



# Master Class:

# Web3D

World Bank Land and Poverty Conference 2015

Nicholas F. Polys, Ph.D.

# cs.vt.edu

- About me

File Edit View History Bookmarks Tools Help

npolys | Computer Science ... x +

cs.vt.edu/user/polys Search

VirginiaTech *Invent the Future* College of Engineering Department of Computer Science Exemplary Department Award

Search within VTCS  
Enter your search here GO

Department Head Search Faculty Search

About Us  
People  
Research

Undergraduate  
Graduate

Events and Seminars

Alumni  
Partnering with Industry  
Northern VA Campus

Contact Us

f YouTube in b

Feed aggregator

Home User Polys

**Nicholas F. Polys**  
Affiliate Professor

Office: 3030B Torgersen Hall  
Email: [npolys@vt.edu](mailto:npolys@vt.edu)  
Phone: (540) 231-0968  
Website: <http://people.cs.vt.edu/~npolys/>  
Publication statistics: [Google Scholar Profile](#)  
Office Hours: R: 3:00 to 5:00 p.m. and by appointment

About Labs Publications Projects Courses

Nicholas F. Polys is Director of Visual Computing with Virginia Tech Research Computing Group and Affiliate Research Professor in the Department of Computer Science. He has developed interactive 3D graphic content and systems for over 15 years. His research interests lie at the center of graphics and Human Computer Interaction: the intersection of visualization, virtual environments, and perception. After his undergraduate research in Cognitive Science at Vassar College (1996), he jumped into the networked information space of the WWW developing audio, visual, and 3D assets and software. His doctoral work at Virginia Tech (2006) examined perceptual cues and layout behaviors for Information-Rich Virtual Environments for desktop to immersive platforms.

**Research Interests**

- ▶ 3D Interaction
- ▶ Center for Human Computer Interaction
- ▶ Human Computer Interaction

# Today's Mission

- Understand what's possible with Web technologies
- Identify your stakeholders who benefit
- Clarify questions of value
  - *Portability*
  - *Interoperability*
  - *Durability*
- Understand what to ask for in data and software deliverables

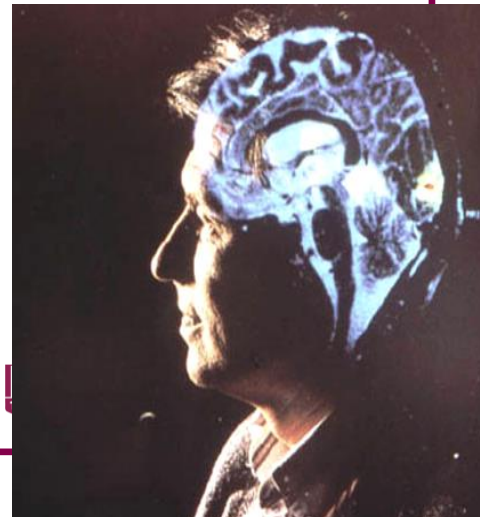
# Outline

- 3D Geospatial Visualization:
  - Analytics, Design, Consensus, ...
- The value of extensible standards (X3D)
- The value of the OpenStack (OGC)
- Content pipelines
- Authoring & Publishing to OGC and Web3D (ISO) standards (X3D and X3DOM)

# Information Fusion

## *Integrated Information Spaces*

- Unified environment for analysis & learning
- Scalability for heterogeneous data types (spatial, abstract, temporal)
- Represent real world 4D objects and systems
  - Reduce cognitive distance by putting information in familiar context
  - Leverage natural spatial abilities of users
- ... ultimately to support multi-criteria *decision-making*



# USDA Eastern Vineyards Project

- Data fusion for site suitability
- <http://vmdev.cgit.vt.edu/ECVineyards/>

www.  
cgit.  
vt.edu

The screenshot shows a web browser window displaying the USDA Eastern Vineyards Project interface. The browser address bar shows the URL <http://vmdev.cgit.vt.edu/ECVineyards/test/>. The page features a header with the Virginia Tech logo and the tagline "Invent the Future". Below the header, there is a navigation bar with "Legend" and "Details" tabs. The main content area is divided into three sections: a left sidebar, a central map, and a right-hand "Site Report Generation Tool" panel. The sidebar contains a graphic for the "GRAPE & WINE QUALITY EASTERN U.S. INITIATIVE" and text describing the application's purpose: "About this application: This web application is used to display maps and utilize geoprocessing tools built for the USDA-SCRI funded project, 'Improved grape and wine quality in a challenging environment: An eastern US model for sustainability and economic vitality.' This site is in beta form and its tools are still under development." It also includes a "Generate site report" section with instructions to click the "Get Started" button and input an email. The central map shows an aerial view of a vineyard with a red polygon drawn around a specific site. The right-hand panel, titled "Site Report Generation Tool", contains instructions: "1. Zoom map to your site, or find the site address on the map." (with a search input field), "2. Draw a polygon around the site of 200 acres or less." (with a small map thumbnail showing a red polygon and a "Double-click to complete" label), and "3. Click 'Get Site Report' to generate report and send as email." Below these instructions are buttons for "Draw Polygon", "Delete Polygon", and "Get Site Report". A yellow warning box states "Please wait while the report is generated. This may take 4 - 6 minutes." and a "Back" button is at the bottom of the panel. The bottom of the browser window shows the Windows taskbar with various application icons and the system clock displaying 8:11 PM on 3/26/2015.

# Report Excerpt (test site 3/26/15)

## Soils

### Information

"Soil affects grapevine productivity and wine quality. Confounding influences of vineyard management, climate, varieties and clones, fertilizer and irrigation practices, as well as variation in fruit harvest and winery practices, may easily obscure the more subtle, unique soil contributions to wine quality. Soils cannot be evaluated independently of the other vineyard site considerations, and some compromises in soil quality may be necessary so that the vineyard site selection process does not become too exclusive." - Wolf and Boyer, 2009



### Soil Conditions

**Organic Matter** Avg: 0.63 Min: 0.54 Max: 0.97  
 Organic matter is generated by the decomposition of plant and animal waste by the communities of soil arthropods and microbial decomposers that it supports. Organic matter improves soil fertility, structure, aeration and drainage. In large quantities, organic matter releases excess Nitrogen that can lead to vigorous vine growth.  
**Suitability Info:** Unsuitable: < 1% or > 3% Suitable: 1% - 3%

**Soil Depth (cm)** Avg: 200.0 Min: 5.35 Max: 200.0  
 Deep soil depth acts as a protective buffer against drought as it allows for greater volume of potential soil moisture and ample space for cultivation of large, healthy, perennial root structures.  
**Suitability Info:** Unsuitable: < 75 cm (30 in.) Suitable: > 75 cm (30 in.)

**Available Water Capacity (AWC - in./in.)**  
 Avg: 0.16 Min: 0.11 Max: 0.16  
 This describes the quantity of water available for uptake by plants after gravitational forces have removed excess water from a saturated soil. The ability of a soil to hold water is a function of soil texture and organic matter content.  
**Suitability Info:** Poorly Suited: > .14in./in. Fairly Suited: .10 - .14in./in. Well Suited: < .1 in./in.

**Saturated Hydraulic Conductivity (Ksat - in./hr)**  
 Avg: 1.78 Min: 0.73 Max: 2.87  
 Ksat is a measure of the rate at which water moves through a column of saturated soil also described as permeability. Soils with Ksat values above 0.6 inches per hour tend to be better-suited for viticultural production.  
**Suitability Info:** Poorly Suited: < 0.6 in./hr Fairly Suited: 0.6 - 2.0 in./hr Well Suited: >2.0 in./hr

**Bulk Density (g/cm3)**  
 Avg: 1.42 Min: 1.38 Max: 1.46  
 Bulk density describes the relationship between soil solids and pore space where air and water can be stored in a given volume of soil. Bulk density is a key factor in productive viticulture because bulk densities higher than 1.6 g/cm3 indicate compacted soil, restricted water movement, poor root development and loss of soil aeration.  
**Suitability Info:** Unsuitable: > 1.6 g/cm3 Suitable: < 1.6 g/cm3

**Soil pH** Avg: 5.13 Min: 4.85 Max: 5.91  
 Soil pH is easily amended, but the cost of amendment whether through lime or gypsum applications may be cost prohibitive for some growers if pH is above 7.5 or below 4.0. Appropriate soil pH levels are critical to vine health. Low pH values are especially detrimental to grapevines as Aluminum and Copper are made plant available which can lead to stunted growth and toxicity.  
**Suitability Info:** Unsuitable: ph < 4.0 or > 7.5 Suitable: ph = 4.0 - 7.5

Basemap Source: ESRI World Imagery

**Soil Series Details**  
 Guemsey silt loam, 2 to 7 percent slopes  
 Unison and Braddock cobbly soils, 7 to 15 percent slopes  
 Unison and Braddock soils, 15 to 25 percent slopes  
 Unison and Braddock soils, 2 to 7 percent slopes  
 Unison and Braddock soils, 7 to 15 percent slopes

## Climate and Weather

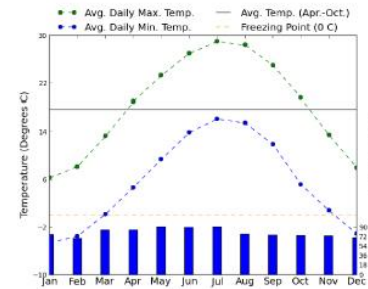
### Information

Grapes can be exposed to environmental stresses that can reduce crop quality and yields and injure or kill grapevines. Damaging winter temperatures, spring and fall frosts, extremes of rainfall, and higher than optimal summer temperatures occur with regularity in some regions. Climate refers to the average course of the weather at a given location over a period of years and is measured by temperature, precipitation, wind speed and other meteorological conditions. "Weather" is the state of the atmosphere at a given moment with respect to those same meteorological conditions.  
 - Wolf and Boyer, 2009

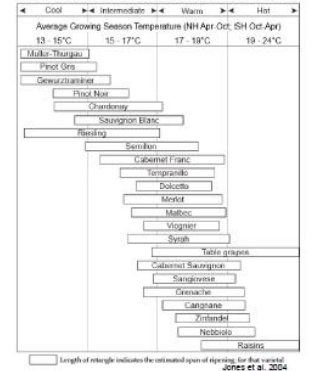


Basemap Source: ESRI World Imagery

### Seasonal Temperature Analysis



### Grapevine Climate/Maturity Groupings



## Climate and Weather Conditions

### Basic Climate Factors

- Average Growing Season Temperature (Mean Temperature April - October)  
 °C: 17.68°C °F: 63.824°F
- Average Growing Season Degree Days (C)  
 (Avg. Daily Mean Temp. - Base Temp 10°C)  
 °C: 1679.51 °F: 3023.12
- Length of Growing Season - frost-free days 164
- Annual Precipitation in inches 37.37
- Growing Season Precipitation in inches 22.8
- Spring Frost Index in °F April: 12.8 May: 12.5  
 (Avg. Daily Mean Temp. - Avg. Daily Min Temp)

### Extreme Low Temperature Risk Factor (Number of winters < threshold in a decade)

Threshold:	5°F	0°F	-5°F	-10°F	-15°F
Winters:	5.0	1.0	0.0	0.0	0.0

### Other Information:

The length of the growing season will determine whether grapes will ripen or not. A minimum of 180 frost-free days is recommended.

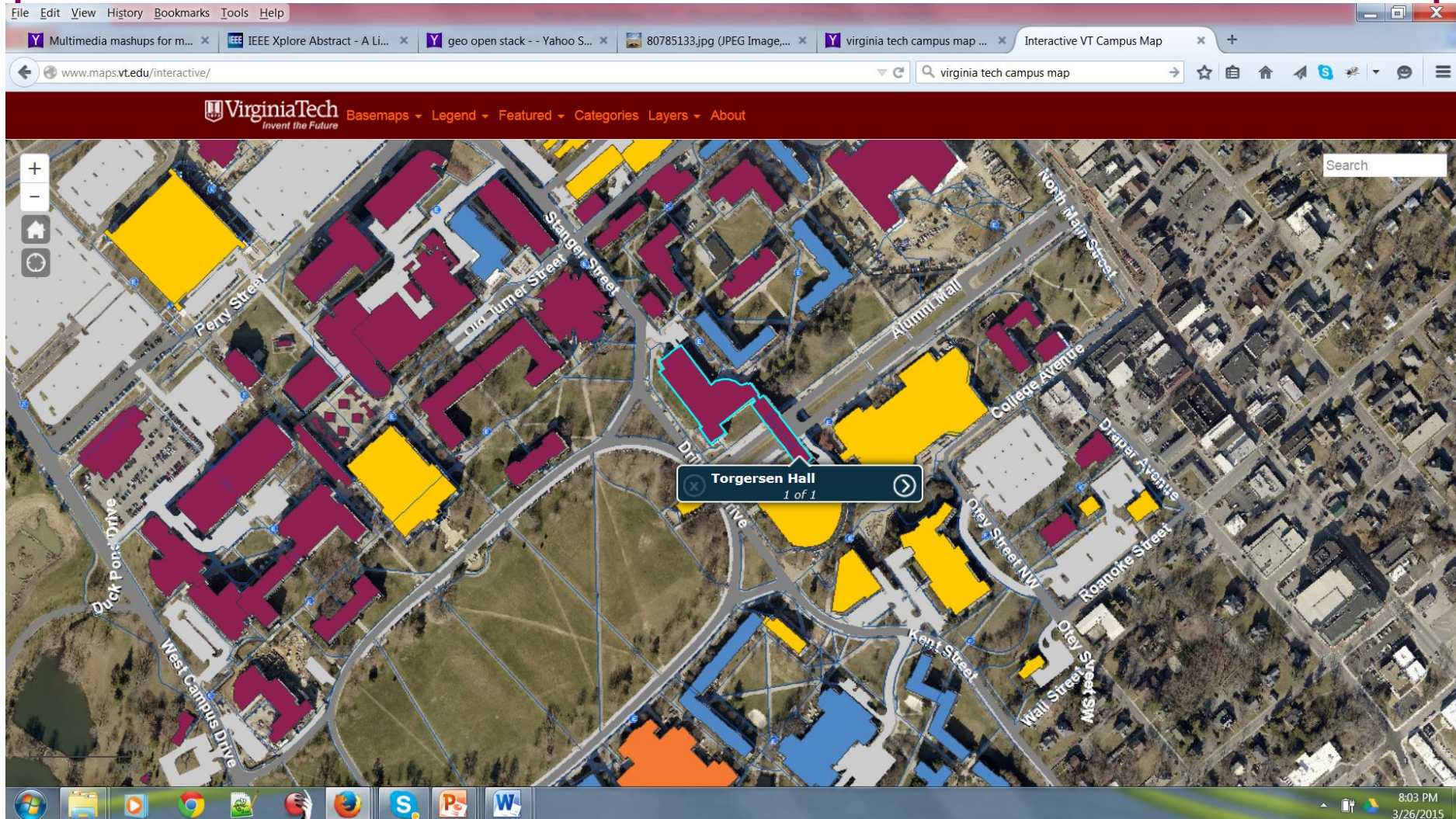
Grapevines can be injured or killed by winter cold. See chart above for statistics on average number of winters with extreme cold temperatures.

# 3D Portrayal

- Mental rotations from 2D map to 3D reality are notoriously difficult
- Interactive 3D makes these relationships cognitively explicit
- Elevation, aspect, viewshed, solar exposure, ...
- Relevant information exists below the ground, under a bridge, on the floor above, etc.



# 2D Interactive Campus Map

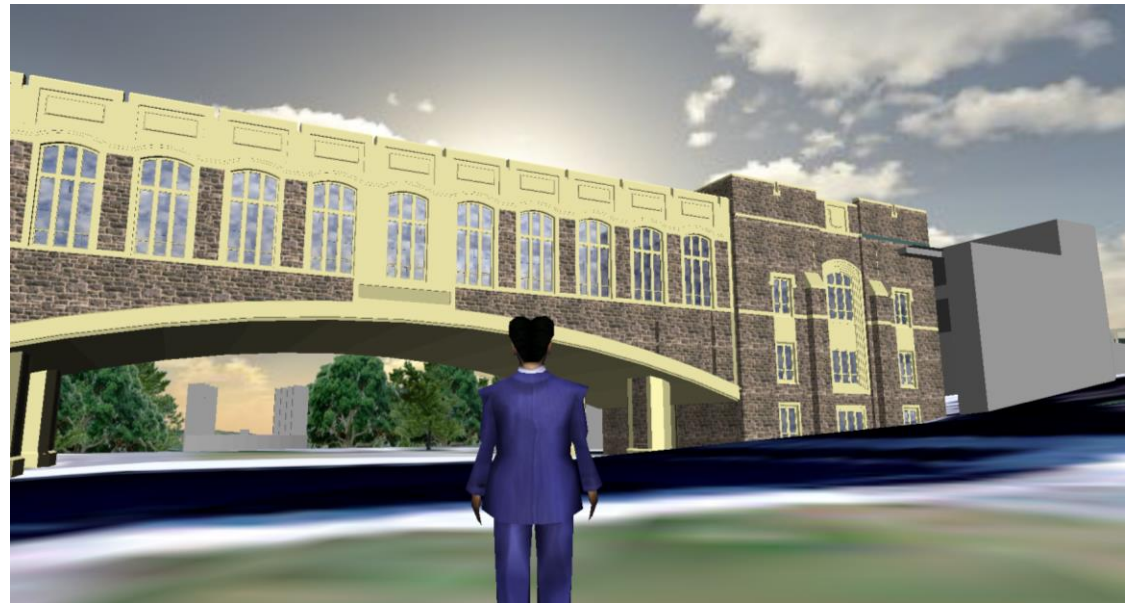


# VT



## 3D VT

- Torgersen Hall -  
Torgersen Bridge



# 3DBlacksburg.org

The screenshot shows a web browser window displaying the homepage of 3DBlacksburg.org. The browser's address bar shows the URL www.3dblacksburg.org. The website features a large header with the logo and navigation links for Home, Contact, About, and Register. A search bar is also present. Below the header is a large banner image of a 3D city model with three callout boxes: 'Learn' (Learn about our goals for the new digital citizenship!), 'Explore' (Check out the project status, data sources and the download page!), and 'Get Involved' (Help us build our virtual town! View upcoming events, and learn how you can contribute.). The main content area includes a section titled 'The 3D Blacksburg Collaborative' with a paragraph describing the project's goals. To the right, there are sections for 'Explore' (with a 'Downloads' link for 'Download Models (Login Required)') and 'This Site' (with links for Home, Site Map, Login, and Login Form). The Windows taskbar at the bottom shows various application icons.

File Edit View History Bookmarks Tools Help

Home

www.3dblacksburg.org

Search

3D Blacksburg collaborative

Home Contact About Register

Search...

**Learn**  
*Learn about our goals for the new digital citizenship!*

**Explore**  
*Check out the project status, data sources and the download page!*

**Get Involved**  
*Help us build our virtual town! View upcoming events, and learn how you can contribute.*

**The 3D Blacksburg Collaborative**

The X3D Blacksburg Collaborative will develop and curate an n-D city model of the Town of Blacksburg and its surrounds. This spatial data infrastructure will support several interactive information services including building models and terrain. Citizens, Scientists and Scholars can use these resources for many applications including planning and community and economic development. Check out this online video describing our mission and goals!

**Learn**

about our vision for a mirror world of networked cohabitation! We are using Spatial Data Infrastructure to catalyze information services

**Get Involved**

in building our mirror world town model! We maintain a calendar of mapping events and trainings. Find out about our licensing and

**Explore**

**Downloads**  
[Download Models \(Login Required\)](#)

**Explore**  
[Solar Suitability](#)

**This Site**

[Home](#)

[Site Map](#)

[Login](#)

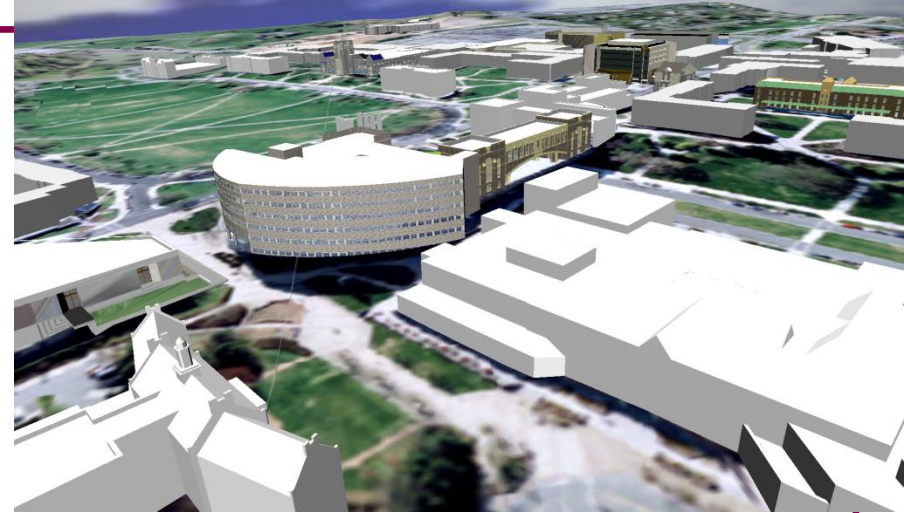
[Login Form](#)

Advanced

Tech  
the Future

# 3D Blacksburg

- n-D City model
- Enterprise scale GIS infrastructure
- International standards:
  - Web3D (ISO X3D)
  - OGC (Web3DS)
- Integrates sensor feeds and crowd-sourced content





Town & Building LODs



X3D shared multi-user VT Campus



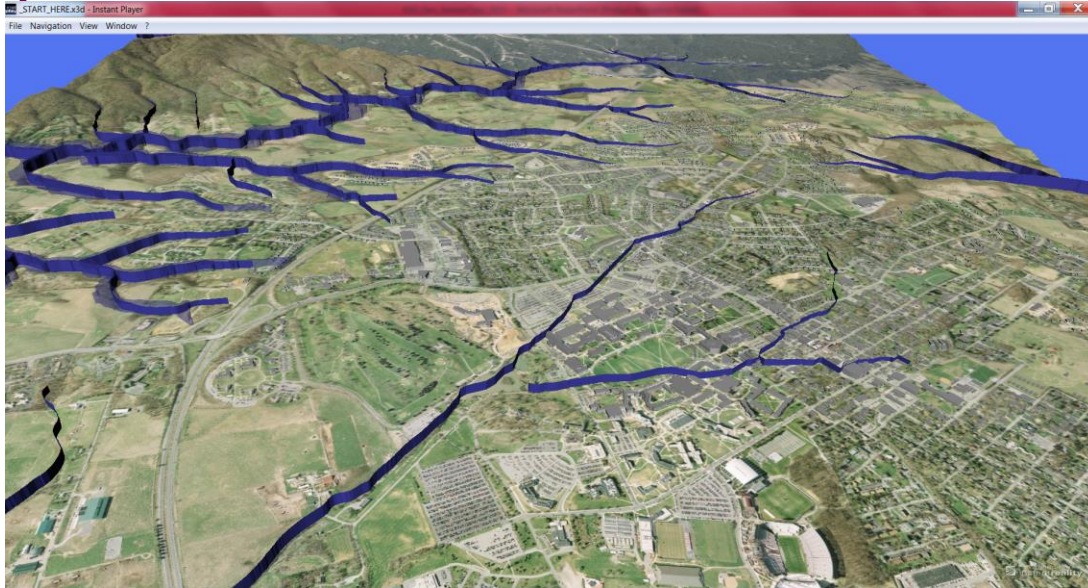
X3D Immersive



# Mashups

- WWW: Data and Software Services
  - The new interface for connected platforms
  - But all information is not created equal (G Earth and MS Bing data sets have unknown provenance / accuracy)
- Open repositories like StreetMap and Areal Map can be useful
- Need to handle coordinate systems / geospatial projections

# Information Layer Fusion

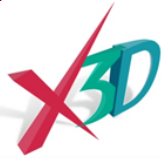


- USGS Elevation
- VA Imagery
- GIS building footprint
- Crowdsources buildings
- Stream center and floodplain



Advanced Research Computing





## Extensible 3D (X3D):

The ISO-IEC Greatest Common Denominator for 3D Processing, Publishing and Printing

### Biology, Chemistry

- Visual Molecular Dyna (VMD)
  - Chimera
  - JMol/ PyMol
- Vis**
- Revit/ VIZ
  - Amira/ OI

### Science & Medicine

- Seg3D/ImageJ
- Paraview/VTK
- Osirix
- COVISE/ OpenCover
- MatLab/ Simulink

### Culture & Design

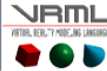
#### DCC tools

- Blender
- Modo
- Ayam
- 3D Studio Max
- Maya
- Rhino3D

### CAD

- BRL CAD
  - Inventor/ AutoCAD/ CADStudio
  - FreeCAD
- Geo**
- PostGIS
  - Geoserver
  - CityServer3D

Fraunhofer InstantHub, ...  
 Bitmanagement Content Studio, ...  
 MeshLab, Okino Polytrans, X3D-Edit, ...



### X3D for 3D Printing

Carries material and metadata!

- Netfabb
- Mcor GrowShapes
- NIH 3D Print Exchange
- Shapeways
- www.web3d.org



### X3D for Web Publishing

- X3D Stand-alone:
  - Commercial: Instant Reality, Contact, ...
  - Open: H3D, Xj3D, Titania, Castle3D, FreeWRL, ...
- X3D browser plugins : Contact
- X3DOM [native HTML5/WebGL]



## Extensible 3D (X3D):

The ISO-IEC Greatest Common Denominator for 3D Processing, Publishing and Printing



Biology, Chemistry



Medicine



Culture



CAD

BIM

Commercial and Open Source Tools:  
 Exporters, Editors, Translators

- X3D Encodings (XML, VRML, Binary)
- X3D APIs (Javascript, Java, Python, ...)



### X3D for 3D Printing

- Easy STL, AMF
- Carries appearance information (per vertex)
- Carries metadata (e.g. provenance)
- www.web3d.org



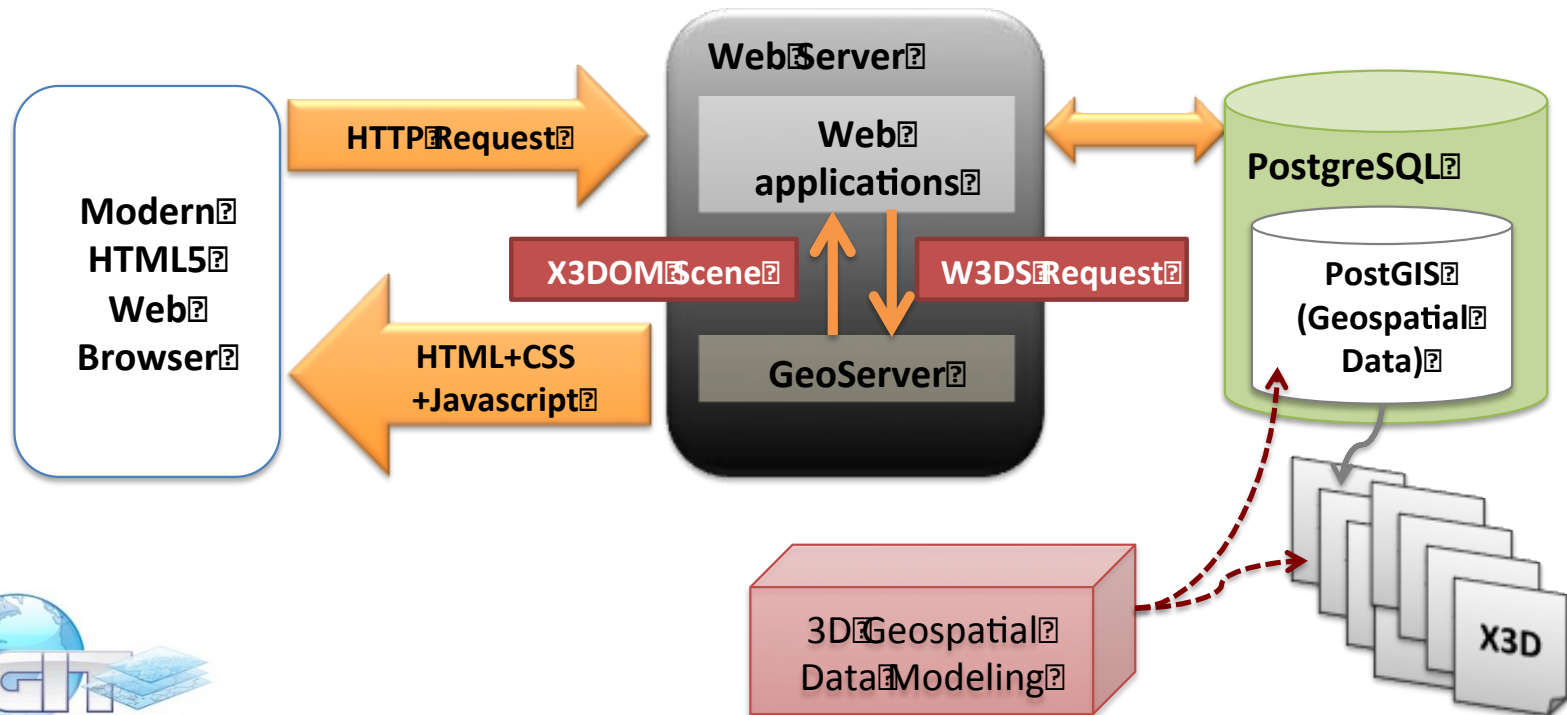
### X3D for Web Publishing

- Interoperability: Easy HTML5, DOM
- Portability: Rich Graphics from desktops to HMDs and CAVEs
- Durability: ISO lifetime



# Web3D Geospatial Publishing

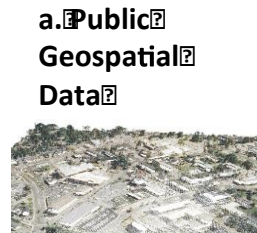
- OGC Web3D Service
- X3DOM Portrayal



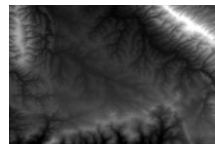
# The Open Geo Stack

Open Source Implementations of OGC, WWW and Web3D Standards:

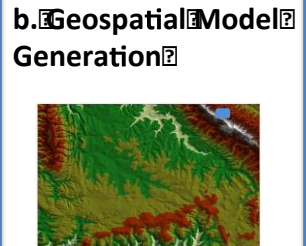
- X3D, X3DOM
- OpenLayers
- ...
- GeoServer, OpenStreetMap, OpenArealMap
- GDAL
- Post-GIS



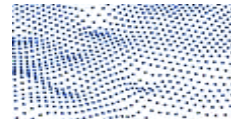
LiDAR post-processed data (points)



Raster Mosaic DEM



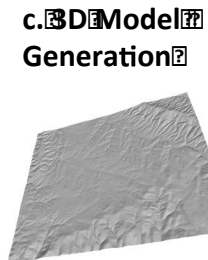
Triangulation Irregular Network (TIN)



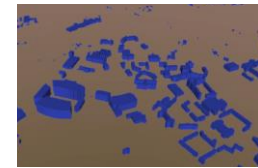
Grid



Building Footprints



X3D terrain model



X3D building model (LoD)



Satellite Aerial Image



OSM data-based image

*See also: FOSS4G*

# Mirror Worlds

- Interactive spaces that evolve over time
- Contain spatially-located media resources
  - Audio
  - Video
  - Sensors & historical information
- Hyperlinked worlds
- Federated data services: ‘mashups’ on the Web

# Live Sensors & Streams

- Video Web Cameras
- Stream Guages
- Wind / weather information
- ...


File Edit View History Bookmarks Tools Help

Web3D Consortium | Open... 3D Globe Weather

www.web3d.org/x3d-models/Globe Search

## 3D Weather Globe

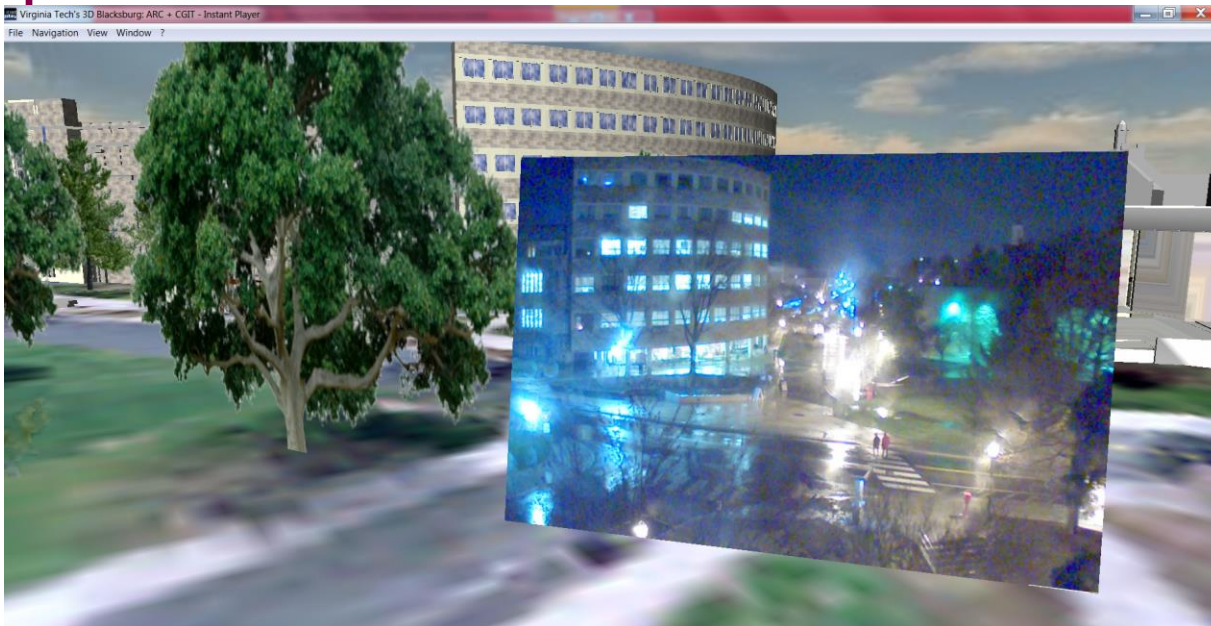
Drag the globe with your cursor. The weather in the city closest to the center point will be displayed. The *Reset View* button returns the globe to 0° latitude, 0° longitude.



Reset View

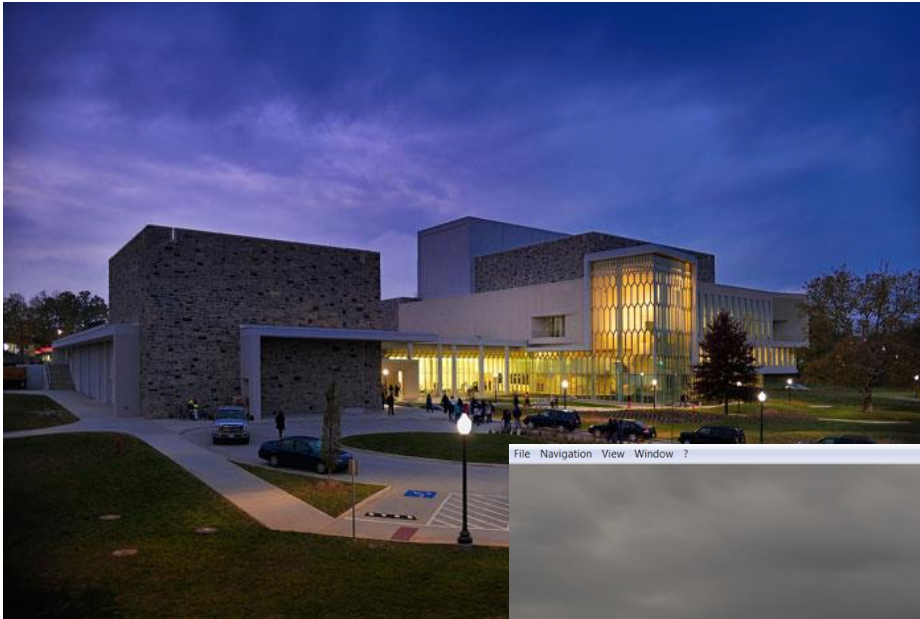
**Closest Weather Data**  
City: Chesapeake Beach, US  
Location: 38.62 Latitude by -76.51 Longitude.  
Right Now: light rain  
Temperature: 64F  
Humidity: 78%  
Wind: 13.422mph at 209.001 degrees  
Cloud Coverage: 64%

Data courtesy of [openweathermap.org](http://openweathermap.org)



# Mirror Worlds

- Institute for Creativity, Arts and Technology



File Navigation View Window ?



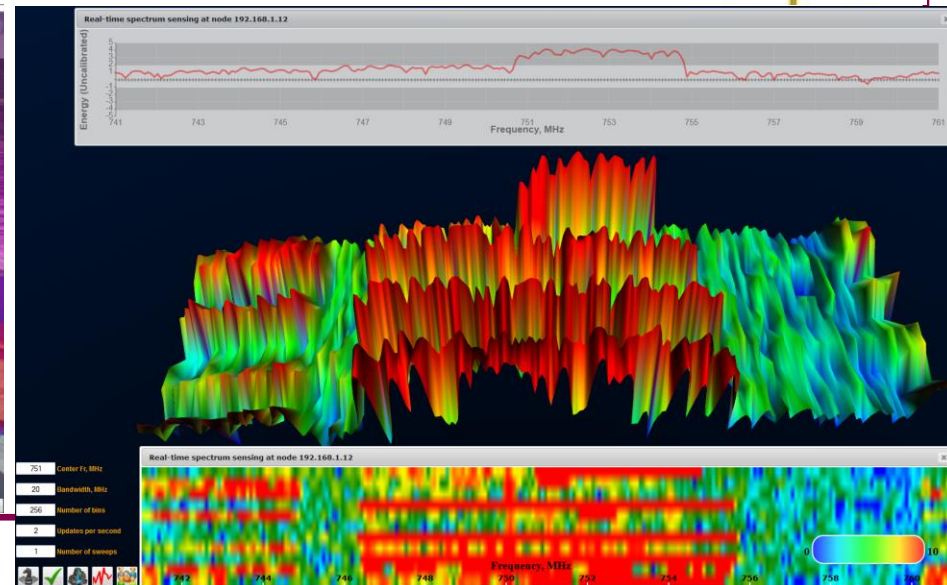
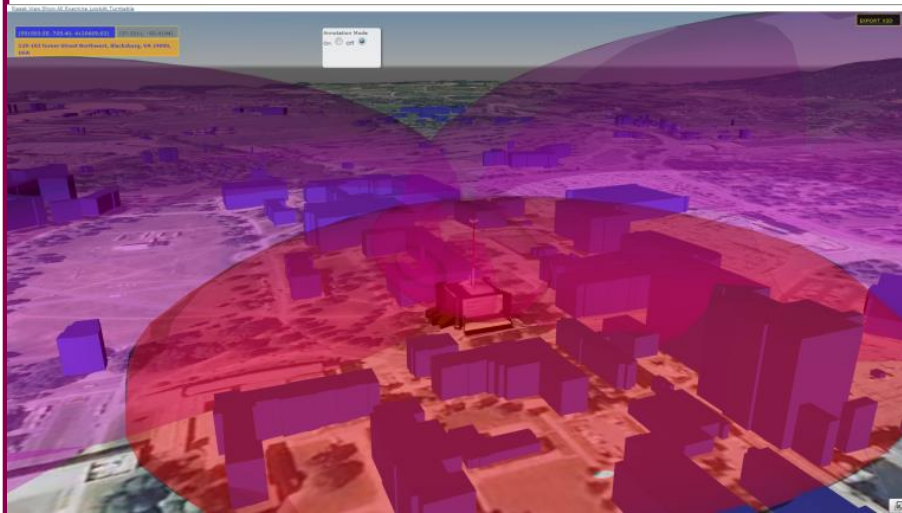
# ICAT Lobby



Advanced Research Computing

# CORNET3D

## Wireless coverage Visualization



# Open Standards

[www.web3d.org](http://www.web3d.org)

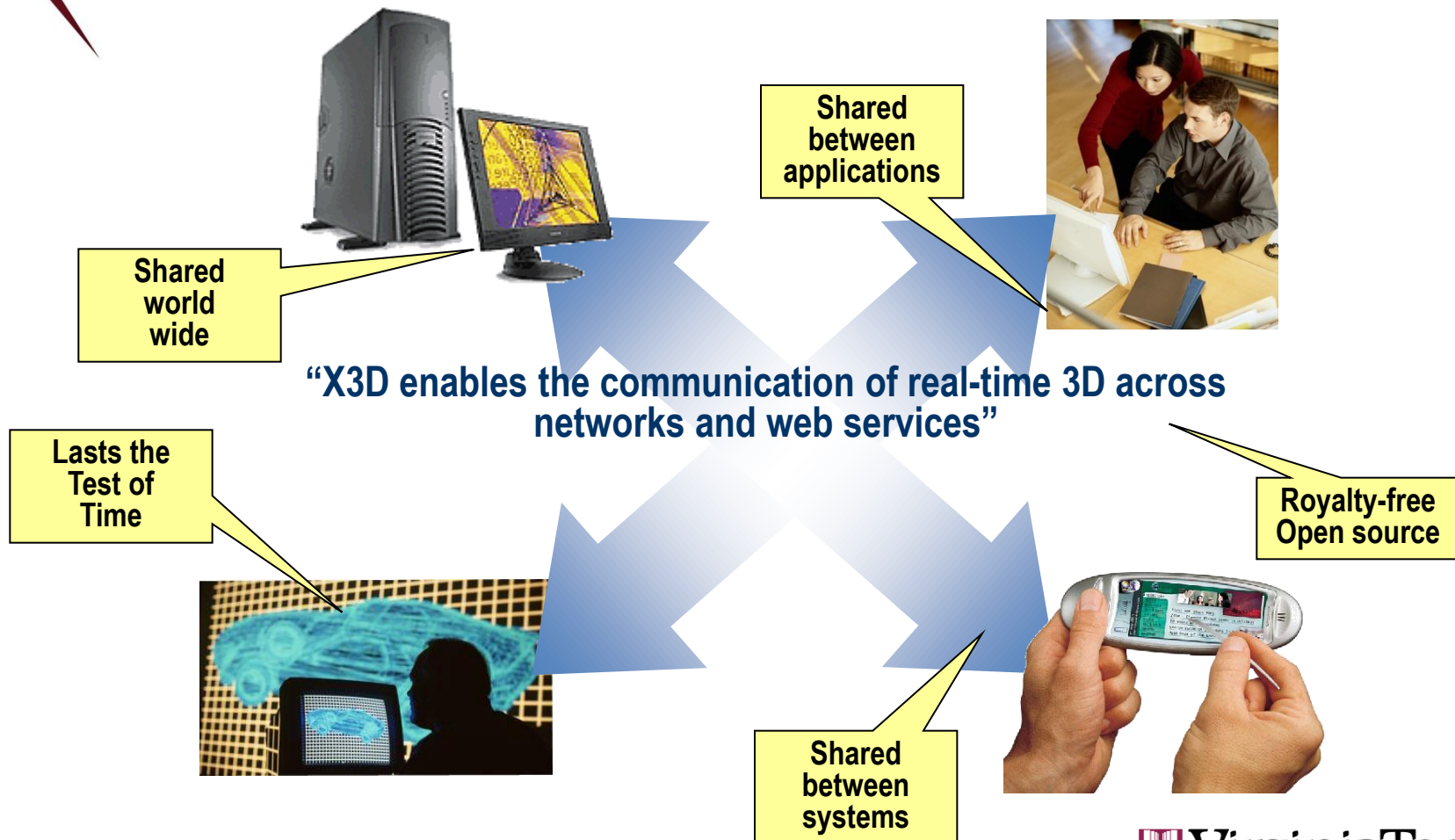
- Portability
- Durability
- IP independence (royalty-free)
- International recognition and support  
(ISO-ratified)





# X3D

## Extensible 3D (X3D): The ISO Standard for 3D on the Web



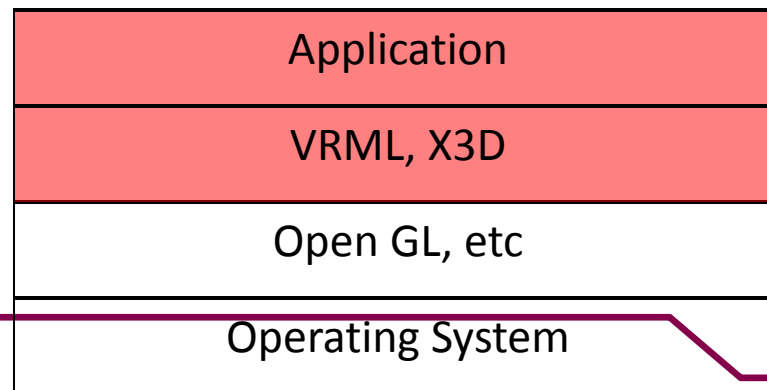
# Extensibility

- 20 years of scholarship & practice in ACM and IEEE
- Georeferenced 3D
- Advanced Appearances
- Massive Multi-User
- Training Formalisms
- Mesh Compression
- New devices ...



# Foundations

- ISO standard, openly published and royalty-free
- A layer above media and rendering libraries
- Multiple implementations including open source codebases
- X3D Scene graph includes the *Transformation graph* and the *Behavior graph*

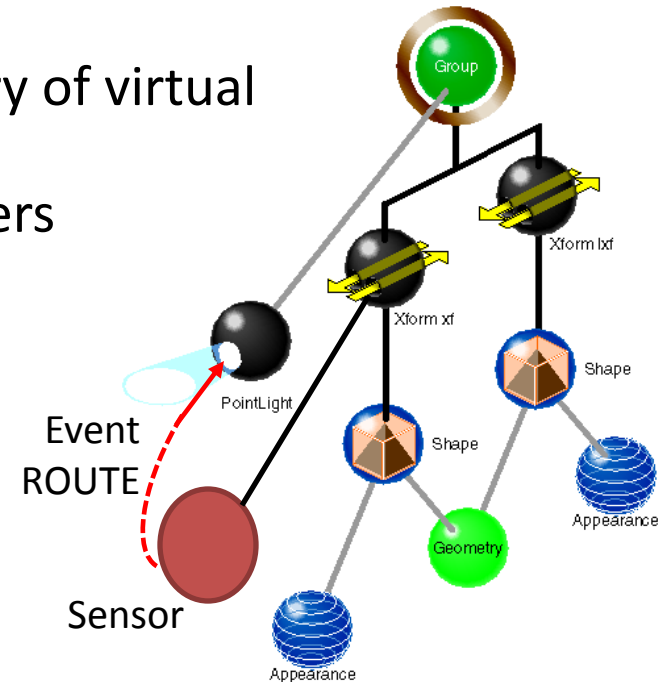




# Standard Scope

Scene graph for real-time interactive delivery of virtual environments over the web:

- Meshes, lights, materials, textures, shaders
  - Integrated video, audio
  - Animation
  - Interaction
  - Behaviors
  - Scripts
  - Application Programming Interfaces
- 
- 3.3 examples for Medical Imaging, CAD and Geospatial support!



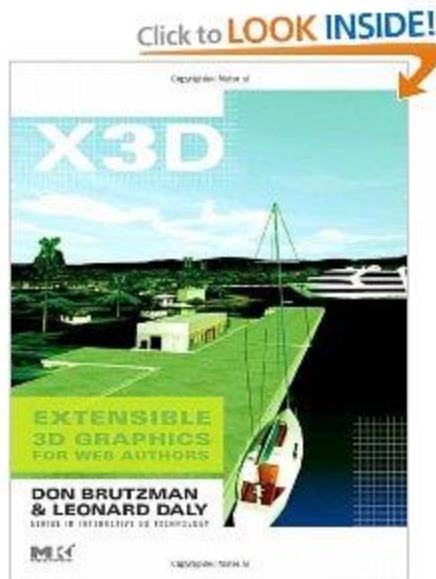
**Source of Specs, Models, Links,  
Bulleting boards, Blogs, Mailing lists,**

...

<http://www.web3d.org>

# X3D Book & Online Resources

- <http://www.x3dgraphics.com/>



## **Extensible 3D Graphics For Web Authors**

*From NPS grad class –  
slides, videos, examples  
all online!!!*

# Publishing X3D Worlds

URLs- a file or CGI web request delivers to clients:

- Stand-alone applications
  - InstantReality.org, COVISE, Titania, FreeWRL, Xj3D
- Plug-ins for an internet browser
  - Bitmangement.de, OctagaVS, Cortona3D
- HTML5 : with no plug-ins
  - X3DOM.org



# **X3DOM.org:**

***Next-Generation Web3D Applications  
on Open Standards and Open Source***

Web3D Consortium

[www.web3d.org](http://www.web3d.org)



# Participatory Web3D

- User Driven Annotations
- Historical Photos
- What if scenarios for the future
- [http://metagrid2.sv.vt.edu:8080/scripts/geoserver\\_iframe.html](http://metagrid2.sv.vt.edu:8080/scripts/geoserver_iframe.html)



# Web3DS Blacksburg

Reset View Show All Examine LookAt Turntable

(551301.15, 625.79, 4120107.55) 157.2051 -83.4214

Virginia Polytechnic Institute and State University Blacksburg, VA 24060, USA

Annotation Mode On Off FPS 28.92 fps

**A-1?**

**A.?**

**A-2?**

**Annotations?**

1931-01-01
1931-04-07
1931-05-01
1931-07-01
1931-07-04
1931-09-01
1931-11-21
1932-01-06
1932-04-01
1932-07-12
1933-01-01
1933-03-07
1933-04-01
1933-04-08
1933-08-15
1933-10-01
1934-01-01
1934-01-01
1934-02-01
1934-05-01
1934-11-01
1935-01-01

## Change Bounding Box

### Manual BBox

Min X: 542958.88082

Min Y: 4116170.4708

-OR-

Max X: 558506.11994

Max Y: 4124028.5297

Apply BBox Reset BBox

### Map Extent as BBox



Apply BBox Reset BBox

## B.?

### Custom Request

```
http://metagrid2.sv.vt.edu:8080/geoserver/x3d_lods/w3ds?version=0.4&service=w3ds&request=GetScene&format=text/html&crs=EPSG:26917&layers=x3d_lods:url_terrain_montgomery_ifs_bf,x3d_lods:url_building_lidar_ifs_bf&boundingbox=542958.88082315,4116170.4708488,558506.11994672,4124028.5297961
```

## B-2?

Aerial Image Texture

Apply Custom URL

M B A R I



# MBARI

- STOQS

(Spatial Temporal Oceanographic Query System)

- <http://odss.mbari.org/canon/default/query/>
- On GitHub: <https://github.com/stoqs/stoqs>
- Youtube:  
<https://www.youtube.com/watch?v=E8wO3qMevV8>
- [https://www.youtube.com/watch?feature=player\\_embedded&v=Vq\\_9sCGCt0s](https://www.youtube.com/watch?feature=player_embedded&v=Vq_9sCGCt0s)

# The Web

- Can be the great equalizer
- The platform of the future
- The interface to data, information and knowledge

## Web3D

- Here today!
- Confidence in investment

# Extensible 3D: Ask for it!

- Making data accessible to many devices and systems
- Making data available in the future
- Contracts may not include ISO standard support... unless you ask for it!

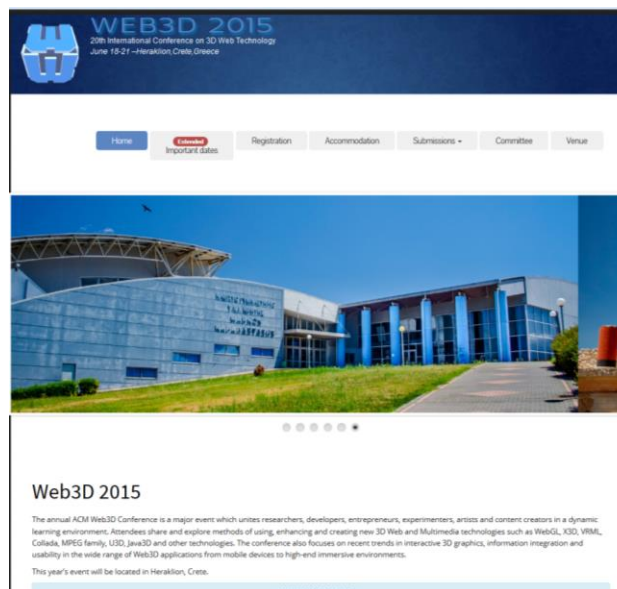


# Web3D 2015

<http://web3d2015.web3d.org/>

## 20<sup>th</sup> Annual ACM SIGGRAPH Conference Co-located with SIGGRAPH in Crete, Greece!!

In Cooperation with  
Eurographics  
and the Web3D Consortium



# Thank You

- Nicholas Polys – npolys@vt.edu

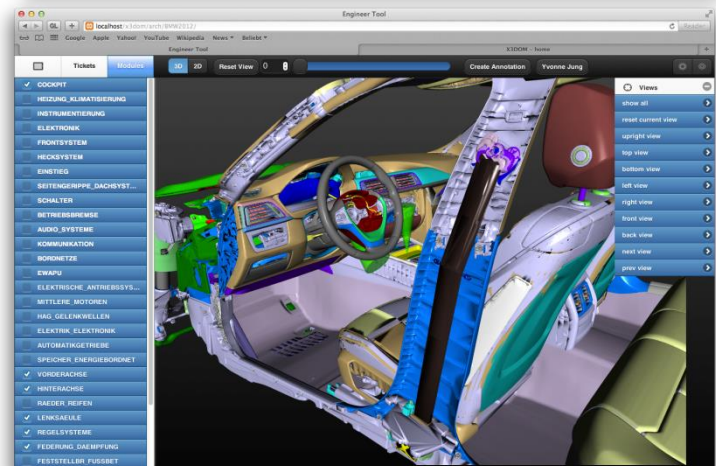
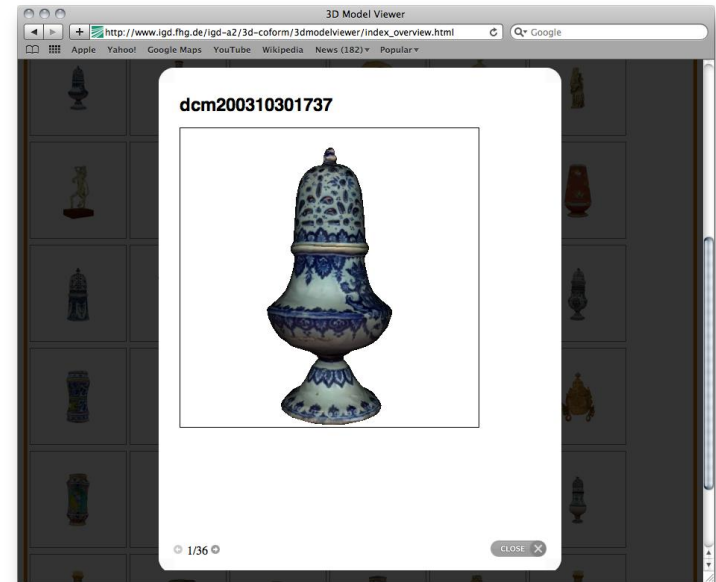


Center for Geospatial Information Technology

Advanced Research Computing

# 3D Information inside the Web

- Websites (have) become Web applications
- Increasing interest in 3D for
  - Product presentation
  - Visualization of abstract information
  - Experiencing Cultural Heritage data etc.
  - Supporting decision making, e.g. in Virtual Engineering
- Enhancing user experience with more sophisticated visualizations
  - Yesterday: Flash-based site with videos
  - Today: Immersive 3D inside Browsers





# X3DOM.org Online Examples

- Basic Examples
  - [http://www.x3dom.org/?page\\_id=5](http://www.x3dom.org/?page_id=5)
- Showcase Applications
  - Dynamic Shadows on large oilrig model  
[http://examples.x3dom.org/binaryGeo/oilrig\\_demo/index.html](http://examples.x3dom.org/binaryGeo/oilrig_demo/index.html)
  - OculusRift, more [http://www.x3dom.org/?page\\_id=2429](http://www.x3dom.org/?page_id=2429)
- Geometry Compression
  - binaryGeometry : <http://examples.x3dom.org/binaryGeo/index.html>
  - POP buffers : <http://examples.x3dom.org/pop-pg13/>

# Web Publishing

- X3D / VRML - web3d.org
  - any url with local rendering engine
- X3DOM
  - compression and transcoding via **aopt**
  - HTML/DOM integration via Javascript
    - [http://x3dom.org/x3dom/example/x3dom\\_paraviewExport.xhtml](http://x3dom.org/x3dom/example/x3dom_paraviewExport.xhtml)
    - [http://examples.x3dom.org/binaryGeo/oilrig\\_demo/index.html](http://examples.x3dom.org/binaryGeo/oilrig_demo/index.html)

# X3DOM Benefits

- **Development costs:** Web developer vs. graphics expert
- **Adaptability:** Declarative material abstraction allows shading adoption per client hardware (e.g. GLSL, ray-tracing...)
- **Efficiency:** UI events, culling, rendering can be implemented in native code, thus utilizes battery resources efficiently
- **Accessibility:** High level navigation and interaction styles allow very late adaptations for specific use cases
- **Metadata:** Allow indexing and searching content
- **Mash-ups:** Asset reuse in new context
- **Security:** No plugins or even direct GPU calls necessary
  
- → ***Powerful Abstraction for Web Applications !!!***

# X3DOM – Declarative (X)3D in HTML5

Completes today's graphics technologies

2D

(Final HTML5 spec)

**Declarative**

Scene-graph

Part of HTML document

DOM Integration

CSS / Events



3D

(No W3C spec yet)

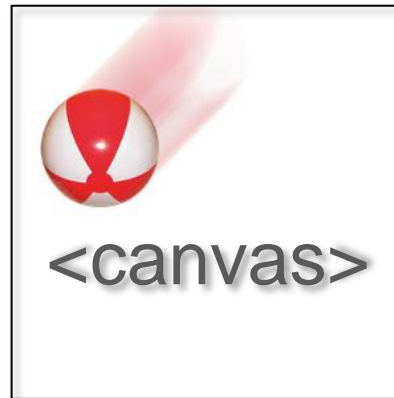


**Imperative**

Procedural API

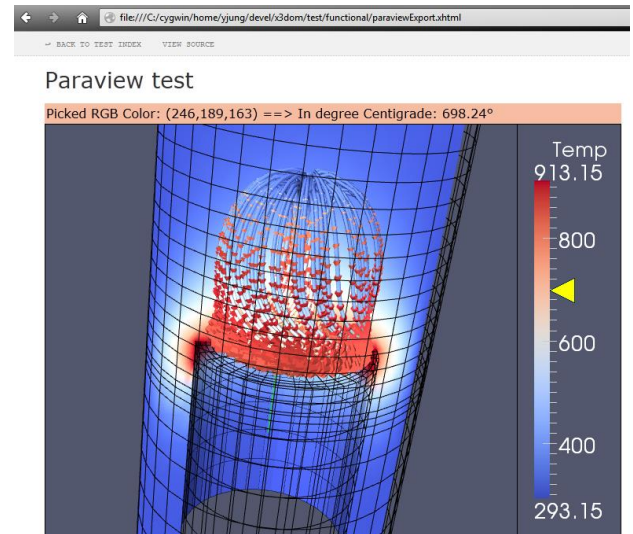
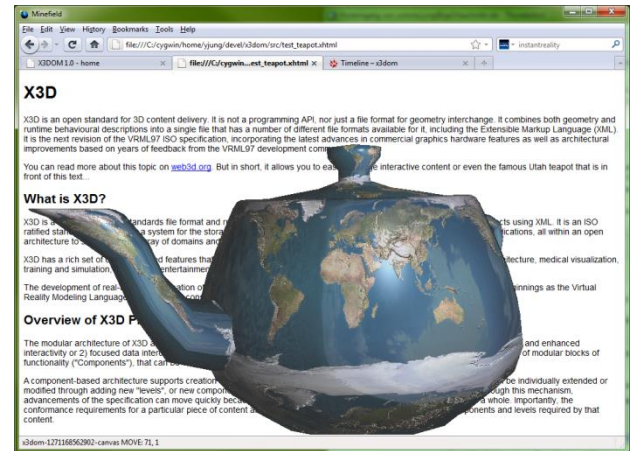
Drawing context

Flexible



# OpenGL + GLSL on the Web: WebGL

- JavaScript Binding for OpenGL ES 2.0 in Web Browser
  - → Firefox, Chrome, Safari, Opera
- Only GLSL shader based, no fixed function pipeline
  - No variables from GL state
  - No Matrix stack, etc.
- HTML5 `<canvas>` element provides 3D rendering context
  - `gl = canvas.getContext('webgl');`
- API calls via GL object
  - X3D via X3DOM framework
  - <http://www.x3dom.org>



# Convert X3D to X3DOM

- There is a converter online:

[http://doc.instantreality.org/tools/x3d\\_encoding\\_converter/](http://doc.instantreality.org/tools/x3d_encoding_converter/)

- Also, the aopt.exe tool in the InstantReality /bin can provide these translations to batch or shell scripts
- 3DS Max InstantExport
- BitManagement Contact Studio

# X3DOM Example 1: Interactive Car Configurator

Interaction via standard Web technologies (e.g. JavaScript Events etc.)

```

```

Click on <img> element...

```
document.getElementById('body_color').
setAttribute("diffuseColor", '#000066');
```

...causes attribute change of <texture> url (i.e., other wheel rims appear)

**Car configuration prototype**  
Using HTML + JavaScript, to change color and rims

**<x3d> element**  
Part of DOM/ HTML document like every other HTML element (e.g. <p>, <img> etc.)

# X3DOM Example 2: Painting Textures of 3D Objects

The screenshot shows a Mozilla Firefox 4.0 Beta 4 browser window displaying a 3D scene. On the left, a grey cylinder with a human-like face texture is shown. A red arrow points from a 2D canvas on the right to the cylinder's face. The 2D canvas shows a simple line drawing of a face with blue eyes, a green nose, and orange lips. To the right of the canvas is a control panel with the heading "Paint the texture!". It includes a "Choose background color:" section with a text input containing "000000" and a "Clear image with background color:" label. Below this is a "Choose pen color:" section with a text input containing "1A2B22" and a color picker. A "Reset" button is also present. In the top right corner of the browser window, there is a "Feedback" link and a "STAR" button. The browser's address bar shows the file path: file:///C:/cygwin/home/yvonne/devel/x3dom/src/test\_canvas.html. The browser's menu bar includes "Datei", "Bearbeiten", "Ansicht", "Chronik", "Lesezeichen", "Extras", and "Hilfe". The browser's tab bar shows "Dynamic HTML - Wikipedia", "Web 2.0 - Wikipedia", and "Canvas Path Test".

47.62 fps  
anim: 0  
traverse: 0  
sort: 7  
render: 1  
#Tris: 104  
#Pnts: 125

Paint the texture!

Choose background color:  
000000

Clear image with background color:

Reset

Choose pen color:  
1A2B22

HTML5 <canvas> element  
Painted image used as texture on 3D object

<x3d> element  
Part of DOM/ HTML document like every other HTML element  
(JavaScript implementation based on new WebGL API of HTML5 <canvas> element)

jQuery UI (User Interface)  
jQuery JavaScript library:  
<http://jqueryui.com/>



# X3DOM Application (Large Data and Picking): 3D-Internet Design Review

The screenshot displays the X3DOM application interface. The top navigation bar includes 'Tickets', 'Modules', '3D', '2D', 'Reset View', '0', 'Create Annotation', and 'Yvonne Jung'. The sidebar menu lists various car components such as COCKPIT, HEIZUNG\_KLIMATISIERUNG, INSTRUMENTIERUNG, ELEKTRONIK, FRONTSYSTEM, HECKSYSTEM, EINSTIEG, SEITENGERIPPE\_DACHSYSTEME..., SCHALTER, BETRIEBSBREMSE, AUDIO\_SYSTEME, EWAPU, KOMMUNIKATION, BORDNETZE, ELEKTRISCHE\_ANTRIEBSSYS..., MITTLERE\_MOTOREN, HAQ\_GELENKWELLEN, ELEKTRIK\_ELEKTRONIK, AUTOMATIKGETRIEBE, and SPEICHER\_ENERGIEBORDNET. The main 3D view shows a car model with various components highlighted in different colors and labeled with text boxes. A second screenshot shows a different view of the car model with a different set of components highlighted.

**Maximum Visualization**

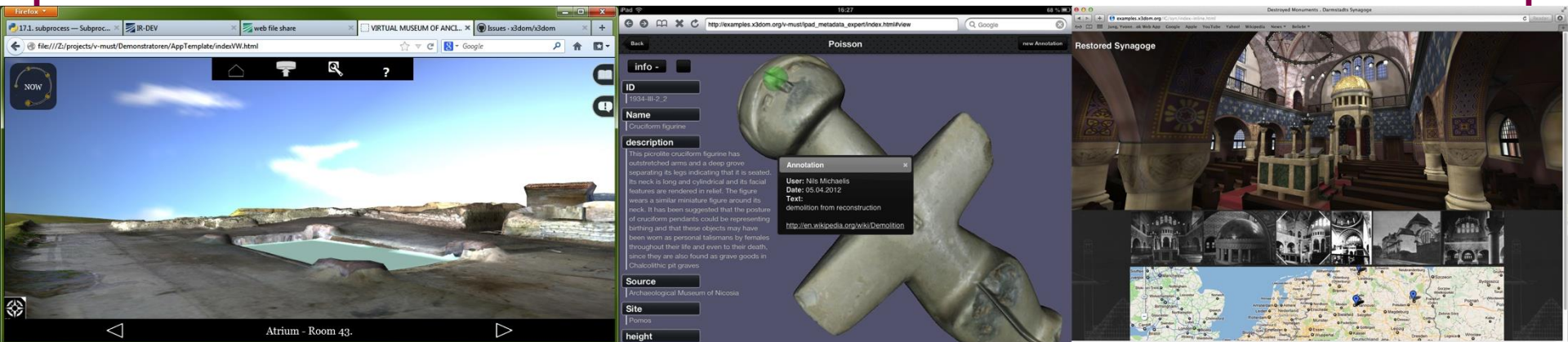
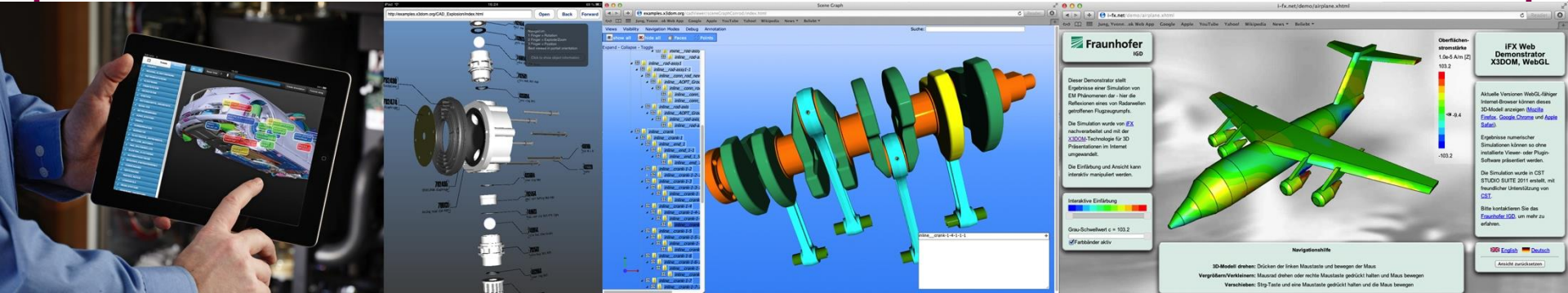
- Whole car incl. modules and parts
- Whole car incl. modules
- Modules with parts
- Only parts

**Legend:**

- 20% (Light Blue)
- 20% (Light Green)
- 60% (Light Red)

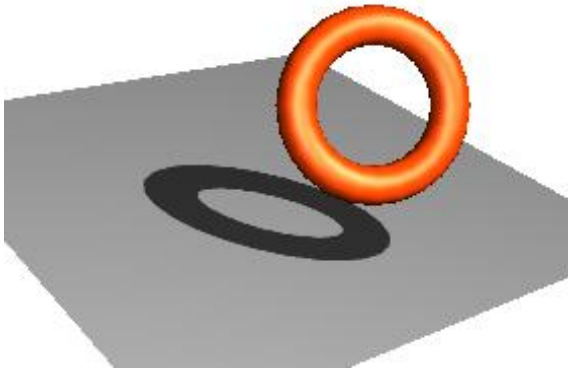
# X3DOM Application Integration:

## Virtual Engineering and Cultural Heritage on the Web



# Other X3DOM rendering effects

shadows



fog



textures



- `<directionalLight direction='0 0 -1' intensity='1' shadowIntensity='0.7'></directionalLight>`
- `<fog visibilityRange='1000'></fog>`
- `<imageTexture url="myTextureMap.jpg"></imageTexture>`
  - Note: like `<material>` only as child node of `<appearance>` possible!

# X3D-Edit

- A structured text editor for XML- X3D Editing
- Node palette defined via DTD and Schema
- Internationalized (I18N), contextual authoring hints

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