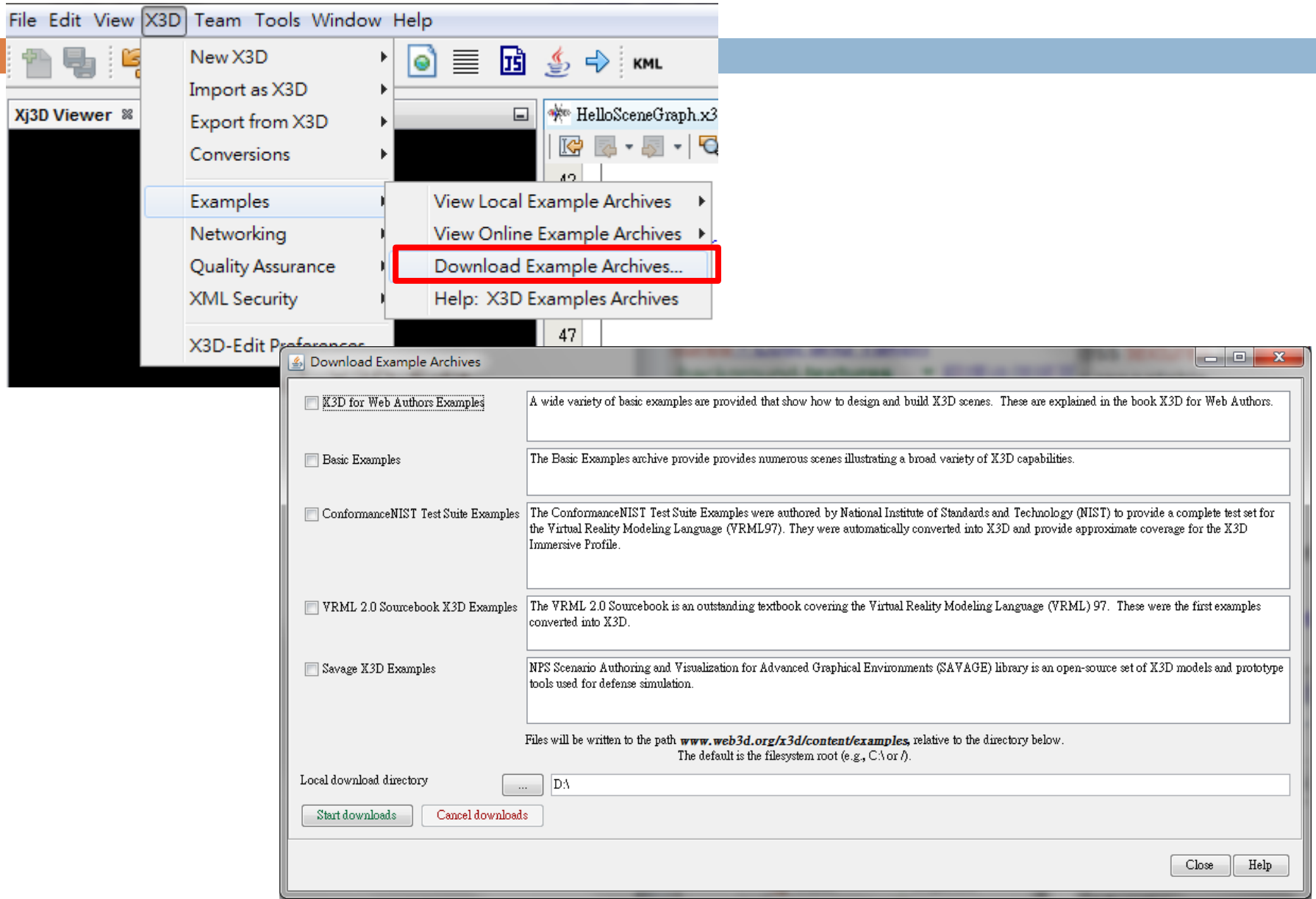
HelloSceneGraph_withTex.x3d

Other Texture Mapping Methods

- Other kinds of texture mapping are supported, E.g.
- Movie Texture Mapping
  - Use MovieTexture Node
- Pixel Texture Mapping
  - Use Pixel Texture Node



X3D Examples download panel, X3D-Edit



X3D Examples Archives

X3D for Web Authors 244 models

- Textbook on how to design and build X3D scenes

Basic 653 models

- Diverse scenes illustrating various X3D capabilities

Conformance NIST 732 models

- Strictly defined test examples for correct operation

VRML 2.0 Sourcebook 269 models

- Textbook on VRML97, examples converted to X3D

Savage 1181 models

- Open-source military models and tools

3000+ models available

Summary

- Introduction of X3D
- Use of X3D-Edit to create X3D file
- Create simple geometry
- Setup of simple materials
- Simple transformation
- Apply of texture to geometry
- More Information and Resources: http://www.web3d.org/x3d/content/examples/X3dResources.html#Applications