VirginiaTech
Invent the Future

Fulfilling the Mandate of Information Durability and Access

Nov 2, 2018

Nicholas F. Polys, Ph.D. Virginia Tech, Web3D Consortium

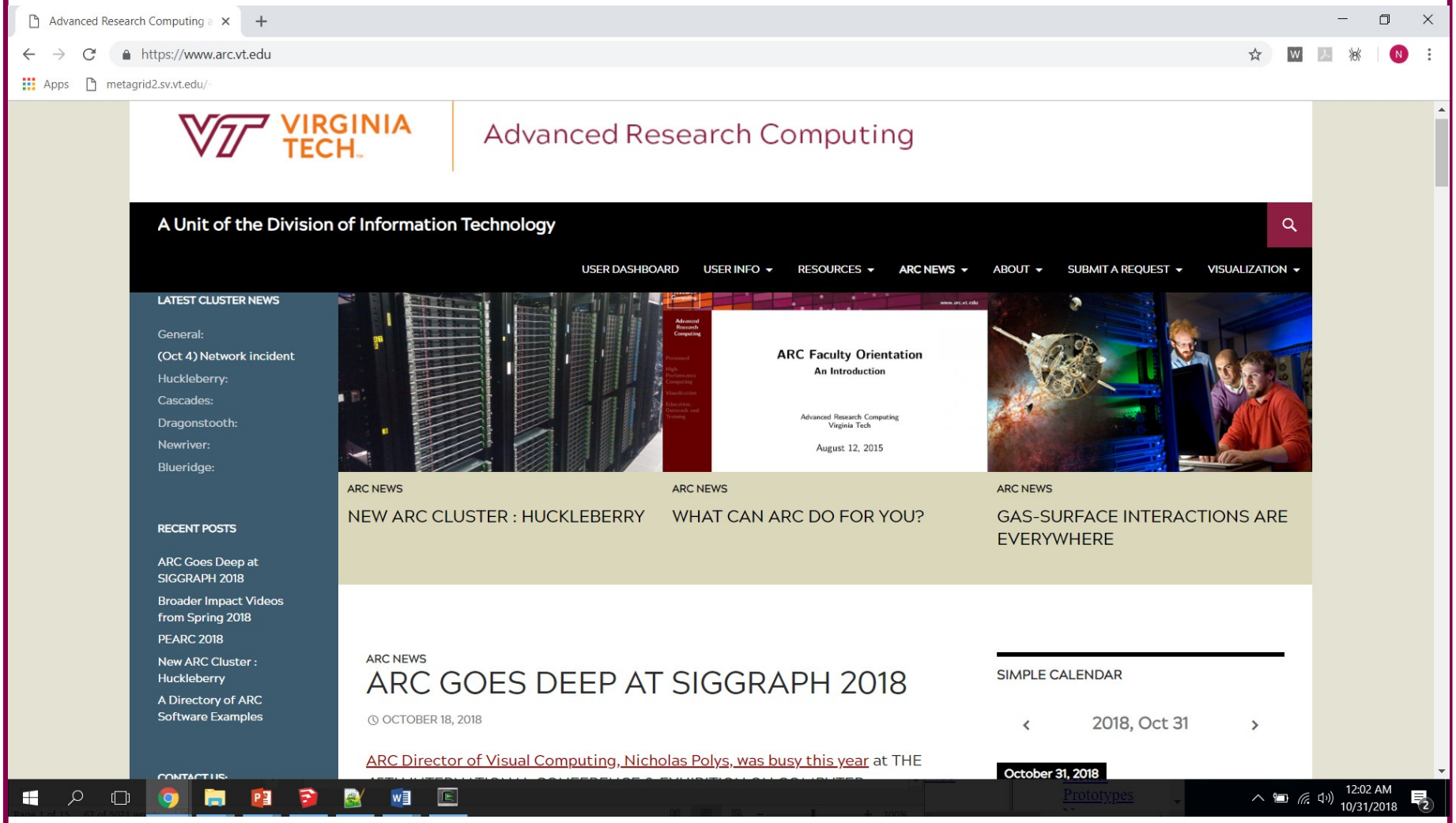
Virginia Tech (VT): Ut Prosim

- A land-grant University serving the Public Good
- ***Science*** and the *Reproducibility* of Research is a core mission
- Investments in a broad spectrum of digital content **and access**:
  - **Simulation**
  - **Analytics**
  - **Capture (i.e. scanning)**
  - **Design**
  - **Archival and sharing**
- International Standards provide:

  interoperability, accessibility, and durability

  - the basis for a long-term strategy

VT Advanced Research Computing



VT Dept. of Computer Science

- www.cs.vt.edu

Missions and Mandates

"… to develop qualitatively the Library's universal collections, which document the history and further the creativity of the American people and which record and contribute to the advancement of civilization and knowledge throughout the world, and **to acquire, organize, provide access to, maintain, secure, and preserve these collections**."

Mandates

On the National Archives building:

"This *X* holds in trust the records of our national life and symbolizes our faith in the permanency of our national institutions. "

Smithsonian:

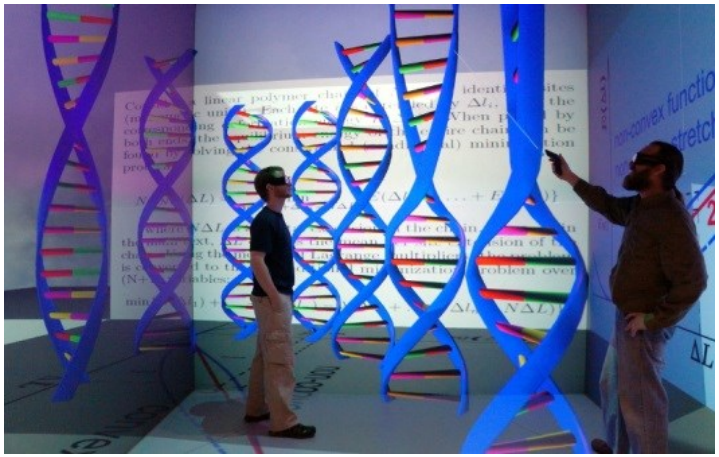
"The increase and diffusion of knowledge."

Our Job:

- ***The Public Record: Durability***
- ***Public Money: Access***

- ***Navigate technology trends and economics with the 'long view'***

Something in Common?



Vis.arc.vt.edu

Instantreality.org

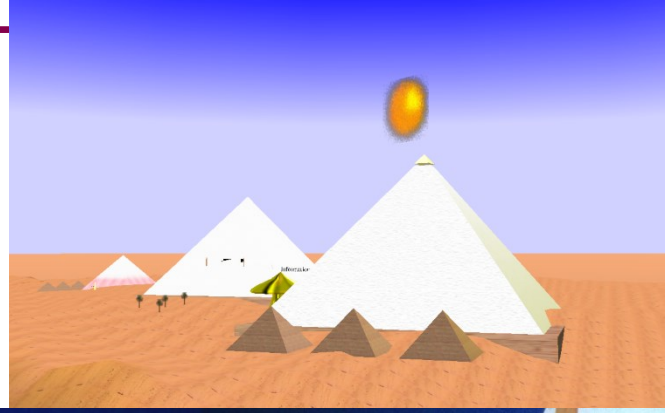
3dprint.nih.gov

Durability

Long-term Stewardship:

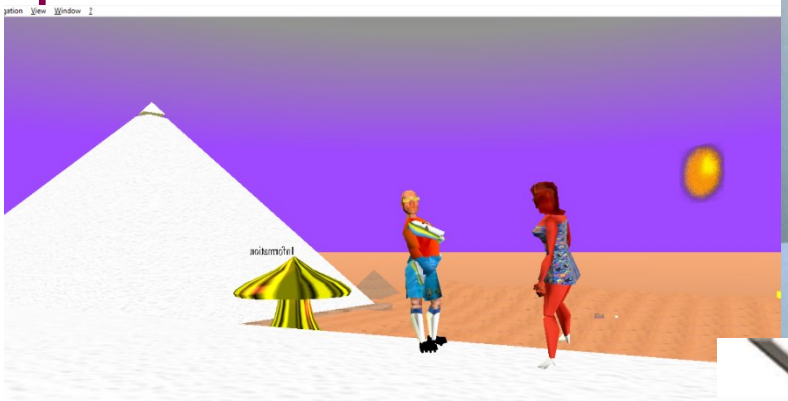
** The US and UK National Archives recommend the ISO-IEC X3D format!*

VirtuWorlds™ Giza (1998 ----> 2018!)



Early explorations into Web3D and Virtual Reality:

- ***Epistemology***
- ***Metaphysics***
- ***The Web***
- ***Archival 3D***



VRML
VIRTUAL REALITY MODELING LANGUAGE

Open Standards

www.web3d.org

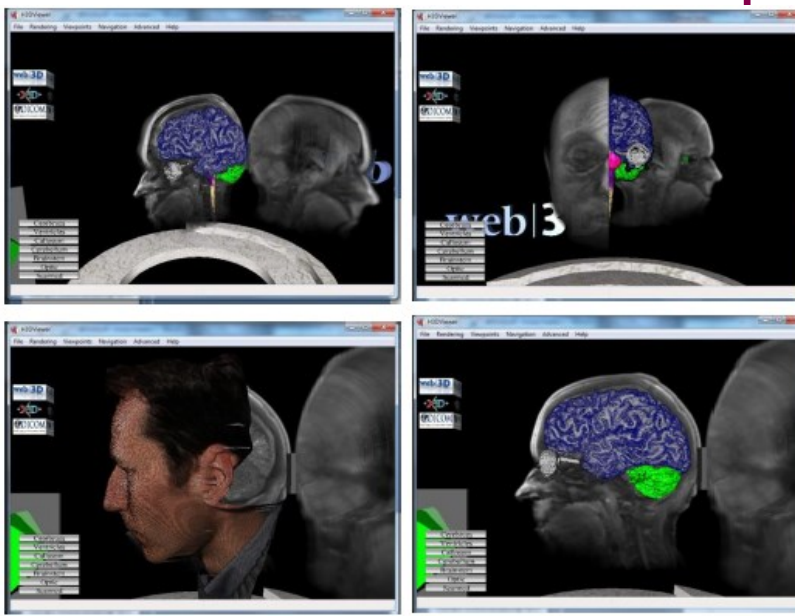
- Durability
- IP independence
- International recognition and support
- Portability

Web3D.org & WG introductions

Enterprise 3D (X3D):

ISO-IEC formats and API:

- Royalty-free, open X3D holds:
  - Volumes, meshes, appearances, text, metadata
  - Lights, cameras
  - Animation, interaction



The X3D ISO-IEC Standards

Demonstrated compatibility:

- Interactive 3D graphics
- Lossless metadata travels with the asset
- Data Assurance and Security with W3C's XML Encryption and Authentication
- Semantic Web3D

Access

… For all

The Web Is the Interface

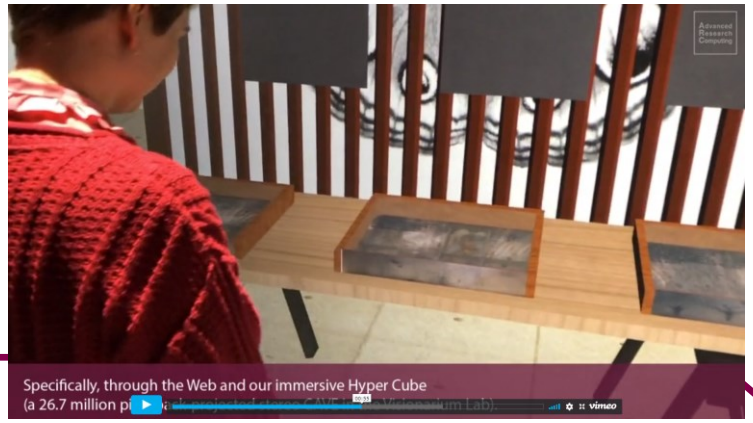
3D Everywhere

- Workstations
- High-Resolution projection
- WWW
- Web3D
  - Mobile
  - WebVR (HMDs)
- Device-specific interaction

Lesson 1: Things Change

A lifetime of 3D … ‘Mission-critical data’

- Requires durability longer than Silicon Valley cycles and market hype
- Requires IP and provenance for public records
- Emerging technologies and Access
  - VR
  - AR
  - …



Industry Standards unify communities

ISO-IEC

Creates and ratifies specifications into International Standards through their National bodies :

- Experts around the world review and approve
- Proven process for global cooperation
- Proven value for governments, citizens, and industry

ISO-IEC Web3D Standards Evolution

Durability of 3D information across industry epochs:

- 1994: VRML 1.0
- 1997: VRML 2.0
- 2002: VRML 2.1
- 2005: X3D 3.0
- 2006: X3D 3.1 ; H-Anim 1.0
- 2008: X3D 3.2
- 2013: X3D 3.3
- 2018: H-Anim 2.0

Encodings:

- ***XML,***
- ***utf8,***
- ***binary,***
- ***JSON***

Bindings:

- ***Javascript,***
- ***Java,***
- ***C#,***
- ***C++, C,***
- ***Python***

The Way Forward

Archival 3D: Fulfill the mandate

- Procurements require ISO-IEC standards conformance and deliverables (e.g. X3D)
- Invest in extensible, open software platforms to guarantee application-specific needs
- Invest in improving the Standards themselves for increased capability

Web3D 2019

24th Annual ACM SIGGRAPH Conference

Los Angeles, USA

July 26-28: Co-Located w/ SIGGRAPH

In Cooperation with

Eurographics and the Web3D Consortium

Contact!

Nicholas Polys

npolys@vt.edu

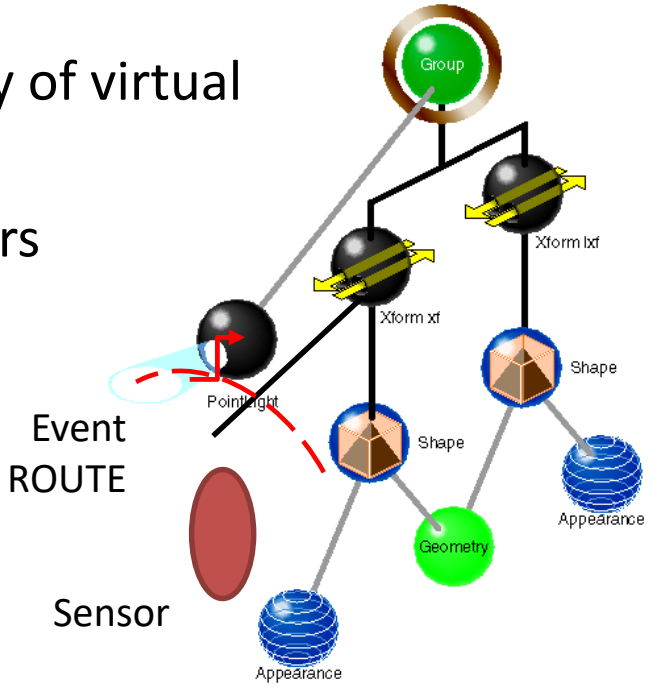
Appendix

More info~!

ISO-IEC Standard Scope

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

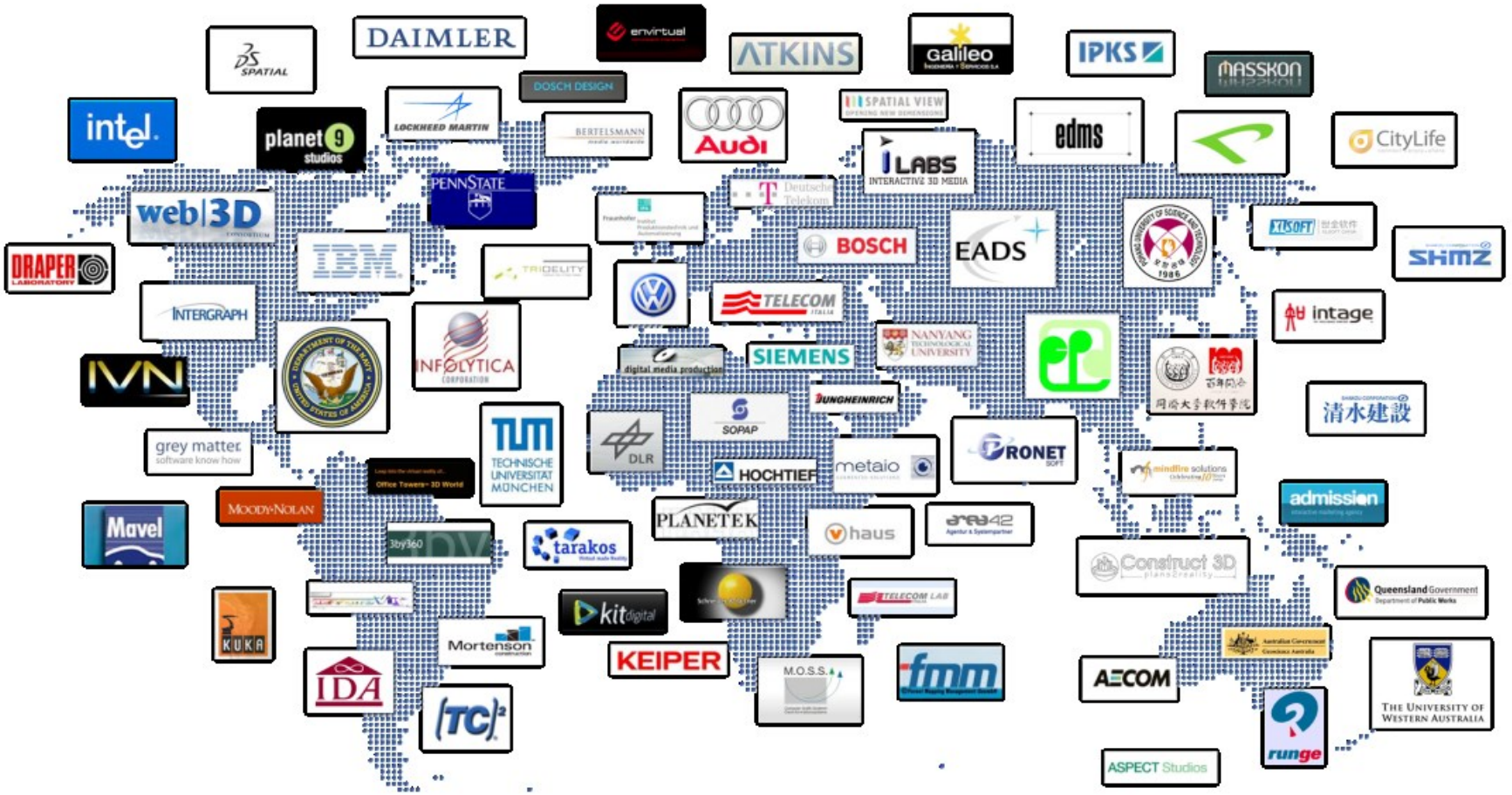
- Meshes, lights, materials, textures, shaders
- Integrated video, audio
- Animation
- Interaction
- Behaviors
- Scripts
- Application Programming Interfaces



3.3 examples for Medical Imaging, CAD and Geospatial support!

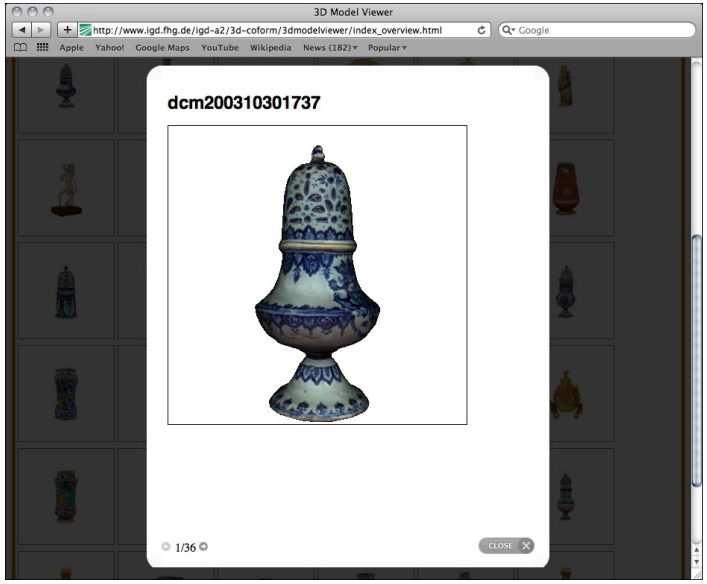
Web3D members are making this happen

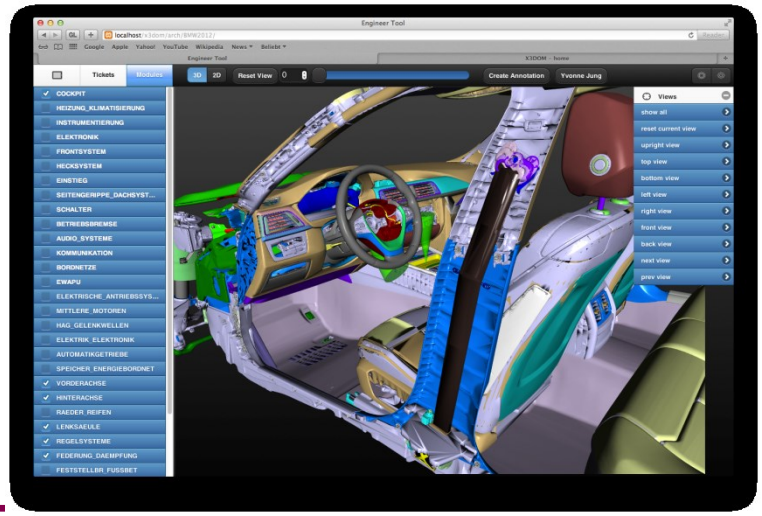
Adoption

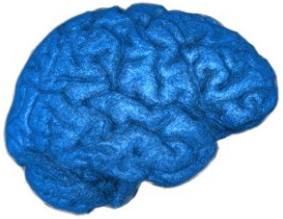

DAIMLER
envirtual
ATKINS
galileo
IPKS
MASSKON
SPATIAL
DOSCH DESIGN
SPATIAL VIEW
intel
planet 9 studios
LOCKHEED MARTIN
BERTELSMANN
Audi
edms
CityLife
PENNSTATE
LABS
INTERACTIVE 3D MEDIA
web3D
Deutsche Telekom
BOSCH
EADS
XISOFT
SHMZ
DRAPER
IBM
TRIDELITY
INTERGRAPH
TELECOM
intage
INFOLYTICA
NANYANG TECHNOLOGICAL UNIVERSITY
IVN
digital media production
SIEMENS
清水建設
SOPAC
JUNGHEINRICH
grey matter
software know how
TECHNISCHE UNIVERSITÄT MÜNCHEN
DLR
HOCHTIEF
metaio
PRONET
mindfire solutions
admission
Mavel
MOODY·NOLAN
PLANETEK
haus
tarakos
Construct 3D
Queensland Government
KUKA
kitdigital
TELECOM LAB
Mortenson
IDA
KEIPER
M.O.S.S.
fmm
AECOM
THE UNIVERSITY OF WESTERN AUSTRALIA
(TC)²
runge
ASPECT Studios

3D Information throughout 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
  - Yesterday: Flash-based site with videos; Today: Immersive 3D inside Browsers







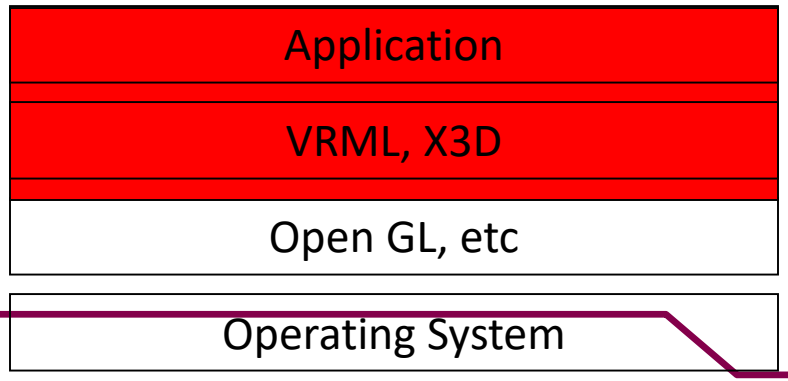
4D: a first-class citizen

What's new?

- Networked 3D digital assets
  - Objects and components
  - Appearances & materials
  - Environments
- Animation and Timeseries databases
- Metadata & web-aware referencing
- Interaction semantics

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*



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

http://www.web3d.org

- http://www.web3d.org/getting-started-x3d
- http://www.web3d.org/hack-web3d-vr

X3D Book & Online Resources

- http://www.x3dgraphics.com/

Extensible
3D Graphics
For Web Authors

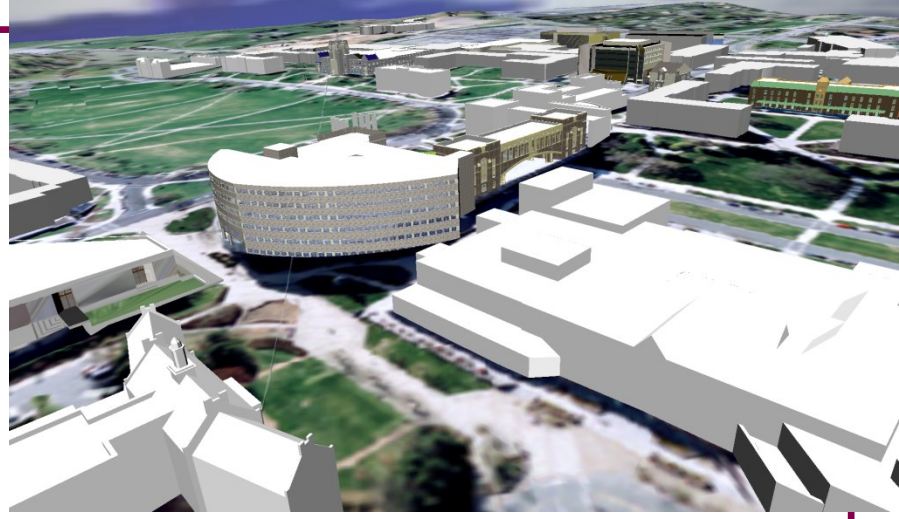
From NPS grad class – slides, videos, examples all online!!!

X3DOM – Declarative (X)3D in HTML5

Completes toda echn

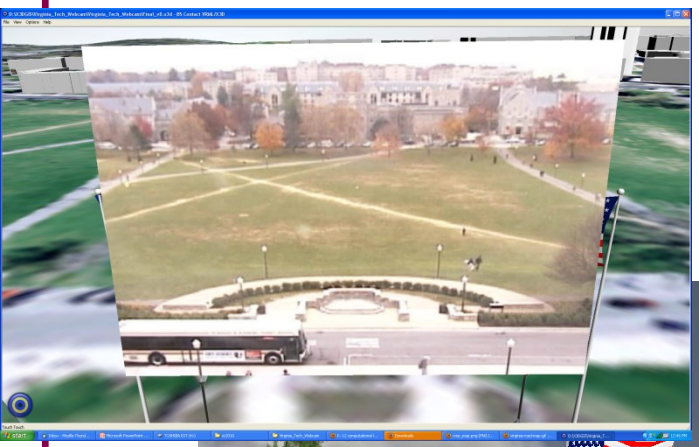
	2D (Final HTML5 spec)	3D (No W3C spec
Declarative Scene-graph Part of HTML document DOM Integration CSS / Events		
Imperative Procedural API Drawing context Flexible		

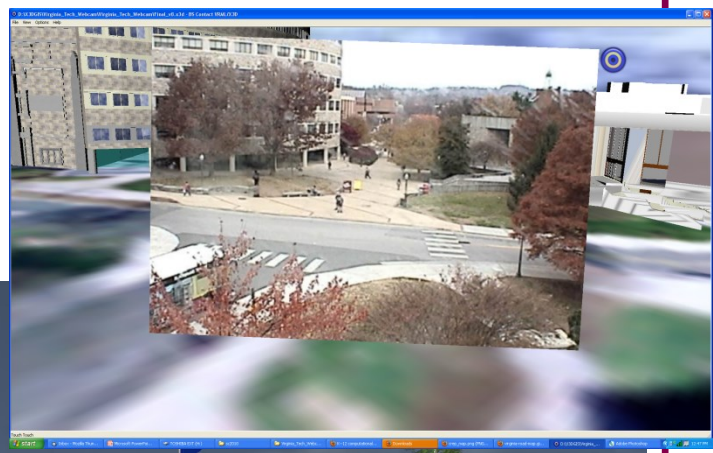
3D Blacksburg



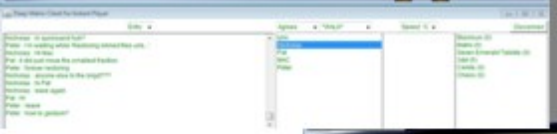
- n-D City model
- Enterprise scale GIS infrastructure
- International standards:
  - Web3D (X3D)
  - OGC (Sensor Web)
- Integrates sensor feeds and crowd-sourced content

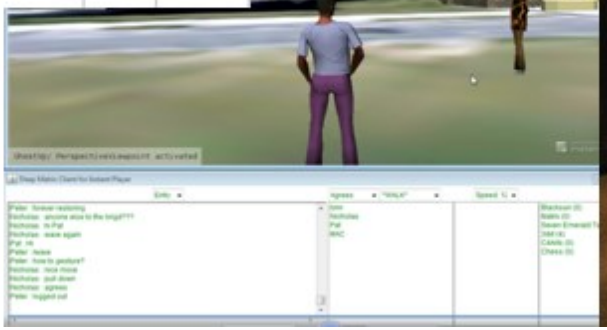
3D Blacksburg Mirror World





Town & Building LODs





X3D
shared
multi-user
VT Campus

X3D
Immersive

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Abstracting Rendering Layer with Scene Graphs

Extensible 3D (X3D)

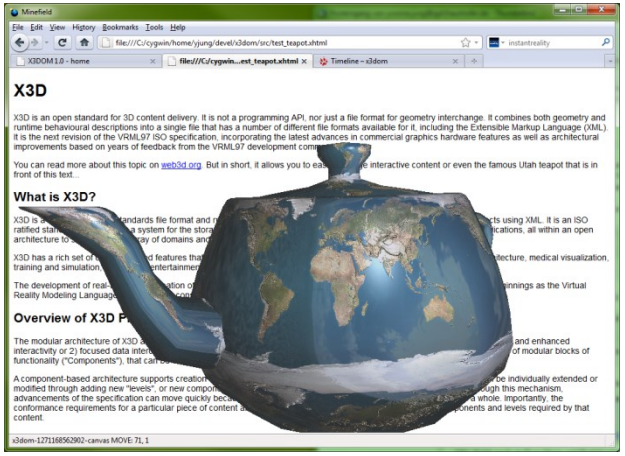
- Refactored VRML descendant - new features, multiple encodings (XML, binary, utf-8)
- Open ISO-Standard Scene graph

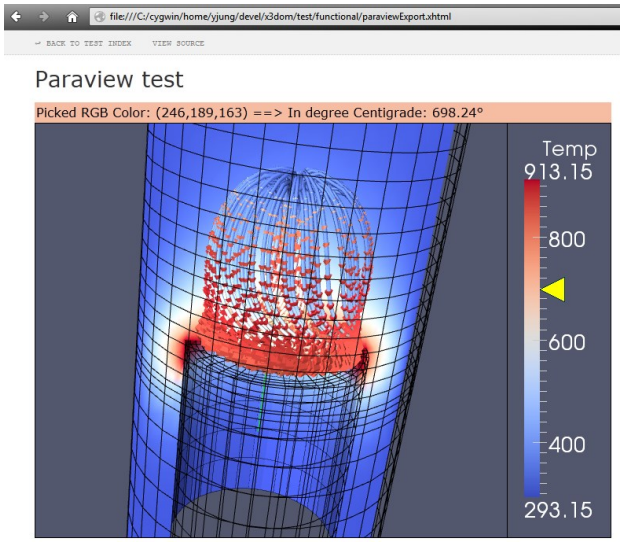
X3DOM, x_ite

- Profile of X3D integrating with W3C infrastructure (HTML5, CSS, DOM)
- Liberal Open Source (Javascript / WebGL)

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**





X3DOM Example 1: Interactive Car Configurator

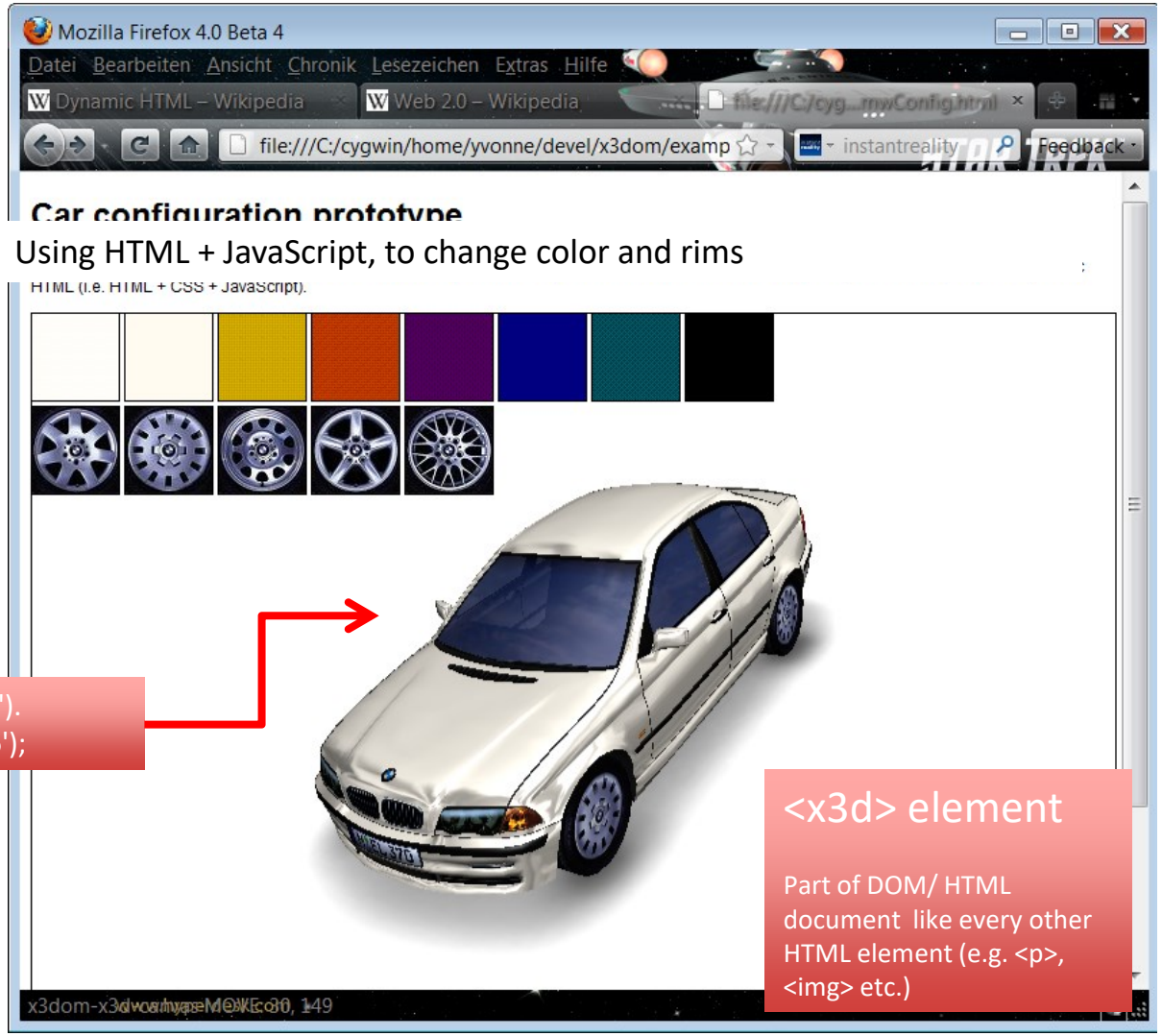
Interaction via standard Web technologies (e.g. JavaScript Events etc.)

```
<img src="felge1_64.jpg“
   onclick="..." style="…">
```

Click on <img> element…

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

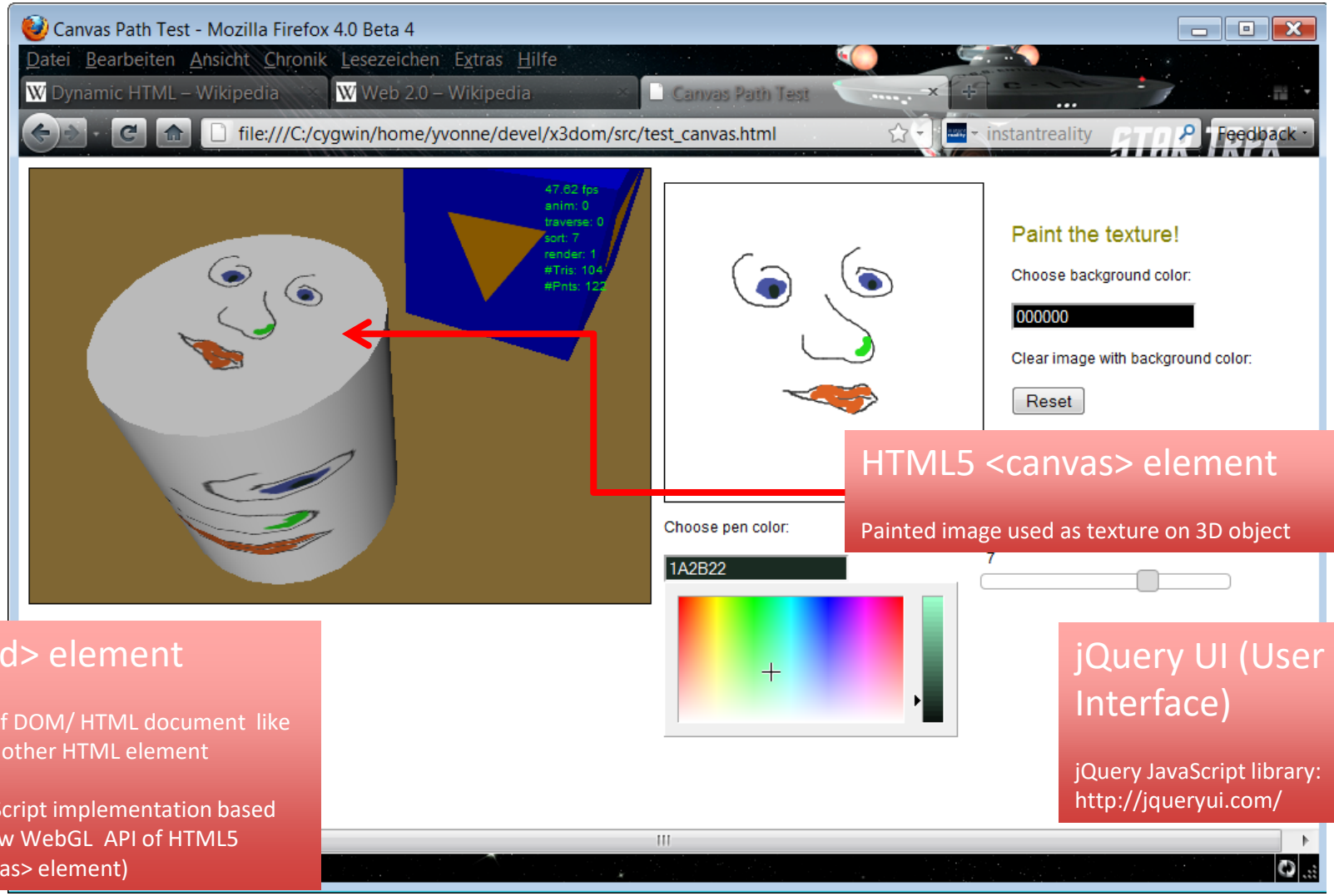
…causes attribute change of <texture> url (i.e., other wheel rims appear)



<x3d> element

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

X3DOM Example 2: Painting Textures of 3D Objects



HTML5 <canvas> element

Painted image used as texture on 3D object

<x3d> element

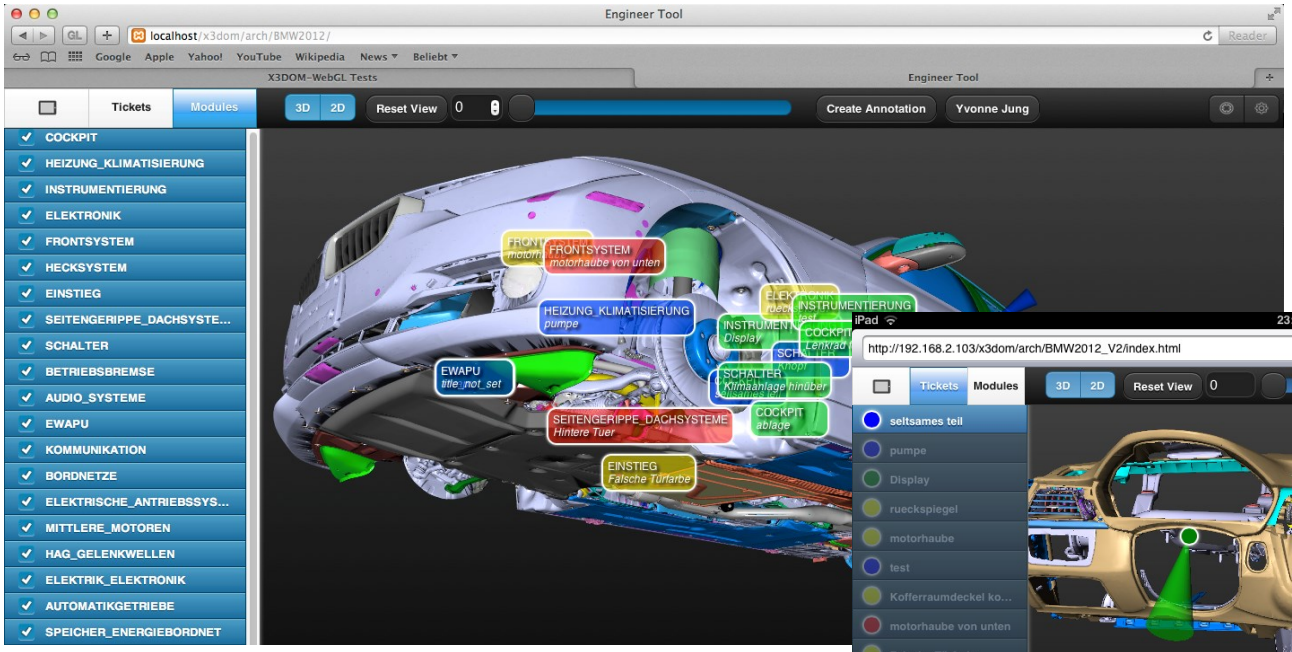
Part of DOM/ HTML document like every other HTML element

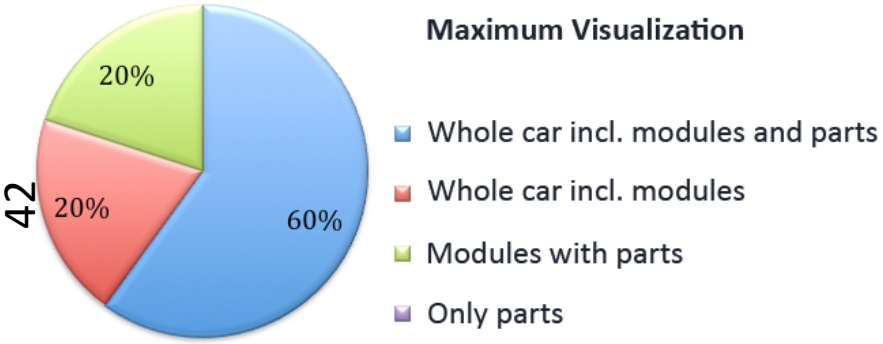
(JavaScript implementation based on new WebGL API of HTML5 <canvas> element)

jQuery UI (User Interface)

jQuery JavaScript library: http://jqueryui.com/

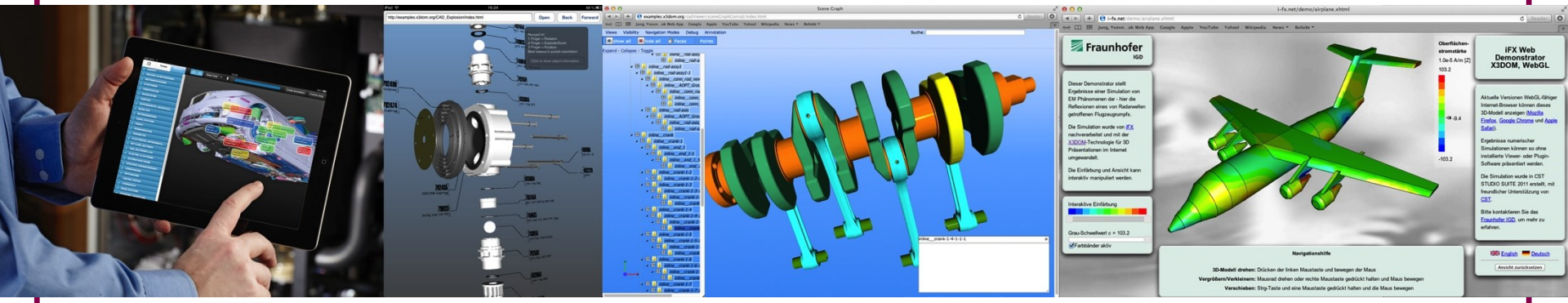
X3DOM Application (Large Data and Picking): 3D-Internet Design Review

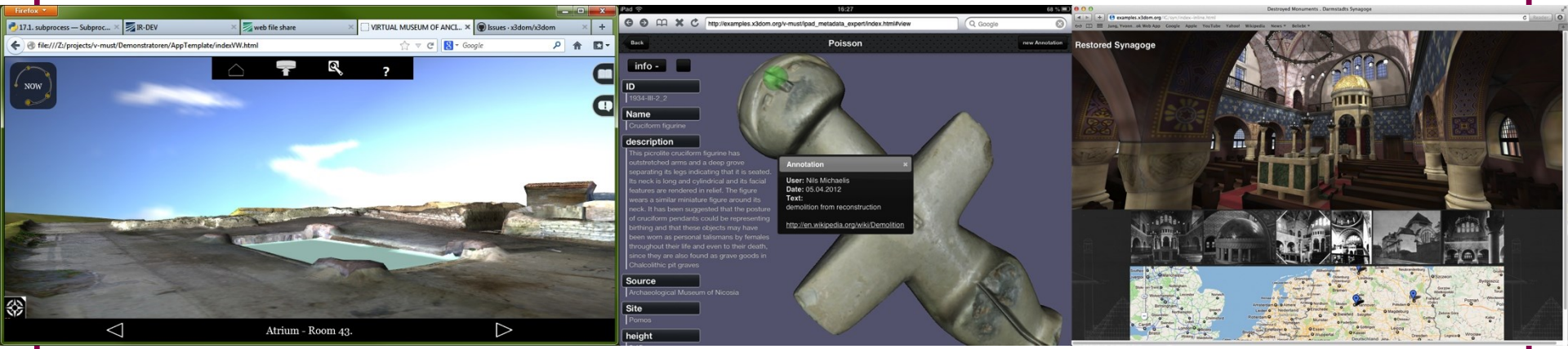




X3DOM Application Integration:

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 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