X3D Graphics for Web Authors

Chapter 2

Geometry 1: Primitive Shapes

Dorothy in Oz: "Toto, I've a feeling we're not in Kansas anymore."

—L. Frank Baum, Wizard of Oz, 1939

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X3D

Chapter Overview

Overview: Geometry 1, Primitive Shapes

Common pattern for Shape nodes

- Shape contains geometry node
- Appearance and Material nodes

Five nodes for primitive geometry

- Box, Cone, Cylinder, Sphere, Text
- Text node is flat, not extruded
- FontStyle modifies Text node parameters

X3D tooltips and specification are helpful to use

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Concepts

Shape and geometry

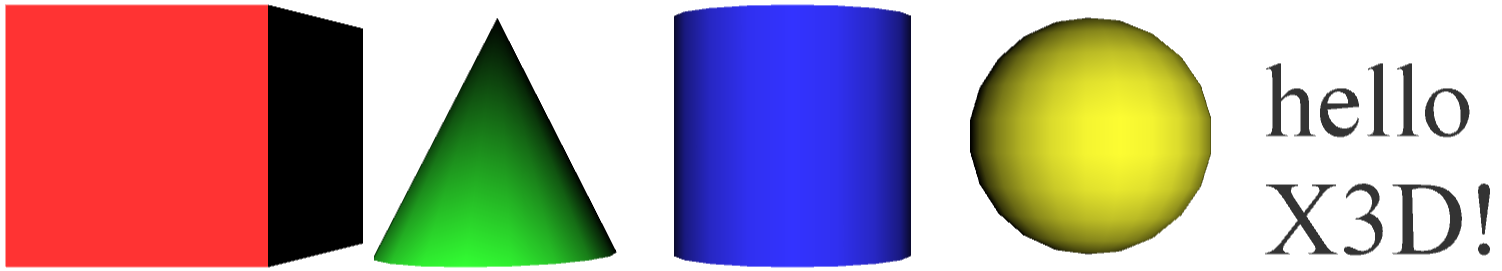
Shape nodes can contain a single geometry node

- For example, one of the five geometry primitive nodes
- Alternatively contains a more-advanced geometry node
  - Chapter 2: Geometric primitives
  - Chapter 6: Points Lines and Polygon nodes
  - Chapter 10: Geometry2D nodes
  - Chapter 13: Triangle nodes

Shape nodes can also contain an Appearance node

- Which in turn contains a Material node for coloring
- Covered in Chapter 3

Geometry Primitives



- Primitives are simple geometric constructs
- Shape, geometry, Appearance, Material pattern
- Browsers decide implementation details, including tessellation (polygon count) and thus quality

Common field: *solid*

In 3D graphics, all triangles have 2 sides

- Graphics term: backface culling only draws front sides

The *solid* field defines whether a geometry node has an inside or not, with a default value of true

- *solid*='true' means do not render (draw) the inside
- *solid*='false' means render both inside and outside

This approach reduces the number of polygons needing to be drawn, thus improving performance

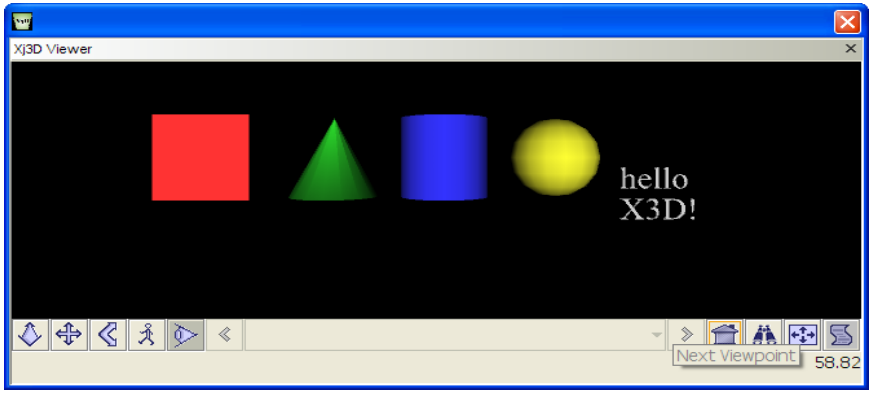
Confusing if user gets lost inside invisible geometry

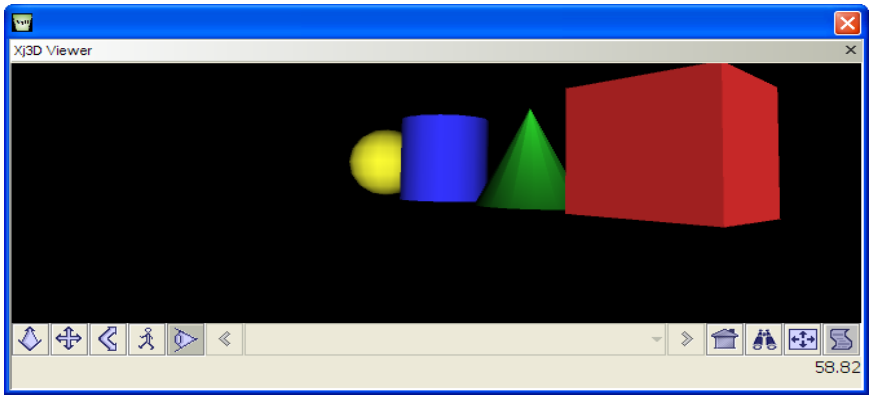
- Hint: set *solid*='false' to draw both sides

Common field: *solid*

To see an example of 'solid' geometry, rotate the GeometryPrimitives.x3d scene by 180 degrees

- Once rotated, the first four shapes remain visible, but the Text node disappears
- This is because *solid='true'* by default, so the reverse side of text is not drawn by default





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X3D Nodes and Examples

Shape parent with geometry child

```
<Shape>
    <Box size='1 2 3'/>
    <Appearance>
        <Material/>
    </Appearance>
</Shape>
```

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

Appearance and Material nodes define colors, transparency, etc.

```
<Shape>
    <Sphere radius='1'/>
    <Appearance>
        <Material/>
    </Appearance>
</Shape>
```

Primitives have simple dimensions

- Typical volume ~1 m radius

All units are in meters

Box node

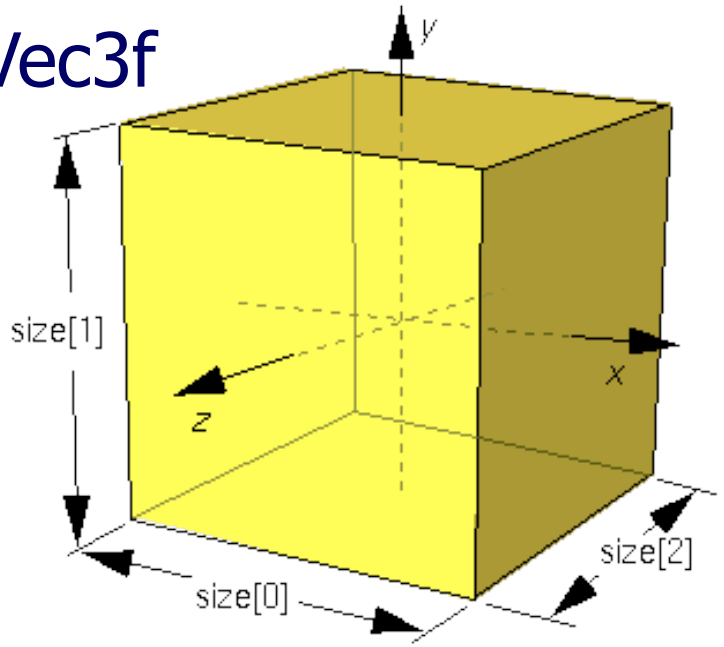
Six-sided rectangular parallelpiped

- meaning: not necessarily a cube, but it can be
- Three non-zero non-negative *size* dimensions for x y z

Centered at local origin

size field has X3D data type SFVec3f

- SF Vec = Single-field vector
- array length of 0 or 1 only
- 3f = 3 floating-point values



Box.x3d - Editor

Box.x3d

```
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    <meta content='Copyright Don Brutzman and Leonard Daly 2007' name='rights'/>
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               orientation='-0.747 -0.624 -0.231 1.05'/>
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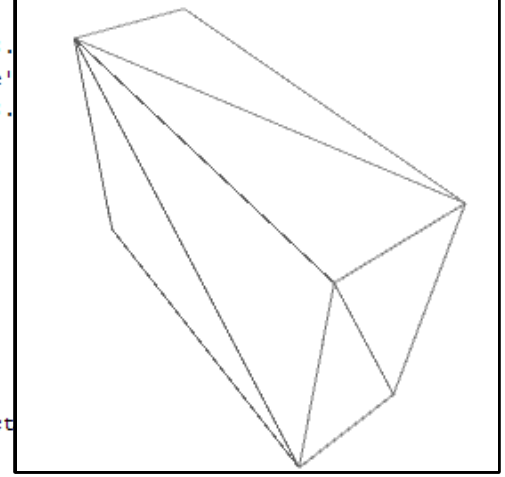
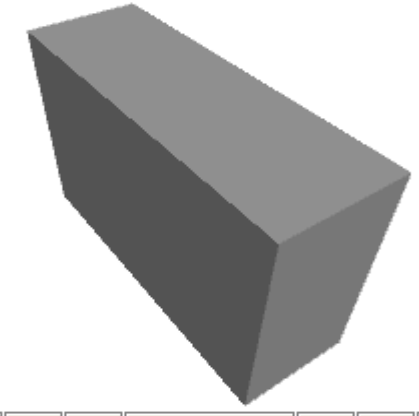
```

25:26 INS

Xj3D Viewer



Xj3D Viewer



Book View

Edit Box

DEF

USE

containerField

geometry

size 1 2 3

solid

OK Cancel Help

Box.x3d

X3D Tooltips - Mozilla Firefox

File Edit View History Bookmarks Tools GUtil! Help

http://www.web3d.org/x3d/content/X3dTooltips.html#Box

Google

	top help credits
Box	**Box is a geometry node.** **Hint: insert a Shape node before adding geometry or Appearance.**
DEF	**[DEF ID #IMPLIED]** DEF defines a unique ID name for this node, referencable by other nodes. **Hint:** descriptive DEF names improve clarity and help document a model.
USE	**[USE IDREF #IMPLIED]** USE means reuse an already DEF-ed node ID, ignoring _all_ other attributes and children. **Hint:** USEing other geometry (instead of duplicating nodes) can improve performance. **Warning:** do NOT include DEF (or any other attribute values) when using a USE attribute!
size	**[size: accessType initializeOnly, type SFVec3f CDATA "2 2 2"]** size x y z in meters. **Warning:** simple-geometry dimensions cannot be changed after initial creation, use Transform scale instead.
solid	**[solid: accessType initializeOnly, type SFBool (true|false) "true"]** Setting solid true means draw only one side of polygons (backface culling on), setting solid false means draw both sides of polygons (backface culling off). **Warning:** default value true can completely hide geometry if viewed from wrong side! **Warning:** solid false not supported in VRML97.
containerField	**[containerField: NMTOKEN "geometry"]** containerField is the field-label prefix indicating relationship to parent node. Examples: geometry Box, children Group, proxy Shape. containerField attribute is only supported in XML encoding of X3D scenes.
class	**[class CDATA #IMPLIED]** class is a space-separated list of classes, reserved for use by XML stylesheets. class attribute is only supported in XML encoding of X3D scenes.
	top help credits

Cone node

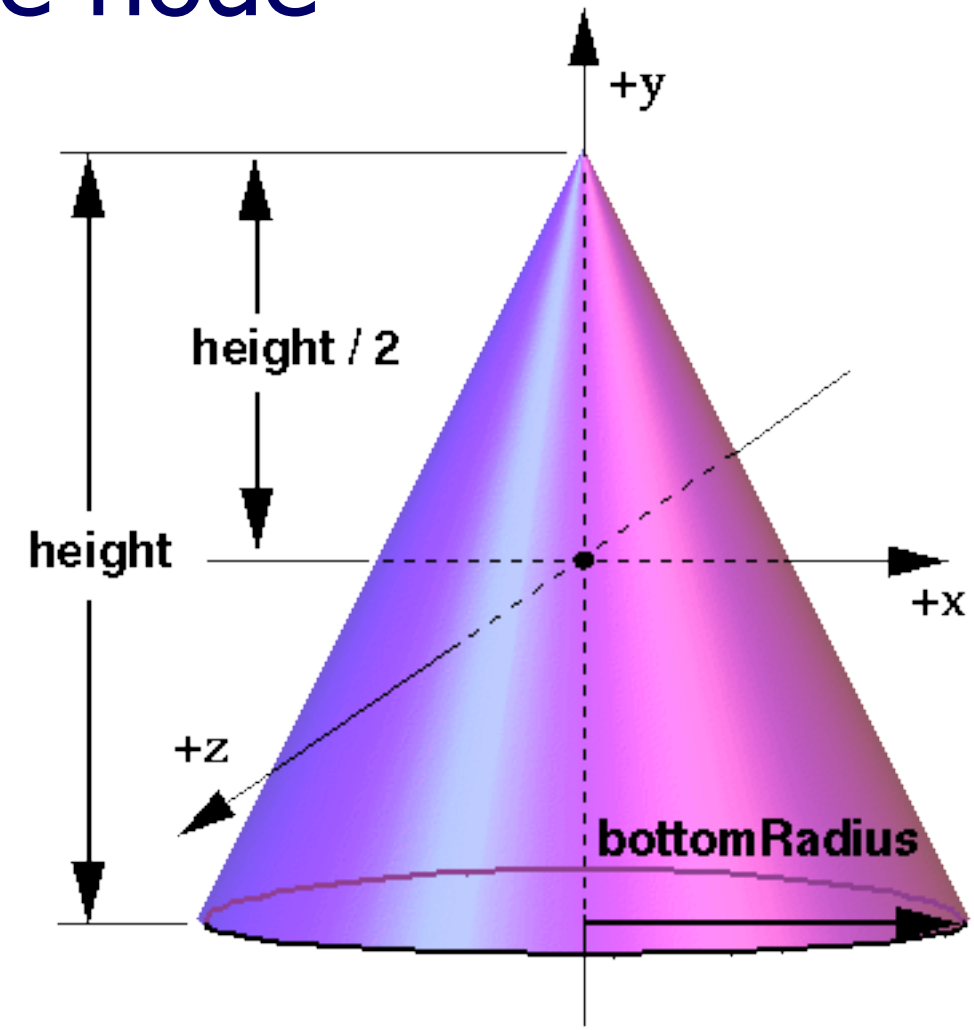
Circular *bottomRadius*

non-zero non-negative *height* above bottom

Centered at local origin

Can hide different parts

- *side*='false'
- *bottom*='false'



Set *side*='false' (for bottom only) defines a flat circle

Cone.x3d - Editor

Cone.x3d

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    <meta content='26 December 2007' name='modified'/>
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    <Viewpoint description='Book View' orientation='-1 0 0 0.68' position='0 1.11 1.9
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      <Cone bottom='true' bottomRadius='1' height='1' side='true'/>
      <Appearance>
        <Material/>
      </Appearance>
    </Shape>
  </Scene>
</X3D>
```

25:68 INS

Xj3D Viewer

Side View

Side...

Edit Cone

DEF

USE

containerField

geometry

bottom

bottomRadius 1

height 1

side

solid

OK Cancel Help

Cone.x3d

X3D Tooltips - Mozilla Firefox

File Edit View History Bookmarks Tools GUtil! Help

http://www.web3d.org/x3d/content/X3dTooltips.html#Cone

Google

	top help credits
Cone	**Cone is a geometry node.** **Hint: insert a Shape node before adding geometry or Appearance.**
DEF	**[DEF ID #IMPLIED]** DEF defines a unique ID name for this node, referencable by other nodes. **Hint:** descriptive DEF names improve clarity and help document a model.
USE	**[USE IDREF #IMPLIED]** USE means reuse an already DEF-ed node ID, ignoring _all_ other attributes and children. **Hint:** USEing other geometry (instead of duplicating nodes) can improve performance. **Warning:** do NOT include DEF (or any other attribute values) when using a USE attribute!
height	**[height: accessType initializeOnly, type SFFloat CDATA "2"]** Size in meters. **Warning:** simple-geometry dimensions cannot be changed after initial creation, use Transform scale instead.
bottomRadius	**[bottomRadius: accessType initializeOnly, type SFFloat CDATA "1"]** Size in meters. **Warning:** simple-geometry dimensions cannot be changed after initial creation, use Transform scale instead.
side	**[side: accessType initializeOnly, type SFBool (true|false) "true"]** Whether to draw sides (other inside faces are not drawn). **Warning:** cannot be changed after initial creation.
bottom	**[bottom: accessType initializeOnly, type SFBool (true|false) "true"]** Whether to draw bottom (other inside faces are not drawn). **Warning:** cannot be changed after initial creation.
solid	**[solid: accessType initializeOnly, type SFBool (true|false) "true"]** Setting solid true means draw only one side of polygons (backface culling on), setting solid false means draw both sides of polygons (backface culling off). **Warning:** default value true can completely hide geometry if viewed from wrong side! **Warning:** solid false not supported in VRML97.
containerField	**[containerField: NMTOKEN "geometry"]** containerField is the field-label prefix indicating relationship to parent node. Examples: geometry Box, children Group, proxy Shape. containerField attribute is only supported in XML encoding of X3D scenes.
class	**[class CDATA #IMPLIED]** class is a space-separated list of classes, reserved for use by XML stylesheets. class attribute is only supported in XML encoding of X3D scenes.
	top help credits

Cylinder node

Right-angle cylinder with top and bottom caps

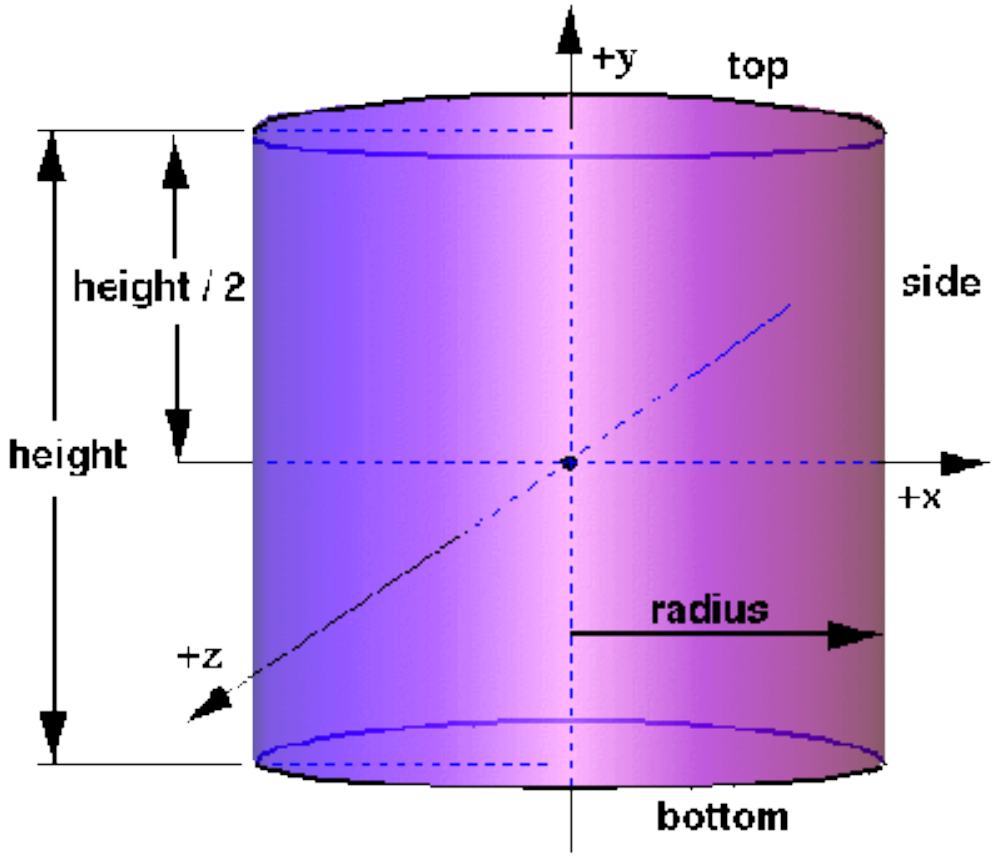
non-zero non-negative *height* above bottom

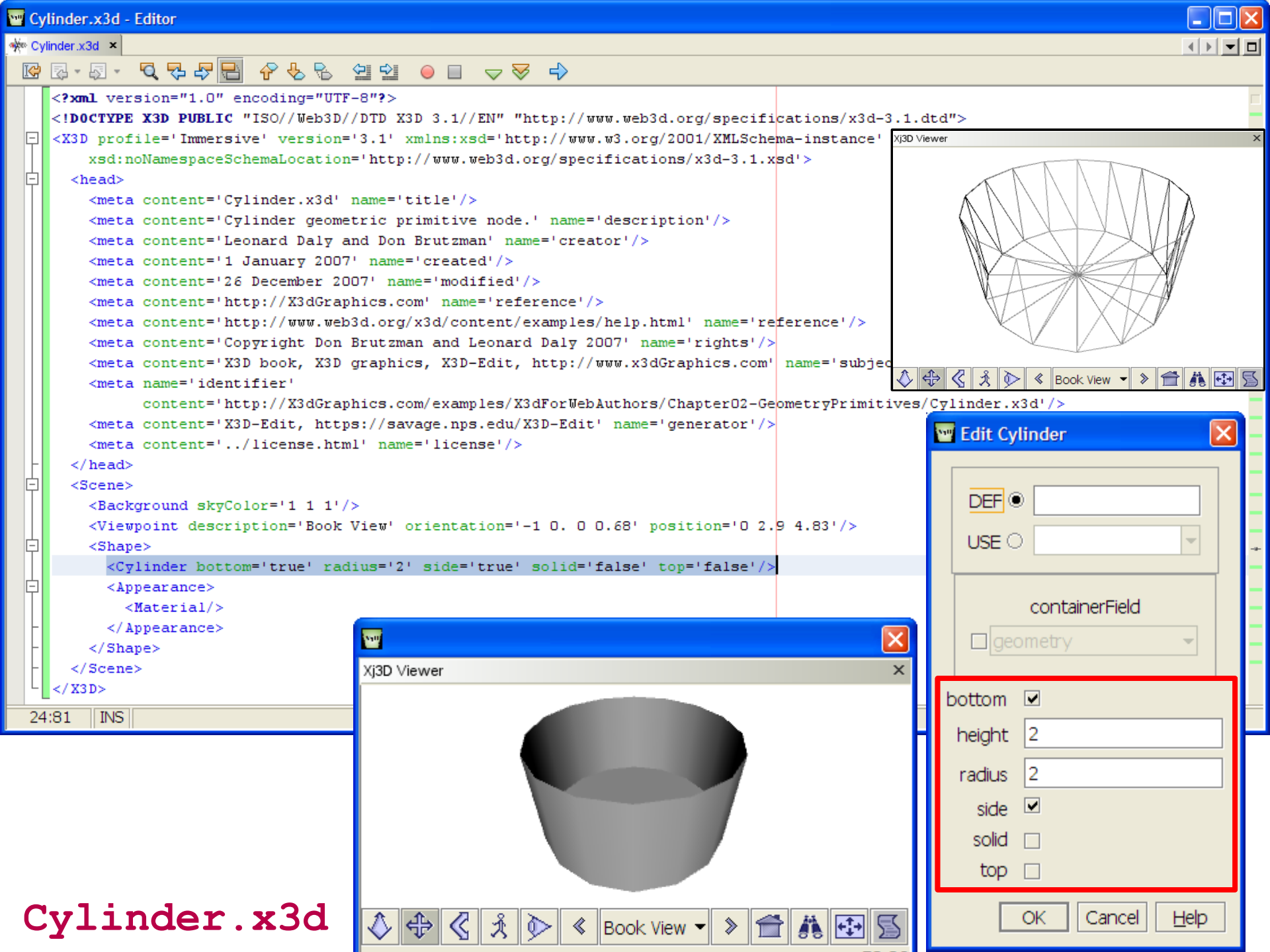
Circular *radius*

Centered at local origin

Can hide different parts

- *side*='false'
- *top*='false'
- *bottom*='false'




Cylinder.x3d - Editor
Cylinder.x3d
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<Material/>
</Appearance>
</Shape>
</Scene>
</X3D>
24:81
INS
Xj3D Viewer
Book View
Xj3D Viewer
Book View
Edit Cylinder
DEF
USE
containerField
geometry
bottom
height
2
radius
2
side
solid
top
OK
Cancel
Help
Cylinder.x3d

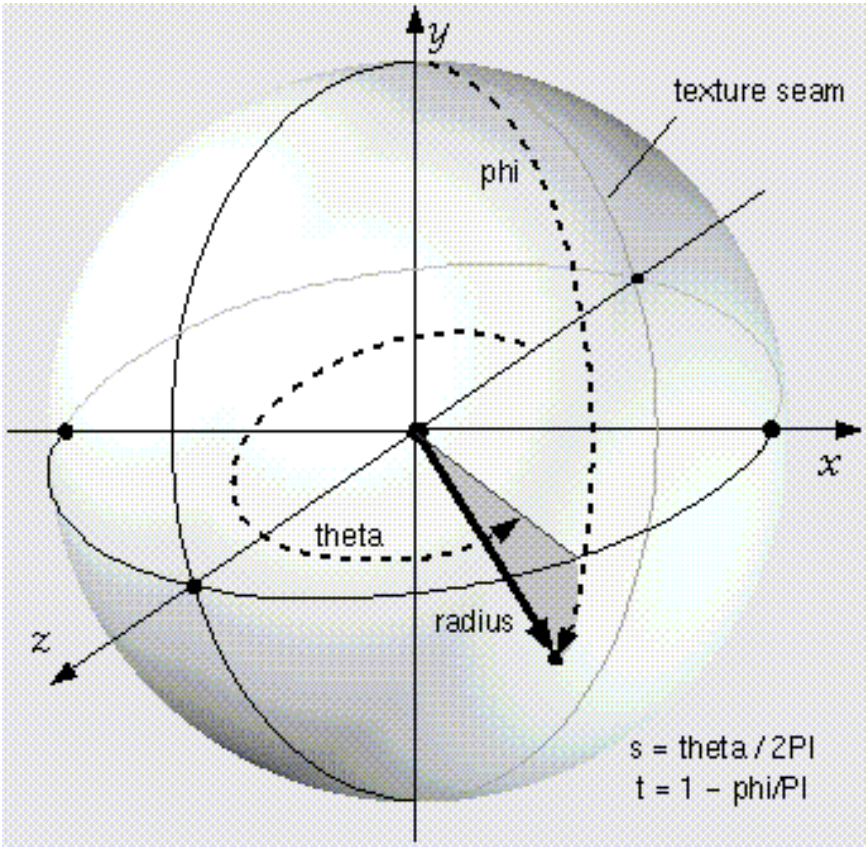
Cylinder	**Cylinder is a geometry node.** **Hint: insert a Shape node before adding geometry or Appearance.**
DEF	**[DEF ID #IMPLIED]** DEF defines a unique ID name for this node, referencable by other nodes. **Hint:** descriptive DEF names improve clarity and help document a model.
USE	**[USE IDREF #IMPLIED]** USE means reuse an already DEF-ed node ID, ignoring _all_ other attributes and children. **Hint:** USEing other geometry (instead of duplicating nodes) can improve performance. **Warning:** do NOT include DEF (or any other attribute values) when using a USE attribute!
height	**[height: accessType initializeOnly, type SFFloat CDATA "2"]** Size in meters. **Warning:** simple-geometry dimensions cannot be changed after initial creation, use Transform scale instead.
radius	**[radius: accessType initializeOnly, type SFFloat CDATA "1"]** Size in meters. **Warning:** simple-geometry dimensions cannot be changed after initial creation, use Transform scale instead.
top	**[top: accessType initializeOnly, type SFBool (true|false) "true"]** Whether to draw top (inside faces are never drawn). **Warning:** cannot be changed after initial creation.
side	**[side: accessType initializeOnly, type SFBool (true|false) "true"]** Whether to draw sides (inside faces are never drawn). **Warning:** cannot be changed after initial creation.
bottom	**[bottom: accessType initializeOnly, type SFBool (true|false) "true"]** Whether to draw bottom (inside faces are never drawn). **Warning:** cannot be changed after initial creation.
solid	**[solid: accessType initializeOnly, type SFBool (true|false) "true"]** Setting solid true means draw only one side of polygons (backface culling on), setting solid false means draw both sides of polygons (backface culling off). **Warning:** default value true can completely hide geometry if viewed from wrong side! **Warning:** solid false not supported in VRML97.
containerField	**[containerField: NMTOKEN "geometry"]** containerField is the field-label prefix indicating relationship to parent node. Examples: geometry Box, children Group, proxy Shape. containerField attribute is only supported in XML encoding of X3D scenes.
class	**[class CDATA #IMPLIED]** class is a space-separated list of classes, reserved for use by XML stylesheets. class attribute is only supported in XML encoding of X3D scenes.

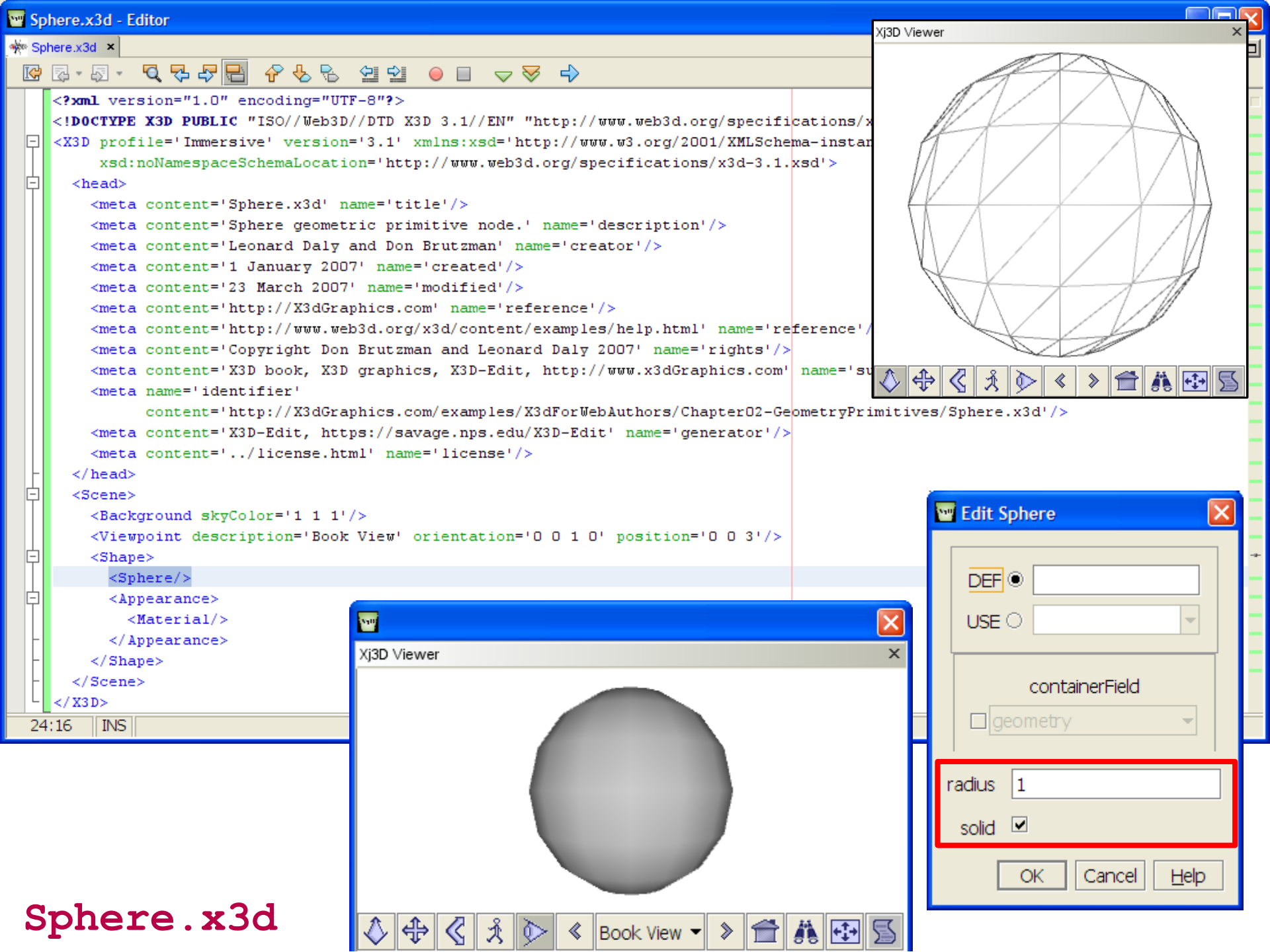
Sphere node

Circular *radius*

Centered at local origin

- phi and theta are implicit
- not defined by author




Sphere.x3d - Editor
Sphere.x3d
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<meta content='1 January 2007' name='created'/>
<meta content='23 March 2007' name='modified'/>
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<meta content='Copyright Don Brutzman and Leonard Daly 2007' name='rights'/>
<meta content='X3D book, X3D graphics, X3D-Edit, http://www.x3dGraphics.com' name='su
<meta name='identifier'
content='http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/Sphere.x3d'/>
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<Shape>
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</Shape>
</Scene>
</X3D>
24:16
INS
Xj3D Viewer
Xj3D Viewer
Book View
Edit Sphere
DEF
USE
containerField
geometry
radius
1
solid
OK
Cancel
Help
Sphere.x3d

X3D Tooltips - Mozilla Firefox

File Edit View History Bookmarks Tools GUtil! Help

http://www.web3d.org/x3d/content/X3dTooltips.html#Sphere

Google

	top help credits
Sphere	**Sphere is a geometry node.** **Hint: insert a Shape node before adding geometry or Appearance.**
DEF	**[DEF ID #IMPLIED]** DEF defines a unique ID name for this node, referencable by other nodes. **Hint:** descriptive DEF names improve clarity and help document a model.
USE	**[USE IDREF #IMPLIED]** USE means reuse an already DEF-ed node ID, ignoring _all_ other attributes and children. **Hint:** USEing other geometry (instead of duplicating nodes) can improve performance. **Warning:** do NOT include DEF (or any other attribute values) when using a USE attribute!
radius	**[radius: accessType initializeOnly, type SFFloat CDATA "1"]** Size in meters. **Warning:** simple-geometry dimensions cannot be changed after initial creation, use Transform scale instead.
solid	**[solid: accessType initializeOnly, type SFBool (true|false) "true"]** Setting solid true means draw only one side of polygons (backface culling on), setting solid false means draw both sides of polygons (backface culling off). **Warning:** default value true can completely hide geometry if viewed from wrong side! **Warning:** solid false not supported in VRML97.
containerField	**[containerField: NMTOKEN "geometry"]** containerField is the field-label prefix indicating relationship to parent node. Examples: geometry Box, children Group, proxy Shape. containerField attribute is only supported in XML encoding of X3D scenes.
class	**[class CDATA #IMPLIED]** class is a space-separated list of classes, reserved for use by XML stylesheets. class attribute is only supported in XML encoding of X3D scenes.
	top help credits

Text node

Produce readable flat, 2D text strings in X3D world

string field is MFString array of "quoted strings"

- Each "quoted string" appears on a separate line

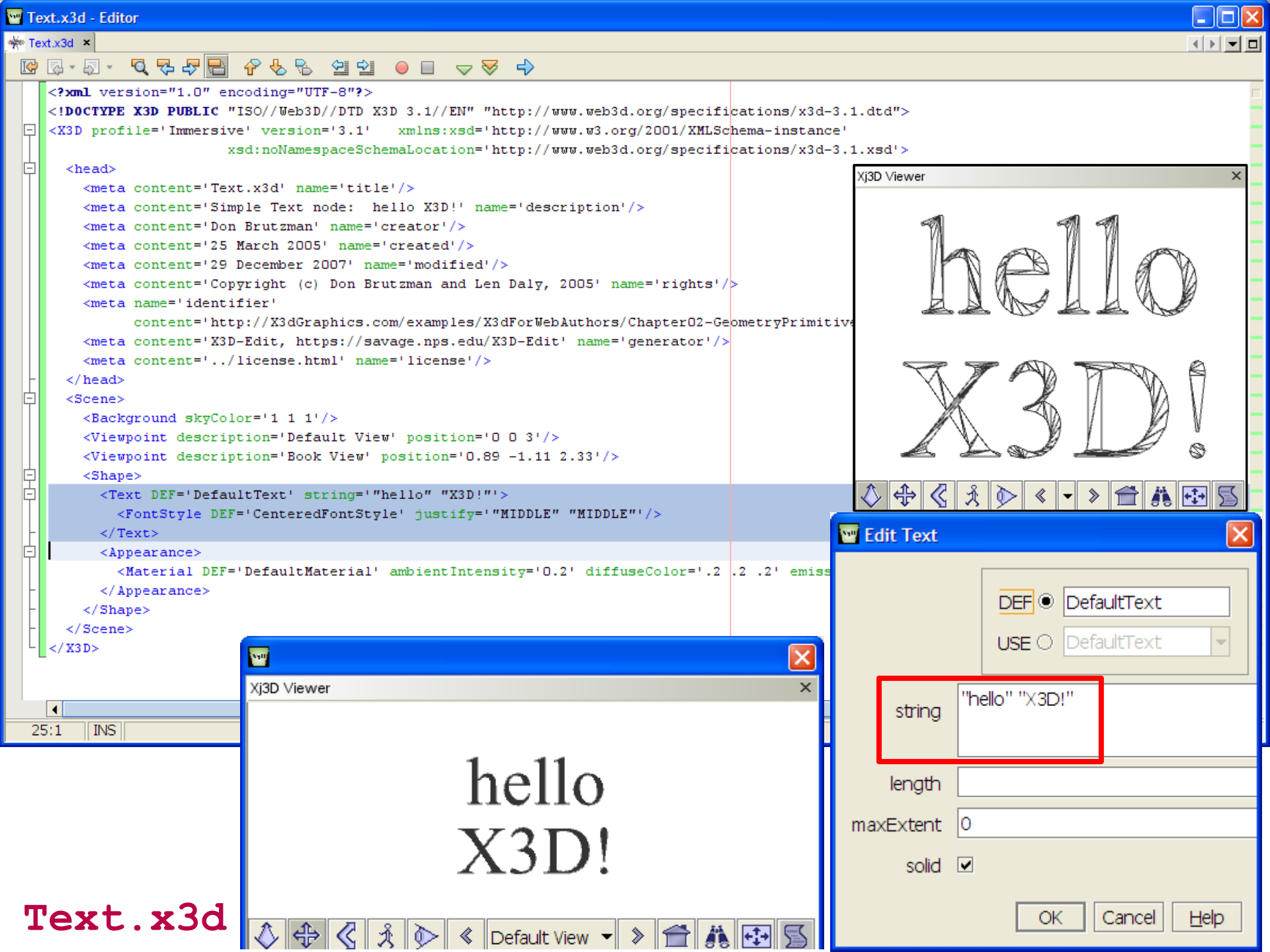
length field is MFFloat array of lengths for each line

- Can shrink or stretch size of each line if needed

maxExtent is maximum length for all substring lines

Note characters have no 3D depth

- Flat when viewed from alongside
- Not viewable from behind unless *solid*='false'
- Hint: use Billboard to face user


Text.x3d - Editor
Text.x3d
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.1//EN" "http://www.web3d.org/specifications/x3d-3.1.dtd">
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<meta content='29 December 2007' name='modified'/>
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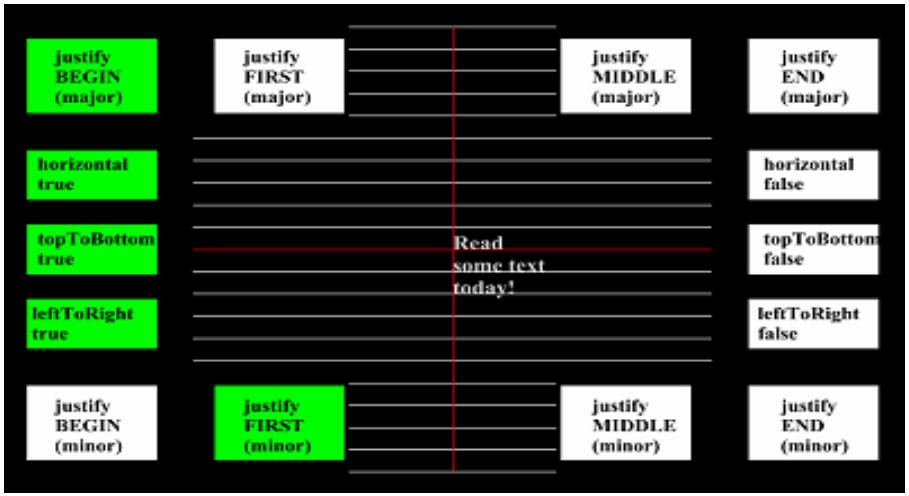
</Text>
<Appearance>
<Material DEF='DefaultMaterial' ambientIntensity='0.2' diffuseColor='.2 .2 .2' emiss
</Appearance>
</Shape>
</Scene>
</X3D>
25:1
INS
Xj3D Viewer
hello
X3D!
Xj3D Viewer
hello
X3D!
Default View
Edit Text
DEF
DefaultText
USE
DefaultText
string
"hello" "X3D!"
length
maxExtent
0
solid
OK
Cancel
Help
Text.x3d

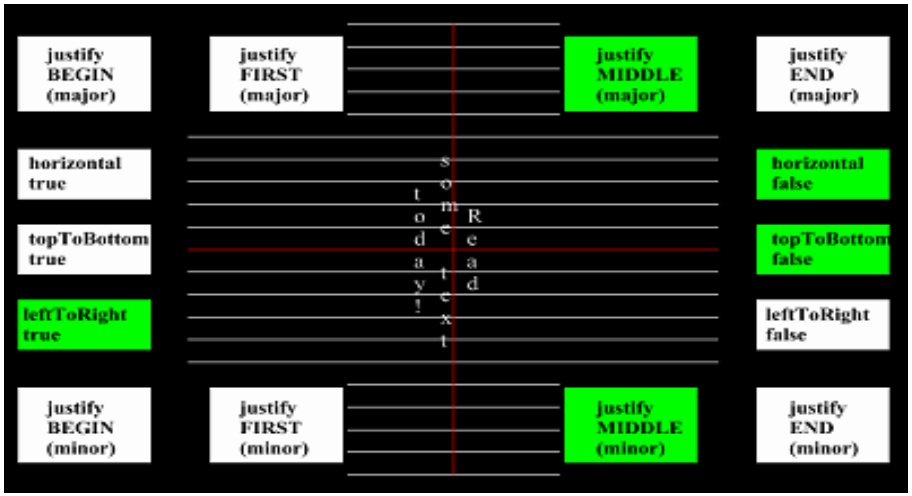
X3D Tooltips - Mozilla Firefox
File Edit View History Bookmarks Tools GUtil! Help
http://www.web3d.org/x3d/content/X3dTooltips.html#Text
Google

Text	**Text is a geometry node that can contain a FontStyle node.** **Hint: insert a Shape node before adding geometry or Appearance. You can also substitute a type-matched ProtoInstance.**
DEF	**[DEF ID #IMPLIED]** DEF defines a unique ID name for this node, referencable by other nodes. **Hint:** descriptive DEF names improve clarity and help document a model.
USE	**[USE IDREF #IMPLIED]** USE means reuse an already DEF-ed node ID, ignoring _all_ other attributes and children. **Hint:** USEing other geometry (instead of duplicating nodes) can improve performance. **Warning:** do NOT include DEF (or any other attribute values) when using a USE attribute!
string	**[string: accessType inputOutput, type MFString CDATA #IMPLIED]** Single or multiple string values to present as Text. **Hint:** Strings can have multiple values, so separate each string by quote marks **Hint:** Strings can contain quote marks by first escaping them with a backslash example: "say \"hello\" please" **Hint:** many XML tools substitute XML character references automatically if needed (like & for & or " for ").
length	**[length: accessType inputOutput, type MFFloat CDATA #IMPLIED]** Array of length values for each text string in the local coordinate system. Each string is stretched or compressed to fit.
maxExtent	**[maxExtent: accessType inputOutput, type SFFloat CDATA "0.0"]** Limits/compresses all text strings if max string length is longer than maxExtent, as measured in local coordinate system.
solid	**[solid: accessType initializeOnly, type SFBool (true|false) "true"]** Setting solid true means draw only one side of polygons (backface culling on), setting solid false means draw both sides of polygons (backface culling off). **Warning:** default value true can completely hide geometry if viewed from wrong side! **Warning:** solid false not supported in VRML97.
lineBounds	**[lineBounds: accessType outputOnly, type MFVec2f CDATA #IMPLIED]** Array of 2D bounding box values for each line of text in the local coordinate system.
textBounds	**[textBounds: accessType outputOnly, type SFVec2f CDATA #IMPLIED]** 2D bounding box value for all lines of text in the local coordinate system.
containerField	**[containerField: NMTOKEN "geometry"]** containerField is the field-label prefix indicating relationship to parent node. Examples: geometry Box, children Group, proxy Shape. containerField attribute is only supported in XML encoding of X3D scenes.
class	**[class CDATA #IMPLIED]** class is a space-separated list of classes, reserved for use by XML stylesheets. class attribute is only supported in XML encoding of X3D scenes.

FontStyle node

Defines *size*, font *family*, layout directions and justification, language, and style for Text strings





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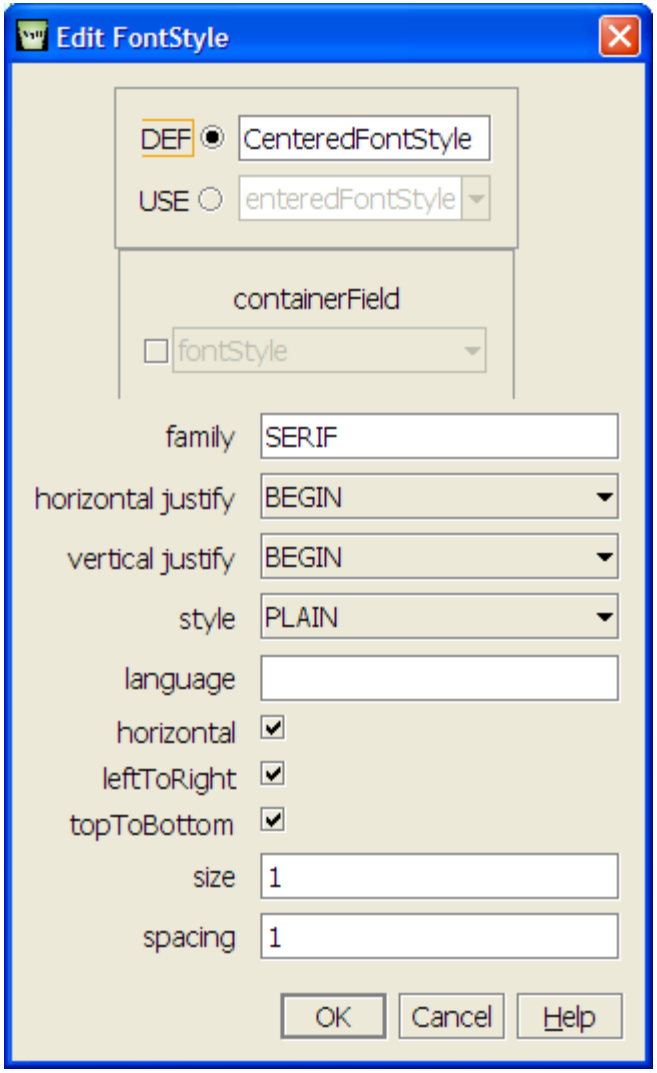
X3D

```
<FontStyle justify=' "MIDDLE" "MIDDLE" '/>
```



- FontStyle is only allowed as child of a Text node
  - FontStyle modifies that parent
- Other supported default font family values are SANS (serif) and TYPEWRITER
  - Additional font families require special browser support
- Other field values support internationalization (I18N) and localization (L10N)
  - DEF, USE for consistent look

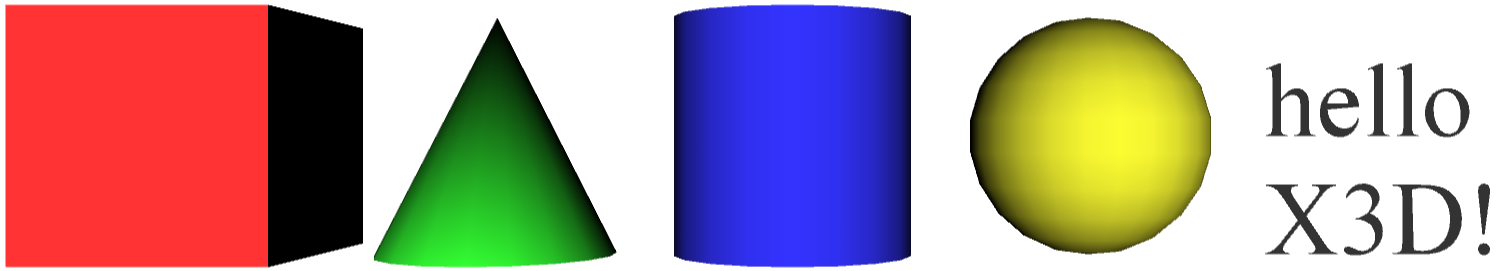
top help credits

FontStyle	**FontStyle defines the size, family, and style used for Text nodes.** **Hint: first add a Text node as parent.**
DEF	**[DEF ID #IMPLIED]** DEF defines a unique ID name for this node, referencable by other nodes. Hint: descriptive DEF names improve clarity and help document a model.
USE	**[USE IDREF #IMPLIED]** USE means reuse an already DEF-ed node ID, ignoring _all_ other attributes and children. Hint: USEing other geometry (instead of duplicating nodes) can improve performance. Warning: do NOT include DEF (or any other attribute values) when using a USE attribute!
family	**[family: accessType initializeOnly, type MFString CDATA "SERIF"]** Sequence of font family names in preference order - browsers use first supported family. Supported values include "SERIF" "SANS" "TYPEWRITER". Hint: SERIF and SANS are variable-width fonts (for example, Roman and Arial). Hint: TYPEWRITER is a fixed-width font (for example, Courier). Hint: Strings can have multiple values, so separate "each string" "by" "quote marks".
style	**[style: accessType initializeOnly, type SFString CDATA (PLAIN|BOLD|ITALIC|BOLDITALIC) "PLAIN"]** Pick one of four values for text style.
justify	**[justify: accessType initializeOnly, type MFString CDATA "BEGIN"]** Two string values are provided for major and minor axis alignment, possible values are "FIRST" "BEGIN" "MIDDLE" "END"] Example: "MIDDLE" "MIDDLE". Hint: Strings can have multiple values, so separate "each string" "by" "quote marks".
size	**[size: accessType initializeOnly, type SFFloat CDATA "1.0"]** Nominal height (in local coordinate system) of text glyphs Also sets default spacing between adjacent lines of text.
spacing	**[spacing: accessType initializeOnly, type SFFloat CDATA "1.0"]** Adjustment factor for line spacing between adjacent lines of text.
language	**[language: accessType initializeOnly, type SFString CDATA #IMPLIED]** Language codes consist of a primary code and a (possibly empty) series of subcodes. [language-code = primary-code ("-" subcode)*] Two-letter primary codes are reserved for language abbreviations. [RFC1766, http://www.ietf.org/rfc/rfc1766.txt] Two-letter primary codes include en (English), fr (French), de (German), it (Italian), nl (Dutch), el (Greek), es (Spanish), pt (Portuguese), ar (Arabic), he (Hebrew), ru (Russian), zh (Chinese), ja (Japanese), hi (Hindi), ur (Urdu), and sa (Sanskrit). Any two-letter subcode is understood to be a country code. [ISO3166 or http://www.oasis-open.org/cover/iso639a.html]
horizontal	**[horizontal: accessType initializeOnly, type SFBool (true|false) "true"]** Whether text direction is horizontal (true) or vertical (false).
leftToRight	**[leftToRight: accessType initializeOnly, type SFBool (true|false) "true"]** Whether text direction is left-to-right (true) or right-to-left (false).
topToBottom	**[topToBottom: accessType initializeOnly, type SFBool (true|false) "true"]** Whether text direction is top-to-bottom (true) or bottom-to-top (false).
containerField	**[containerField: NMTOKEN "fontStyle"]** containerField is the field-label prefix indicating relationship to parent node. Examples: geometry Box, children Group, proxy Shape. containerField attribute is only supported in XML encoding of X3D scenes.
class	**[class CDATA #IMPLIED]** class is a space-separated list of classes, reserved for use by XML stylesheets. class attribute is only supported in XML encoding of X3D scenes.

top help credits

Review

Geometry Primitives



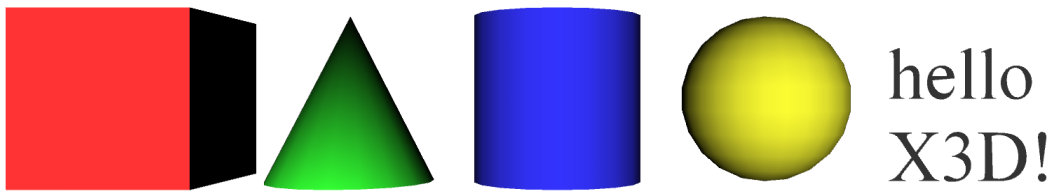
Primitives are simple geometric constructs

Shape, geometry, Appearance, Material pattern

Browsers decide implementation details, including quality of tessellation resolution

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, B
    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,
    meta:  name: identifier,  content: GeometryPrimitiveNodes.x3d
    meta:  name: generator,  content: X3D-Edit, http://www.web3d.org/x3d,
    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
```



Transform nodes position each Shape so that they do not obscure each other

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Additional Resources

Multilingual X3D tooltips

X3D tooltips are available online and bundled in the X3D-Edit help pages

X3D tooltips are available in the following languages

- English
- Chinese
- French
- German
- Italian
- Portuguese
- Spanish

Translations into other languages are welcome

http://www.web3d.org/x3d/content/X3dTooltips.html

X3D spec excerpt for Shape node

12.4.5 Shape

```
Shape : X3DShapeNode {
  SFNode  [in,out] appearance NULL      [X3DAppearanceNode]
  SFNode  [in,out] geometry   NULL      [X3DGeometryNode]
  SFNode  [in,out] metadata   NULL      [X3DMetadataObject]
  SFVec3f []       bboxCenter 0 0 0     (-∞,∞)
  SFVec3f []       bboxSize   -1 -1 -1 [0,∞) or -1 -1 -1
}
```

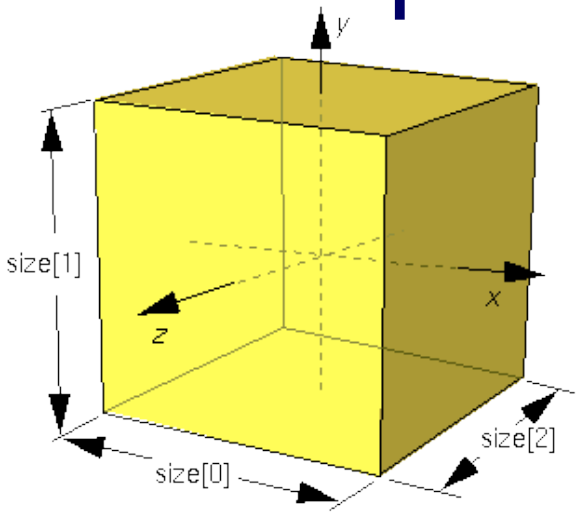
The Shape node has two fields, *appearance* and *geometry,* which are used to create rendered objects in the world. The *appearance* field contains an Appearance node that specifies the visual attributes (e.g., material and texture) to be applied to the geometry. The *geometry* field contains a geometry node. The specified geometry node is rendered with the specified appearance nodes applied. See 12.2 Concepts for more information.

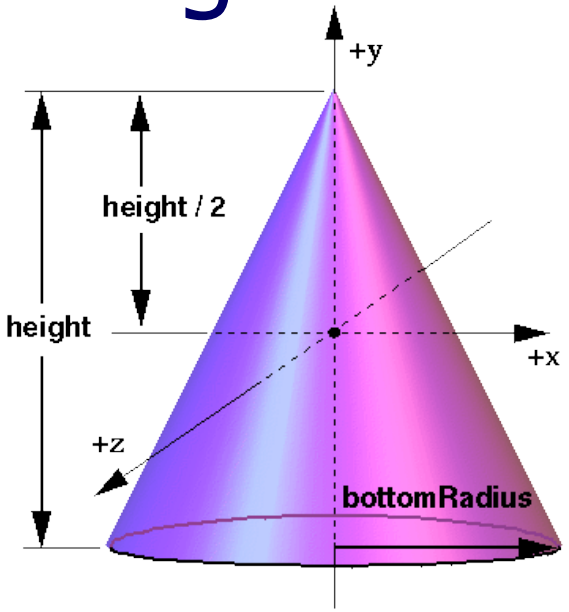
17 Lighting component contains details of the X3D lighting model and the interaction between Appearance nodes and geometry nodes.

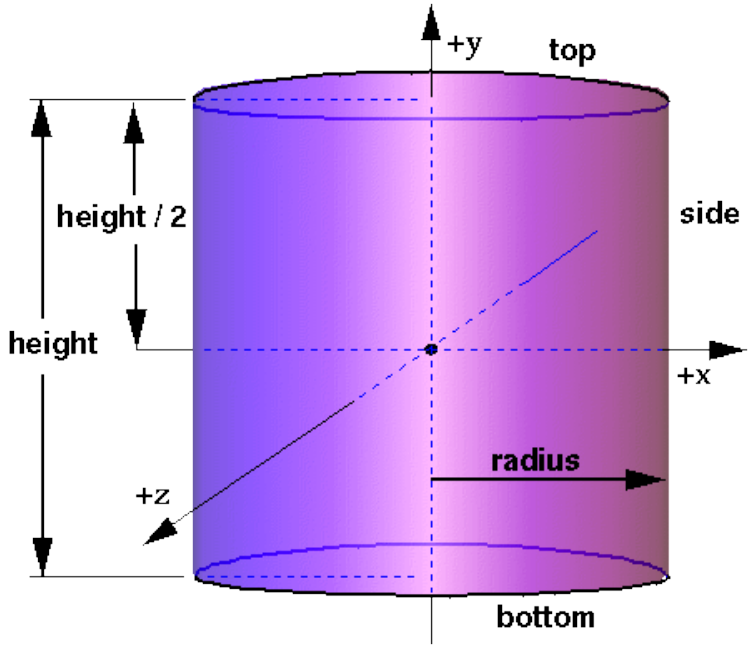
If the *geometry* field is `NULL`, the object is not drawn.

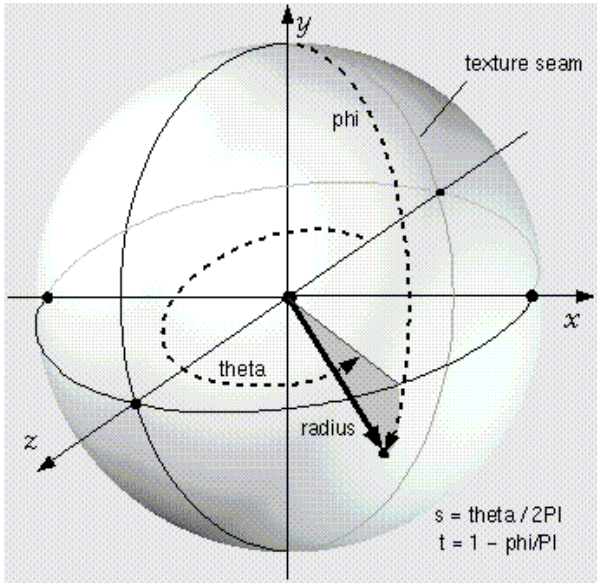
The *bboxCenter* and *bboxSize* fields specify a bounding box that encloses the Shape node's geometry. This is a hint that may be used for optimization purposes. The results are undefined if the specified bounding box is smaller than the actual bounding box of the geometry at any time. A default *bboxSize* value, (-1, -1, -1), implies that the bounding box is not specified and, if needed, is calculated by the browser. A description of the *bboxCenter* and *bboxSize* fields is contained in 10.2.2 Bounding boxes.

X3D Specification Diagrams









Chapter Summary

Chapter Summary

Shape is a container node for a single piece of geometry

Geometry primitive nodes

- Box, Cone, Cylinder, Sphere, Text
- FontStyle supports Text

Numerous additional resources

- X3D tooltips, with multilingual versions available
- X3D specifications
- Each are integrated within X3D-Edit authoring tool

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References

References 1

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

- Chapter 2, Geometry Primitives
- http://x3dGraphics.com

X3D Examples Help

- http://www.web3d.org/x3d/content/examples/help.html

X3D-Edit Authoring Tool

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

References 2

VRML 2.0 Sourcebook by Andrea L. Ames, David R. Nadeau, and John L. Moreland, John Wiley & Sons, 1996.

- http://www.wiley.com/legacy/compbooks/vrml2sbk/cover/cover.htm
- http://www.web3d.org/x3d/content/examples/Vrml2.0Sourcebook
- Chapter 02 – Introduction
- Chapter 03 – Shapes
- Chapter 04 – Text

Related concepts

Appearance node: chapter 5
Background node: chapter 11
Material node: chapter 5
Transform node: chapter 3
Viewpoint node: chapter 4

Bounding boxes: chapter 12

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X3D Graphics for Web Authors

Chapter 2

Geometry 1: Primitive Shapes

Dorothy in Oz: "Toto, I've a feeling we're not in Kansas anymore."
—L. Frank Baum, Wizard of Oz, 1939

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Chapter Overview

Overview: Geometry 1, Primitive Shapes

Common pattern for Shape nodes

- Shape contains geometry node
- Appearance and Material nodes

Five nodes for primitive geometry

- Box, Cone, Cylinder, Sphere, Text
- Text node is flat, not extruded
- FontStyle modifies Text node parameters

X3D tooltips and specification are helpful to use

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Concepts

Shape and geometry

Shape nodes can contain a single geometry node

- For example, one of the five geometry primitive nodes
- Alternatively contains a more-advanced geometry node
  - Chapter 2: Geometric primitives
  - Chapter 6: Points Lines and Polygon nodes
  - Chapter 10: Geometry2D nodes
  - Chapter 13: Triangle nodes

Shape nodes can also contain an Appearance node

- Which in turn contains a Material node for coloring
- Covered in Chapter 3

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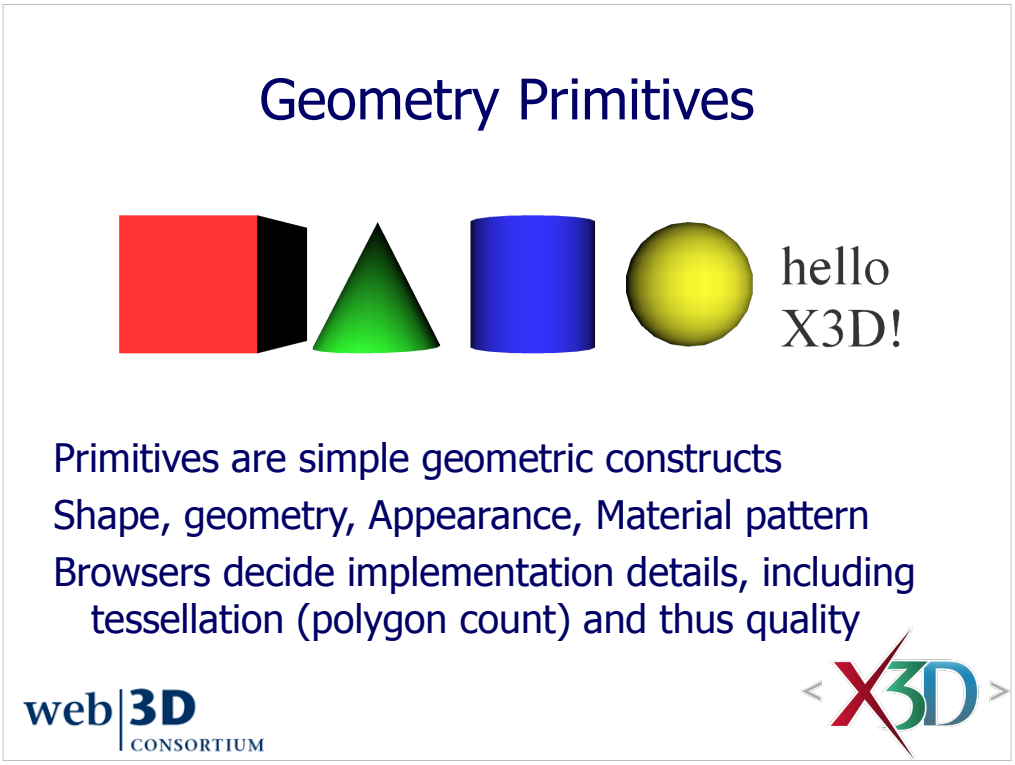
Since every individual piece of geometry to be drawn must have a parent Shape node, expect to see a lot of Shape nodes in your X3D scenes.

The structure provided by having many Shape nodes helps keep a scene organized and clearly separates capabilities that might otherwise get unintentionally mixed up.



There are five primitive geometry nodes: Box Cone Cylinder Sphere and Text

Improving the polygon count of primitive geometry is a frequently requested X3D feature.

Some browsers (e.g. Xj3D) allow setting a parameter for primitive quality.

Maybe a new field will eventually be added to the X3D specification, or maybe not.

Authors can generate their own geometry (e.g. IndexedFaceSet) if they do not want to live with the uncertainty of browser quality when drawing geometry primitives.

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/GeometryPrimitiveNodes.x3d

Common field: *solid*

In 3D graphics, all triangles have 2 sides

- Graphics term: backface culling only draws front sides

The *solid* field defines whether a geometry node has an inside or not, with a default value of true

- *solid*='true' means do not render (draw) the inside
- *solid*='false' means render both inside and outside

This approach reduces the number of polygons needing to be drawn, thus improving performance

Confusing if user gets lost inside invisible geometry

- Hint: set *solid*='false' to draw both sides

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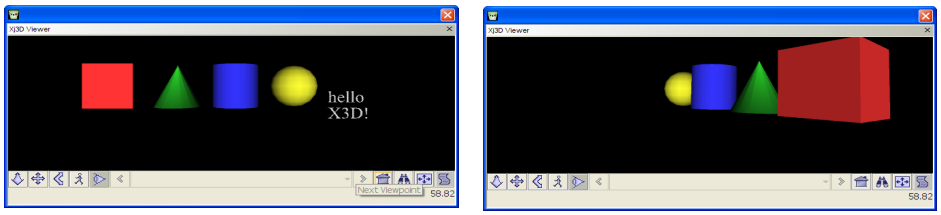
Common field: *solid*

To see an example of 'solid' geometry, rotate the GeometryPrimitives.x3d scene by 180 degrees

- Once rotated, the first four shapes remain visible, but the Text node disappears
- This is because *solid='true'* by default, so the reverse side of text is not drawn by default



Here we are still using the example

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/GeometryPrimitiveNodes.x3d

The original scene (on the left) is rotated about 150 degrees to the right. To do this, click on the left center of the screen and drag the mouse (pointer) to the right.

You need to have browser navigation in EXAMINE mode for this view rotation to work. In Xj3D, which is used in X3D-Edit, the EXAMINE mode icon is the stylized eye (fifth button on the lower left as shown here).

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X3D Nodes and Examples

Shape parent with geometry child

```
<Shape>
    <Box size='1 2 3'/>
    <Appearance>
        <Material/>
    </Appearance>
</Shape>
```

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

Appearance and Material nodes define colors, transparency, etc.

```
<Shape>
    <Sphere radius='1'/>
    <Appearance>
        <Material/>
    </Appearance>
</Shape>
```

Primitives have simple dimensions

- Typical volume ~1 m radius

All units are in meters

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Box node

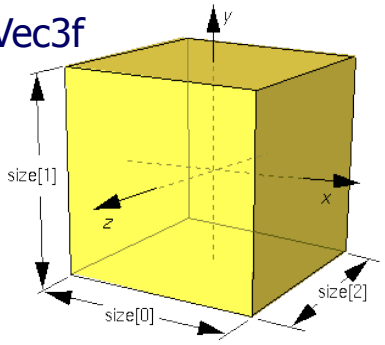
Six-sided rectangular parallelpiped

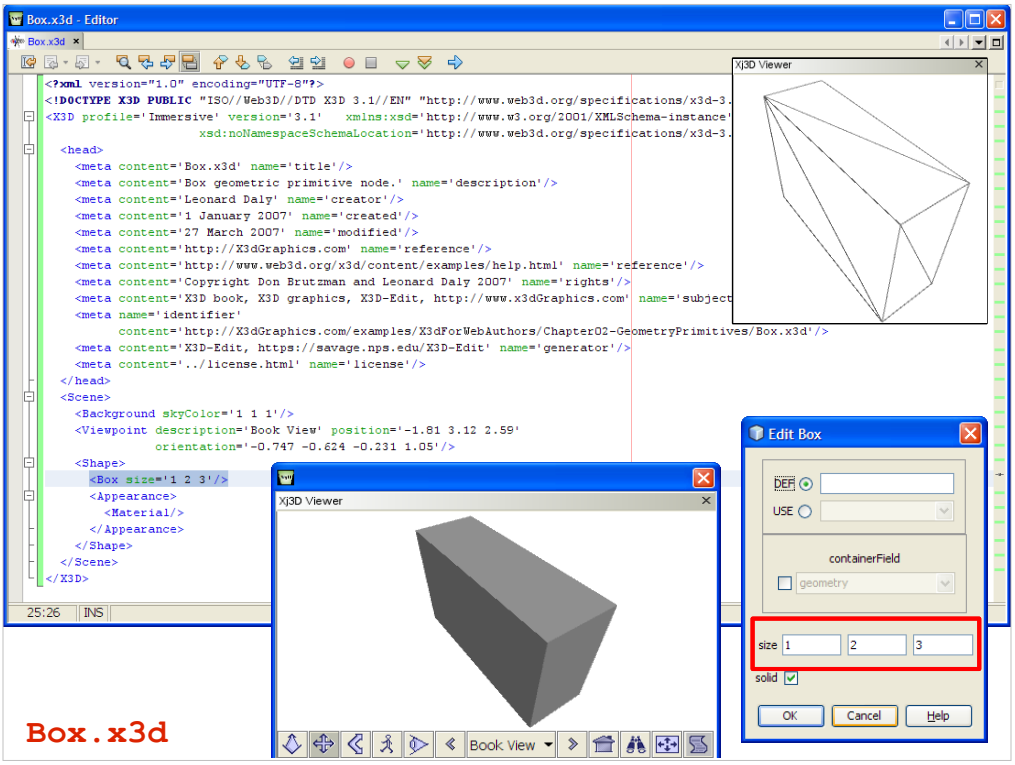
- meaning: not necessarily a cube, but it can be
- Three non-zero non-negative *size* dimensions for x y z

Centered at local origin

size field has X3D data type SFVec3f

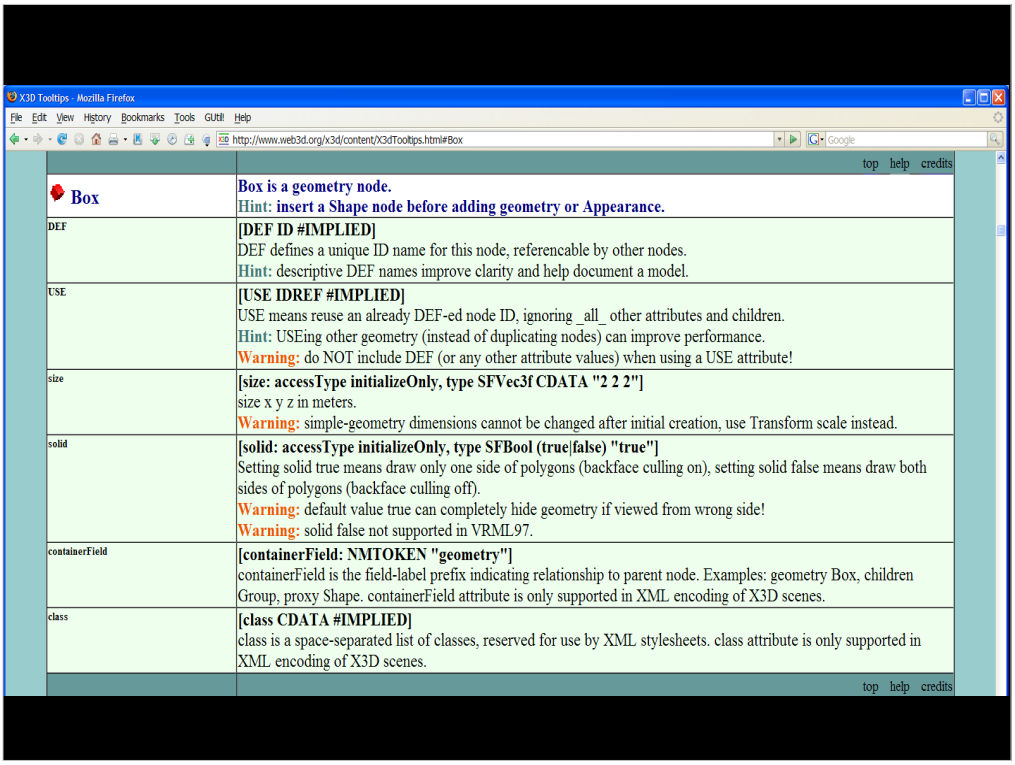
- SF Vec = Single-field vector
- array length of 0 or 1 only
- 3f = 3 floating-point values





From Xj3D help: Alt-W toggles Wireframe rendering mode. Wireframe rendering of geometry is a special feature offered by some browsers and cannot be set by an X3D author.

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/Box.x3d



http://www.web3d.org/x3d/content/X3dTooltips.html#Box

Cone node

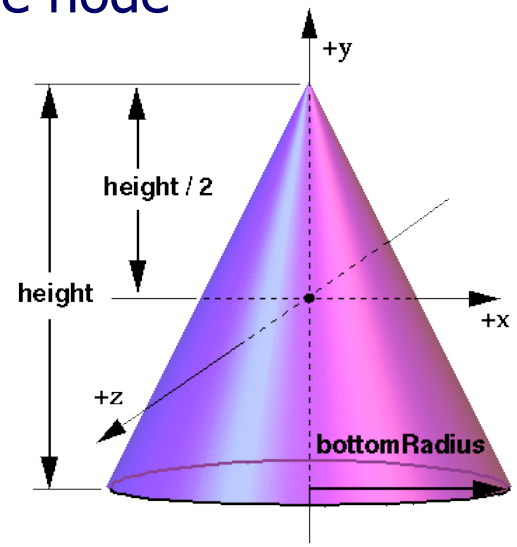
Circular *bottomRadius*

non-zero non-negative *height* above bottom

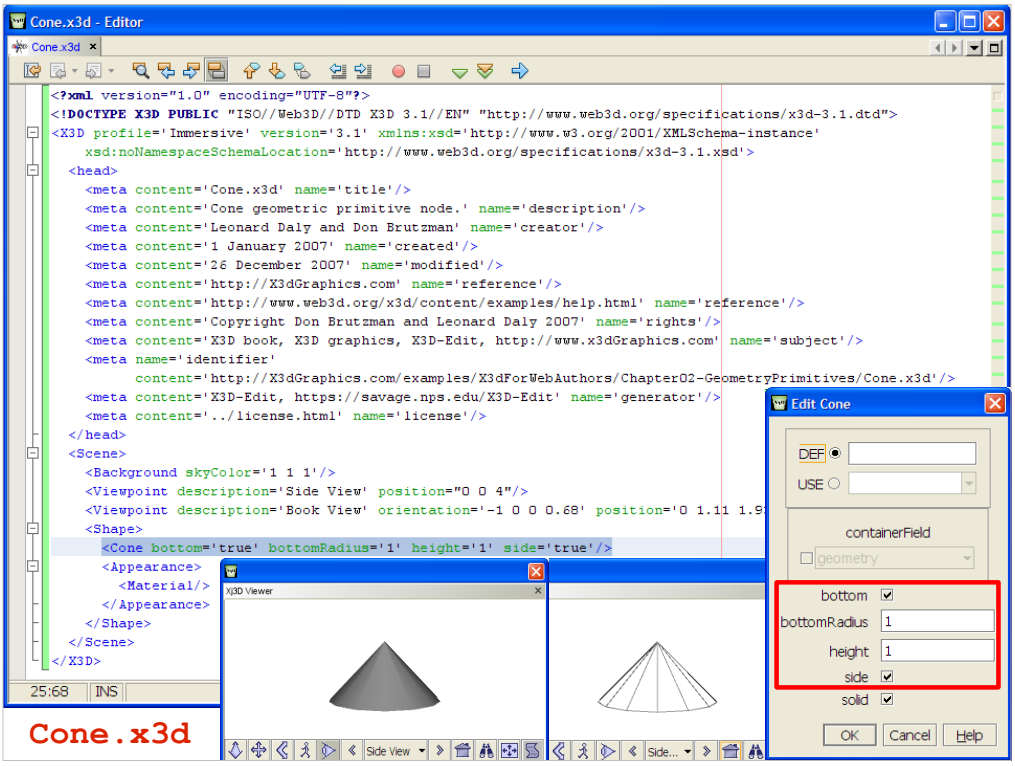
Centered at local origin

Can hide different parts

- *side*='false'
- *bottom*='false'

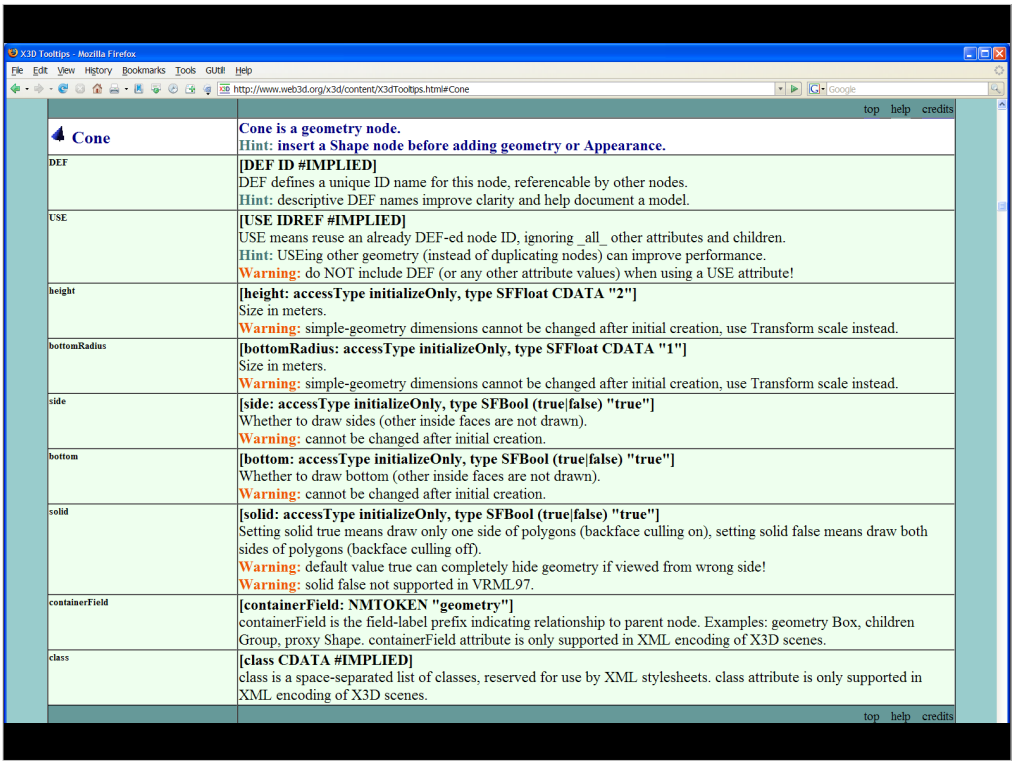


Set *side*='false' (for bottom only) defines a flat circle



From Xj3D help: Alt-W toggles Wireframe rendering mode. Wireframe rendering of geometry is a special feature offered by some browsers and cannot be set by an X3D author.

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/Cone.x3d



http://www.web3d.org/x3d/content/X3dTooltips.html#Cone

Cylinder node

Right-angle cylinder with top and bottom caps

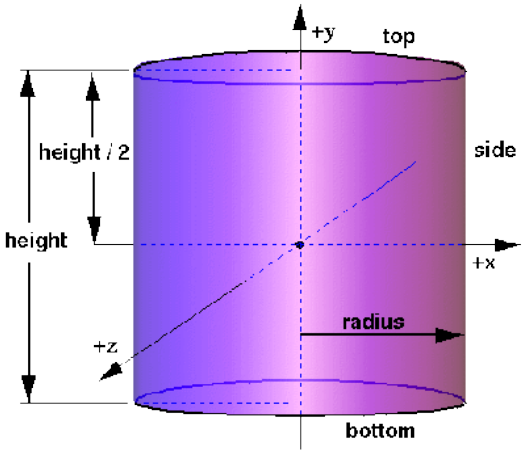
non-zero non-negative *height* above bottom

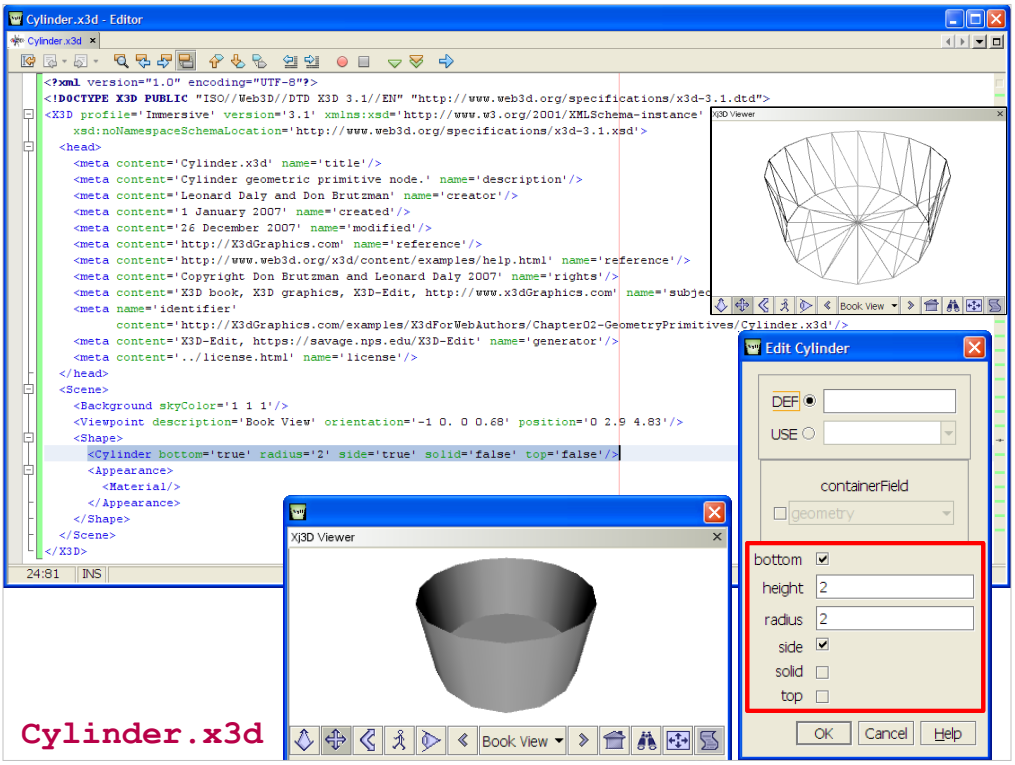
Circular *radius*

Centered at local origin

Can hide different parts

- *side*='false'
- *top*='false'
- *bottom*='false'

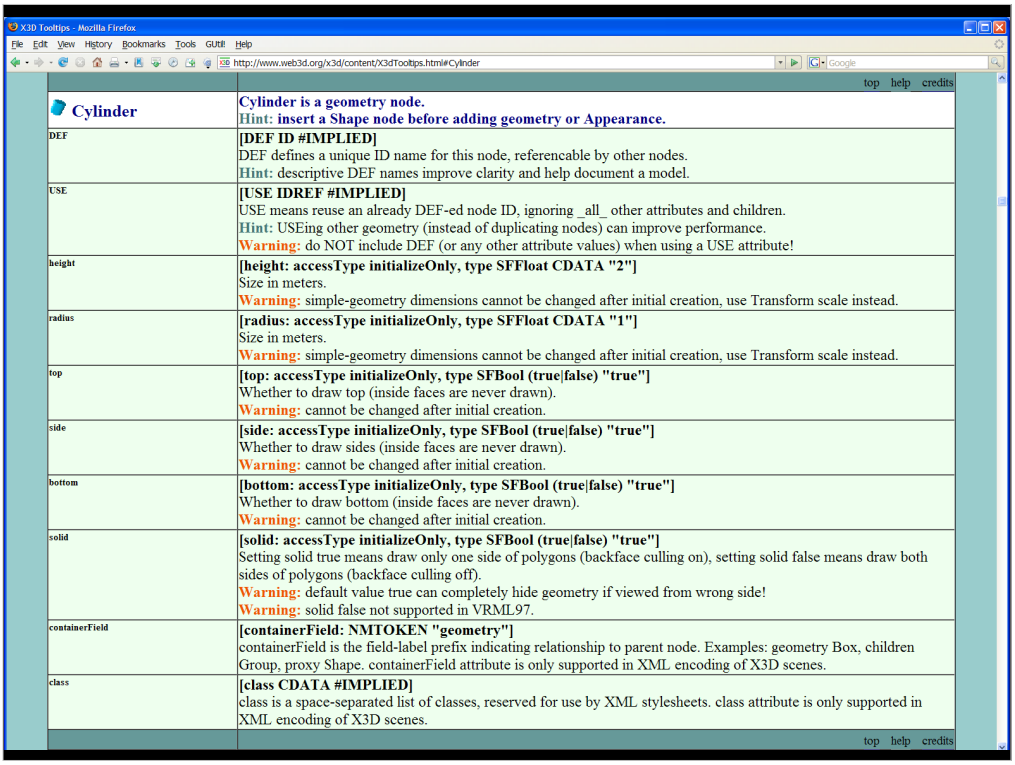




From Xj3D help: Alt-W toggles Wireframe rendering mode. Wireframe rendering of geometry is a special feature offered by some browsers and cannot be set by an X3D author.

Note that wireframe mode can play tricks with your sense of perspective because all line segments are drawn exactly 1-pixel wide.

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/Cylinder.x3d



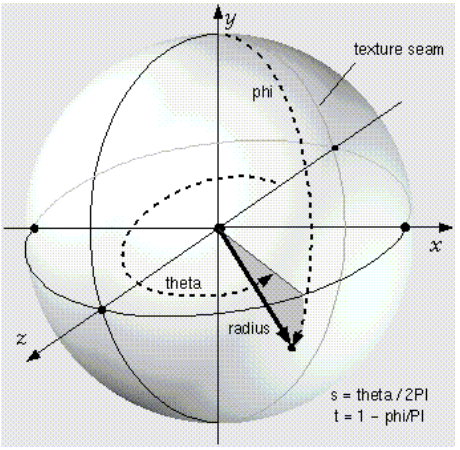
http://www.web3d.org/x3d/content/X3dTooltips.html#Cone

Sphere node

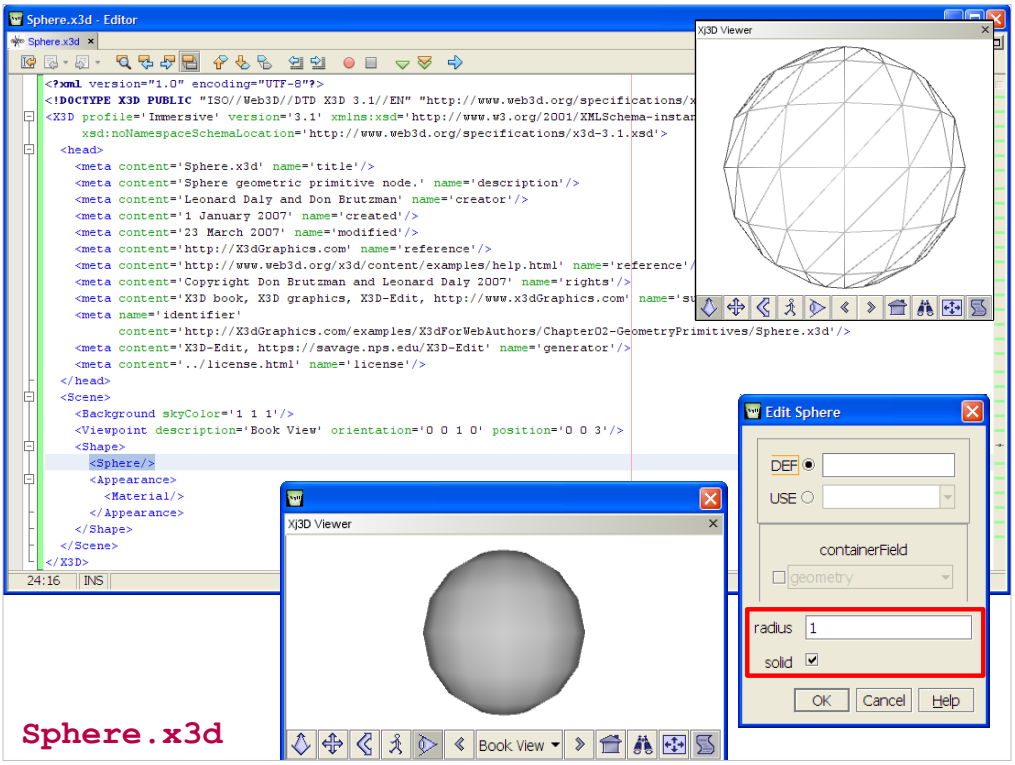
Circular *radius*

Centered at local origin

- phi and theta are implicit
- not defined by author

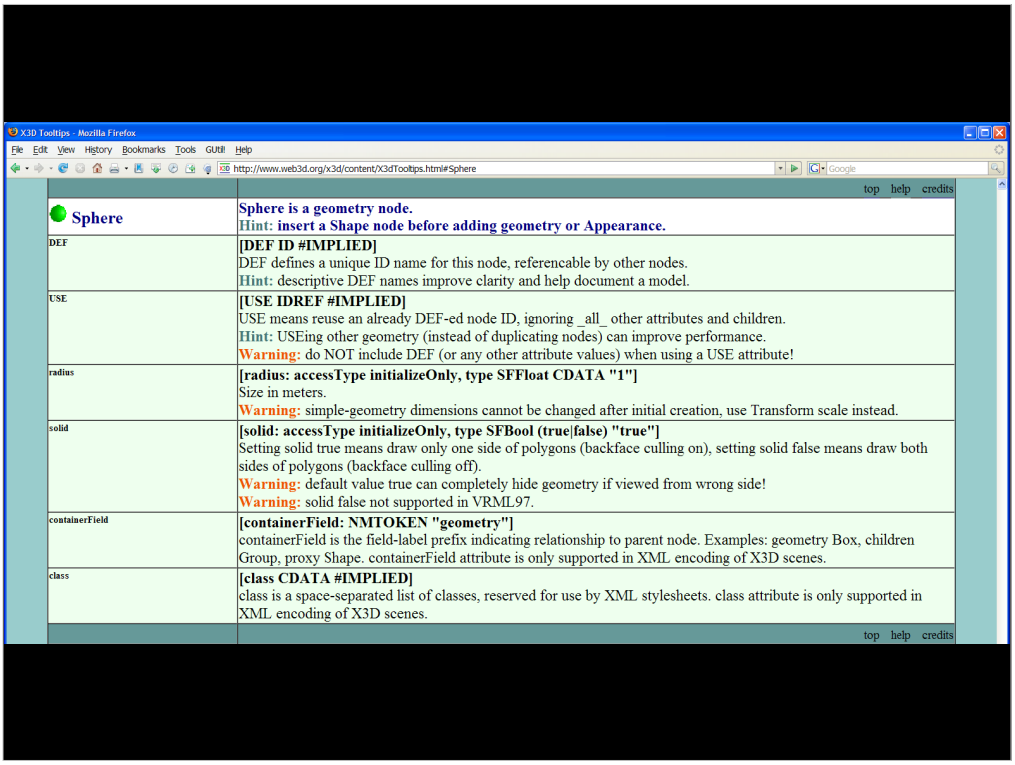


Note that angles are defined in the figure, but these really can't be referenced within the Sphere node.



From Xj3D help: Alt-W toggles Wireframe rendering mode. Wireframe rendering of geometry is a special feature offered by some browsers and cannot be set by an X3D author.

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/Sphere.x3d



http://www.web3d.org/x3d/content/X3dTooltips.html#Sphere

Text node

Produce readable flat, 2D text strings in X3D world

string field is MFString array of "quoted strings"

- Each "quoted string" appears on a separate line

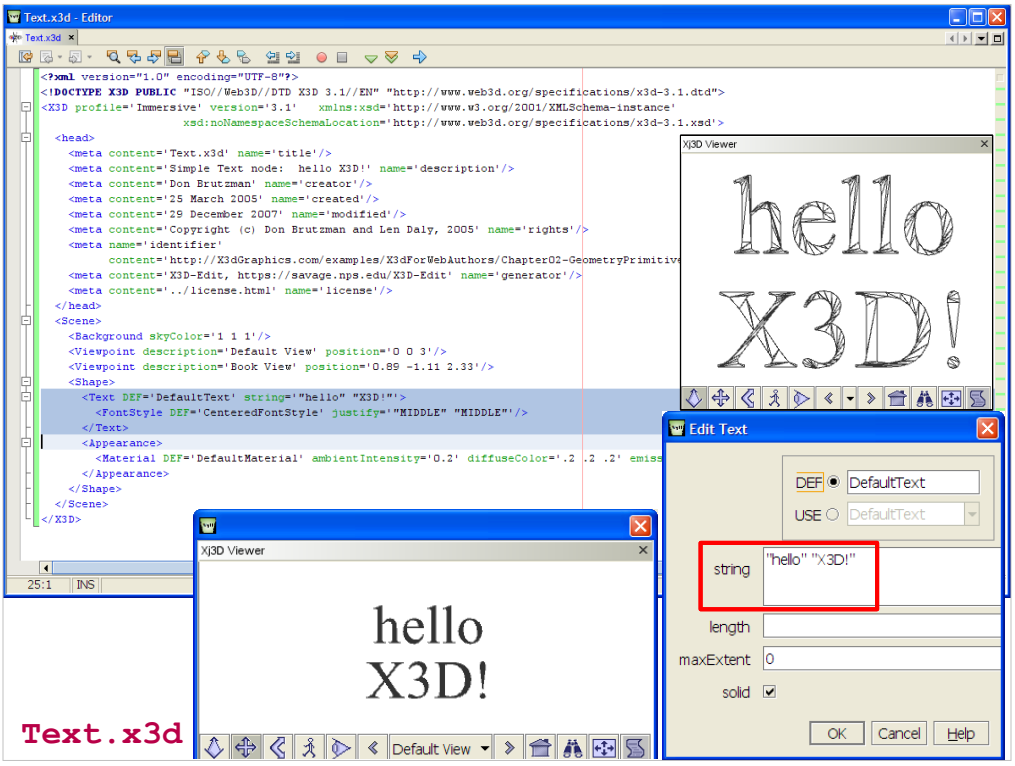
length field is MFFloat array of lengths for each line

- Can shrink or stretch size of each line if needed

maxExtent is maximum length for all substring lines

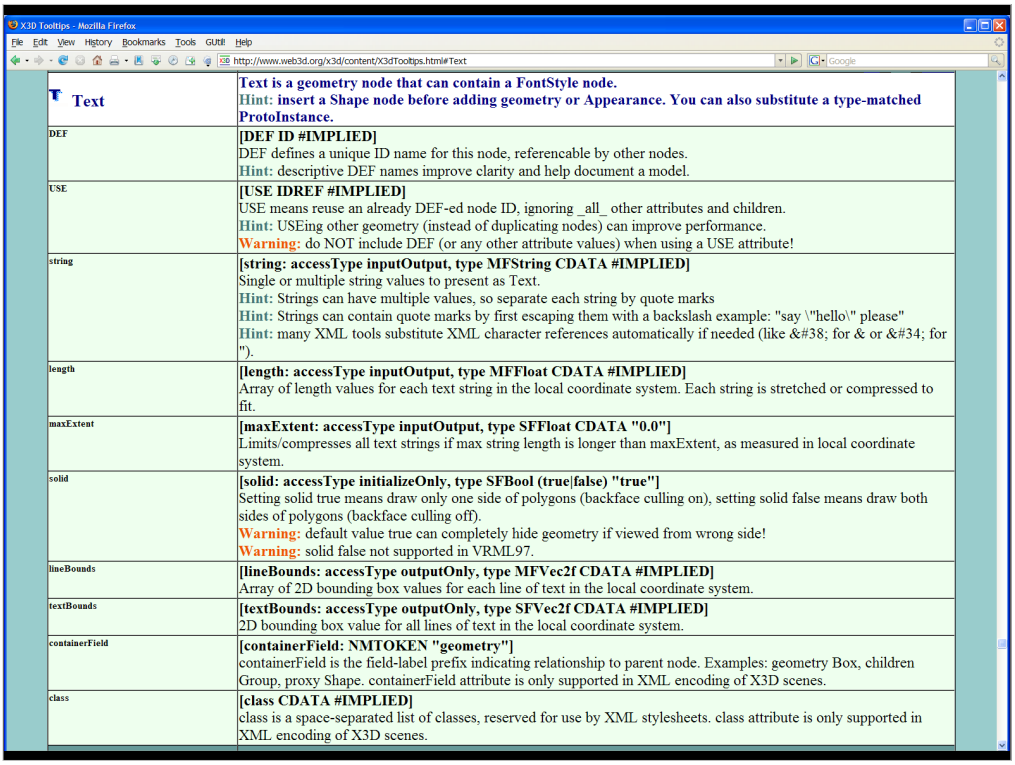
Note characters have no 3D depth

- Flat when viewed from alongside
- Not viewable from behind unless *solid*='false'
- Hint: use Billboard to face user



From Xj3D help: Alt-W toggles Wireframe rendering mode. Wireframe rendering of geometry is a special feature offered by some browsers and cannot be set by an X3D author.

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/Text.x3d

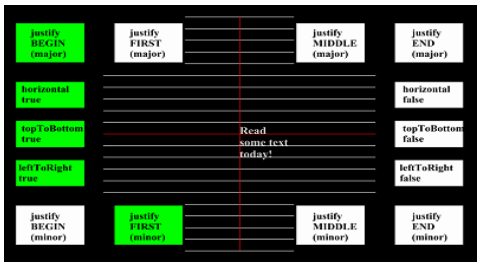


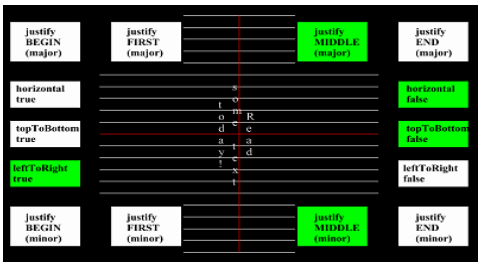
Text	**Text is a geometry node that can contain a FontStyle node.** **Hint: insert a Shape node before adding geometry or Appearance. You can also substitute a type-matched ProtoInstance.**
DEF	**[DEF ID #IMPLIED]** DEF defines a unique ID name for this node, referencable by other nodes. Hint: descriptive DEF names improve clarity and help document a model.
USE	**[USE IDREF #IMPLIED]** USE means reuse an already DEF-ed node ID, ignoring _all_ other attributes and children. Hint: USEing other geometry (instead of duplicating nodes) can improve performance. Warning: do NOT include DEF (or any other attribute values) when using a USE attribute!
string	**[string: accessType inputOutput, type MFString CDATA #IMPLIED]** Single or multiple string values to present as Text. Hint: Strings can have multiple values, so separate each string by quote marks Hint: Strings can contain quote marks by first escaping them with a backslash example: "say \"hello\" please" Hint: many XML tools substitute XML character references automatically if needed (like & for & or " for ").
length	**[length: accessType inputOutput, type MFFloat CDATA #IMPLIED]** Array of length values for each text string in the local coordinate system. Each string is stretched or compressed to fit.
maxExtent	**[maxExtent: accessType inputOutput, type SFFloat CDATA "0.0"]** Limits/compresses all text strings if max string length is longer than maxExtent, as measured in local coordinate system.
solid	**[solid: accessType initializeOnly, type SFBool (true|false) "true"]** Setting solid true means draw only one side of polygons (backface culling on), setting solid false means draw both sides of polygons (backface culling off). Warning: default value true can completely hide geometry if viewed from wrong side! Warning: solid false not supported in VRML97.
lineBounds	**[lineBounds: accessType outputOnly, type MFVec2f CDATA #IMPLIED]** Array of 2D bounding box values for each line of text in the local coordinate system.
textBounds	**[textBounds: accessType outputOnly, type SFVec2f CDATA #IMPLIED]** 2D bounding box value for all lines of text in the local coordinate system.
containerField	**[containerField: NMTOKEN "geometry"]** containerField is the field-label prefix indicating relationship to parent node. Examples: geometry Box, children Group, proxy Shape. containerField attribute is only supported in XML encoding of X3D scenes.
class	**[class CDATA #IMPLIED]** class is a space-separated list of classes, reserved for use by XML stylesheets. class attribute is only supported in XML encoding of X3D scenes.

http://www.web3d.org/x3d/content/X3dTooltips.html#Text

FontStyle node

Defines *size*, font *family*, layout directions and justification, language, and style for Text strings





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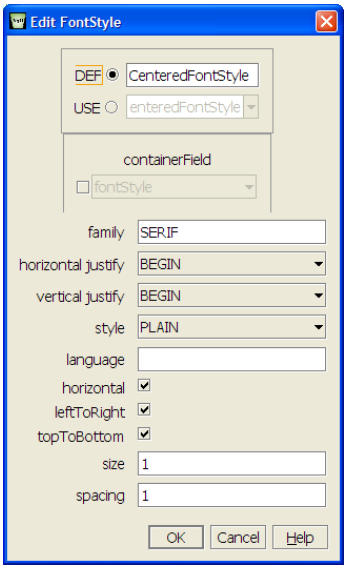
```
<FontStyle justify=' "MIDDLE" "MIDDLE" '/>
```

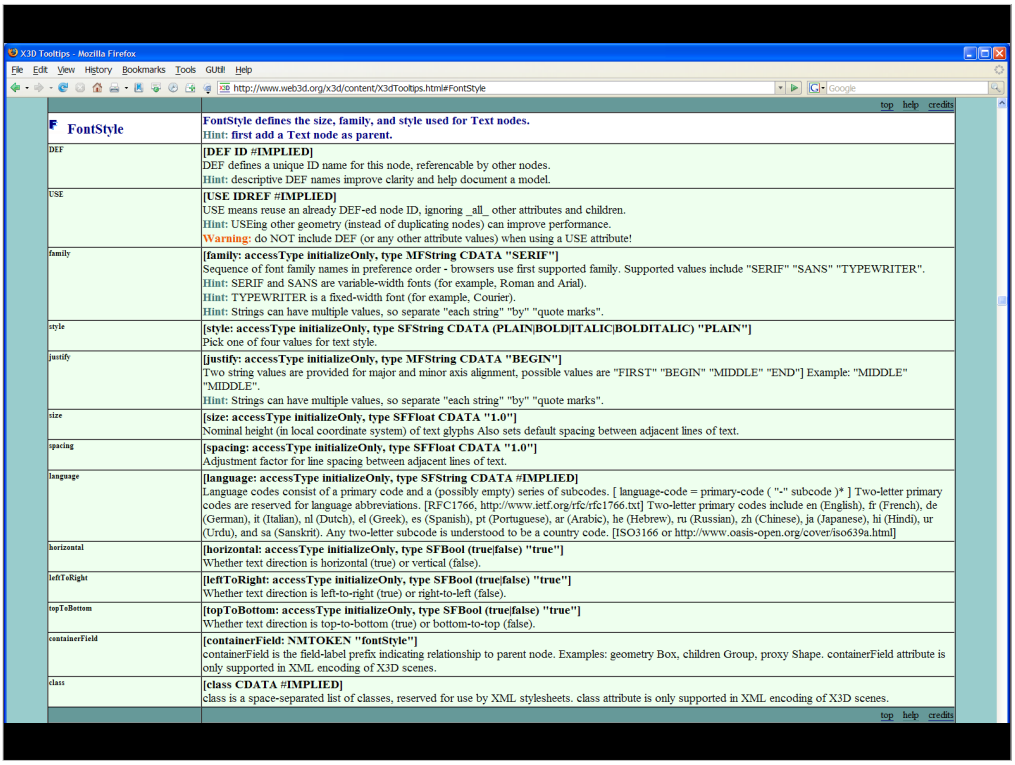


- FontStyle is only allowed as child of a Text node
  - FontStyle modifies that parent
- Other supported default font family values are SANS (serif) and TYPEWRITER
  - Additional font families require special browser support
- Other field values support internationalization (I18N) and localization (L10N)
  - DEF, USE for consistent look

Dialog box is from the same Text.x3d scene:

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives/Text.x3d

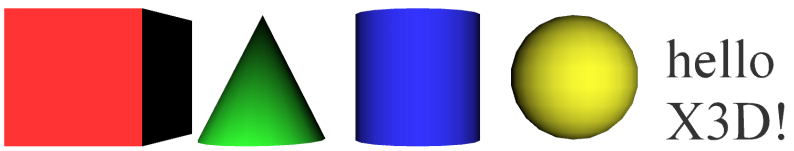
DEF a single FontStyle near the top of a scene, then USE it whenever a Text node appears elsewhere, in order to easily maintain or change consistent font styles throughout a document.



http://www.web3d.org/x3d/content/X3dTooltips.html#FontStyle

Review

Geometry Primitives



Primitives are simple geometric constructs

Shape, geometry, Appearance, Material pattern

Browsers decide implementation details, including quality of tessellation resolution

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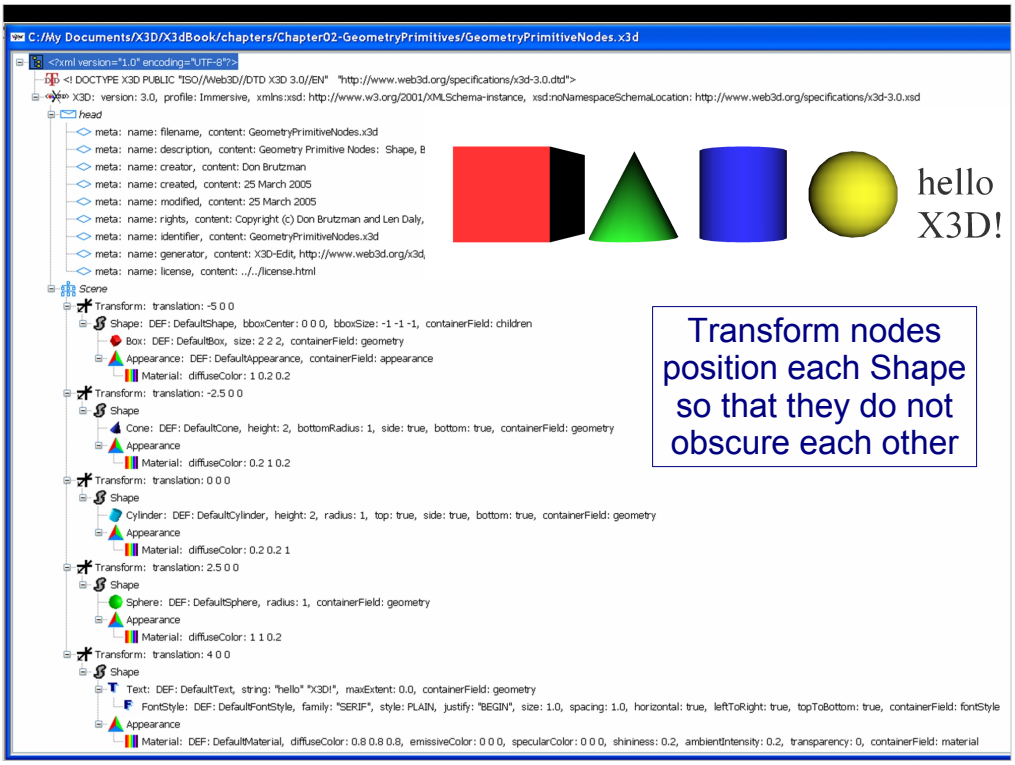

This scene-graph screen snapshot was taken using X3D-Edit 3.1.

http://www.x3dbook.com/examples/X3dForWebAuthors/Chapter02-GeometryPrimitives
GeometryPrimitiveNodes.x3d

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Additional Resources

Multilingual X3D tooltips

X3D tooltips are available online and bundled in the X3D-Edit help pages

X3D tooltips are available in the following languages

- English
- German
- Spanish
- Chinese
- Italian
- French
- Portuguese

Translations into other languages are welcome

http://www.web3d.org/x3d/content/X3dTooltips.html

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http://www.web3d.org/x3d/content/X3dTooltipsChinese.html

http://www.web3d.org/x3d/content/X3dTooltips.html (English)

http://www.web3d.org/x3d/content/X3dTooltipsFrench.html

http://www.web3d.org/x3d/content/X3dTooltipsGerman.html

http://www.web3d.org/x3d/content/X3dTooltipsItalian.html

http://www.web3d.org/x3d/content/X3dTooltipsPortuguese.html

http://www.web3d.org/x3d/content/X3dTooltipsSpanish.html

X3D spec excerpt for Shape node

12.4.5 Shape

```
Shape : X3DShapeNode {
  SFNode  [in,out] appearance NULL     [X3DAppearanceNode]
  SFNode  [in,out] geometry   NULL     [X3DGeometryNode]
  SFNode  [in,out] metadata   NULL     [X3DMetadataObject]
  SFVec3f []       bboxCenter 0 0 0    (-∞,∞)
  SFVec3f []       bboxSize   -1 -1 -1 [0,∞) or -1 -1 -1
}
```

The Shape node has two fields, *appearance* and *geometry,* which are used to create rendered objects in the world. The *appearance* field contains an Appearance node that specifies the visual attributes (e.g., material and texture) to be applied to the geometry. The *geometry* field contains a geometry node. The specified geometry node is rendered with the specified appearance nodes applied. See 12.2 Concepts for more information.

17 Lighting component contains details of the X3D lighting model and the interaction between Appearance nodes and geometry nodes.

If the *geometry* field is `NULL`, the object is not drawn.

The *bboxCenter* and *bboxSize* fields specify a bounding box that encloses the Shape node's geometry. This is a hint that may be used for optimization purposes. The results are undefined if the specified bounding box is smaller than the actual bounding box of the geometry at any time. A default *bboxSize* value, (-1, -1, -1), implies that the bounding box is not specified and, if needed, is calculated by the browser. A description of the *bboxCenter* and *bboxSize* fields is contained in 10.2.2 Bounding boxes.

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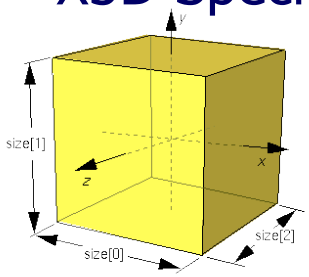
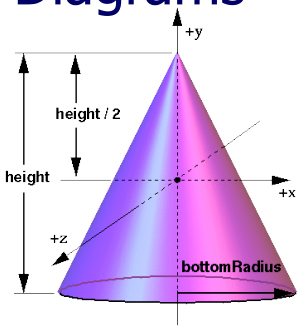
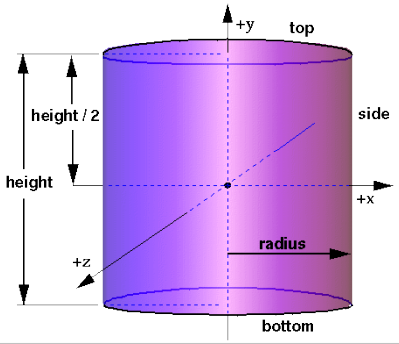
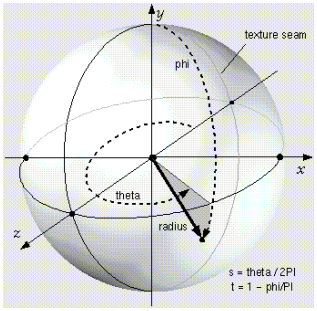
X3D Specification Diagrams









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Chapter Summary

Chapter Summary

Shape is a container node for a single piece of geometry

Geometry primitive nodes

- Box, Cone, Cylinder, Sphere, Text
- FontStyle supports Text

Numerous additional resources

- X3D tooltips, with multilingual versions available
- X3D specifications
- Each are integrated within X3D-Edit authoring tool

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References

References 1

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

- Chapter 2, Geometry Primitives
- http://x3dGraphics.com

X3D Examples Help

- http://www.web3d.org/x3d/content/examples/help.html

X3D-Edit Authoring Tool

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

References 2

VRML 2.0 Sourcebook by Andrea L. Ames, David R. Nadeau, and John L. Moreland, John Wiley & Sons, 1996.

- http://www.wiley.com/legacy/compbooks/vrml2sbk/cover/cover.htm
- http://www.web3d.org/x3d/content/examples/Vrml2.0Sourcebook
- Chapter 02 – Introduction
- Chapter 03 – Shapes
- Chapter 04 – Text

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Related concepts

Appearance node: chapter 5
Background node: chapter 11
Material node: chapter 5
Transform node: chapter 3
Viewpoint node: chapter 4

Bounding boxes: chapter 12

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