X3D Graphics for Web Authors

Getting Started with X3D

A journey of a thousand miles begins with a single step.

Chinese proverb
Contents

Goals, motivation and student background

Software support

• X3D Examples
• X3D-Edit authoring tool and Hello World example

X3D for Web Authors

• book organization and use

Summary and References
Goals

This work presents Extensible 3D (X3D) Graphics, the open, royalty-free, international standard for 3D graphics on the Web.

Book and slideset goals include

- Show Web authors experienced with HTML and XML how to build and connect X3D models
- Teach students principles of Web-capable 3D graphics
- Serve as a ready-reference book for X3D experts

Explain broad principles and specific details of X3D for anyone learning how to build 3D models.
Motivation

Over 30 years of steady growth and innovation have made 3D graphics an exciting field.

Key professional organization is SIGGRAPH for computer graphics and interactive techniques:

- Includes technical experts and artists alike
- [http://www.siggraph.org](http://www.siggraph.org)

Nevertheless, few people actually build 3D models themselves:

- Usually requires advanced programming skills
- Costly proprietary tools and approaches compete
Motivation

Rather than creating another expensive technical niche, X3D is designed for Web interoperability

• Support capabilities common to most (or all) tools
• Provide import/export publishing compatibility for many other formats
• Align 3D with Architecture of the World Wide Web

This approach works well for simple 3D models, scaling up to large-scale virtual environments

• Ultimate X3D success means that 3D graphics becomes a “first-class citizen” for Web multimedia
Student background

Provide introductory course in to 3D graphics achievable at undergraduate level

• Course successfully taught first as VRML, then X3D

The following are all helpful but not required

• XML authoring background
• Programming skills
• Modeling-tool experience

Lots of free resources are available

• Can be self-taught with dedicated effort
• Support and feedback from online community
X3D Examples

Software support
Software support for X3D authoring

Lots of free plugins, tools and resources provided
  • X3D Resources at
    http://www.web3d.org/x3d/content/examples/X3dResources.html

Best first step is to install an X3D plugin into your default Web browser
  • Letting you easily view any X3D scene

Set up to author X3D scenes using plain-text editor, or else by using an X3D-aware authoring tool
  • X3D-Edit provided free for any use
  • Other tools listed on X3D Resources page above
X3D Examples

Numerous (thousands) of X3D examples are available online

- http://x3dgraphics.com/examples/X3dResources.html#Examples

Can browse all examples in *X3D for Web Authors*

- http://x3dgraphics.com/examples summary
- http://x3dgraphics.com/examples/X3dForWebAuthors archive
- http://x3dgraphics.com/X3dExamplesX3dForWebAuthors.zip

Recommended approach:

- Browse examples online
- Download and edit on local system
X3D Examples Archives

X3D for Web Authors 242 models
  • Textbook on how to design and build X3D scenes

Basic 637 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 1134 models
  • Open-source military models and tools

3000+ models available
### X3D Examples download panel, X3D-Edit

**Download Example Archives**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X3D for Web Authors Examples</td>
<td>A wide variety of basic examples are provided that show how to design and build X3D scenes. These are explained in the book X3D for Web Authors.</td>
</tr>
<tr>
<td>Basic Examples</td>
<td>The Basic Examples archive provides numerous scenes illustrating a broad variety of X3D capabilities.</td>
</tr>
<tr>
<td>ConformanceNIST Test Suite Examples</td>
<td>The ConformanceNIST Test Suite Examples were authored by the National Institute of Standards and Technology (NIST) to provide a complete test set for the Virtual Reality Modeling Language (VRML97). They were automatically converted into X3D and provide approximate coverage for the X3D Immersive Profile.</td>
</tr>
<tr>
<td>VRML 2.0 Sourcebook X3D Examples</td>
<td>The VRML 2.0 Sourcebook is an outstanding textbook covering the Virtual Reality Modeling Language (VRML) 97. These were the first examples converted into X3D.</td>
</tr>
<tr>
<td>Savage X3D Examples</td>
<td>NPS Scenario Authoring and Visualization for Advanced Graphical Environments (SAVAGE) library is an open-source set of X3D models and prototype tools used for defense simulation.</td>
</tr>
</tbody>
</table>

**Local download directory**: C:\

**Buttons**: Start downloads, Cancel downloads, Close, Help
X3D-Edit authoring tool

Software support
X3D-Edit

Available free for any use
- https://savage.nps.edu/X3D-Edit
- Written using Java, XML and X3D
- Windows, MacOSX, Linux, Solaris operating systems

Standalone application with automatic updates available once installed

Also available for Netbeans as plugin module
- Open integrated development environment (IDE), primarily (but not exclusively) for Java
- http://www.netbeans.org
X3D-Edit features

X3D-Edit features include direct editing of X3D scenes using the XML (.x3d) encoding, embedded visualization of scenes using the Xj3D viewer, XML validation against X3D DTDs and Schemas, drag-and-drop palette for X3D nodes, popup panels for node editing, and extensive help resources.

New features include ClassicVRML and X3D compressed binary encoding support, plus encryption and digital-signature authentication using XML Security standards.
X3D-Edit Authoring Tool for Extensible 3D (X3D) Graphics

X3D-Edit is an Extensible 3D (X3D) Graphics authoring tool for simple error-free editing, authoring and validation of X3D scenes.

Overview

The X3D-Edit 3.2 Authoring Tool for Extensible 3D (X3D) Graphics supports the creation, checking, display and publication of X3D scenes. It is written in open-source Java and XML using the Netbeans platform, making it suitable both as a standalone application and as a plugin module for the Netbeans integrated development environment (IDE).

X3D-Edit features include direct editing of X3D scenes using the XML (.x3d) encoding, embedded visualization of scenes using the Xj3D viewer, XML validation against X3D DTDs and Schemas, drag-and-drop palette for X3D nodes, popup panels for node editing, and extensive help resources. Planned features include ClassicVRML and X3D compressed binary encoding support, encryption and digital-signature authentication using XML Security standards, and additional X3D scene authoring support.
X3D-Edit download and installation

Options on X3D-Edit home page
• https://savage.nps.edu/X3D-Edit/#Downloads

Standalone executable application:
• Download and extract X3D-Edit3.2.zip
• https://savage.nps.edu/X3D-Edit/X3D-Edit3.2.zip
• Launch runX3dEditWin.bat on a Windows machine
• Launch runX3dEditMac.sh.command on a Mac
• Successful test reports received for Linux...
• That's all there is to it!
X3D-Edit built using Netbeans

X3D-Edit 3.2 is written in Java using the Netbeans platform, and so is portable across major desktop and laptop operating systems (Windows MacOSX Linux Solaris)

• http://www.netbeans.org

Lots of help and documentation are provided, both online and within X3D-Edit help system
X3D-Edit updates

Icon in lower-left corner of screen indicates when updates are available for automatic installation.
Using the IDE Help System

See Also
Click any entry in the Contents tab to view the topic in the right pane of the Help viewer.

Searching the Online Help
To perform a full-text search of all IDE help topics, click the Search tab and type a keyword in the Find text box.

Using the Index
Click any entry in the Index tab to view the topic. To search the index, enter a term in the search field and press Enter. Press Enter multiple times to cycle through all occurrences of the term in the index.

Getting Help for IDE Dialogs and Windows
Press F1 in any part of the IDE to open a help topic that is specific to the task you are doing or where you are in the IDE.

Tutorials and Additional Documentation
For general information about the IDE, see the Getting Started section of the online help. Tutorials and other documentation can be found in the Help menu.

See Also
Help Viewer Shortcuts
Displaying Help in a Web Browser

Legal Notices
## Finding, Searching, and Replacing

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl-F3</td>
<td>Search word at insert point</td>
</tr>
<tr>
<td>F3/Shift-F3</td>
<td>Find next/previous in file</td>
</tr>
<tr>
<td>Ctrl-F/H</td>
<td>Find/Replace in file</td>
</tr>
<tr>
<td>Alt-F7</td>
<td>Find usages</td>
</tr>
<tr>
<td>Ctrl-Shift-P</td>
<td>Find/replace in projects</td>
</tr>
<tr>
<td>Alt-Shift-U</td>
<td>Find usages results</td>
</tr>
<tr>
<td>Alt-Shift-H</td>
<td>Turn off search result highlights</td>
</tr>
<tr>
<td>Ctrl-R</td>
<td>Rename</td>
</tr>
<tr>
<td>Ctrl-U, then U</td>
<td>Convert selection to uppercase</td>
</tr>
<tr>
<td>Ctrl-U, then L</td>
<td>Convert selection to lowercase</td>
</tr>
<tr>
<td>Ctrl-U, then S</td>
<td>Toggle case of selection</td>
</tr>
<tr>
<td>Alt-Shift-V</td>
<td>Paste formatted</td>
</tr>
</tbody>
</table>

## Navigating through Source Code

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl-O/Alt-Shift-O</td>
<td>Go to type/file</td>
</tr>
<tr>
<td>Ctrl-Shift-T</td>
<td>Go to JUnit test</td>
</tr>
<tr>
<td>Alt-O</td>
<td>Go to source</td>
</tr>
<tr>
<td>Ctrl-B</td>
<td>Go to declaration</td>
</tr>
<tr>
<td>Ctrl-G</td>
<td>Go to line</td>
</tr>
<tr>
<td>Ctrl-Shift-M</td>
<td>Toggle add/remove bookmark</td>
</tr>
<tr>
<td>Ctrl-Shift- Period/Comma</td>
<td>Next/previous bookmark</td>
</tr>
<tr>
<td>Ctrl-</td>
<td>Next/previous usage/compile error</td>
</tr>
<tr>
<td>Ctrl-Shift-1/2/3</td>
<td>Select in</td>
</tr>
<tr>
<td>Ctrl-[]</td>
<td>Projects/Files/Favorites</td>
</tr>
<tr>
<td>Ctrl-K/Ctrl-Shift-K</td>
<td>Move caret to matching bracket</td>
</tr>
<tr>
<td>Alt-Left/Alt-Right/Ctrl-Q</td>
<td>Go backward/forward/to last edit</td>
</tr>
</tbody>
</table>

## Coding in Java

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt-Insert</td>
<td>Generate code</td>
</tr>
<tr>
<td>Ctrl-Shift-I</td>
<td>Fix all class imports</td>
</tr>
<tr>
<td>Alt-Shift-I</td>
<td>Fix selected class's import</td>
</tr>
<tr>
<td>Alt-Shift-F</td>
<td>Format selection</td>
</tr>
<tr>
<td>Alt-Shift-Left/Right/Up/Down</td>
<td>Shift lines left/right/up/down</td>
</tr>
<tr>
<td>Ctrl-Shift-Up/Down</td>
<td>Copy lines up/down</td>
</tr>
<tr>
<td>Ctrl/AI/F12</td>
<td>Inspect members/hierarchy</td>
</tr>
<tr>
<td>Ctrl-/</td>
<td>Add/remove comment lines</td>
</tr>
<tr>
<td>Ctrl-E</td>
<td>Delete current line</td>
</tr>
</tbody>
</table>

## Coding in C/C++

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt-Shift-C</td>
<td>Go to declaration</td>
</tr>
<tr>
<td>Ctrl-F9</td>
<td>Evaluate expression</td>
</tr>
</tbody>
</table>

## Coding in Ruby

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl-Shift-A</td>
<td>Jump Rails action &gt; view</td>
</tr>
<tr>
<td>Alt-Shift-Period/Comma</td>
<td>Select Next/Previous element</td>
</tr>
<tr>
<td>Ctrl-Shift-Space</td>
<td>Show documentation</td>
</tr>
<tr>
<td>Ctrl-Shift-T</td>
<td>Jump from test file to file</td>
</tr>
</tbody>
</table>

## SOA

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tab-Shift-Arrows</td>
<td>Move through elements</td>
</tr>
<tr>
<td>Alt-Shift-F</td>
<td>Advanced search</td>
</tr>
<tr>
<td>Alt/Shift-Enter</td>
<td>Expand/collapse elements</td>
</tr>
<tr>
<td>Ctrl-Shift-9</td>
<td>Show BPEL Mapper</td>
</tr>
</tbody>
</table>

## UML

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt-Shift-A/O</td>
<td>Insert attribute/operation into selected element</td>
</tr>
<tr>
<td>Ctrl-Shift-F</td>
<td>Fit diagram into window</td>
</tr>
<tr>
<td>F8</td>
<td>Toggle Overview window</td>
</tr>
<tr>
<td>Ctrl-Shift-5</td>
<td>Select active UML diagram</td>
</tr>
</tbody>
</table>

## Compiling, Testing, and Running

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F9</td>
<td>Compile package/file</td>
</tr>
<tr>
<td>F11</td>
<td>Build main project</td>
</tr>
<tr>
<td>Shift-F11</td>
<td>Clean &amp; build main project</td>
</tr>
<tr>
<td>Ctrl-Q</td>
<td>Set request parameters</td>
</tr>
<tr>
<td>Ctrl-Shift-U</td>
<td>Create JUnit test</td>
</tr>
<tr>
<td>Ctrl-F6/Alt-F6</td>
<td>Run JUnit test on file/project</td>
</tr>
<tr>
<td>F6/Shift-F6</td>
<td>Run main project/file</td>
</tr>
</tbody>
</table>

## Opening and Toggling between Views

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl-Tab (Ctrl-`)</td>
<td>Toggle between open documents</td>
</tr>
<tr>
<td>Shift-Escape</td>
<td>Maximize window (toggle)</td>
</tr>
<tr>
<td>Ctrl-F4/Ctrl-W</td>
<td>Close currently selected window</td>
</tr>
<tr>
<td>Ctrl-Shift-F4</td>
<td>Close all windows</td>
</tr>
<tr>
<td>Shift-F20</td>
<td>Open contextual menu</td>
</tr>
<tr>
<td>Alt-Shift-D</td>
<td>Undock window</td>
</tr>
</tbody>
</table>

## Debugging

<table>
<thead>
<tr>
<th>Key Combination</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl-F5</td>
<td>Start debugging main project</td>
</tr>
<tr>
<td>Ctrl-Shift-F5</td>
<td>Start debugging current file</td>
</tr>
<tr>
<td>Ctrl-Shift-F6</td>
<td>Start debugging test for file (JUnit)</td>
</tr>
<tr>
<td>Shift-F5/F5</td>
<td>Stop/Continue debugging session</td>
</tr>
<tr>
<td>F4</td>
<td>Run to cursor location in file</td>
</tr>
<tr>
<td>F7/F8</td>
<td>Step into/over</td>
</tr>
<tr>
<td>Ctrl-F7</td>
<td>Step out</td>
</tr>
<tr>
<td>Ctrl-Alt-Up</td>
<td>Go to called method</td>
</tr>
<tr>
<td>Ctrl-Alt-Down</td>
<td>Go to calling method</td>
</tr>
<tr>
<td>Ctrl-F9</td>
<td>Evaluate expression</td>
</tr>
<tr>
<td>Ctrl-F8</td>
<td>Toggle breakpoint</td>
</tr>
<tr>
<td>Ctrl-Shift-F8</td>
<td>New breakpoint</td>
</tr>
<tr>
<td>Ctrl-Shift-F7</td>
<td>New watch</td>
</tr>
</tbody>
</table>
Hello World example
Hello World example

Hello World programs are simple examples of a computer language to illustrate their structure

- HelloWorld.x3d actually has a small world in it!
- Found in local-directory archive download at www.web3d.org/x3d/content/examples

X3D-Edit display includes color-coded text, node palette, validation, XML tree, Xj3D rendering

- Pretty-print HTML version is another useful output

Studying and modifying HelloWorld.x3d is an excellent way to learn a lot about X3D graphics
Suggested exercise

Recreate the HelloWorld.x3d scene with X3D-Edit

- Create a new X3D scene, Save As using a new filename of your choosing
- Iconize the <head> element by clicking margin '+'
- Drag and drop nodes to build the scene
- Edit by typing, and by using node editors
- Make sure you maintain valid XML as you go
- Save, view, repeat as necessary

This matches how we build many X3D scenes
Hello World

Simple X3D example

```xml
<Scene>
  <Group description="hello, world" position="0 0 0" />
  <Transform rotation="0 1 0 3">
    <Shape>
      <Appearance>
        <ImageTexture
          url="earth-topo.png"/>
      </Appearance>
      <Sphere>
        <Appearance>
          <Material
diffuseColor="0.1 0.5 1"/>
        </Appearance>
      </Shape>
      <Text string="Hello" world!" scalable="true">
        <FontStyle justify="MIDDLE" MIDDLE”/>
      </Text>
    </Shape>
  </Transform>
</Scene>
```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "-//Web3D//DTD X3D 3.1//EN" "http://www.web3d.org/specifications/x3d-3.1.dtd">
  <head>
    <meta name="title" content="HelloWorld.x3d"/>
    <meta name="description" content="Simple X3D example"/>
    <meta name="created" content="30 October 2000"/>
    <meta name="modified" content="2 December 2007"/>
    <meta name="creator" content="Don Brutzman"/>
    <meta name="identifier" content="http://www.web3d.org/x3d/content/examples/HelloWorld.x3d"/>
    <meta name="generator" content="X3D-Edit 3.2, https://savage.nps.edu/X3D-Edit"/>
    <meta name="license" content="license.html"/>
  </head>

  <Scene>
    <!-- Example scene to illustrate X3D tags and attributes. -->
    <Group>
      <Viewpoint description="Hello world!" position="0 -1 7" centerOfRotation="0 -1 0"/>
      <Transform rotation="0 1 0 3"/>
      <Shape>
        <Appearance>
          <Material diffuseColor="0 0.5 1"/>
          <ImageTexture url="earth-topo.png"" earth-topo-small.gif" http://www.web3d.org/x3d/content/examples/Basic/earth-topo.png"" http://www.web3d.org/x3d/content/examples/Basic/earth-topo-small.png"/>
        </Appearance>
        <Shape>
          <Text string="Hello world!" solid="false">
            <FontStyle justify="MIDDLE" MIDDLE"/>
          <Text>
          </Appearance>
        </Shape>
        <Transform translation="0 -2 0"/>
        <Shape>
          <Material diffuseColor="0.1 0.5 1"/>
          <Appearance>
        </Appearance>
        <Shape>
        </Shape>
        <Transform/>
      </Shape>
    </Group>
  </Scene>
</X3D>
Other features
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
  • “Launch all viewers” simplifies comparison testing

Can also launch into standalone applications
  • Configuration panel simplifies download, install
Right-click to launch external viewer
Download, configure viewers:

Tools, Options, Miscellaneous, X3D, Players

![Options window with X3D players configuration]

- BS Contact
- FreeWrl
- Heilan
- Instant Reality
- Octaga
- SwirlX3D
- Vivaty
- X3D

Other player

Other player name: X3D-2.0-NPS

Player launch interval: 1 seconds

[Options window with X3D players configuration]
Chat-based collaboration for text messaging or simultaneous file sharing is now available as an integrated capability in X3D-Edit.

Currently the installation procedure is performed by end users. Directions and screen snapshots are available at

XMPP JID for the chat channel is xmpp://x3d@muc.share.java.net
Subscription directions are provided on the installation page
Version control support included
X3D for Web Authors

http://x3dGraphics.com
Book organization
Book organization

Chapter 1 provides a thorough technical background study of how X3D works.

Subsequent chapters covers specific X3D nodes, grouped by similar functionality

• Chapters 2-6 for scene-graph fundamentals
• Chapters 7-9 for event animation and scripting
• Chapters 10-14 can be read in any order

Example scenes are provided in every chapter to enable direct learning, by changing examples and creating new scenes.
Chapter descriptions

1. **Technical Overview.** General introduction of the fundamentals of 3D, including scene graphs, events, node reuse, file structure and encodings, components and profiles, and conformance.

2. **Geometry Nodes, Part 1: Primitives.** The basic primitive shapes.
   - Box, Sphere, Cylinder, Cone, and Text.

3. **Grouping Nodes.** Collecting and positioning objects in the 3D world.
   - Inline, LOD, Group and StaticGroup, Switch, Transform, and Anchor.
4. **Viewing and Navigation.** How to view and navigate in the 3D world
   - Viewpoint and NavigationInfo.

5. **Appearance, Material, and Textures.** Adding colors, shininess, and transparency
   - Material and TwoSidedMaterial,
   or by adding image-file textures
   - PixelTexture, ImageTexture, MovieTexture, TextureTransform, TextureCoordinate, and TextureCoordinateGenerator.
Chapter descriptions

6. **Geometry Nodes, Part 2: Points, Lines, and Polygons.** Geometric creations that are more advanced than the basic shapes.
   - Coordinate, Color, PointSet, LineSet, Extrusion IndexedLineSet, IndexedFaceSet, ElevationGrid.

7. **Event Animation and Interpolation.** Making objects move, twist, wiggle, and shake.
Chapter descriptions

8. **User Interactivity Nodes.** Allowing users to interact with the world by connecting

9. **Event Utilities and Scripting.** Event type conversion and improved animation using the event-utility nodes
   - BooleanFilter, BooleanSequencer, BooleanToggle, BooleanTrigger, IntegerSequencer, IntegerTrigger
   - author-programmable Script node.
10. **Geometry Nodes, Part 3: Geometry2D Nodes.** Flat geometry is helpful for building 2D shapes that face the viewer. Planar nodes include
   - Polypoint2D, Rectangle2D, TriangleSet2D, Polyline2D, Circle2D, Arc2D, ArcClose2D, Disk2D.

11. **Lighting and Environment Nodes.** Achieve lighting and scene background effects using
   - DirectionalLight, PointLight, SpotLight, Background, TextureBackground, Fog, and Sound.
Chapter descriptions

12. **Environment Sensor and Sound Nodes.** User activity in the environment can be detected and processed by using

- LoadSensor, Collision, Billboard, ProximitySensor, and VisibilitySensor

13. **Geometry Nodes, Part 4: Triangles and Quadrilaterals.** Fundamental low-level geometry creation using triangles:

- TriangleSet, TriangleStripSet, TriangleFanSet, IndexedTriangleSet, IndexedTriangleStripSet, and IndexedTriangleFanSet.
14. Creating Prototype Nodes. Probably the most powerful extension feature in X3D is the ability to define new reusable nodes, known as prototypes. Prototype declarations are combinations of already-existing nodes and (optionally) other prototypes. Prototype instances can then be used like any other X3D node. External prototype declarations allow authors to collect reusable prototype definitions together in a single file that can be accessed by other scenes.
How to use the book
How to use the book, 1

Hands-on, eyes-on approach

• Learning is best accomplished by building and modifying scenes, using a text editor or an authoring tool that is X3D capable
• Modify and refresh frequently, you won't break it!
• X3D-Edit is provided free for your use
  https://savage.nps.edu/X3D-Edit

Web authors and X3D students

• Chapter 1 section 1 only, then start with Chapter 2 and proceed in order
• Review chapter 1 periodically later, when you want
How to use the book, 2

Experienced 3D programmers
• Read Chapter 1 first to figure out how X3D is both similar to (and different from) the technologies which you already understand
• Skim chapters 2-6 scene graph fundamentals, then study chapters 2-9 animation, use others as needed

Experienced X3D authors
• Study Chapter 1 descriptions of XML + ClassicVRML encodings, which are functionally equivalent
• Remainder of book in any order, can use it as a ready-reference manual
Summary
Summary

Reading this “Getting Started” slideset prepares you to work examples in *X3D for Web Authors*

Topics include

- Goals, Motivation and Student background
- X3D-Edit Authoring Tool and Hello World example
- *X3D for Web Authors*: book organization and use
- It is important to get your system fully set up to view and edit X3D example scenes
- Can skip Chapter 1, Technical Introduction
  - Start right in working examples in Chapter 2
References

**X3D: Extensible 3D Graphics for Web Authors**
by Don Brutzman and Leonard Daly, Morgan Kaufmann Publishers, April 2007, 468 pages.

- [http://x3dGraphics.com](http://x3dGraphics.com)
- [http://x3dgraphics.com/examples/X3dForWebAuthors](http://x3dgraphics.com/examples/X3dForWebAuthors)

**X3D Resources**

- [http://www.web3d.org/x3d/content/examples/X3dResources.html](http://www.web3d.org/x3d/content/examples/X3dResources.html)

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References

X3D-Edit Authoring Tool
  • https://savage.nps.edu/X3D-Edit

X3D Scene Authoring Hints
  • http://x3dgraphics.com/examples/X3dSceneAuthoringHints.html

X3D Graphics Specification
  • http://www.web3d.org/x3d/specifications
  • Also available as help pages within X3D-Edit
References 3

Netbeans

- http://www.netbeans.org
- http://plugins.netbeans.org/PluginPortal


- http://www.netbeans.org/kb/articles/NBFieldGuide.html
References


- “Your Guide to Finding Your Way Around the NetBeans IDE”
Contact

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The Computer Graphics Educational Materials Source (CGEMS) site is designed for educators
• to provide a source of refereed high-quality content
• as a service to the Computer Graphics community
• freely available, directly prepared for classroom use
• http://cgems.inesc.pt

X3D for Web Authors recognized by CGEMS! 😊
• Book materials: X3D-Edit tool, examples, slidesets
• Received jury award for Best Submission 2008

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X3D Graphics for Web Authors

Getting Started with X3D

A journey of a thousand miles begins with a single step.
Chinese proverb

web 3D CONSORTIUM
Contents

Goals, motivation and student background

Software support
  • X3D Examples
  • X3D-Edit authoring tool and Hello World example

X3D for Web Authors
  • book organization and use

Summary and References
Goals

This work presents Extensible 3D (X3D) Graphics, the open, royalty-free, international standard for 3D graphics on the Web

Book and slideset goals include

• Show Web authors experienced with HTML and XML how to build and connect X3D models
• Teach students principles of Web-capable 3D graphics
• Serve as a ready-reference book for X3D experts

Explain broad principles and specific details of X3D for anyone learning how to build 3D models

Excerpted and adapted from Chapter 1, *X3D Graphics for Web Authors*
http://x3dGraphics.com
Motivation

Over 30 years of steady growth and innovation have made 3D graphics an exciting field.

Key professional organization is SIGGRAPH for computer graphics and interactive techniques:
  • Includes technical experts and artists alike
  • http://www.siggraph.org

Nevertheless, few people actually build 3D models themselves:
  • Usually requires advanced programming skills
  • Costly proprietary tools and approaches compete.

Association for Computing Machinery (ACM) at http://www.acm.org
is the parent organization of the Special Interest Group on Graphics (SIGGRAPH) http://www.siggraph.org
Motivation

Rather than creating another expensive technical niche, X3D is designed for Web interoperability

- Support capabilities common to most (or all) tools
- Provide import/export publishing compatibility for many other formats
- Align 3D with Architecture of the World Wide Web

This approach works well for simple 3D models, scaling up to large-scale virtual environments

- Ultimate X3D success means that 3D graphics becomes a “first-class citizen” for Web multimedia

Students (and experts) working in 3D graphics usually get “locked into” one authoring tool or software package. This means they are often learning methods techniques that are peculiar to the tool interface, rather than 'nondenominational' 3D graphics knowledge that is more general, more portable, and suitable for Web export.

We hope that the book and associated materials changes this long-running situation.

The Architecture of the World Wide Web is a World Wide Web Consortium (W3C) Recommendation, administered by the W3C Technical Architecture Group (TAG) and online at http://www.w3.org/TR/webarch
Student background

Provide introductory course in to 3D graphics achievable at undergraduate level

• Course successfully taught first as VRML, then X3D

The following are all helpful but not required

• XML authoring background
• Programming skills
• Modeling-tool experience

Lots of free resources are available

• Can be self-taught with dedicated effort
• Support and feedback from online community

We are working to make X3D learnable and usable by any Web author.
X3D Examples

Software support
Software support for X3D authoring

Lots of free plugins, tools and resources provided

- X3D Resources at http://www.web3d.org/x3d/content/examples/X3dResources.html

Best first step is to install an X3D plugin into your default Web browser

- Letting you easily view any X3D scene

Set up to author X3D scenes using plain-text editor, or else by using an X3D-aware authoring tool

- X3D-Edit provided free for any use
- Other tools listed on X3D Resources page above

Get ready, get set...
X3D Examples

Numerous (thousands) of X3D examples are available online
  • http://x3dgraphics.com/examples/X3dResources.html#Examples

Can browse all examples in *X3D for Web Authors*
  • http://x3dgraphics.com/examples summary
  • http://x3dgraphics.com/examples/X3dForWebAuthors archive
  • http://x3dgraphics.com/X3dExamplesX3dForWebAuthors.zip

Recommended approach:
  • Browse examples online
  • Download and edit on local system

... go!
X3D Examples Archives

**X3D for Web Authors**  
- Textbook on how to design and build X3D scenes  
  242 models

**Basic**  
- Diverse scenes illustrating various X3D capabilities  
  637 models

**Conformance NIST**  
- Strictly defined test examples for correct operation  
  732 models

**VRML 2.0 Sourcebook**  
- Textbook on VRML97, examples converted to X3D  
  269 models

**Savage**  
- Open-source military models and tools  
  1134 models  
  3000+ models available

Model archives, .zip distributions and version control inspection are available at  
- http://x3dgraphics.com/examples/X3dResources.html#Examples

NPS students from USA and other government agencies can also use the restricted-access SavageDefense archive.

- NPS SavageDefense library is an open-source set of models used for defense simulation. Access is restricted to NPS partners working on government-sponsored projects. Bug reports are tracked privately.
- Online at https://savagedefense.nps.navy.mil/SavageDefense
- Compressed archive (~450 MB) at X3dExamplesSavageDefense.zip
- Subversion master source is retrievable via subversion check out:
X3D-Edit includes this download panel. Select the top-level *Examples* menu, then *Download X3D Example Archives*.

All .zip distributions remain available at

- [http://x3dgraphics.com/examples/X3dResources.html#Examples](http://x3dgraphics.com/examples/X3dResources.html#Examples)
X3D-Edit authoring tool

Software support

Acknowledgements at https://savage.nps.edu/X3D-Edit/#Acknowledgements
The X3D-Edit 3.2 Authoring Tool for Extensible 3D (X3D) Graphics supports the creation, checking, display and publication of X3D scenes.

It is written in open-source Java and XML using the Netbeans platform, making it suitable both as a standalone application and as a plugin module for the Netbeans integrated development environment (IDE).
X3D-Edit features

X3D-Edit features include direct editing of X3D scenes using the XML (.x3d) encoding, embedded visualization of scenes using the Xj3D viewer, XML validation against X3D DTDs and Schemas, drag-and-drop palette for X3D nodes, popup panels for node editing, and extensive help resources.

New features include ClassicVRML and X3D compressed binary encoding support, plus encryption and digital-signature authentication using XML Security standards.
X3D-Edit home page is online at https://savage.nps.edu/X3D-Edit
As the name implies, X3D-Edit is primarily oriented towards editing X3D text. Additional features include:

- Pop-up editors for each node
- Palette for dragging/dropping new nodes
- Xj3D scene visualization
- XML tree view
- Automatic code completion and element matching
- Validation and error checking
- Help system including multilingual tooltips, X3D specifications, examples help and X3D Scene Authoring Hints
- Automatic updates

https://savage.nps.edu/X3D-Edit
X3D-Edit download and installation

Options on X3D-Edit home page

- https://savage.nps.edu/X3D-Edit/#Downloads

Standalone executable application:

- Download and extract X3D-Edit3.2.zip
- https://savage.nps.edu/X3D-Edit/X3D-Edit3.2.zip
- Launch runX3dEditWin.bat on a Windows machine
- Launch runX3dEditMac.sh.command on a Mac
- Successful test reports received for Linux...
- That's all there is to it!

Further customization for Linux is welcome, expert help is invited

Work in progress: Java WebStart version
X3D-Edit built using Netbeans

X3D-Edit 3.2 is written in Java using the Netbeans platform, and so is portable across major desktop and laptop operating systems (Windows MacOSX Linux Solaris)

- http://www.netbeans.org

Lots of help and documentation are provided, both online and within X3D-Edit help system
X3D-Edit updates

Icon in lower-left corner of screen indicates when updates are available for automatic installation.

It is also possible to manually trigger an X3D-Edit update, if one is available. From top menu, select Tools > Plugins > Updates and then click the Update button.
F1 or the Help menu launches the JavaHelp system.
### Highlights of NetBeans IDE 6.0 Keyboard Shortcuts & Code Templates

#### Finding, Searching, and Replacing
- **Ctrl+F3**: Search word at insert point
- **F2/Shift-F3**: Find next/previous in file
- **Alt+F7**: Find/replace in file
- **Ctrl+Shift-P**: Find/replace in projects
- **Alt-Shift-U**: Find usages
- **Alt-Shift-H**: Turn off search result highlights
- **Ctrl+R**: Run file
- **Ctrl+U, then U**: Convert selection to uppercase
- **Ctrl+U, then L**: Convert selection to lowercase
- **Ctrl+F, then S**: Toggle case of selection
- **Alt-Shift-V**: Paste formatted

#### Navigating through Source Code
- **Ctrl+O/Alt-Shift-O**: Go to type/file
- **Ctrl-Shift-T**: Go to JUnit test
- **Ctrl+G**: Go to source
- **Ctrl+B**: Go to declaration
- **Ctrl+G**: Go to line
- **Ctrl-Shift-M**: Toggle add/remove bookmark
- **Ctrl-Shift-**: Next/previous bookmark
- **Ctrl-Period/Comma**: Select in Projects/files/sources
- **Ctrl+Shift-1/2/3**: Move caret to matching bracket
- **Ctrl+K/Ctrl-Shift-K**: Next/previous word match
- **Alt-Left/Right/Ctrl-0**: Go back/forward/to last edit

#### Coding in Java
- **Alt-Insert**: Generate code
- **Ctrl-Shift-I**: Fix all class imports
- **Alt-Shift-U**: Fix selected class's import
- **Alt-Shift-F**: Format selection
- **Alt-Shift-Left/right/Up/down**: Shift lines left/right/up/down
- **Ctrl-Shift-Up/Down**: Copy lines up/down
- **Ctrl+Alt-1/2**: Insert member/hierarchy
- **Ctrl+I**: Add/remove comment lines
- **Ctrl+L**: Delete current line

#### Coding in C/C++
- **Alt-Shift-C**: Go to declaration
- **Ctrl+F9**: Evaluate expression

#### Coding in Ruby
- **Ctrl-Shift-A**: Jump Rails action > view
- **Alt-Shift-**: Select Next/Previous
- **Period/Comma**: Show documentation
- **Ctrl-Shift-T**: Jump from test file to file

#### SOA
- **Tab-Shift-** Arrows: Move through elements
- **Alt-Shift-F**: Advanced search
- **Alt-Shift-Enter**: Expand/Collapse elements
- **Ctrl-Shift-9**: Show BPEL Mapper

#### UML
- **Alt-Shift-A/O**: Insert attribute/operation into selected element
- **Ctrl-Shift-F**: Fit diagram into window
- **F9**: Toggle overview window
- **Ctrl-Shift-S**: Select active UML diagram

#### Compiling, Testing, and Running
- **F9**: Compile package/file
- **F11**: Run main project
- **Shift+F11**: Clean & build main project
- **Ctrl-0**: Set request parameters
- **Ctrl-Shift-U**: Create Unit test
- **Ctrl+F6/Alt+F6**: Run Unit test on file/project
- **F5/Shift+F5**: Run main project/file

#### Opening and Toggling between Views
- **Ctrl-Rb**: Toggle between open documents
- **Shift-Escape**: Maximize window (toggle)
- **Ctrl-F5/Ctrl-W**: Close currently selected window
- **Ctrl-Shift-F1**: Close all windows
- **Shift-F10**: Open contextual menu
- **Alt-Shift-D**: Unlock window

#### Debugging
- **Ctrl-F5**: Start debugging main project
- **Ctrl-Shift-F5**: Start debugging current file
- **Ctrl-Shift-F6**: Start debugging test for file (JUnit)
- **Shift-F5/F5**: Stop/Continue debugging session
- **F6**: Run to cursor location in file
- **F7/F8**: Step into/over
- **Ctrl+F7**: Stop out
- **Ctrl+Alt-Up**: Go to called method
- **Ctrl-Alt-Down**: Go to calling method
- **Ctrl+F9**: Evaluate expression
- **Ctrl+F8**: Toggle breakpoint
- **Ctrl-Shift-F8**: New breakpoint
- **Ctrl-Shift-F7**: New watch

Available via the top Help menu, and also online at http://wiki.netbeans.org/wiki/view/KeymapProfileFor60
Hello World example
Hello World example

Hello World programs are simple examples of a computer language to illustrate their structure

- HelloWorld.x3d actually has a small world in it!
- Found in local-directory archive download at www.web3d.org/x3d/content/examples

X3D-Edit display includes color-coded text, node palette, validation, XML tree, Xj3D rendering

- Pretty-print HTML version is another useful output

Studying and modifying HelloWorld.x3d is an excellent way to learn a lot about X3D graphics

http://x3dgraphics.com/examples/HelloWorld.x3d

http://www.web3d.org/x3d/content/examples/HelloWorld.x3d

master in version control:
http://x3d.svn.sourceforge.net/viewvc/*checkout*/x3d/www.web3d.org/x3d/content/examples/HelloWorld.x3d
Hello world!

```xml
<Scene version="1.1" encoding="VRML">
  <Viewpoint version="1.1" orientation="#0 0 1 1" description="#1 0 1 1" position="#0 0 1 1"/>
  <Transform translation="#0 0 1 1" description="#0 0 1 1"/>
  <Shape>
    <Appearance>
      <Material diffuseColor="#0 0 0 1"/>
      <ImageTexture texture="earth-top.png"/>
    </Appearance>
    <Geometry>
      <Triangle souce '"">'
    </Geometry>
  </Shape>
</Scene>
```
Suggested exercise

Recreate the HelloWorld.x3d scene with X3D-Edit

• Create a new X3D scene, Save As using a new filename of your choosing
• Iconize the <head> element by clicking margin '+'
• Drag and drop nodes to build the scene
• Edit by typing, and by using node editors
• Make sure you maintain valid XML as you go
• Save, view, repeat as necessary

This matches how we build many X3D scenes
Pretty-printed HTML output using X3dToXhtml.xslt stylesheet

http://www.web3d.org/x3d/content/examples/HelloWorld.html
Other features
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
  • “Launch all viewers” simplifies comparison testing

Can also launch into standalone applications
  • Configuration panel simplifies download, install

http://www.xj3d.org

http://www.web3d.org/x3d/content/examples/X3dResources.html#Applications
Right-click to launch external viewer
Download, configure viewers:  
*Tools, Options, Miscellaneous, X3D, Players*

X3D-Edit menu selections:  *Tools, Options, Miscellaneous, X3D, Players*
X3D-Edit collaboration chat

Chat-based collaboration for text messaging or simultaneous file sharing is now available as an integrated capability in X3D-Edit.

Currently the installation procedure is performed by end users. Directions and screen snapshots are available at

X3D-Edit collaboration chat  2

XMPP JID for the chat channel is xmpp://x3d@muc.share.java.net
Subscription directions are provided on the installation page
Version control support included

Version control allows multiple authors to share updates and work together. Prerequisite: you must have the Collabnet subversion client installed.

If the file being edited is under version control, the Netbeans platform detects that and offers Subversion or CVS version control (as appropriate) without further setup.

Developers can work with X3D-Edit directly to update, diff (difference compare) and commit any file changes. X3D-Edit 3.2 subversion master source is at http://x3d.svn.sourceforge.net/viewvc/x3d/www.web3d.org/x3d/tools/X3dEdit3.2
X3D for Web Authors

http://x3dGraphics.com
Book organization
Book organization

Chapter 1 provides a thorough technical background study of how X3D works.

Subsequent chapters covers specific X3D nodes, grouped by similar functionality

• Chapters 2-6 for scene-graph fundamentals
• Chapters 7-9 for event animation and scripting
• Chapters 10-14 can be read in any order

Example scenes are provided in every chapter to enable direct learning, by changing examples and creating new scenes
Chapter descriptions

1. **Technical Overview.** General introduction of the fundamentals of 3D, including scene graphs, events, node reuse, file structure and encodings, components and profiles, and conformance.

2. **Geometry Nodes, Part 1: Primitives.** The basic primitive shapes.
   - Box, Sphere, Cylinder, Cone, and Text.

3. **Grouping Nodes.** Collecting and positioning objects in the 3D world.
   - Inline, LOD, Group and StaticGroup, Switch, Transform, and Anchor.
Chapter descriptions

4. **Viewing and Navigation.** How to view and navigate in the 3D world
   • Viewpoint and NavigationInfo.

5. **Appearance, Material, and Textures.**
   Adding colors, shininess, and transparency
   • Material and TwoSidedMaterial,
   or by adding image-file textures
   • PixelTexture, ImageTexture, MovieTexture,
     TextureTransform, TextureCoordinate, and
     TextureCoordinateGenerator.
Chapter descriptions

6. **Geometry Nodes, Part 2: Points, Lines, and Polygons.** Geometric creations that are more advanced than the basic shapes.
   - Coordinate, Color, PointSet, LineSet, Extrusion IndexedLineSet, IndexedFaceSet, ElevationGrid.

7. **Event Animation and Interpolation.** Making objects move, twist, wiggle, and shake.
Chapter descriptions

8. **User Interactivity Nodes.** Allowing users to interact with the world by connecting

9. **Event Utilities and Scripting.** Event type conversion and improved animation using the event-utility nodes
   - BooleanFilter, BooleanSequencer, BooleanToggle, BooleanTrigger, IntegerSequencer, IntegerTrigger
   - author-programmable Script node.
Chapter descriptions

10. **Geometry Nodes, Part 3: Geometry2D Nodes.** Flat geometry is helpful for building 2D shapes that face the viewer. Planar nodes include
   - Polypoint2D, Rectangle2D, TriangleSet2D, Polyline2D, Circle2D, Arc2D, ArcClose2D, Disk2D.

11. **Lighting and Environment Nodes.** Achieve lighting and scene background effects using
   - DirectionalLight, PointLight, SpotLight, Background, TextureBackground, Fog, and Sound.
Chapter descriptions

12. **Environment Sensor and Sound Nodes.** User activity in the environment can be detected and processed by using
   - LoadSensor, Collision, Billboard, ProximitySensor, and VisibilitySensor

13. **Geometry Nodes, Part 4: Triangles and Quadrilaterals.** Fundamental low-level geometry creation using triangles:
   - TriangleSet, TriangleStripSet, TriangleFanSet, IndexedTriangleSet, IndexedTriangleStripSet, and IndexedTriangleFanSet.
14. **Creating Prototype Nodes.** Probably the most powerful extension feature in X3D is the ability to define new reusable nodes, known as prototypes. Prototype declarations are combinations of already-existing nodes and (optionally) other prototypes. Prototype instances can then be used like any other X3D node. External prototype declarations allow authors to collect reusable prototype definitions together in a single file that can be accessed by other scenes.
How to use the book
How to use the book, 1

**Hands-on, eyes-on approach**

- Learning is best accomplished by building and modifying scenes, using a text editor or an authoring tool that is X3D capable
- Modify and refresh frequently, you won't break it!
- X3D-Edit is provided free for your use https://savage.nps.edu/X3D-Edit

**Web authors and X3D students**

- Chapter 1 section 1 only, then start with Chapter 2 and proceed in order
- Review chapter 1 periodically later, when you want.

Note that url for the X3D-Edit home page starts with https not http
How to use the book, 2

**Experienced 3D programmers**

- Read Chapter 1 first to figure out how X3D is both similar to (and different from) the technologies which you already understand
- Skim chapters 2-6 scene graph fundamentals, then study chapters 2-9 animation, use others as needed

**Experienced X3D authors**

- Study Chapter 1 descriptions of XML + ClassicVRML encodings, which are functionally equivalent
- Remainder of book in any order, can use it as a ready-reference manual
Summary
Summary

Reading this “Getting Started” slideset prepares you to work examples in *X3D for Web Authors*

Topics include

• Goals, Motivation and Student background
• X3D-Edit Authoring Tool and Hello World example
• *X3D for Web Authors:* book organization and use

• It is important to get your system fully set up to view and edit X3D example scenes
• Can skip Chapter 1, Technical Introduction
  • Start right in working examples in Chapter 2

Students should have an X3D plugin installed in their Web browser by now, along with X3D-Edit or another editor.
References 1

X3D: Extensible 3D Graphics for Web Authors
by Don Brutzman and Leonard Daly, Morgan Kaufmann Publishers, April 2007, 468 pages.

- http://x3dGraphics.com
- http://x3dgraphics.com/examples/X3dForWebAuthors

X3D Resources
- http://www.web3d.org/x3d/content/examples/X3dResources.html
References 2

X3D-Edit Authoring Tool
• https://savage.nps.edu/X3D-Edit

X3D Scene Authoring Hints
• http://x3dgraphics.com/examples/X3dSceneAuthoringHints.html

X3D Graphics Specification
• http://www.web3d.org/x3d/specifications
• Also available as help pages within X3D-Edit
References 3

Netbeans
- http://www.netbeans.org
- http://plugins.netbeans.org/PluginPortal

- http://www.netbeans.org/kb/articles/NBFieldGuide.html

Netbeans IDE Field Guide website online at http://www.netbeans.org/kb/articles/NBFieldGuide.html
References  4


- “Your Guide to Finding Your Way Around the NetBeans IDE”

Netbeans IDE Field Guide website online at [http://www.netbeans.org/kb/articles/NBFieldGuide.html](http://www.netbeans.org/kb/articles/NBFieldGuide.html)
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The Computer Graphics Educational Materials Source (CGEMS) site is designed for educators
• to provide a source of refereed high-quality content
• as a service to the Computer Graphics community
• freely available, directly prepared for classroom use
• http://cgems.inesc.pt

X3D for Web Authors recognized by CGEMS! 😊
• Book materials: X3D-Edit tool, examples, slidesets
• Received jury award for Best Submission 2008

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From the CGEMS home page:
• http://cgems.inesc.pt

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• http://cgems.inesc.pt/authors/ListModules.aspx

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for X3D-Edit software and X3D example scenes
http://www.web3d.org/x3d/content/examples/license.html

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Good references on open source:

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