HYPERGLYPHES

Exploring the Limits of Glyph Structure

Jeff Sale
Learning Design Technologist
San Diego Supercomputer Center, UC San Diego
Background and a Brief History of Glyphs
Introduction to Advanced 3D Glyph Design
Basic Glyph Structures (and Functions)
• Parent-Child Relationships
• Multiple levels of information macro vs. micro, forest vs. tree
• Interactivity
• Embedded information
• Drill-down query interface
Demonstrations
Q & A*

(*Questions are encouraged via the Chat throughout the presentation)
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
Motivation...
THE JOHN MUIR TRAIL
Computational Painting
SDSC Education, Outreach, and Training
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”
Mark Pesce* Gives Credit to PC in Landmark Paper

- PSI
- PHX
- PHI

“Mind in the Loop”

*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  Patrick Keller
Steve Price  Bill Rojas
Jeff Sale  Markus Schmidt
Dave Gilsdorf  Rik Rusovic
Jodi Reed*  Steve Birch
*My better half  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

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

Each cube environment holds a data graph and links back to central question spheres for which the data was required.
SynGlyphX, A Spinoff Start-Up
Brief History of Glyphs
Nature Emulates Math
What is a Glyph?

From Wikipedia:
“In typography, a glyph /ˈɡlɪf/ 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
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.

But NOT related to ...
Phoneme: A phoneme (/ˈfɒnɪːm/) is one of the units of sound (or gesture in the case of sign languages, see chereme) that distinguish one word from another in a particular language.

Why not??
A Classic: The Wind Glyph

Wind Speed and Direction

<table>
<thead>
<tr>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calm</td>
</tr>
<tr>
<td>5 knots</td>
</tr>
<tr>
<td>10 knots</td>
</tr>
<tr>
<td>15 knots</td>
</tr>
<tr>
<td>20 knots</td>
</tr>
<tr>
<td>50 knots</td>
</tr>
<tr>
<td>75 knots</td>
</tr>
</tbody>
</table>

South east wind at 75 knots
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 as 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 principles of this approach are straightforward, the 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...
Glyph-based Visualization: Foundations, Design Guidelines, Techniques and Applications

R. Borgo¹, J. Kehrer², D. H. S. Chung³, E. Maguire⁴, R. S. Laramée⁵, H. Hauser⁶, M. Ward⁷ and M. Chen⁸

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.
## Previous Work Inspiring this Work

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

Table 1: Visual Channels [CF12].
Previous Work Inspiring this Work

Figure 7: Glyph design criteria [CLP* 13].
Principle of Small Multiples

Edward Tufte, Viz Pioneer
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.

Chernoff Faces
Space-Time Cubes

Now an ArcGIS Official Viz Option

Similar Apps

Geotime
Datascape
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...”
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
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  

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/AF1QipP8D91YeXKA4skazgdS3r2Rxl6n28ml3MMKvE1a

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=1luAOL4bc2s
The Case for Toroids
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

Scale ~ # of ‘Reads’ (or ‘Writes’)
Colored by Course
Moodle Course Visualization
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
Audio Synesthesetics: 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
“Topic Space”
Arlington Trails Pedestrian and Bicycle Traffic
Capital Bikeshare Bicycle Traffic
Glyph As Event: Red Bull Project Endurance

Glyph as Event: Burning Man 2015

Events are distributed sequentially around toroid as listed in the database