CS448
Special Topics in Computer Graphics

Visualization

The Purpose of Visualizations

Pat Hanrahan

Cognition and Perception

Information Tools

External aids to cognition

1. Multiplication table
2. Map
3. ...

Amplifies Cognition

1. Expand working memory
2. Reduce search time
3. Pattern detection and recognition
4. Perceptual inference
5. Perceptual monitoring and controlling attention
6. Interaction is important for cognition

Chapter 1, Readings in Information Visualization

The Eyes Have It

Task

- Overview
- Zoom
- Filter
- Details (Select)
- Relate
- History
- Extract (Refine)

Taxonomy

- 1D
- 2D (maps)
- 3D (shapes)
- Temporal
- nD (relational)
- Trees (hierarchies)
- Networks (graphs)

B. Schneiderman, The eyes have it: A task by data type taxonomy for information visualization, 1996

Slogans

"The purpose of computing is insight, not numbers" [Hamming]

"A picture is worth a thousand words"

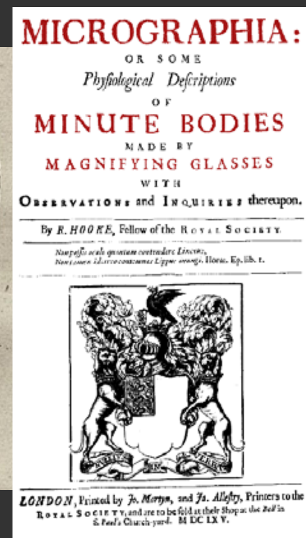
"The eye is not a camera"

Observation

Robert Hooke, F.R.S

Curator of Experiments

Flea

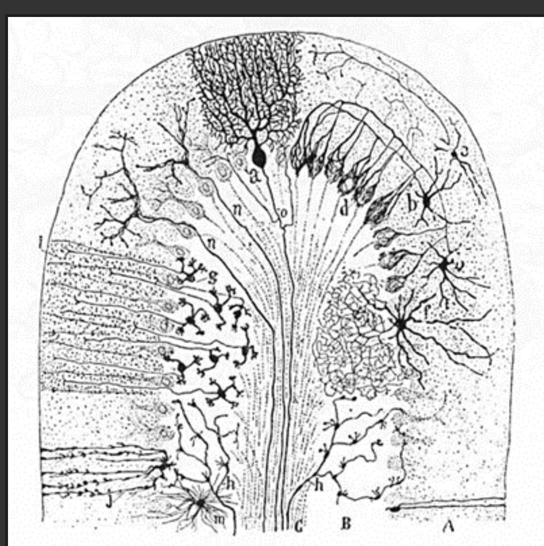


MICROGRAPHIA:
OR SOME
Physiological Descriptions
OF
MINUTE BODIES
MADE BY
MAGNIFYING GLASSES
WITH
OBSERVATIONS and INQUIRIES thereupon.

By R. HOOKE, Fellow of the ROYAL SOCIETY.

LONDON, Printed by Jo. Martyn, and Ja. Allestry, Printers to the ROYAL SOCIETY, and are to be sold at their Shop at the Bell in S. Paul's Church-yard. M DC LX V.

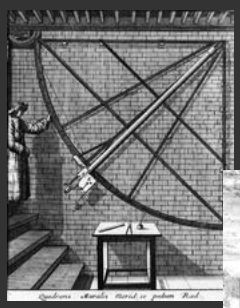
Illustrations



Santiago
Ramon Y Cajal (1894)
Cell Types in the
Cerrebellum
From Robin, p. 44

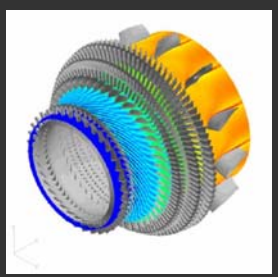
Microscopes and Telescopes

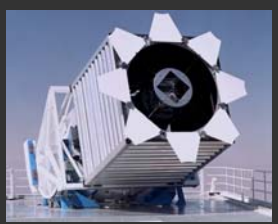
Hooke's Microscope



Flamsteed's Telescope

Simulation and Instrumentation

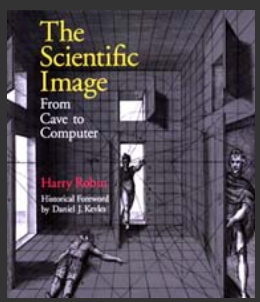




- Ctr for Int. Turbulence Simulation
  - PW6000 Turbine
  - 93.8 million cell mesh
  - 5700 time steps, 30 iter/ts
  - 5970 hours on 1K proc
- Sloan Digital Sky Survey
  - Robotic telescope
  - 5x6 2048x2048 CCD sensors
  - 40 TB of imagery
  - 100 million object catalog

Purposes

Purposes of Scientific Images



The Scientific Image
H. Robin, 1992

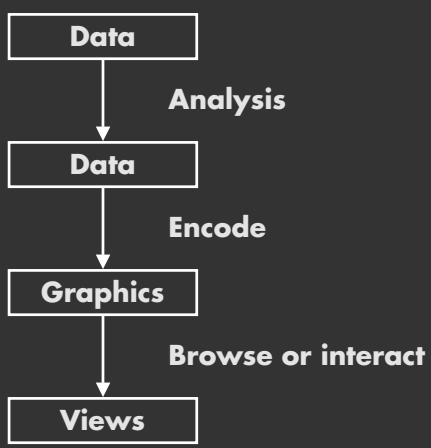
- **Records of observations**
- **Self-illustrating phenomena**
- **Concepts and classifications**
- **Descriptions of equipment and methodology**

vs.

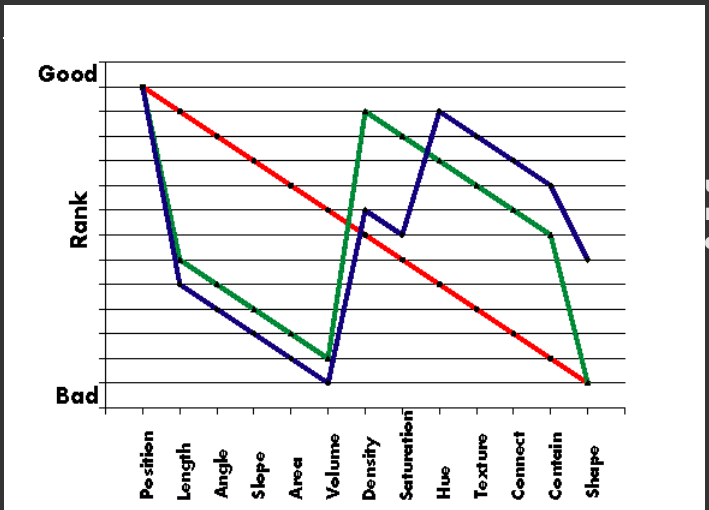
- **Exploration**
- **Presentation**

Topics

Visualization Pipeline



2. Data and Encodings



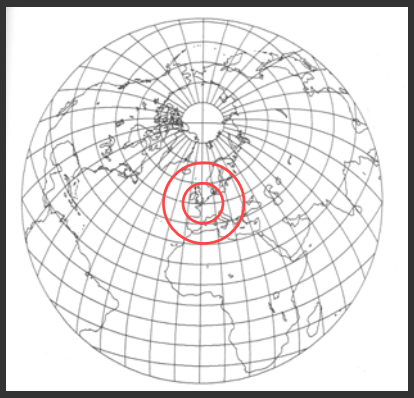
uantitative
rdinal
ominal

Cleveland and McGill
Mackinlay

2. Data Models and Encodings

Stolte, Tang and Hanrahan, Polaris

3. Spatial Encodings



Equiheading vs. Equidistance Projection

4. Interaction

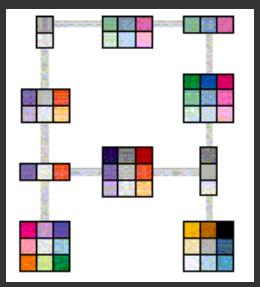
Francois Guimbretiere

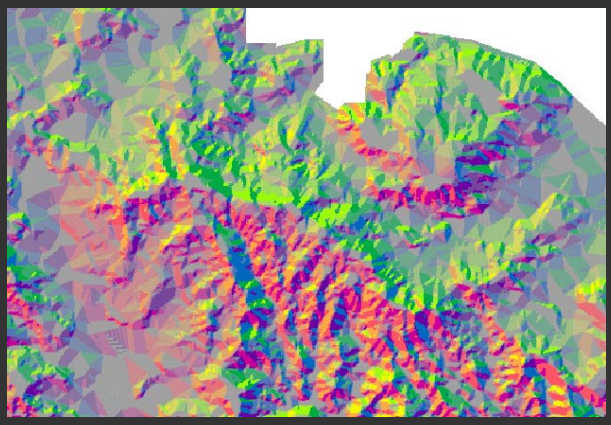
Gibson's Experiment
Goal: Match 2 shapes
Active touch: 96%
Passive (rotation) 72%
Passive (imprint) 49%

From J. J. Gibson (1966)
The Senses Considered as a Perceptual System, p. 124

Thanks to David Kirsh for this example.

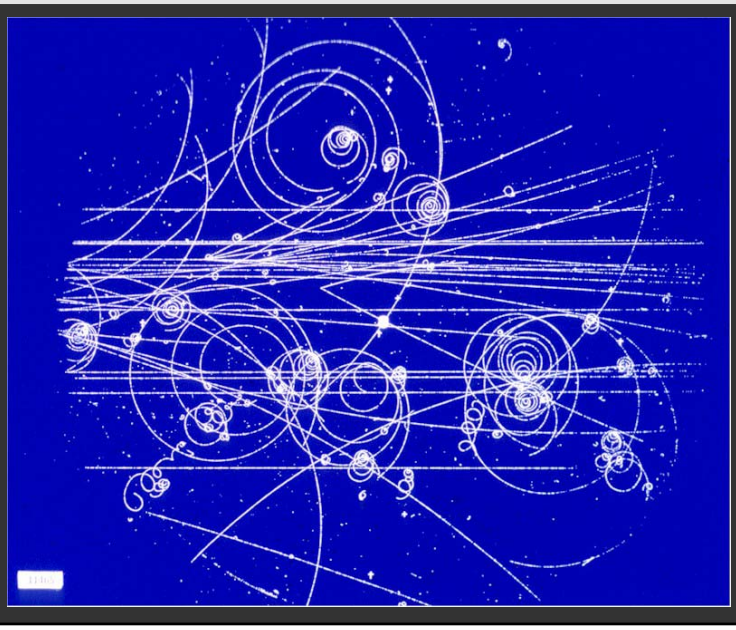
5. Color Encodings



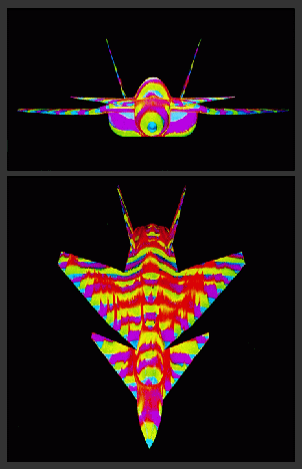


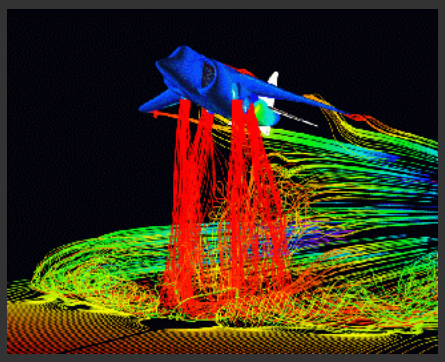
From C. Brewer

6. Self-Illustrating Phenomena



6. Self-Illustrating Phenomena



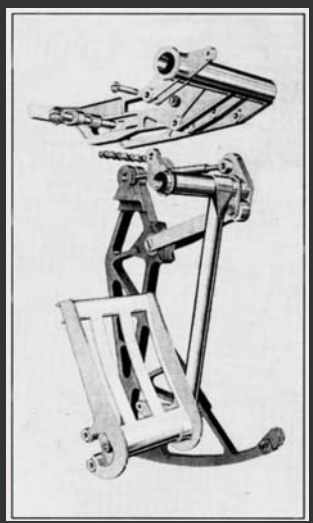


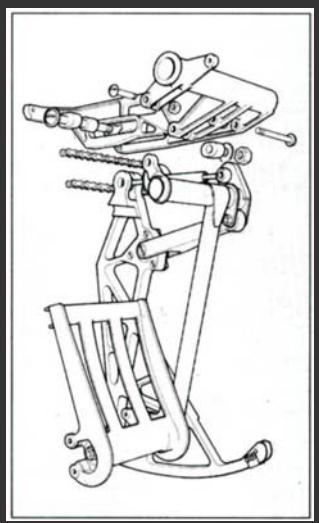
Harrier Jet flow during landing
NASA Ames FAST System

Eric Schulzinger (1988)
Air-Flow on a Supersonic Aircraft
From Robin, p. 141

7. Conveying Shape

Good view
Silhouettes
Shading
Texture



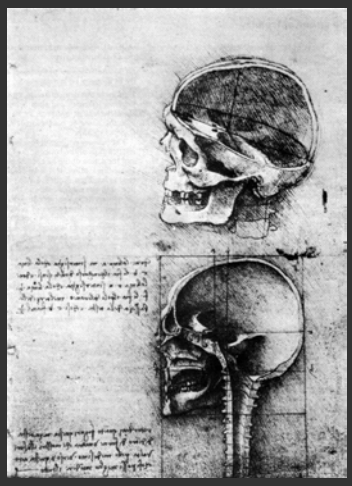


From Gooch[2]

8. Conveying Structure

Maneesh Agrawala

Karl Heinz Hoehne's Voxel-Man
Images of the Visible Man



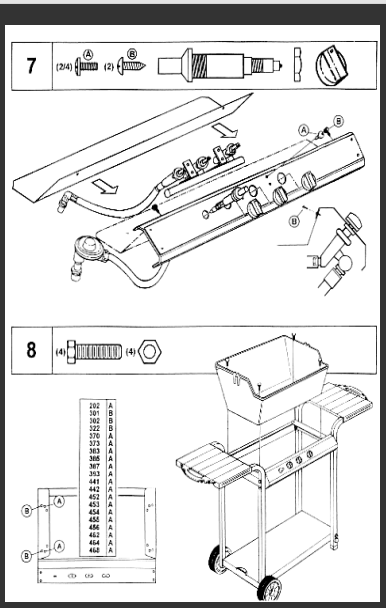
Leonardo's Notebooks

9. Motion and Animation

Tamara Munzner

10. Diagrams of Processes

Maneesh Agrawala



Domains

Astronomy
Microscopy
Molecules and macromolecules
Genes and regulatory networks
Cartography
Engineering drawing
Fluid flow
Medical imaging and anatomy
Botanical illustration
Technical illustration
Statistical graphics
Scientific diagrams
Mathematical proofs and figures

Challenge

Data sets are increasing in size and complexity
Graphics and imaging tools widespread
Fewer tools for mapping data to visualizations
Best visualizations created by graphics designers
Computer-mediated communication is ubiquitous
Humans cannot make all the visualizations

Therefore: Visualizations are regressing

Challenge: Develop better visualization tools