



Microsoft® Research

# FacultySummit 2011

Cartagena, Colombia | May 18-20 | In partnership with COLCIENCIAS



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# FacultySummit 2011

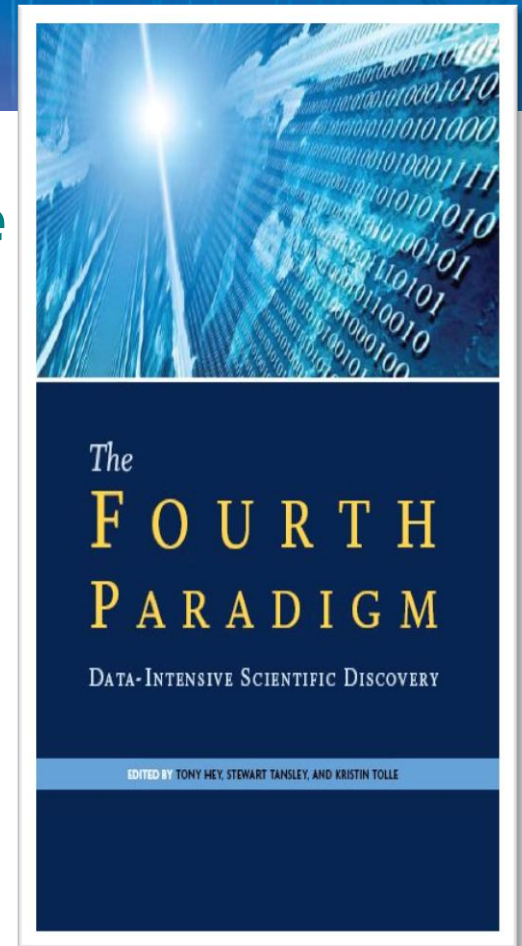
Cartagena, Colombia | May 18-20 | In partnership with COLCIENCIAS

## Visualizing Scientific Data

Derick Campbell  
Director of Engineering, Microsoft Research Connections

# The Fourth Paradigm

- A thousand years ago – **Experimental Science**
  - Description of natural phenomena
- Last few hundred years – **Theoretical Science**
  - Newton's Laws, Maxwell's Equations...
- Last few decades – **Computational Science**
  - Simulation of complex phenomena
- Today – **Data-Intensive Science**
  - Data sets from many sources...
  - Data captured by instruments
  - Data generated by simulations
  - Data generated by sensor networks



<http://fourthparadigm.org>

<http://blogs.nature.com/fourthparadigm>

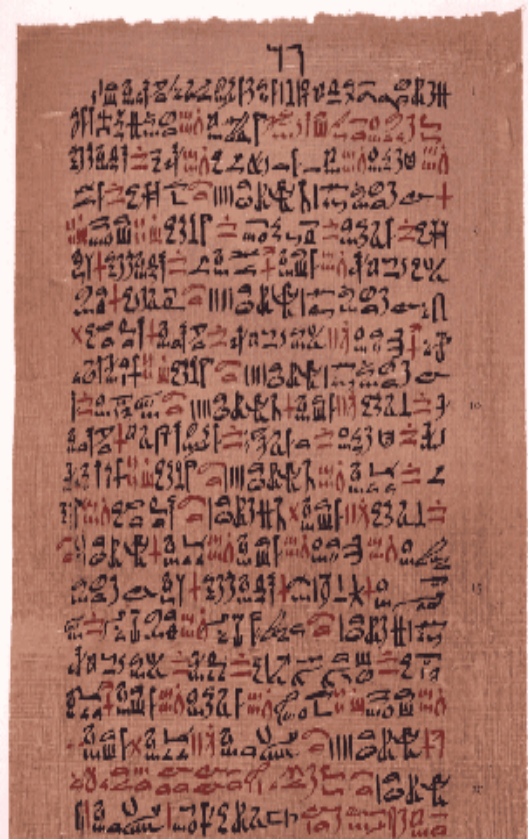
**Chauvet Cave art from southern France (32,000 years ago)**  
**Contains the earliest known paintings.**



**Stone tablet from northern Spain (14,000 years ago)**  
**Contains the earliest known representation of a landscape.**

**Babylonian Clay Tablet - Plimpton 322 (1800 BC)**

**Early example of Babylonian mathematics.**



**Ebers Papyrus (1500 BC)**

**Asthma prescription on Egyptian medical papyrus.**

Circulus arcticus

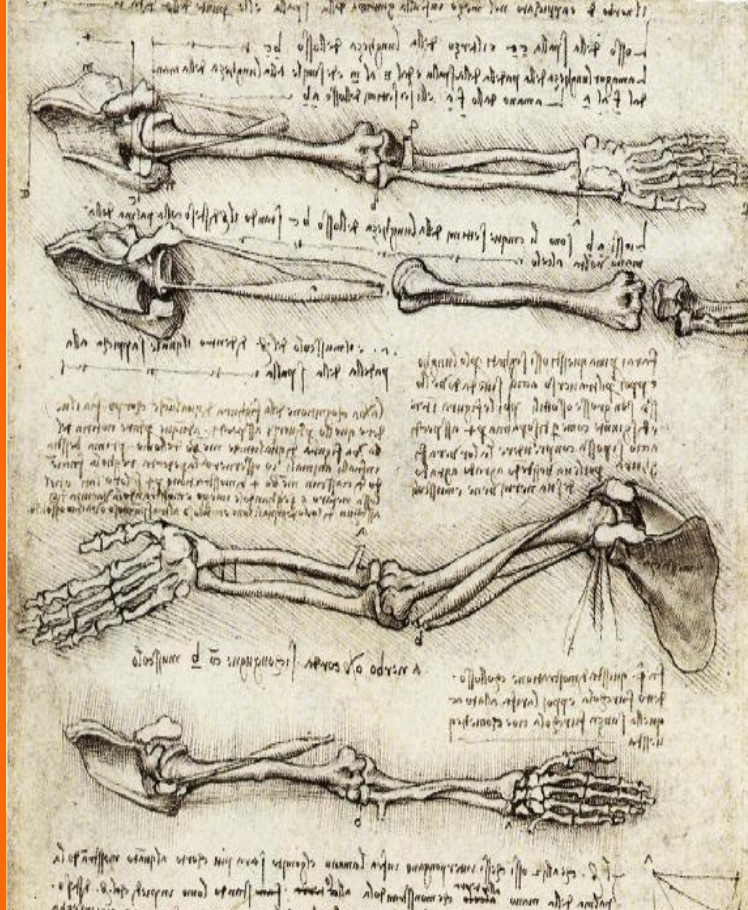
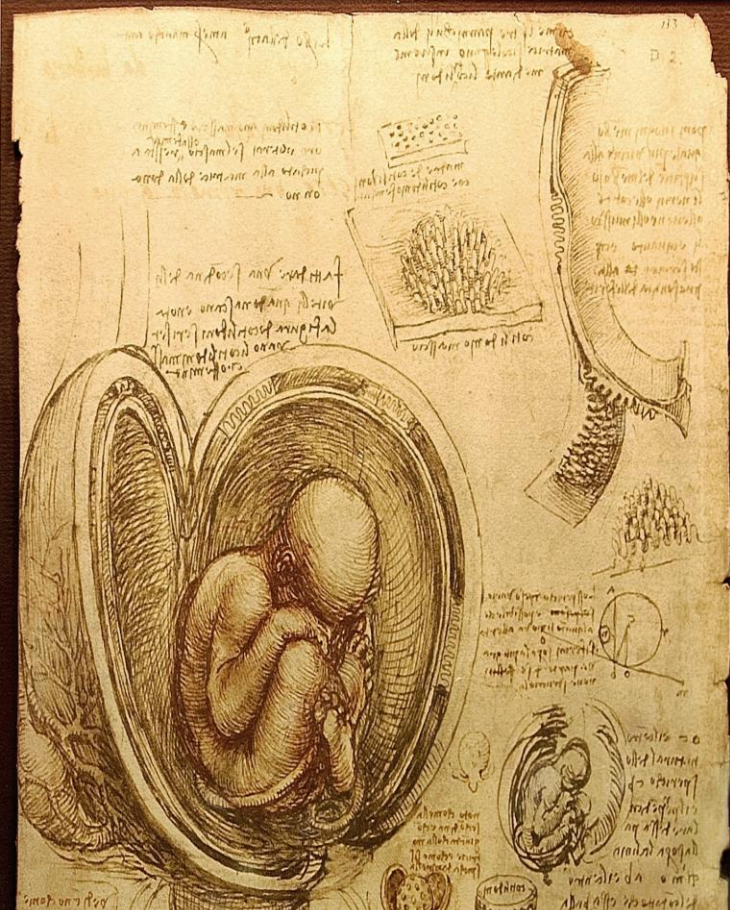
Parte Italia

Circulus arcticus

# Cantino World Map (1502)

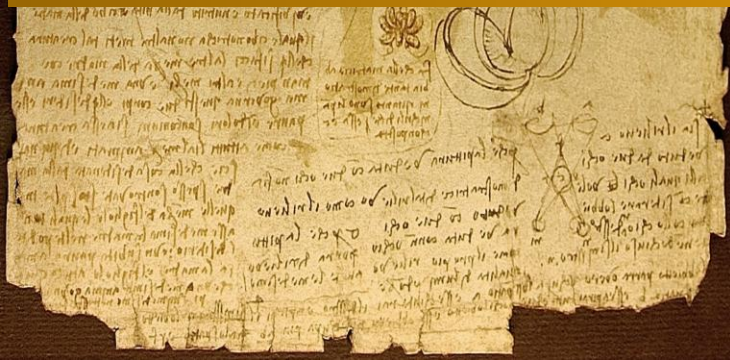
Earliest known map showing Portuguese discoveries of the east and west.

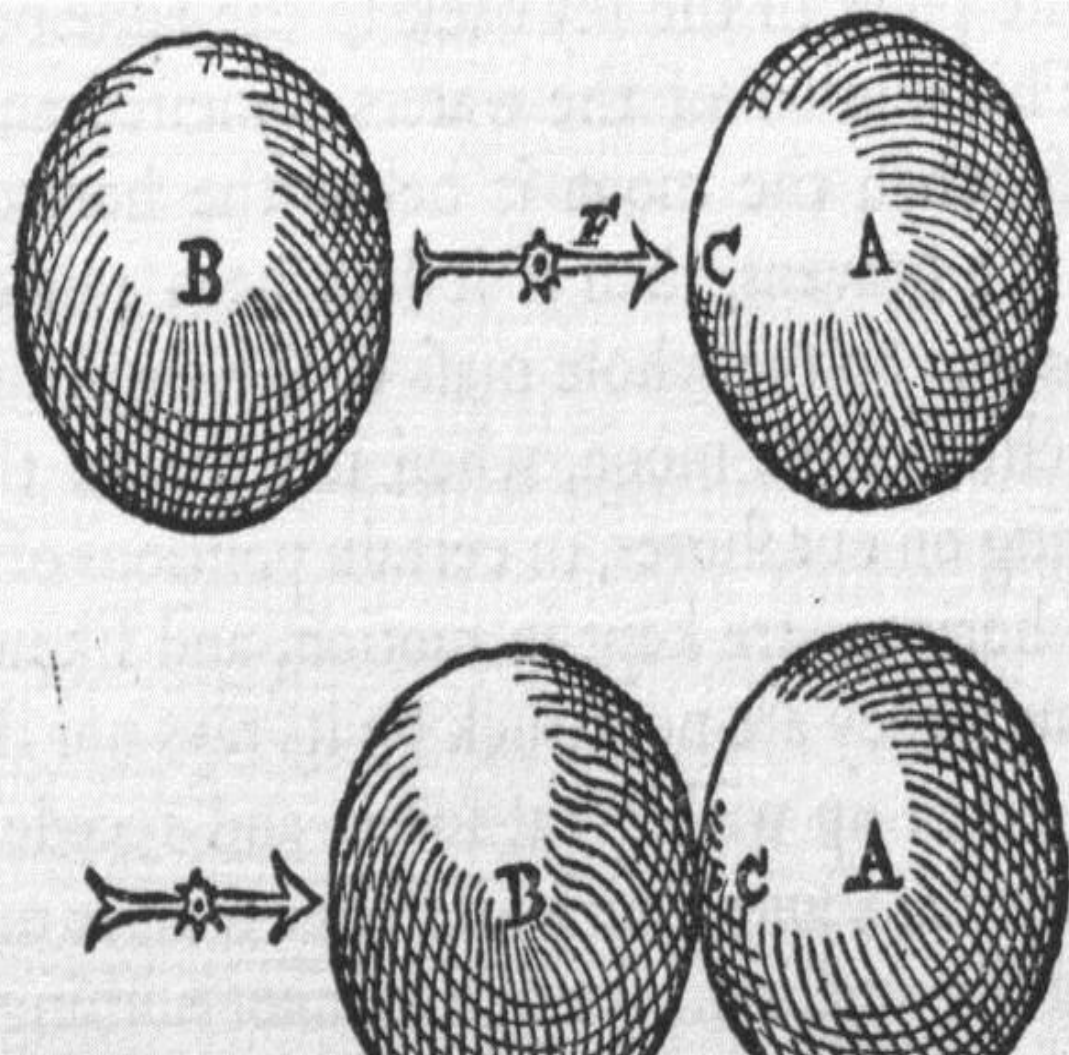
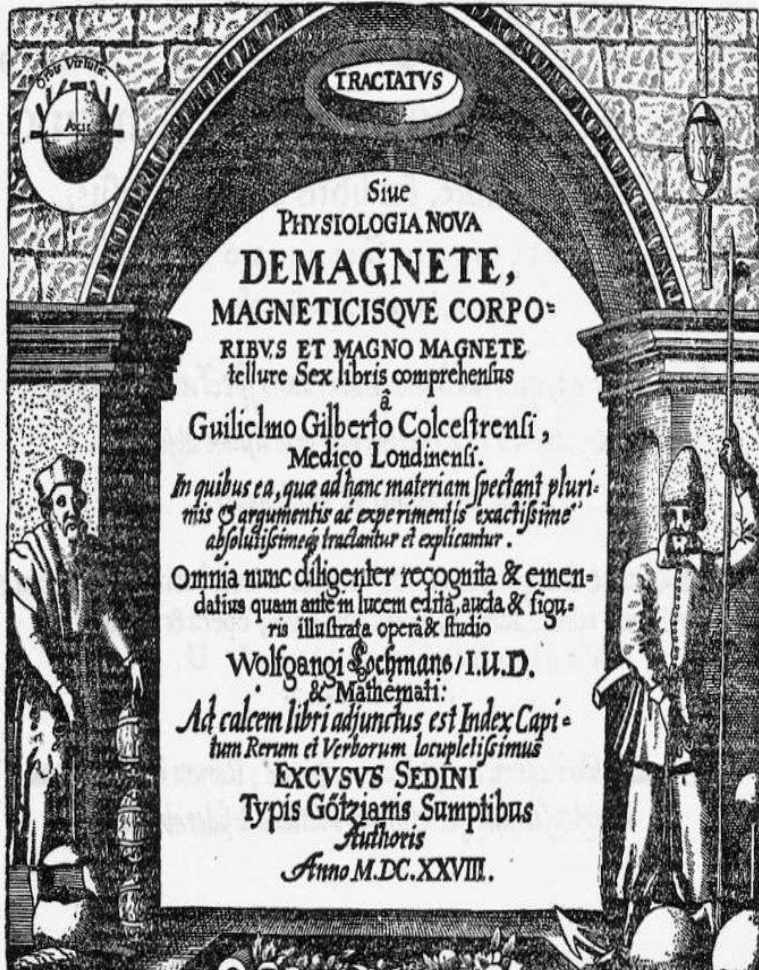




Leonardo da Vinci (1452-1519)

Leonardo's drawings in science and engineering are as impressive as his artistic work.





**“On the Magnet and Magnetic Bodies, and on That Great Magnet the Earth” by William Gilbert (1600)**

**Describes Earth’s magnetic field. Begins the modern science of geomagnetism.**



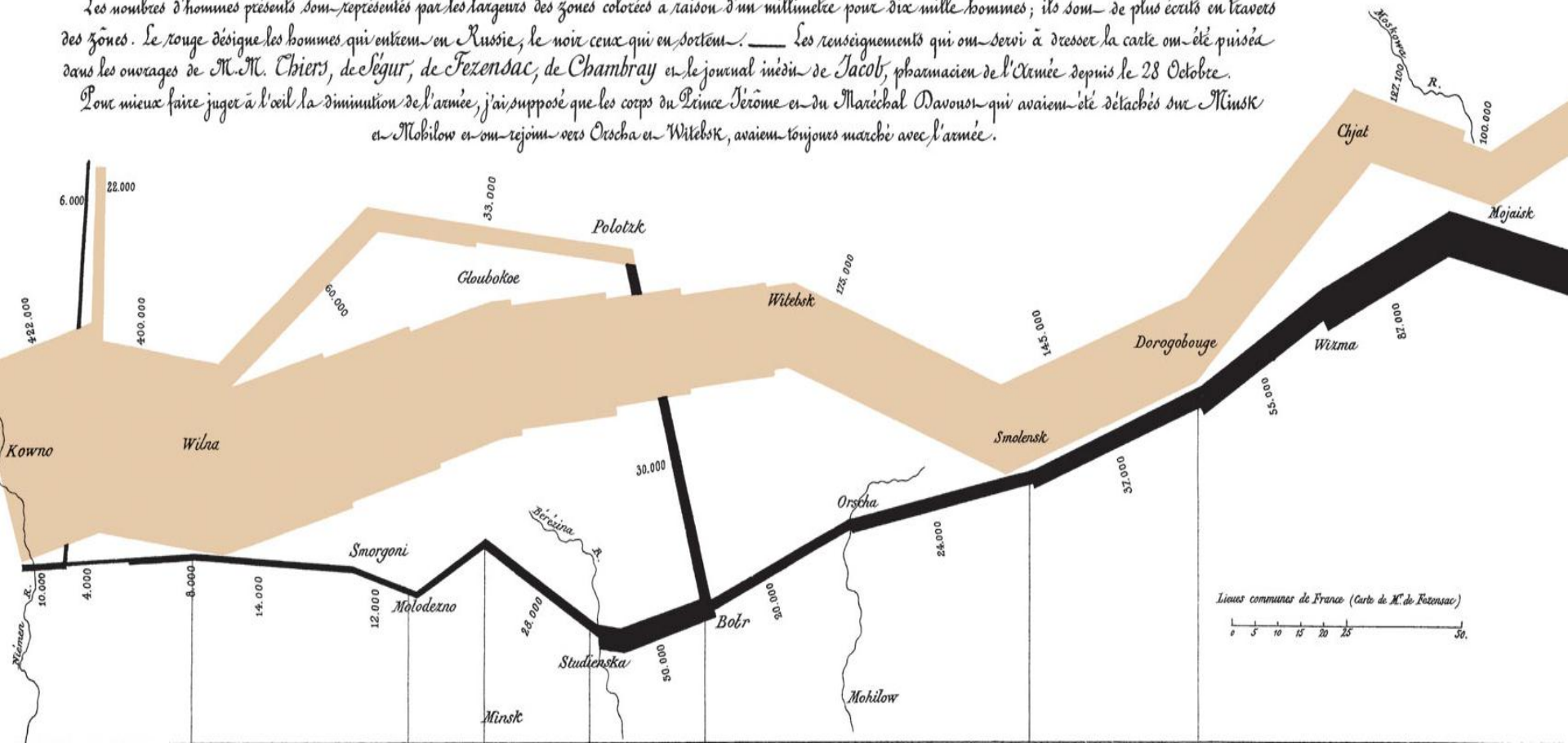


# Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

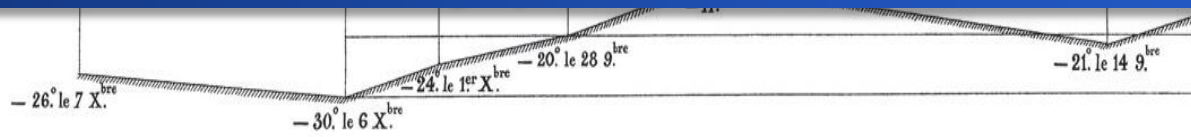
Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Ségur, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davout qui avaient été détachés sur Minsk et Mohilow et ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.

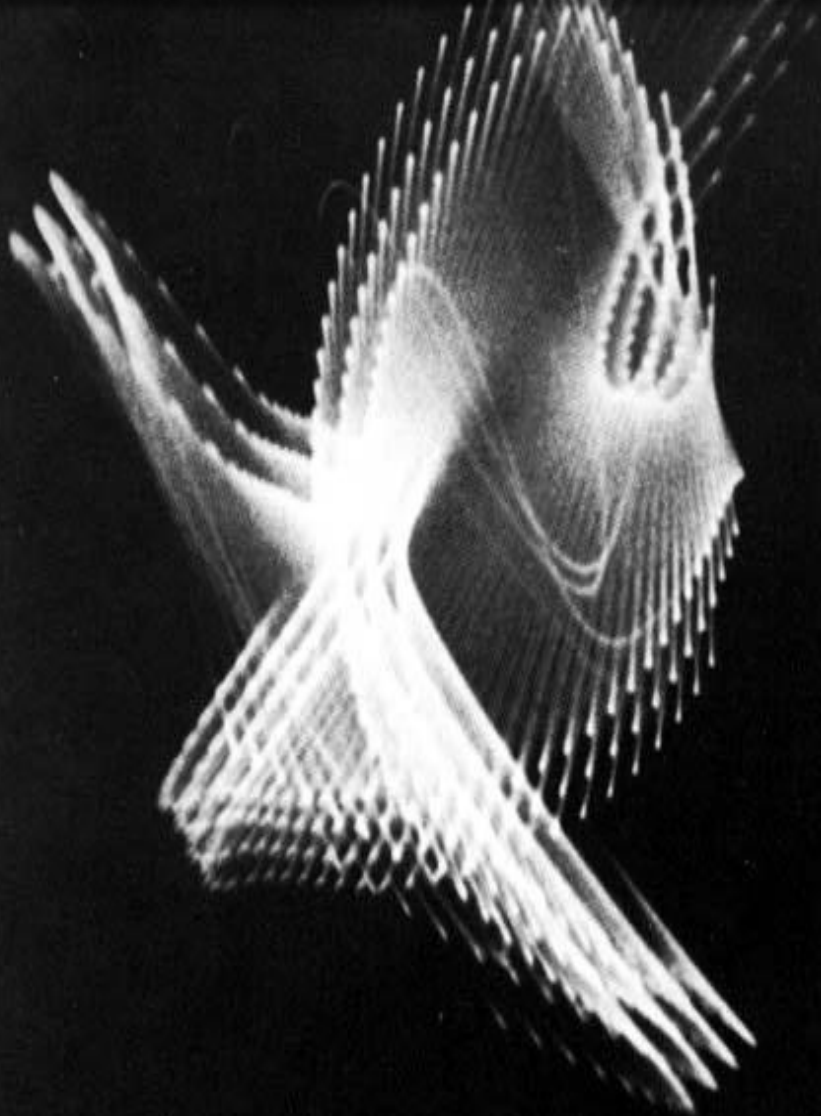


**French Army losses in the 1812 Russian campaign, by Charles Minard (1869)**  
**Infographic shows losses of men, their movements, and temperature.**



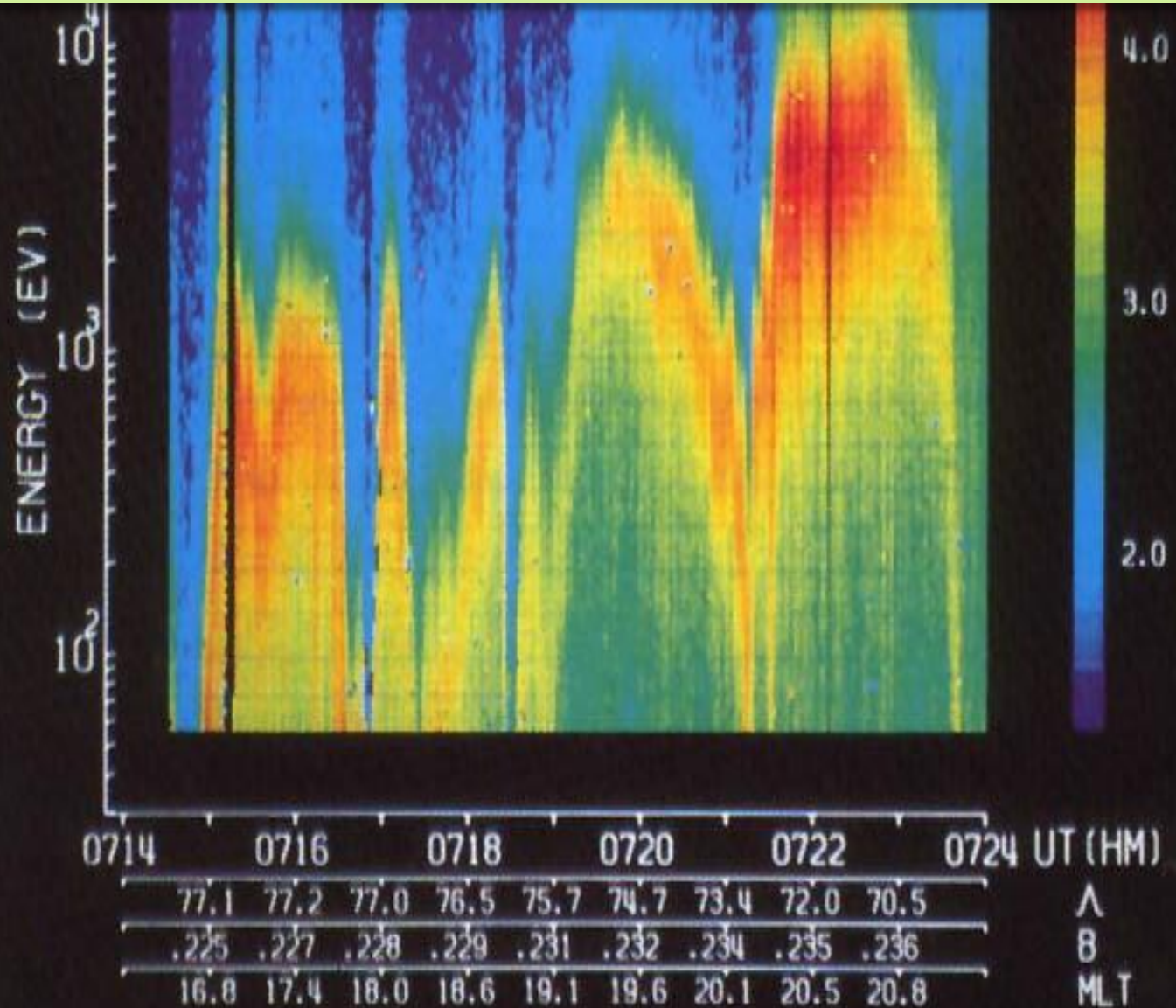
**Oscillons, by Ben Laposky (1950)**

**The first graphic images generated by an electronic (analog) machine.**



# Energy Spectra of Spacecraft Plasma, Dr. Louis Frank (1969)

One of the earliest color visualizations done by computer.



# Sorting out Sorting, Ron Baeker (1981)

Visual demonstration of sort

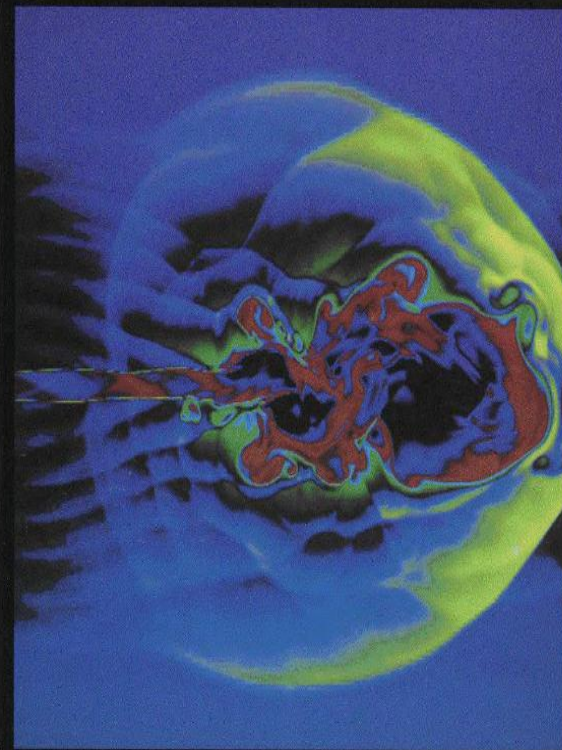
Dynamic Graphics Project

Computer Systems Research C

University of Toronto

## VISUALIZATION IN SCIENTIFIC COMPUTING

Computer Graphics • Volume 21 • Number 6 • November 1987  
Edited by Bruce H. McCormick, Thomas A. DeFanti, Maxine D. Brown  
Published by ACM SIGGRAPH

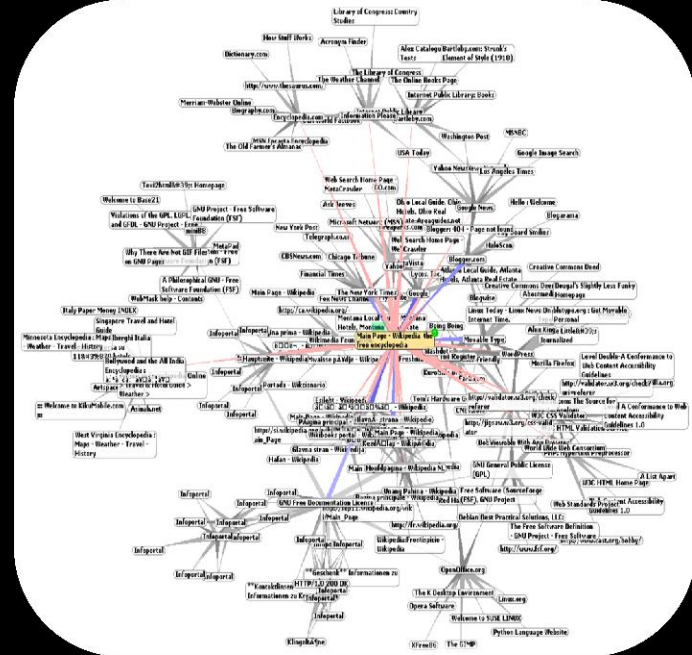
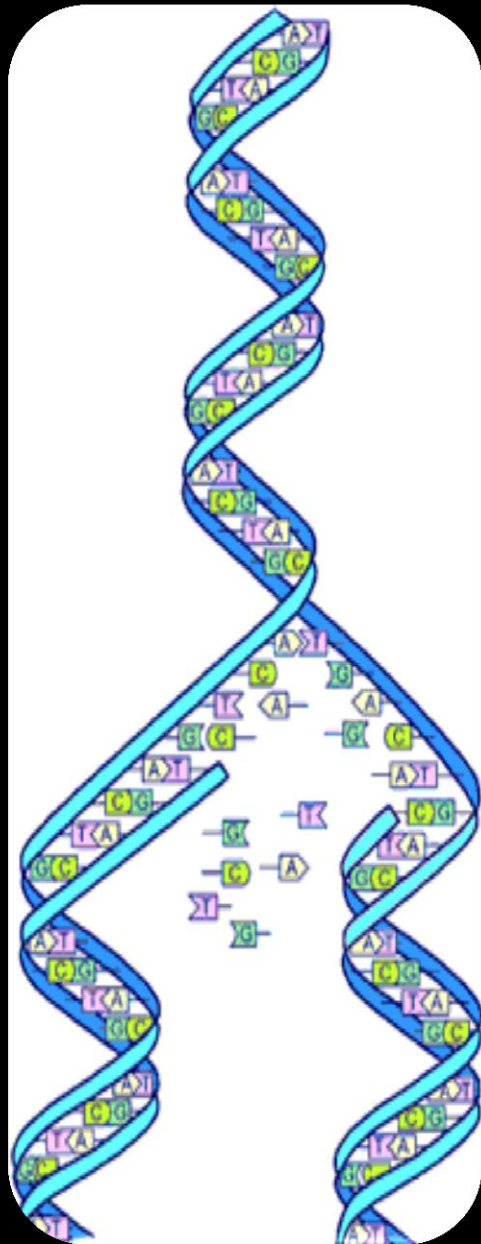


Volume Visualization  
with the  
Pixar  
Image Computer

(C) 1987 Pixar

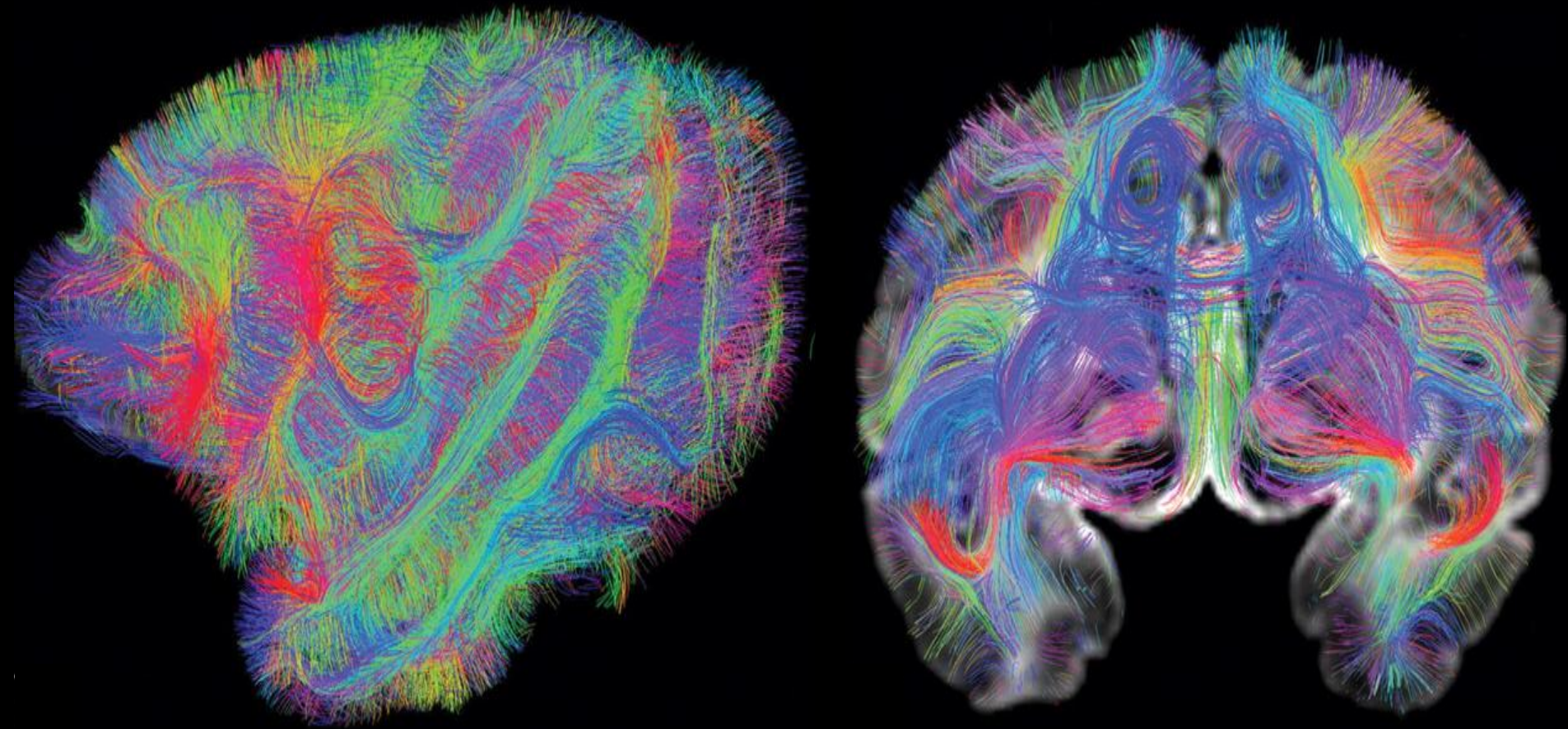
Volume Visualization, Pixar (1987)

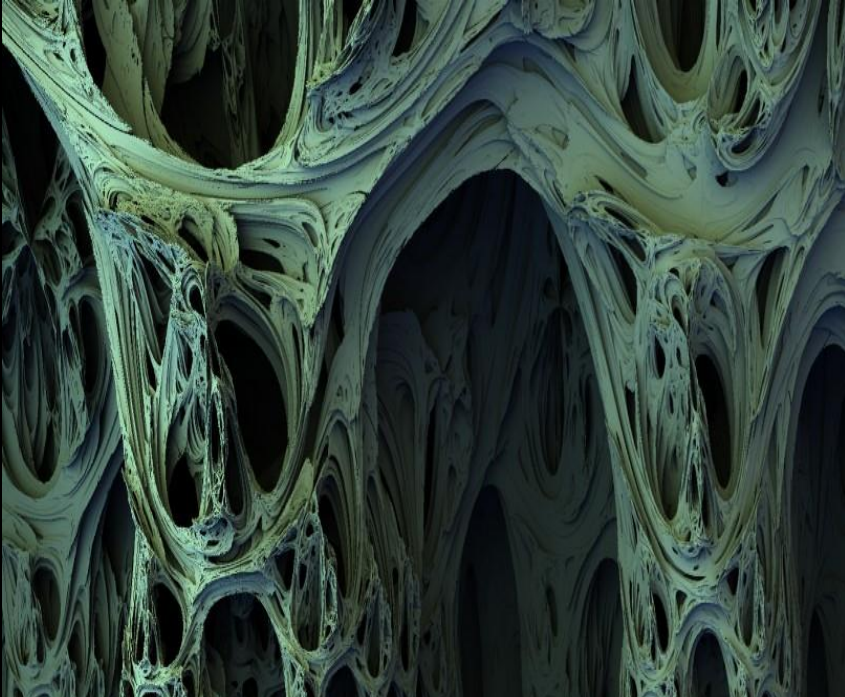
Pixar sold high-end computers.



**DSI Data Set of a Monkey Brain, by Schmammann J D et al. (2007)**

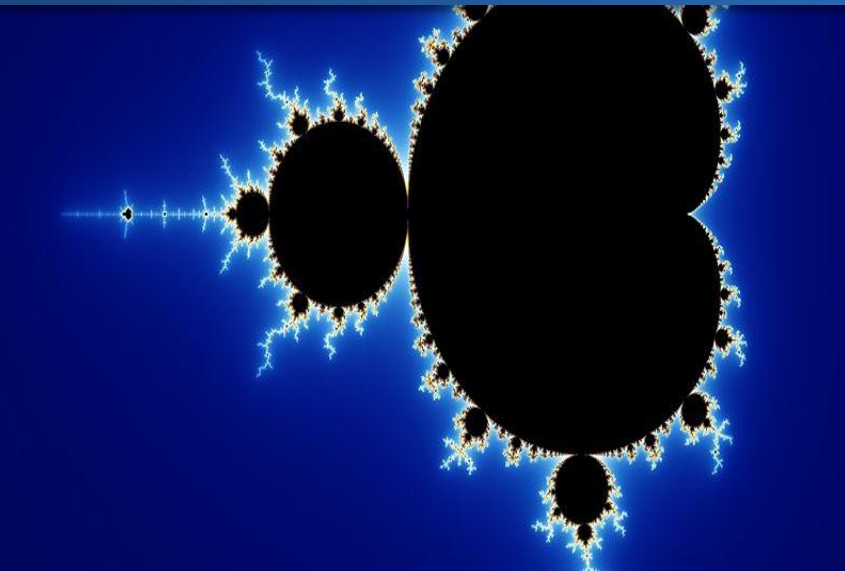
**Fibre pathways shown through diffusion spectrum imaging.**





**3D Mandelbulb, by Daniel White (2009)**

**A 3D version of the 2D Mandelbrot set discovered 30 years earlier**



# Visualizing Friendships, by Paul Butler (2010)

A social graph of 500 million friendships.



facebook

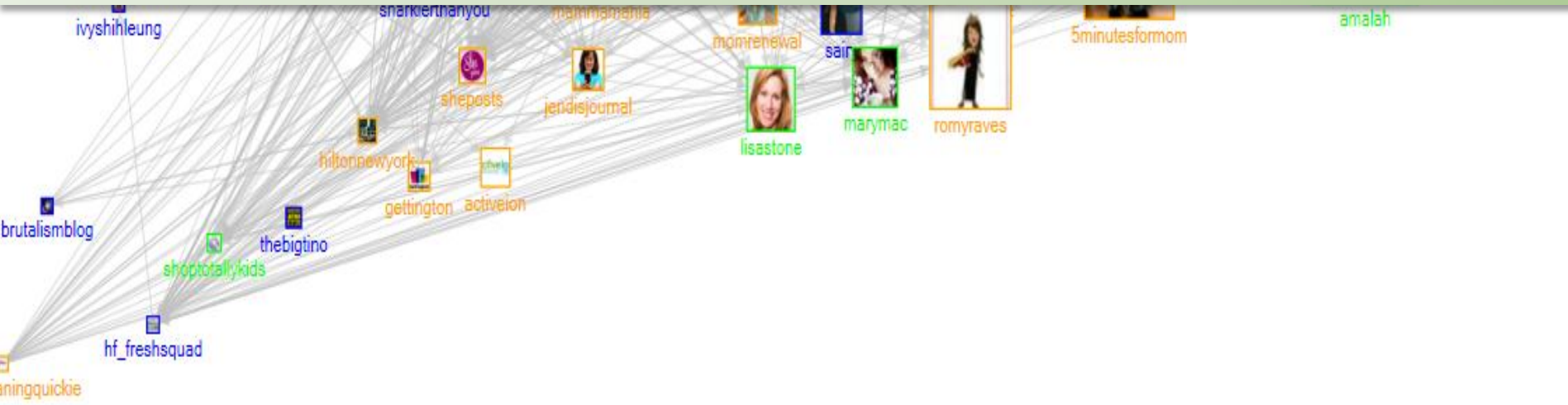
December 2010





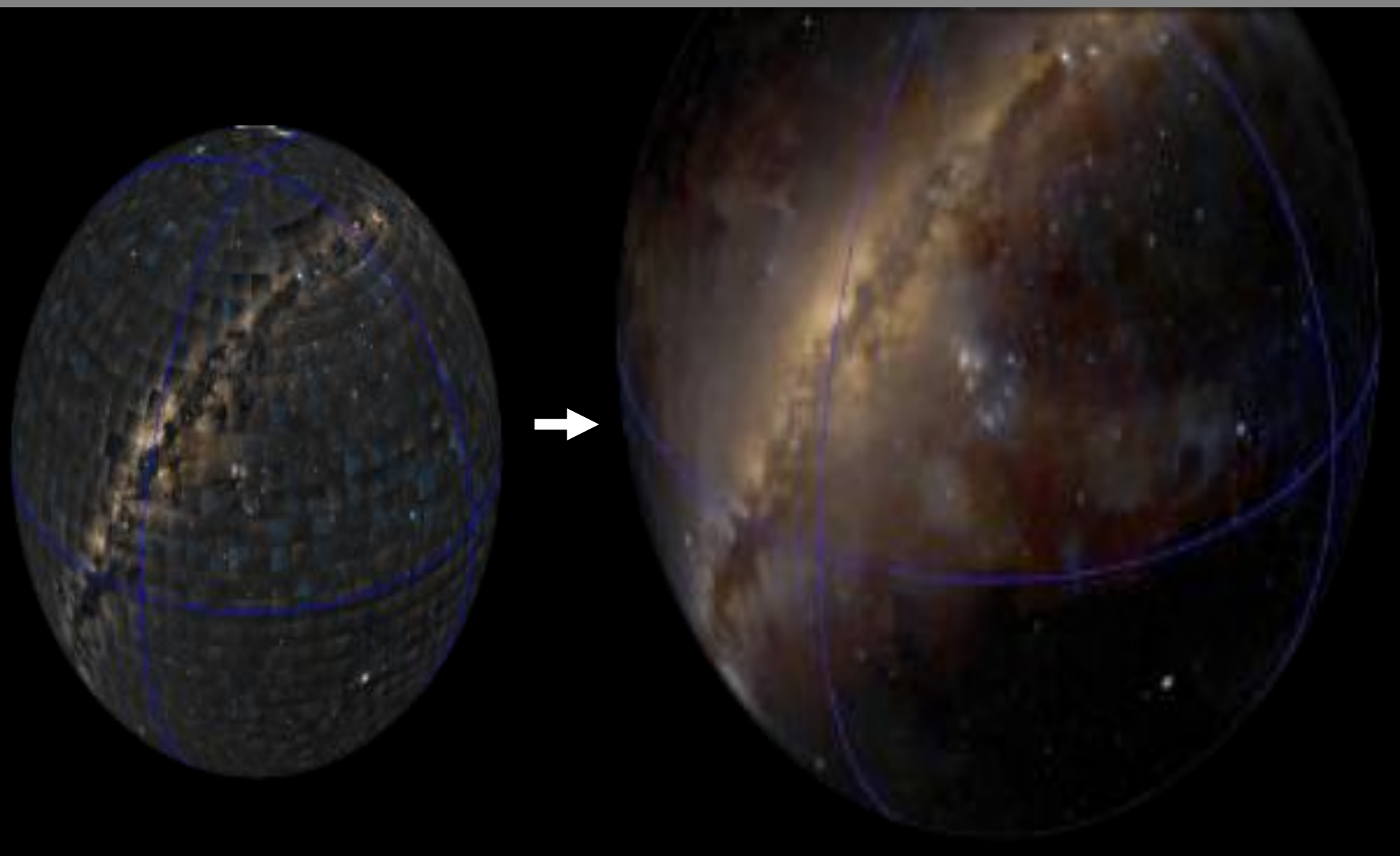
**BlogHer 2010: Influential Twitter Users, by Marc Smith (2010)**

**Social network graph created with Excel and NodeXL.**



Terapixel, by Microsoft Research (2010)

The largest and clearest image of the night sky.



# 3D segmentation and visualization of medical images

*A. Criminisi, T. Sharp, A. Blake and D. Robertson  
Microsoft Research Cambridge, UK*

<http://research.microsoft.com/projects/medicalimageanalysis/>

**Medical Image Analysis, by Microsoft Research Cambridge (2011)**

**Interactive segmentation and identification of patient scans.**

# A PERIODIC TABLE OF VISUALIZATION METHODS

<b>C</b> continuum	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><b>Data Visualization</b> Visual representations of quantitative data in schematic form (either with or without axes)</p> <p><b>Information Visualization</b> The use of interactive visual representations of data to amplify cognition. This means that the data is transformed into an image, it is mapped to screen space. The image can be changed by users as they proceed working with it</p> <p><b>Concept Visualization</b> Methods to elaborate (mostly) qualitative concepts, ideas, plans, and analyses.</p> </div> <div style="width: 45%;"> <p><b>Strategy Visualization</b> The systematic use of complementary visual representations in the analysis, development, formulation, communication, and implementation of strategies in organizations.</p> <p><b>Metaphor Visualization</b> Visual Metaphors position information graphically to organize and structure information. They also convey an insight about the represented information through the key characteristics of the metaphor that is employed</p> <p><b>Compound Visualization</b> The complementary use of different graphic representation formats in one single schema or frame</p> </div> </div>												<b>G</b> graphic facilitation						
<b>Tb</b> table	<b>Ca</b> cartesian coordinates													<b>Me</b> meeting trace	<b>Mm</b> metro map	<b>Tm</b> temple	<b>St</b> story template	<b>Tr</b> tree	<b>Ct</b> cartoon
<b>Pi</b> pie chart	<b>L</b> line chart													<b>Co</b> communication diagram	<b>Fp</b> flight plan	<b>Cs</b> concept skeleton	<b>Br</b> bridge	<b>Fu</b> funnel	<b>Ri</b> rich picture
<b>B</b> bar chart	<b>Ac</b> area chart	<b>R</b> radar chart cobweb	<b>Pa</b> parallel coordinates	<b>Hy</b> hyperbolic tree	<b>Cy</b> cycle diagram	<b>T</b> timeline	<b>Ve</b> venn diagram	<b>Mi</b> mindmap	<b>Sq</b> square of oppositions	<b>Cc</b> concentric circles	<b>Ar</b> argument slide	<b>Sw</b> swim lane diagram	<b>Gc</b> gant chart	<b>Pm</b> perspectives diagram	<b>D</b> dilemma diagram	<b>Pr</b> parameter ruler	<b>Kn</b> knowledge map		
<b>Hi</b> histogram	<b>Sc</b> scatterplot	<b>Sa</b> sankey diagram	<b>In</b> information lense	<b>E</b> entity relationship diagram	<b>Pt</b> petri net	<b>Fl</b> flow chart	<b>Cl</b> clustering	<b>Lc</b> layer chart	<b>Py</b> minto pyramid technique	<b>Ce</b> cause-effect chains	<b>Tl</b> toulmin map	<b>Dt</b> decision tree	<b>Cp</b> cpm critical path method	<b>Cf</b> concept fan	<b>Co</b> concept map	<b>Ic</b> iceberg	<b>Lm</b> learning map		
<b>Tk</b> tukey box plot	<b>Sp</b> spectrogram	<b>Da</b> data map	<b>Tp</b> treemap	<b>Cn</b> cone tree	<b>Sy</b> system dyn./ simulation	<b>Df</b> data flow diagram	<b>Se</b> semantic network	<b>So</b> soft system modeling	<b>Sn</b> synergy map	<b>Fo</b> force field diagram	<b>Ib</b> ibis argumentation map	<b>Pr</b> process event chains	<b>Pe</b> pert chart	<b>Ev</b> evocative knowledge map	<b>V</b> Vee diagram	<b>Hh</b> heaven 'u' hell chart	<b>I</b> infomural		

**Cy** Process Visualization

**Hy** Structure Visualization

Overview  
 Detail

Detail AND Overview

Divergent thinking

Convergent thinking

Note: Depending on your location and connection speed it can take some time to load a pop-up picture.

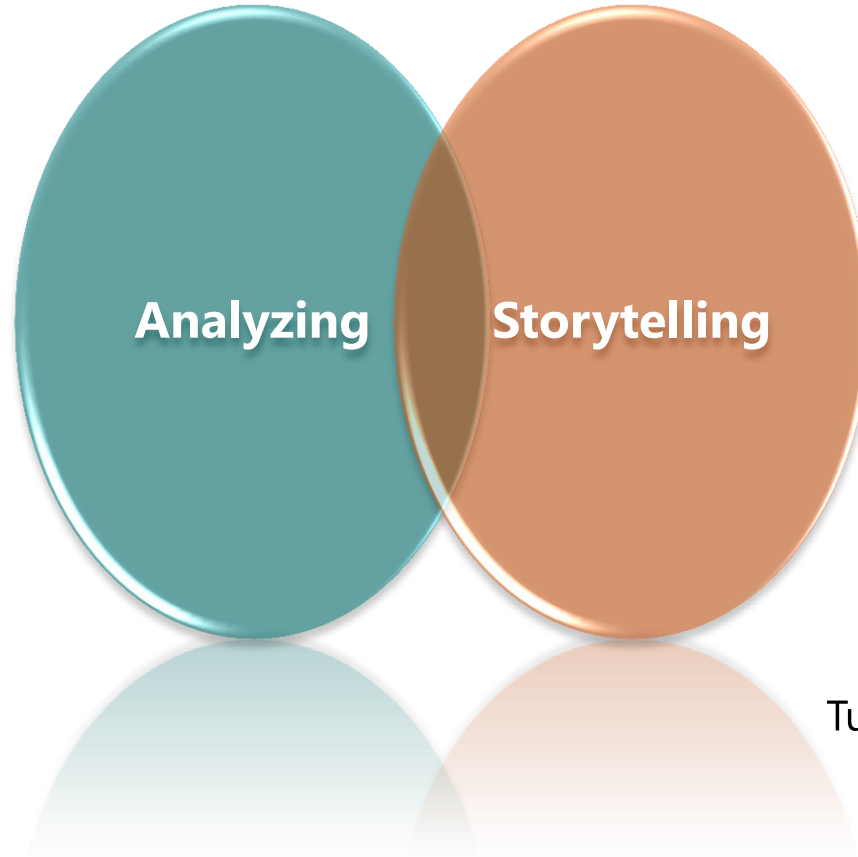
version 1.5

© Ralph Lengler & Martin J. Eppler, [www.visual-literacy.org](http://www.visual-literacy.org)

<b>Su</b> supply demand curve	<b>Pe</b> performance charting	<b>St</b> strategy map	<b>Oc</b> organisation chart	<b>Ho</b> house of quality	<b>Fd</b> feedback diagram	<b>Ft</b> failure tree	<b>Mq</b> magic quadrant	<b>Ld</b> life-cycle diagram	<b>Po</b> porter's five forces	<b>S</b> s-cycle	<b>Sm</b> stakeholder map	<b>Is</b> ishikawa diagram	<b>Tc</b> technology roadmap
<b>Ed</b> edgeworth box	<b>Pf</b> portfolio diagram	<b>Sg</b> strategic game board	<b>Mz</b> mintzberg's organigraph	<b>Z</b> zwickly's morphological box	<b>Ad</b> affinity diagram	<b>De</b> decision discovery diagram	<b>Bm</b> bcg matrix	<b>Stc</b> strategy canvas	<b>Vc</b> value chain	<b>Hy</b> hype-cycle	<b>Sr</b> stakeholder rating map	<b>Ta</b> taps	<b>Sd</b> spray diagram

Individual research  
and analysis

Turns data and information  
into **my** knowledge



Publishing and sharing

Teaching and learning

Turns data and information  
into **our** knowledge

**Microsoft Research visualizations in the near future...**

# Rich Interactive Narratives



## MICROSOFT RESEARCH TECHFEST 2011

Jump in and explore 17 of Microsoft Research's most exciting projects on display during TechFest 2011. This Rich Interactive Narrative enables you to delve more deeply into the research through the eyes and ears of the researcher—all made possible by the use of Microsoft Research technologies.

This is a preview of the Rich Interactive Narratives technology created by Microsoft® Research. The narratives are best experienced in full-screen mode with an internet connection speed of 2 Mbps or higher.

# ChronoZoom: History in its broadest possible context

Challenge: The exploration of Big History, with smooth transition from billions of years down to individual nanoseconds.

This is what Walter Alvarez, Professor of Earth and Planetary Science at University of Berkeley set out to do. And he did it, with the help of Microsoft Research and the Live Labs team.

*A service that allows researchers to browse, overlay, and explore interdisciplinary data sources*





# ChronoZoom: History in its broadest possible context

The image shows a screenshot of the ChronoZoom website. At the top, there is a horizontal bar with various colored segments representing different historical periods. Below this bar, three main sections are visible: "Pre-Roman Italy" (green), "Roman Italy" (cyan), and "Post-Roman Italy" (yellow). The "Roman Italy" section contains a sub-section titled "Periodization strategy for Roman Italy" with descriptive text. Below these sections is a large blue area with the title "Historical Italy" in large black font. Underneath the title, there is a section titled "A periodized, graphical time line of human history" and another titled "Periodization of History". The "Periodization of History" section contains two columns of text explaining the concept of periodization and how ChronoZoom uses it. To the right of this text is a small thumbnail image of a grid-like interface. The overall layout is clean and organized, with a clear focus on the historical periods of Italy.

## Pre-Roman Italy

## Roman Italy

## Post-Roman Italy

### Periodization strategy for Roman Italy

# Historical Italy

## A periodized, graphical time line of human history

### Periodization of History

Periodization is the dividing up of history into coherent chronological segments. This is done to make it possible to see historical patterns, and to recognize when major change has occurred.

ChronoZoom/Student uses periodization to make it easy to see and remember historical patterns, to learn the dates needed as a framework for understanding the past, and to dig deeper and deeper into the topics that interest you. Keep in mind that history is not really this neat and organized. ChronoZoom's periodizations are significant only to help you acquire a broad overview in the early steps of studying history.

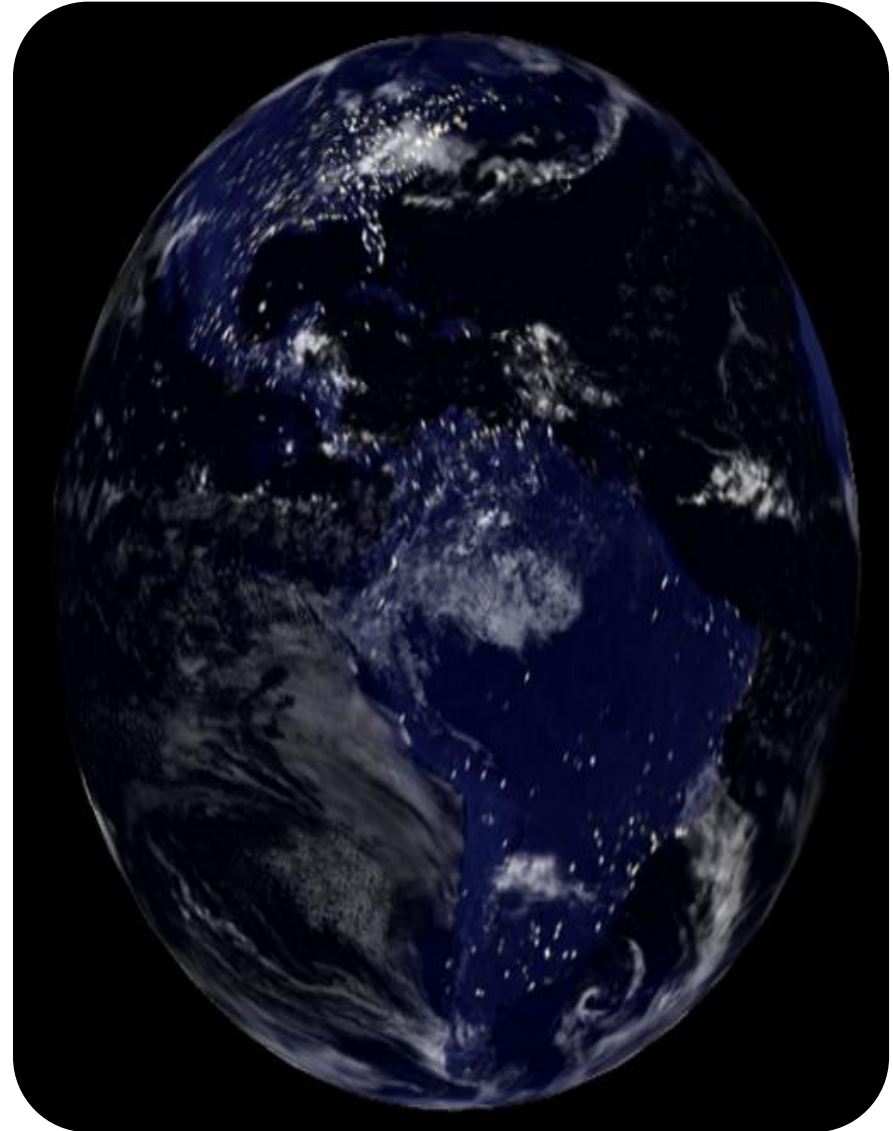
For those interested in a general overview of the human history of Italy, it is useful to have a periodization on the dramatic emergence of Rome as the greatest power in European and Mediterranean Antiquity. Thus the ChronoZoom time line is periodized into Pre-Roman Italy, Roman Italy, and Post-Roman Italy.

If you are interested, the technical article to the right will let you explore in depth the idea of periodization, and to understand how periodization of human history differs from the way geologists and paleontologists divide up the history of Earth and of life into formal time units.

# Worldwide Telescope | Earth

- A seamless visual environment
- Sky and earth-based visualizations
- Create and share tours of your data

*Introducing an Excel Add-in  
for geo-spatial data  
visualizations*





Cooperation through the sharing of data and information generates new knowledge.

**“If I have seen a little further it is by standing on the shoulders of Giants.”**

**– Issac Newton, 1676**



<http://research.microsoft.com/Accelerators>