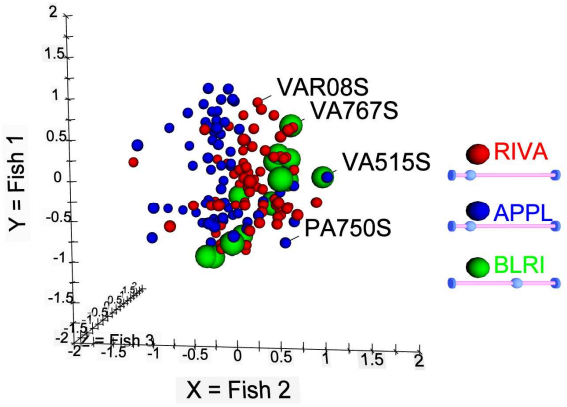
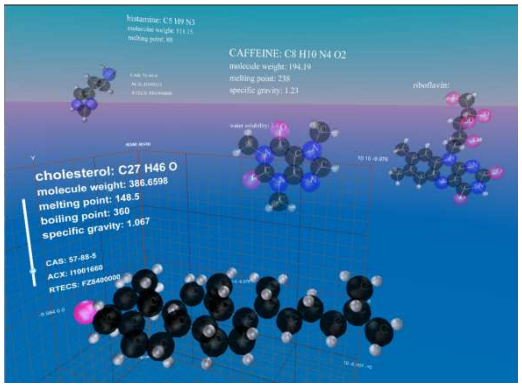
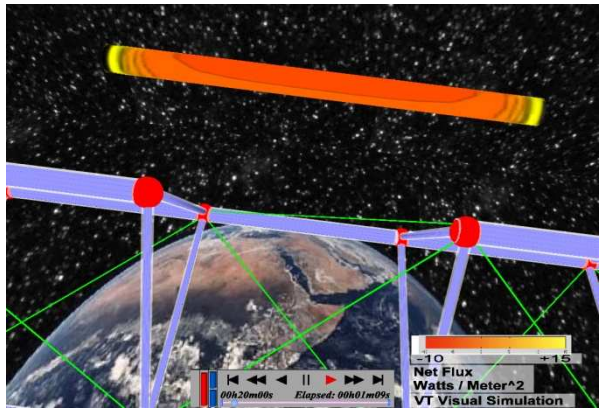
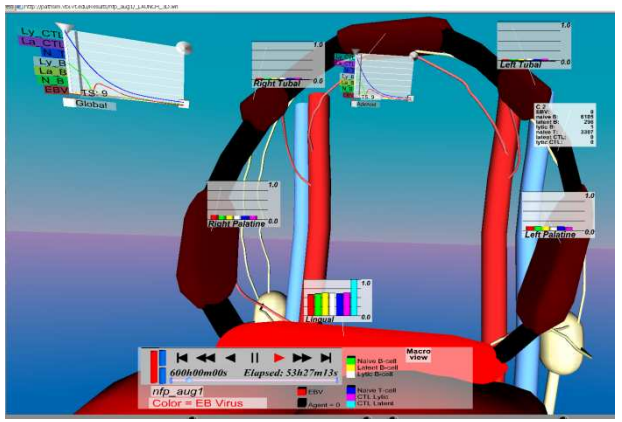




FDI 2011:
Visual Computing

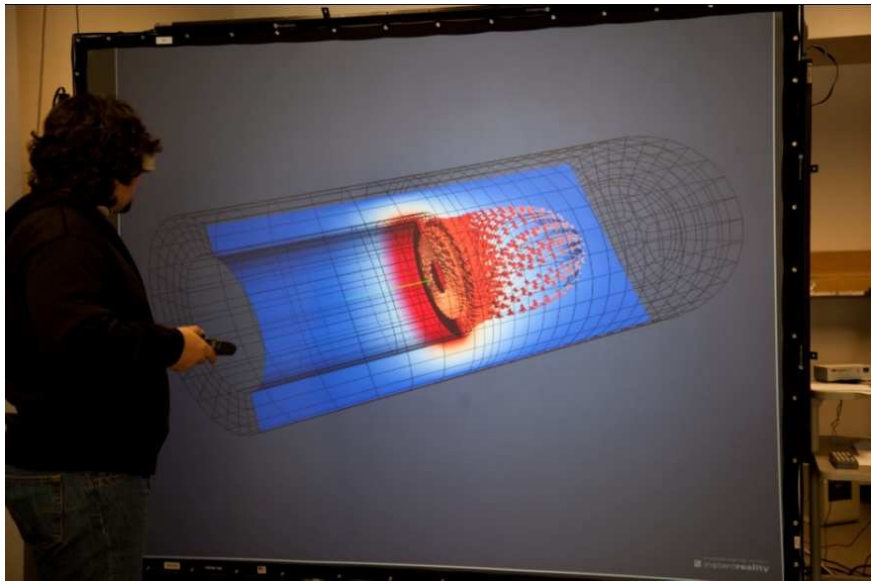


Nicholas F. Polys, Ph.D.
VT Advanced
Research Computing



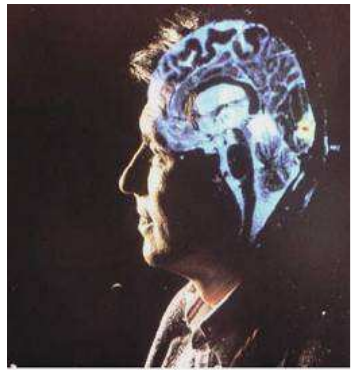
Thursday Outline

- “Visualization”
- Deep Media Tour
- VT Resources
  - *break*
- Principles of Perception
  - *lunch*
- Tools: Paraview
  - *break (*)*
- Tools: Visit +



Visualization

- A Core Competency for this century's scientist:
  - Drives hypothesis generation, analysis, ***insight***
  - Enables communication, collaboration
- Understanding data requires exploration, search, comparison and pattern recognition
- Larger and more complex systems require tools with computational and cognitive scalability!



Human Vision

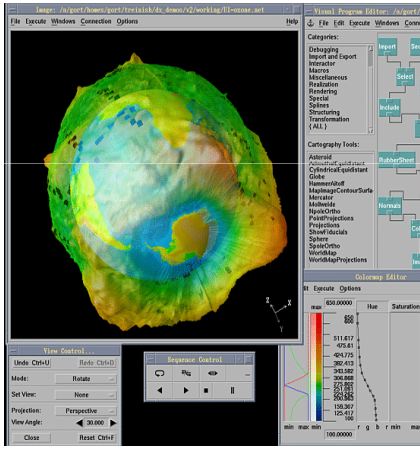
- Highest bandwidth sense
- Fast, parallel
- Pattern recognition
- Pre-attentive
- Extends memory and cognitive capacity
    - (Multiplication test)
- People think visually
- Brain = 8 lbs, vision = 3 lbs

Impressive… Lets use it!

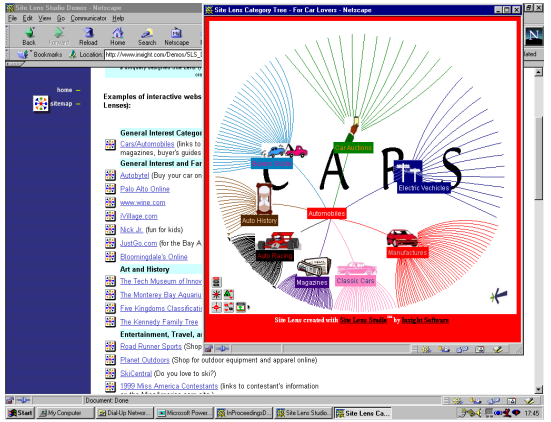
A Definition

- Generally:
  - The use of computer-supported, interactive, visual representations of data to amplify cognition

Card, McKinlay and Schneiderman

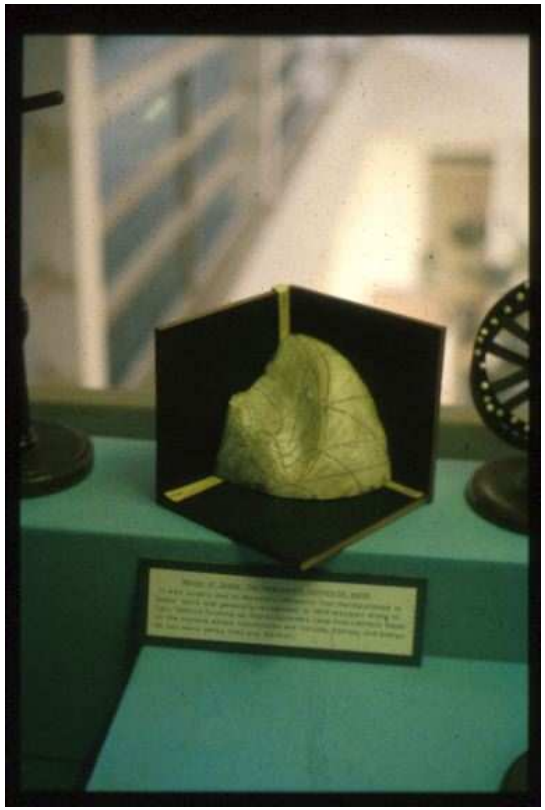


  - Scientific Visualization
  - Information Visualization
  - Virtual Environments



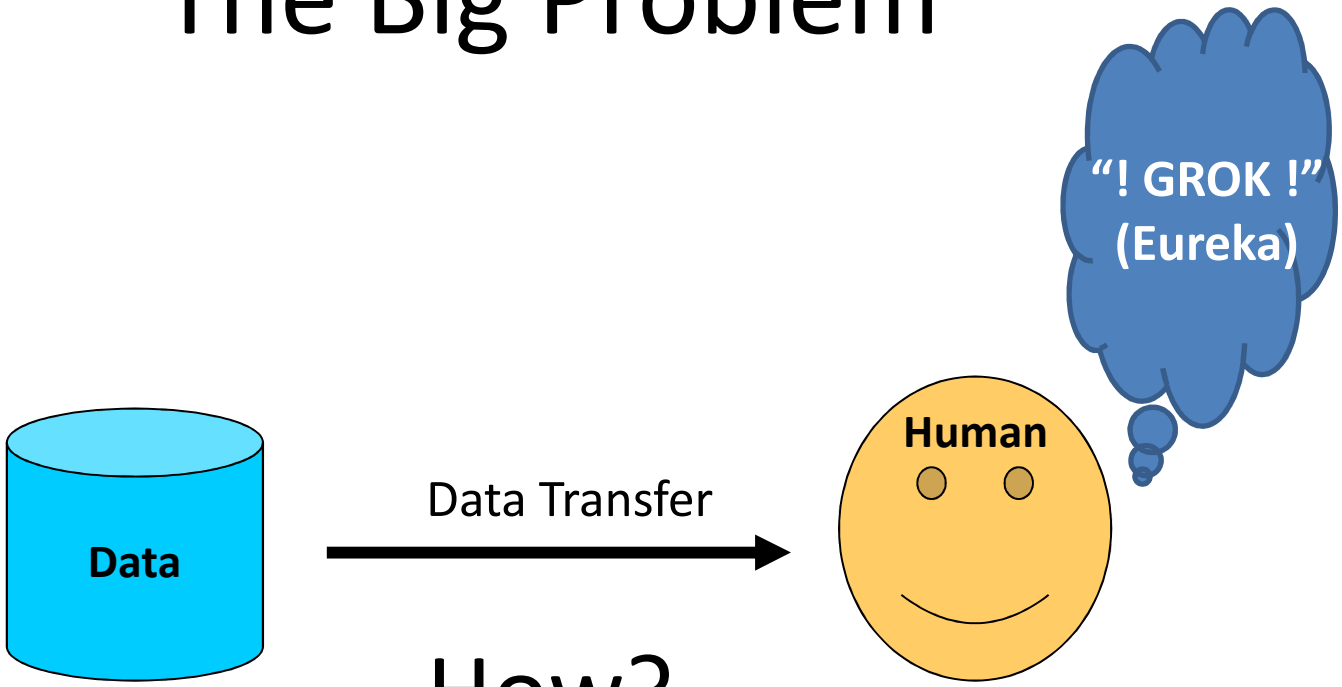
Visual Thinking

- Many of the great scientists were good at visual thinking:
  - Leonardo da Vinci
  - James Clerk Maxwell
  - Michael Faraday
  - Albert Einstein
- This was often at the expense of verbal skills
- Tom West : “In the Mind’s Eye”
  - See also http://www.krasnow.gmu.edu/twest/maxwell_visual.html



Maxwell’s clay model now in
New Cavendish Laboratory, Cambridge
(picture by Tom West)

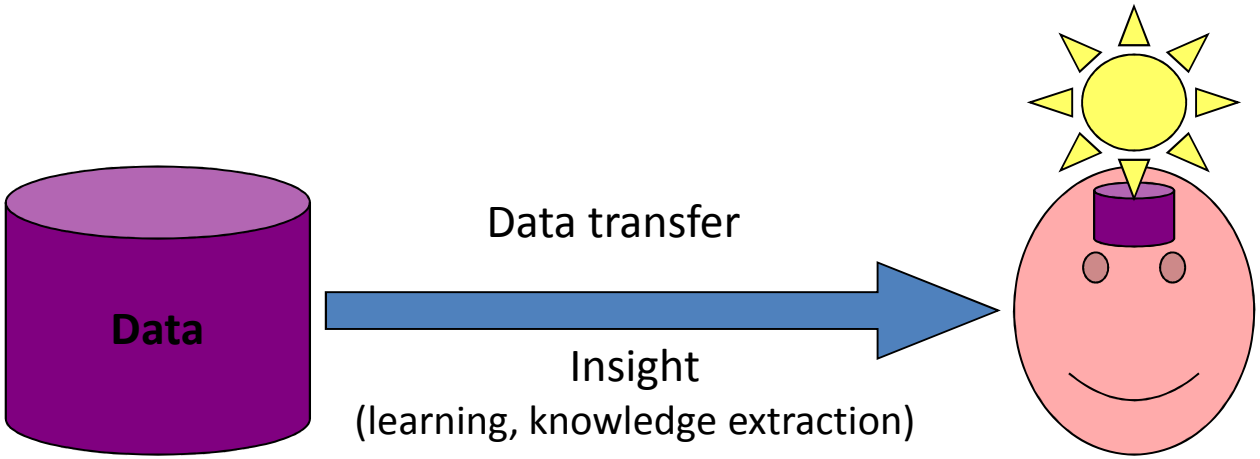
The Big Problem



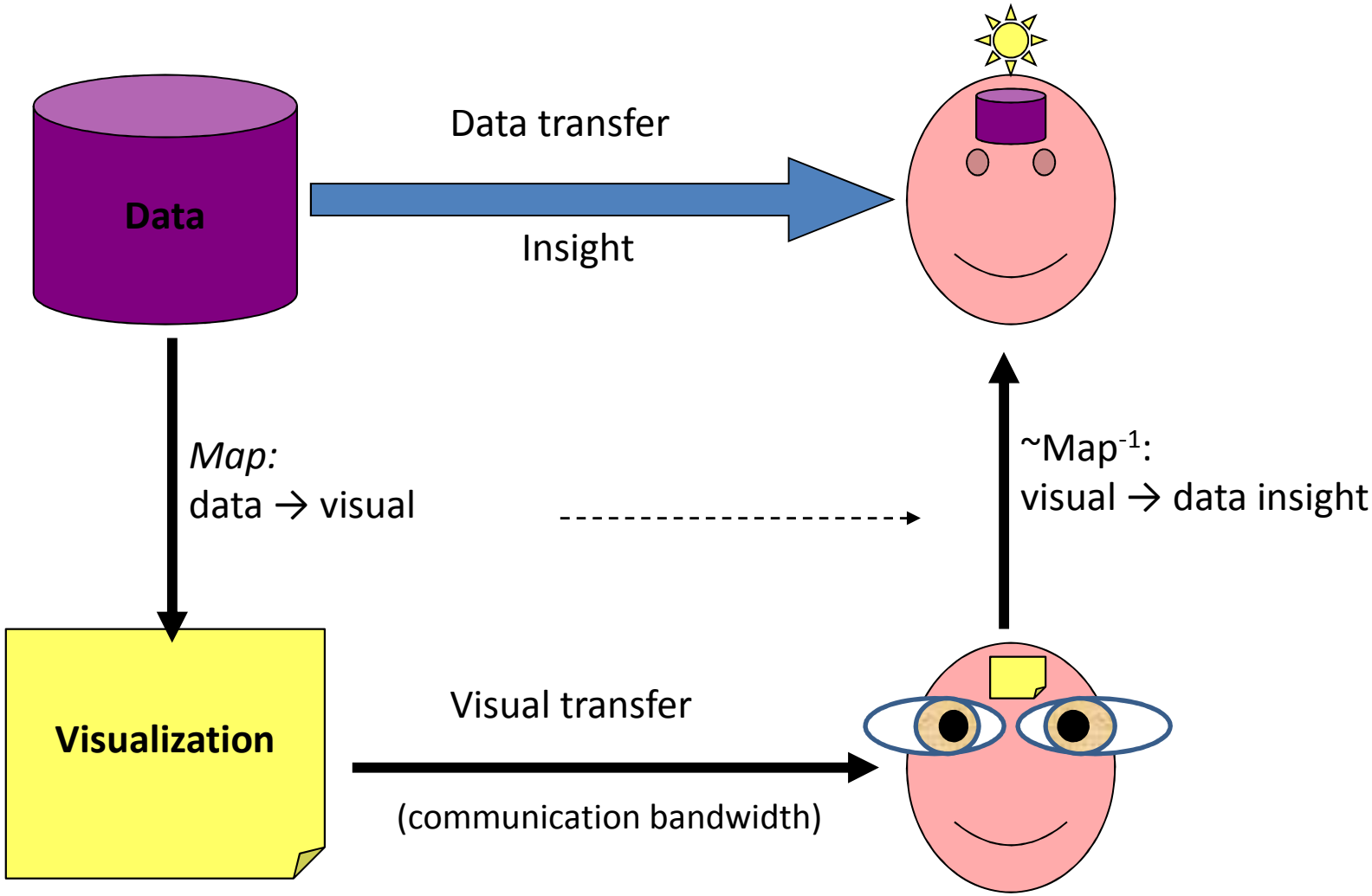
How?

Vision
Aural
Smell
Haptics
Taste

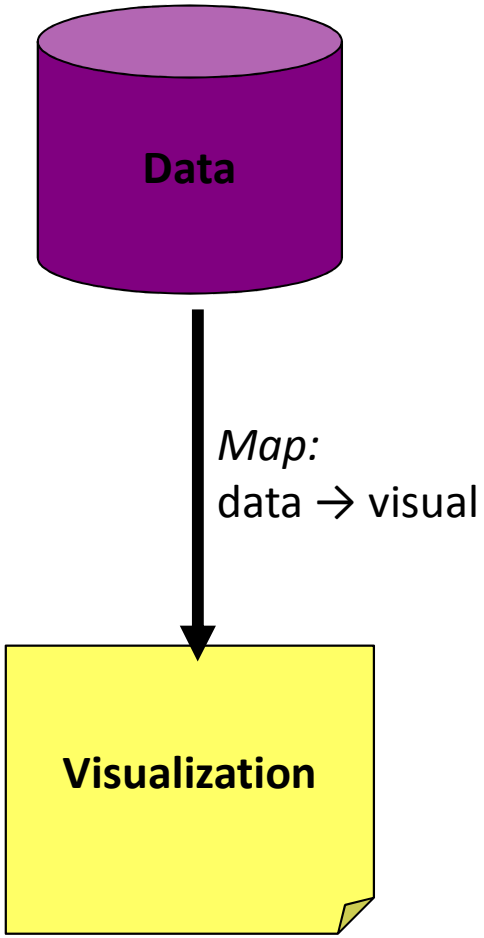
Goal


Data
Data transfer
Insight
(learning, knowledge extraction)

Method


Data
Data transfer
Insight
Map:
data → visual
~Map-1:
visual → data insight
Visualization
Visual transfer
(communication bandwidth)

Visual Mappings



Visual Mappings must be:

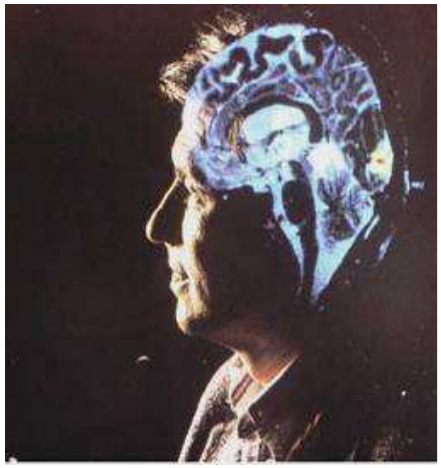
- Computable (math)

  visual = f(data)

- Comprehensible (invertible)

  data = f^{-1}(visual)

- *Creative!*



Visualization Overview

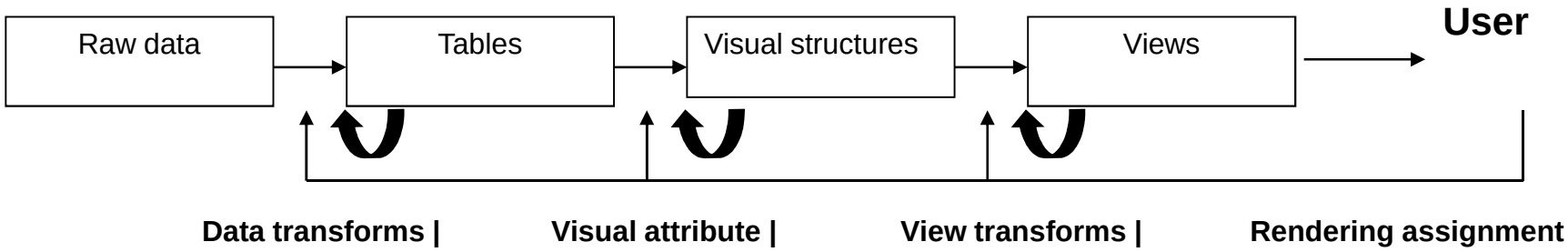
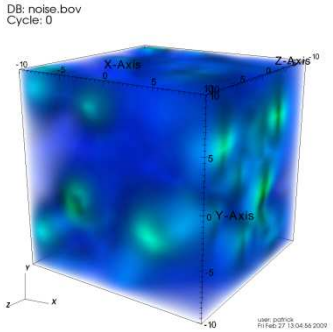


Figure 2.1: Processing in a typical visualization pipeline (from Card et al, 1999)

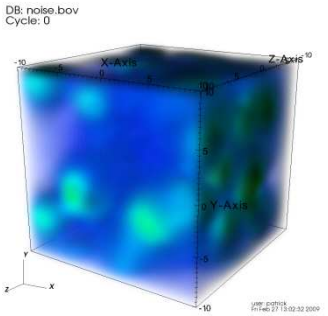
Visual Encoding Examples

Sci Vis

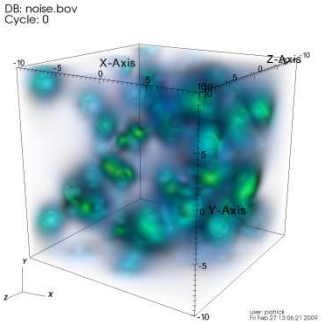
- Spatial substrate
- Visual ‘marks’
  - Visual properties
  - Time-varying



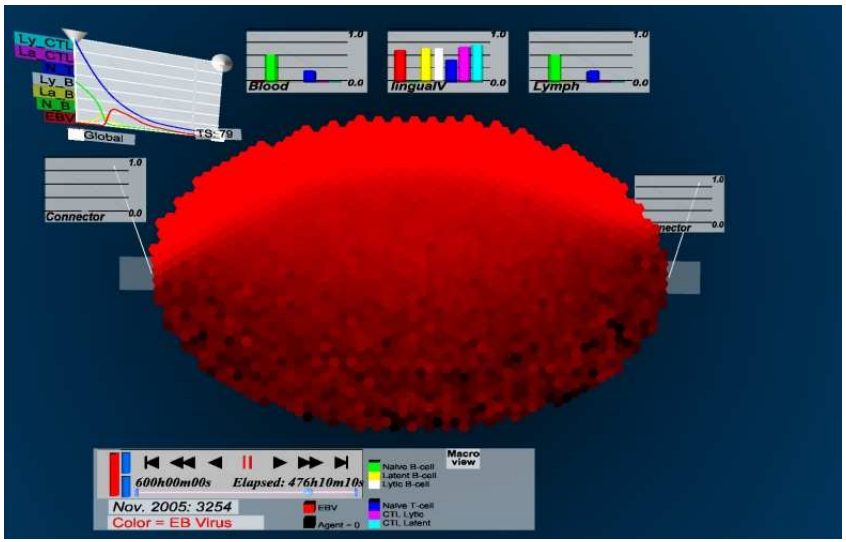
3D Texture method

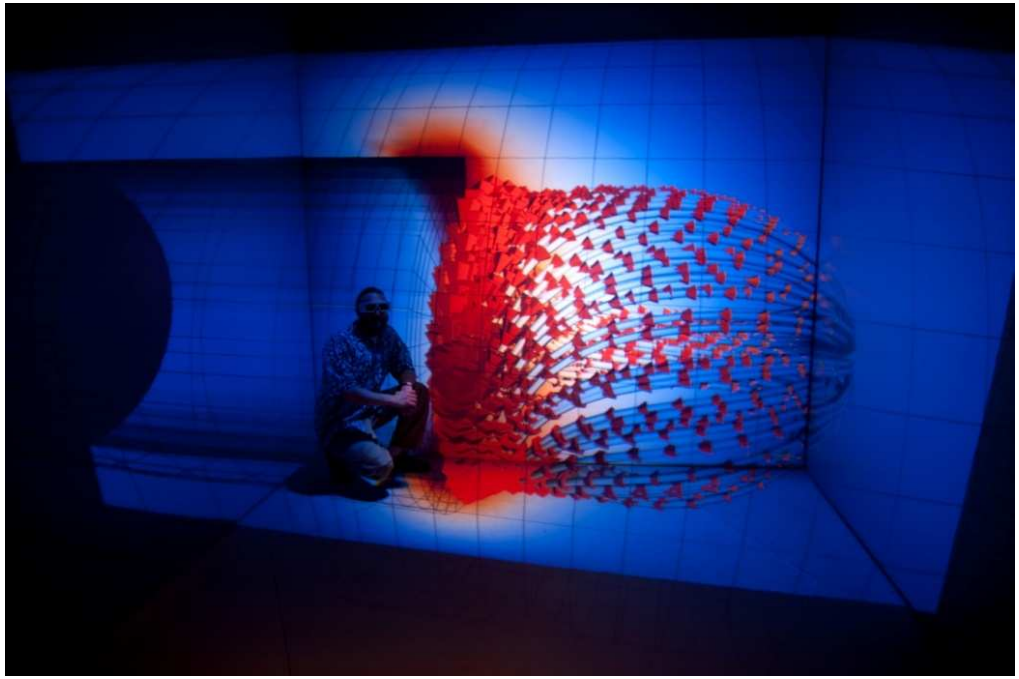


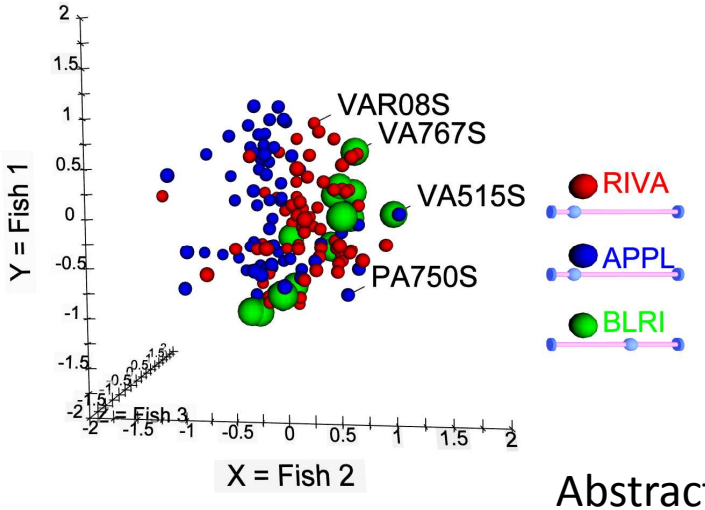
Splatting method

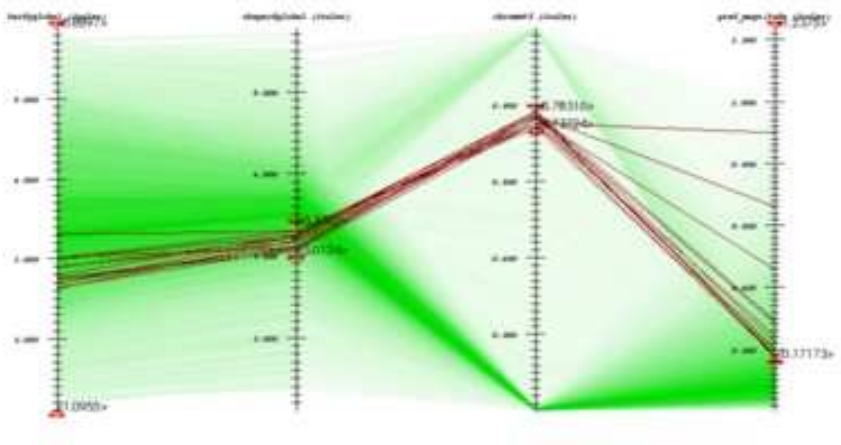


Raycasting method

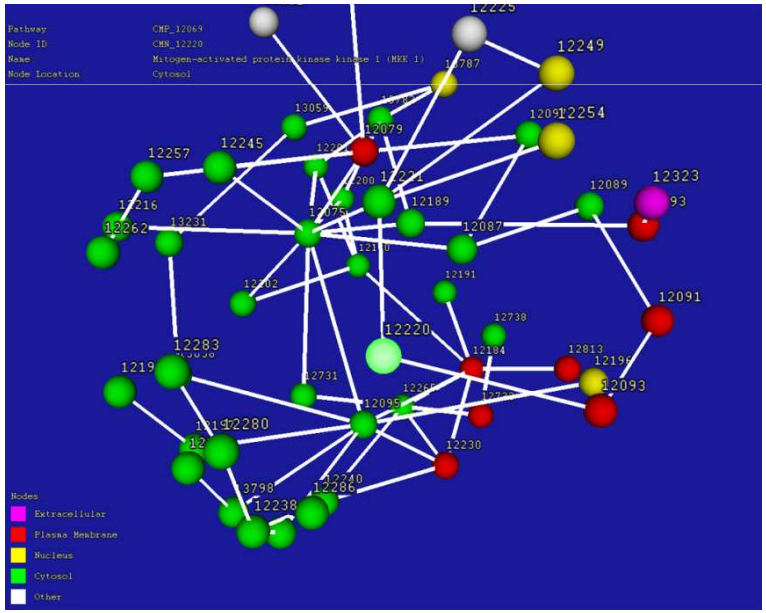








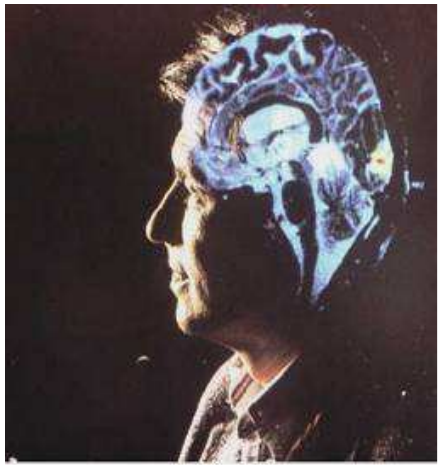
Abstract Data



Network Data

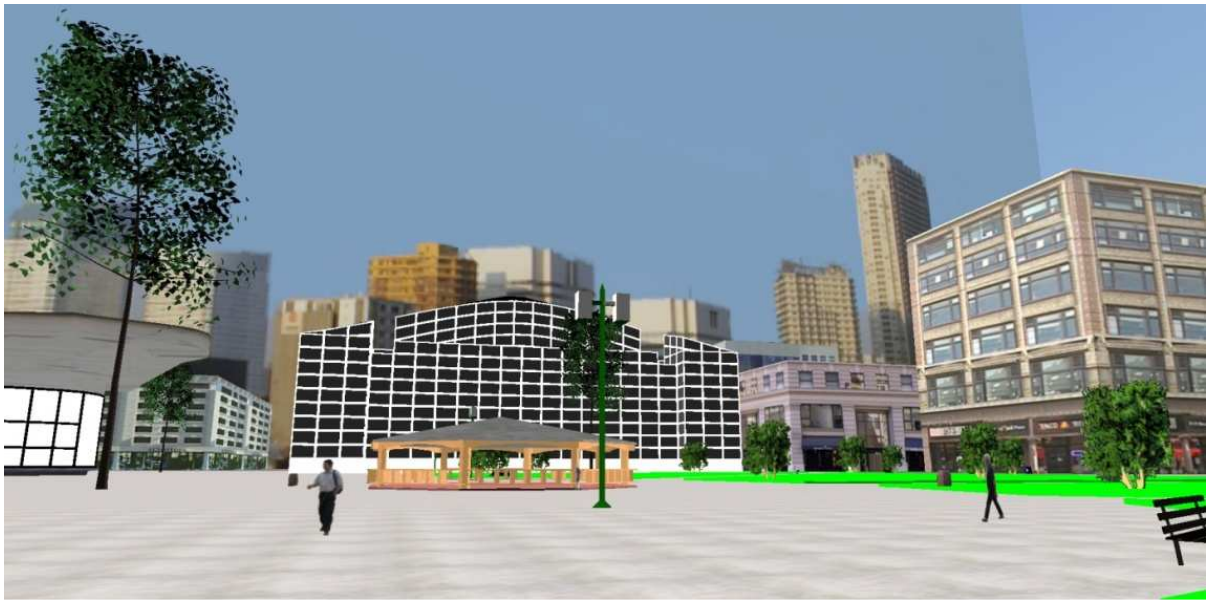
Visualization

- An instrument / tool to
  - look at your data and see things otherwise hidden…
  - Amplify Cognition
- 3 key stages:
  - Transforming data
  - Encoding data
  - Delivering / Rendering



Deep Media Tour

- Web3D & ISO Technology
- Web3D & ISO Applications
- Emerging Paradigms



The ISO Standard for 3D on the Web

Shared world wide

Shared between applications

"X3D enables the communication of real-time 3D across networks and XML-based web services"

Lasts the Test of Time

Royalty-free Open source

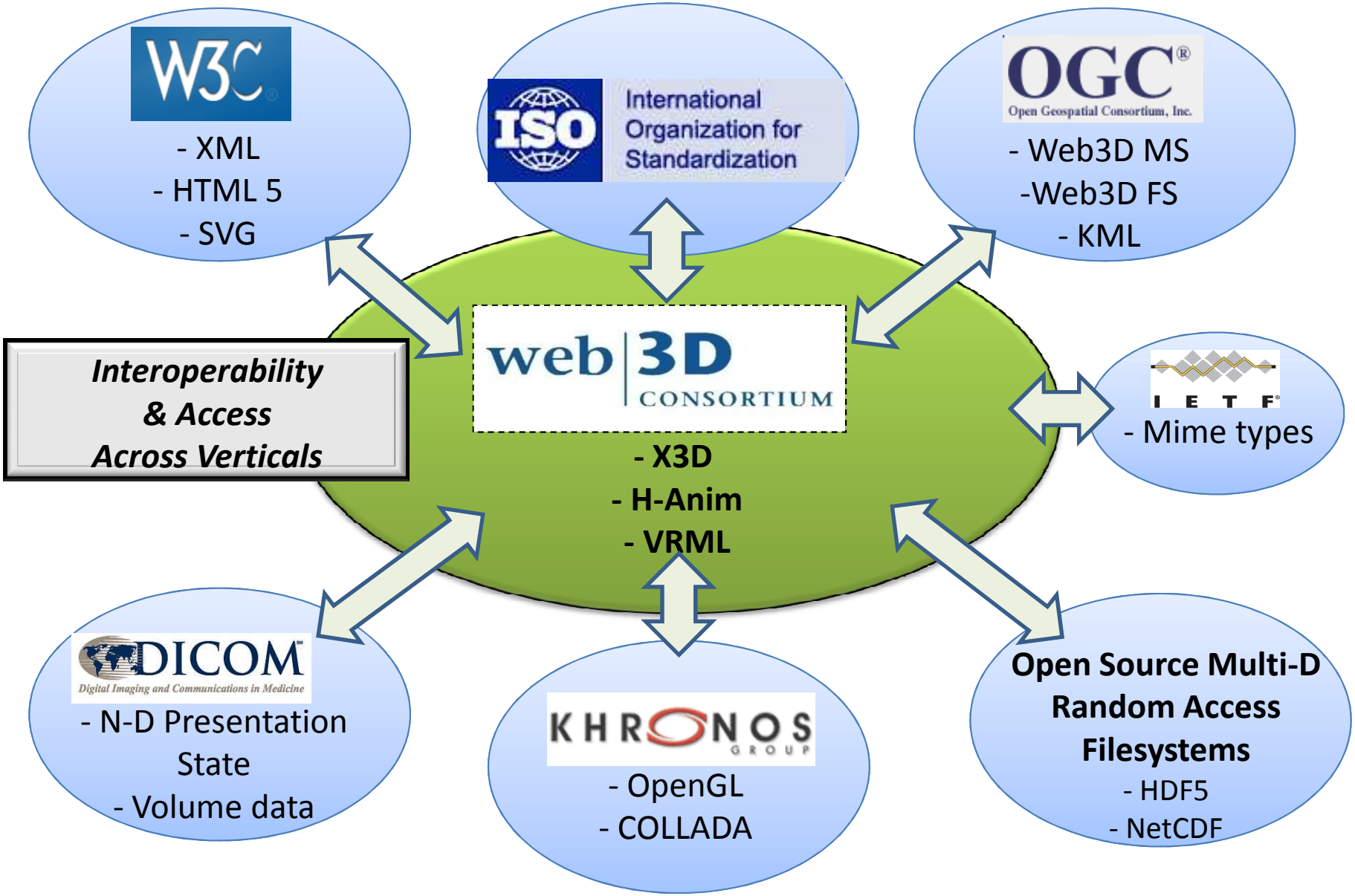
Shared between systems

Open Standards

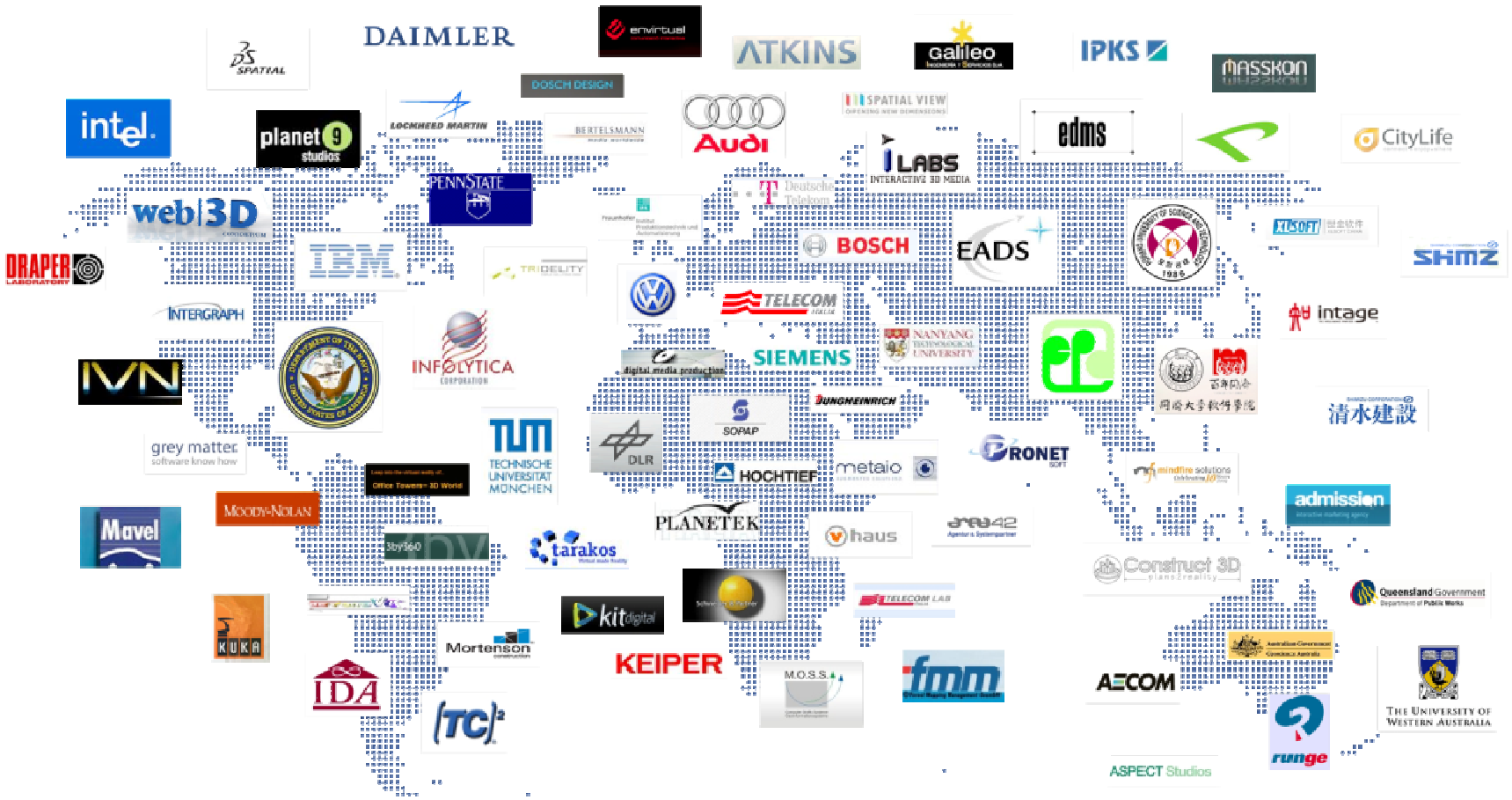
www.web3d.org

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

Web3D Collaboration & Convergence

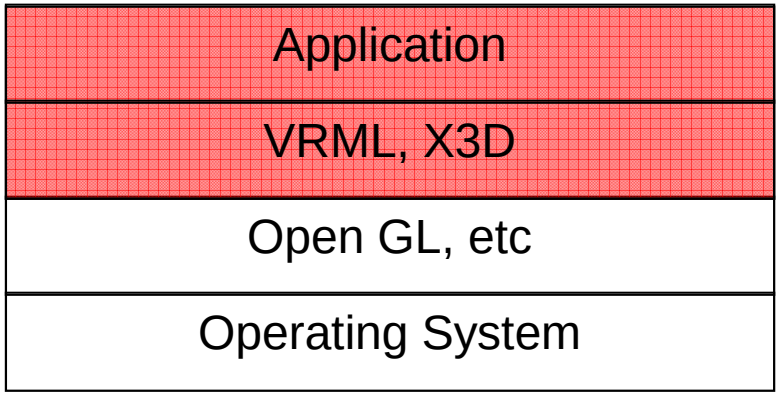


Adoption


DAIMLER
envirtual
ATKINS
Galileo
IPKS
MASSKON
DOSCH DESIGN
intel
planet 9 studios
LOCKHEED MARTIN
BERTELSMANN
Audi
SPATIAL VIEW
edms
CityLife
i LABS
INTERACTIVE 3D MEDIA
PENNSTATE
web3D
BOSCH
EADS
XUSOFT
SHMZ
DRAPER
IBM
TRIDELITY
INTERGRAPH
TELECOM
intage
INFOLYTICA
SIEMENS
NANYANG TECHNOLOGICAL UNIVERSITY
IVN
digital media production
JUNGHEINRICH
清水建設
SOPAP
grey matter
software know how
TECHNISCHE UNIVERSITÄT MÜNCHEN
DLR
PRONET
HOCHTIEF
metaio
mindfire solutions
Office Towers+ 3D World
admission
Moody-Nolan
Mavel
PLANETEK
haus
area42
tarakos
Construct 3D
Queensland Government
KUKA
kit digital
TELECOM LAB
Mortenson
KEIPER
M.O.S.S.
fmm
AECOM
IDA
THE UNIVERSITY OF WESTERN AUSTRALIA
runge
ASPECT Studios

Foundations

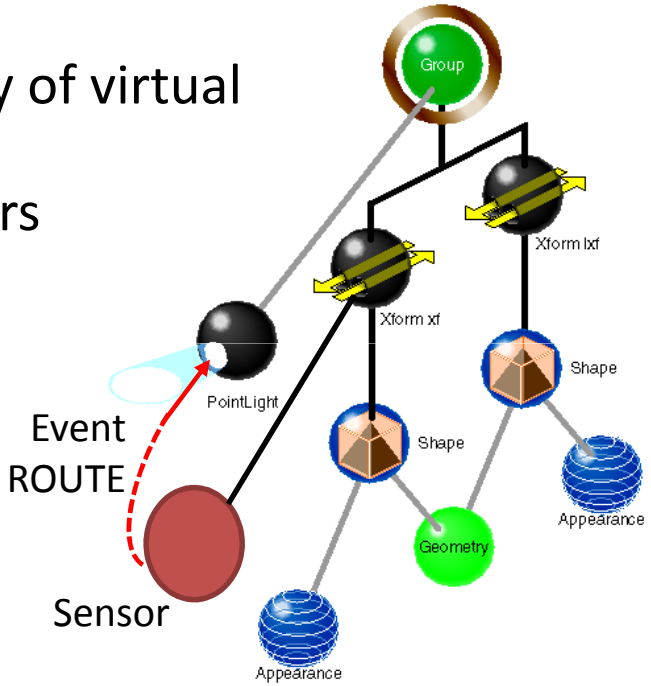
- ISO standard, openly published and royalty-free
- A layer above media and rendering libraries
- Multiple implementations including open source codebases
- X3D Scene graph includes the *Transformation graph* and the *Behavior graph*



Standard Scope

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

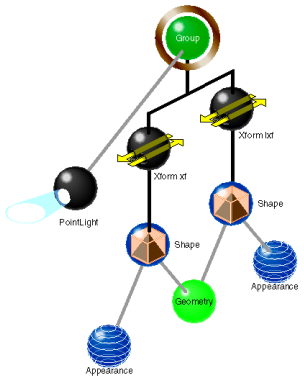
- Meshes, lights, materials, textures, shaders
- Integrated video, audio
- Animation
- Interaction
- Behaviors
- Scripts
- Application Programming Interfaces



- 3.3 examples for Medical Imaging, CAD and Geospatial support!

The Scene graph

- De-constructing Reality to re-construct it in a computer … and present it interactively
- Provides a layer of abstraction above multimedia formats and rendering libraries
- Efficient traversal for manipulation and drawing
- A data representation (Directed Acyclic Graph, DAG) which includes a
  - *Transformation graph* and a
  - *Behavior graph*



Standardized Scenegraph

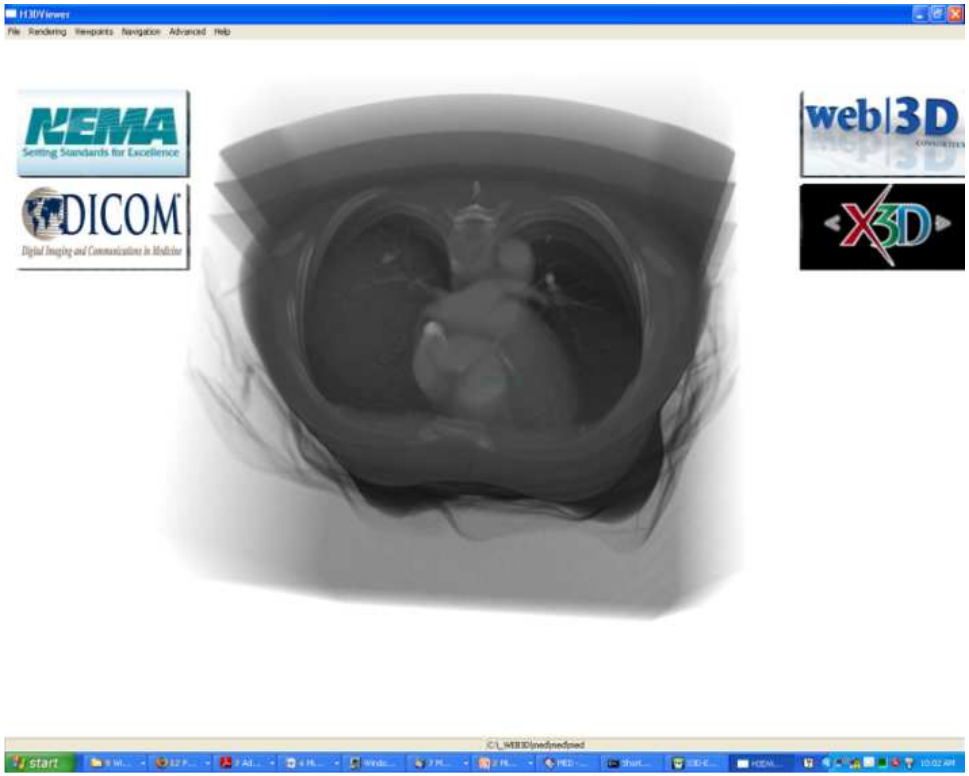
- ***Extensible 3D (X3D):***
  - ISO spec suite describing 4D assets, behaviors and interactive scenarios (scene graph)
  - Extensible: Profiles aggregate Components
  - Multiple Encodings and APIs
- ***Efficiency:*** *Binary encoding, compression*
- ***Fidelity:*** *double precision floats*
- ***Portable:*** Hardware & Platform Independent
- ***Interoperable:*** WWW, Semantic web, …
- ***Durable:*** archive-quality format
- ***Proven:*** Network-aware, Enterprise-ready, Royalty-free

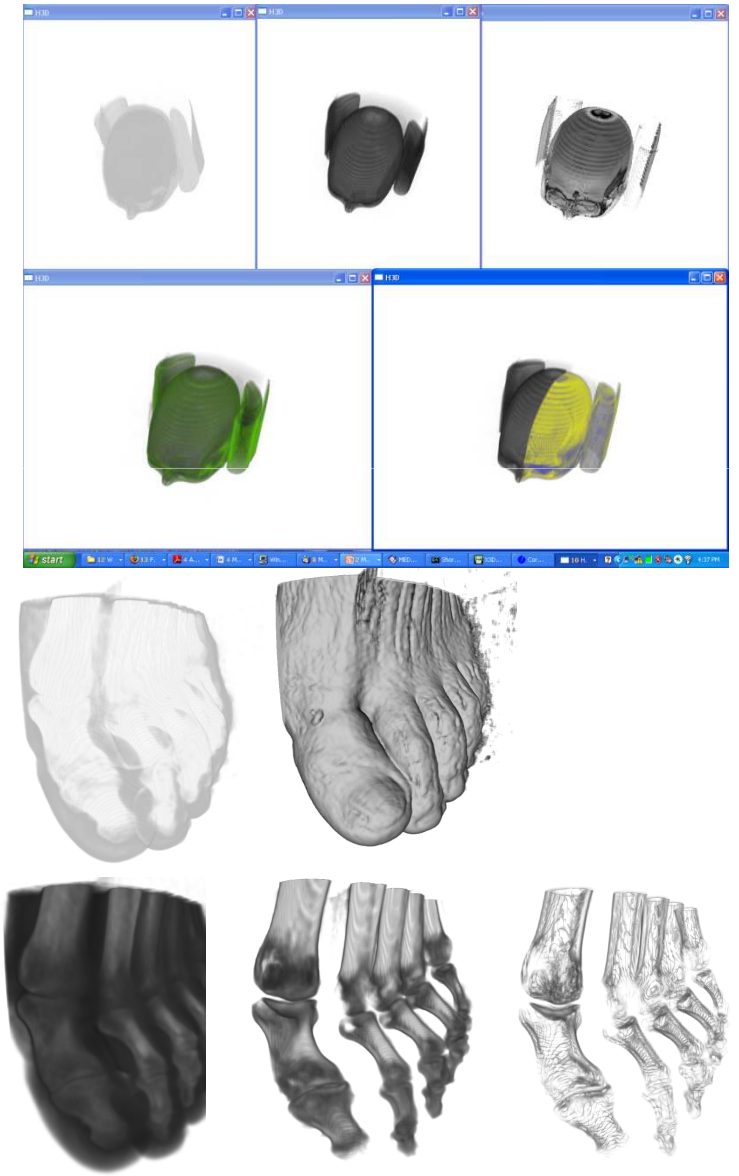
Source of Specs, Models, Links,
Bulleting boards, Blogs, Mailing lists, …

http://www.web3d.org

SIGGRAPH 2010

- N-D Presentation States
- Volume Rendering Component





Perspectives on Web3D

Content publishing:

- Delivery by existing stand-alone app or plug-in
  - See: http://legacy.caus.vt.edu/setareh/archresearch/Module_2/How_to_X3D.html

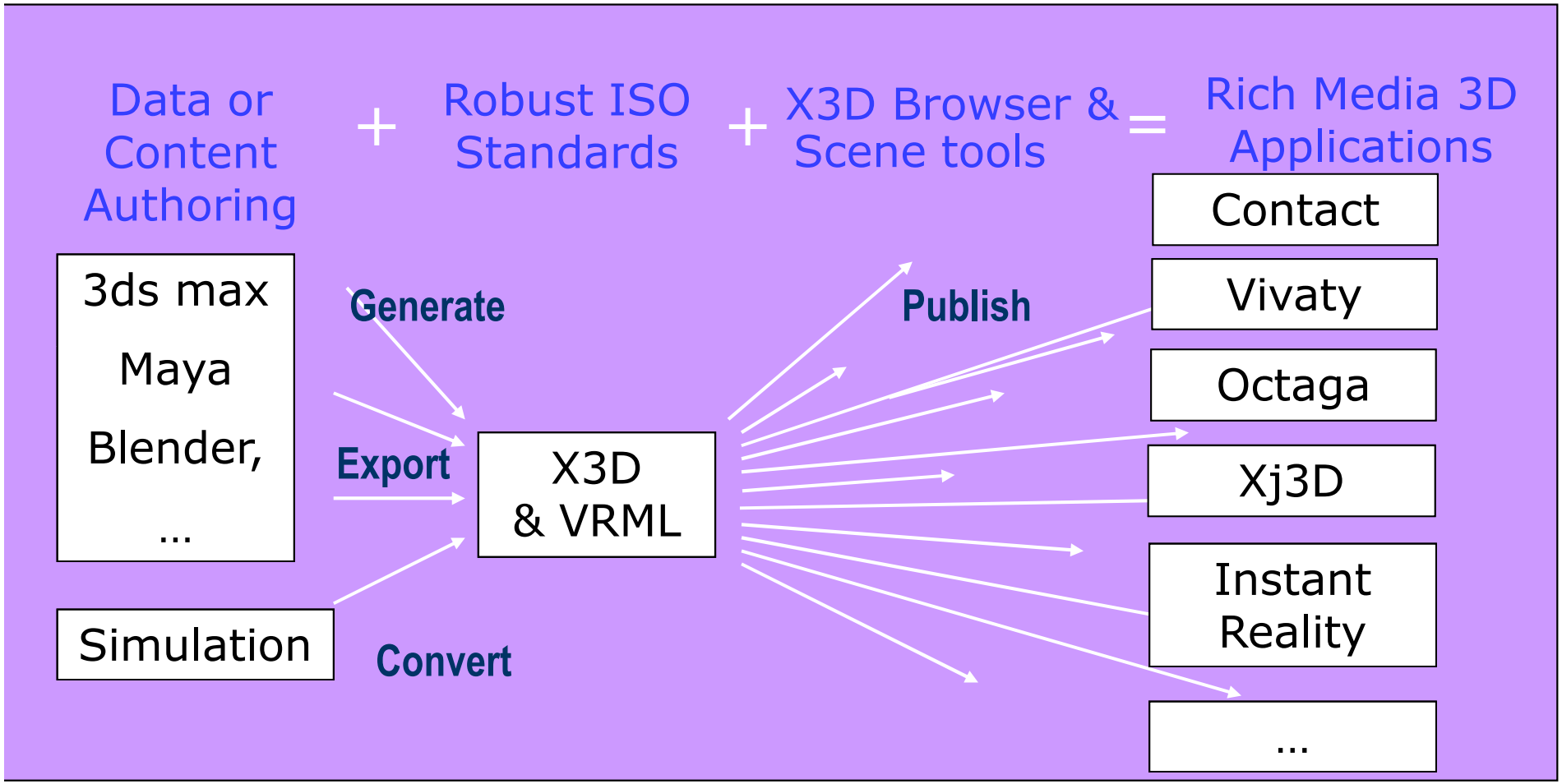
Application Development:

- Integrate a run-time engine into your application (numerous SDKs and codebases)

Web Integration Historically

- A URL/URI resource a piece of 4D content
- Objects, Worlds and media are aggregated with Inlines and connected with Anchors
- Worlds can be dynamically built and served
  (e.g. Web 2.0)
- Worlds can also be included inside HTML pages with <Object> tag and runtimes connects (ecmascript/ajax, Java, …)

Tool Independent Workflow



Explore!

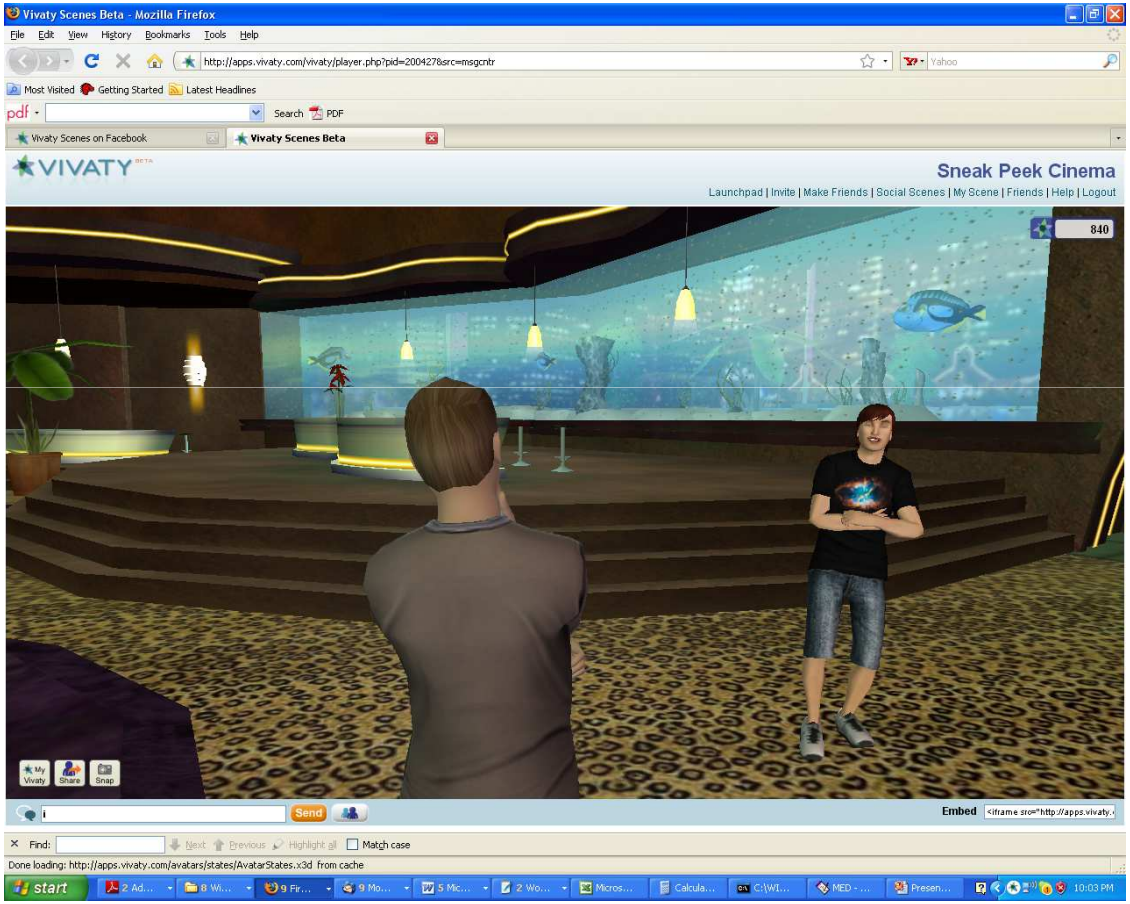
Open up new worlds on the web!

(examples w/ Instant Player)

One place to start now:

http://people.cs.vt.edu/~npolys/IT/2010_bootcamp

Emerging Paradigms



Online, Multi-User Collaborative Spaces

Web Browser Evolution

- Stand-Alone ->
- Plug-in ->
- Native Support via
  - WebGL (ES)
  - Optimize ECMA script
  - www.X3dom.org
  - HTML 5

In dev builds of:

- Mozilla
- Chrome
- Safari
- Opera
- …?

Delivery to Mobiles

Hardware and software profiles are a moving target, but:

- Also expect rendering on top of OpenGL ES
- Likely includes HTML 5 too
- X3D apps on iPhone, Android now (e.g.):
  - Raygun (www.planet9.com)
  - InstantPlayer port
  - …

Remote Cluster Rendering

- Data is too BIG!
- Must analyze *in situ*
- A paradigm reflected in the National Labs, DOE, NSF
- Interactive and Batch sessions possible
- … Athena ! , HokieSpeed !
- GPUs can also be used for general computation (e.g. CUDA, OpenCL)

Virginia Tech ARC Resources

Visual Computing

- Developing new website, currently at:
  - http://Snoid.sv.vt.edu
  - New Immersive Theater (VisCube) available in Visionarium Lab this month !
  - Athena Vis services rolling out this semester

Visual Computing Group

Provide staff to:

- Consult with researchers about applications of visualization technology
- Train faculty and students on how to use, develop, and demo visualization equipment
- Develop visualization solutions for domain experts / HPC users
- Develop additional grants and funding streams with domain experts to include visualization tools and HPC

Visual Computing Group

- Provide ‘World-Class’ visualization facilities for university researchers, faculty, and students
- Build cutting-edge software stack for domains, emphasizing content portability and ease-of-use
- Deploy visualization web services middleware to HPC systems
- Build and maintain online multi-user collaborative spaces
- Upgrade and proliferate display hardware for speed, resolution, and brightness

Facilities / Labs – VT ARC

- ***VT Visionarium*** (TORG 3050)
  - Immersive Theater (VisCube) w/ tracking
  - Stereo wall w/ tracking
  - Stereo TV (65”)
  - 6 x30” tiled display
  - MultiTouch Screen (52”)
  - Video Conferencing
  - lab machines
- Other depts have stereo walls (architecture, art, civil engineering, geo)

Software Stack

Support for many data & disciplines:

- X3D/VRML
- CFD
- CAD
- Architecture
- Molecular Dynamics
- DIVERSE VR (Win, Mac, Linux)
- … documentation available !

Faculty & Student Training

- FDI classes in Visualization Technology & production skills 6-session track run in spring, 2 x 2-session tracks in fall; summer Bootcamp/FDI

- VisCube & Vis Equipment training
  - Operation of, development for
  - Documentation online
  - Free, open to faculty, grad, undergrad
  - by appointment