

Web3D Quickstart 2

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Virginia Tech

Web3D Consortium President



Extensible 3D (X3D)

- Components and Profiles collect a structured nodeset (scene graphs)
 - Geometry, appearance, lighting
 - Animation, multimedia (sound, video)
 - Interaction and application logic
- File format with multiple encodings: XML, UTF8, Binary, JSON
- Runtime API for a Unified Object Model with multiple programming language bindings (JavaScript, Java, C#, C++, Python, ...)
- Widespread support through multiple commercial and open-source engines and VRML heritage
- ISO-IEC Standard

Tons of Tools...

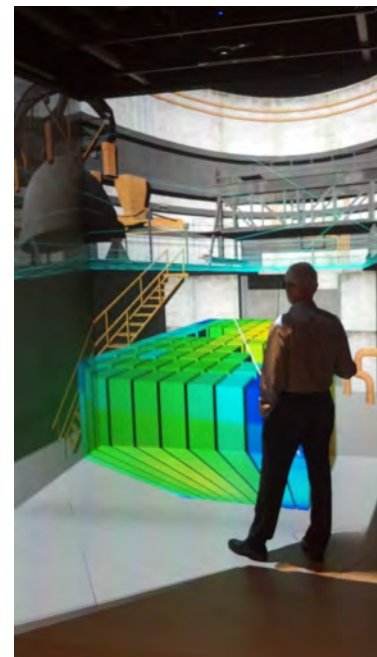
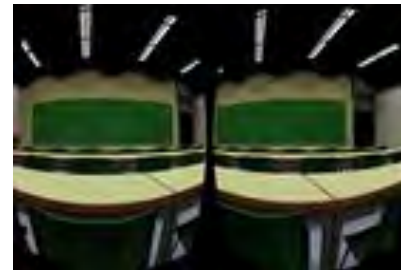
- Blender
- MeshLab
- 3DS Max
- Maya
- Rhino
- Paraview
- Agisoft
- ARCScene
- Creoform
- Unity
- ...

export me!

- Titania (Linux)
<http://create3000.de/>
- X3D-Edit
<https://savage.nps.edu/X3D-Edit/>
- AOPT (w/
InstantPlayer)
- XML &
stylesheets
- ...
- 3DPrint Exchange
- POSTGIS
<https://postgis.net/>
- ...
- Okino Polytrans
- Safe Software
- ...

Immersive X3D Examples

- Samsung GearVR, Google Pixel
- Oculus Rift via WebVR 1.1 + X3DOM
 - <https://examples.x3dom.org/Demos/ClassroomVR/classroom-rift.html>
 - <http://metagrid2.sv.vt.edu/~jagath/>
- Multi-projector CAVEs (same X3D file)
- Variety of implementation efforts
- Annual Web3D Conference June 20-22, 2018 (ACM SIGGRAPH; Poznan, Poland)
- [VR Hackathons](#)



Major development work: [Samsung GearVR](#)

Why implement X3D in GearVR



- Samsung began this effort February, 2016
- X3D is a widely supported file format
 - Exported by 3DS Max, Blender, Maya, Moto
 - Or exports VRML and converts to X3D
- No other file format had similar capabilities.
 - Interactivity via JavaScript
 - Declarative format easy to edit / visualize the scene.
- GearVR is not just a VR game console like Sony PSVR
 - We are a phone, web access device, camera, apps platform
 - X3D enables web applications:
 - Compliments the game influence in GearVR from Unity, Unreal.
 - Enables new VR web apps including: Google Maps, Facebook, Yelp JavaScript API's.

Presentation at
SIGGRAPH 2017
Web3D BoF Session

Scripting

- Build an X3D file with scripts (perl, python, ...)
 - Read a CSV
 - Re-project GIS
 - Pointclouds
 - ...
- Build the scenegraph at runtime with Scripts
 - Java, Javascript
 - DOM
 - JSON

Examples

DNA <http://people.cs.vt.edu/~npolys/DNA/index.xhtml>

Zebrafish

<http://metagrid2.sv.vt.edu/~npolys/NIH/Burgess/ZebraFishBrowser/ZebrafishBrowser.html>

Catawba drone

http://metagrid2.sv.vt.edu/~npolys/Fusality_Fall2017/home.html

http://metagrid2.sv.vt.edu/~npolys/Fusality_Summer2016/Catawba/Local2Million.html

Catawba GIS

http://metagrid2.sv.vt.edu/~npolys/Fusality_Summer2016/catawba_deer_hunting_x3d/

PhotoSpheres

http://metagrid2.sv.vt.edu/~npolys/ForestFarming/McDaniels_NutGrove/grove1_Xb.html

Live Streamlab data

http://metagrid2.sv.vt.edu/~lance/proxy_test_Stroubles_Fall2016/Bridge1_SphereFeed2.html

Smithsonian

<http://metagrid2.sv.vt.edu/~npolys/Web3DHeritage/smithsonian/>

3D Graphs and Plotting with X3D

- **MatLab:**

- <https://www.mathworks.com/help/sl3d/x3d-extensible-3d-graphics.html?requestedDomain=true>

- <https://www.mathworks.com/matlabcentral/fileexchange/32207-matlab-3d-figure-to-3d--x-html>

- **R (vrmolgen):**

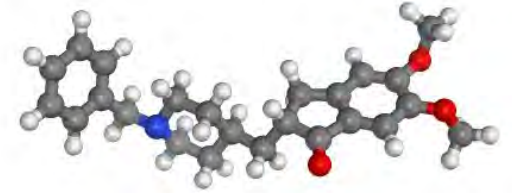
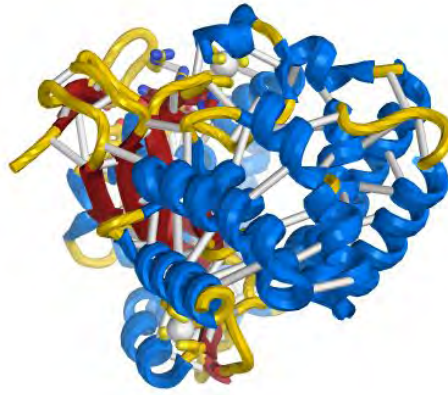
- <http://ico2s.org/software/vrmolgen.html>

- **mayavi:**

- the open source Python tool Mayavi has a builtin save function that exports to X3D such as `mlab.savefig('./fig.x3d')` <http://docs.entought.com/mayavi/mayavi/>

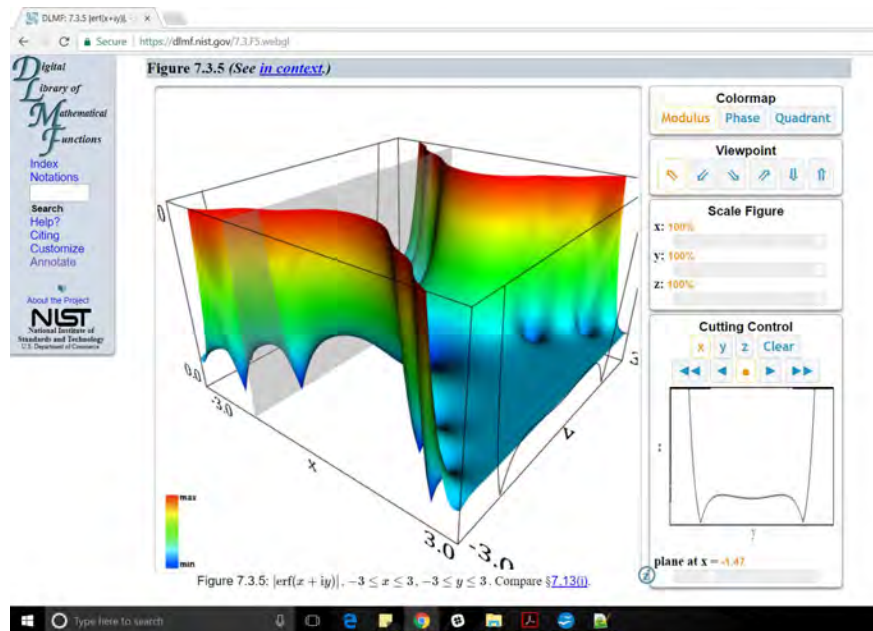
Molecules

- Chimera
- VMD
- *Mol
- CML
- ...

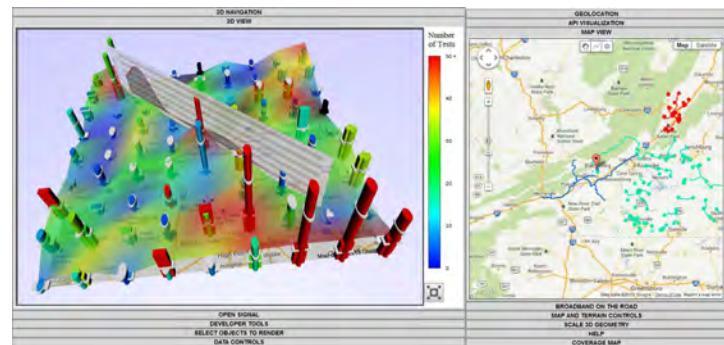


Interactive X3D Graphing

<https://dlmf.nist.gov/>



Nikita Sharakhov, **Nicholas Polys**, and Peter Sforza. (2013). “SpeedSpy: a mobile Web3D platform for visualizing broadband data”. In *Proceedings of the 18th International Conference on 3D Web Technology (Web3D '13)*. ACM, New York, NY, USA, pg. 208.

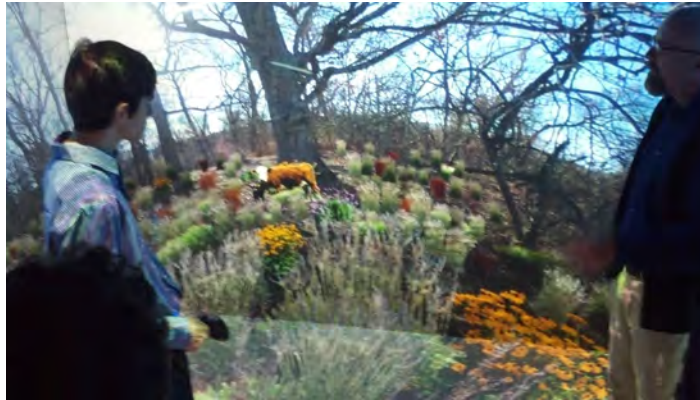


Design & Planning examples

Exhibits

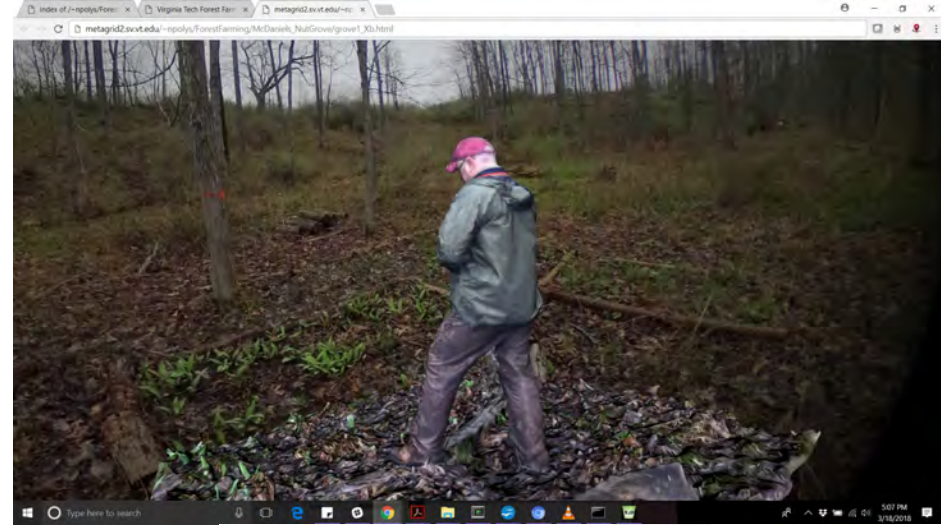


Landscapes



Design & Planning II

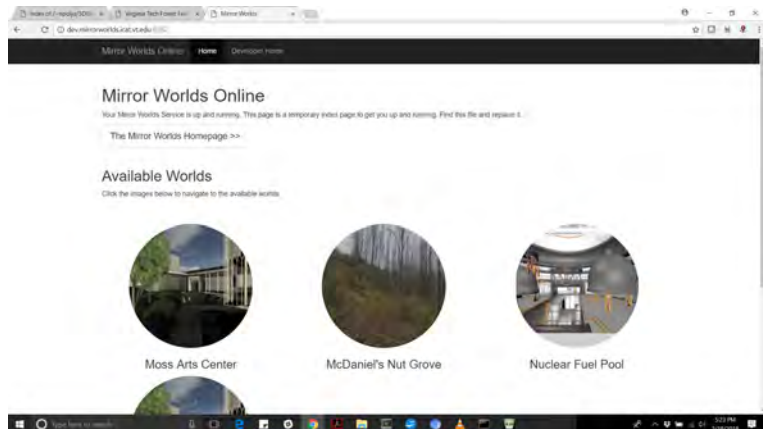
- Virtual Tours
 - photospheres
 - Structure.io scans
- Town Planning (Sketchcup + X3D Blacksburg)



Smart Buildings

<http://icat.vt.edu/mirrorworlds/>

- VT Moss Arts Center
- Telepresence platform
- Multi-user online building (HTML5 + node.js)



W/



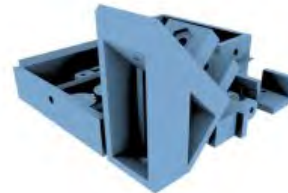
<https://youtu.be/ybi77t6WNO8>



3dprint.nih.gov



- Molecules
- Cells & tissues
- Anatomical models
- Prosthetics
- Labware
- ...



e-NABLE Printed Prosthetics

NIH 
3D PRINT EXCHANGE



<http://enablingthefuture.org/>

3D Printing Support

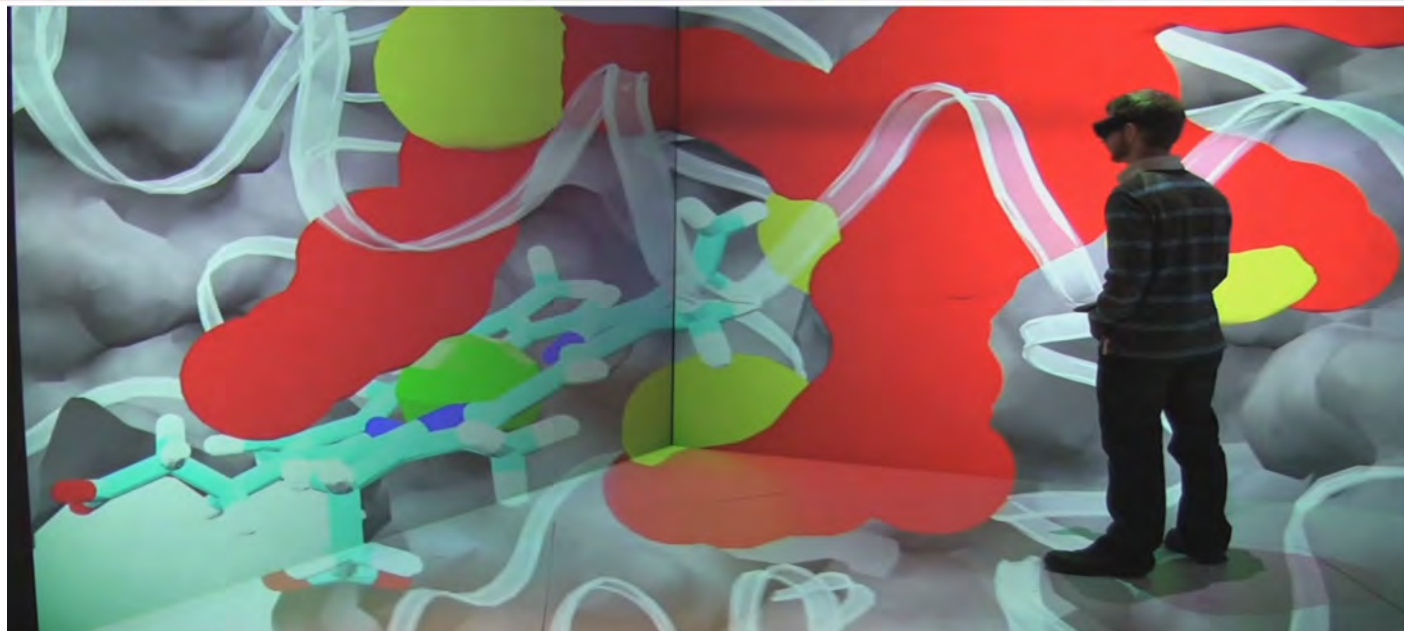
- CURA,
- Netfab,
- Shapeways,
- ...

Native support of
X3D for 3D Printing

(including color and metadata)!

*Can always convert to
STL with tools like:*

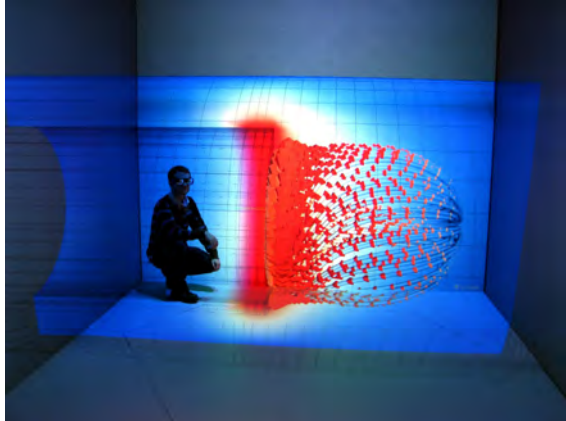
- Blender
- Meshlab,
- 3DPrintExchange
- ...



Jory Z. Ruscio, Deept Kumar, Maulik Shukla, Michael G. Prisant, T. M. Murali, and Alexey V. Onufriev, "Atomic level computational identification of ligand migration pathways between solvent and binding site in myoglobin", Proceedings of the National Academy of Sciences, (USA), 15, 9204-9209 (2008).

Immersive Displays

Gallery @ vis.arc.vt.edu

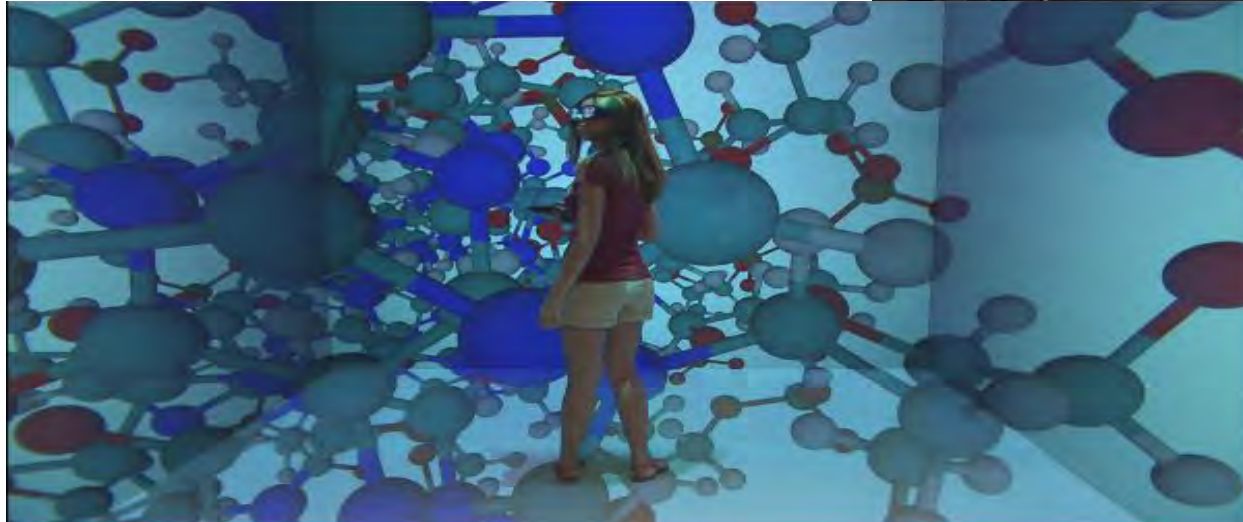


Youtube
Channel!

<http://www.youtube.com/user/VTVisionarium>



- CAVM stereo wall ->
- VisCube, HyperCube

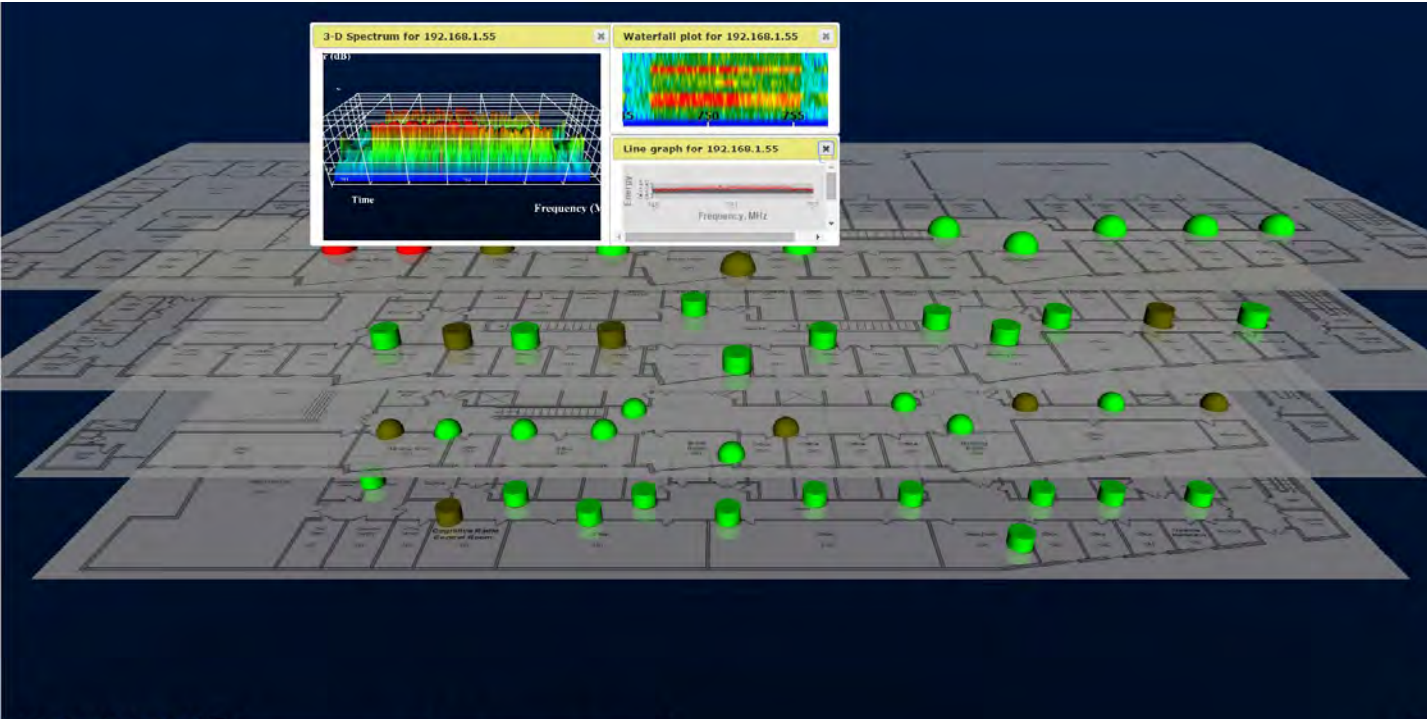


SAFAS
Space Frame designer &
Structural Simulator:

Creation and Visualization
via Web3D
Service

CORNET 3D

<https://www.youtube.com/watch?v=i8rqwmEDIUI>

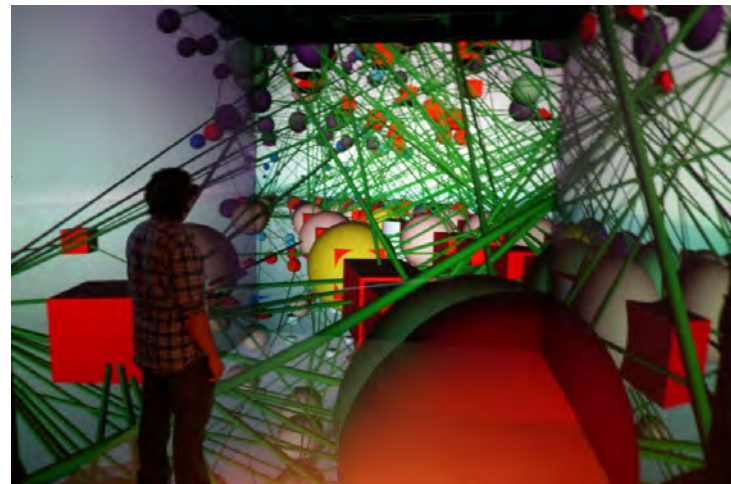
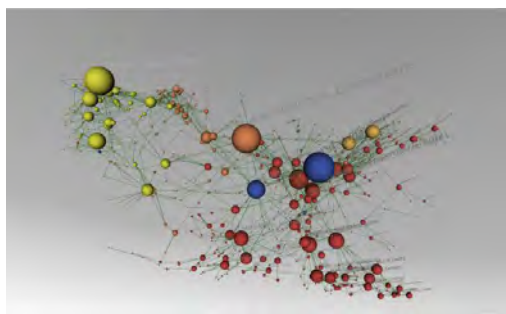


***Real-time
Wireless
Spectrum
Visualization***



BioPax Ontology Vis

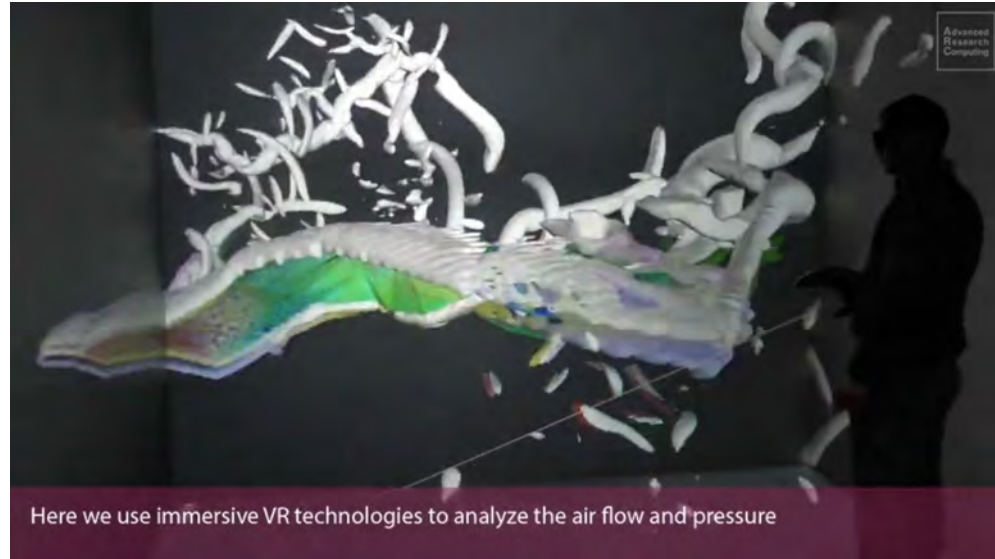
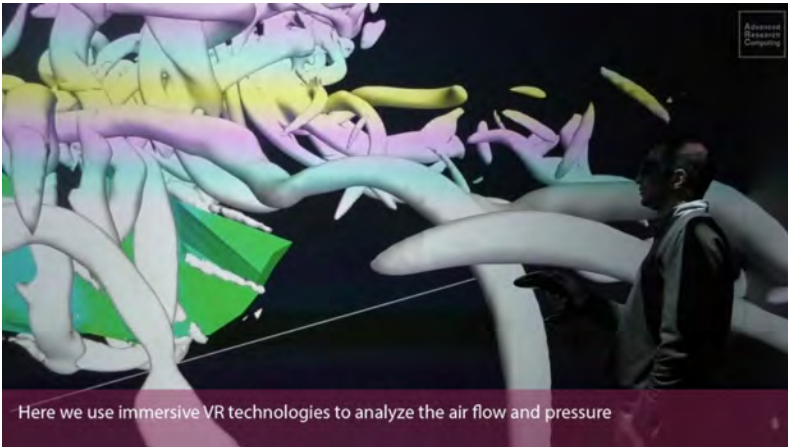
Peter J. Radics, **Nicholas F. Polys**, Shawn P. Neuman, and William H. Lund. "OSNAP! Introducing the open semantic network analysis platform". *Proceedings of Visualization and Data Analysis*, IS&T/SPIE Electronic Imaging; 2015.



Scientific Visualization: CFD

Immersive X3D

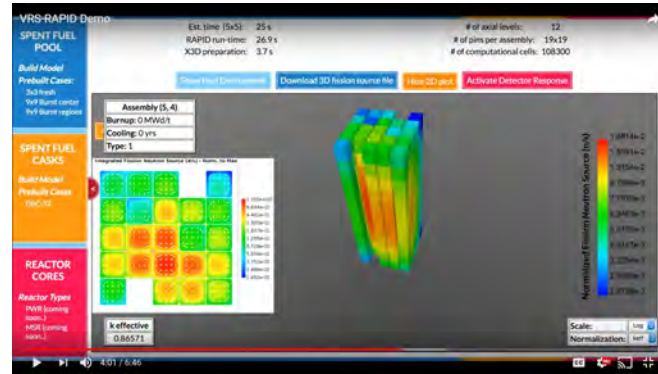
via Paraview



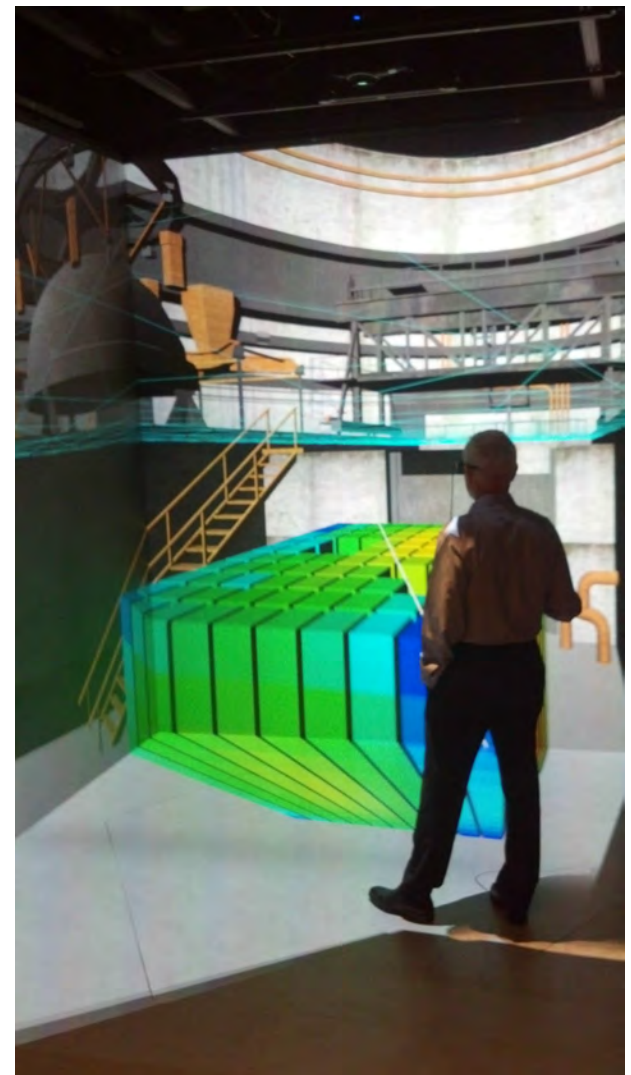
<https://vimeo.com/255413564>

Online Vis - Sim Services

VRS - RAPID

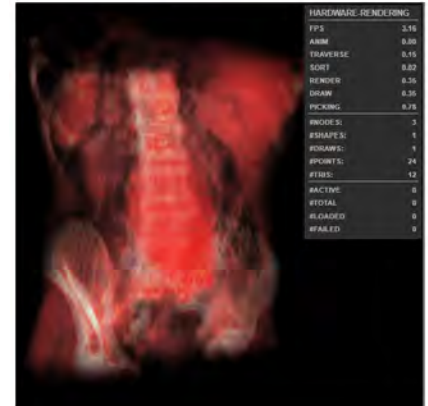
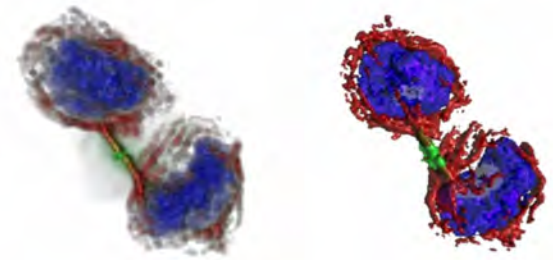


<https://www.youtube.com/watch?v=1Q2ytjBrmXc&t=1s>



Volume data

- Cell Image library
- Fossils (CT)
- Zoology (Prof Hoffmann, Bonn)
 - <http://vnhm.de/>
- VICOMTech:
 - MIRROR4All
 - <https://github.com/VolumeRC/AtlasConversionScripts>



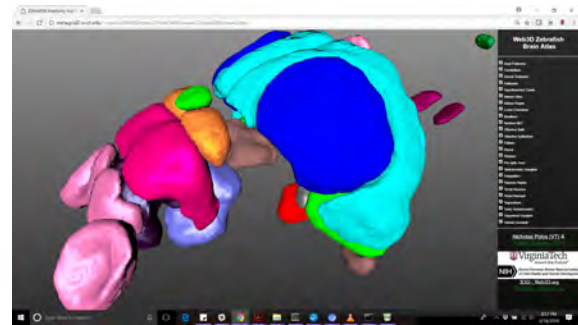
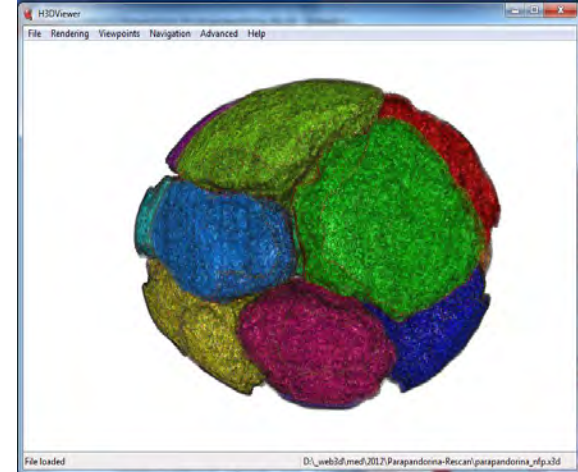
Fossils and Evolution

Xiao, S., A. Muscente, L. Chen, C. Zhou, J. D. Schiffbauer, A. D. Wood, **N. F. Polys** and X. Yuan (2014). "The Weng'an biota and the Ediacaran radiation of multicellular eukaryotes." National Science Review 1 (4): 498-520.

Michael Bruce Meyer, David Elliott, Andrew D Wood, **Nicholas F Polys**, Matthew Colbert, Jessica A Maisano, Patricia Vickers-Rich, Michael Hall, Karl H Hoffman, Gabi Schneider, Shuhai Xiao. (2014). "Three-dimensional microCT analysis of the Ediacara fossil Pteridinium simplex sheds new light on its ecology and phylogenetic affinity." Journal of Precambrian Research, 249: 79-87.

Surfaced:

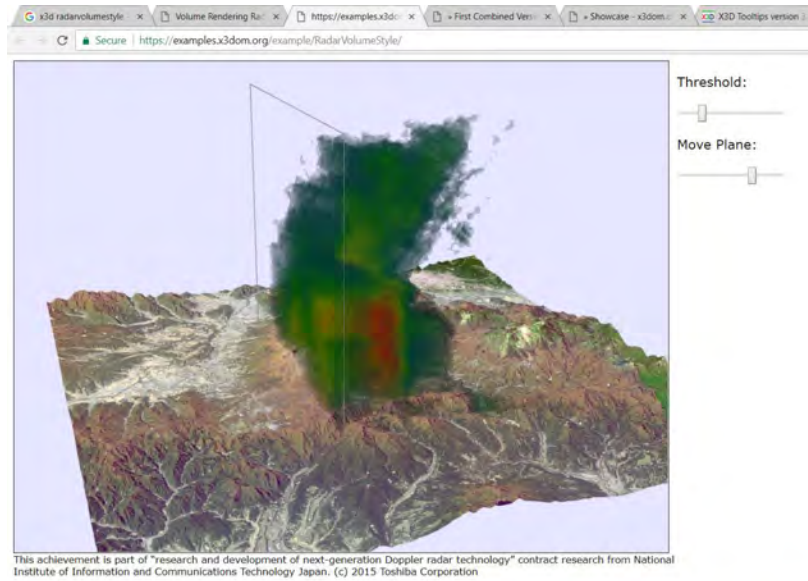
Marquart, G. D., Tabor, K. M., Horstick, E. J., Brown, M., Geoca, A. K., **Polys, N. F.**, ... & Burgess, H. A. (2017). "High precision registration between zebrafish brain atlases using symmetric diffeomorphic normalization". *GigaScience* 6 (8).



X3DOM Volume Rendering (cont'd)

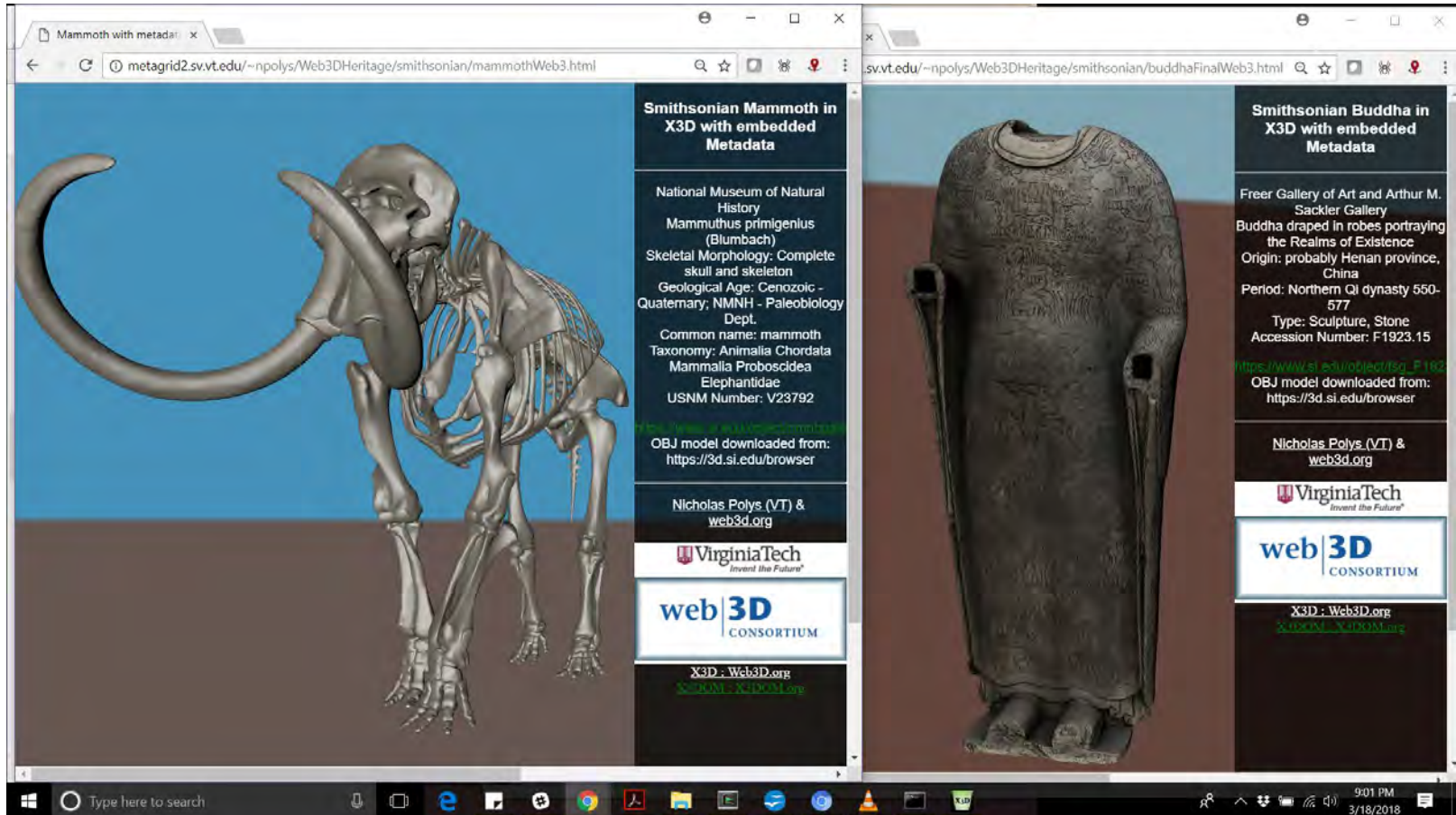
- RadarVolumeStyle + ClipPlane

- <https://examples.x3dom.org/example/RadarVolumeStyle/>



Toshiba,
Web3d.org

Smithsonian Heritage + metadata in X3D



The image displays two browser windows side-by-side, each showing a 3D model of a Smithsonian artifact with its associated metadata. The left window features a 3D model of a mammoth skeleton, and the right window features a 3D model of a Buddha statue. Both windows include a title bar, address bar, and a sidebar with detailed information about the object.

Left Window: Smithsonian Mammoth in X3D with embedded Metadata

URL: metagrid2.sv.vt.edu/~npolys/Web3DHeritage/smithsonian/mammothWeb3.html

Smithsonian Mammoth in X3D with embedded Metadata

National Museum of Natural History
Mammuthus primigenius (Blumbach)
Skeletal Morphology: Complete skull and skeleton
Geological Age: Cenozoic - Quaternary; NMNH - Paleobiology Dept.
Common name: mammoth
Taxonomy: Animalia Chordata Mammalia Proboscidea Elephantidae
USNM Number: V23792

OBJ model downloaded from: <https://3d.si.edu/browser>

Nicholas Polys (VT) & web3d.org

VirginiaTech
Invent the Future®

web3D CONSORTIUM

X3D : Web3D.org
www.khronos.org/x3d/

Right Window: Smithsonian Buddha in X3D with embedded Metadata

URL: sv.vt.edu/~npolys/Web3DHeritage/smithsonian/buddhaFinalWeb3.html

Smithsonian Buddha in X3D with embedded Metadata

Freer Gallery of Art and Arthur M. Sackler Gallery
Buddha draped in robes portraying the Realms of Existence
Origin: probably Henan province, China
Period: Northern Qi dynasty 550-577
Type: Sculpture, Stone
Accession Number: F1923.15

https://www.si.edu/object/159_F1923.15
OBJ model downloaded from: <https://3d.si.edu/browser>

Nicholas Polys (VT) & web3d.org

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web3D CONSORTIUM

X3D : Web3D.org
www.khronos.org/x3d/

GIS

- ESRI
- OGC / Geoserver/ PostGIS



<https://vimeo.com/vtgis/3dburg>

Polys, Sforza, & Singh (2016). “A Novel level-Of-Detail Technique for Virtual City Environments”. In *Proceedings of the 21th International Conference on 3D Web Technology (Web3D '16)*. ACM, New York, NY, USA.

Polys, N. F., A. Singh, P. Sforza (2012). “Extended LOD Concept for X3D, 3DBlacksburg”. 3D Portrayal Interoperability Experiment (3DPIE) Final Report, Eds. Schilling, Hagedorn & Coors. The Open Geospatial Consortium (OGC) Public Engineering Reports. <http://www.opengeospatial.org/standards/per>

- GDAL

Ji-Sun Kim, **Nicholas Polys**, and Peter Sforza. (2015). “Preparing and evaluating geospatial data models using X3D encodings for web 3D geovisualization services”. In *Proceedings of the 20th International Conference on 3D Web Technology (Web3D '15)*. ACM, New York, NY, USA, 55-63. DOI=<http://dx.doi.org/10.1145/2775292.2775304>

X3D Blacksburg

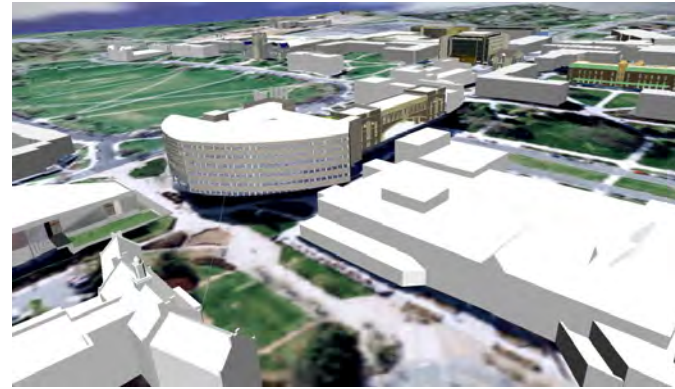
Environmental Awareness E.g. <https://youtu.be/ZIXbsR4KSzc>

- Terrain
- Imagery, openstreetmap
- Town buildings
- Campus buildings
- Sketchup buildings
- Frog scans
- ...



X3D Blacksburg

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



X3D Blacksburg



X3D Blacksburg Mirror World





Town & Building LODs



*X3D
shared
multi-user
VT Campus*

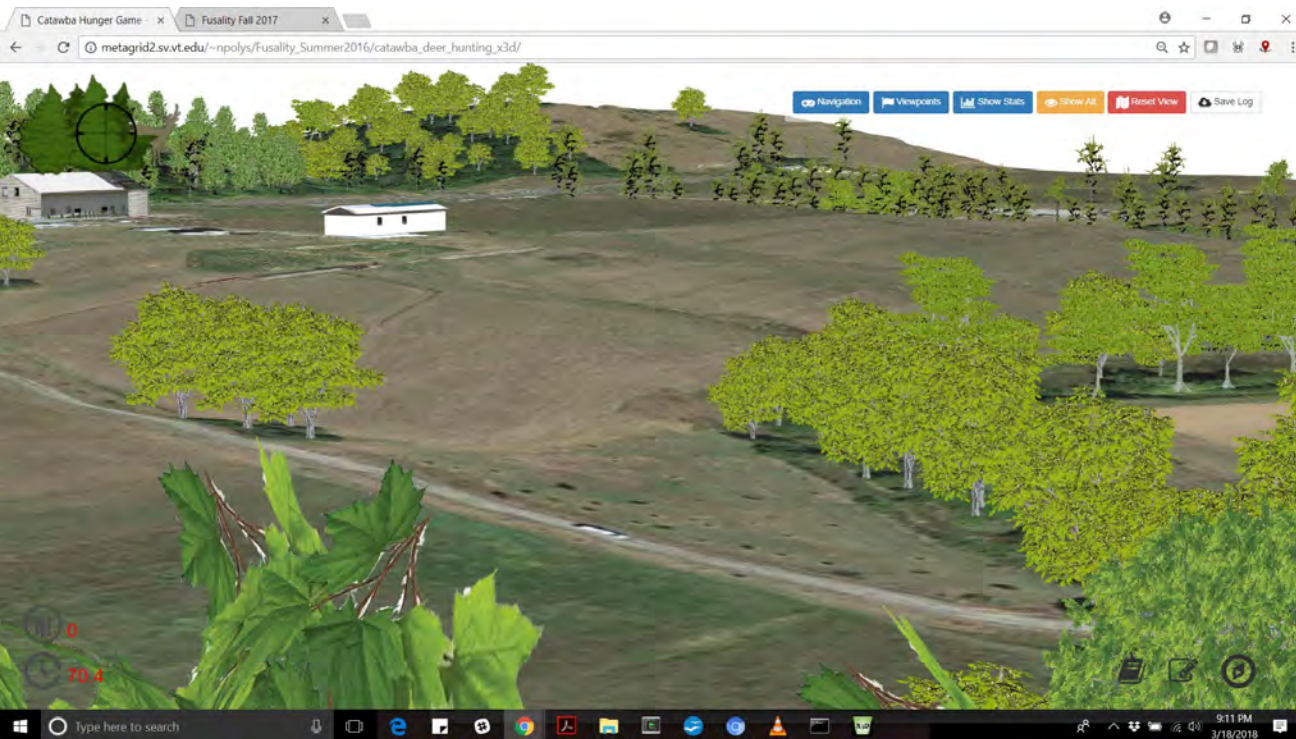


*X3D
Immersive*



Catawba GIS & tree LOD

http://metagrid2.sv.vt.edu/~npolys/Fusality_Summer2016/catawba_deer_hunting_x3d/

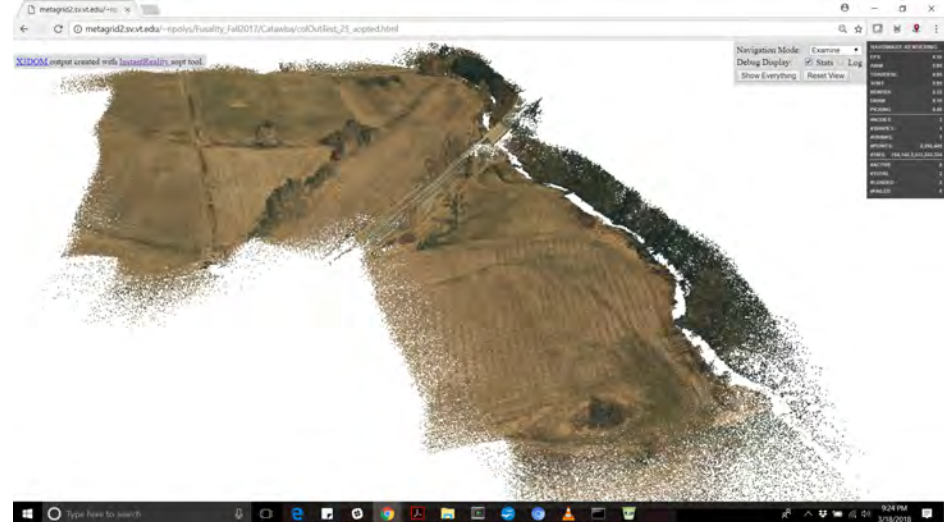
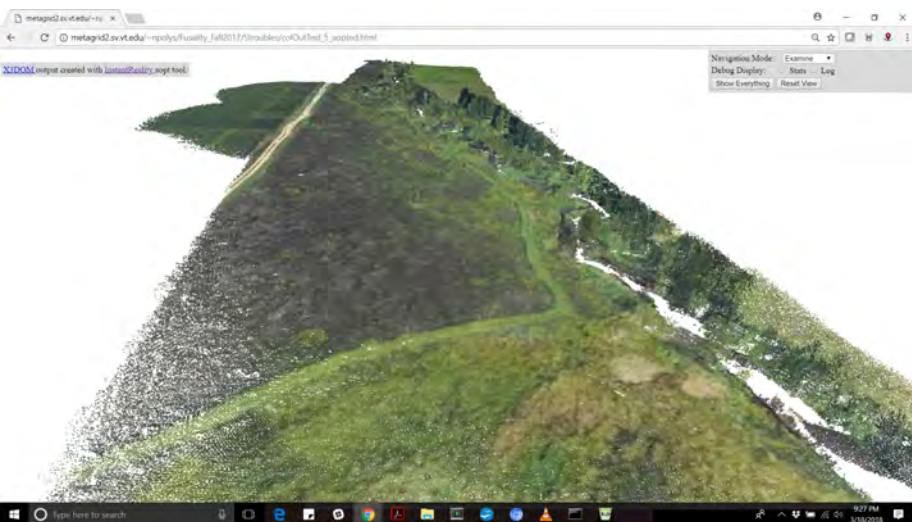


Haitao Wang, Xiaoyu Chen, **Nicholas Polys** and Peter Sforza (2017). "A Web3D Forest Geo-Visualization and User Interface Evaluation". In *Proceedings of the 22nd International Conference on 3D Web Technology (Web3D '17)*. ACM, New York, NY, USA.

Drone Lidar Pointclouds

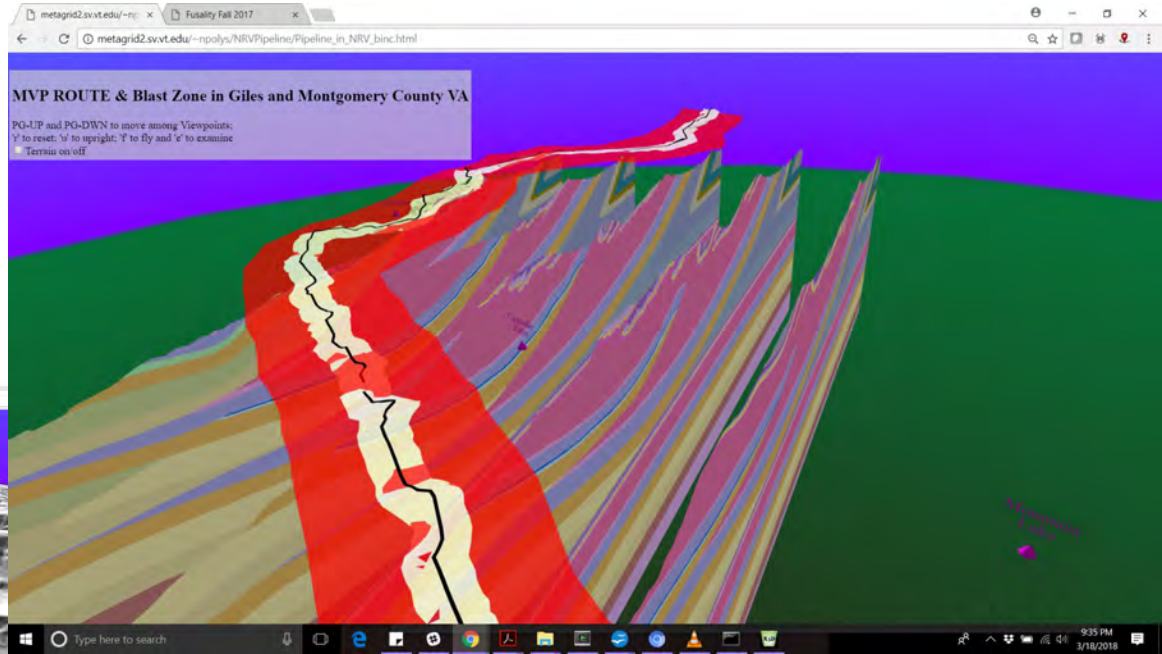
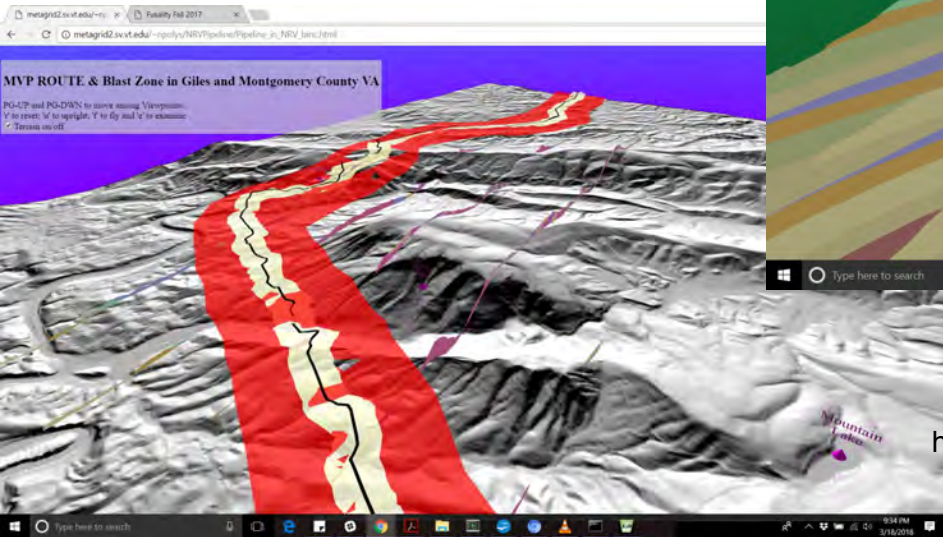
200-300 GB .las files

Stroubles Creek, Catawba Lidar ... -> binary X3D



Pipeline Risk

vis-a-vis Geology



http://metagrid2.sv.vt.edu/~npolys/NRV/Pipeline/Pipeline_in_NRV_binc.html

GLTF

Use with Inline, ExternalShape, or convert:

- X3DOM:

- <https://examples.x3dom.org/x3dom-inline-gltf-2/>

- X_CITE:

- <http://create3000.de/users-guide/components/rendering/indexedtriangleset/>

JSON

Another encoding of X3D! :

- <http://www.web3d.org/x3d/content/#Examples>
- <https://coderextreme.net/X3DJSONLD/src/main/html/index.html>

... Easy for Javascript!

X3D Evolution Strategy for VR

1. X3D v4.0 specification integrates with HTML5, DOM

- a. Currently working through “how precisely do we do that in the specification”
- b. These capabilities will ensure technical alignment with WebVR is possible via Web browser (Fraunhofer and VT already demonstrated WebVR 1.1 with X3DOM)
- c. Demonstration work with Samsung, others has proven particularly helpful
- d. Similarities to SVG and other W3C examples are being examined and utilized whenever possible

2. X3D v4.1 adds VR, AR, MAR

- a. Add any missing WebVR technical requirements : hooks into X3D Scenegraph (SAI)
- b. Consider X3D WebVR Profile for content authors and VR-experience generators
- c. Next add Augmented Reality (AR) and Mixed Augmented Reality (MAR) features according to ISO/IEC SC24 WG9 Mixed Augmented Reality (MAR) abstract reference model
- d. 2+ open-source implementations, public evaluation, content examples, specification approval
- e. Deep-dive testing to date indicates no “show stoppers” and X3D participation continues

Web3D Consortium Strategic Roadmap for X3D

web3D
CONSORTIUM

2017

|

2018

|

2019

|

2020

X3D

VR, AR, MR, xR

Identify Member projects
Track industry efforts

Define gaps, new
goals in X3D
standards

Extend X3D to support full range of
Mixed and Augmented Reality (MAR)

X3D 4.0

HTML encoding and DOM binding: Design,
Specification, Implementation, X3D v4 /HTML
examples

Maintain alignment: W3C HTML5, DOM
updates

X3D 4.1

ISO MAR Reference Model efforts
Compare/contrast, align with WebVR

ISO/IEC Mixed Augmented Reality (MAR) Reference
Model implemented in X3D for VR/AR

Web3D products provide a [coordinated set of steadily evolving ISO/IEC standards](#)

In development

In Planning

Ongoing Specification Development Activity

- Continued dialogue on mailing lists and at community events!
- Continue open proofs and development of X3D and HTML5, WebVR
- Web3D Specifications Development, Implementation and Evaluation
 - Multiple file encodings and programming languages within X3D Unified Object Model
 - **X3D 4.0 aligning with HTML5 and DOM**
 - Expand on CSS design efforts to date, confirm full alignment with HTML5 and DOM
 - Add glTF inline / import
 - **X3D 4.1 aligning with VR/AR/MR capabilities**
 - ISO-IEC Mixed Augmented Reality (MAR) Reference Model
 - Augment X3D node set to integrate additional WebVR parameters
 - Design, implement, evaluate WebVR Profile for X3D
- Web3D working groups are quite active. Participation and liaison are welcome.

Join Web3D!

- Deploy Web3D systems and content
- Communicate on Web3D public Listserves
- Comment on Specifications
- Slack
- Public / Member wiki
- Professional / Student memberships
- Member Area

Contact

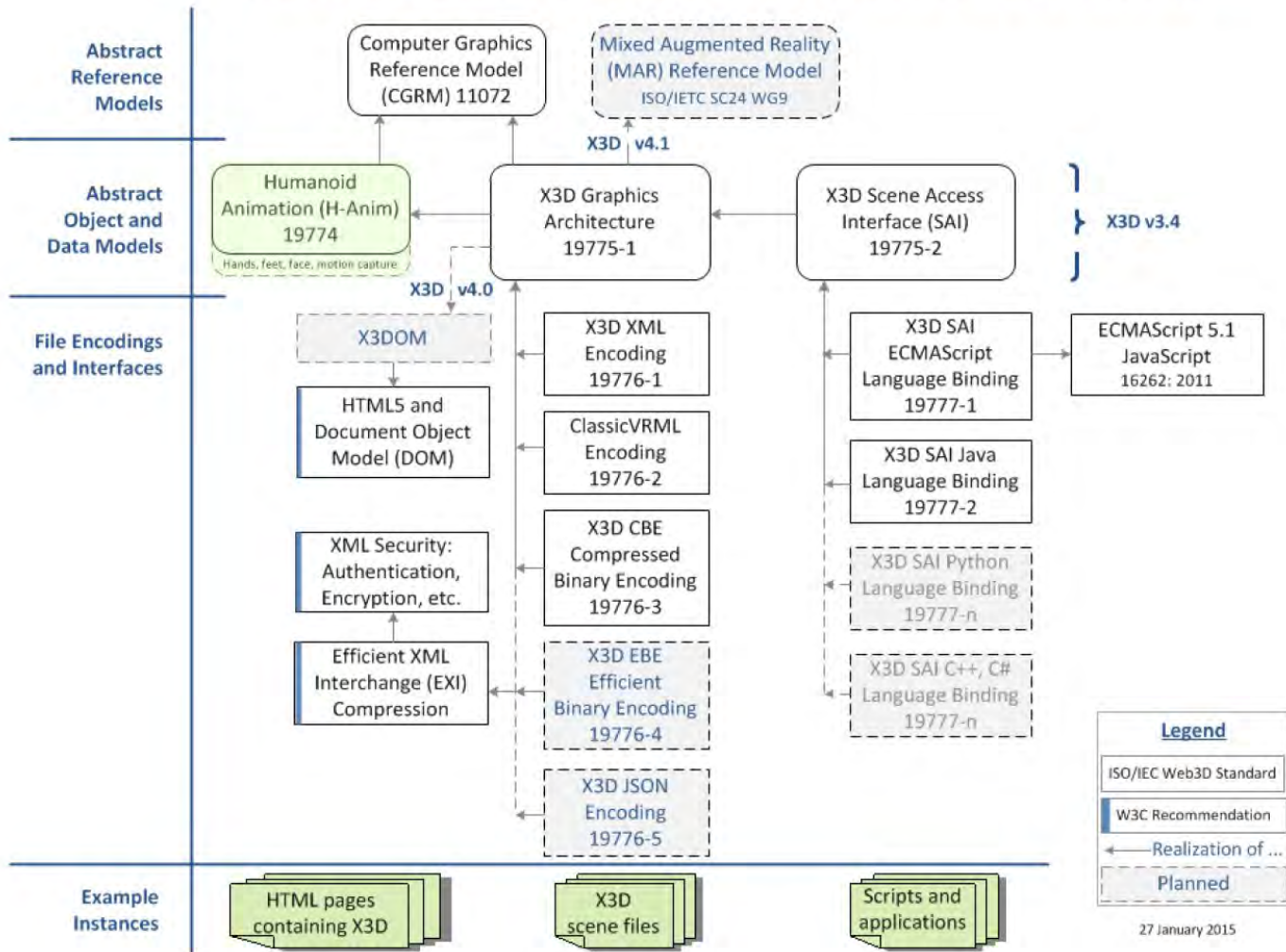
www.web3d.org

npolys@vt.edu

Appendices

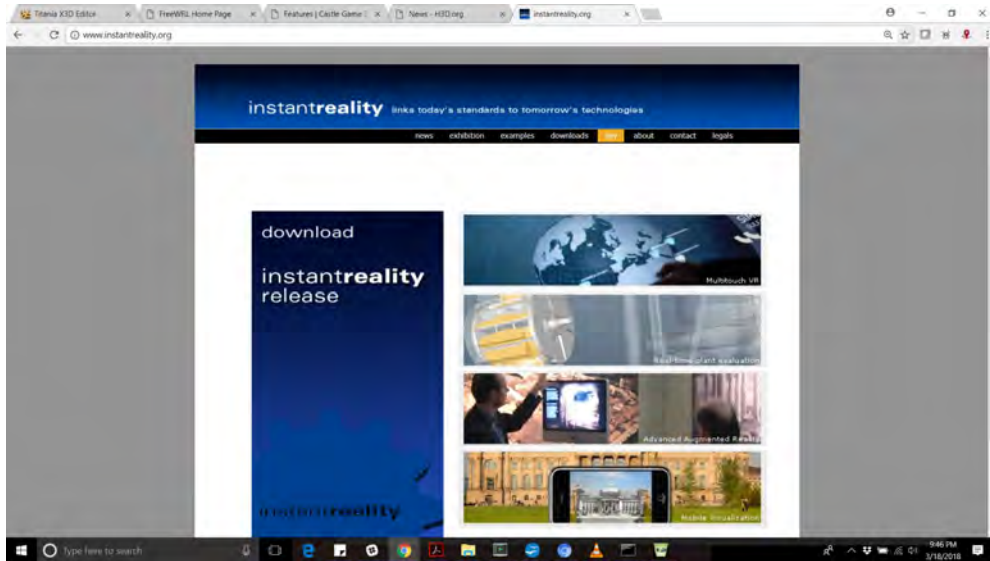
Extra info and links!!!

X3D Graphics Standards: Specification Relationships



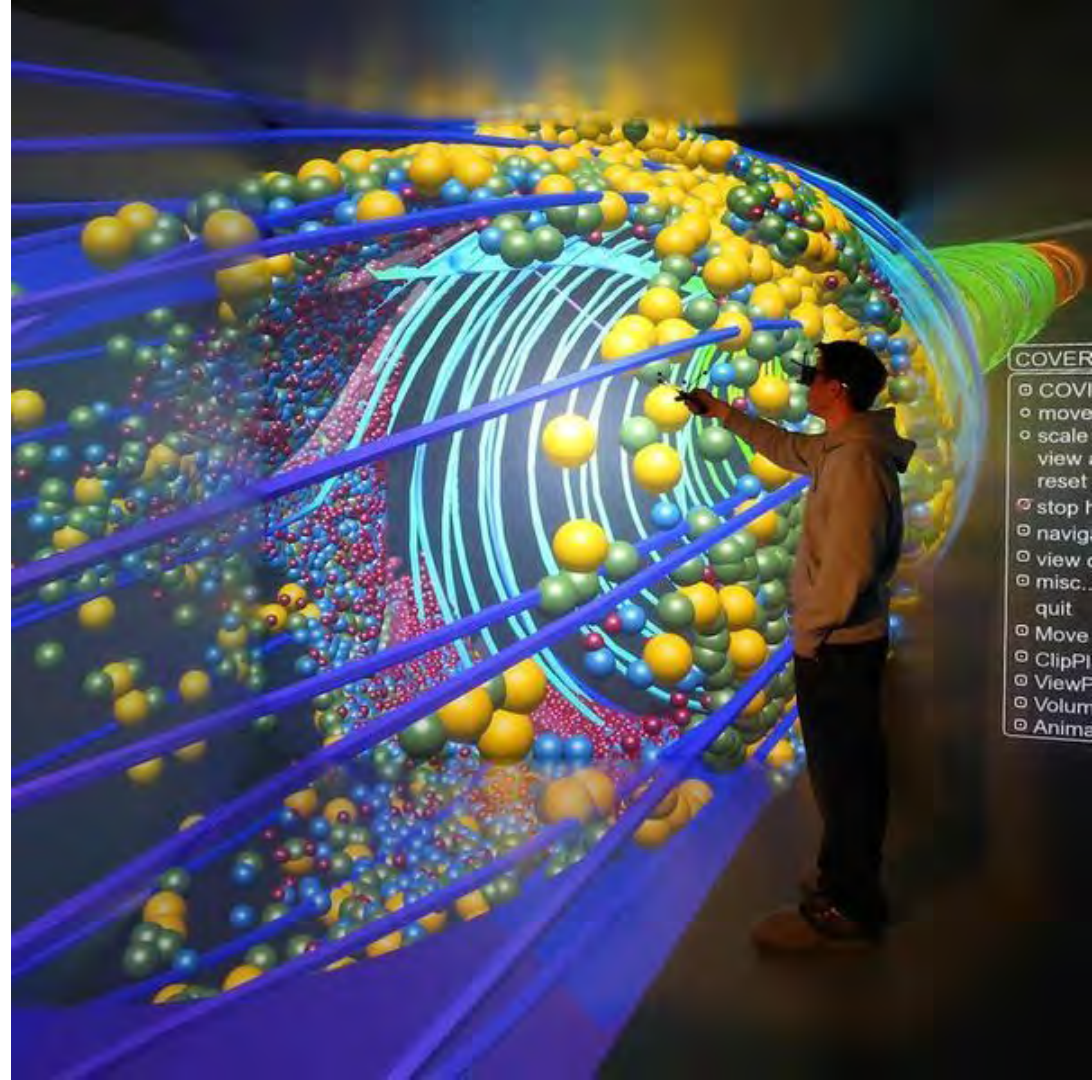
Instant Reality

<http://www.instantreality.org/>



Covise/OpenCover

<https://github.com/hlrs-vis/covise>



X_CITE and LINUX X3D Editor

TITANIA

<http://create3000.de/>



Castle3D Game Engine

<https://castle-engine.io/>



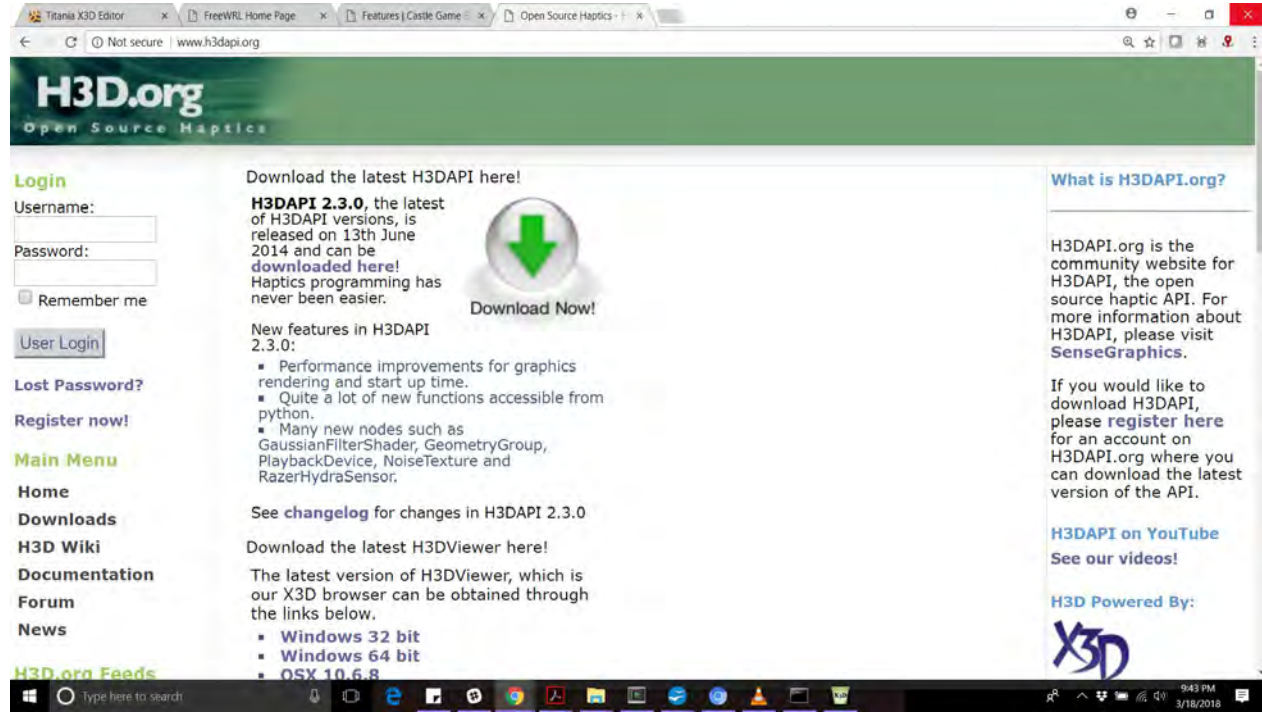
FreeWRL

<http://freewrl.sourceforge.net/>



H3D.org - Haptics

X3D + Volume Component (MEDX3D)



The screenshot shows the H3D.org website with the following content:

- Header:** H3D.org Open Source Haptics
- Login:** Username: [input], Password: [input], Remember me [checkbox], User Login [button]
- Lost Password?** [link]
- Register now!** [link]
- Main Menu:** Home, Downloads, H3D Wiki, Documentation, Forum, News
- H3D.org Feeds:** [link]
- Download the latest H3D API here!**
 - H3D API 2.3.0:** the latest of H3D API versions, is released on 13th June 2014 and can be downloaded here! Haptics programming has never been easier.
 - Download Now!** [button with green arrow icon]
 - New features in H3D API 2.3.0:**
 - Performance improvements for graphics rendering and start up time.
 - Quite a lot of new functions accessible from python.
 - Many new nodes such as GaussianFilterShader, GeometryGroup, PlaybackDevice, NoiseTexture and RazerHydraSensor.
 - See [changelog](#) for changes in H3D API 2.3.0
- Download the latest H3DViewer here!**


The latest version of H3DViewer, which is our X3D browser can be obtained through the links below.

 - Windows 32 bit
 - Windows 64 bit
 - OSX 10.6.8
- What is H3D API.org?**

H3D API.org is the community website for H3D API, the open source haptic API. For more information about H3D API, please visit [SenseGraphics](#).

If you would like to download H3D API, please [register here](#) for an account on H3D API.org where you can download the latest version of the API.

[H3D API on YouTube](#)
See our videos!

H3D Powered By:


X3D + HTML5

Two open-source implementations, Javascript WebGL libraries

Interpret and render X3D documents with interaction:

- X3DOM - www.x3dom.org
- X_ITE - create3000.de/x_ite

x3dom
Instant 3D the HTML way!





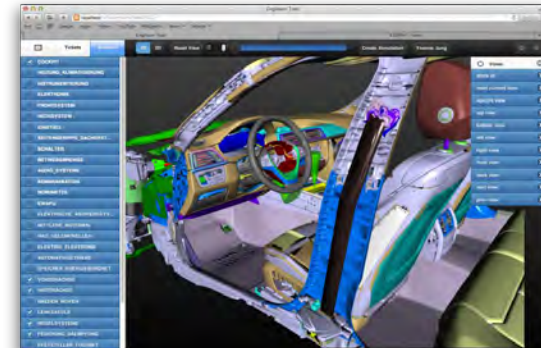
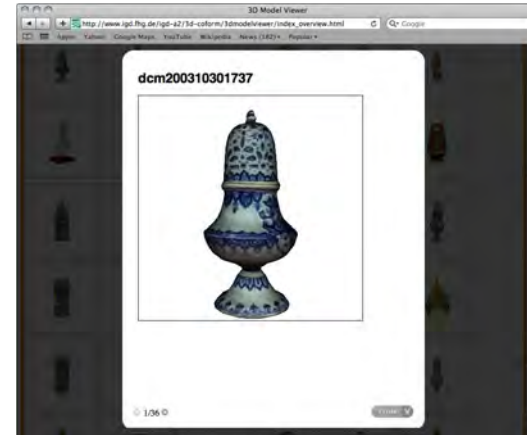
Web3D Consortium
www.web3d.org



X3DOM.org:
*Next-Generation Web3D
Applications
on Open Standards and Open
Source*

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
 - Supporting decision making, e.g. in Virtual Engineering
- Enhancing user experience with more sophisticated visualizations



X3DOM – Declarative (X)3D in HTML5

Completes today's graphics technologies

2D

Declarative

Scene-graph

Part of HTML
document



3D



Imperative

Procedural API

Drawing context

Flexible



X3DOM Example 1: Interactive Car

Configurator

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

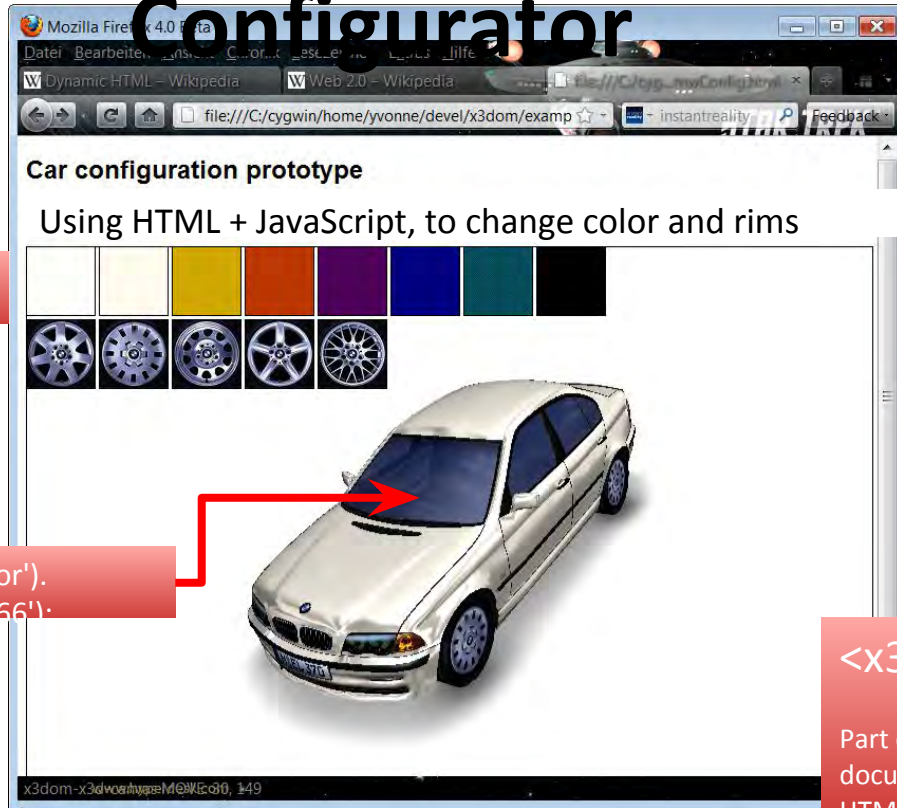
```

```

Click on element...

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

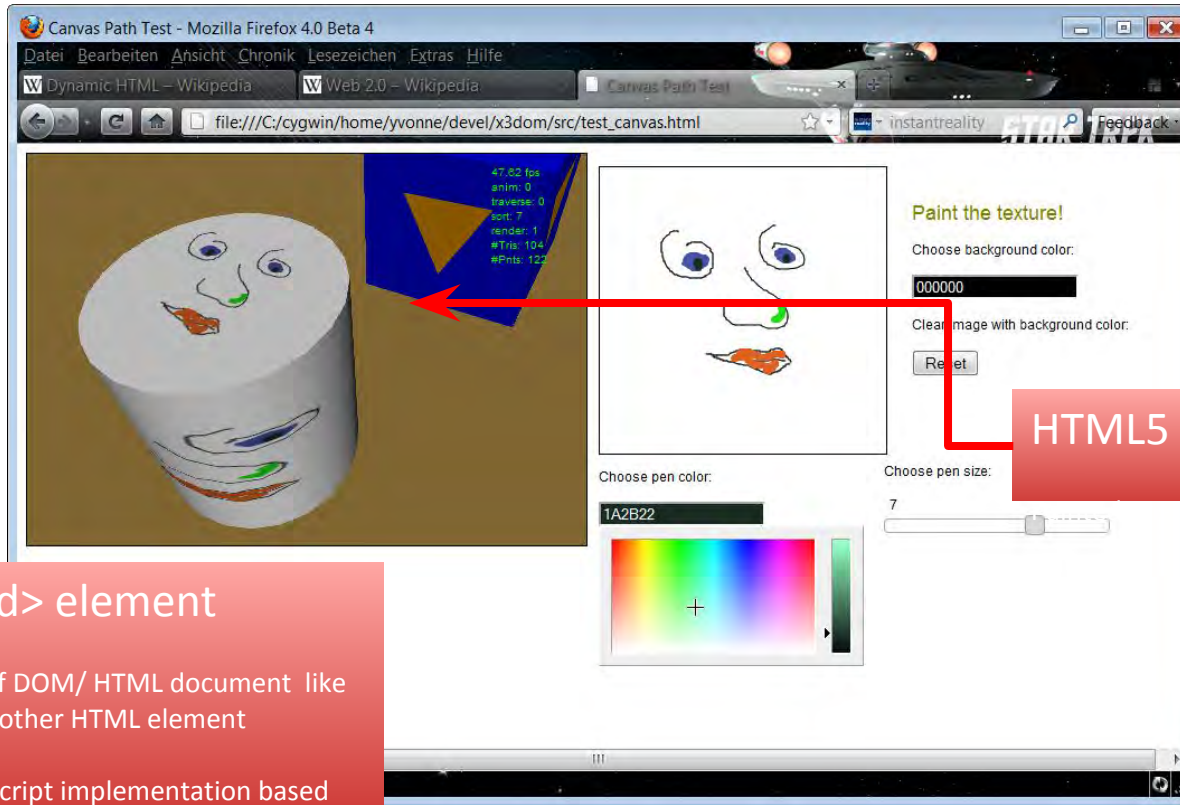
...causes attribute change of <texture> url (i.e., other wheel rims appear)



<x3d> element

Part of DOM/ HTML
document like every other
HTML element (etc.)

X3DOM Example 2: Painting Textures of 3D Objects



`<x3d>` element

Part of DOM/ HTML document like every other HTML element

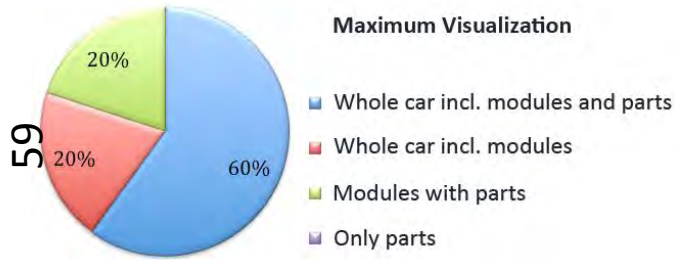
(JavaScript implementation based)

HTML5 `<canvas>` element

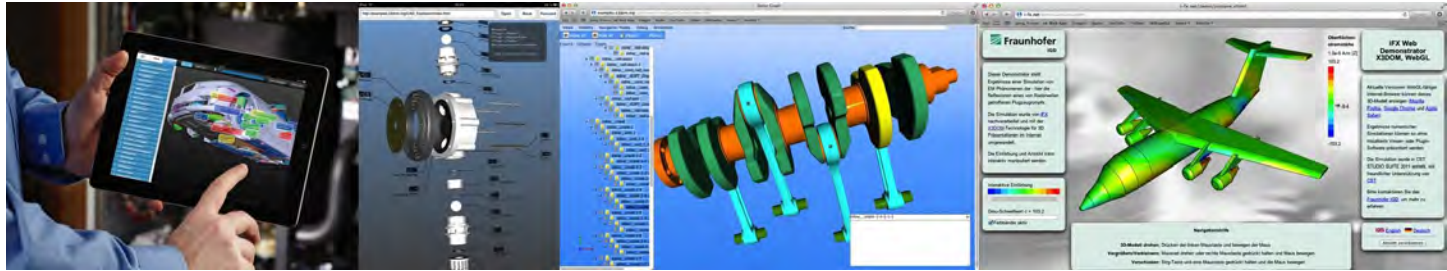
jQuery UI (User Interface)

jQuery JavaScript library

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

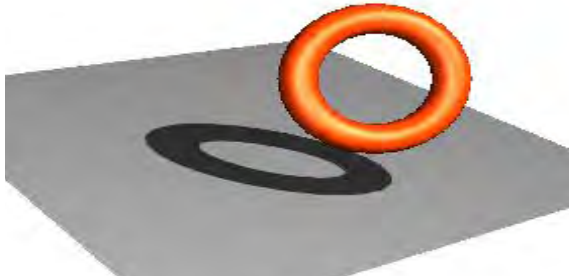


X3DOM Application Integration: Virtual Engineering and Cultural Heritage on the Web



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!

X3DOM.org Online Examples

- Basic Examples
 - http://www.x3dom.org/?page_id=5
- Showcase Applications
 - Dynamic Shadows on large oilrig model
http://examples.x3dom.org/binaryGeo/oilrig_demo/index.html
 - OculusRift, more 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/>

Entry points for getting started

1.5 Release with advanced 3D graphics features

<http://www.x3dom.org/?p=3423>

X3DOM online documentation and code examples

- <http://x3dom.org/docs/dev/> (tutorials and docs)
- <http://www.x3dom.org/school/> (12 simple examples)
- <http://www.x3dom.org/iX/> (7 examples with animation)
- <http://www.x3dom.org/x3dom/test/functional/> (lots of feature tests)

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

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/>