#### X3D Graphics for Web Authors

Chapter 11

## Lighting and Environment Nodes

*Daylight encourages good behavior.* Don Brutzman





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**Chapter Overview** 

Lighting Concepts and Lighting Nodes

**Environment Concepts and Environment Nodes** 

**Chapter Summary and Suggested Exercises** 





#### **Chapter Overview**





### **Overview: Lighting and Environment**

#### Lighting concepts

• Illuminating scene geometry with virtual lights

#### Lighting nodes

web

- DirectionalLight
- NavigationInfo headlight
- PointLight, Spotlight
- **Environment concepts** 
  - X3DBackgroundNode type and common fields

Environmental effects nodes

• Background, TextureBackground, Fog



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## Lighting Concepts



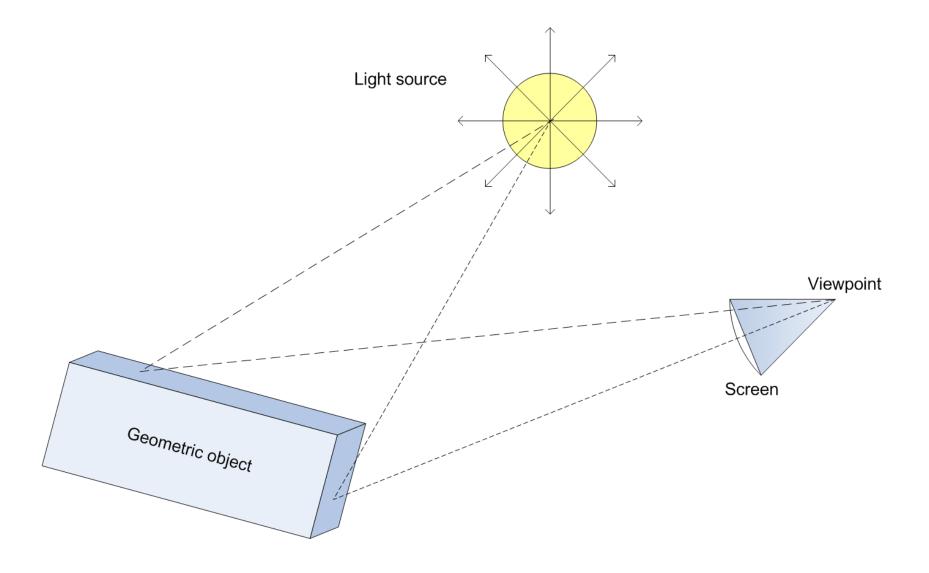


#### Illuminating objects in 3D scenes 1

- So far we have studied the creation of 3D shapes and then positioning the camera to view them
- Third major component is needed for 3D scenes: virtual lights that emulate sources in real world
- Such lighting occurs computationally angles of incidence and reflection between lights and viewer are computed for each geometric shape
  - Additional lighting factors are also considered
- Pixel brightness reaching viewer thus depends on light sources, shape appearance, view angle



#### Illuminating objects in 3D scenes 2



#### Performance is paramount

Frame rate (measured in fps, frames per second) must be high for users to believe a 3D scene is interactive and responsive to their touch

- Human perception of smooth motion is 7-8 fps
- Keep frame rate above 10-15 fps in your scenes
- Adding multiple lights in a scene can improve realism, if done properly
  - Contributions of each can be added, pixel by pixel
- However lights add significant computational cost, doubling/tripling/etc. rendering overhead
  - Thus light management requires careful control

Approximations necessary for interactive real-time performance The mathematics of optics are quite complex

Compare sizes of graphics and optics textbooks!

Ultra-high-fidelity computation of lighting effects is possible, and subject of ongoing research

Nevertheless the computational complexity of such effects are prohibitive for most computers

Thus a number of careful approximations made in lighting equations and material functions, allowing reasonable rendering to occur while supporting interactive real-time performance



### Other render techniques possible

A variety of higher-fidelity systems are available that use different techniques

• Ray tracing, volumetric rendering, light fields, etc. Nevertheless most interactive 3D graphics systems use identical (or at least similar) lighting equations and rendering techniques Following precomputation, advanced techniques can often export results for 3D rendering Thus X3D is a good match for each approach when interactive export to Web is needed web

## Achieving a balance

Authoring the right mix of lighting, appearance and viewing is both technical and artistic

 This is why both types of activity are prevalent in the graphics community

Making a scene "look good" sometimes requires technical shortcuts or workarounds that do not exactly match the original real-world effects

Carefully applying these techniques to achieve an attractive, functional scene is the primary challenge facing all 3D graphics authors





# Common lighting fields 1

- *ambientIntensity* determines brightness of assumed reflected background ambient lighting, which occurs in most indoor and outdoor locations. This field also helps ensure that objects remain visible.
- *intensity* indicates the direct brightness of a light shining from the source location, and can be used to adjust relative strengths of multiple lights
- color specifies the red-green-blue (RGB) spectral components of the light source; adding to (or subtracting from) all three components affects the output by whitening (or darkening) the light source





### Common color values

Color	RGB Value	HTML Value
Black	000	#000000
Green	0 0.5 0	#008000
Silver	0.75 0.75 0.75	#C0C0C0
Lime	010	#00FF00
Gray	0.5 0.5 0.5	#808080
Olive	0.5 0.5 0	#808000
White	111	#FFFFFF
Yellow	1 1 0	#FFFF00
Maroon	0.500	#800000
Navy	000.5	#000080
Red	100	#FF0000
Blue	001	#0000FF
Purple	0.500.5	#800080
Teal	0 0.5 0.5	#008080
Fuchsia	101	#FF00FF
Aqua	011	#00FFFF

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# Common lighting fields 2

- *global* indicates whether the scope of a light affects the entire 3D scene, or simply the local geometry shared within a common parent grouping node. This can be expensive in large scenes, do not set *global=*'true' unless the effect is intentional
- *on* is the boolean field which turns a light on/off, allowing simple animation effects





# Lighting limitations 1

Light shines through geometry and illuminates objects that block each other

- Necessary limitation to support real-time rendering
- Can be surprising but usually not noticeable

No shadows

• Might be supported in a future X3D specification

Placing a light inside an object is problematic

- Only illuminates back faces, resulting in no light to externally visible faces
- Avoid, unless intentionally showing light location



# Lighting limitations 2

Maximum number of active lights: 8

- Can use more if turned off/on appropriately
- Matches limits of OpenGL, DirectX, GPU hardware
- Actually this is a high number for most applications





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#### Lighting Nodes and Examples





### DirectionalLight node

DirectionalLight provides uniform-intensity light as set of parallel rays sharing a single direction

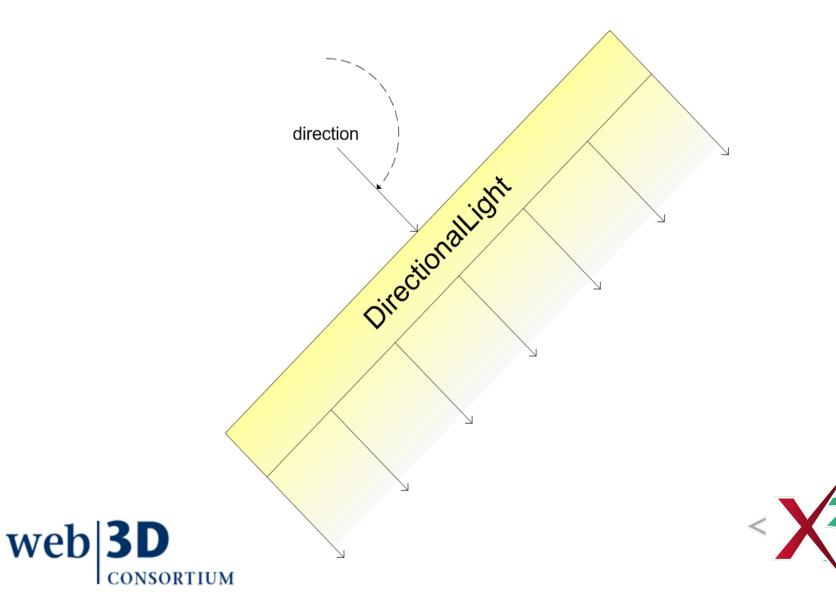
- Each surface facing the light gets some illumination
- Backface polygons, surfaces parallel to light rays remain unlit by direct *intensity*
- All surfaces lit by *ambientIntensity*, facing or not

Angle of incidence/reflection and appearance properties of lit shapes are primary factors on reflected color, brightness of lit objects

Emulates distant light source, such as the sun

• Intensity does not diminish with distance

### DirectionalLight geometry



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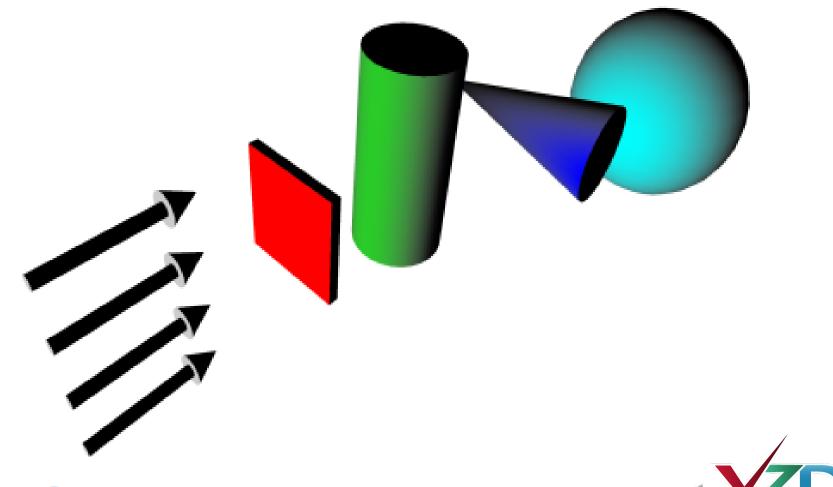
## DirectionalLight fields

- *ambientIntensity, color, global, intensity, on* same
- *direction* is x-y-z vector indicating direction of rays in local coordinate system, which in turn depends on rotations in parent Transform node hierarchy

#### Hints

- Misdirected DirectionalLight nodes hard to debug, since light nodes themselves are not visible
- Substitute a PointLight node to get indication of where the light actually is located
- Can rotate DirectionalLight via parent Transform, also semitransparent Cone for direction, range
- Position irrelevant since constant intensity, direction

#### No shadows, constant intensity







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➡ DirectionalLight	DirectionalLight creates parallel light rays to illuminate geometric shapes. Light is scoped and only illuminates geometry within its enclosing parent group! No source location is needed since rays are parallel from an infinitely distant source. DirectionalLight nodes do not attenuate with distance. Lights have no visible shape themselves and shine through occluding geometry. Hint: animate direction to simulate time-of-day sunlight effects. Hint: HeadLight is controlled by NavigationInfo. Interchange profile hint: light might not be scoped by parent Group or Transform. [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 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!
	[on: accessType inputOutput, type SFBool (true false) "true"] Enables/disables this light source.
	[color: accessType inputOutput, type SFColor CDATA "111"] color of light, applied to colors of objects.
	[direction: accessType inputOutput, type SFVec3f CDATA ''0 0 -1''] Orientation of light relative to local coordinate system. Hint: animate direction to simulate time-of-day sunlight effects.
	[intensity: accessType inputOutput, type SFFloat CDATA "1"] [01] Brightness of direct emission from the light.
	[ambientIntensity: accessType inputOutput, type SFFloat CDATA "0"] [01] Brightness of ambient (nondirectional background) emission from the light. Interchange profile hint: this field may be ignored.
	[global: accessType inputOutput, type SFBool (true false) "false"] Global lights illuminate all objects within their volume of lighting influence. Scoped lights only illuminate objects within the same transformation hierarchy.
	[containerField: NMTOKEN "children"] 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 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.

## NavigationInfo headlight

- The NavigationInfo node's *headlight* field enables a special DirectionalLight that follows user's current view location, pointing straight ahead
  - Enables a light source that is always pointing in direction of user's view, ensuring objects are lit
  - *headlight*='true' by default, color is always white

*headlight* matches the following characteristics, pointed out from center of current active view:

<DirectionalLight color='1 1 1'
 intensity='1' ambientIntensity='1'
 direction='0 0 -1'/>



## NavigationInfo headlight, X3D-Edit

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# PointLight node

PointLight emulates single light source that radiates equally in all directions

• Analogy: single small light

PointLight intensity varies with distance to object

- Longer travel means less light arrives from source
   Rotation is irrelevant since light is omnidirectional
   Shared traits with other lights:
  - No shadows, light not blocked by other geometry
  - No visible representation in space of light itself



omnidirectional

PointLight

## PointLight fields

- *ambientIntensity, color, global, intensity, on* same
- attenuation array holds constant, linear, quadratic coefficients for distance-attenuation factor
   factor = 1 / max (atten[0] + atten[1]•r + atten[2]•r<sup>2</sup>, 1)
   Note that non-constant (linear and quadratic)

Note that non-constant (linear and quadratic) coefficients are computationally expensive per pixel

- *location* is SFVec3f position indicating origin of rays relative to local coordinate system, which in turn depends on translations and rotations in parent Transform node hierarchy
- *radius* gives maximum effective range of light rays from source *location*, must be nonnegative web 3D CONSORTIUM

## PointLight considerations

- Because light intensity falls off with distance, brightness can vary across a single object
  - Computed on a polygon-per-polygon basis for computational efficiency

This effect is not visible if a large polygon is used

- Since entire polygon receives consistent shading
- Thus special tools for detailed tesselation of simple shapes might be needed to achieve special lighting effects
  - Careful choice of viewing angle usually sufficient



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🔆 PointLight	PointLight is a light source that illuminates shapes in all directions. Light illuminates all geometry and is normally scoped to illuminate peers and children nodes within the scene graph hierarchy Lights have no visible shape themselves and shine through occluding geometry. Hint: HeadLight is controlled by NavigationInfo.
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 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!
on	[on: accessType inputOutput, type SFBool (true false) "true"] Enables/disables this light source.
color	[color: accessType inputOutput, type SFColor CDATA ''1 1 1''] color of light, applied to colors of objects.
location	[location: accessType inputOutput, type SFVec3f CDATA ''0 0 0''] Position of light relative to local coordinate system.
intensity	[intensity: accessType inputOutput, type SFFloat CDATA "1"] [01] Brightness of direct emission from the light.
ambientIntensity	[ambientIntensity: accessType inputOutput, type SFFloat CDATA "0"] [01] Brightness of ambient (nondirectional background) emission from the light.
radius	[radius: accessType inputOutput, type SFFloat CDATA ''100''] Maximum effective distance of light relative to local light position, affected by ancestor scaling.
attenuation	[attenuation: accessType inputOutput, type SFVec3f CDATA ''1 0 0''] Constant, linear-distance and squared-distance dropoff factors.
global	[global: accessType inputOutput, type SFBool (true false) "false"] Global lights illuminate all objects within their volume of lighting influence. Scoped lights only illuminate objects within the same transformation hierarchy.
containerField	[containerField: NMTOKEN "children"] 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.

## SpotLight node

SpotLight illuminates shapes within conical beam

- Intensity decreases with distance from source
- Spotlight can be considered similar to PointLight with exception that computed light is constrained to be within conical beams, defined by solid angles
  - Center portion of cone (indicated by *beamWidth*) receives full intensity
  - Outer portion of light cone has linear drop off of reduced intensity (indicated by *cutOffAngle*)



## SpotLight fields 1

- *ambientIntensity, color, global, intensity, on* same
- attenuation array holds constant, linear, quadratic coefficients for distance-attenuation factor
   factor = 1 / max (atten[0] + atten[1]•r + atten[2]•r<sup>2</sup>, 1)
   Note that non-constant (linear and quadratic)

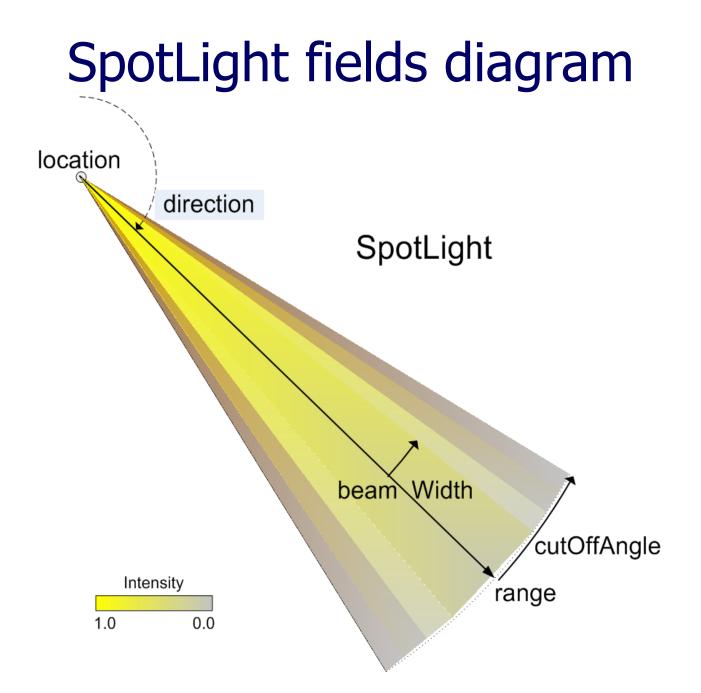
coefficients are computationally expensive per pixel

- *location* is SFVec3f position indicating origin of rays relative to local coordinate system, which in turn depends on translations and rotations in parent Transform node hierarchy
- *radius* gives maximum effective range of light rays from source *location*, must be nonnegative web 3D CONSORTIUM

# SpotLight fields 2

- *beamWidth* specifies the half angle (in radians) about the SpotLight direction that corresponds to maximum uniform intensity
- cutOffAngle specifies the half angle (in radians) about the SpotLight direction that corresponds to outer bound of SpotLight node's effect. Outside of this solid angle, no light is provided.
- Constraint:  $0 \le beamWidth \le cutOffAngle \le pi/2$
- *direction* is x-y-z vector indicating direction of rays in local coordinate system, which in turn depends on rotations in parent Transform node hierarchy





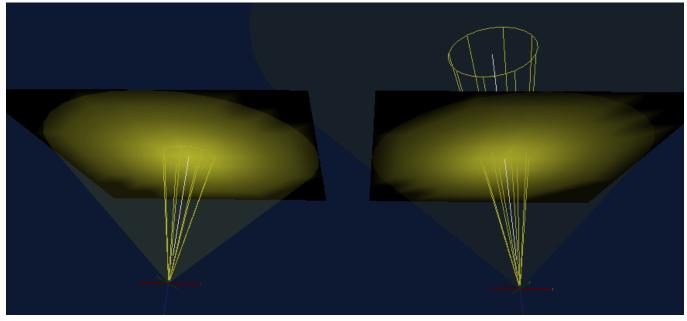
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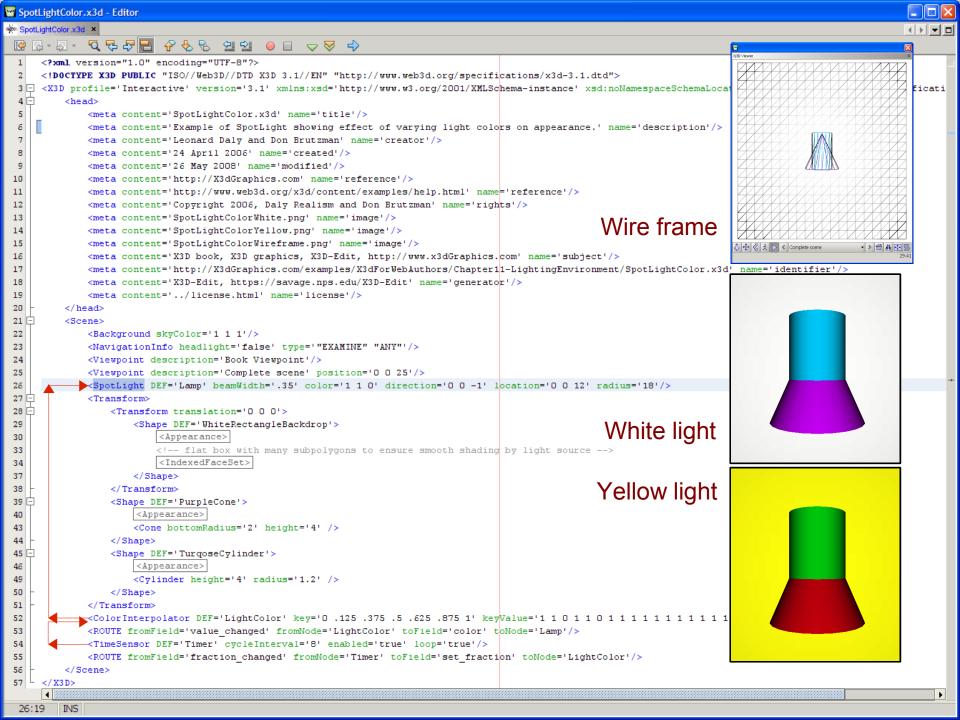
## SpotLight visualization

X3D-Edit has an authoring assist to show outlines for SpotLight fields

- cutOffAngle shown by wireframe
- *beamWidth* shown by transparent Cone
- Example: SpotLightVisualization.x3d

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USE	
on	
color	0.8 0.8 0.2
location	0 0 0
radius	10
direction	0 0 -1
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关 SpotLight	SpotLight is a light source that illuminates geometry within a conical beam. Light illuminates all geometry and is normally scoped to illuminate peers and children nodes within the scene graph hierarchy Lights have no visible shape themselves and shine through occluding geometry. Hint: HeadLight is controlled by NavigationInfo.
	[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 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!
on	[on: accessType inputOutput, type SFBool (true false) "true"] Enables/disables this light source.
color	[color: accessType inputOutput, type SFColor CDATA ''1 1 1 1''] color of light, applied to colors of objects.
	[location: accessType inputOutput, type SFVec3f CDATA "0 0 0"] Position of light relative to local coordinate system.
direction	[direction: accessType inputOutput, type SFVec3f CDATA ''0 0 -1''] Orientation of light relative to local coordinate system.
	[intensity: accessType inputOutput, type SFFloat CDATA "1"] [01] Brightness of direct emission from the light.
ambientIntensity	[ambientIntensity: accessType inputOutput, type SFFloat CDATA "0"] [01] Brightness of ambient (nondirectional background) emission from the light.
attenuation	[attenuation: accessType inputOutput, type SFVec3f CDATA ''1 0 0''] Constant, linear-distance and squared-distance dropoff factors.
radius	[radius: accessType inputOutput, type SFFloat CDATA ''100''] Maximum effective distance of light relative to local light position, affected by ancestor scaling.
beamWidth	[beamWidth: accessType inputOutput, type SFFloat CDATA ''1.570796''] Inner solid angle (in radians) where light source has uniform full intensity if beamWidth > cutOffAngle, beamWidth reset to equal cutOffAngle.
cutOffAngle	[cutOffAngle: accessType inputOutput, type SFFloat CDATA ''.785398''] Outer solid angle (in radians) where light source intensity becomes zero if beamWidth > cutOffAngle, beamWidth reset to equal cutOffAngle.
global	[global: accessType inputOutput, type SFBool (true false) "false"] Global lights illuminate all objects within their volume of lighting influence. Scoped lights only illuminate objects within the same transformation hierarchy.
containerField	[containerField: NMTOKEN "children"] 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.

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### **Environment Concepts**





## **Environmental effects**

Three nodes provide environmental effects that can increase overall realism of an X3D scene

- Background defines either color arrays or images for defining the scene horizon, including vertical variations that emulate both sky and earth/sea
- TextureBackground similarly defines background but uses ImageTexture nodes instead of image urls
- Fog emulates actual fog by washing out pixels according to distance from camera, usually to match color (or blackness) of the background

Helpful techniques to improve scene realism



# X3DBackgroundNode type 1

The X3DBackgroundNode type defines common functionality and fields for background nodes

Background and TextureBackground

Each node is bindable, on same binding stack

- Thus only one Background or TextureBackground node can be active at a single time
- Similar to Viewpoint, NavigationInfo, Fog

Binding nodes explained in detail for Viewpoint

- Chapter 4, Viewing and Navigation
- Same techniques apply for all four binding stacks



# X3DBackgroundNode type 2

Conceptually the background nodes apply colors or images to the horizon

- Color arrays are mapped to a distant sphere
- Images are mapped to a distant box
- The user viewpoint is not able to approach these background colors and images, since they are always kept at the horizon
  - Other objects in the scene always appear in front, and cannot be placed behind the background

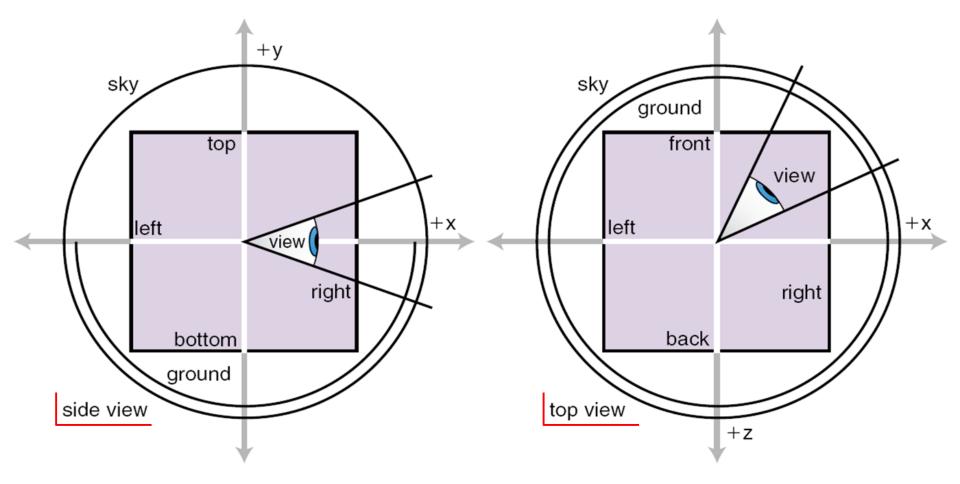
Affected by parent rotations, not translations





## X3DBackgroundNode fields 1

Side and top views show geometric relationships for sky+ground, top+bottom, left+right, front+back



# X3DBackgroundNode fields 2

- groundAngle and skyAngle arrays list angles corresponding to color values for ground and sky
- groundAngle in radians monotonically increases from 0.0 (nadir, or straight down) to pi/2 (horizon), going upward
- *skyAngle* in radians monotonically increases from 0.0 (zenith, or straight up) to pi/2 (horizon) and on to pi (nadir, or straight down), going downward
- groundColor and skyColor arrays provide corresponding color values for each angle, intermediate RGB colors are smoothly interpolated



# X3DBackgroundNode fields 3

#### Constraints on angles and colors:

wel

- First color in array is zenith/nadir, no angle needed *skyAngle.*length + 1 = *skyColor.*length *groundAngle.*length + 1 = *groundColor.*length
- Each angle value must monotonically increase (thus repetition is allowed for constant color bands)
- When duplicate angular coverage is provided, groundColor values obscure skyColor values (but only as far as the horizon, by definition)
- If no *groundColor* values are provided, then final *skyColor* value is clamped and continues to nadir

• Thus sole skyColor value defines entire background

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### **Environment Nodes and Examples**





### Background node: color arrays

Background can provide simple colors or images for ground and sky, which appear behind any other geometric shapes in the scene

Background implements X3DBackgroundNode and X3DBindableNode types

Background colors form horizontal circular bands at the user's horizon which gradually change from one color value to the next along the vertical direction





### Background node: image files via url

Images (if used) form a box around user

- Once again, positioned at distance of horizon
- Top+bottom, left+right, front+back
- Not all images required, but usually at least 4 side images included for visual coverage Various url fields are each arrays
  - Allowing both local, remote addresses for each file
- Transparent pixels are allowed in image textures
  - If present, background colors appear through them





## Background fields

topUrl, bottomUrl, leftUrl, rightUrl, frontUrl, backUrl

• Separate url arrays for each image, for reliability

X3DBindableNode fields

- *set\_bind* is inputOnly event to bind or unbind node
- *isBound* is outputOnly event indicating whether the node is bound or unbound
- *bindTime* is outputOnly event providing the time that the node is bound





#### UniversalMediaPanorama backgrounds

#### The UniversalMedia project includes a number of high-quality image backgrounds

http://www.web3d.org/x3d/content/examples/Basic/UniversalMediaPanoramas

#### Excerpt showing large number of url addresses:

- <Background
  - backUrl='
  - "urn:web3d:media:textures/panoramas/desert\_1\_back.jpg"
  - "desert\_1\_back.jpg"

"file:///c:/www.web3d.org/x3d/content/examples/UniversalMediaPanoramas/desert\_1\_back.jpg"

"http://www.web3d.org/WorkingGroups/media/textures/panoramas/desert\_1\_back.jpg"

"http://www.web3d.org/x3d/content/examples/Basic/UniversalMediaPanoramas/desert\_1\_back.jpg"

- "http://www.web3dmedia.com/UniversalMedia/textures/panoramas/desert\_1\_back.jpg"
- "http://www.officetowers.com/UniversalMedia/textures/panoramas/desert\_1\_back.jpg"

"http://geometrek.com/UniversalMedia/textures/panoramas/desert\_1\_back.jpg"

"http://www.sc.ehu.es/ccwgamoa/UniversalMedia/textures/panoramas/desert\_1\_back.jpg"

/> <!-- etc. for other fields -->



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1	<pre><?xml version="1.0" encoding="UTF-8"?></pre>
2	X3D PUBLIC "ISO//Web3D//DTD X3D 3.1//EN" "http://www.web3d.org/specifications/x3d-3.1.dtd"
<b>3</b> 📮	] <x3d background-kelpforestmain.x3d'="" name="title" profile="Immersive" version="3.1" xmlns:xsd="http://www.w3.org/2001/XMLSchema-instance" xsd:nonamespaceschemalocation="http://www.web3d.or&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;4 🛱&lt;/td&gt;&lt;td&gt;&lt;head&gt;&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;5&lt;/td&gt;&lt;td&gt;&lt;meta content="></x3d>
6	<pre><meta content="Added a Background node to the KelpForest world." name="description"/></pre>
7	<meta content="Don Brutzman Revised: Leonard Daly for X3D Book" name="creator"/>
8	<meta content="1 June 1998" name="created"/>
9	<meta content="26 May 2008" name="modified"/>
10	<meta content="http://web.nps.navy.mil/~brutzman/kelp" name="reference"/>
11	<pre><meta content="http://web.nps.navy.mil/~brutzman/kelp/KelpForestDesignPaper.pdf" name="reference"/></pre>
12	<meta content="Kelp Forest 3D models" name="subject"/>
13	<meta content="All content has permissions for free use. Please provide credit to the Naval Postgraduate School (NPS) Modeling Virtual Envi&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;14&lt;/td&gt;&lt;td&gt;&lt;meta content=" examples="" http:="" kelpforestexhibit="" kelpforestmain.x3d'="" name="reference" x3dforwebauthors="" x3dgraphics.com=""/>
15	<meta content="http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3d" https:="" name="generator" savage.nps.edu="" x3d-edit'="" x3d-edit,=""/>
17	<meta content="/license.html" name="license"/>
18	-
19 -	
20	<background "="" "added:="" "dtg="" "kelpforestmain3.4.wrl"="" "model="" "upda<br="" "urn:web3d.org="" 111500jun98"="" and="" aquarium="" background="" backurl='"urn:web3d.org/x3d/content/example and the Mantana Background backgr&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;21&lt;br&gt;22&lt;/td&gt;&lt;td&gt;&lt;WorldInfo info=' bay="" content="" example="" forest"="" kelp="" last="" mantana="" monterey="" of="" the="" updated:="" x3d=""><navigationinfo speed="3.0"></navigationinfo></background>
22 +	
31 +	
34 ±	
58 -	
59	<pre><viewpoint description="Kelp Forest Monterey Bay Aquarium" position="0.0 -5.0 45.0"></viewpoint></pre>
60	<pre><viewpoint description="Side Windows" fieldofview="0.5" orientation="0.0 1.0 0.0 0.9" position="25.0 -4.0 15.0"></viewpoint></pre>
61	<pre><viewpoint description="Star Fish" orientation="0.0 1.0 0.0 1.25" position="14.0 -5.75 1.0"></viewpoint></pre>
62	<pre><viewpoint description="Inside Tank" orientation="0.0 1.0 0.0 3.14" position="0.0 -5.0 -7.0"></viewpoint></pre>
63	<pre><viewpoint description="Top floor" fieldofview="1.04719" orientation="-0.3 1.0 0.3 1.57079" position="12.5 5.0 -2.0"></viewpoint></pre>
64	<pre><viewpoint description="Bird's Eye View" orientation="1.0 0.0 0.0 -1.57" position="0.0 19.0 -3.5"></viewpoint></pre>
65	<pre><viewpoint description="Pump House" fieldofview="0.6" orientation="0.0 1.0 0.0 1.3" position="-5.0 1.0 0.0"></viewpoint></pre>
66	-  Welcome to the NPS simulation of the
<b>67</b> 🛱	<pre></pre>
68	<inline "http:="" "sharkleftylocale.wrl"="" examples="" td="" url='"IntroductionMessage.wrl" "http://X3dGraphics.com/examples/X3dForWebAuthor&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;&lt;b&gt;6&lt;/b&gt;9 🛱&lt;/td&gt;&lt;td&gt;&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;70&lt;/td&gt;&lt;td&gt;&lt;Transform&gt;&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;71&lt;/td&gt;&lt;td&gt;&lt;Inline url=' x3dforwebautho<="" x3dgraphics.com=""></inline>
72	
73	<transform></transform>
74	<inline 0="" 0'="" url='"SharkLucyLocale.wrl" "http://X3dGraphics.com/examples/X3dForWebAuthor&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;75&lt;/td&gt;&lt;td&gt;&lt;/Transform&gt; Find sharks! See new viewpoints! Prove Deep Deep Prove Prov&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;76&lt;/td&gt;&lt;td&gt;&lt;Transform translation='> (Inline url=! "KelnTank url" "http://Y3dGraphice.com/evamples/Y3dForWebluthors/Keln E 2007.Davkselim and Den Butman XD Extended 30 Graphics for Weblandes on Figure 1.5</inline>
77	

## Background node X3D-Edit

🚾 Edit Backgro	🐨 Edit Background					
	containerF :hildren	ield T	DEF ()			
skyAngle, skyColor	angle zenith 1.309 1.5707	r 0 0 0	g 0.5 0 0	b 1 1 1		
groundAngle, groundColor	angle 1.5707 1.309 nadir	r 0.6 0.4 0.1	g 0.6 0.25 0.1	b 0.6 0.2 0		
left∪rl	"urn:web3d:m		/panoramas/h			
rightUrl frontUrl	"urn:web3d:m "urn:web3d:m	edia:textures,	/panoramas/h	orizon_3_from	nt.jpg"	]
		edia:textures,	/panoramas/h	orizon_3_top	.jpg" "	5
bottomUrl	"urn:web3d:m	eura textures,	rpanor amas/n		ancel <u>H</u> elp	

web|3

- skyColor values go down from zenith to nadir
- *groundColor* values go up from nadir to horizon

🐨 leftUrl 🛛 🗙
urn:web3d:media:textures/panoramas/horizon_3_left.jpg
horizon_3_left.jpg
file:///c:/www.web3d.org/x3d/content/examples/Basic/UniversalMediaPanoramas/horizon_3_left.jpg
http://www.web3d.org/WorkingGroups/media/textures/panoramas/horizon_3_left.jpg
http://www.web3d.org/x3d/content/examples/UniversalMediaPanoramas/horizon_3_left.jpg
http://www.web3dmedia.com/UniversalMedia/textures/panoramas/horizon_3_left.jpg
http://www.officetowers.com/UniversalMedia/textures/panoramas/horizon_3_left.jpg
http://geometrek.com/UniversalMedia/textures/panoramas/horizon_3_left.jpg
http://www.sc.ehu.es/ccwgamoa/UniversalMedia/textures/panoramas/horizon_3_left.jpg
< Edit Load Launch + - 🔂 😓 >
OK Cancel



<b>Kookground</b>	Background simulates ground and sky, using vertical arrays of wraparound color values, Background can also provide backdrop textures on all six sides. Background, Fog, NavigationInfo, TextureBackground and Viewpoint are bindable nodes.
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 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!
	[skyColor: accessType inputOutput, type MFColor CDATA "0 0 0"] Color of the sky at various angles on the sky sphere. First value is color of sky at 0.0 radians representing the zenith (straight up). Warning: you must have one more skyColor value than skyAngle values. Interchange profile hint: only one color might be rendered, others can be ignored.
	[skyAngle: accessType inputOutput, type MFFloat CDATA #IMPLIED] [0pi] The angle values increase from 0.0 zenith (straight up) to Π/2=1.57 (horizon) to Π=3.14159 (nadir). Warning: you must have one more skyColor value than skyAngle values. Warning: colors at skyAngle=0 are ignored. Interchange profile hint: this field may be ignored.
	[groundColor: accessType inputOutput, type MFColor CDATA #IMPLIED] Color of the ground at the various angles on the ground partial sphere. First value is color of ground at 0.0 radians representing the nadir (straight down). Warning: you must have one more groundColor value than groundAngle values. Interchange profile hint: this field may be ignored.
	[groundAngle: accessType inputOutput, type MFFloat CDATA #IMPLIED] [0pi/2] The angle values increase from 0.0 nadir (straight down) to II/2=1.5708 (horizon). Warning: you must have one more groundColor value than groundAngle values. Warning: colors at groundAngle=0 are ignored. Interchange profile hint: this field may be ignored.

frontUrl	[frontUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.url1.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is & quot; (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
backUrl	[backUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.url1.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is & quot; (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
leftUrl	[leftUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.url1.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
rightUrl	[rightUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.url1.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
topUrl	[topUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.url1.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is & quot; (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
bottomUrl	[bottomUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.url1.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
set_bind	[set_bind: accessType inputOnly, type SFBool (true false) #FIXED ""]
	Input event set_bind=true makes this node active, input event set_bind=false makes this node inactive. Thus setting set_bind true/false will pop/push (enable/disable) this node.
bindTime	[bindTime: accessType outputOnly, type SFTime CDATA #FIXED ""]
	event sent when node becomes active/inactive.
isBound	[isBound: accessType outputOnly, type SFBool (true false) #FIXED ""]
	event true sent when node becomes active, event false sent when unbound by another node.
containerField	[containerField: NMTOKEN "children"]
	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.

### TextureBackground node

TextureBackground nearly same as Background

- Includes ground and sky color, angle arrays
- Coexists on same bindable node stack
- Instead of using six *url* arrays, instead use six ImageTexture nodes for background images
  - Thus allows reuse of ImageTexture nodes if needed

**Requires** <component name='EnvironmentalEffects' level='3'/>

Also allows overall *transparency* value, so that anything on user's desktop or behind browser can be seen behind objects in the scene

• Might be a useful specialty display technique

#### TextureBackground syntax comparison

Note differences in use of containerField for XML syntax versus use of field name for **ClassicVRML** syntax

.x3d)	ClassicVRML Syntax (.x3dv)
<pre>Background "MyTextureBackgroundNode" "ency="0" gle="1.55" )lor="0 1 0, 0.1 1 0.3" "="1.45" "="0.7 1 0.7, 0.9 1 0.9"&gt; exture containerField= xture" url='"leftImage.png"'/&gt; exture containerField= "exture" "rightImage png"'/&gt; exture containerField= "exture" "frontImage.png"'/&gt; exture containerField= exture" "backImage.png"'/&gt; exture containerField= cture" "topImage.png"'/&gt; exture containerField= nTexture" "bottomImage.png"'/&gt; eBackground&gt;</pre>	<pre>DEF MyTextureBackgroundNode TextureBackground { transparency 0 groundAngle [1.55] groundColor [0 1 0, 0.1 1 0.3] skyAngle [1.45] skyColor [ 0.7 1 0.7, 0.9 1 0.9 ] leftTexture ImageTexture { url "leftImage.png"} rightTexture ImageTexture { url "rightImage.png"} frontTexture ImageTexture { url "frontImage.png"} backTexture ImageTexture { url "backImage.png"} topTexture ImageTexture { url "topImage.png"} bottomTexture ImageTexture { url "topImage.png"} }</pre>

NI	TextureBac	karound-Ke	InForestMain	.x3d - Editor
	TextureDat	KELUUHU-KE	IDI OLESUMAII	I.AJU - LUILUI

≪ TextureBackground-KelpForestMain.x3d ×

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Background, Fog, NavigationInfo, TextureBackground and Viscoption are bindable nodes.           DFT         DFF of MPLIPDI           DFF of differs a unique ID name for this node, referenciable by other nodes.         Init: descriptive DEF names improve clarity and help document a model.           DFS         USE IDREF AINPIDI           USE means reuse an already DEF - de node ID, ignoring_all_ other attributes and children. Hint: USE means reuse an already DEF - den node ID, ignoring_all_ other attributes and children. Hint: USE means reuse an already DEF - den node ID, ignoring_all_ other attributes and children.           Varing: Co NOT include DEF (or any other attribute values) when using a USE attribute!           Varing: you must have on emore skyColor values than yould values. Warring: you must have on emore skyColor value than skyAngle values. Warring: you must have on emore skyColor value than skyAngle values. Warring: you must have on emore skyColor value than skyAngle values. Warring: you must have on emore skyColor value than skyAngle values. Warring: you must have one more skyColor value than skyAngle values. Warring: you must have one more skyColor value than skyAngle values. Warring: you must have one more skyColor value than skyAngle values. Warring: you must have one more skyColor value than skyAngle values. Warring: you must have one more skyColor value than skyAngle values. Warring: you must have one more skyColor value than groundAngle values. Warring: you must have one more sgrounColor value than groundAngle values. Warring: you must have one more sgrounColor value than groundAngle values. Warring: you must have one more sgrounColor value than groundAngle values. Warring: you must have one more sgrounColor value than groundAngle values. Warring: you must have one more sgrounColor value t		TextureBackground simulates ground and sky, using vertical arrays of wraparound color values, TextureBackground can also provide backdrop texture images on
DFF         DFF         default           DFF         default         DEF         DEF </th <th>TextureBackground</th> <td>all six sides. Field names of child texture nodes are in alphabetic order: backTexture, bottomTexture, frontTexture, leftTexture, rightTexture, topTexture.</td>	TextureBackground	all six sides. Field names of child texture nodes are in alphabetic order: backTexture, bottomTexture, frontTexture, leftTexture, rightTexture, topTexture.
DEF defines a unique ID name for this node, referenceble by other nodes.     Hint: descriptive DEF names improve clarkly and help document a model.     USE IDREF #INTHED]     USE means reuse an already DEF-ed node ID, ignoring _all_other attributes and children.     Hint: USEng other generative trading on improve performance.     Warning: do NOT include DEF (or any other attribute values) when using a USE attribute!     (sky Color: accessType inputOntput, type MFColor CDATA "0 0 0"]     Color of the sky at virous mgles on the sky sphere. First value is color of sky at 0.0 radius representing the zenith (straight up).     Warning: you must have one more aky Color value than skyAngle values.     Inter-change profile hint: only one color might be reindered, others can be ignored.     (kyAngle: accessType inputOntput, type MFColor CDATA #IMPLIED]     (D, D, D)     (D, D,	C	Background, Fog, NavigationInfo, TextureBackground and Viewpoint are bindable nodes.
Hist: descriptive DEF annes improve clarity and help document a model.           CSR         [USE IDREF #INPLIED] USE mean reuse an already DEF-ed node ID, ignoring _all_other attributes and châdren. Hint: USEig other geometry (instead of duplicating nodes) on improve performance. Warning: do NOT indued DEF (or any other attribute values) when using at USE attribute!           Abcelar         [SkyColor: accessType inputOtuput, type MFColor CDATA "00 0"] Color of the sky at various angles on the sky uppere. Fist values: Interchange profile hinti: ondy one color onglith be rendered, others can be ignored.           Abvelar         [skyAngle: accessType inputOtuput, type MFFoot CDATA #INPLIED] (D, pl] The angle values increase from 0.0 remli (straight up) II 2-1.57 (horizon) to II-3.14159 (nadir). Warning: you must have one more skyColor value than skyAngle values. Interchange profile hint: this field must be ignored.           abvelar         [styAngle: accessType inputOtuput, type MFFoot CDATA #INPLIED] (D, pl] The angle values increase from 0.0 remli (straight up) II 2-1.57 (horizon) to II-3.14159 (nadir). Warning: you must have one more sgyColor value than skyAngle values. Interchange profile hint: this field must be ignored.           groundColor: accessType inputOtuput, type MFFoot CDATA #IMPLIED] (D, pl2] The angle values increase from 0.0 and (straight down) to III-2-1.5708 (horizon). Warning: you must have one more groundColor value than gave values. Interchange profile hint: this field must be ignored.           groundAngle: accessType inputOtuput, type MFFloat CDATA #IMPLIED] (D, pl2] The angle values increase from 0.0 and (straight down) to III-2-1.5708 (horizon). Warning: you must have one more groundColor value than skyteme is color of ground at 0.0 radiums representing the nadir (straight	DEF	[DEF ID #IMPLIED]
Optimization         USE IDREF #IMPLIED USE means reuse an already DEF-ed node ID, ignoring _all_other attributes and children. Hint: USEing other geometry (instead of deplicating nodes) can improve performance. Warning: do NOT include DEF (or any other attribute value) when using a USE attribute!           keColar         (ES) Color: accessType inputOtingt, type MTCOol CDATA '0 00''           Color of the sky at various angles on the sky sphere. First value is color of sky at 0.0 radians representing the zenith (straight up). Warning: you must have come nore sky/Color value than sky/Angle values. Interchange profile hint: only one color might be rendered, others: can be ignored.           (sky/Angle: accessType inputOtingt, type MTFIoot CDATA #IMPLIED] [0, pi] The angle values increase from 0. zenith (straight up) to 124–15.7 (burcion) to 11=3.14159 (nadir). Warning: color at sky/Angle <sup>-0</sup> are ignored. Interchange profile hint: this field may be ignored.           ground-Color: accessType inputOtingt, type MTFIoot COATA #IMPLIED] [Color of the ground at the various angles on the ground partial sphere. First value is color of ground at 0.0 radians representing the nadir (straight down). Warning: you must have one more ground/Color value than ground/Angle values. Interchange profile hint: this field may be ignored.           ground-Color: accccssType inputOtingt, type MTFIoot CDATA #IMPLIED] [0, pi] The angle values increase from 0.0 nadir (straight down) to 172–15.7 (boritor). Warning: colors at sky e ignored.           ground-Lange         [ground-Lange: acccssType inputOtingt, type MTFIoot CDATA #IMPLIED] [0, pi] The angle values increase from 0.0 nadir (straight down) to 172–15.7 (boritor). Warning: colors at sky pre ignored.           tarterchange profile hinit: this field may be		DEF defines a unique ID name for this node, referencable by other nodes.
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Hint: USE go other geometry (instead of duplicating nodes) can improve performance.         Warning: do NOT indude DEF (or any other attribute values) when using a USE attribute!         AptCohr       Cells of the sky at various angles on the sky sphere. First value is color of sky at 0 or 10 condinans representing the zenith (straight up).         Warning: you must have one more skyColor value than skyAngle values.       Interchange profile hint: only one color might be rendered, others can be ignored.         (b, yAngle: accessType inputOthyt, type NIFColor CDATA #INPLIDI)       (b, yAngle: accessType inputOthyt, type AIFColor CDATA #IMPLIDI)         (b, yP)       The angle values increase from 0.0 zenith (straight up) to II.2=1.57 (horizon) to II=3.14159 (andir).         Warning: you must have one more skyColor value than skyAngle values.       Warning: you must have one more skyColor value than skyAngle values.         Warning: you must have one more goundColor value than groundAngle values.       Interchange profile hint: this field may be ignored.         groundColor: accessType inputOthyt, type NIFLoat CDATA #IMPLIEDI       Color of the ground at the values angroundAngle values.         (b, p2)       The angle values increase from 0.0 and (rising thory) to TI.2=1.570 (horizon).         Warning: you must have one more goundColor value than groundAngle values.       Naring: you must have one more goundColor value than groundAngle values.         (b, p2)       The angle values increase from 0.0 and (rising thory).       Naring: you must have one more goundColor value than groundAngle values.	USE	[USE IDREF #IMPLIED]
Warning: do NOT include DEF (or any other attribute values) when using a USE attribute!           abp(view         [skyColor: accessType inputOtrput, type MIFColor CDATA ''0 0 0'']           Advised         [chyColor: accessType inputOtrput, type MIFColor CDATA ''0 0 0'']           Warning:; you must have one more skyColor value than skyAagle values. Interchange profile hint: only one coord might be rendered, others can be ignored.           Advised         [skyAagle: accessType inputOtrput, type MIFColor CDATA #IMPLIED] [0, ap] The angle values increase from 0.0 zentil (straight up) to II-2-1.57 (horizon) to II-3.14159 (nadir).           Warning: you must have one more skyColor value than skyAagle values. Warning: colors at skyAagle=0 are ignored. Interchange profile hint: this field may be ignored.           presendColor:         [groundColor: accessType inputOutput, type MIFColor CDATA #IMPLIED] Color of the syn value than groundAgide values. Interchange profile hint: this field may be ignored.           presendColor:         [groundAgle: accessType inputOutput, type MIFColor CDATA #IMPLIED] Color of the syn value in secone more spoundColor value than groundAgide values. Interchange profile hint: this field may be ignored.           presendAgle:         [groundAgle: accessType inputOutput, type MIFColor CDATA #IMPLIED] Color of the syn values increase from 0.0 adir (straight down) to II.2-1.5708 (horizon). Warning: you must have one more groundColor value than groundAgide values. Interchange profile hint: this field may be ignored.           massarency applied to testure image.         [set_binit: accessType inputOutput, type MIFLot CDATA #IMPLIED] (D, pi/2] The angle values increase from 0.0 a		USE means reuse an already DEF-ed node ID, ignoring all_ other attributes and children.
Special         [skyColor: accessType inputOutput, type MFColor CDATA "0 0 0"]           Color of the sky at various angles on the sky sphere. First value is color of sky at 0.0 radians representing the zenith (straight up). Warning: you must have one more skyColor value than skyAngle values. [skyAngle: accessType inputOutput, type MFFloat CDATA #IMPLIED]           [0, n] The angle values increase from 0.0 zenith (straight up) to 112=1.57 (horizon) to 11=3.14159 (nadir). Warning: you must have one more skyColor value than skyAngle values. Warning: you must have one more skyColor value than skyAngle values.           [0, n] The angle values increase from 0.0 zenith (straight up) to 112=1.57 (horizon) to 11=3.14159 (nadir). Warning: you must have one more sigored.           [groundColor: accessType inputOutput, type MFFloat CDATA #IMPLIED] Color of the ground at the various angles on the ground partial sphere. First value is color of ground at 0.0 radians representing the nadir (straight down). Warning: you must have one more groundColor value than groundAngle values. Interchange profile hint: this find may be ignored.           groundAngle:         [groundAngle: accessType inputOutput, type MFFloat CDATA #IMPLIED] (0, pt/2) The angle values increase from 0.0 radia (straight down) to 11/2=1.5708 (horizon). Warning: you must have one more groundColor value than groundAngle values. Warning: you ground the various angles on the ground Angle values. Warning: you ground the value may be ignored.           Interchange profile hint: this field may be ignored.         [groundAngle=70 are ignored. Interchange profile hint: this field may be ignored.           Interchange profile to texture image.         [groundAngle=0 are ignored. Interchange profile hint: this field may be ignored. </th <th></th> <th>Hint: USEing other geometry (instead of duplicating nodes) can improve performance.</th>		Hint: USEing other geometry (instead of duplicating nodes) can improve performance.
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Warning: colors at skyAngle=0 are ignored. Interchange profile hint: this field may be ignored.           groundColor         [groundColor accessType inputOutput, type MFColor CDATA #IMPLIED] Color of the ground at the various angles on the ground partial sphere. First value is color of ground at 0.0 radians representing the nadir (straight down). Warning: you must have one more groundColor value than groundAngle values. Interchange profile hint: this field may be ignored.           groundAngle         [groundAngle: accessType inputOtupt, type MFFloat CDATA #IMPLIED] [0. pi/2] The angle values increase from 0.0 nadir (straight down) to II/2=1.5708 (horizon). Warning: you must have one more groundColor value than groundAngle values. Warning: colors at groundAngle=0 are ignored. Interchange profile hint: this field may be ignored.           transparency:         [transparency: accessType inputOutput, type MFFloat CDATA "O"] transparency applied to texture image.           st_bind         [set_bind: accessType inputOnly, type SFBool (true[false) #FIXED ""] Input event set bind=true makes this node active, input event set_bind=false makes this node inactive. Thus setting set_bind true/false will pop/push (enable/disable) this node.           bindTime:         [bindTime: accessType outputOnly, type SFBool (true[false) #FIXED ""] event twe sent when node becomes active, event false sent when unbound by another node.           containerField         [containerField: NMTIOKEN "children "] 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 XJD scenes.		
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class CDATA #IMPLIED]		

# Fog node

Fog is an important environmental effect

- Use it sparingly for best effect
- Another X3DBindableNode

White or grey fog can emulate fog in real world Black fog can emulate night-time effects

Fog works by gradually recoloring scene pixels to match fog color, depending on range to viewer

Thus fog color must match Background color to work properly, otherwise silhouettes created

Experimentation is helpful to get things right
 3D

# Fog fields

- *color* field is single RGB value for replacement color
- fogType has two defined enumeration values for rate of dropoff in visibility as viewer range increases
  - LINEAR indicates linear dropoff
  - EXPONENTIAL indicates exponential dropoff, which increases the fog effect and is more computationally expensive
- visibilityRange indicates distance from view camera where objects become completely obscured
  - Avoid scaling in parent transformation hierarchy, otherwise this value will no longer be in meters





🖻 Fog-KelpForestMain.x3d - Editor	
🖗 Fog-KelpForestMain.x3d 🗙	
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23 + <externprotodeclare> 31 + <protoinstance></protoinstance></externprotodeclare>	
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🚟 Fog	Fog simulates atmospheric effects by blending distant objects with fog color. Background, Fog, NavigationInfo, TextureBackground and Viewpoint are bindable nodes.
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!
color	[color: accessType inputOutput, type SFColor CDATA "1.0 1.0 1.0"] Hint: match Background color to make objects fade away.
fogType	[fogType: accessType inputOutput, type SFString CDATA (LINEAR EXPONENTIAL) "LINEAR"] Specifies algorithm for rate of increasing Fog, either LINEAR or EXPONENTIAL. Hint: EXPONENTIAL is more natural but also more computationally expensive.
visibilityRange	[visibilityRange: accessType inputOutput, type SFFloat CDATA "0.0"] Distance in meters where objects are totally obscured by the fog, using local coordinate system. Hint: visibilityRange 0 disables Fog.
set_bind	[set_bind: accessType inputOnly, type SFBool (true false) #FIXED ""] Setting set_bind true makes this node active setting set_bind false makes this node inactive. Thus setting set_bind true/false will pop/push (enable/disable) this node.
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containerField	[containerField: NMTOKEN "children"] 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.

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### **Chapter Summary**





# **Chapter Summary**

Lighting concepts

- Illuminating scene geometry with virtual lights
- Lighting nodes

web

- DirectionalLight
- NavigationInfo headlight
- PointLight, Spotlight
- **Environment concepts** 
  - X3DBackgroundNode type and common fields

Environmental effects nodes

• Background, TextureBackground, Fog



## Suggested exercises

Use a TouchSensor to turn a light on/off

- Include BooleanToggle so that state is persistent
   Also indicate the physical location of a light source by using a Cone or Sphere
- Be sure to set *emissiveColor* and *transparency* Demonstrate use of Background colors
   Demonstrate use of (Texture)Background images
   Demonstrate use of Fog for day or night effects





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### References





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



- Chapter 11, Lighting and Environment Nodes
- http://x3dGraphics.com
- http://x3dgraphics.com/examples/X3dForWebAuthors

#### X3D Resources

http://www.web3d.org/x3d/content/examples/X3dResources.html





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





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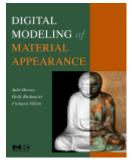
- http://www.wiley.com/legacy/compbooks/vrml2sbk/cover/cover.htm
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- Chapter 20 Lighting
- Chapter 22 Background
- Chapter 23 Fog







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- http://www.siggraph.org/s2005/main.php?f=conference&p=courses&s=24

RGB World explains additive, subtractive color

http://www.rgbworld.com/color.html





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- Book materials: X3D-Edit tool, examples, slidesets
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# Open-source license for X3D-Edit software and X3D example scenes

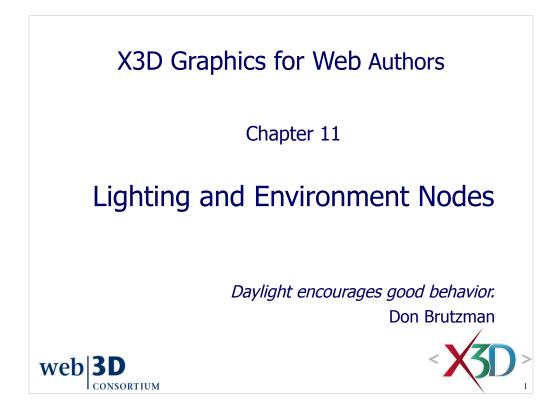
http://www.web3d.org/x3d/content/examples/license.html

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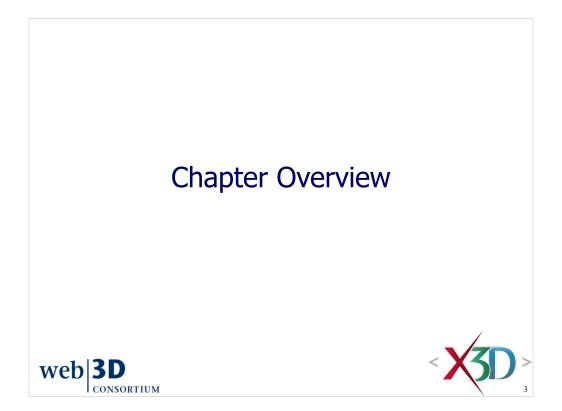
Alternate quote:

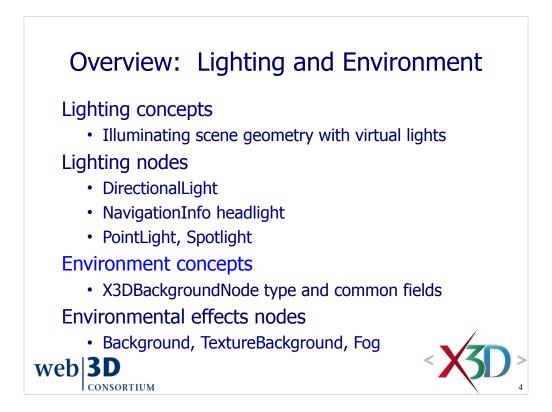
*Fiat lux*, let there be light! Book of Genesis, Old Testament, Bible http://en.wikipedia.org/wiki/Let\_there\_be\_light

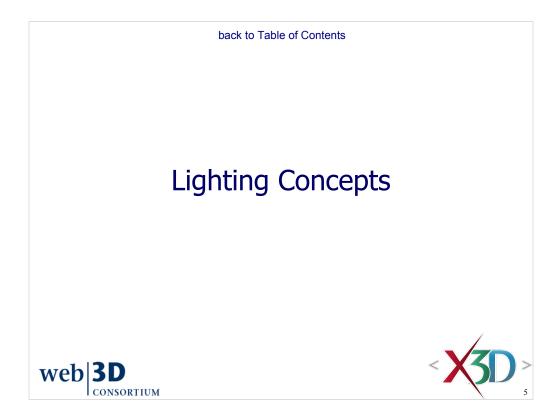
Of further interest:

Graphica Obscura by Paul Haeberle http://www.graficaobscura.com

# Contents Chapter Overview Lighting Concepts and Lighting Nodes Environment Concepts and Environment Nodes Chapter Summary and Suggested Exercises References WEDEDED



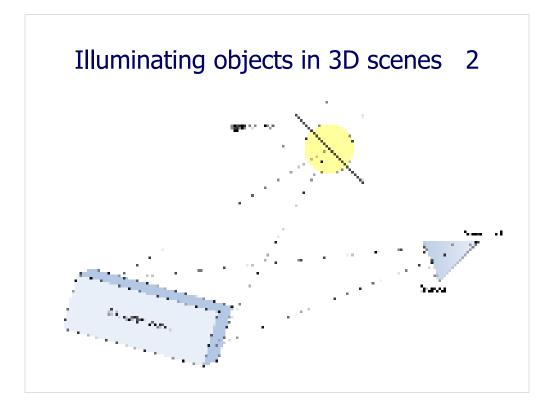




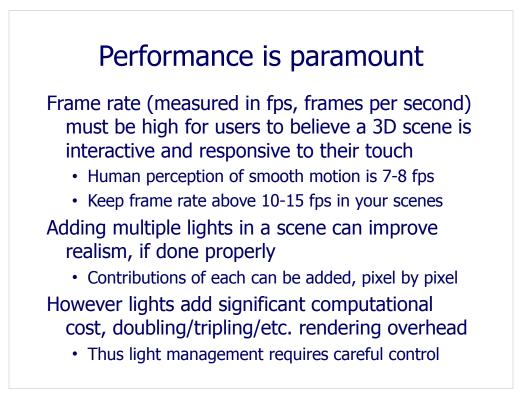
## Illuminating objects in 3D scenes 1

So far we have studied the creation of 3D shapes and then positioning the camera to view them Third major component is needed for 3D scenes: virtual lights that emulate sources in real world Such lighting occurs computationally – angles of incidence and reflection between lights and viewer are computed for each geometric shape • Additional lighting factors are also considered Pixel brightness reaching viewer thus depends on light sources, shape appearance, view angle web|3D

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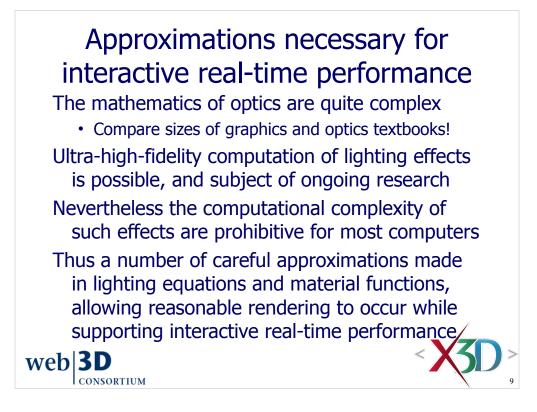


Page 301, Figure 11.1. X3D lighting and rendering is made up of a light source, rays, geometric object surfaces, reflection, and the screen rendering that displays a user's point of view (POV).

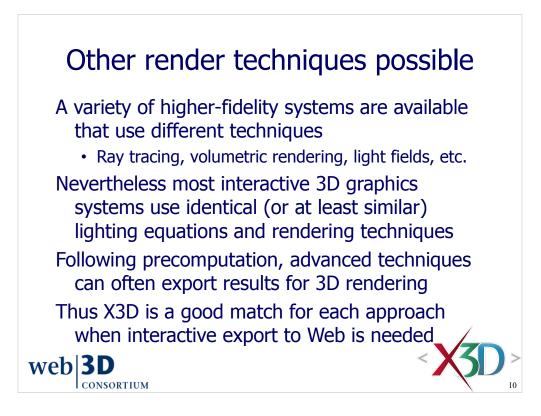


Each added light with global scope adds the same amount of computational complexity as the first light, thus making the addition of lights one of the easiest ways to change an interactive scene into something slow and unresponsive.

Keeping PointLight and SpotLight definitions scoped to only affect local peer and child nodes (default *global=*'false') is a good way to easily manage multiple lights. This approach ensures that local lights (such as individual lights for individual rooms) don't accumulate unnecessarily.

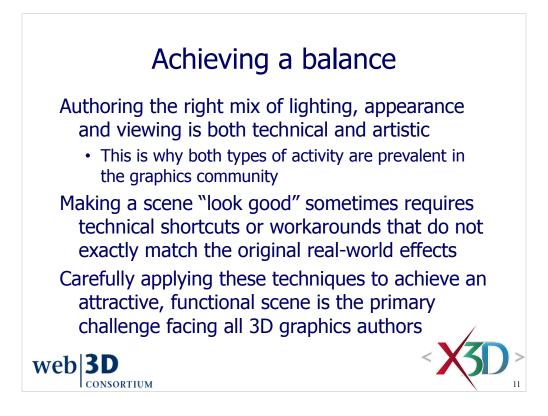


The full lighting equations are included in the X3D Abstract Specification. However these are rarely (if ever) needed by authors, so we don't study them here.

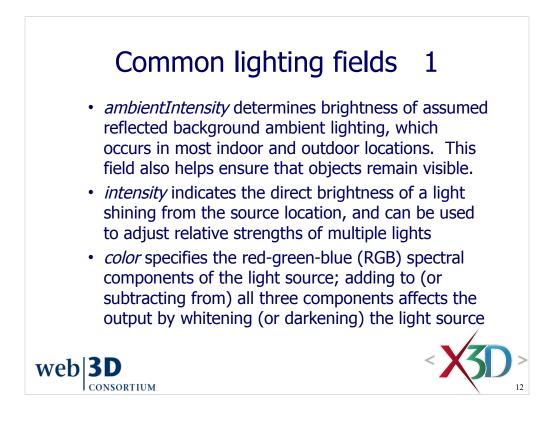


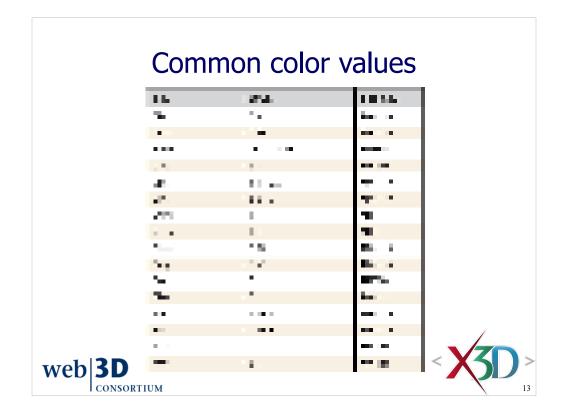
Individual modeling tools can be checked for export capabilities.

X3D conversion and translation tools are another good option for adapting the results of other rendering techniques. A list of such tools is maintained on the X3D Help page at http://www.web3d.org/x3d/content/examples/help.html#Conversions



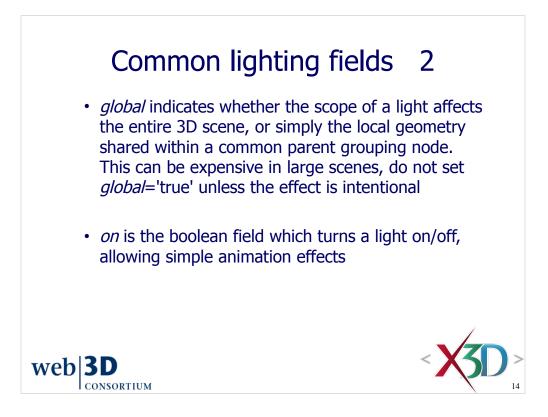
Often a scene which might be sluggish can be optimized and frame rate improved. Over time such scenes are likely to run even better as graphics hardware and software continues to improve rapidly.

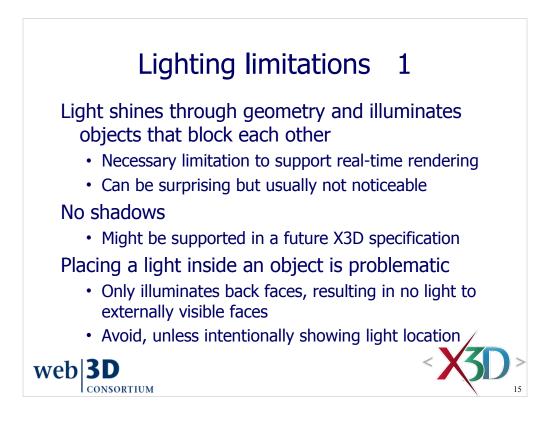




Page 305, Table 11.2. Common Colors and Corresponding RGB and HTML Values

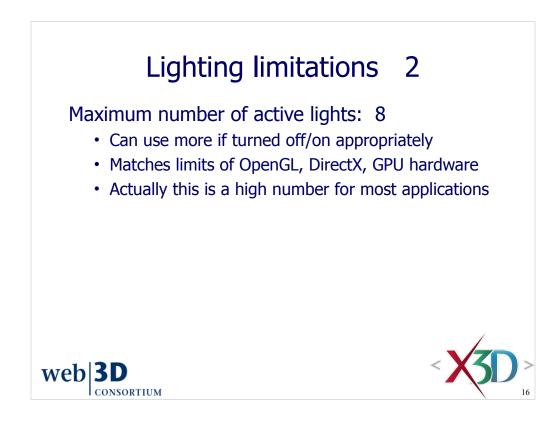
It is worth noting that lights are typically white, thus letting colors depend on the appearance of each shape.

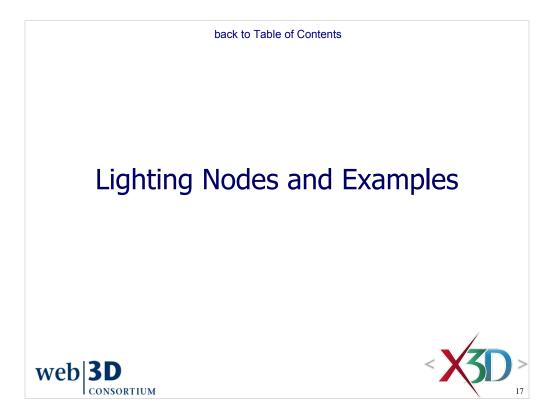




Shadows proposal

- Yvonne Jung, Tobias Franke, Patrick D<sup>°</sup>ahne, and Johannes Behr, "Enhancing X3D for advanced MR appliances," *Twelfth ACM SIGGRAPH International Symposium on Web3D Graphics,* Peruggia Italy, 15-18 April 2007, pp. 27-36 and 207.
- InstantReality: http://www.instantreality.org/tutorial/dynamic-shadows
- BS Contact: http://www.bitmanagement.com/demos/dynamic\_shadow.en.html
- Octaga: http://www.octaga.com then search for 'shadows'





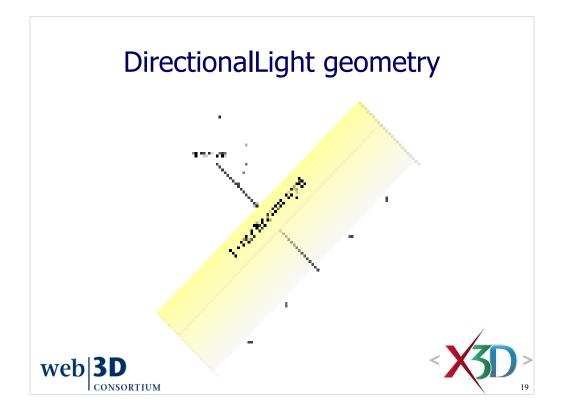
# DirectionalLight node

DirectionalLight provides uniform-intensity light as set of parallel rays sharing a single direction

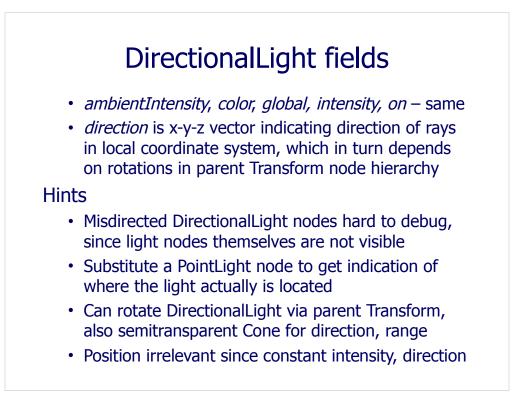
- Each surface facing the light gets some illumination
- Backface polygons, surfaces parallel to light rays remain unlit by direct *intensity*
- All surfaces lit by ambientIntensity, facing or not

Angle of incidence/reflection and appearance properties of lit shapes are primary factors on reflected color, brightness of lit objects Emulates distant light source, such as the sun

· Intensity does not diminish with distance



Page 310, Figure 11.3. DirectionalLight provides a virtual light source where all rays are parallel.



Could animate DirectionalLight directly by using a PositionInterpolator (SFVec3f). Interesting pattern for SFRotation animation of DirectionalLight: rotate parent Transform as follows.

<TimeSensor DEF='Clock'/>

```
<OrientationInterpolator DEF="Spinner" key='0 1' keyValue='0 1 0 0, 0 1 0 1.57'/>
```

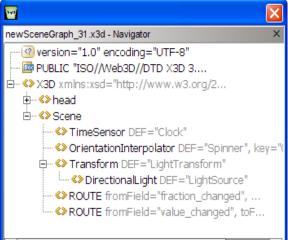
```
<Transform DEF='LightTransform'>
```

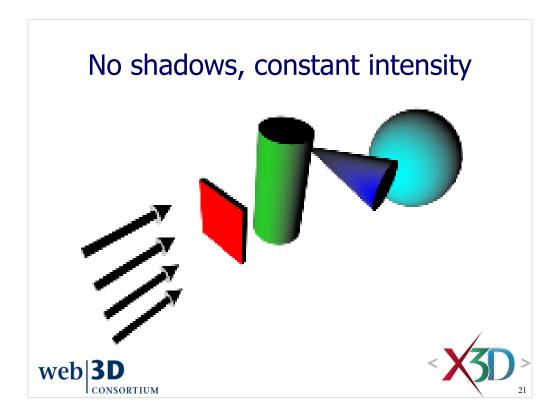
<DirectionalLight DEF='LightSource' />

### </Transform>

<ROUTE fromField='fraction\_changed' fromNode='Clock' toField='set\_fraction' toNode='Spinner'/>

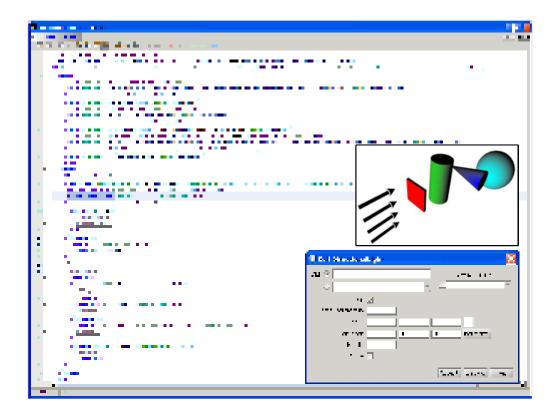
<ROUTE fromField='value\_changed' fromNode='Spinner' toField='rotation' toNode='LightTransform'/>





Page 310, Figure 11.4. DirectionalLight nodes do not interact with objects to cast shadows, and distance does not decrease their intensity.

http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/DirectionalLight.x3d

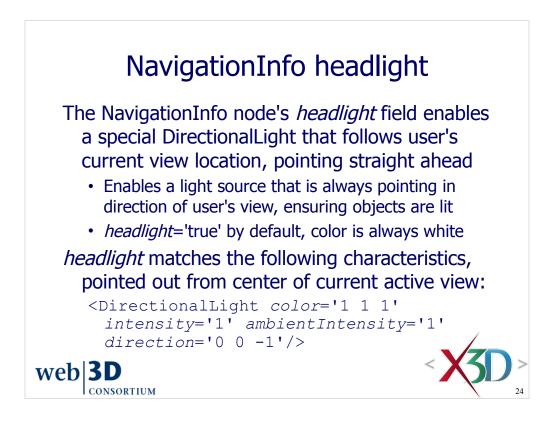


Page 310, Figure 11.4. DirectionalLight nodes do not interact with objects to cast shadows, and distance does not decrease their intensity.

http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/DirectionalLight.x3d

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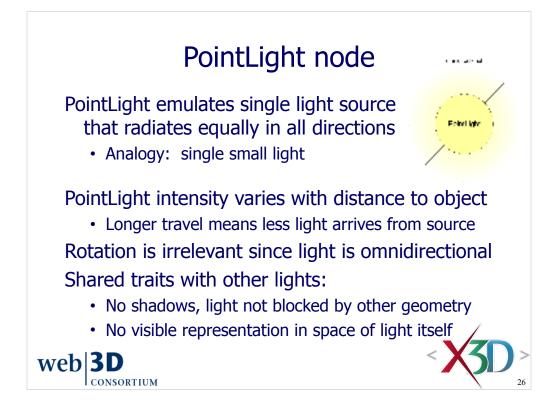
http://www.web3d.org/x3d/content/X3dTooltips.html#DirectionalLight



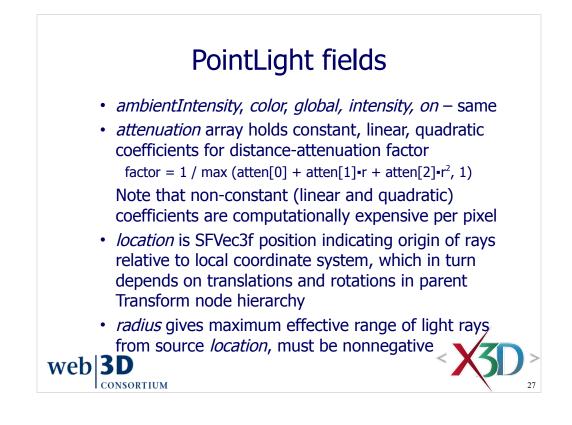
Further details in Chapter 4, Viewing and Navigation

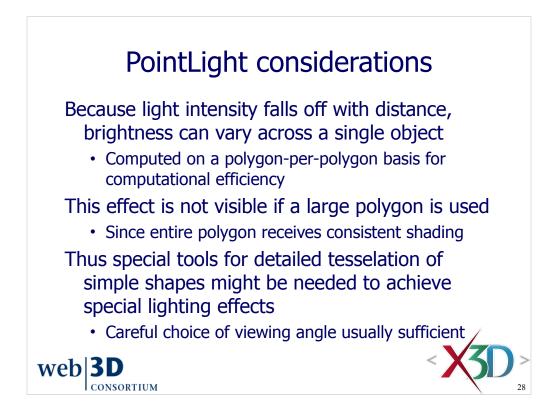
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Further details in Chapter 4, Viewing and Navigation



Page 312, Figure 11.5. PointLight provides a virtual light source such that rays emanate radially in all directions from a single location.



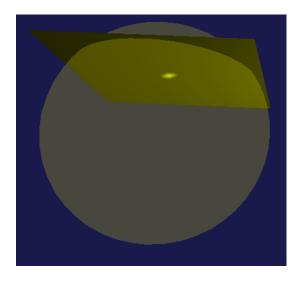


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Page 313, (improved snapshot)

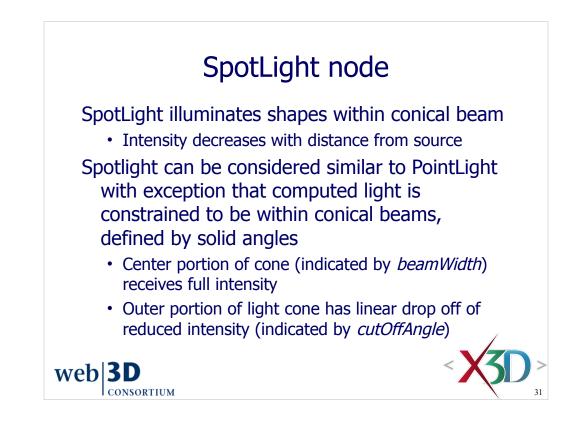
http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/PointLight.x3d

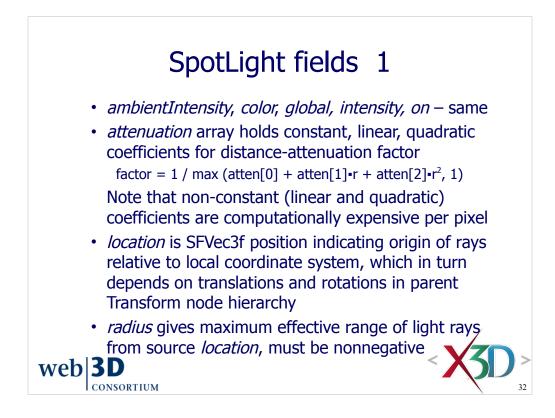
Visualizing PointLight: when the "show outline" checkbox is selected, a Sphere with the correct location and radius is inserted in the scene with the same *emissiveColor* as the PointLight. This authoring assist can help visualize the coverage of lights.



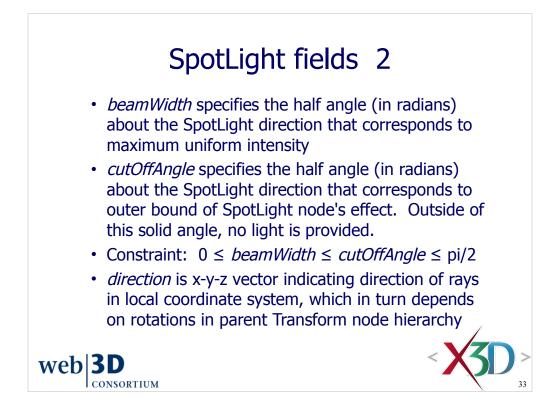
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## http://www.web3d.org/x3d/content/X3dTooltips.html#PointLight





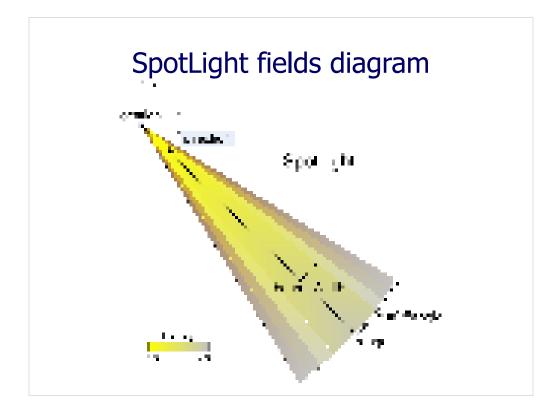
These Spotlight fields are identical to the PointLight fields. SpotLight contains a superset of the PointLight fields.



SpotLight *direction* field is the same as PointLight *direction* field.

If the inner *beamWidth* angle is mistakenly set greater than the outer *cutOffAngle*, then *cutOffAngle* still determines the maximum width of the SpotLight cone and internal intensity is uniform throughout.

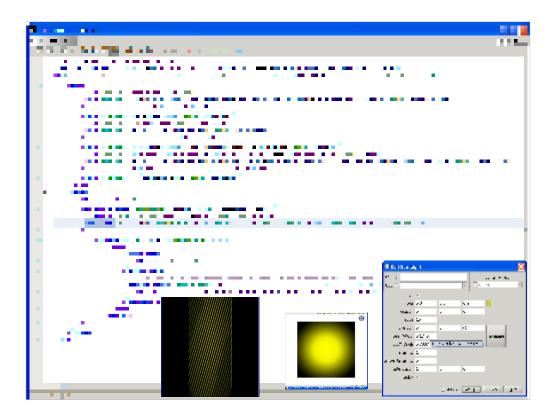
The X3D-Edit SpotLight editor will offer to swap values if inner *beamWidth* angle is mistakenly set greater than the outer *cutOffAngle*.



Page 316, Figure 11.7. SpotLight provides a virtual light source such that rays emanate radially with a conical outline from a single location.

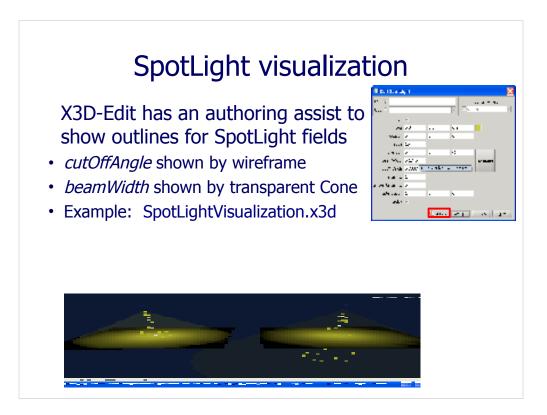
**Note earlier error** on original figure in the published book which incorrectly swapped *beamWidth* and *cutOffAngle*.

Book errata are maintained at http://x3dgraphics.com/errata.php



Page 317, Figure 11.8. Central beam intensity and fall-off are visible in this SpotLight example.

http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/SpotLight.x3d



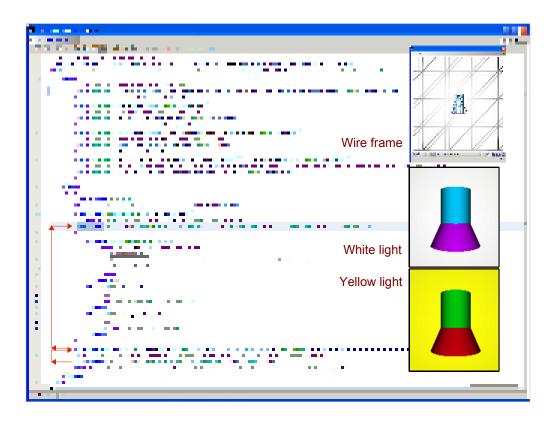
A common difficulty when authoring SpotLight nodes is to not be able to find their effect. The SpotLight may be pointed in a different direction than expected, or perhaps located in an unexpected position. Such surprises may be due to parent Transform nodes.

One simple technique to test where a SpotLight is located is to change it to a PointLight (for omnidirectional effect) and perhaps adding a sphere at the expected location. This approach can be somewhat tedious, however.

X3D-Edit includes a selectable checkbox for adding geometry to a scene that matches SpotLight dimensions and directions. A special example scene (SpotLightVisualization.x3d) is also provided to illustrate this author-assist feature. Edit the first SpotLight in the scene and select 'show outline' to see the pair of cones appear on the right-hand side.

http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironmentalEffects/SpotLightVisualization.x3d

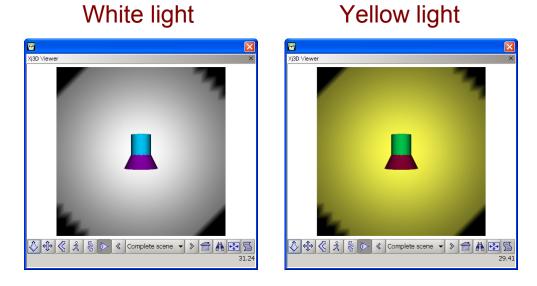
http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/PointLightVisualization.png

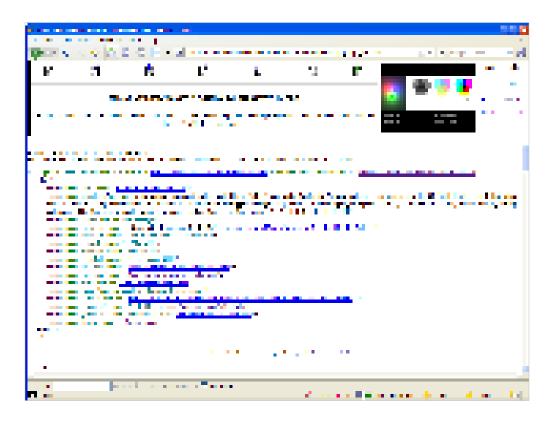


SpotLightColor.x3d provides an example of SpotLight showing effect of varying light colors on appearance, the color of objects can appear quite different.

http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/SpotLightColor.x3d

Zooming out to see the complete scene shows the background grid behind the cylinder and cone. Note that the scene background color is unaffected by lighting.





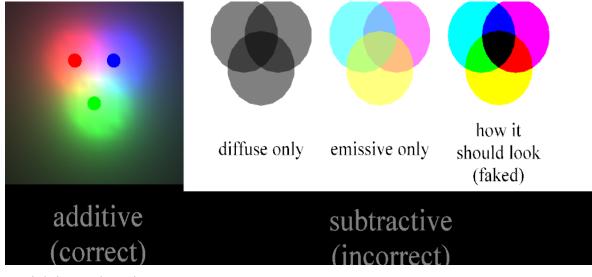
Interesting example from the X3D Basic archives. Original author Miriam English.

http://www.web3d.org/x3d/content/examples/Basic/development/\_pages/page01.html http://www.web3d.org/x3d/content/examples/Basic/development/AdditiveSubtractiveLight.x3d

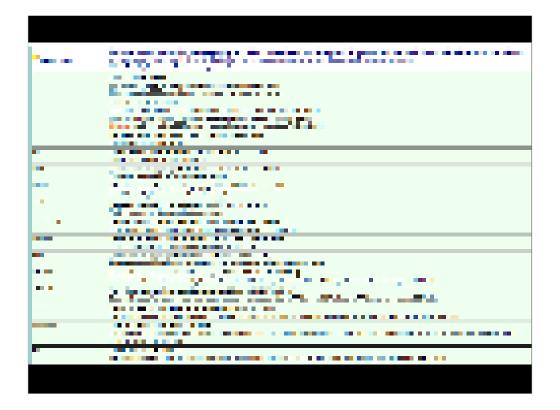
Additive Subtractive Light example description. This example tests various color combination capabilities, and also demonstrating that filtering (negative colors) are not supported in the X3D/VRML color model. Discussion follows. There are 2 ways to combine colors:

- Additive (e.g. a TV screen, overlapping spotlights, or pointillist art), for example
- [red + green = yellow] [1 0 0 + 0 1 0 = 1 1 0].
- Subtractive (e.g. mixing paints or stacking filters), for example

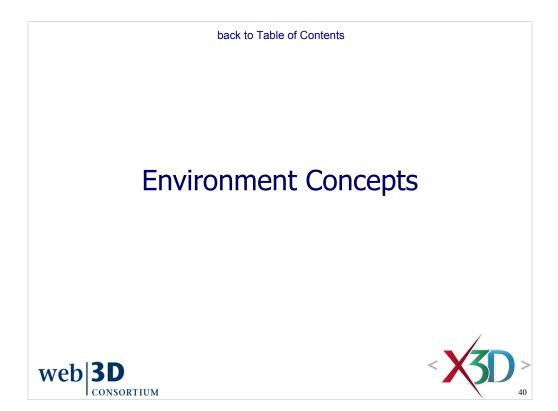
[white background + yellow filter + cyan filter = green] [1 1 1 + 0 0 - 1 + -1 0 0 = 0 1 0].

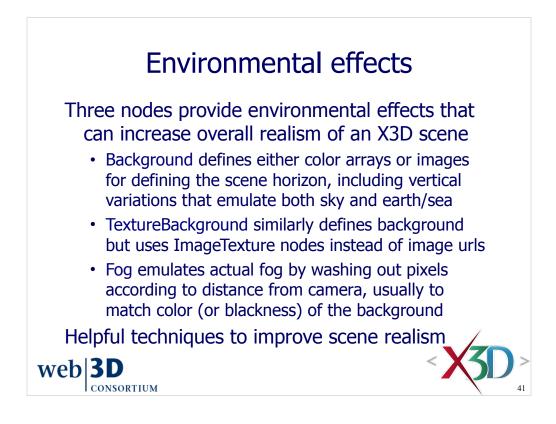


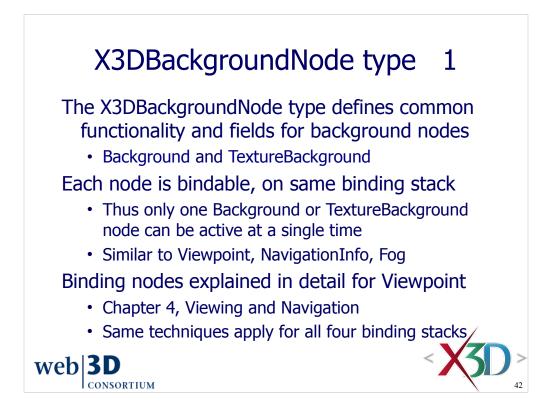
Chapter 11 - Lighting and Environment



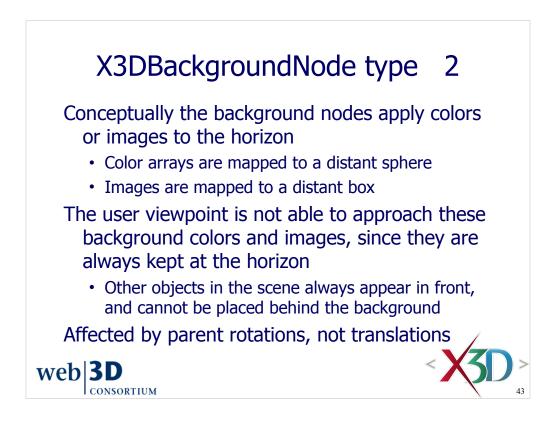
http://www.web3d.org/x3d/content/X3dTooltips.html#SpotLight

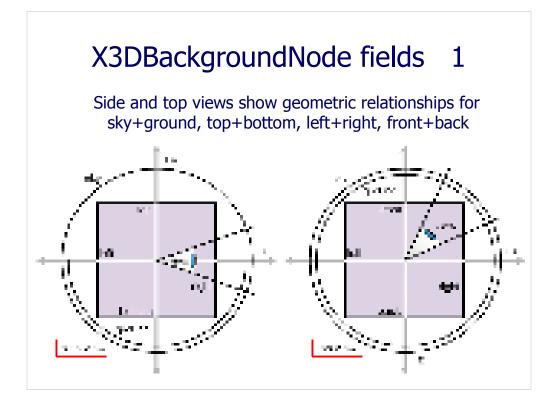






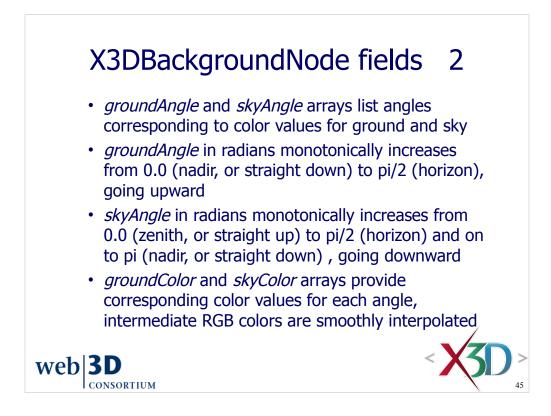
Typically browsers only provide selection controls for the Viewpoint stack and do not provide selection controls for the Background, Fog or NavigationInfo stacks. Thus control and selection of these nodes is only handled by animation chains created by the author.

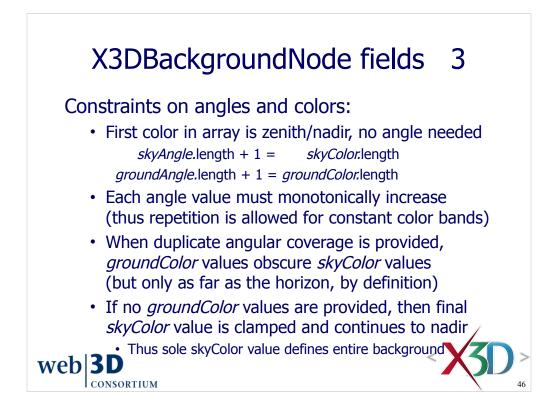




Page 307, Figure 11.2. Placement of background colors and images relative to the user's viewpoint.

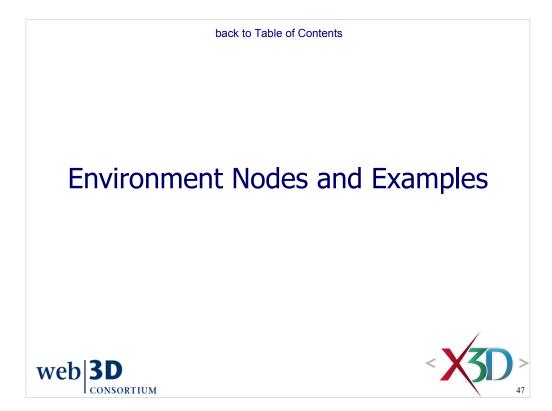
Adapted with permission from X3D Abstract Specification, Figure 24.1.





"Monotonically increase" is a mathematical term that indicates each value in the array must be greater than, or equal to, the value which precedes it.

If provided, the groundColor array obscures the skyColor array values. If no groundColor array is provided, then skyColor provides complete vertical coverage.



## Background node: color arrays

Background can provide simple colors or images for ground and sky, which appear behind any other geometric shapes in the scene

Background implements X3DBackgroundNode and X3DBindableNode types

Background colors form horizontal circular bands at the user's horizon which gradually change from one color value to the next along the vertical direction





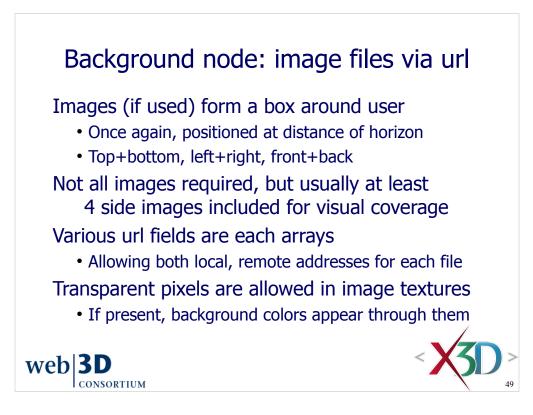
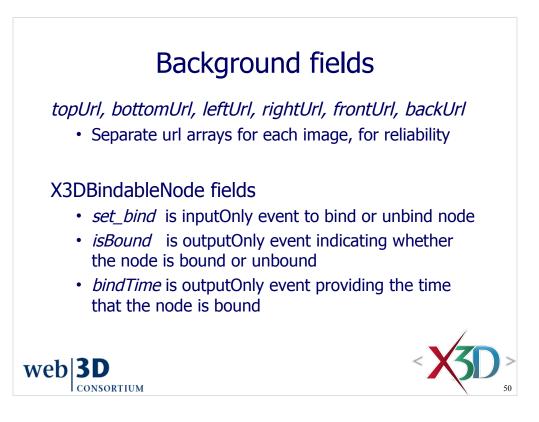
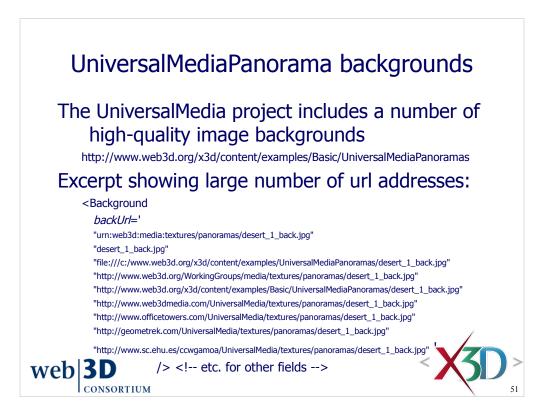


Image files are covered in detail in Chapter 5, Appearance Material and Textures.





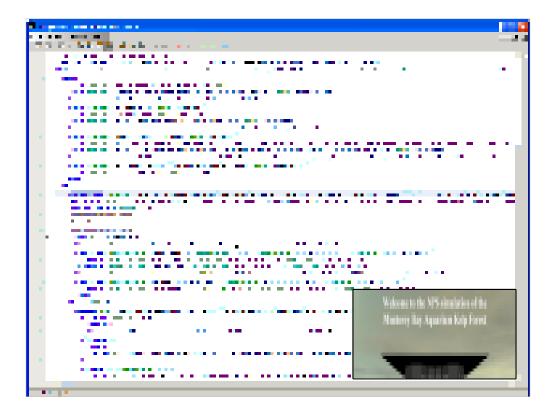
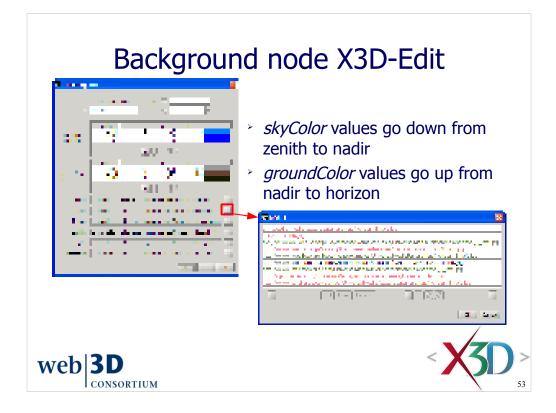


Figure 11.9. This Background example provides a backdrop panorama of an ocean environment.

http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnvironment/Background-KelpForestMain.x3dForWebAuthors/Chapter11-LightingEnviro

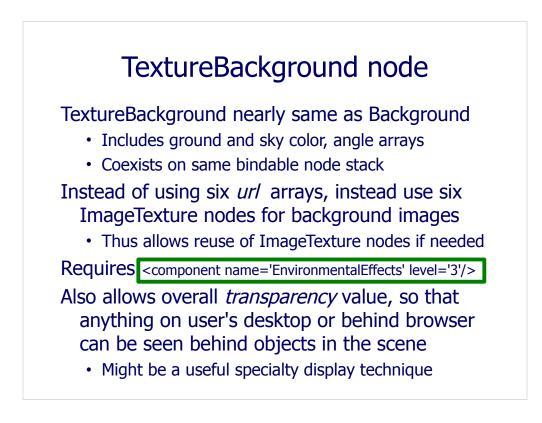


Background	Background simulates ground and sky, using vertical arrays of wraparound color values, Background can also provide backdrop textures on all six sides. Background, Fog. Navigation.Info. TextureBackground and Viewpoint are bindable nodes.
DEF	DACKground, rog, ravigatomino, texarebackground and viewpoint are onnance nodes. [DFE ID in INFLIED] DEF defines a unique ID name for this node, referencible by other nodes. Hint: descriptive DEF names improve clarity and help document a model.
USE	INTER Compare Data mines import cannot be indexed and the proceeded in index.  INSE IDERF FINDPLIED 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 for any other attribute values) when using a USE attribute!
skyColor	[skyColor: accessType inputOutput, type MFColor CDATA "0 0 0"] Color of the sky at various angles on the sky sphere. First value is color of sky at 0.0 radians representing the zenith (straight up). Warning: you must have one more skyColor value than skyAngle values. Interchange profile hint: only one color might be rendered, others can be ignored.
skyAngle	[skyAngle: accessType inputOutput, type MFFloat CDATA #IMPLIED] [0, pi] The angle values increase from 0.0 zenith (straight up) to Π/2=1.5.7 (horizon) to Π=3.14159 (nadir). Warning: colors at skyAngle=0 are ignored. Itaterchange profile hint: this field may be ismored.
groundColor	[groundColor: accessType inputOutput, type MFColor CDATA #IMPLIED] Color of the ground at the various angles on the ground partial sphere. First value is color of ground at 0.0 radians representing the nadir (straight down). Warning: you must have one more groundColor value than groundAngle values. Interchange profile hint: this field may be ignored.
groundAngle	[groundAngle: accessType inpatOutpat, type MFFloat CDATA #INIPLIED] [0. pi2] The angle values increase from 0.0 nafic (straight down) to Tl/2=1.5708 (horizon). Warning: volumes that would control with this groundAngle values. Warning: colors at groundAngle=0 are ignored. Interchange profile hint: this field may be ignored.

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

1	
frontUrl	[frontUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.urll.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
backUrl	[backUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.urll.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
leftUrl	[leftUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.urll.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
rightUrl	[rightUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.url1.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
topUrl	[topUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.urll.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly match directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
bottomUrl	[bottomUrl: accessType inputOutput, type MFString CDATA #IMPLIED]
	Image background panorama between ground/sky backdrop and scene's geometry.
	Hint: Strings can have multiple values, so separate each string by quote marks [ "http://www.urll.org" "http://www.url2.org" "etc." ].
	Hint: XML encoding for " is " (a character entity).
	Warning: strictly much directory and filename capitalization for http links! Hint: can replace embedded blank(s) in url queries with %20 for each blank character.
	Interchange profile hint: this field may be ignored.
set_bind	[set_bind: accessType inputOnly, type SFBool (true false) #FIXED ""]
	Input event set_bind=true makes this node active, input event set_bind=false makes this node inactive. Thus setting set_bind true/false will pop/push (enable/disable) this node.
bindTime	[bindTime: accessType outputOnly, type SFTime CDATA #FIXED ""]
	event sent when node becomes active/inactive.
isBound	[isBound: accessType outputOnly, type SFBool (true false) #FIXED ""]
	event true sent when node becomes active, event false sent when unbound by another node.
containerField	[containerField: NMTOKEN "children"]
	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	[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#Background



Reuse of ImageTexture nodes is accomplished by utilizing DEF/USE nodes.

TextureBackground was introduced in X3D version 3.0. Nevertheless, usage under Immersive profile requires addition of

<component name='EnvironmentalEffects' level='3'/>

http://x3dGraphics.com/examples/X3dForWebAuthors/Chapter 11-LightingEnvironment/TextureBackground-KelpForestMain.x3dForWebAuthors/Chapter 11-LightingEnvironment/Chapter 11-LightingE

## TextureBackground syntax comparison

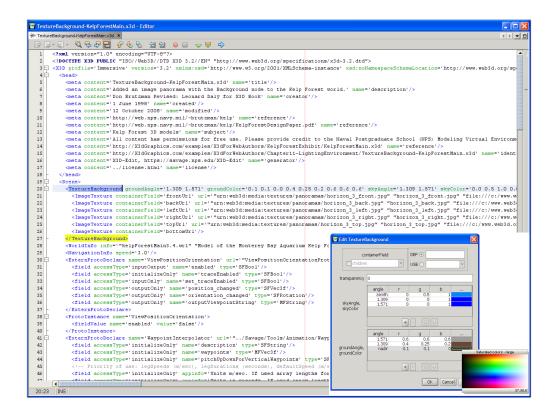
Note differences in use of containerField for XML syntax, versus use of field name for ClassicVRML syntax

.x3d) **Background** "MyTextureBackgroundNode" `ency="0" ıgle="1.55" )lor="0 1 0, 0.1 1 0.3" ·= "1.45" `="0.7 1 0.7, 0.9 1 0.9"> :xture containerField= xture" url='"leftImage.png"'/> xture containerField= xture containerField= 'exture" "frontImage.png"'/> xture containerField= exture" "backImage.png"'/> xture containerField= (ture" "topImage.png"'/> xture containerField= nTexture" "bottomImage.png"'/>

ClassicVRML Syntax (.x3dv) DEF MyTextureBackgroundNode TextureBackground { transparency O groundAngle [1.55] groundColor [0 1 0, 0.1 1 0.3] skyAngle [1.45] skyColor [ 0.7 1 0.7, 0.9 1 0.9 ] leftTexture ImageTexture { url "leftImage.png"} rightTexture ImageTexture { url "rightImage.png"} frontTexture ImageTexture { url "frontImage.png"} backTexture ImageTexture { url "backImage.png"} topTexture ImageTexture { url "topImage.png"} bottomTexture ImageTexture { url "bottomImage.png"}

Page 323, Table 11.13. Node Syntax for TextureBackground

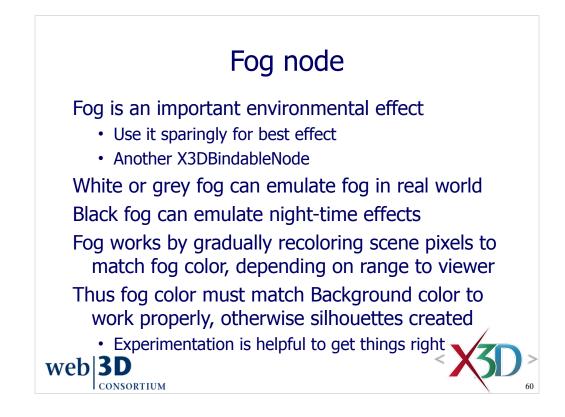
≥Background>



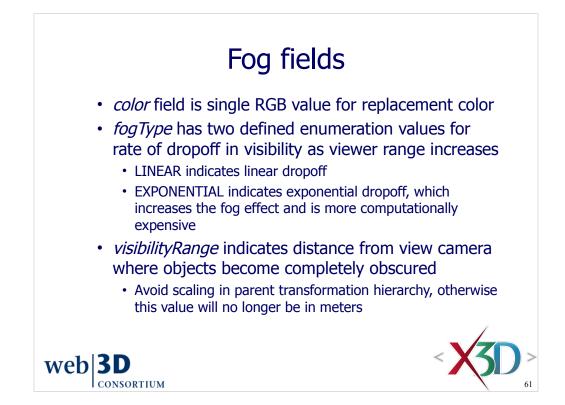
http://X3dGraphics.com/examples/X3dForWebAuthors/Chapter11-LightingEnvironment/TextureBackground-KelpForestMain.x3d

	TextureBackground simulates ground and sky, using vertical arrays of wraparound color values, TextureBackground can also provide backdrop texture images
TextureBackground	all six sides. Field names of child texture nodes are in alphabetic order: backTexture, bottomTexture, frontTexture, leftTexture, rightTexture, topTexture.
	Background, Fog, NavigationInfo, TextureBackground and Viewpoint are bindable nodes.
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!
kyColor	[skyColor: accessType inputOutput, type MFColor CDATA "0 0 0"]
	Color of the sky at various angles on the sky sphere. First value is color of sky at 0.0 radians representing the zenith (straight up).
	Warning: you must have one more skyColor value than skyAngle values.
	Interchange profile hint: only one color might be rendered, others can be ignored.
kyAngle	[skvAngle: accessType inputOutput, type MFFloat CDATA #IMPLIED]
	[0, pi] The angle values increases from 0.0 zenith (straight up) to $\Pi/2=1.57$ (horizon) to $\Pi=3.14159$ (nadir).
	Warning: you must have one more skyColor value than skyAngle values.
	Warning: colors at skyAngle=0 are ignored.
	Interchange profile hint: this field may be ignored.
roundColor	[groundColor: accessType inputOutput, type MFColor CDATA #IMPLIED]
	Color of the ground at the various angles on the ground partial sphere. First value is color of ground at 0.0 radians representing the nadir (straight down).
	Warning: you must have one more groundColor value than groundAngle values.
	Interchange profile hint: this field may be ignored.
roundAngle	[groundAngle: accessType inputOutput, type MFFloat CDATA #IMPLIED]
	[0. pi/2] The angle values increase from 0.0 nadir (straight down) to II/2=1.5708 (horizon).
	Warning: you must have one more groundColor value than groundAngle values.
	Warning: colors at groundAngle=0 are ignored.
	Interchange profile hint: this field may be ignored.
transparency	[transparency: accessType inputOutput, type MFFloat CDATA "0"]
	transparency applied to texture image.
set_bind	[set bind: accessType inputOnly, type SFBool (true[false) #FIXED ""]
	Input event set bind=true makes this node active, input event set bind=false makes this node inactive. Thus setting set bind true/false will pop/push (enable/disable) this node.
bindTime	bindTime: accessType outputOnly. type SFTime CDATA #FIXED ""]
	went sent when node becomes active/inactive.
Bound	ItisBound: accessType outputOhk, vareet
	[ISDOMA: access type output/output/section of the lates o
ontainerField	
	[containerField: NMTOKEN "children"] 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.
lass	[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#TextureBackground

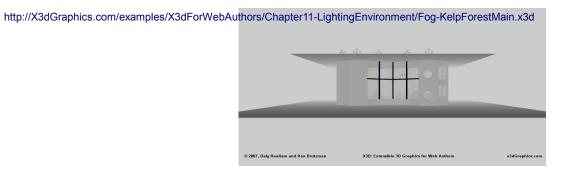


Constraint: Fog nodes within Inline scenes are not automatically bound when loaded, even if they are the only Fog nodes available in the scene.



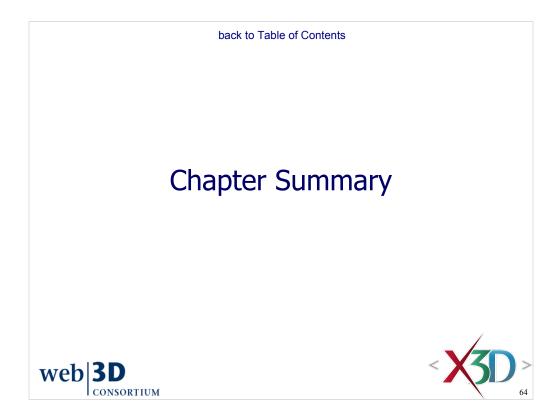
Fog-KelpForestMain.x3d - Editor
Ýv Fog-KelpForestilán.x3d ×
[] · · · · · · · · · · · · · · · · · · ·
1 xml version="1.0" encoding="UTF-8"?
2 X3D PUBLIC "ISO//Web3D//DTD X3D 3.1//EN" "http://www.web3d.org/specifications/x3d-3.1.dtd"
3 🖸 <x3d fog-kelpforestmain.x3d'="" name="title" profile="Immersive" version="3.1" xmlns:xsd="http://www.w3.org/2001/XMLSchema-instance" xsd:nonamespaceschemalocation="http://www.web3d.or&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;4 chead&gt;&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;5 &lt;meta content="></x3d>
6 <meta content="Added fog to the KelpForest world to simulate the typical weather pattern in June in Monterey, CA." name="description"/>
7 <meta content="Don Brutzman Revised: Leonard Daly for X3D Book" name="creator"/>
8 <meta content="1 June 1998" name="created"/>
9 <meta content="26 May 2008" name="modified"/>
<pre>10 <meta content"http:="" kely'="" name"reference'="" web.ngs.navy.mil="" ~brutzman=""/> 11 <meta content"http:="" forestdesionpaper.hdf'="" kely'="" name"reference'="" web.ngs.navy.mil="" ~brutzman=""/></pre>
<pre>11 <meta 3d="" content="http://web.nps.navy.mi/~brutzman/kelp/KelpForestDesignPaper.pdf" examples="" forest="" http:="" kelp="" ketprofestlaint<="" ketprofestlaintin="" models"="" name="subject'/&gt; 13&lt;/pre&gt;&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;&lt;pre&gt;12&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;14 subca concent= http://x3idtrahips.com/examples/X3idtowebauthors/KelpForestkhibit/KelpForestkain.x3dt name='reference'/&gt;&lt;/td&gt;&lt;/tr&gt;&lt;tr&gt;&lt;td&gt;&lt;pre&gt;sweeta content=" sidor@#bluthors="" td="" xidoraphics.com=""/></pre>
16 <meta content="X3D-Edit, https://savage.nps.edu/X3D-Edit" name="generator"/>
17 <meta content="/license.html" name="license"/>
18 -
19 c <scene></scene>
<pre>20 <fog color=".8.8.8" fogtype="LINEAR" visibilityrange="60"></fog></pre>
21 <\U01440rldInfo info='"kelpForestMain3.4.wrl" "Model of the Monterey Bay Aquarium Kelp Forest" "DTG of last updated: 111500Jun98" "Added: " "Updated: 111500Jun98" "Added: 1111500Jun98" "Added: 111500Jun98" "Added: 11150" "Added: 11150" "Added: 11150" "Added: 11150" "Added: 11150" "Added: 11150" "Added: 11150
<pre>22 <navigationinfo speed="3.0"></navigationinfo></pre>
23 C <externprotodeclare></externprotodeclare>
31 • <protoinstance></protoinstance>
34 AKTERNPROLOBECIATE>
S8
s  c = 0 <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  <pc 0="" <="" =="" p=""> c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> c = 0  c = 0  c = 0  <pc 0="" <="" =="" p=""> <pc 0="" <="" =="" p=""> c = 0  c = 0  <pc =<="" td=""></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc></pc>
c)  (i) star into star int
c) system of description - star risk orientation = 0.0 1.0 0.0 1.12 position = 4.0 = 5.7 51.0 />
63 «Viewpoint description='no floor' fieldOfView='1.04719' orientation='-0.3 1.0 0.3 1.57079' position='12.5 5.0 -2.0'/>
64 <viewpoint description="Bird's Eye View" orientation="1.0 0.0 0.0 -1.57" position="0.0 19.0 -3.5"></viewpoint>
65 <viewpoint description="Pump House" fieldofview="0.6" orientation="0.0 1.0 0.0 1.3" position="-5.0 1.0 0.0"></viewpoint>
66 -
67 Group DEF='Root'>
68 <background skycolor=".8.8.8"></background> contamerfeld DFF 0
69 <inline "http:="" examples="" introductionmessage.wrl"="" kelp<="" p="" url="" x3dforvebauthors="" x3dgraphics.com=""></inline>
VG CONTISION ENABLED TAISES
11 «Transform» China wist "Sharklaft slocale wil" there://YidGraphics.com/symmias/YidForMahiuthors/Kab. COMr. 8 8 8
73  fogType LINEAR •
74 <transform> 75 <thine "http:="" examples="" keig<="" sharklucylocale.wrl"="" td="" ul="" x3dforwebauthors="" x3dgraphics.com=""></thine></transform>
76  77 <transform translation="0.0.0"></transform>
20:9 INS
20.3 110

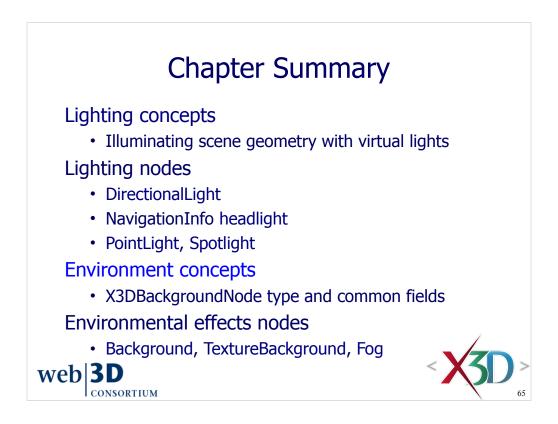
Figure 11.10. A Fog node blends geometry colors and textures to the fog color.



-	Fog simulates atmospheric effects by blending distant objects with fog color. Background, Fog, NavigationInfo, TextureBackground and Viewpoint are bindable
🚈 Fog	nodes.
DEF	[DEF ID #IMPLIED] DEF defines a urique ID anne 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!
color	[color: accessType inputOutput, type SFColor CDATA "1.0 1.0 1.0"] Hint: match Background color to make objects fade away.
fogType	[fogType: accessType inputOutput, type SFString CDATA (LINEAR/EXPONENTIAL) "LINEAR"] Specifies algorithm for rate of increasing Fog, either LINEAR or EXPONENTIAL. Hint: EXPONENTIAL is more natural but also more computationally expensive.
visibilityRange	[visibilityRange: accessType inputOutput, type SFFloat CDATA "0.0"] Distance in meters where objects are totally obscured by the fog, using local coordinate system. Hint: visibilityRange 0 disables Fog.
set_bind	[set_bind: accessType inputOnly, type SFBool (true false) #FIXED ""] Setting set_bind true makes this node active setting set_bind false makes this node inactive. Thus setting set_bind true false will pop/push (enable/disable) this node.
bindTime	[bindTime: accessType outputOnly, type SFTime CDATA #FIXED ""] Event sent when node becomes active/inactive.
isBound	[isBound: accessType outputOnly, type SFBool (true[false) #FIXED ""] Event true sent when node becomes active, event false sent when unbound by another node.
containerField	[containerField: MITOKEN "children"] 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 XJD 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#Fog





# Suggested exercises

Use a TouchSensor to turn a light on/off

Include BooleanToggle so that state is persistent

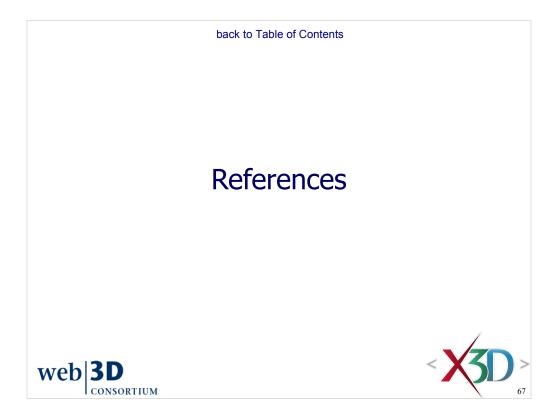
Also indicate the physical location of a light source by using a Cone or Sphere

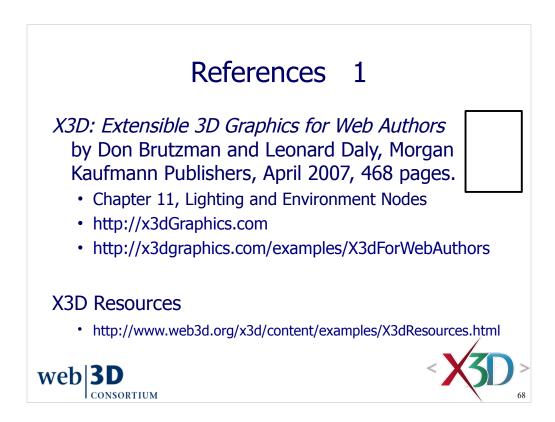
Be sure to set *emissiveColor* and *transparency*Demonstrate use of Background colors

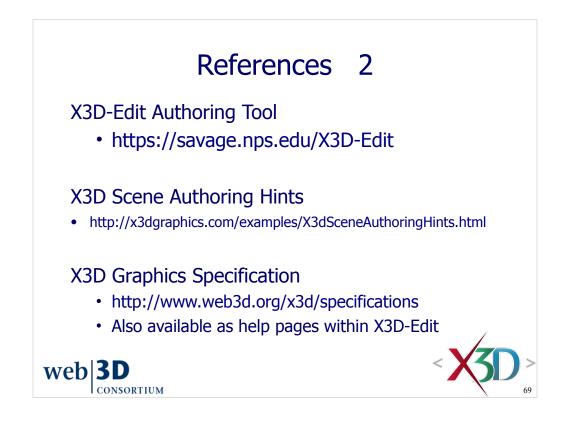
Demonstrate use of (Texture)Background images
Demonstrate use of Fog for day or night effects

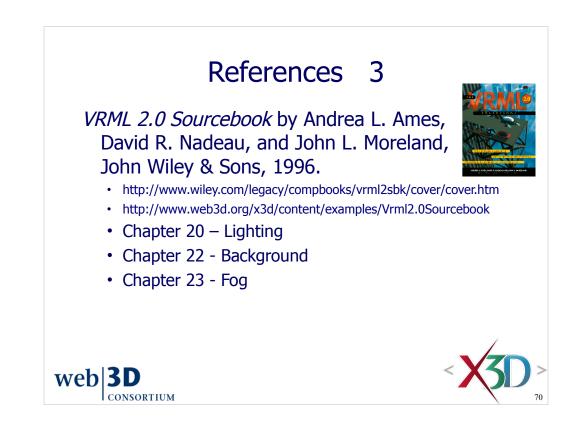


web **3D** 



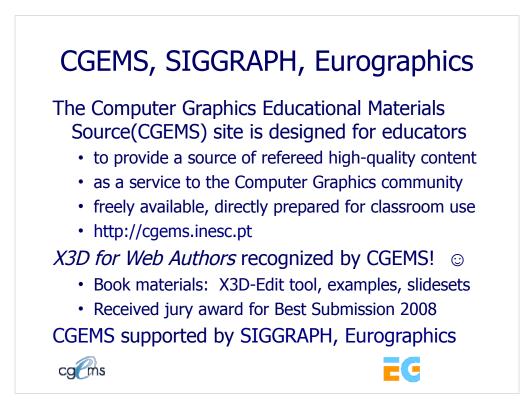












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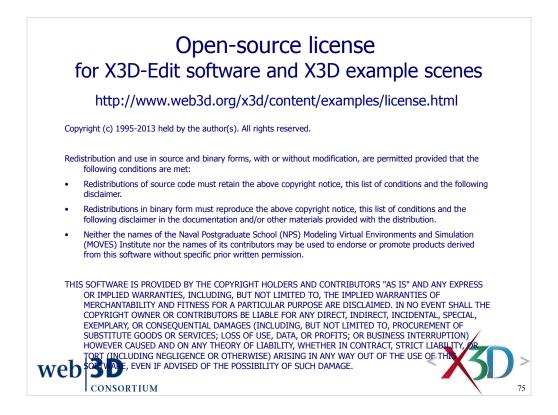
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Good references on open source:

Andrew M. St. Laurent, *Understanding Open Source and Free Software Licensing*, Oreilly Publishing, Sebastopol California, August 2004. http://oreilly.com/catalog/9780596005818/index.html

Herz, J. C., Mark Lucas, John Scott, *Open Technology Development: Roadmap Plan*, Deputy Under Secretary of Defense for Advanced Systems and Concepts, Washington DC, April 2006. http://handle.dtic.mil/100.2/ADA450769



