



VirginiaTech
Invent the Future



Fulfilling the Mandate of Information Durability and Access

Nov 2, 2018

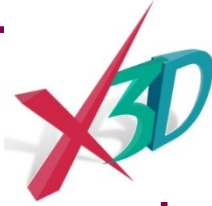
Nicholas F. Polys, Ph.D.

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 Dept. of Computer Science



- www.cs.vt.edu

The screenshot shows a web browser window displaying the Virginia Tech Department of Computer Science website. The browser's address bar shows www.cs.vt.edu. The website header includes the Virginia Tech logo with the tagline "Invent the Future", the text "College of Engineering Department of Computer Science", and an "Exemplary Department Award" badge.

The main content area features a large image of a virtual reality exhibit titled "Computing stretched DNA". The exhibit shows several large, colorful DNA double helix structures in a virtual environment. Two people are visible in the exhibit, one pointing at a screen displaying mathematical text and equations. The text on the screen includes phrases like "linear polymer chain", "Each site is identified by Δ_i ", "When pulled by corresponding forces F_i , the polymer chain can be found by solving a constrained (global) minimization problem", and "minimize $E(\Delta) = \sum_{i=1}^N (E_i(\Delta_i) + \lambda(\Delta_i - \Delta_i^0))$ ".

Below the exhibit image is a navigation bar with the number "123456789". To the left of the exhibit is a sidebar menu with the following items:

- Search within VTCS
- Enter your search here
- Faculty Search
- About Us
- Program Strengths & Goals
- People
- Research
- Undergraduate
- Graduate
- Events and Seminars
- Alumni
- Partnering with Industry
- Northern VA Campus
- Contact Us

Below the sidebar menu are social media icons for Facebook, YouTube, LinkedIn, and RSS.

At the bottom of the page, there are sections for "Upcoming" and "Department News".

Upcoming

Thursday, Mar, 3rd, 2016

- Seminar: Evaluating the Security of Anonymized Big Graph/ Structural Data

Department News

- SeeMore headed to SXSW
- Alumna Cho receives Presidential Early Career Award for Scientists and Engineers
- Denis Gracanin's work with the Center for Autism Research

The browser's taskbar at the bottom shows various application icons and the system tray with the date and time: 9:48 AM 3/3/2016.

Ad

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:

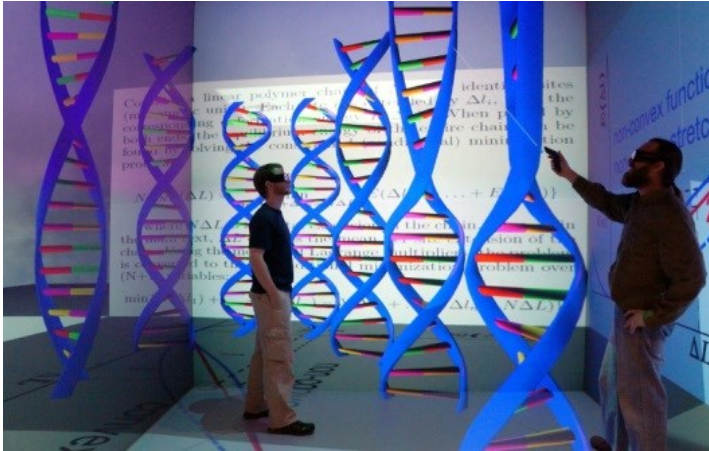
“The increase and diffusion of knowledge.”

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:



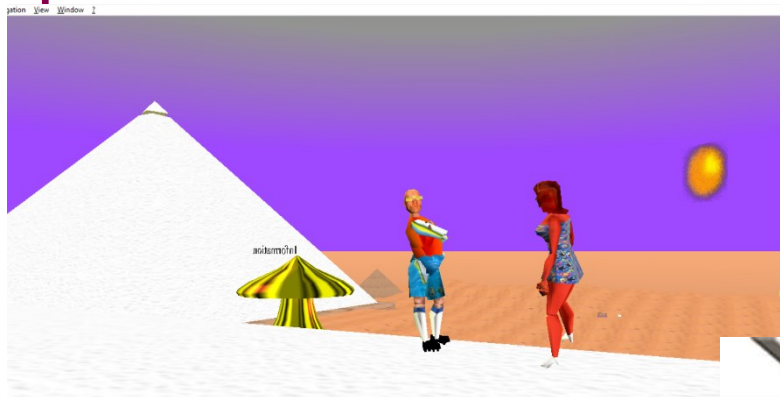
** The US and UK National Archives
recommend the ISO-IEC X3D format!*

VirtuWorlds™ Giza

(1998 ----> 2018!)

*Early explorations into Web3D
and Virtual Reality:*

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



Open Standards

www.web3d.org

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

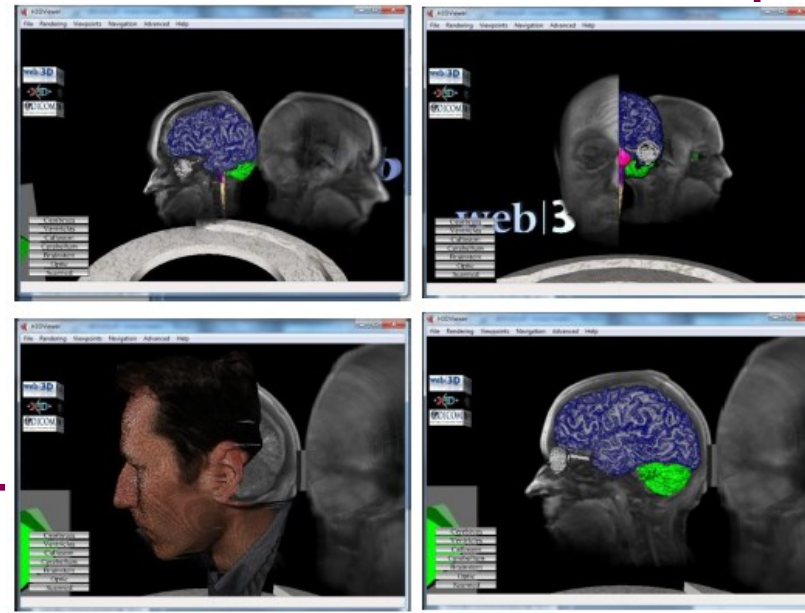


Web3D.org & WG introductions

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

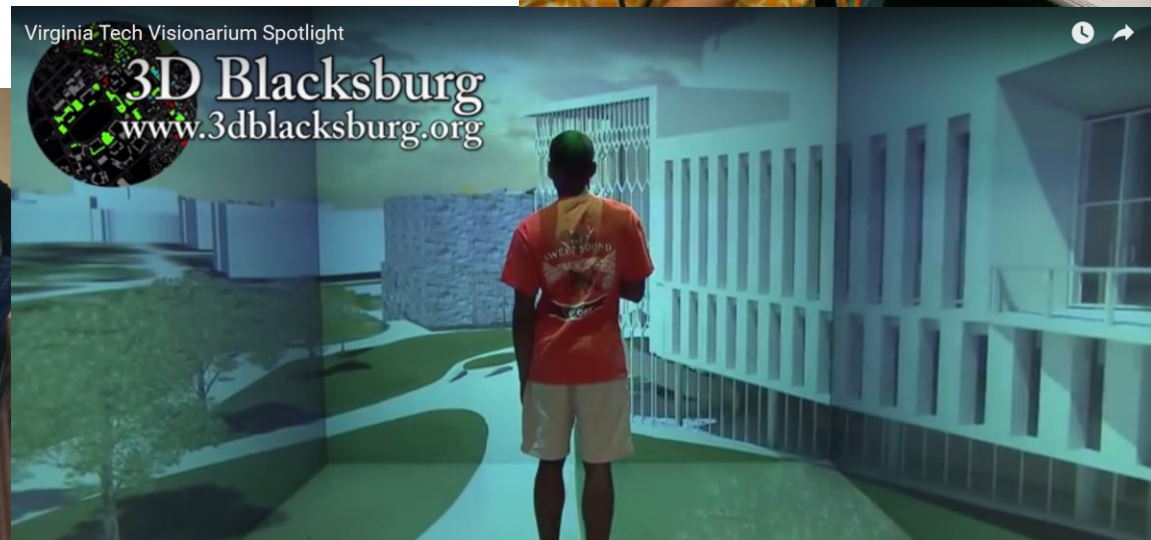
... For all

The Web Is the Interface



3D Everywhere

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



Industry Standards unify communities

web|3D
CONSORTIUM



OGC[®]
Open Geospatial Consortium, Inc.

W3C[®] WORLD WIDE WEB
consortium

KHRONOS
GROUP

 DICOM[™]
Digital Imaging and Communications in Medicine

 HL7[®]
INTERNATIONAL

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!

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Appendix

More info~!

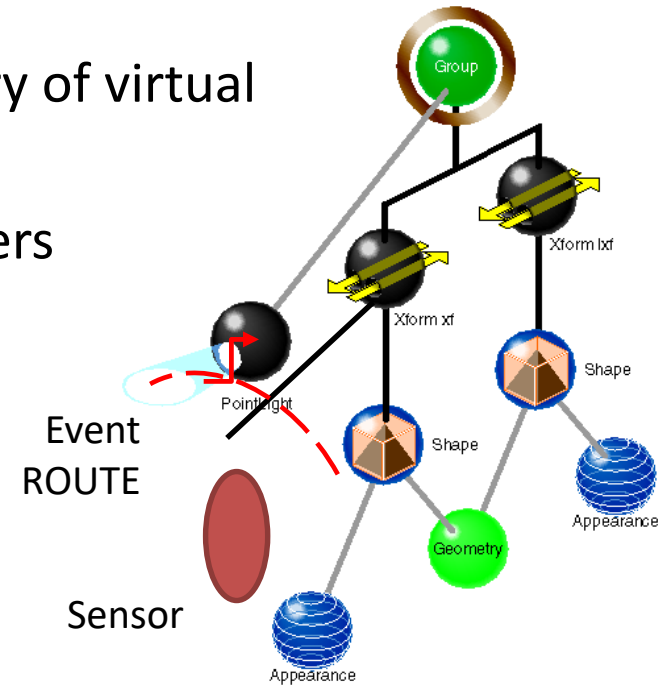


ISO-IEC Standard Scope

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



NAVAL
POSTGRADUATE
SCHOOL

TOSHIBA



Institut
Graphische
Datenverarbeitung



ik4 research alliance



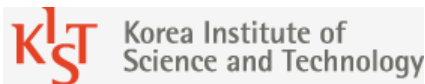
CHUNGBUK
NATIONAL UNIVERSITY



CHUNGBUK
NATIONAL UNIVERSITY

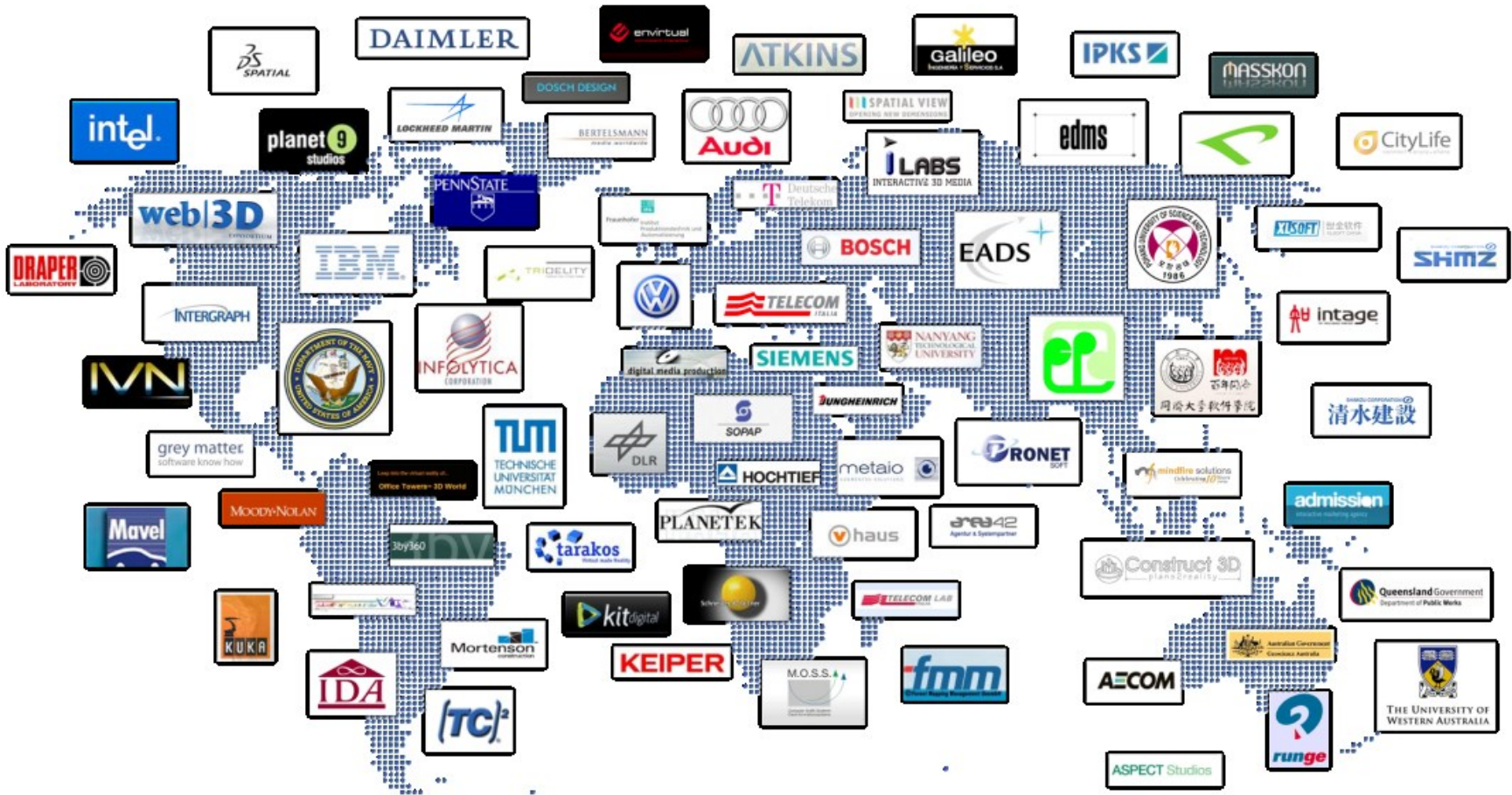
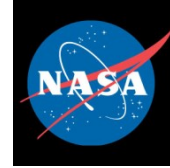


JEJU
NATIONAL UNIVERSITY



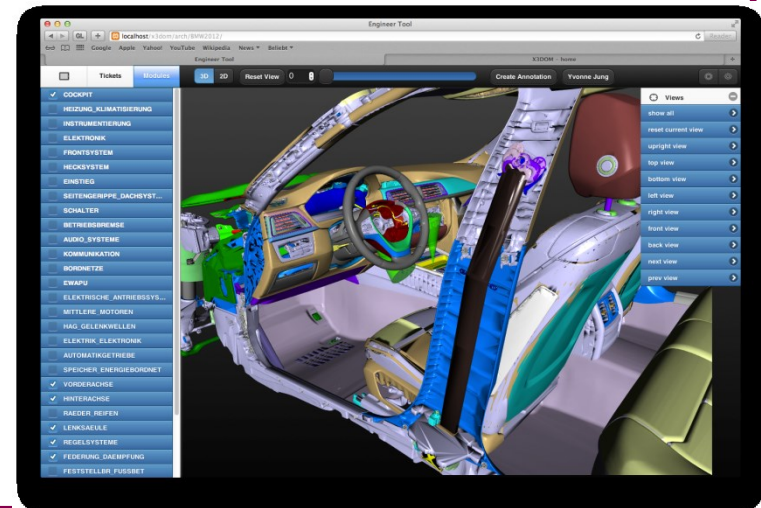
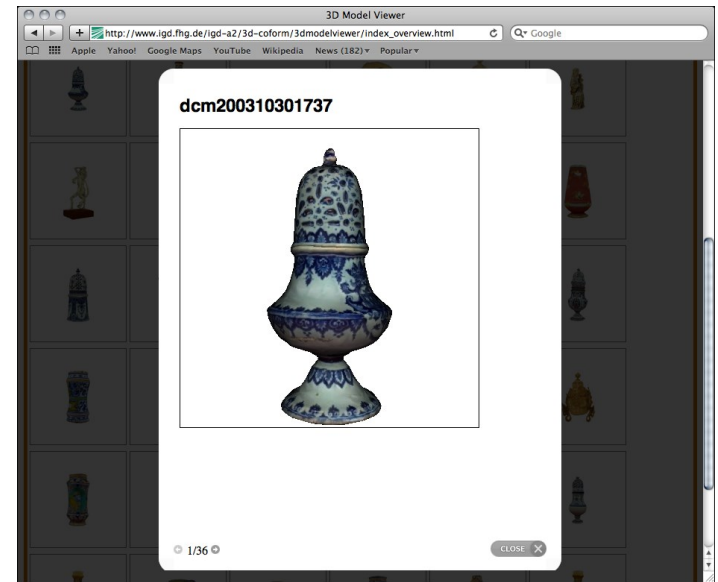


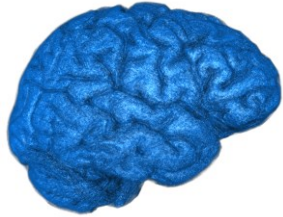
Adoption



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





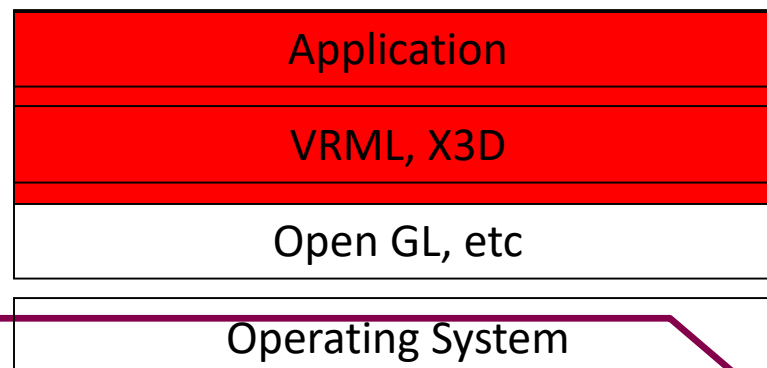
4D: a first-class citizen

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 today's 2D techniques

2D
(Final HTML5 spec)

Declarative

Scene-graph
Part of HTML document
DOM Integration
CSS / Events



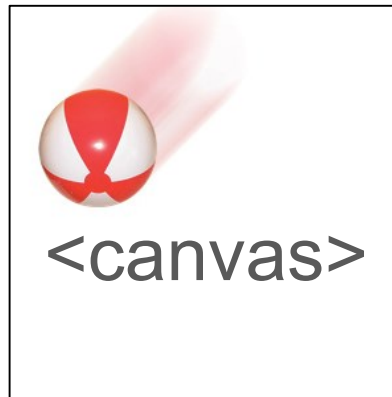
3D

(No W3C spec)

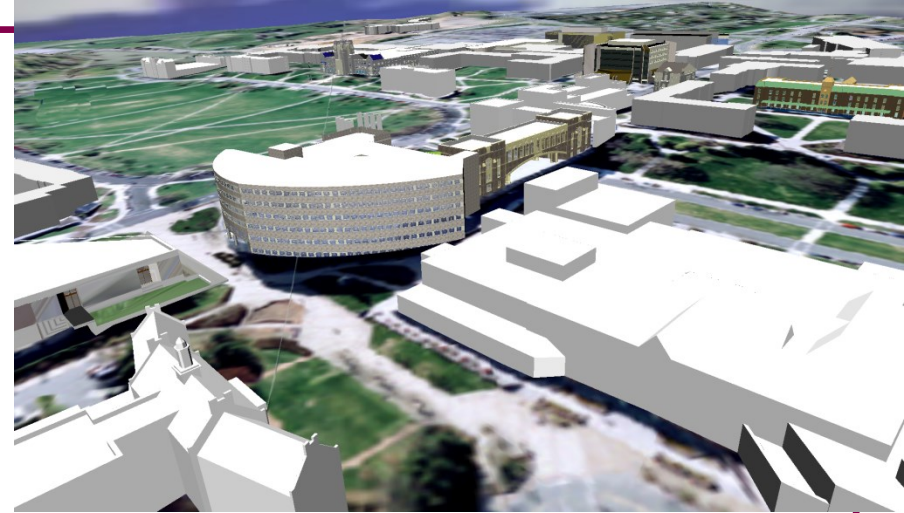


Imperative

Procedural API
Drawing context
Flexible



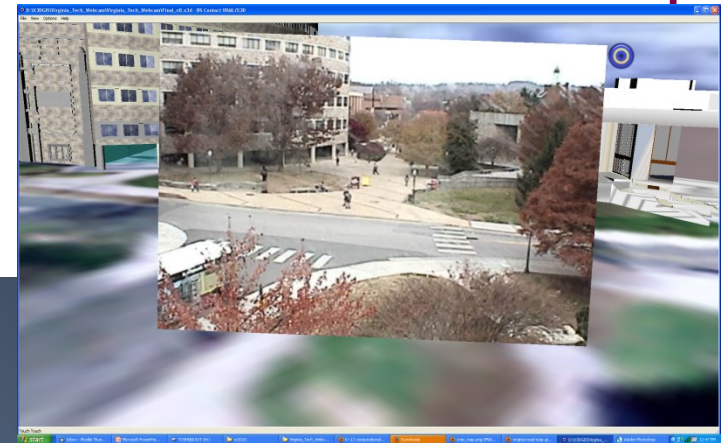
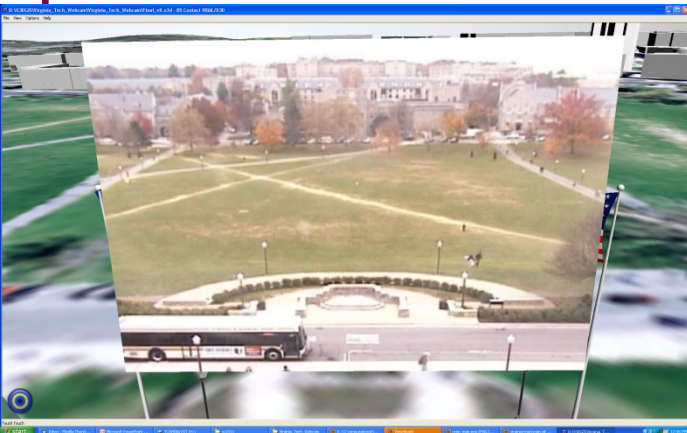
3D Blacksburg



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



3D Blacksburg Mirror World

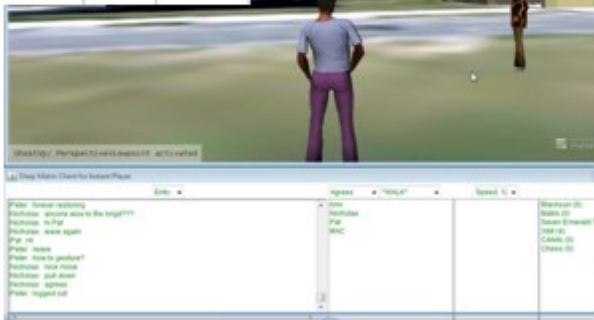




Town & Building LODs



X3D
shared
multi-user
VT Campus



X3D
Immersive

Abstracting Rendering Layer with Scene Graphs

Extensible 3D (X3D)

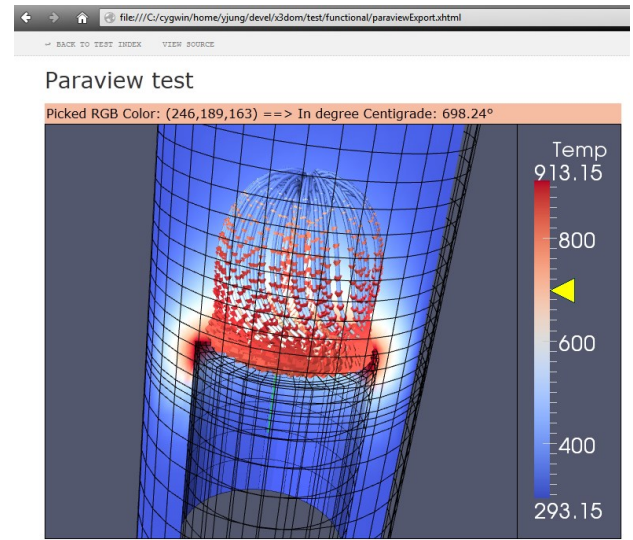
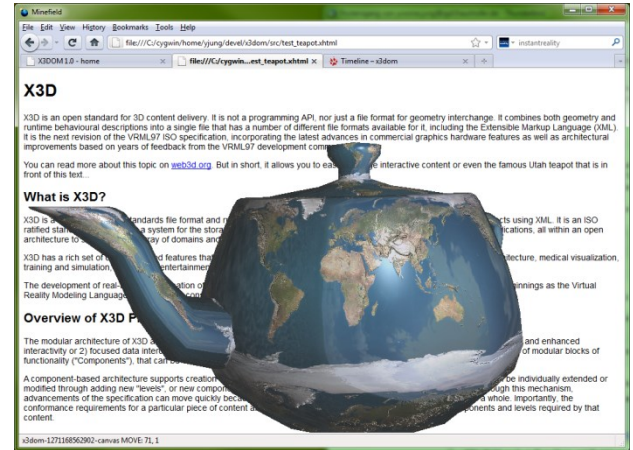
- Refactored VRML descendant - new features, multiple encodings (XML, binary, utf-8)
- Open ISO-Standard Scene graph

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.)

```

```

Click on 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

HTML (i.e. HTML + CSS + Javascript).

<x3d> element
Part of DOM/ HTML document like every other HTML element (e.g. <p>, 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 cylindrical object with a human-like face is rendered. A red arrow points from a 2D canvas on the right to the face on the 3D object. 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 following elements:

- Paint the texture!** (Section header)
- Choose background color:
- Clear image with background color:
- Choose pen color:
- A color picker interface with a rainbow gradient and a vertical slider.
- A horizontal slider below the color picker.

Technical statistics are visible in the top right corner of the 3D view:

```
47.62 fps  
anim: 0  
traverse: 0  
sort: 7  
render: 1  
#Tris: 104  
#Pnts: 127
```

<x3d> element

Part of DOM/ HTML document like every other HTML element

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

HTML5 <canvas> element

Painted image used as texture on 3D object

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" and "Modules" tabs, a "3D 2D" view selector, a "Reset View" button, and a "Create Annotation" button. The sidebar on the left 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

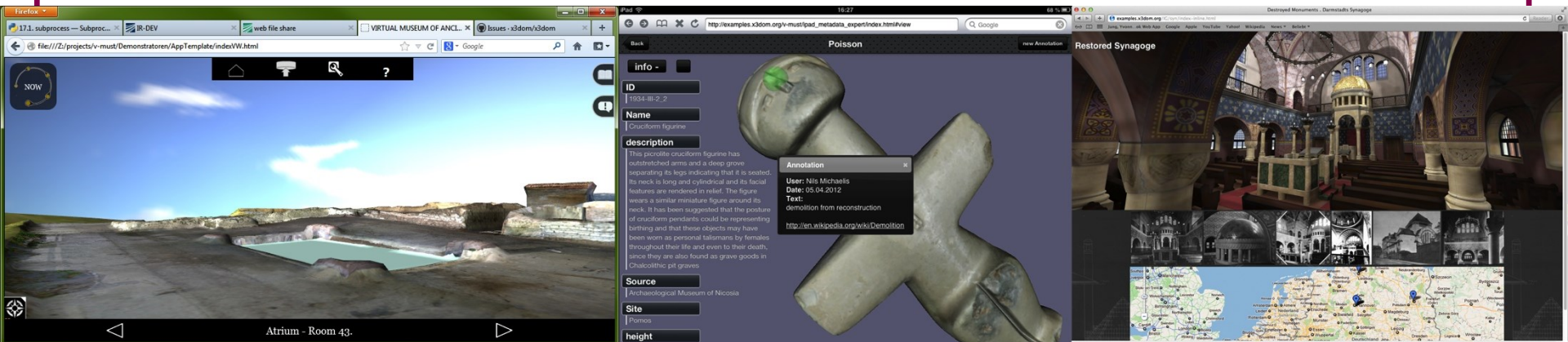
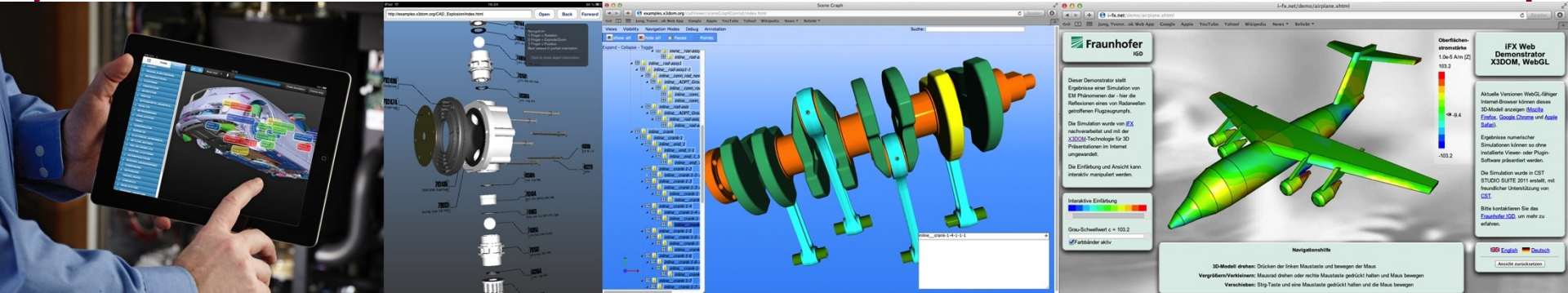
42

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

20% 20% 60%

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