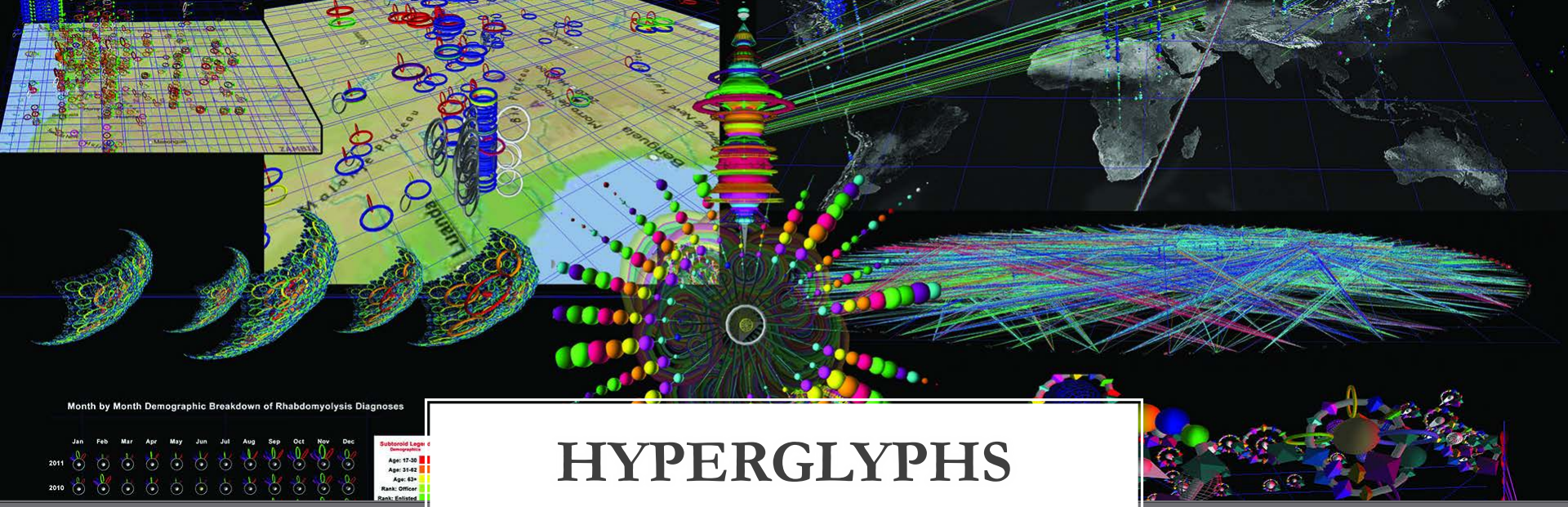



# HYPERGLYPHS

## Exploring the Limits of Glyph Structure to Improve Visual Analytics Methodologies

**Jeff Sale**

Learning Design Technologist

San Diego Supercomputer Center, UC San Diego

PEARC 2018, July 22-26, Pittsburgh, PA

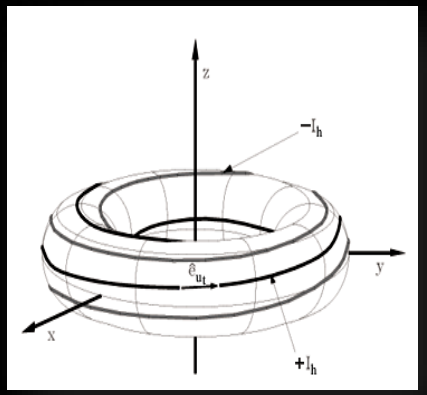
# Agenda

- 1:30-2:00pm: Introduction
- 2:00-2:30pm: Jumping Into It: Hands-On with Hyperglyphs
- 2:30-2:35pm: Break
- 2:35-3:00pm: DIY Hyperglyphs
- 3:00-3:25pm: Simple Link Example
- 3:25-3:35pm: Break
- 3:35-4:00pm: Importing and Visualizing Data
- 4:00-4:30pm: Animations With Channels
- 4:30-5:00pm: Additional Examples:
  - Twitter User Tweet Behavior
  - Hyperdimensional Coordinate System
  - Python Wrapper
  - MySQL Database Interface

# About Me

Born in Canada (becoming an American this month)

B.S., Applied Physics
Emphasis: Condensed Matter ("Solid State Physics")
San Diego State University
Mesa Community College




M.A. Degree
Learning Design and Technology
MOOCs

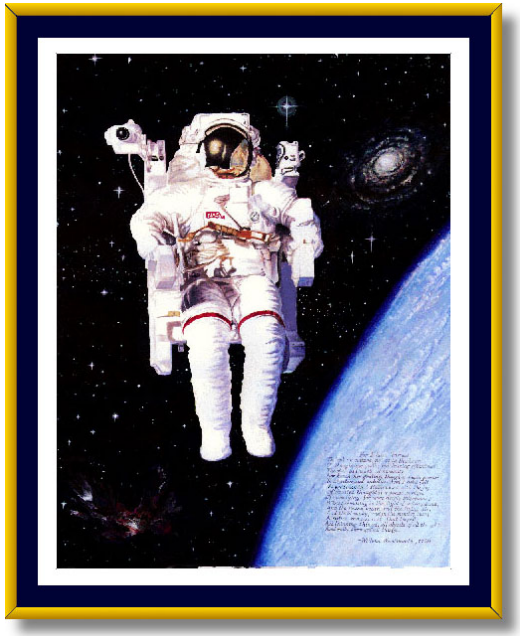
moodle

coursera


Motivation…

# THE JOHN MUIR TRAIL

# Art



# Computational Painting

His art goes up against the wall

By Peter Rowe
Staff Writer

Portrait of a work of art as a young phenomenon.

It stands two stories tall on the wall of a boxy, relentlessly pink apartment building on the east side of Interstate 5. It is a man's head of classical proportions, rendered in three shades of blue, staring intently off to his left, toward Old Town.

It is based on one of Michelangelo's greatest creations, his marble sculpture of David.

It is all yours, San Diego.

"If I had to dedicate it," said the artist, Jeff Sale, "I would dedicate it to San Diego in general. All my experiences in San Diego have been very valuable."

Sale, who describes himself as a "budding artist," is a physics student at San Diego Mesa College, an employee of San Diego Blueprint, an amateur hockey player and something of a philosopher. A Renaissance man — as was his idol, Michelangelo.

"Michelangelo is my hero," said Sale, 27. "He was just such an incredibly great guy when it came to art."

Sale has been dabbling with pencil and paint for years, even before his family moved, after stops in Toronto and Chicago, to San Diego in 1959. But he had never attempted anything on this scale before.

"I just wanted to see if I could do it," he said. "I wanted to say to everybody who saw it, 'This can be done.'"

Selecting his canvas was easy. Sale inhabits one of four apartments in that stunning pink building. "That wall is just so damn ugly. It was just asking to be done."

Selecting a subject, however, was tougher. A woman friend suggested a nude male. His roommate and brother, Rob Sale, and several Baptist neighbors preferred Michelangelo's "Christ on the Cross."

See ART on Page C-2

The San Diego Union/Carol Wonde

Jeff Sale stands in front, top and left photos, of his creation: a rendition of Michelangelo's David on the side of his apartment building near Old Town.

Inside Today





Huge painting highlights apartment building wall — Page C-1.

Fair

Fair today with a temperature range of 47 to 69 degrees along the coast; 37 to 69 degrees inland. Page C-11.

Continued from C-1

Sale's taste led him to reject the first, his religious convictions the second. He believes in God, but is not a Christian. "I was not ready to make that sort of commitment," he said.

David — young man with a sling, psalmist and king — spoke to him more directly, as one of Michelangelo's triumphs and as a product of the Renaissance.

So, for 50 hours, Sale sketched from a photograph of the sculpture. Then he bought a few cheap brushes, two gallons of paint — light "Ice Blue" and dark "Night Blue," mixing them provided the medium tones — borrowed a ladder and set to work.

The painting took a month, although some time was spent correcting early mistakes. "I started from the bottom and worked up," said Sale. "But the drips fell down. So I went to the top and worked down."

He finished in mid-September, but is not entirely satisfied.

"Fixes right and left," he commented. The left eye lacks proper dimension. Pink paint still shows through the right eyebrow.

So says the artist. But an architect, scads of photographers and several wandering art fanciers have dropped by the neighborhood to admire Sale's handiwork. Even his landlord, who had approved the project, likes it.

Sale modestly accepts praise: "I don't consider myself an artist," he said. "I copy things really well. For that reason I think that anyone could do this."

Besides, Sale argued, the artists of today's Renaissance do not necessarily wield paintbrush and palette.

"You can do now with physics what you could do back then with art," he said. "Make a statement about man and his relationship with God."

The expanding universe, quarks, black holes, infinity captured within an atom — physics appeals to his spiritual side. "You just feel close to God learning about this," he said.

But there are times when the interests of science can wait.

# SDSC Education, Outreach, and Training

San Diego Supercomputer Center

TeacherTECH

Sharing Science Technology Tools with Teachers with Educational Science Series Seminars, Hands-On Technology Workshops & User Groups

StudentTECH

The Discover DATA Portal

SDSC A San Diego Supercomputer Center Education Portal

CS-CAVE

Creating a Village of CS Educators

Alice

Learn to Program with Interactive 3D Graphics

a free gift to you from Carnegie Mellon

CS-CAVE Supports Many Options for CS and CSP Education

Computer Science Unplugged

Arduino

Raspberry Pi

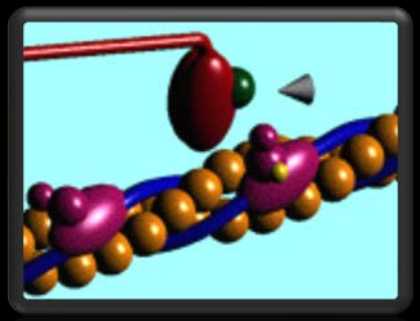
3D Printing

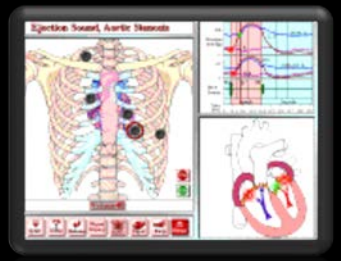
HOUR OF CODE

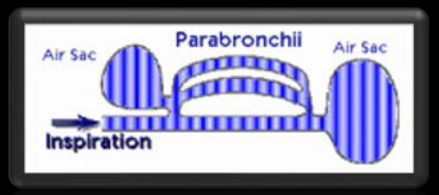
CODE COMBAT

CODE YOUR OWN FLAPPY GAME

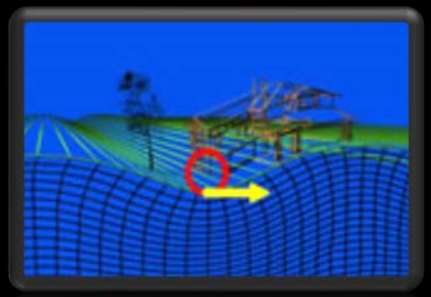
# Models and Simulations for Learning

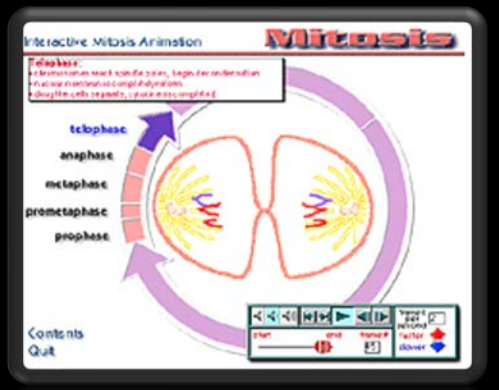


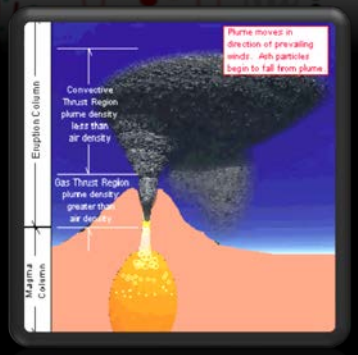


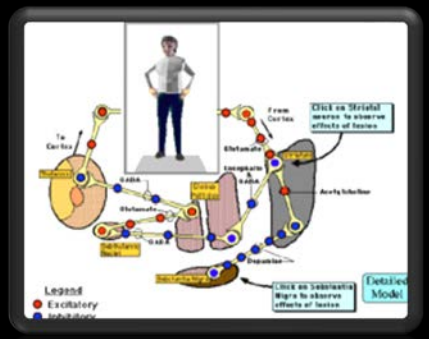


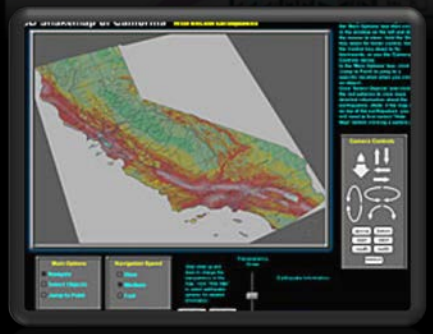






# Virtual Reality in Medicine

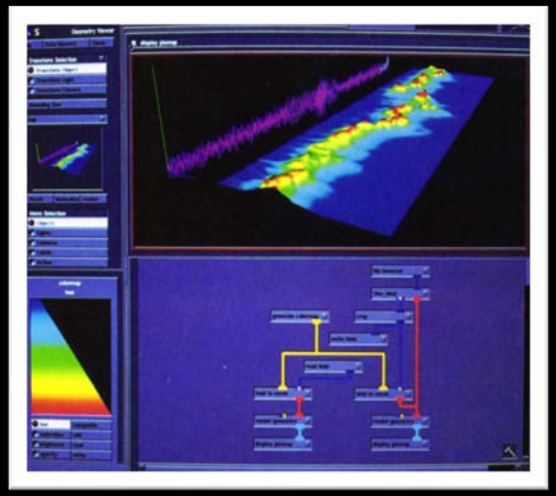
## Quantitative Assessment

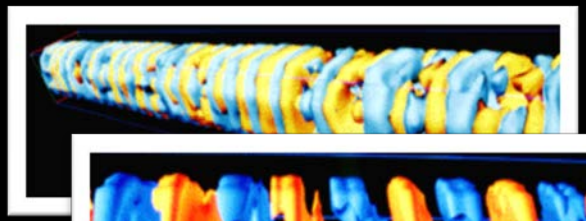
Used the 'Data Glove' to study:

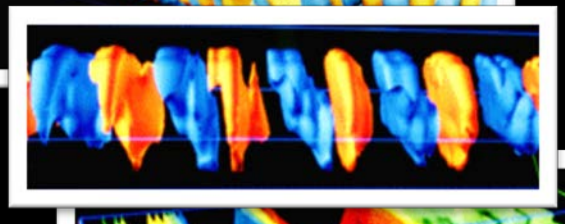
- Parkinson's Disease,
- Lou Gehrig's Disease (ALS),
- Huntington's Disease

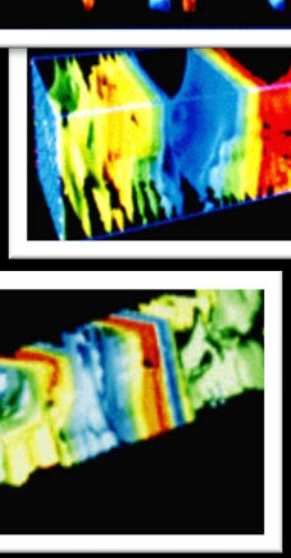
# Data Visualization

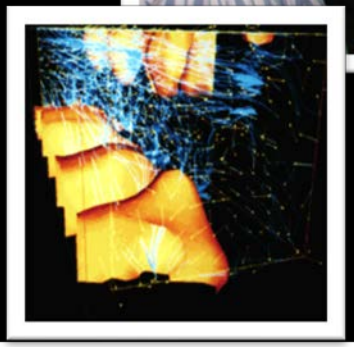
Compressed Dimensional Arrays
EEG, ECG Spatiotemporal Isosurfaces

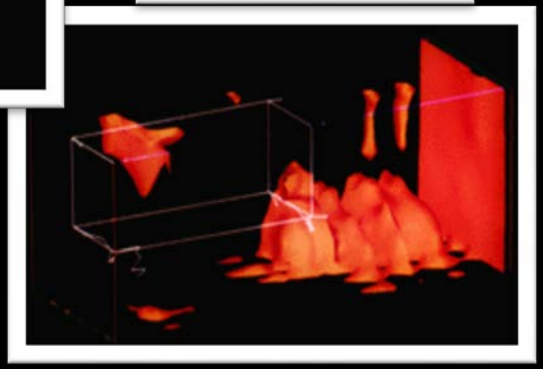












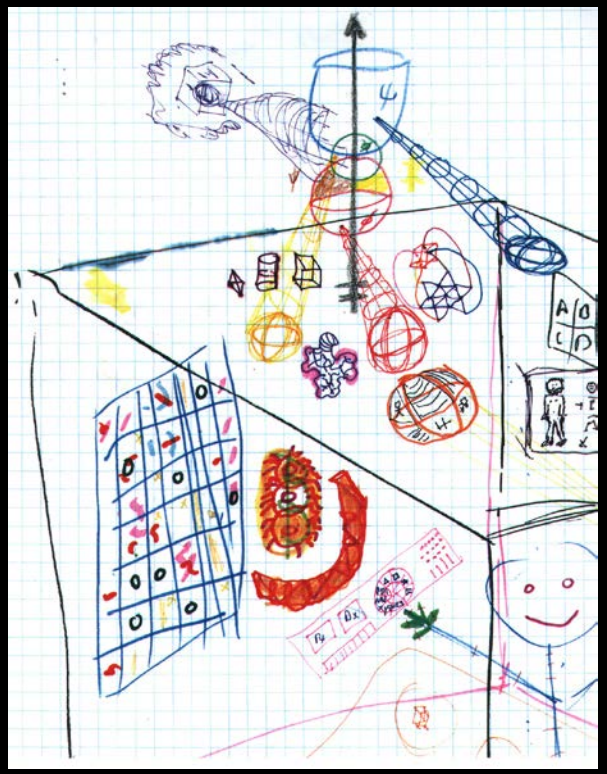
# Dave Warner, the Visionary

M.D., Ph.D, Loma Linda University, "To Make Man Whole"

- Nason Fellow, Syracuse University (Advisor, Dr. Geoffrey Fox)
- Civilian-Military Communications
  - Bridging the Gaps

Perceptual Cybernetics

"Mind-in-the-Loop"



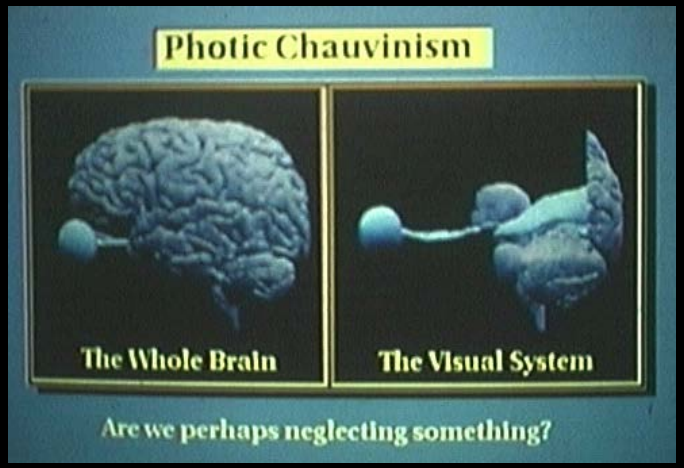
# Perceptual Cybernetics

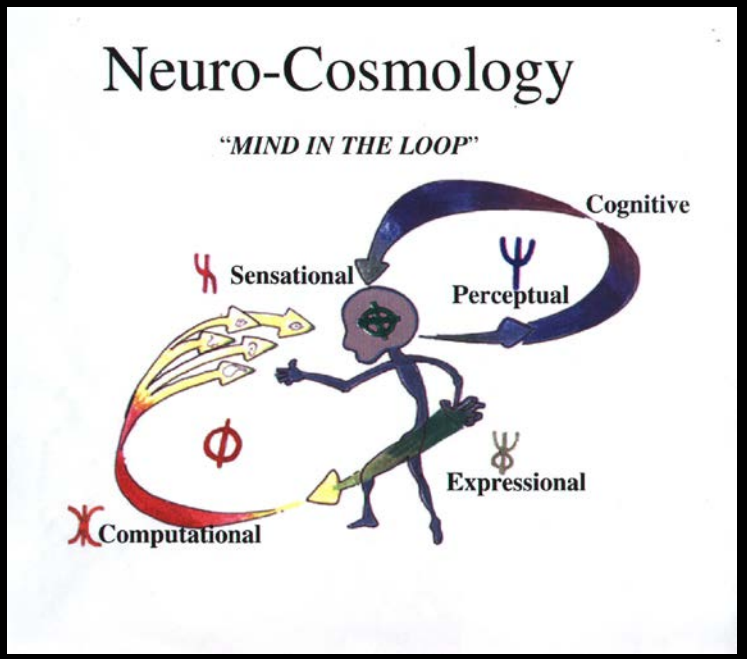
Mark Pesce* Gives Credit to PC in Landmark Paper

- PSI
- PHX
- PHI

"Mind in the Loop"

http://hyperreal.org/~mpesce/interview.html
http://hyperreal.org/~mpesce/fa.html




*Developer of Virtual Reality Markup Language (VRML)

# The Neurology Research Team (NRT)

**The 'NRT' Lab,** "As opposed to INERT!"

**Dr. Doug Will,** Chair, Neurology,
Dean, LLU School of Medicine

Dave Warner

Steve Price

Jeff Sale

Dave Gilsdorf

**Jodi Reed***

**My better half*

Patrick Keller

Bill Rojas

Markus Schmidt

Rik Rusovic

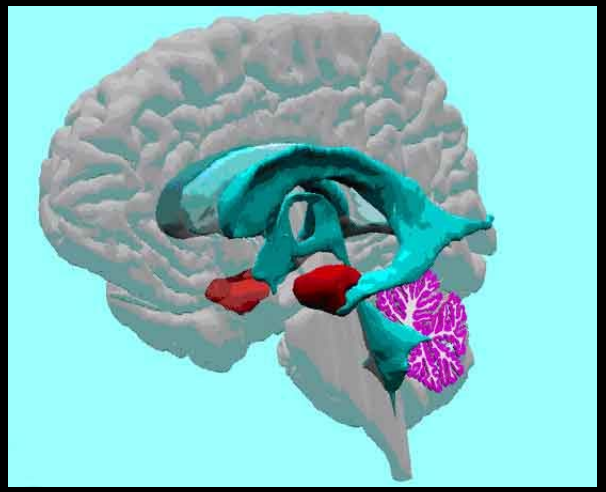
Steve Birch

Alan Barnum-Scrivener

# Medical Education Technology

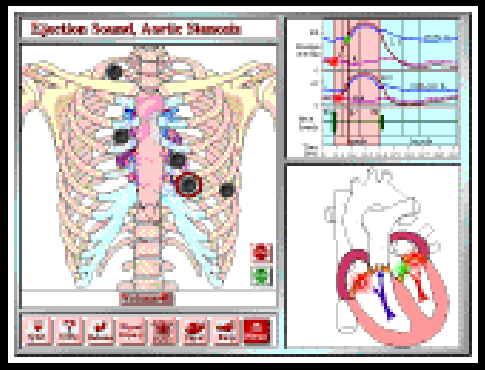
## VR for Anatomy Instruction

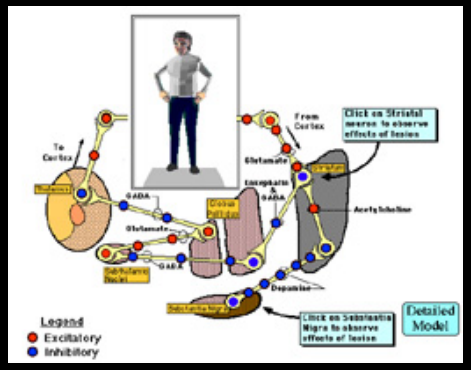
- The Visible Human
- The Digital Anatomist (University of Washington)

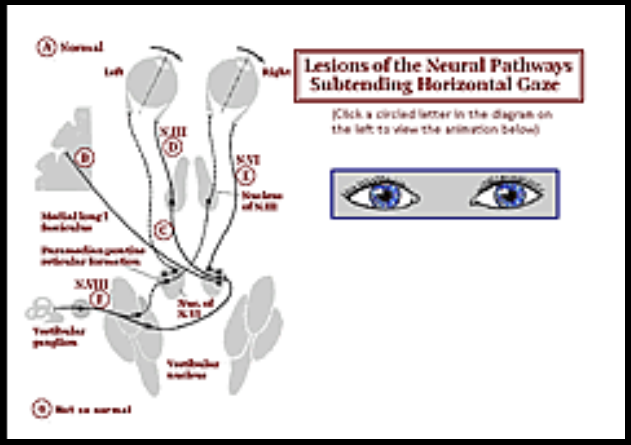


## Interactive Courseware

- Heart Auscultation
- Neuropathology of Movement Disorders
- Neuropathology of Gaze Disorders



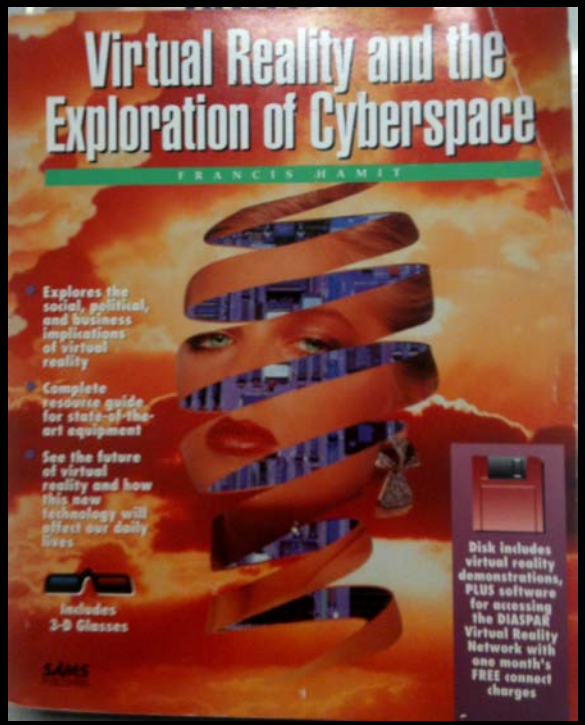
# VR in the Clinic

Augmented communication
Environmental Control
Quantitative Assessment



# James Clark Visits the NRT Lab

SGI Hires Craig Upson, Developer of AVS
Wants to recreate AVS for SGI Platform with Clinical emphasis





# Center for Really Neat Research

VR in the Clinic
Medical Education Technology
Interventional Informatics
Perceptual Cybernetics

The Institute for Interventional Informatics

PULSAR PROJECT

Improving quality of life in Education, Recreation, Communication, and Health Care

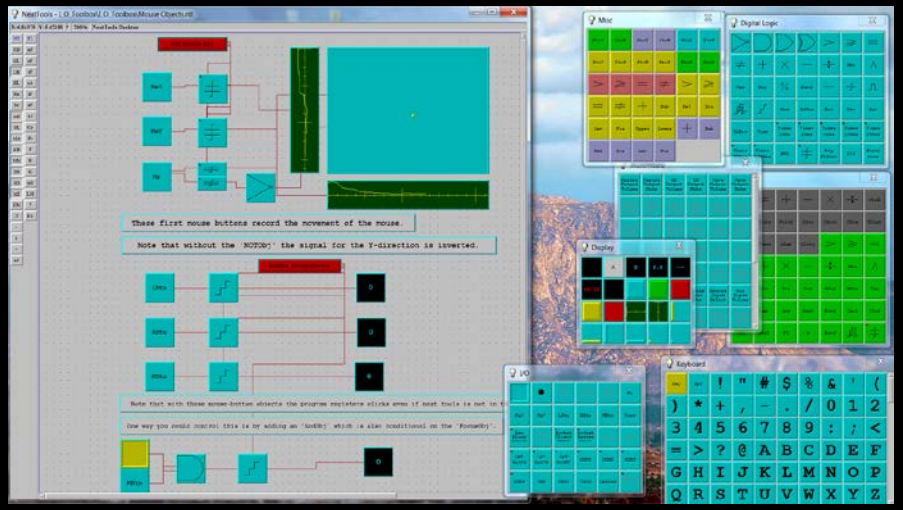
# Cyberarium

Nason Fellowship

Syracuse University, under Dr. Geoffrey Fox

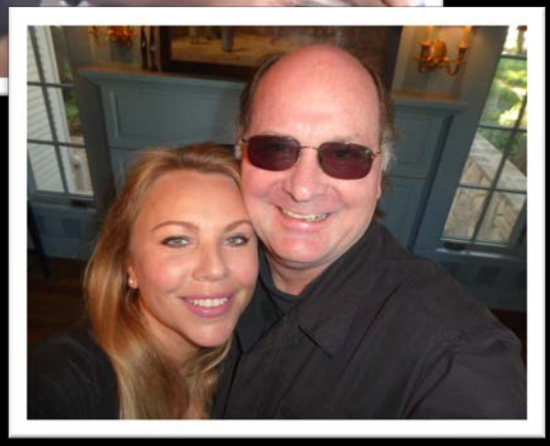
- Yuh-Jye Chang, Ph.D.
  - NeatTools Developer

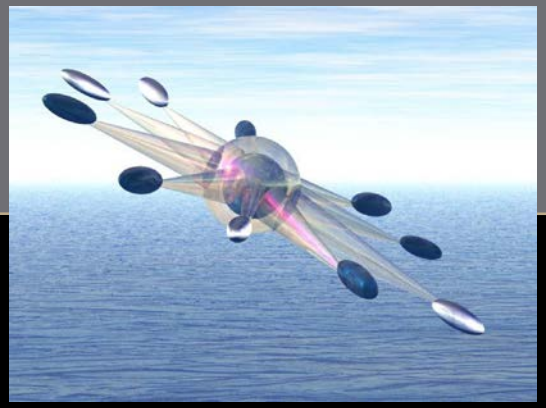
Dr. Ed Lipson, Chair, Physics

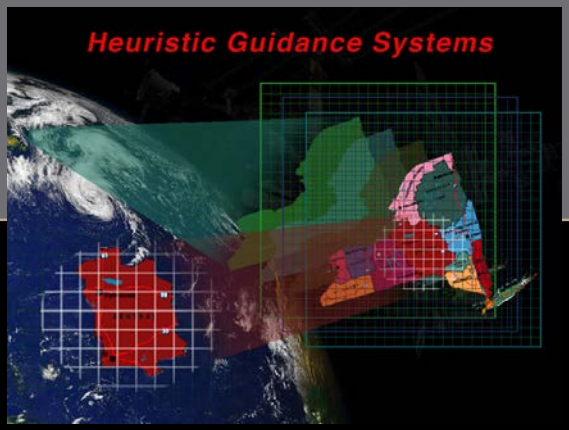


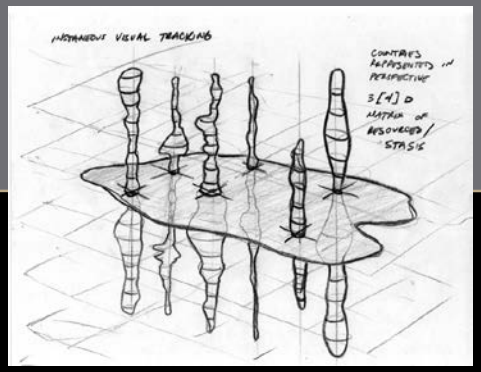
# Humanitarian Communications Operations

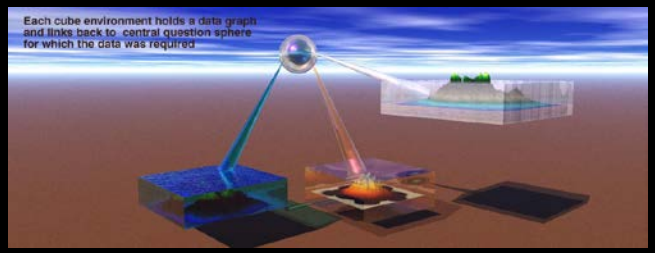


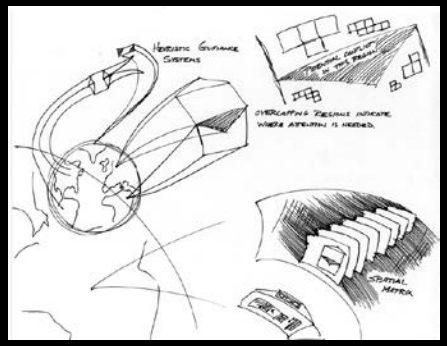


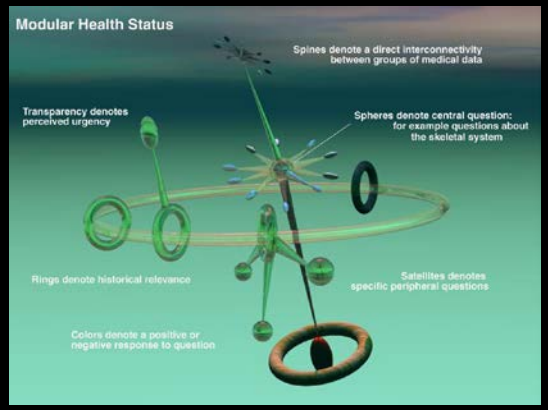

Heuristic Guidance Systems

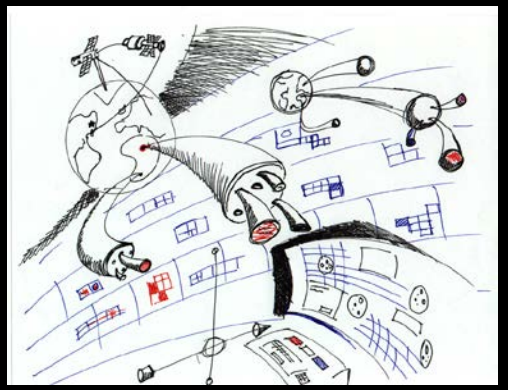

INSTANTANEOUS VISUAL TRACKING
CONTRACTS REPRESENTED IN PERSPECTIVE
3[4] D
MATRIX OF RESOLVED/ STASIS


Each cube environment holds a data graph and links back to central question sphere for which the data was required


Political
Military
Civic
Environmental


HEURISTIC GUIDANCE SYSTEMS
OVERLAPPING REGIONS INDICATE WHERE ATTENTION IS NEEDED.
SPATIAL MATRIX


Modular Health Status
Spines denote a direct interconnectivity between groups of medical data
Transparency denotes perceived urgency
Spheres denote central question: for example questions about the skeletal system
Rings denote historical relevance
Satellites denotes specific peripheral questions
Colors denote a positive or negative response to question

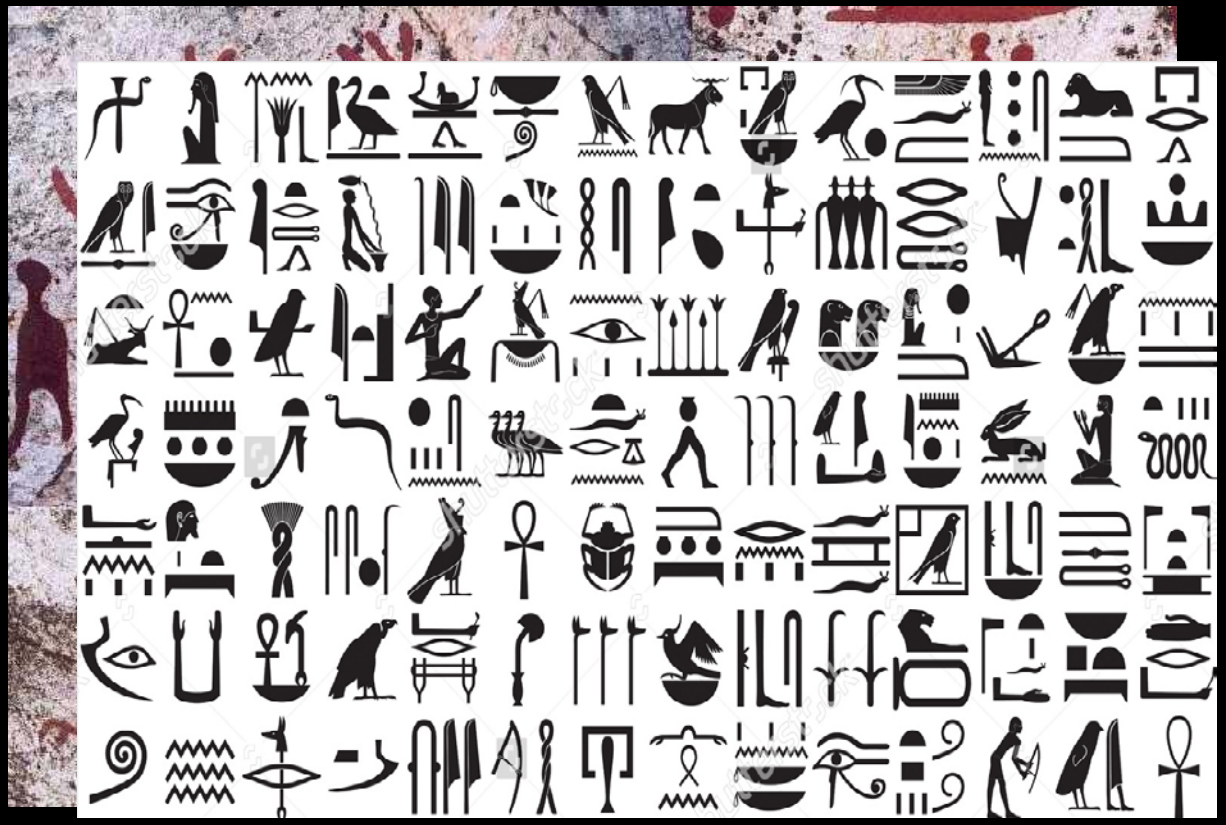


# SynGlyphX, A Spinoff Start-Up

# Brief History of Glyphs

Petroglyphs

# Brief History of Glyphs



Heiroglyphs

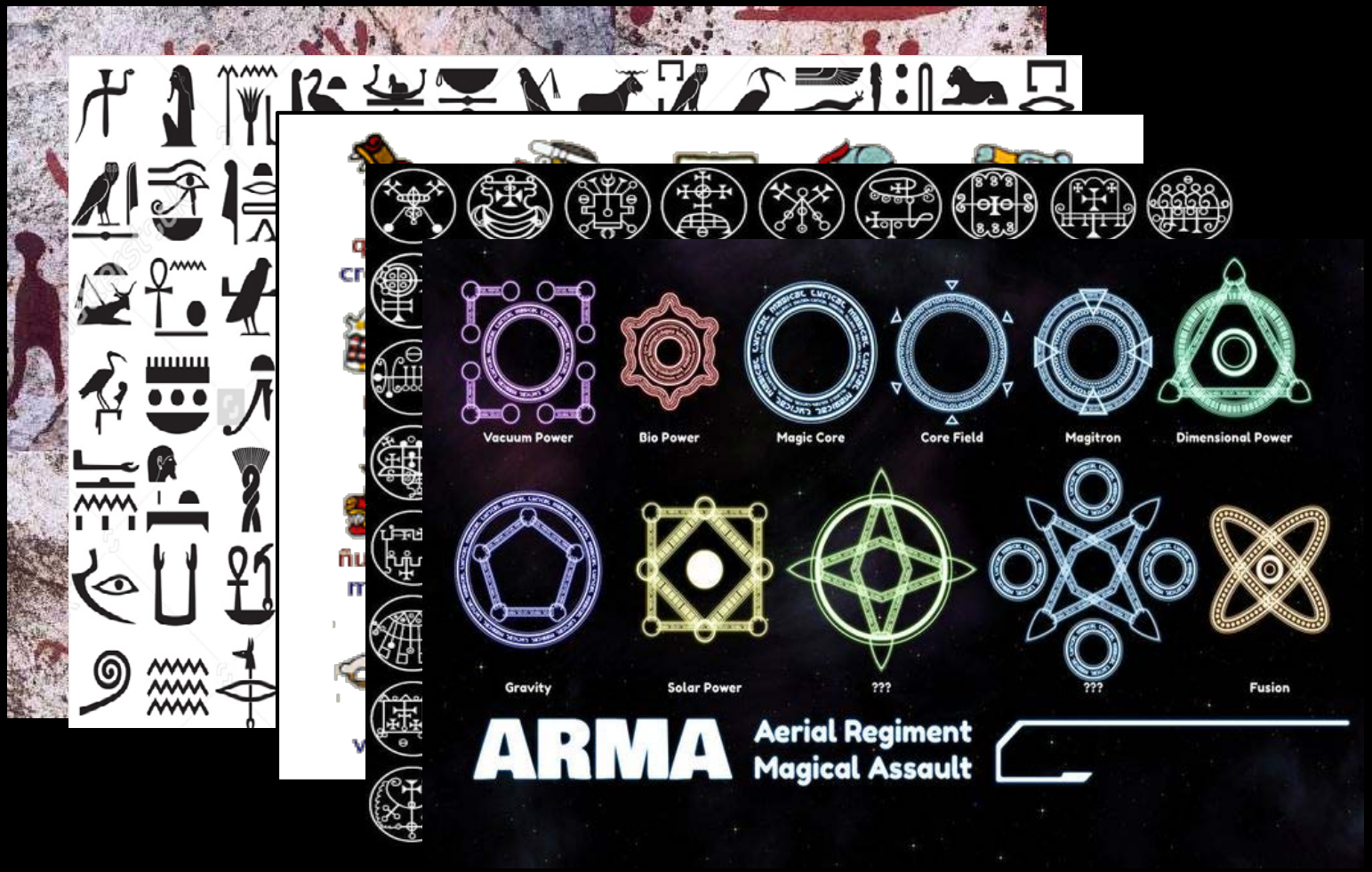
# Brief History of Glyphs


Mayan Glyphs

# Brief History of Glyphs

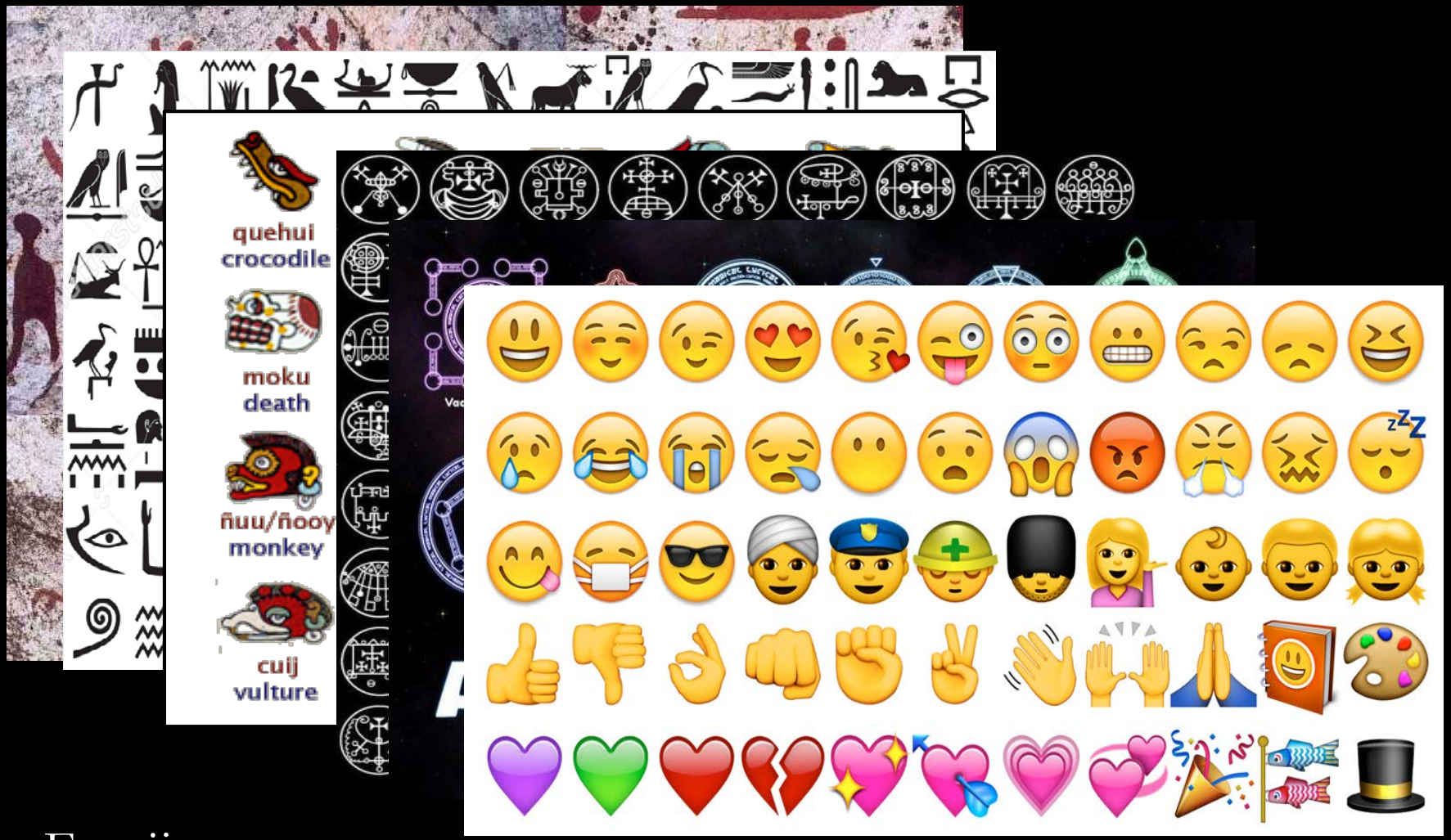
Mystical (Enochian) Glyphs

# Brief History of Glyphs



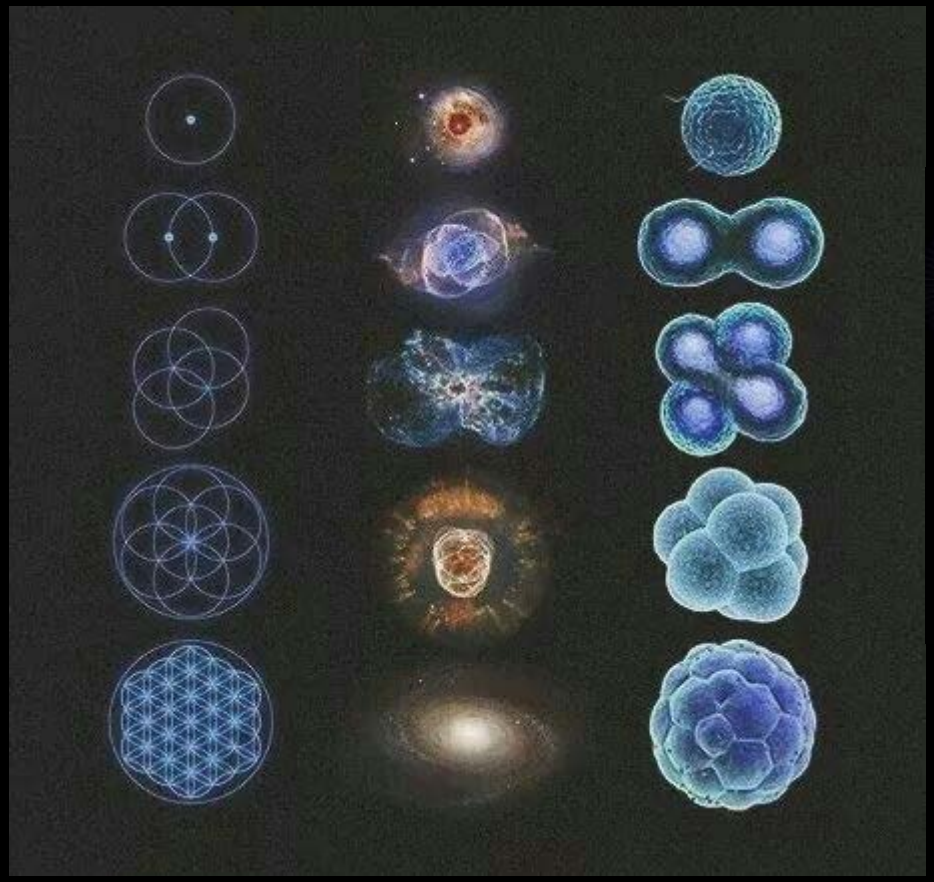

Video Game "Power" Glyphs

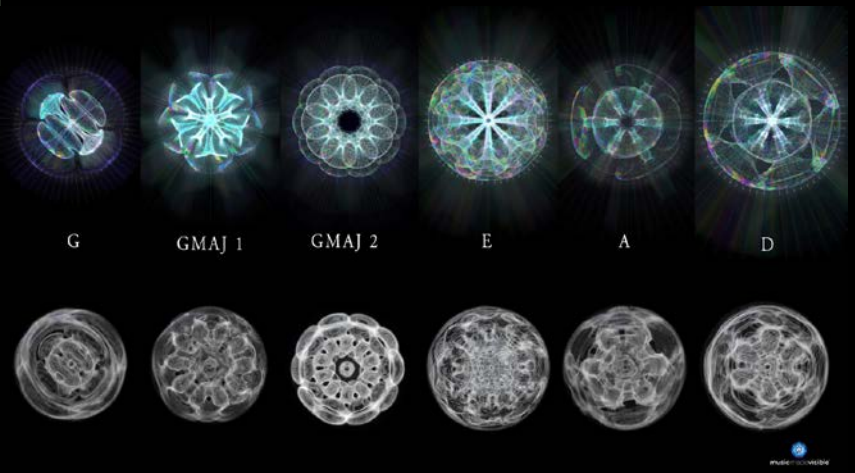
# Brief History of Glyphs




Emojis

# Nature Emulates Math





# What is a Glyph?

## From Wikipedia:

"In typography, a **glyph** /ˈglɪf/ is an elemental symbol within an agreed set of symbols, intended to represent a readable character for the purposes of writing. "

**(No reference to glyphs in visualization)**

## From a Google search, "What is a glyph?":

**1**. a hieroglyphic character or symbol; a pictograph.

"flanges painted with esoteric glyphs"

**2**.

ARCHITECTURE

an ornamental carved groove or channel, as on a Greek frieze.

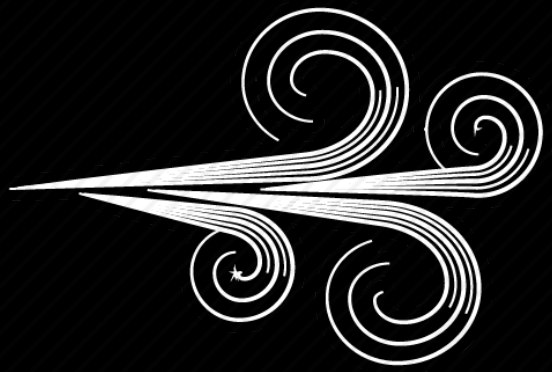

Use of the term "glyph" over time

# A Glyph is related to...

**Grapheme**: In linguistics, a **grapheme** is the smallest unit of a writing system of any given language.[1]

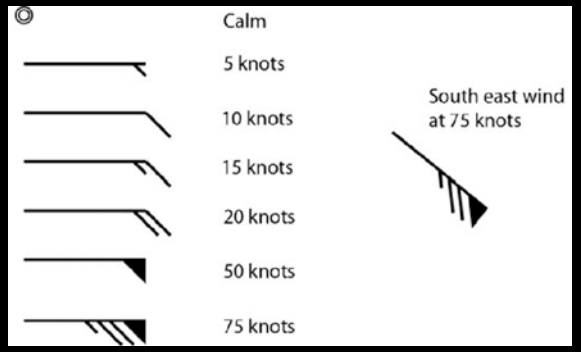
**Morpheme**: In linguistics, a **morpheme** is the smallest grammatical unit in a language.

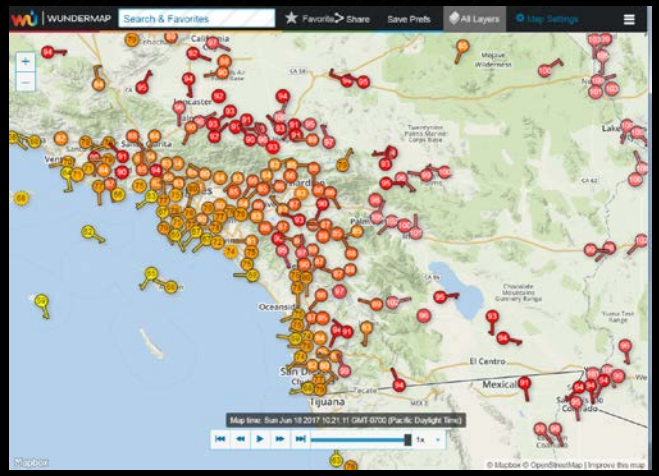
# A Classic: The Wind Glyph

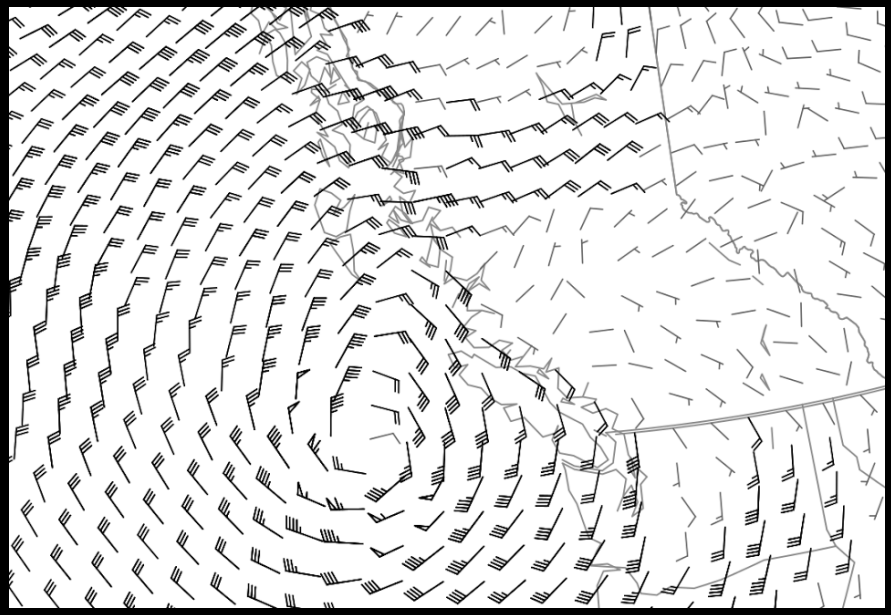


# A Classic: The Wind 'Barb' Glyph

Wind **Speed** and **Direction**



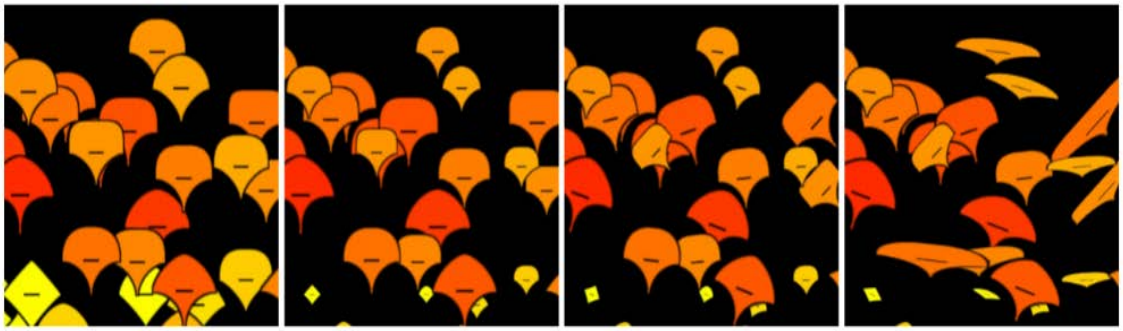
# PREVIOUS WORK INSPIRING THIS WORK

## Critical Design and Realization Aspects of Glyph-based 3D Data Visualization

Andreas E. Lie*
University of Bergen
Norway, www.ii.UiB.no/vis

Johannes Kehrer†
University of Bergen
Norway, www.ii.UiB.no/vis

Helwig Hauser‡
University of Bergen
Norway, www.ii.UiB.no/vis



(a) Two data attributes are represented as the upper / lower glyph shape

(b) Added data attribute to overall glyph size

(c) Glyph rotation has been assigned a data attribute as well

(d) A data attribute has been assigned to glyph aspect ratio

Figure 1: Adding more attributes to the glyph, while preserving the glyph's orthogonality.

### Abstract

Glyphs are useful for the effective visualization of multi-variate data. They allow for easily relating multiple data attributes to each other in a coherent visualization approach. While the basic princi-

resulting datasets are 3D instead of 2D, time-dependent instead of single time step, only, and multi-variate with many values per space-time location, to name just three of more recent properties (which soon will be standard in many cases). This means that not only the large size of simulation datasets is challenging, but also its complexity. With this, it is getting more important and more

# PREVIOUS WORK INSPIRING THIS WORK



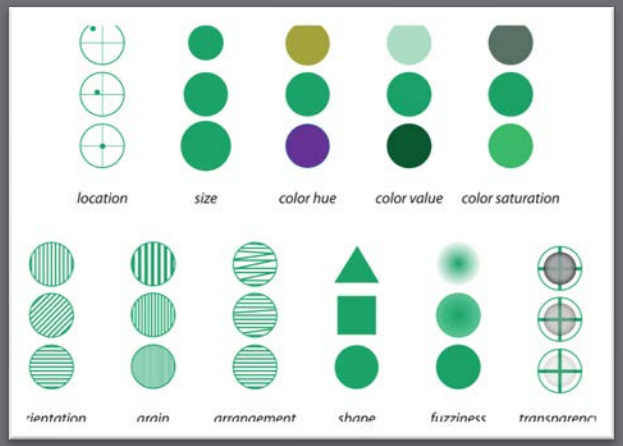
## Glyph-based Visualization: Foundations, Design Guidelines, Techniques and Applications

R. Borgo[1], J. Kehrer[2], D. H. S. Chung[1], E. Maguire[3], R. S. Laramee[1], H. Hauser[4], M. Ward[5] and M. Chen[3]

[1] Swansea University, UK; [2] University of Bergen and Vienna University of Technology, Austria; [3] University of Oxford, UK; [4] University of Bergen, Norway; [5] Worcester Polytechnic Institute, USA

**Abstract**

*This state of the art report focuses on glyph-based visualization, a common form of visual design where a data set is depicted by a collection of visual objects referred to as glyphs. Its major strength is that patterns of multivariate data involving more than two attribute dimensions can often be more readily perceived in the context of a spatial relationship, whereas many techniques for spatial data such as direct volume rendering find difficult to depict with multivariate or multi-field data, and many techniques for non-spatial data such as parallel coordinates are less able to convey spatial relationships encoded in the data. This report fills several major gaps in the literature, drawing the link between the fundamental concepts in semiotics and the broad spectrum of glyph-based visualization, reviewing existing design guidelines and implementation techniques, and surveying the use of glyph-based visualization in many applications.*



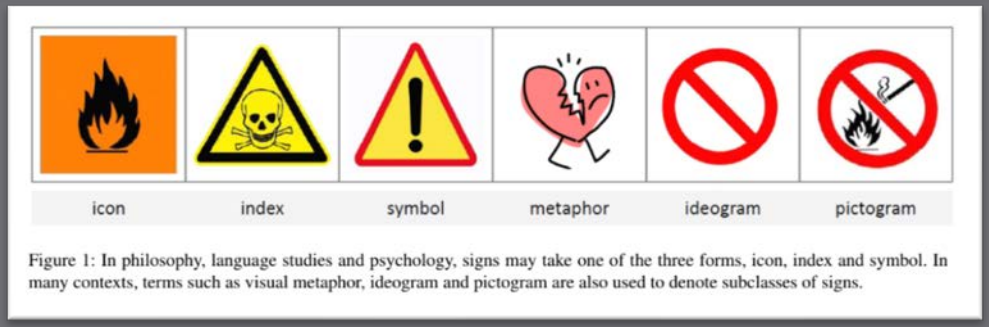




Figure 1: In philosophy, language studies and psychology, signs may take one of the three forms, icon, index and symbol. In many contexts, terms such as visual metaphor, ideogram and pictogram are also used to denote subclasses of signs.

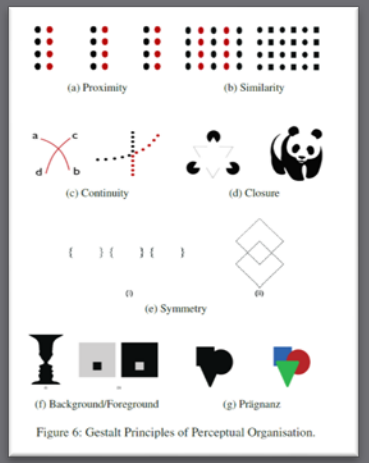



Figure 6: Gestalt Principles of Perceptual Organisation.

# Visual 'Channels'

| Geometric Channels | Optical Channels | Topological and Relational Channels | Semantic Channels |
|---|---|---|---|
| • size / length / width / depth / area / volume<br>• orientation / slope<br>• angle<br>• shape<br>• curvature<br>• smoothness | • intensity / brightness<br>• colour / hue / saturation<br>• opacity / transparency<br>• texture (partly geometric)<br>• line styles (partly geometric)<br>• focus / blur / fading<br>• shading and lighting effects<br>• shadow<br>• depth (implicit / explicit cues)<br>• implicit motion / motion blur<br>• explicit motion / animation / flicker | • spatial location<br>• connection<br>• node / internal node / terminator<br>• intersection / overlap<br>• depth ordering / partial occlusion<br>• closure / containment<br>• distance / density | • number<br>• text<br>• symbol / ideogram<br>• sign / icon / logo / glyph / pictogram<br>• isotype |

Table 1: Visual Channels [CF12].

# Glyph Design Criteria

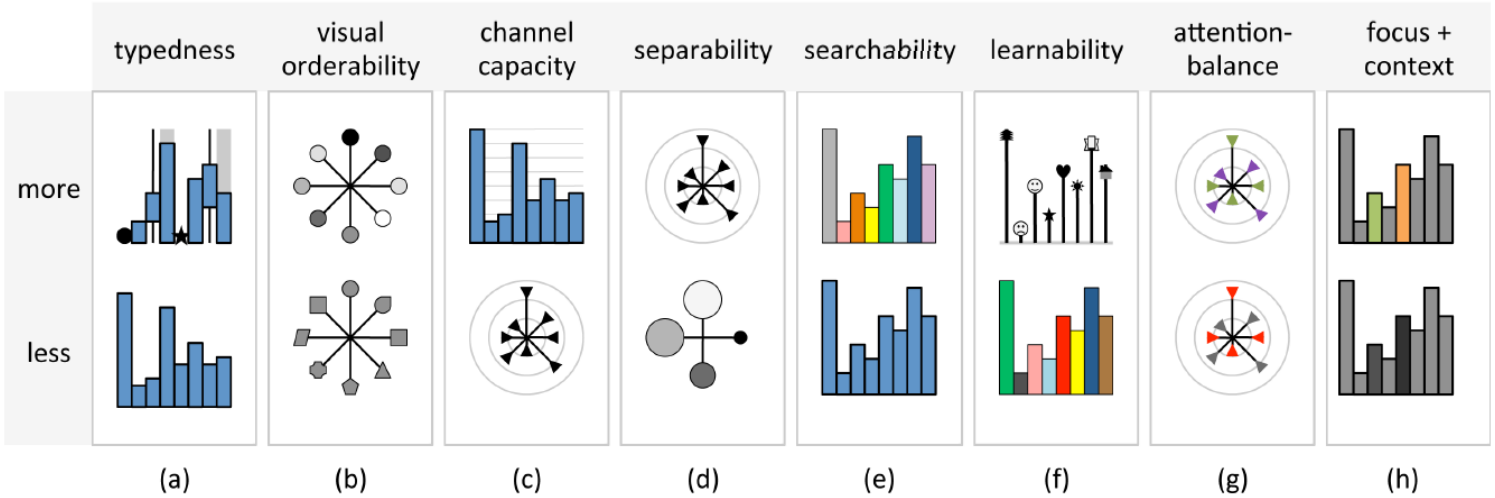
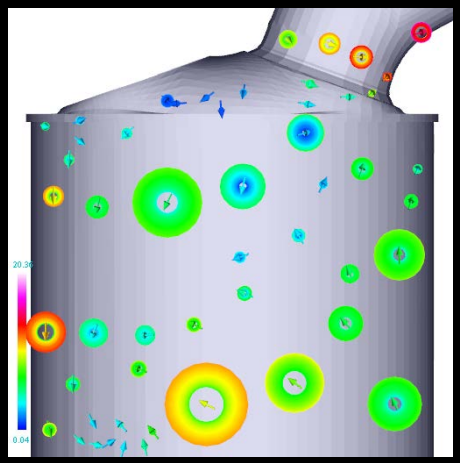
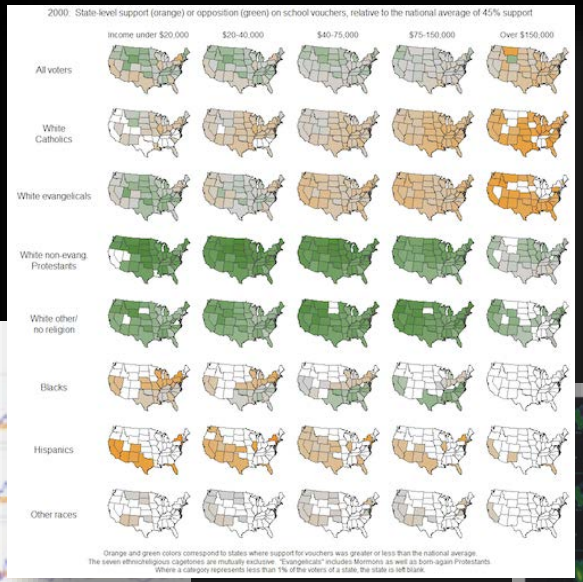


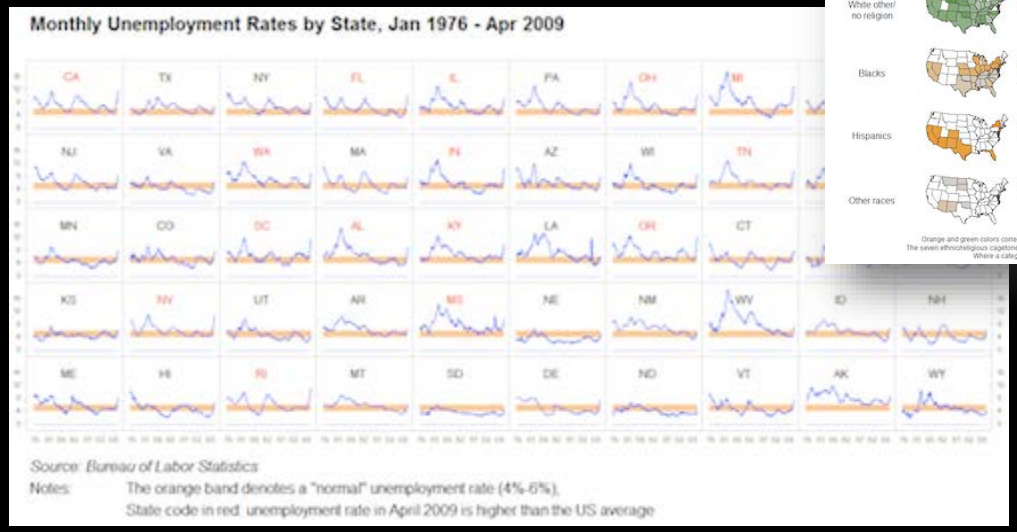

Figure 7: Glyph design criteria [CLP*13].

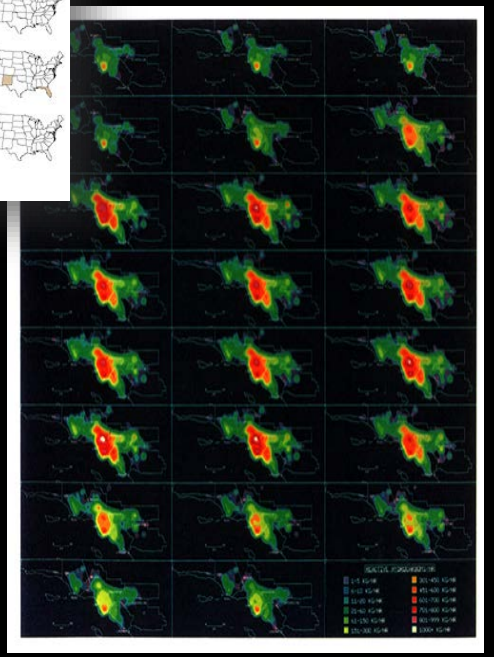


# Principle of Small Multiples

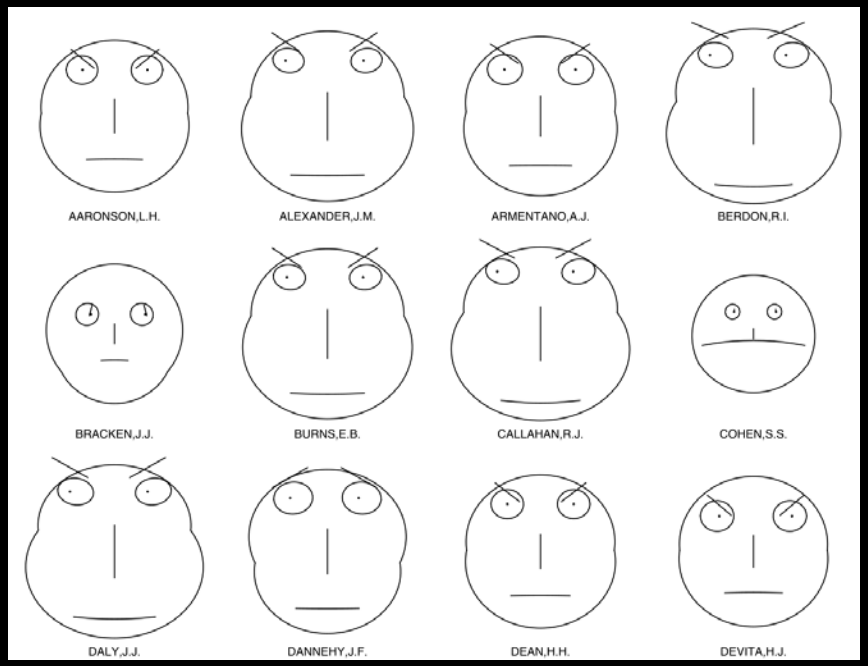
Edward Tufte, Viz Pioneer

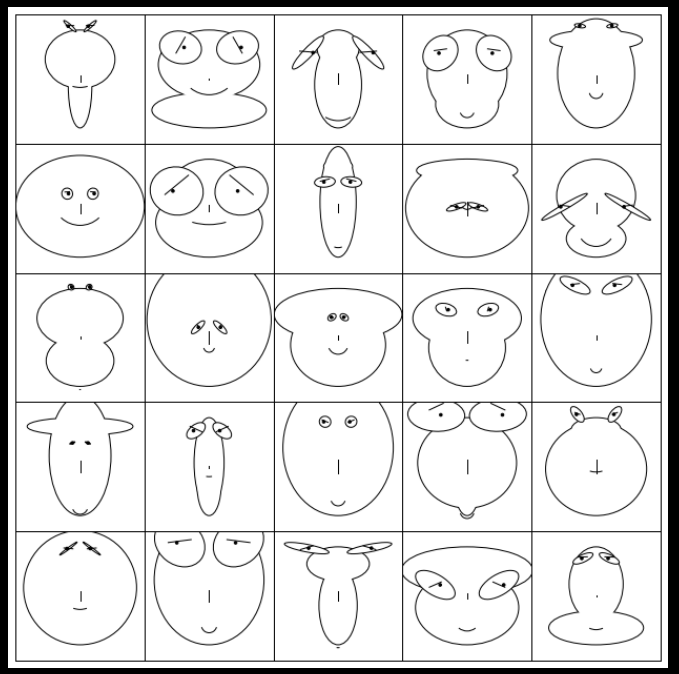


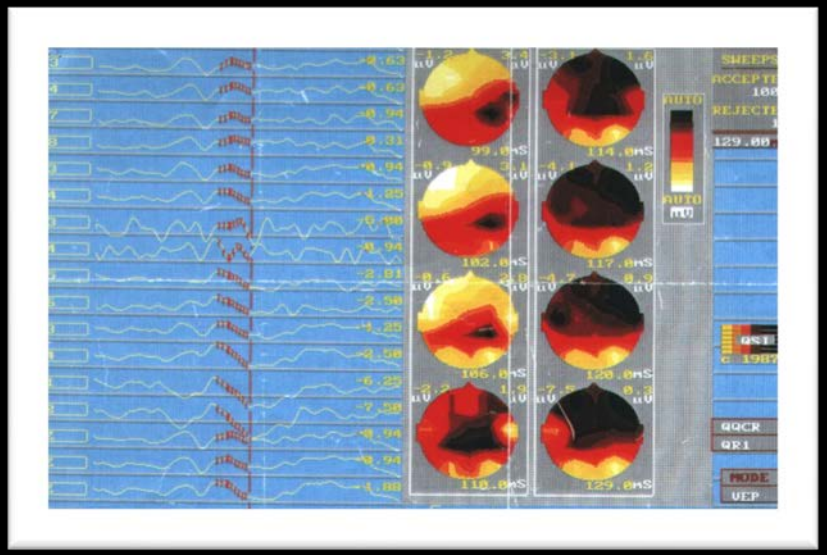
# Chernoff Faces

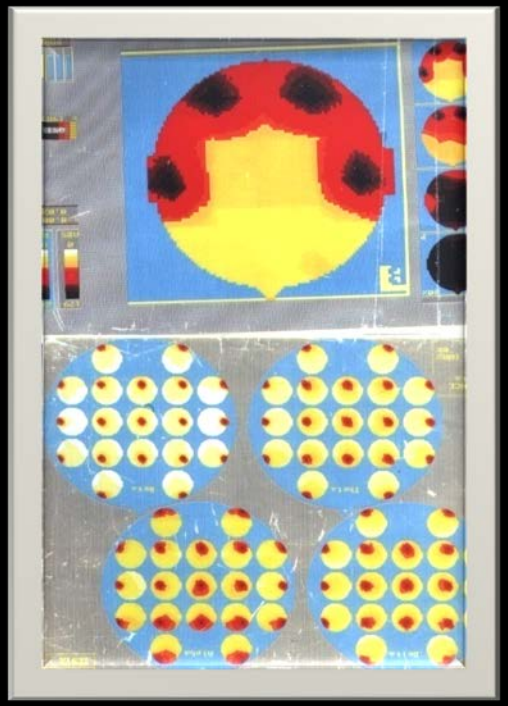


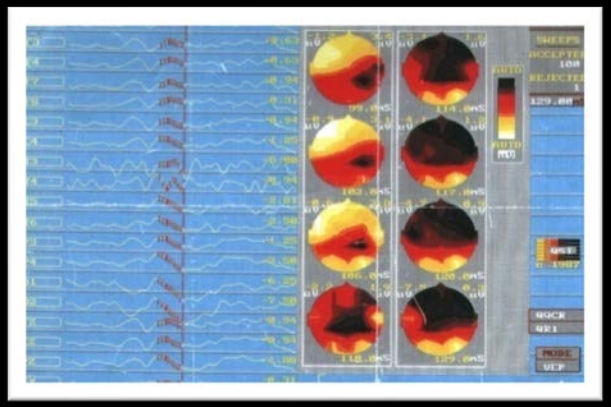
# Spatiotemporal Isosurfaces

Visualization of a 2-dimensional dataset changing with time

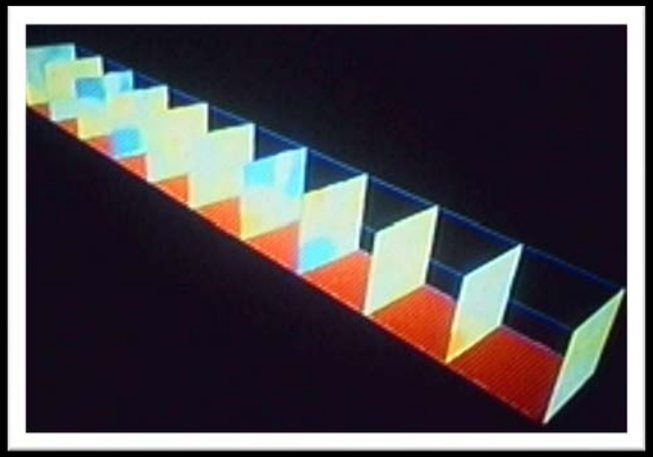


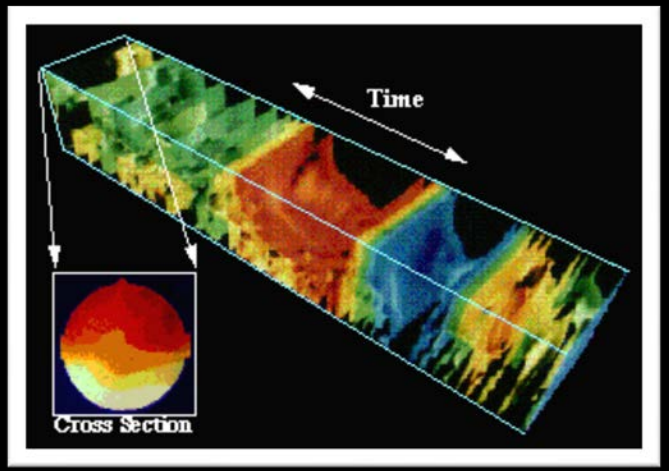



# EEG Spatiotemporal Isosurfaces



Create a stack of 2D Dataset 'Slices' to form a 'Loaf of Break'
Use a visualization tool to create EEG 'Isopotential' Contour Surfaces



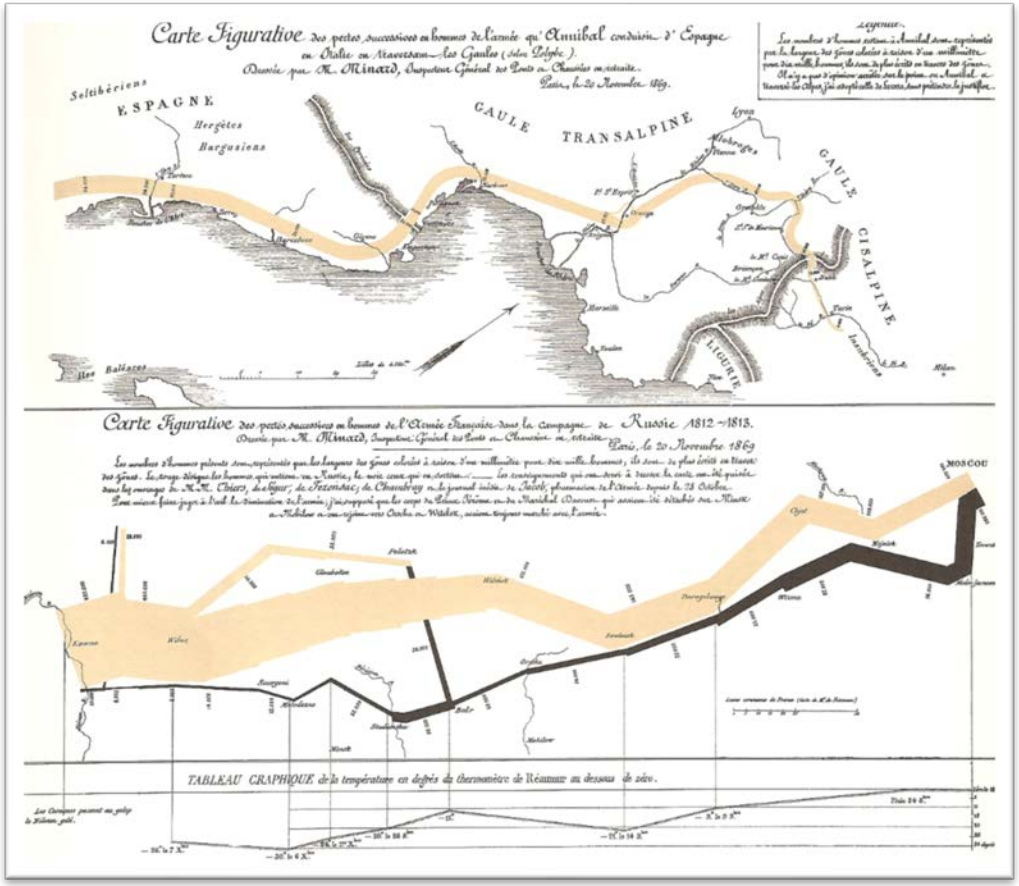


# Narratives in Space and Time

- **Hannibal's campaign in Spain, Gaul, and northern Italy**

- **Napoleon's March on Moscow, 1812-13**

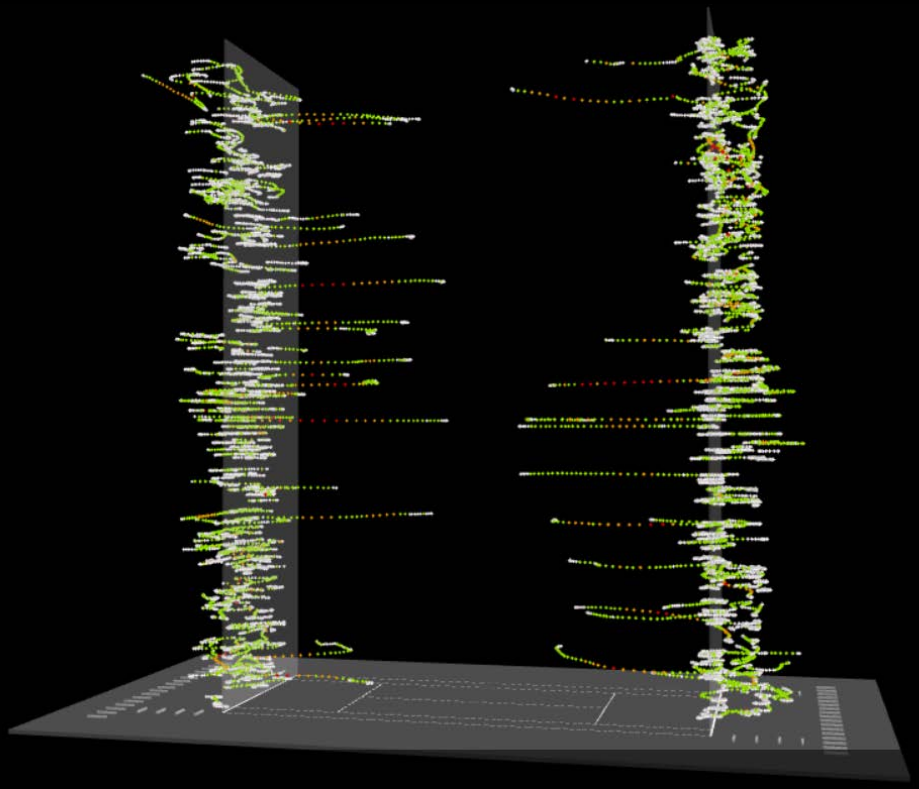
Charles Joseph Minard, Tableaux Graphiques et Cartes Figuratives de M. Minard, 1845-69.

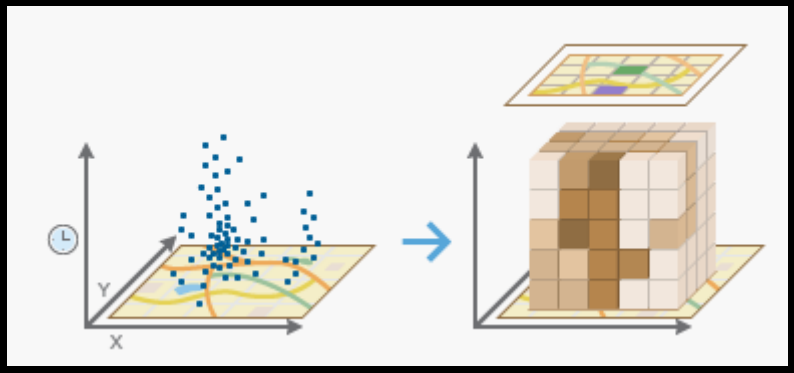


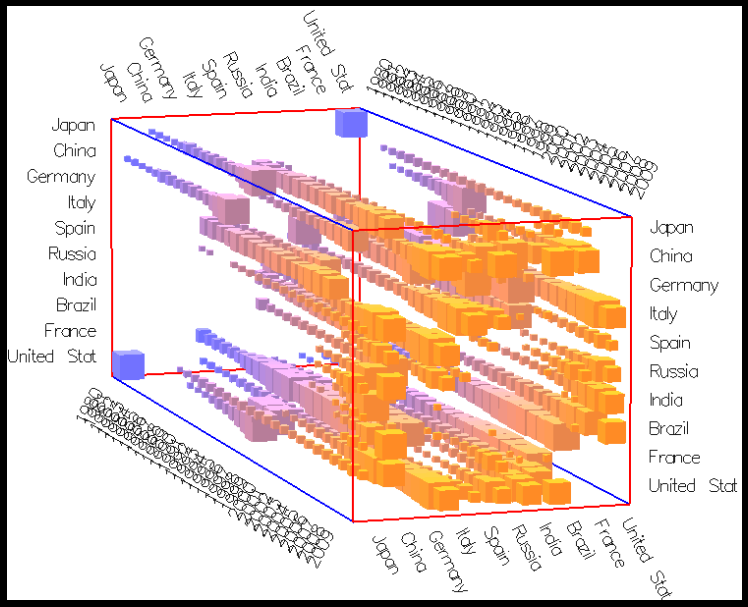

*Edward Tufte, "The Visual Display of Quantitative Information", 1983, Graphics Press*

# Space-Time Cubes

Now an ArcGIS Official Viz Option





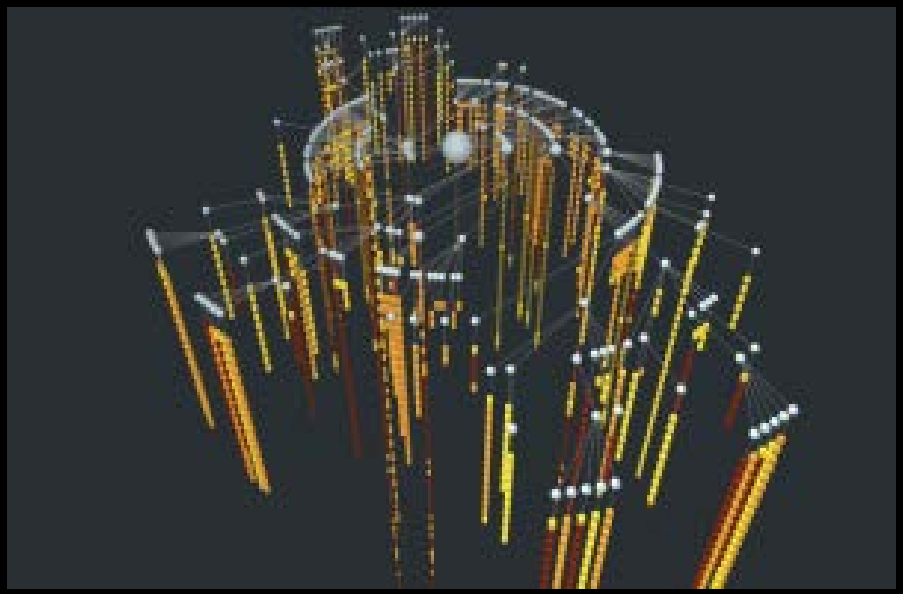



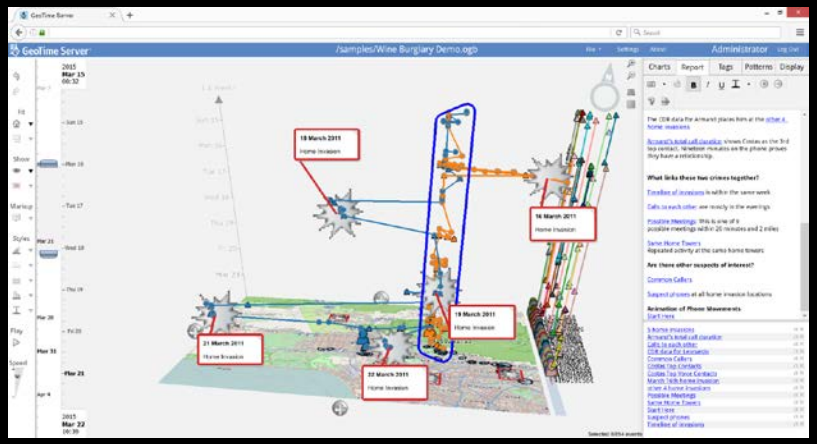

http://www.aviz.fr/~bbach/spacetimecubes/index.php

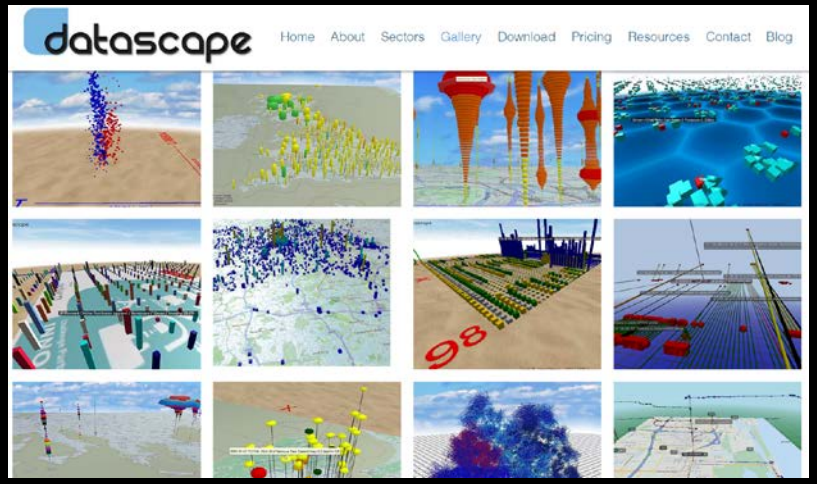
# Apps Which Support Spatiotemporal Viz

Geotime

Datascape





# ANTz: The Next "Kick-Ass" Viz

**Robert Steele, Highest Ranking Civilian in the CIA**

"…some of the most brilliant data visualization I have ever seen!"

"…it literally blew my mind!"

"… so good it could potentially change how we govern and manage everything…"

PUBLIC INTELLIGENCE BLOG

The truth at any cost lowers all other costs

Home About Blog Books Español Francais Links OSEE Reviews Trump #UNRIG Who

2013/12/17

## Robert Steele: Kick-Ass Next Level in Big Data Visualization & Exploitation

Advanced Cyber/IO



Robert David STEELE Vivas

I've been getting cranky as I have been reading and hearing all the hype over big data — data sets created by 1950's mindsets on top of 1970's technology and largely irrelevant to 21st Century solutions. I've also been looking at a few "solutions" packages — SILOBREAKER is still my favorite and Palantir is a complete disappointment. Cheering me up, considerably, are the below two sites.

The first, ANTz is some of the most brilliant data visualization I have ever seen. I spent two hours with it this morning and it literally blew my mind. This stuff is so good it could potentially change how we govern and manage everything, within a decade. Visit them at http://www.edworlds.com/antz/toroids/.




Click on Image to Enlarge




Click on Image to Enlarge

The second, SynglyphX, is a new company that will in my view transform the information industry within the decade.




They are bringing the ANTz technologies (open source, by the way) to market, and

# Visualize the Forest AND the Trees

**Learn the Conventions for Interpretation**

The "Forest":

Spatial topological distribution of data (not necessarily Cartesian)

The "Tree":

Complex Self-contained Structure of Data or Information

**Rules are made to be broken**

The "Hyperglyph":

Blurring the boundaries between forest and tree

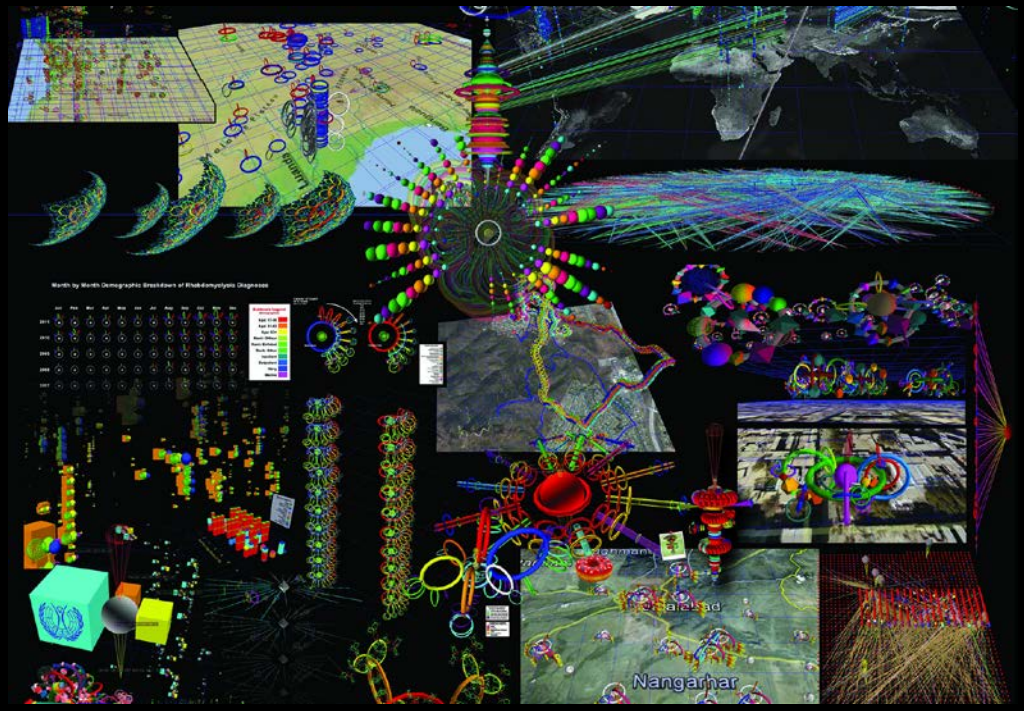
**The Tree Becomes the Forest!**

# HyperGlyph: The Tree Becomes the Forest

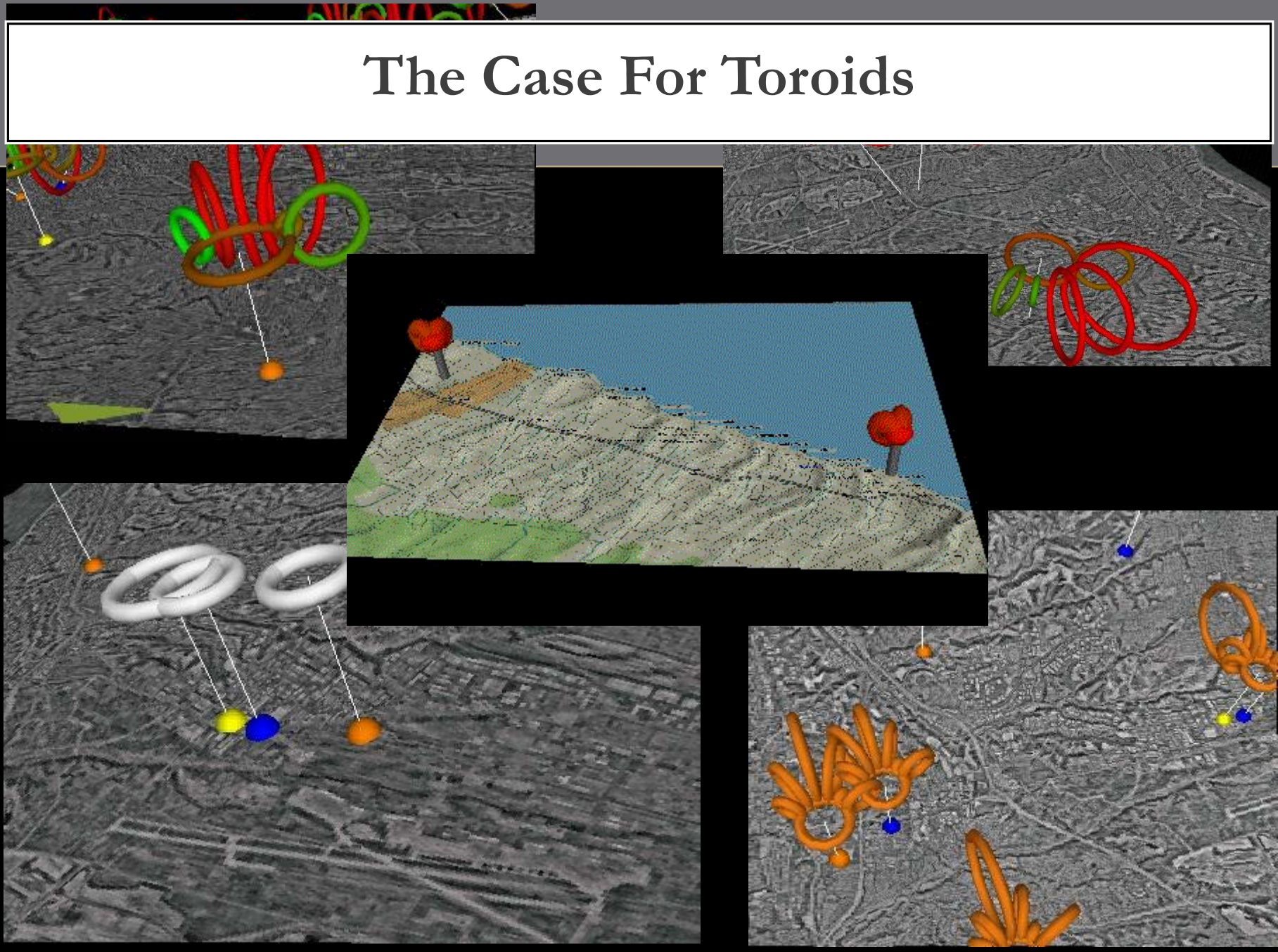
"Toroids on Steroids"
"Spreadsheets Meet Cyberspace"

Features:

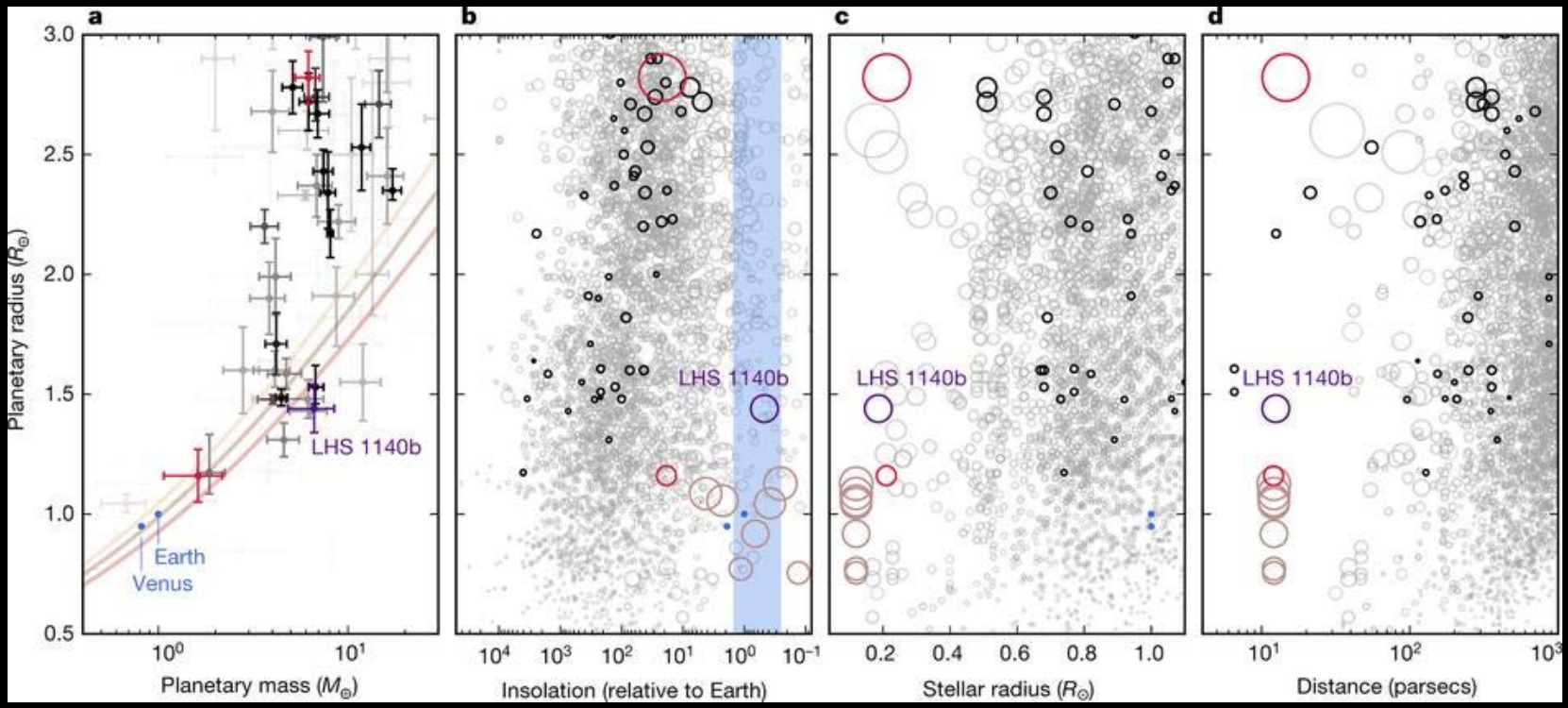
- Interactive
- Multi-modal
- Multi-dimensional
- Dynamic
- Embedded Information



# The Case For Toroids



# The Case for Toroids



# Useful Links

ANTz Main Page
http://www.openantz.com/

ANTz Github
https://www.github.com/openantz/

ANTzers Youtube
https://www.youtube.com/user/Antzers

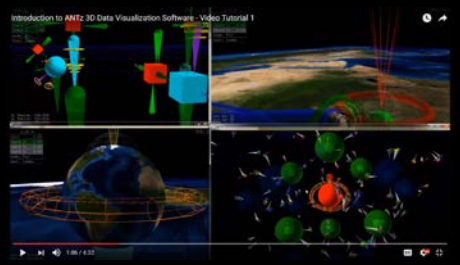
ANTz Tutorial and Sample Code
http://www.edworlds.com/antz/toroids/tutorials/index.html

Ant Research Citation Visualization First Attempt
http://www.edworlds.com/antz/toroids/more.html

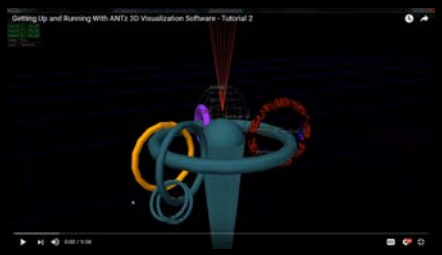
Dave Warner's Picasa Archive
https://get.google.com/albumarchive/100315004074259761063?source=pwa

Jeff's Google Photo Archive
https://photos.google.com/album/AF1QipP8D91YeXKA4skazgdS3rR2xl6n28ml3MMKvE1a

**Introduction to ANTz 3D Data Visualization Software - Video Tutorial 1**
https://www.youtube.com/watch?v=Zq_8AcZXbyg



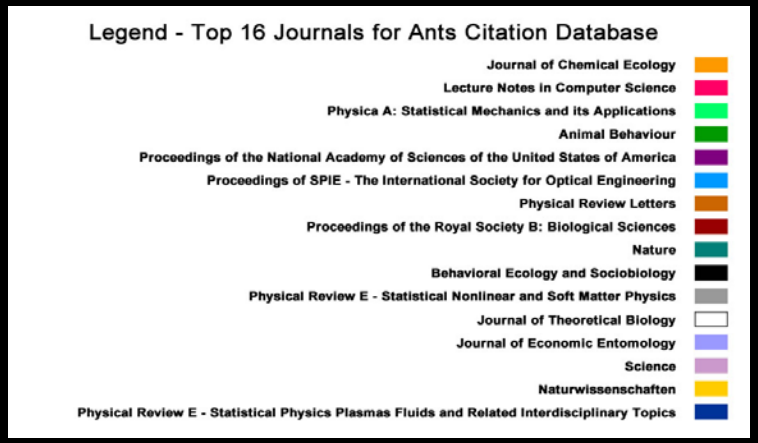

**Getting Up and Running With ANTz 3D Visualization Software - Tutorial 2**
https://www.youtube.com/watch?v=1IuAOL4bc2s

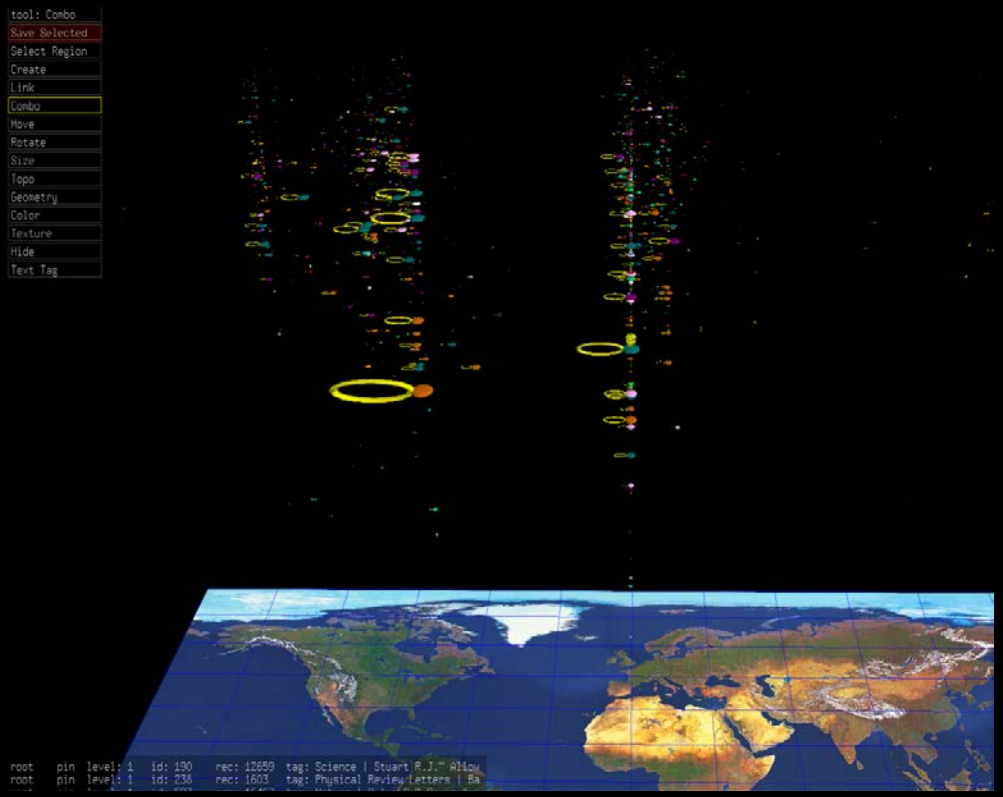


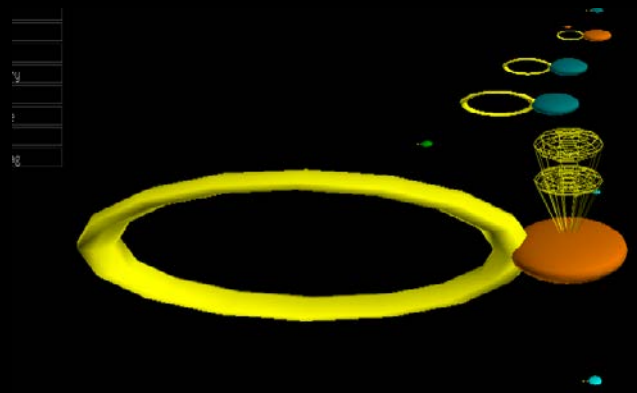
# Data Sets for Demonstration

Lahman Baseball
Global Terrorism Database
Hacking Creativity
Red Bull
ISAT (Find the Fed)
DCDC Viz Meetup
HPWREN
JJMoodle
TeacherTECH Moodle
Synesthesia
Diseasome
Burning Man
Defense Technology Information Ctr.
Arlington Trails
Capital Bikeshare
Cape May Water District
Trigrams
Angola
Syria
Afghanistan
Ant Citations
Cowles Hike
NCAA Football
Parameter Sweeps
Hyperdimensional Coordinate System

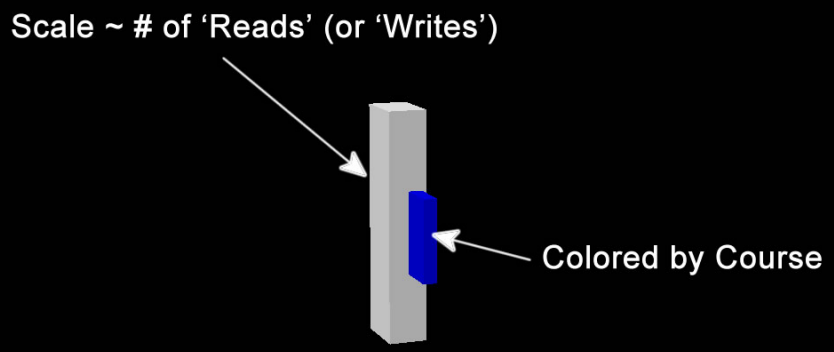
# SCOPUS Search Results –
## Ant Behavior, Sociobiology, Self-organized Criticality

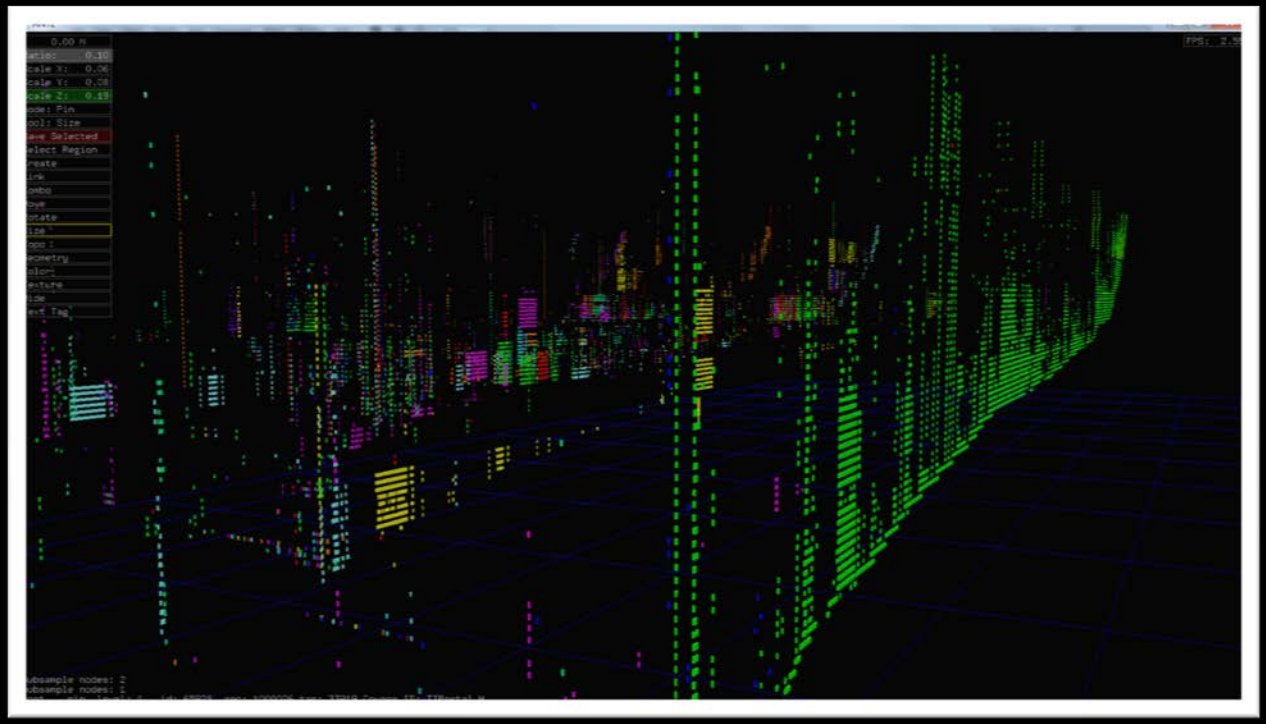


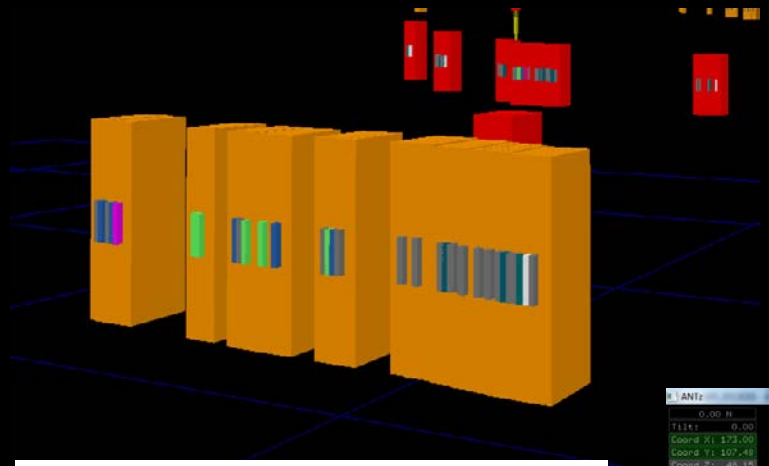



# SDSC TeacherTECH Moodle Database: 100's of Courses, 1000's of Students



# Moodle Course Visualization



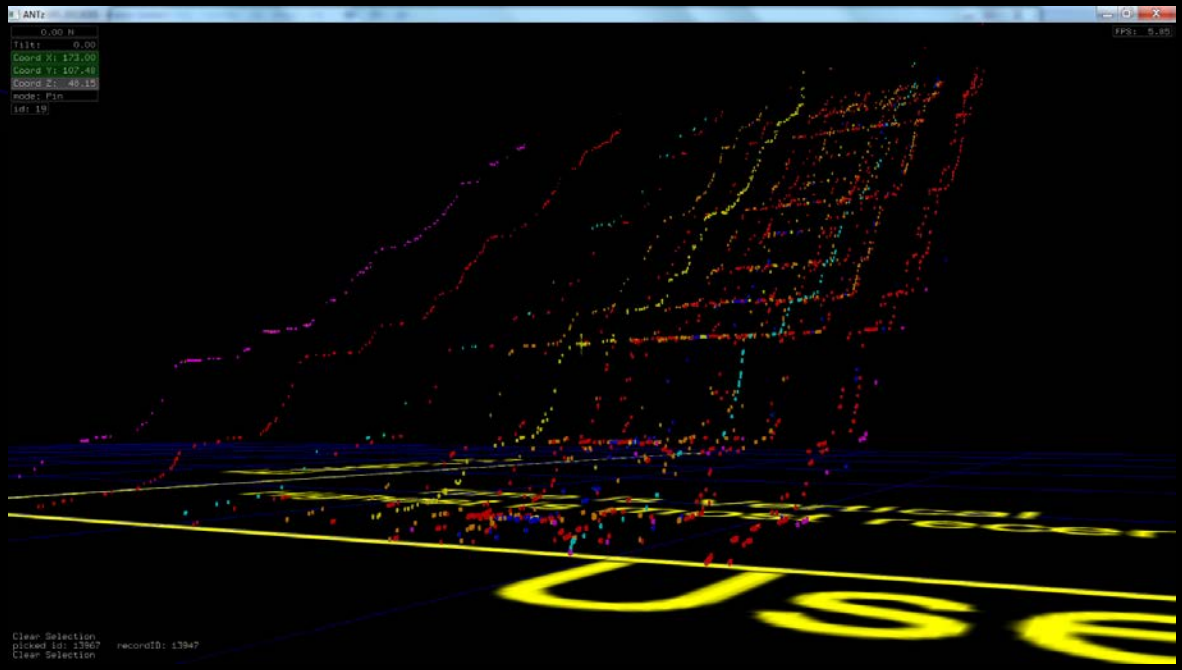
**Cumulative Points**

100

0

**Event Color Codes**

- Forum View Post
- Forum-Print Post
- View Forums
- View Forum
- Add Discussion
- View Discussion
- Add Post
- Attempt Quiz
- Continue Attempt
- View Summary
- Close Attempt
- Review
- Assignment Form
- Submit Assignment



# Lahman Baseball Database

**The Forest**

X - Player, alphabetical, left to right

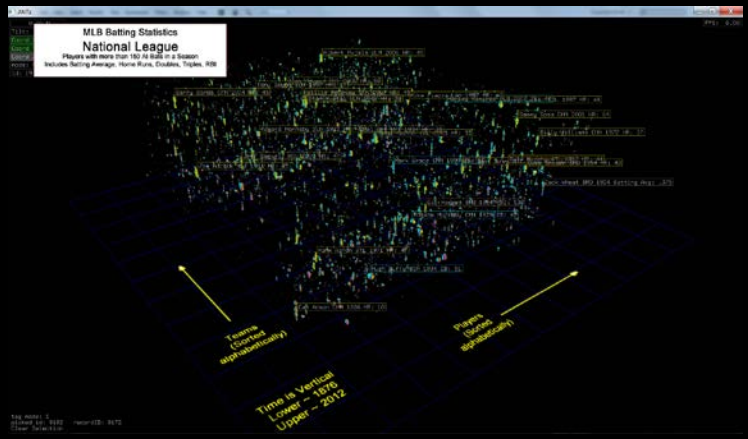
Y - Team, alphabetical, front to back

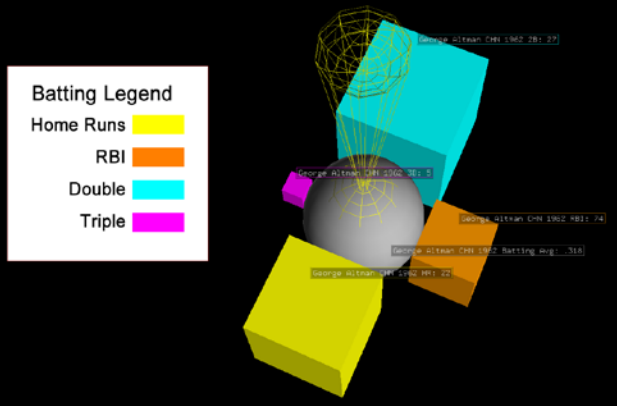
Z - Time (1886 to 2015)

**The Tree**

Five individual batting statistics

HR, RBI, Doubles, Triples, Batting Avg.



# Global Terrorism Database

**The Forest**

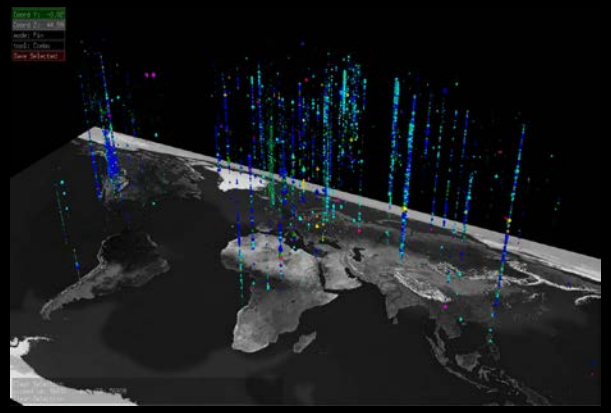
Cartesian Lat, Lon, Elev

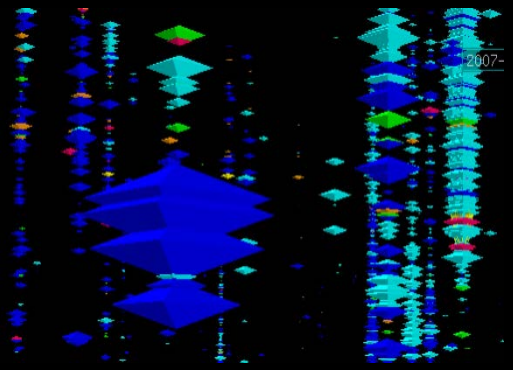
Circular Distribution of Terror Group Glyphs around

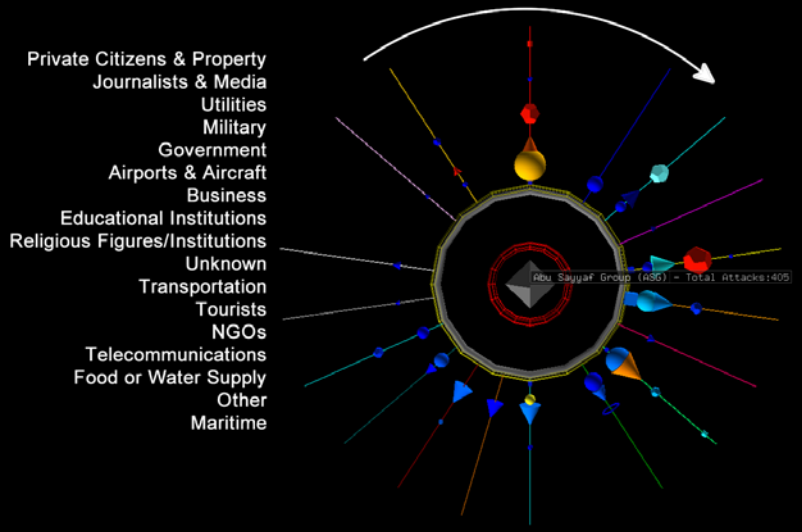
**The Tree(s)**

Simple Glyph (Size => # Killed, Color => Type of Terrorist Attack)

Complex Glyph (see diagram)

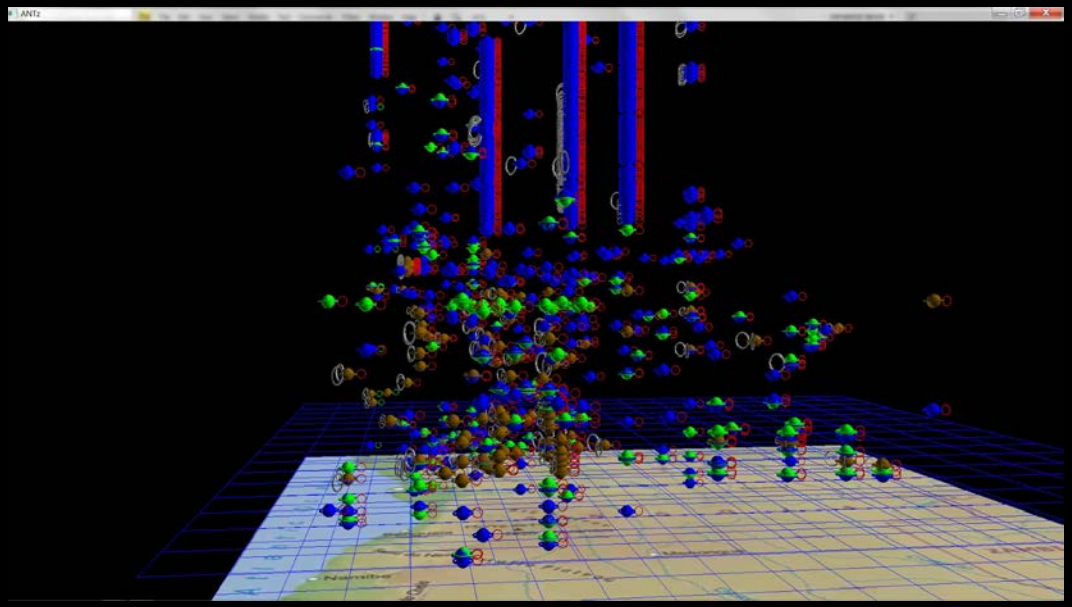


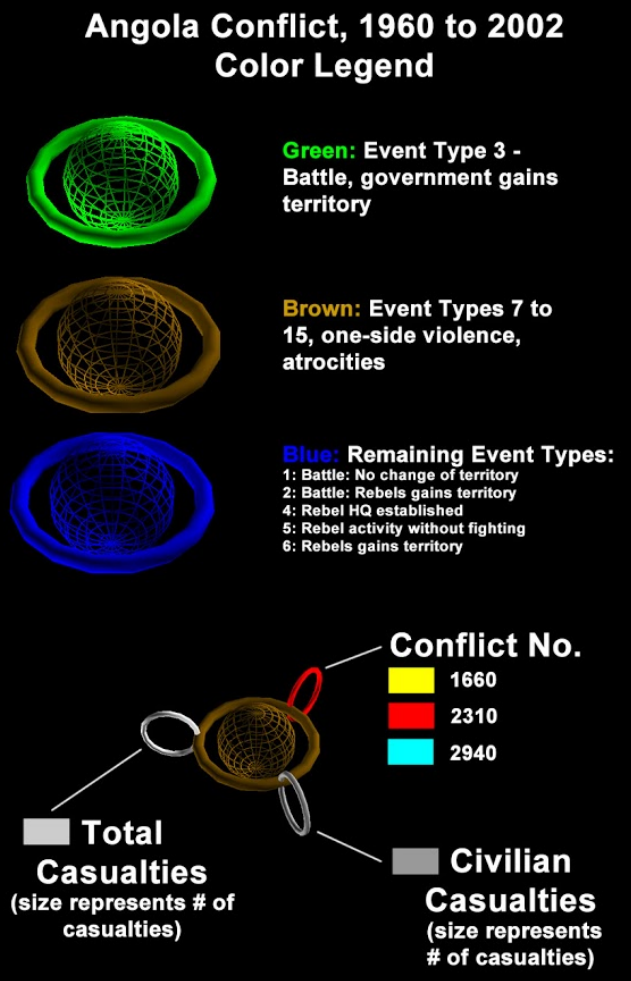


# Angola Civil War, 1960 to 2002

Data provided by Jenn Zeimke of Crisis Mappers
Ph.D. Thesis

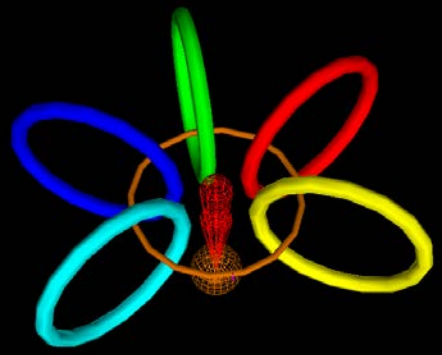




# Syrian Civil War, 2013

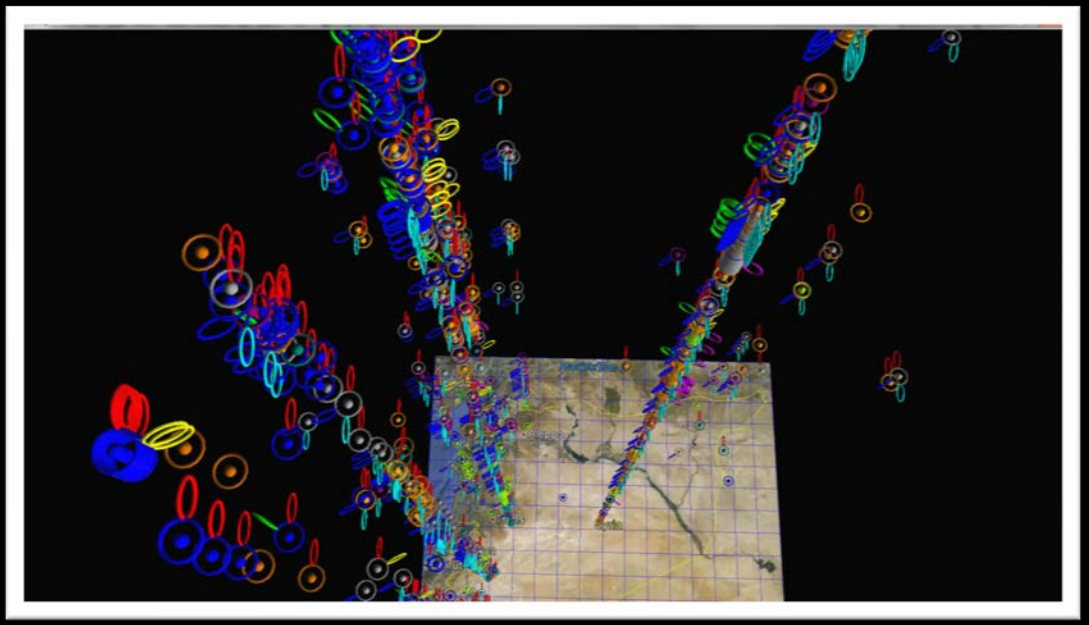
## Legend

- Aggregate
- Eyewitness
- Announcement
- Article
- Killed
- Missing/Detained
- Twitter



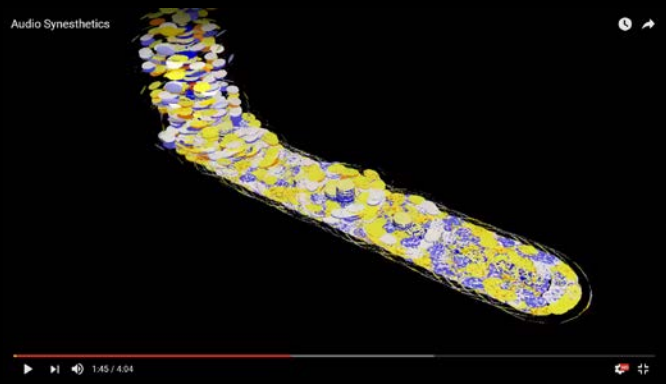
## Subtoroid Legend

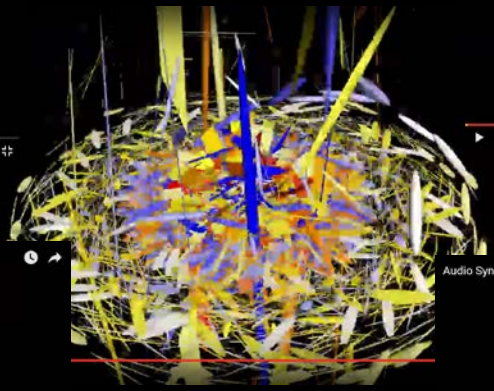
- Killed
- Tortured
- Missing
- Detained
- Refugee
- Child

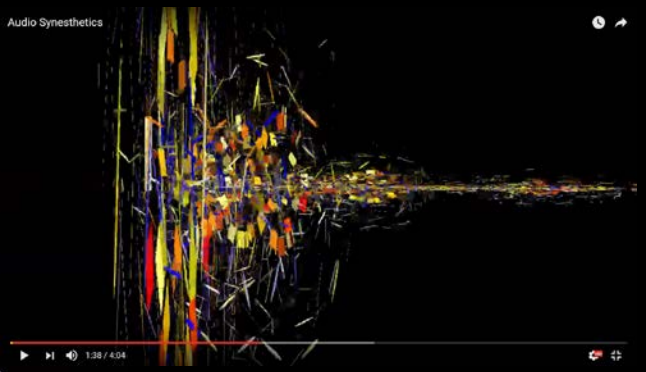


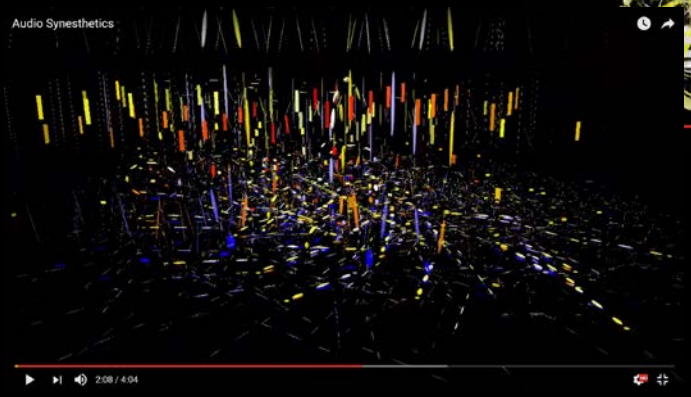
# Audio Synesthetics: Music Visualization

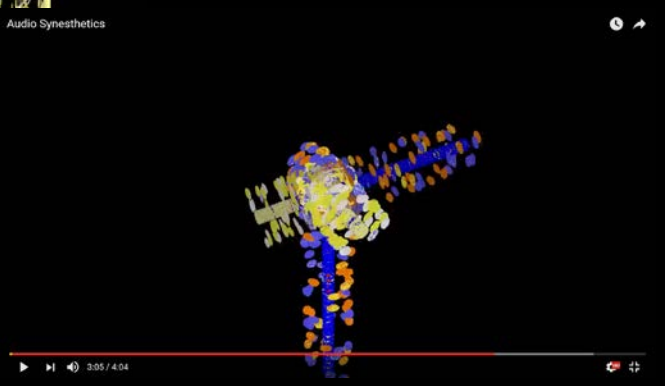
Seeing music, a la Disney's Fantasia
https://www.youtube.com/watch?v=ee13Ksa5Iyo





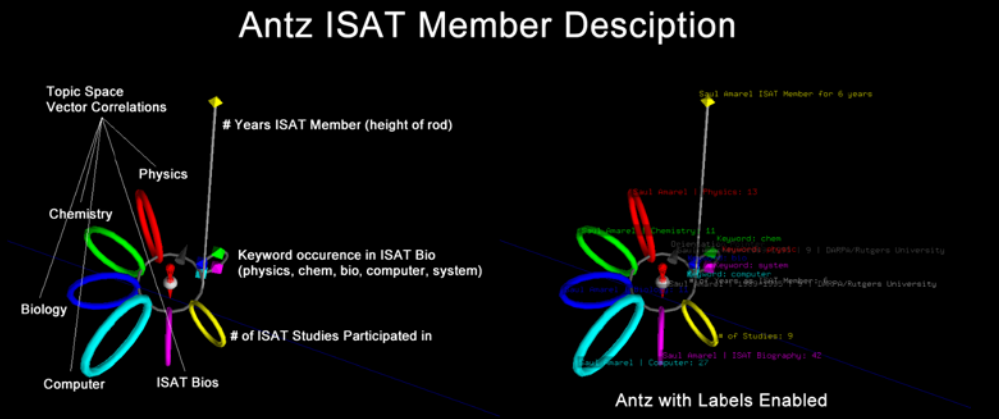



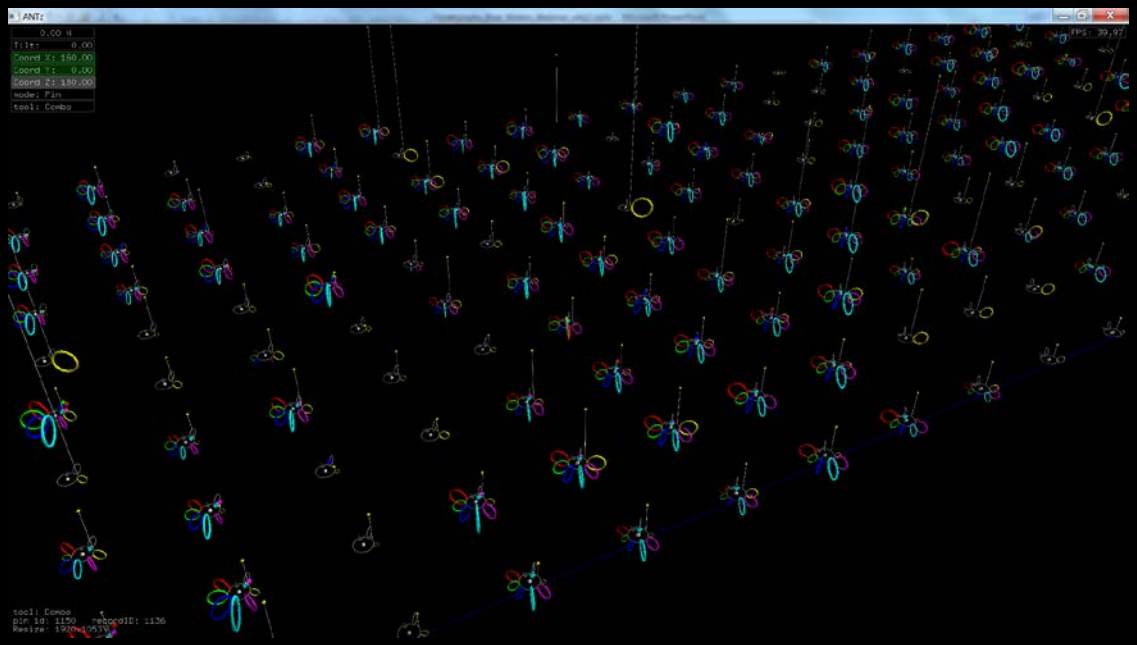



# ISAT: Find the Fed

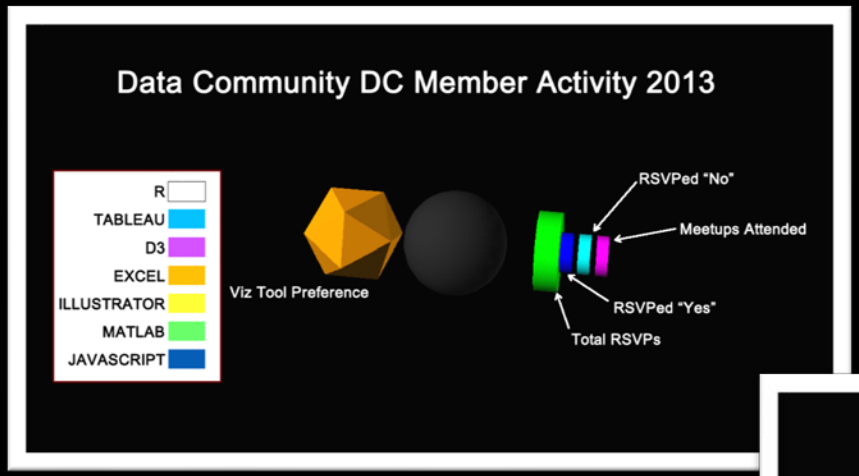
DARPA Information Science and Technology Advisory Group

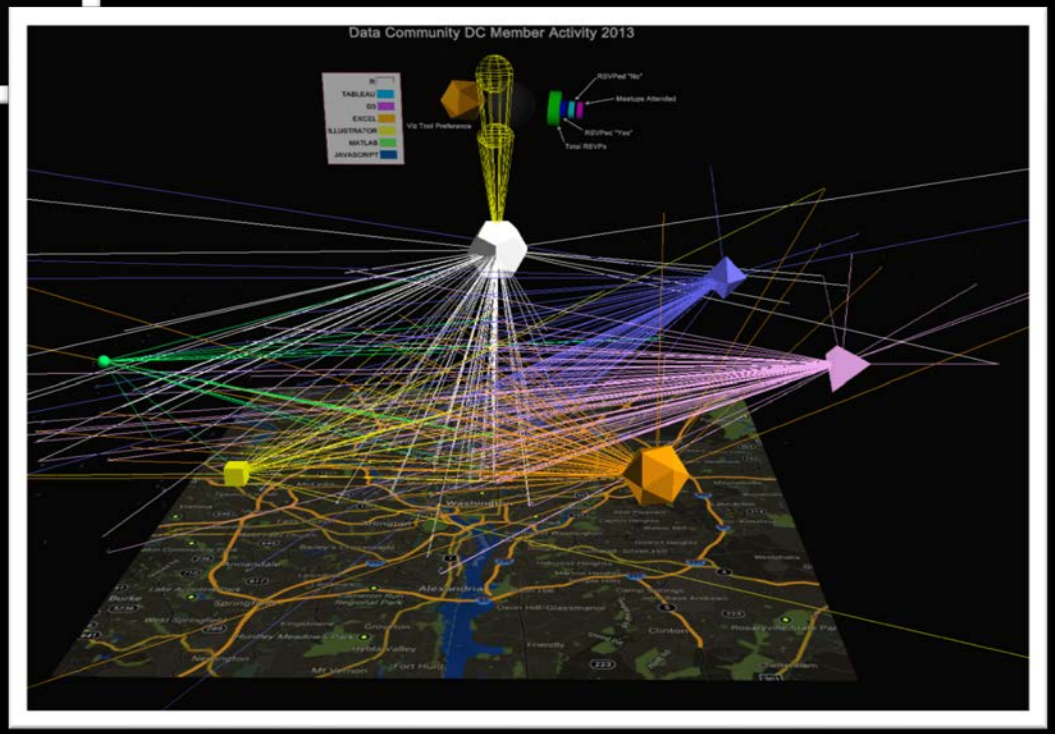
- Prestigious
- Invitation-only
- Three year term



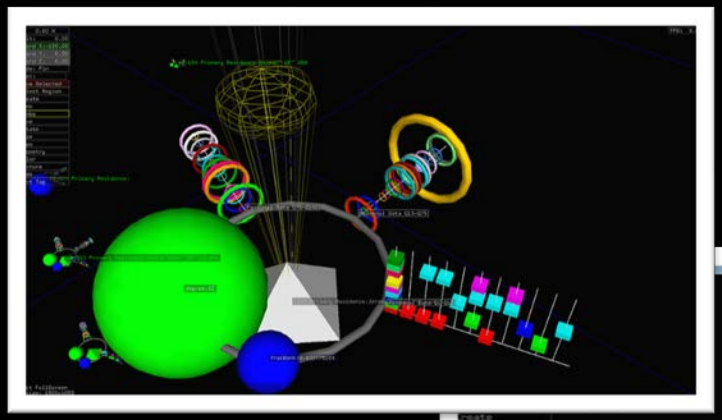



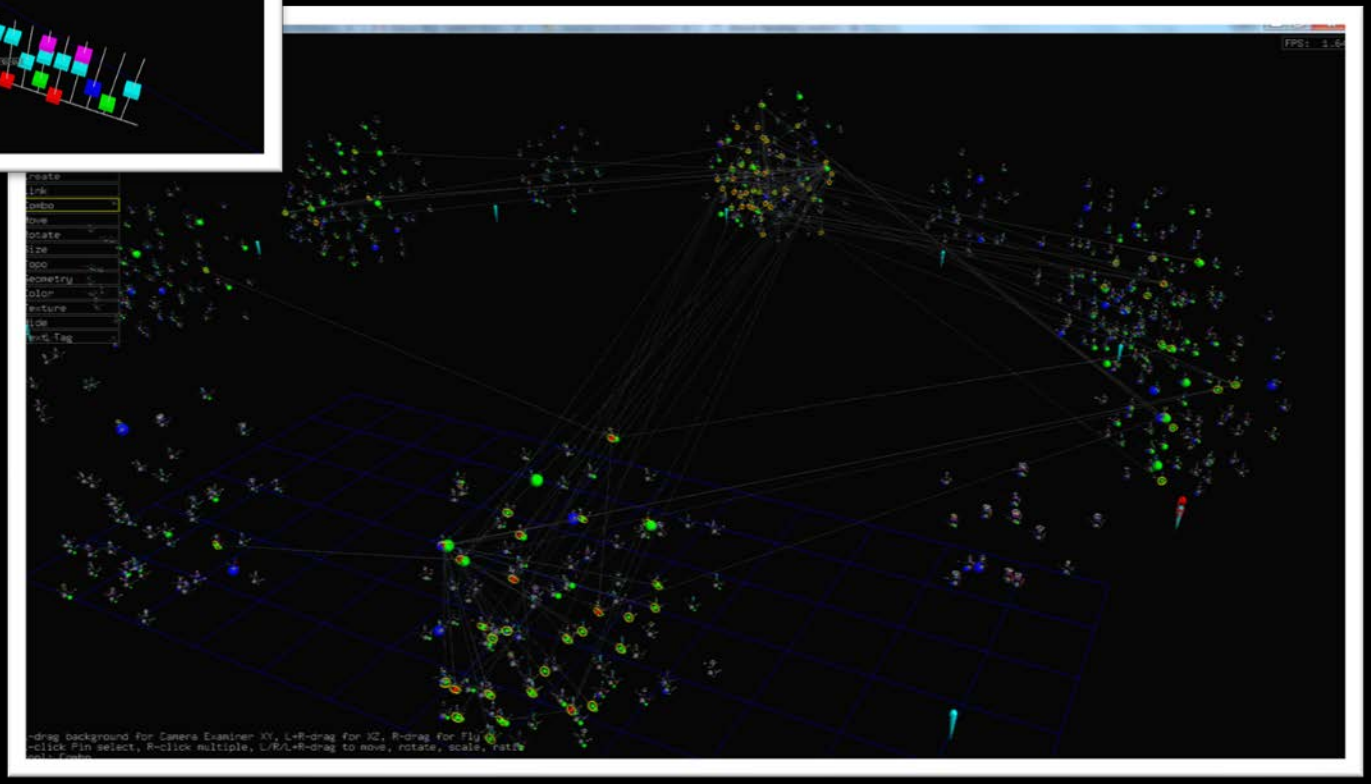
# DC Data Visualization Meetup Membership



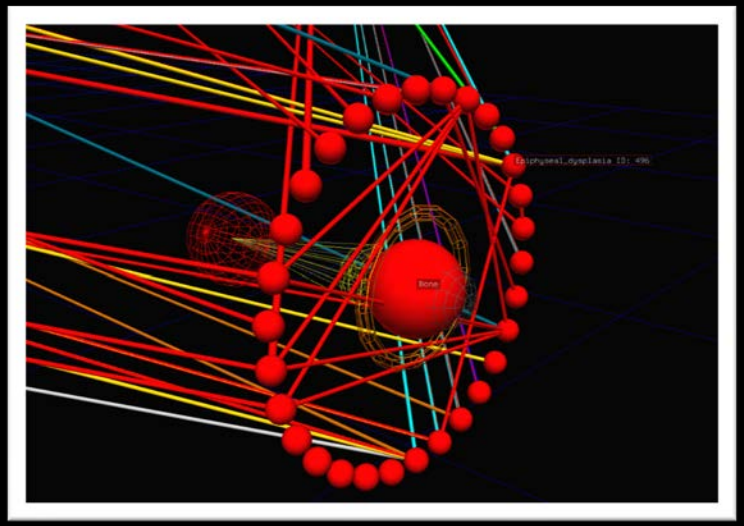



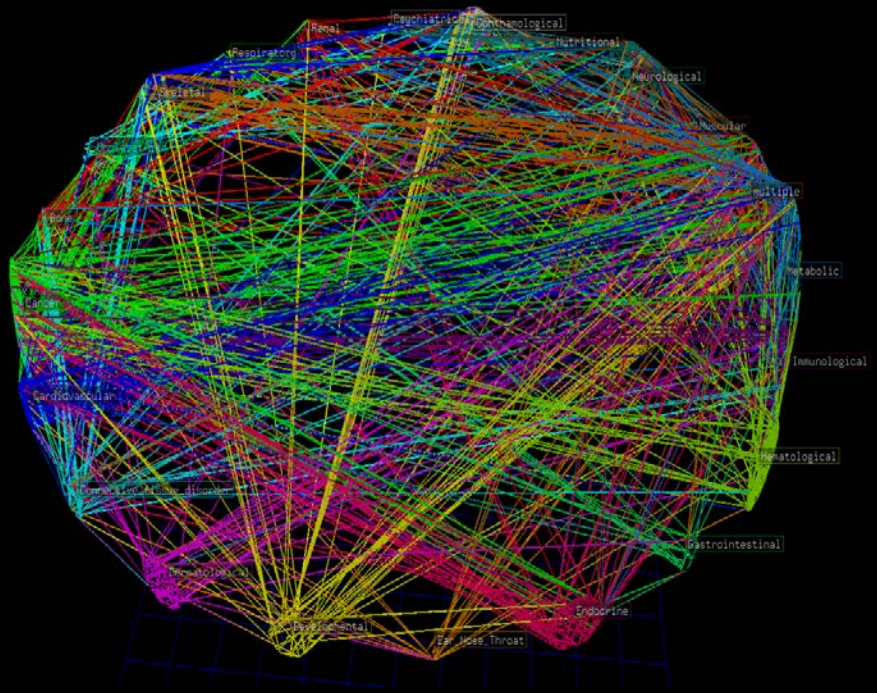
# Hacking Creativity





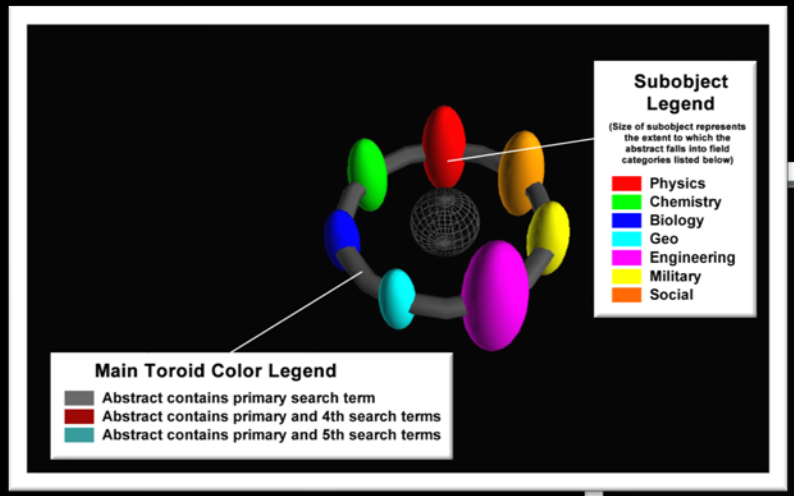
# The Human Diseasome

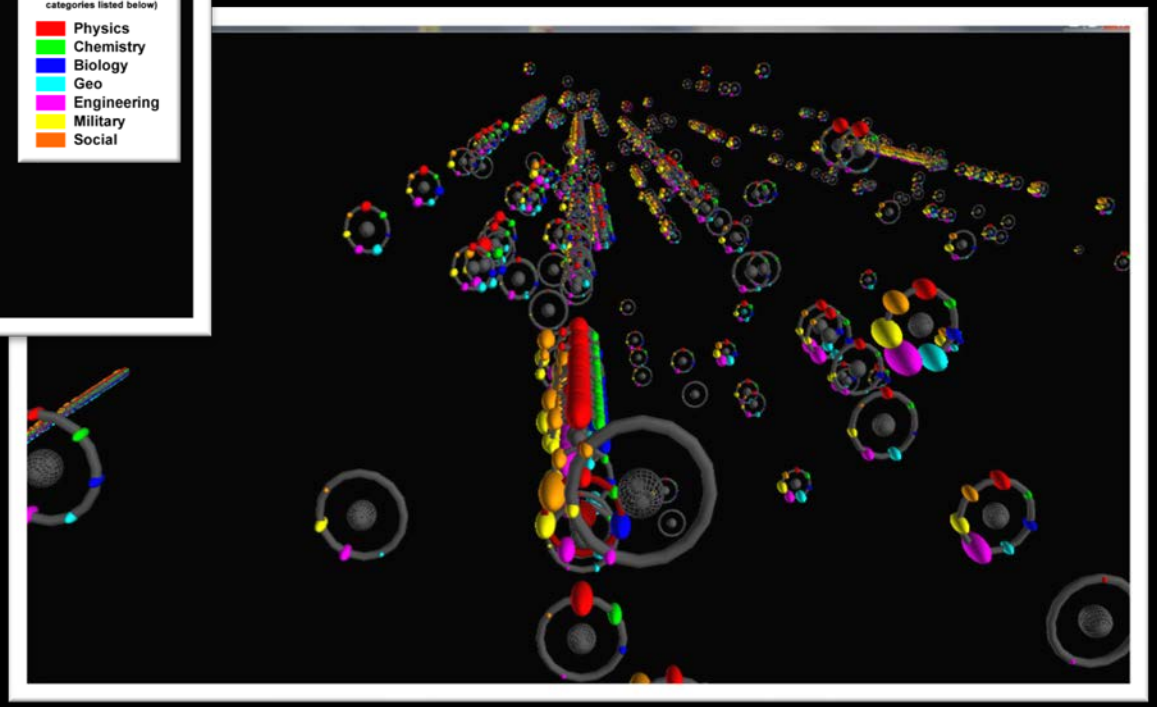


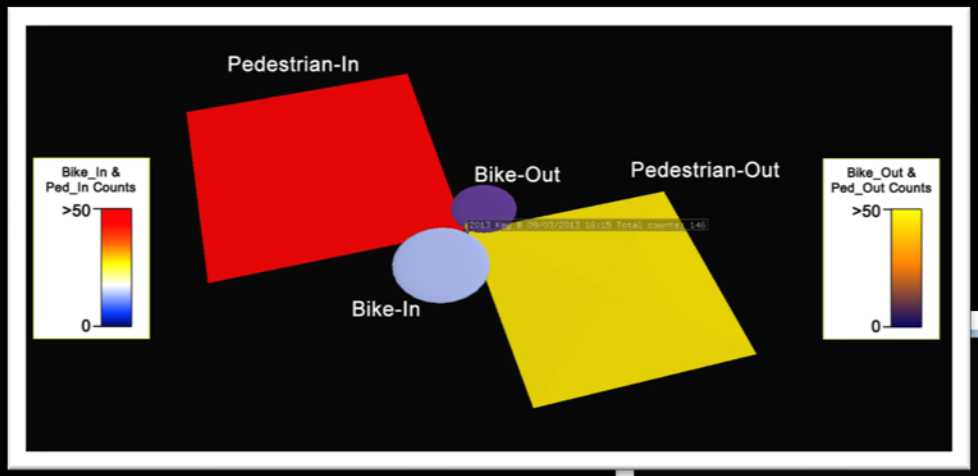
# Defense Technology Information Center

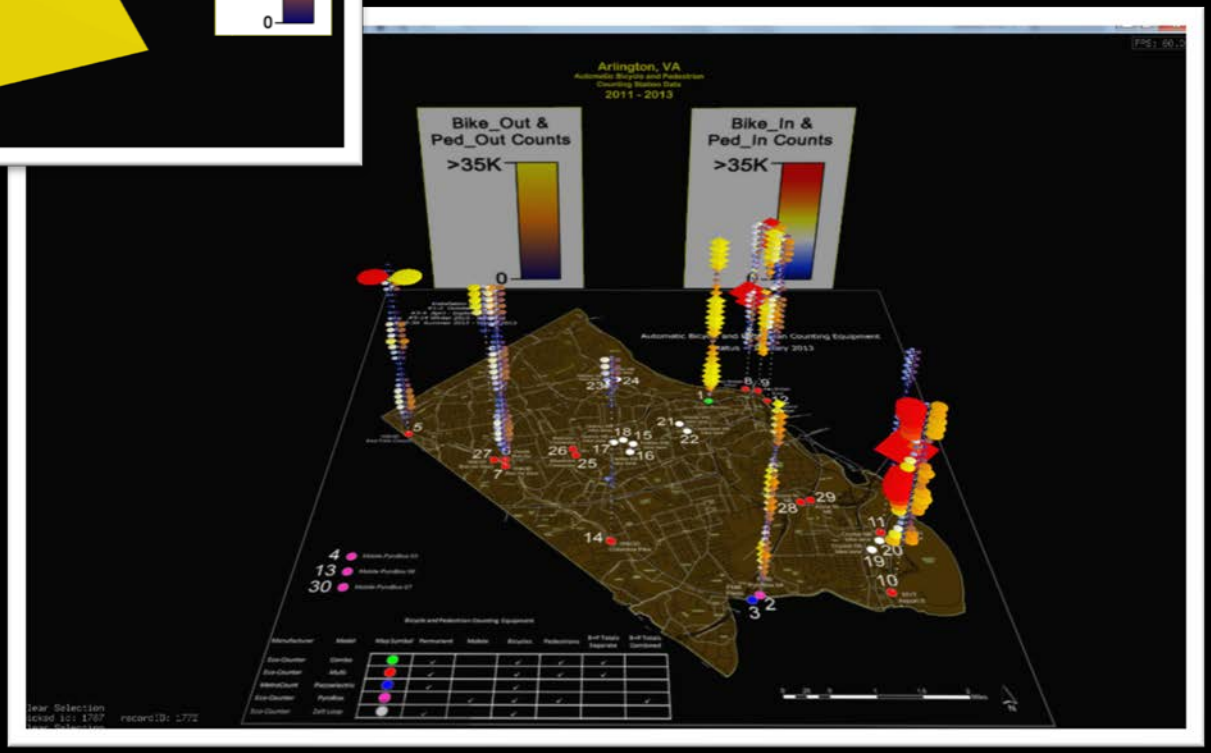
"Topic Space"



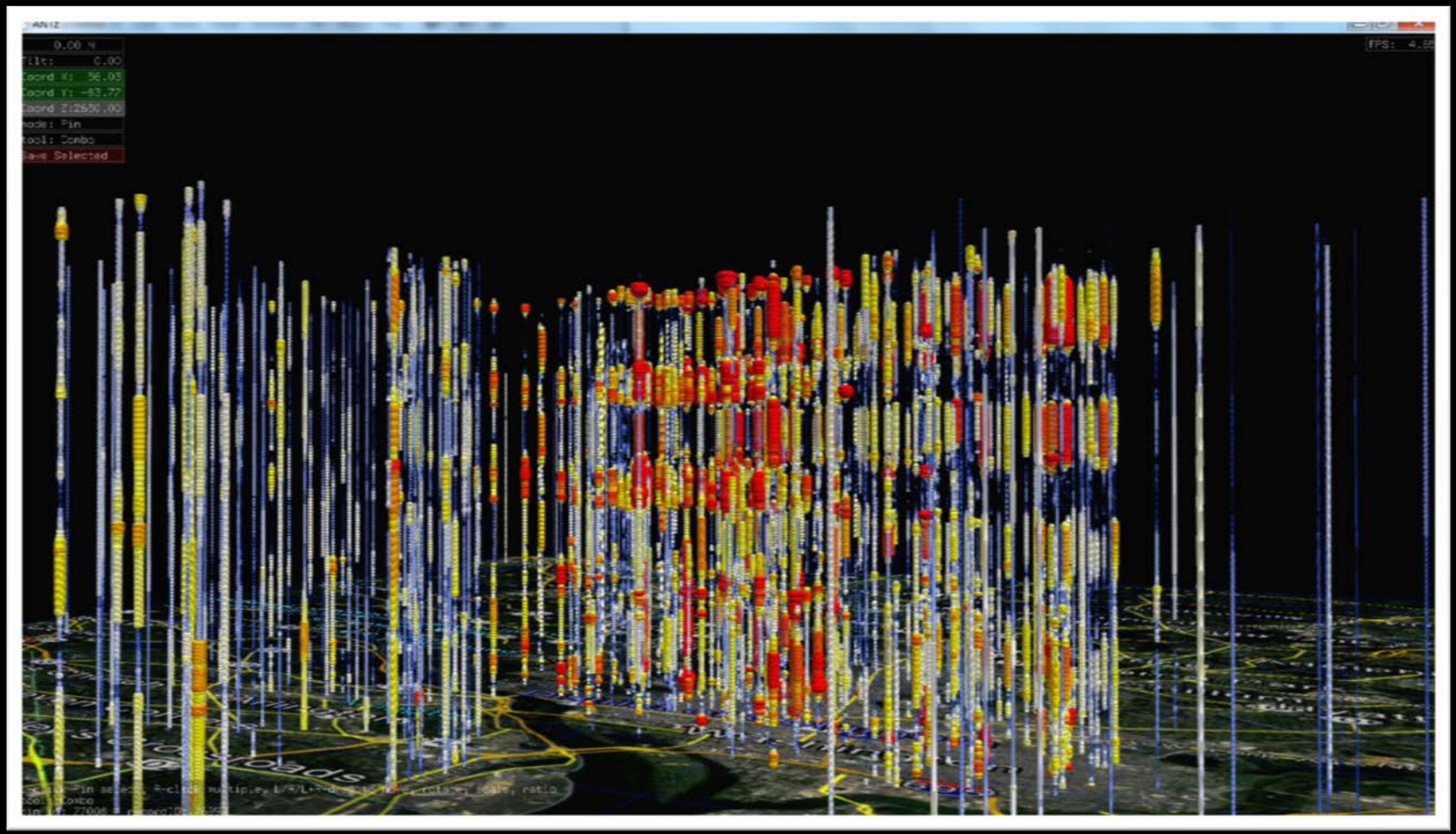



# Arlington Trails Pedestrian and Bicycle Traffic



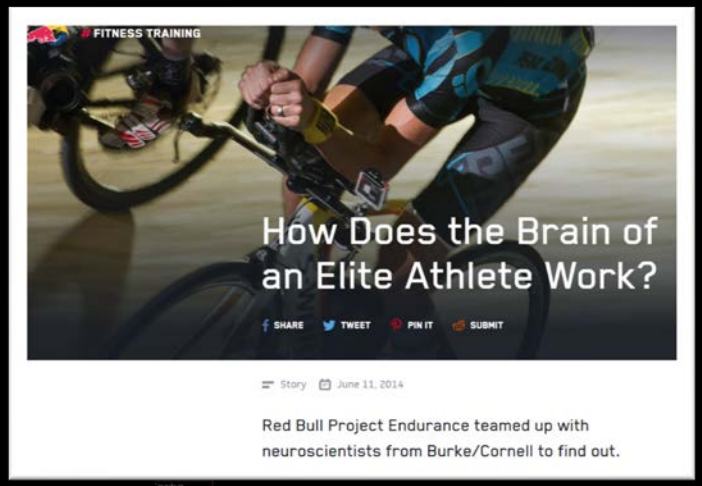



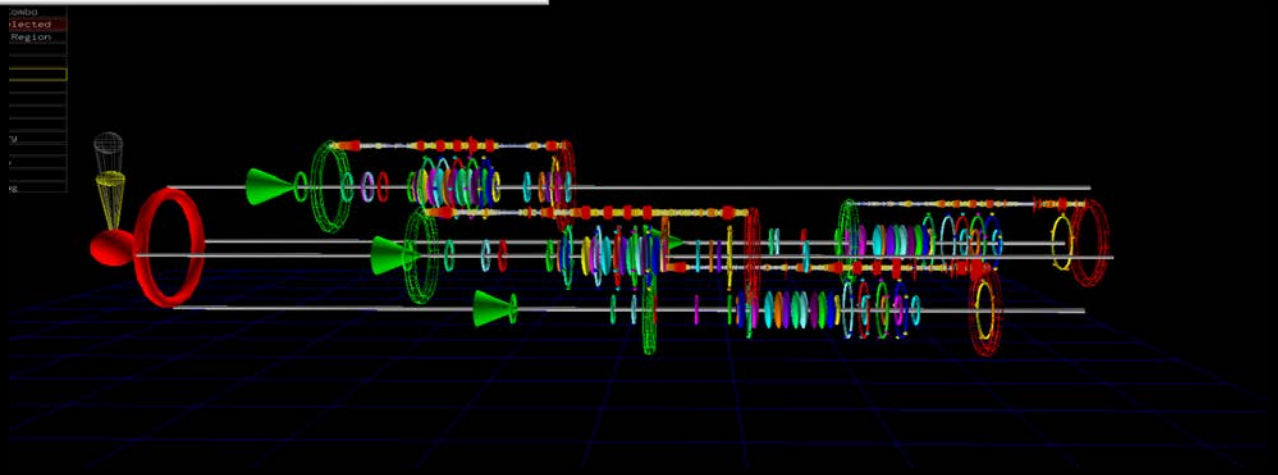
# Capital Bikeshare Bicycle Traffic



# Glyph As Event: Red Bull Project Endurance

https://www.redbull.com/us-en/red-bull-project-endurance



# Glyph as Event: Burning Man 2015