Visualizing Information Spaces

Proposed 1997 ISAT Study

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Visualizing Information Spaces

Today there is much more information available than we can access readily and effectively. The situation is complicated by the fact that we are on the threshold of a vast increase in availablity of information because of new network and computational technologies. Paradoxically, while we continuously process massive amounts of perceptual data as we experience the world, we have perceptual access to very little of the data that resides within our computing systems or that is reachable via network connections. In addition, this information, unlike the world around us, is rarely persented in ways that reflect its rich structure and dynamic character or the requirements of our specific tasks and current situtation.

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Information Visualization 1963 - 1997

Sketchpad: A Man-Machine Graphical Communications System, Proceedings of the Spring Joint Computer Conference, 329-346, 1963.

Nasdaq 55-by-16-foot 100-Screen VideoWall

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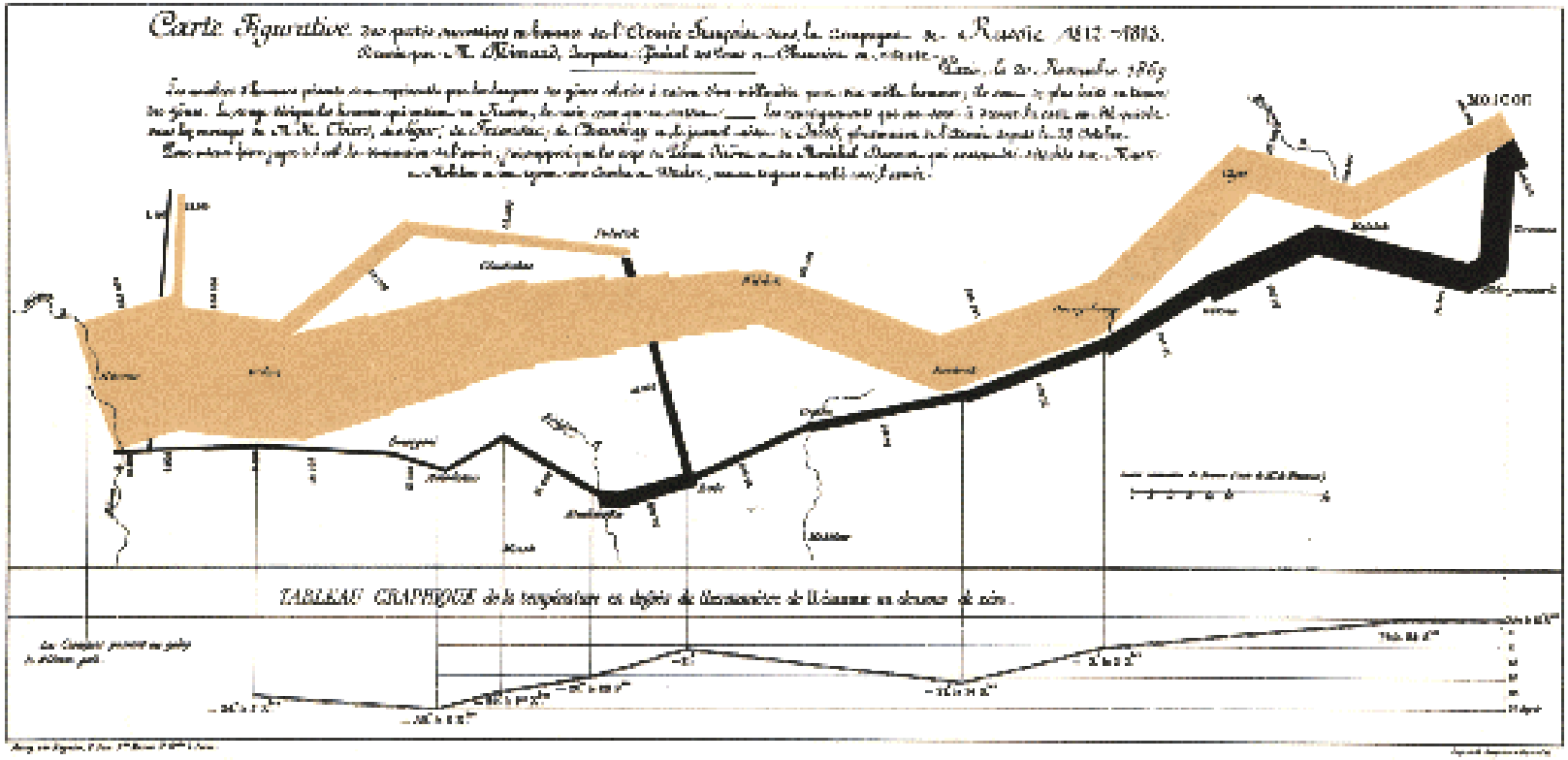
Information Visualization

Charles Joseph Minard (1781-1870) Famous Graphic of Napoleon's 1812 Russian Campaign



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Information Visualization

- **Intellectual Lineage of Most Work Traceable to**
  - Sketchpad
  - Alto
  - Dynabook
- **Unquestioned Presuppositions of Early Systems**
- **Importance of representation, understanding task, understanding cognition, situated nature**
- **Driven By Metaphor**

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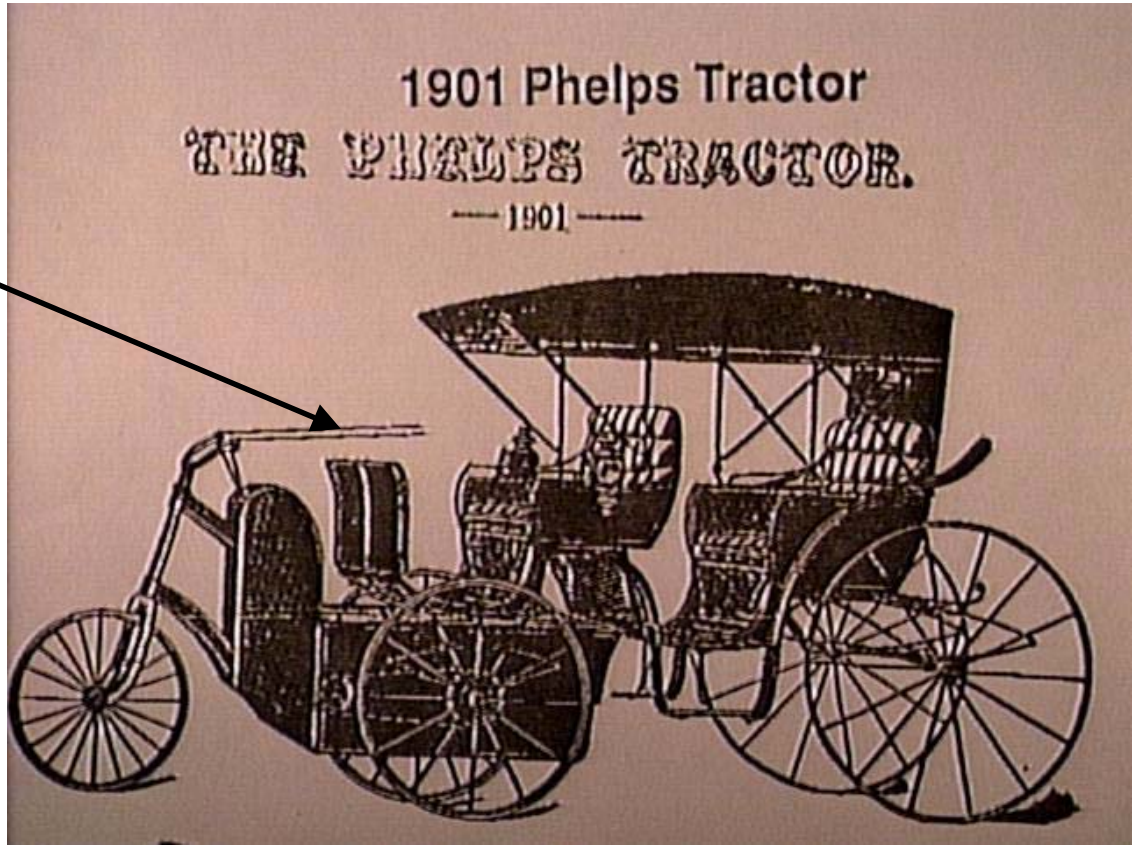
Interface Metaphors

Steam Driven Tractor

Here Pulling a Wagon

Note Interface



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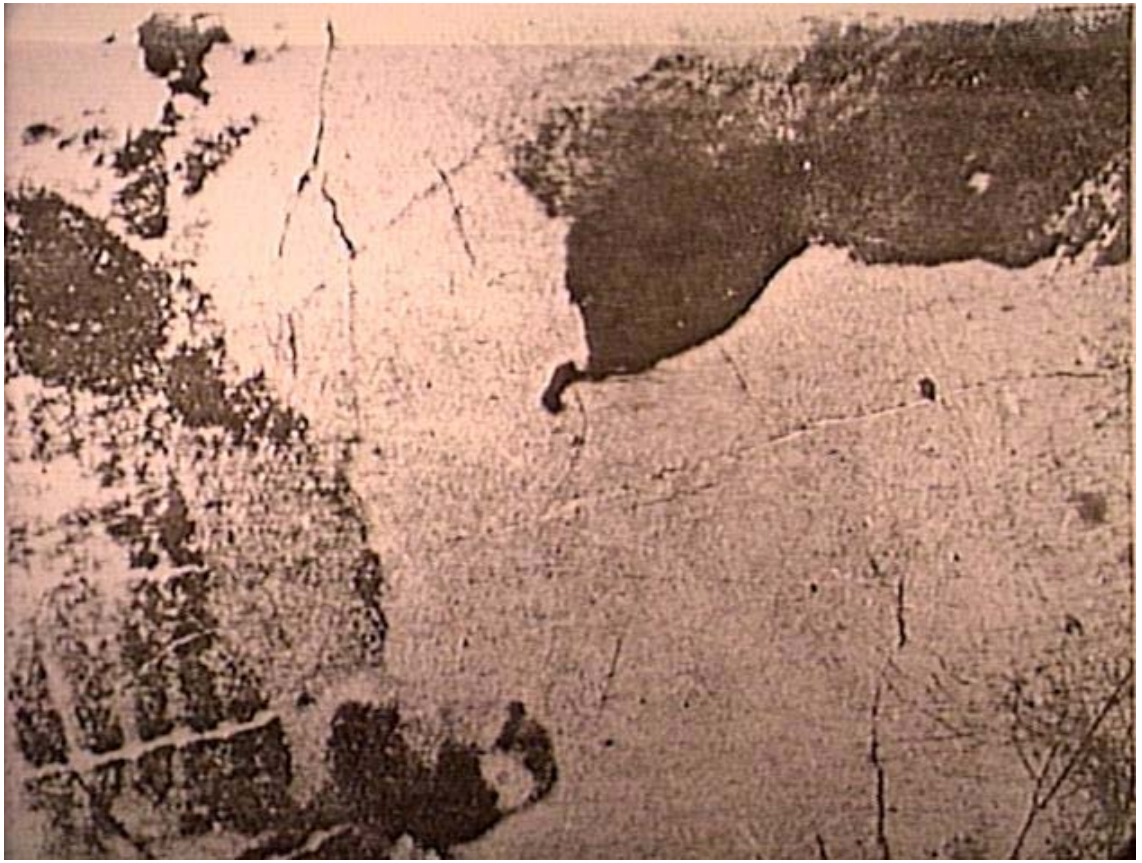
Cognitive Capture

Old Views and
Presuppositions
Difficult To Escape



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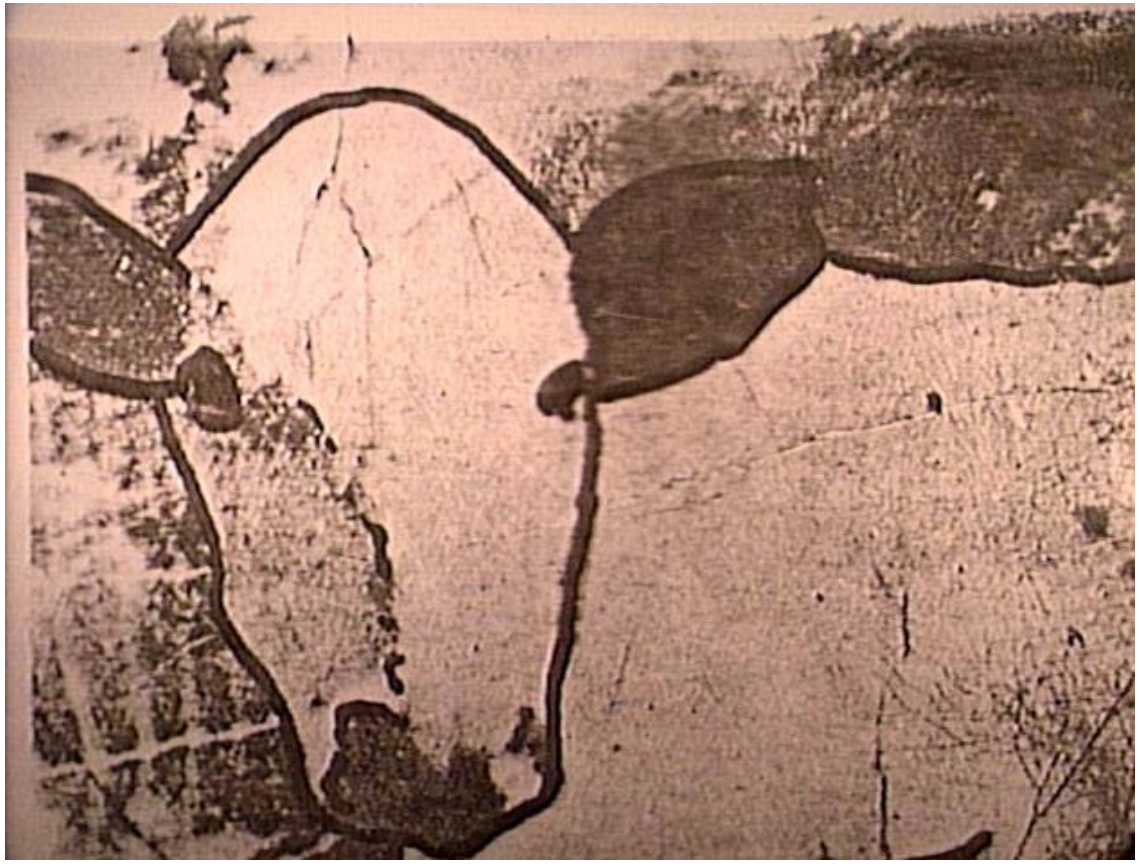
Cognitive Capture

Cognitive Hysteresis



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Information Visualization

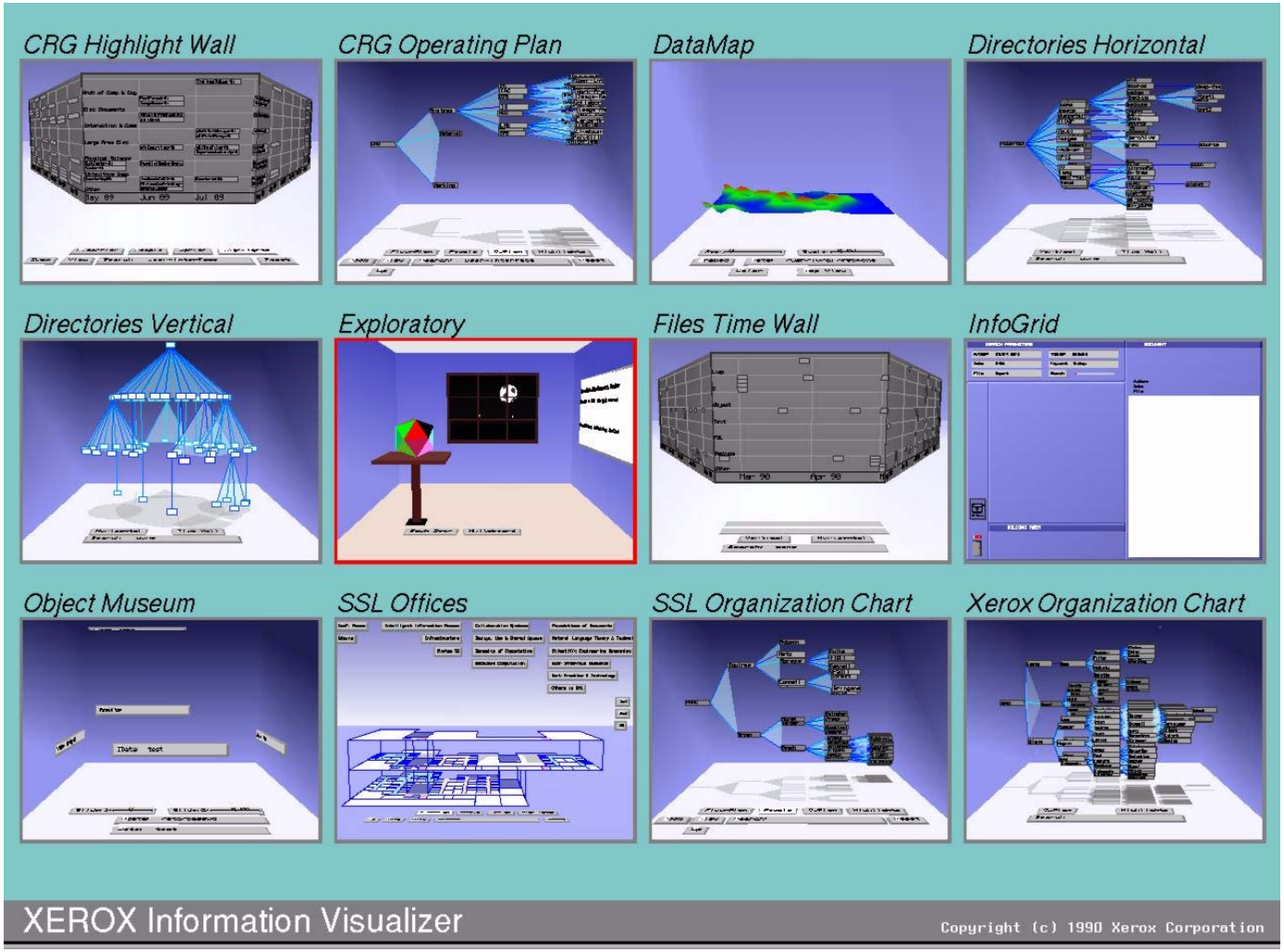
Information Visualizer

Cognitive Co-processor

3D Fisheye

Animation Techniques

Card, Robertson, & Mackinlay, The Information Visualizer, CHI'91.



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Information Visualization

Software Visuailzation

Eich and Colleagues, SeeSoft, CHI'94, Workshop.

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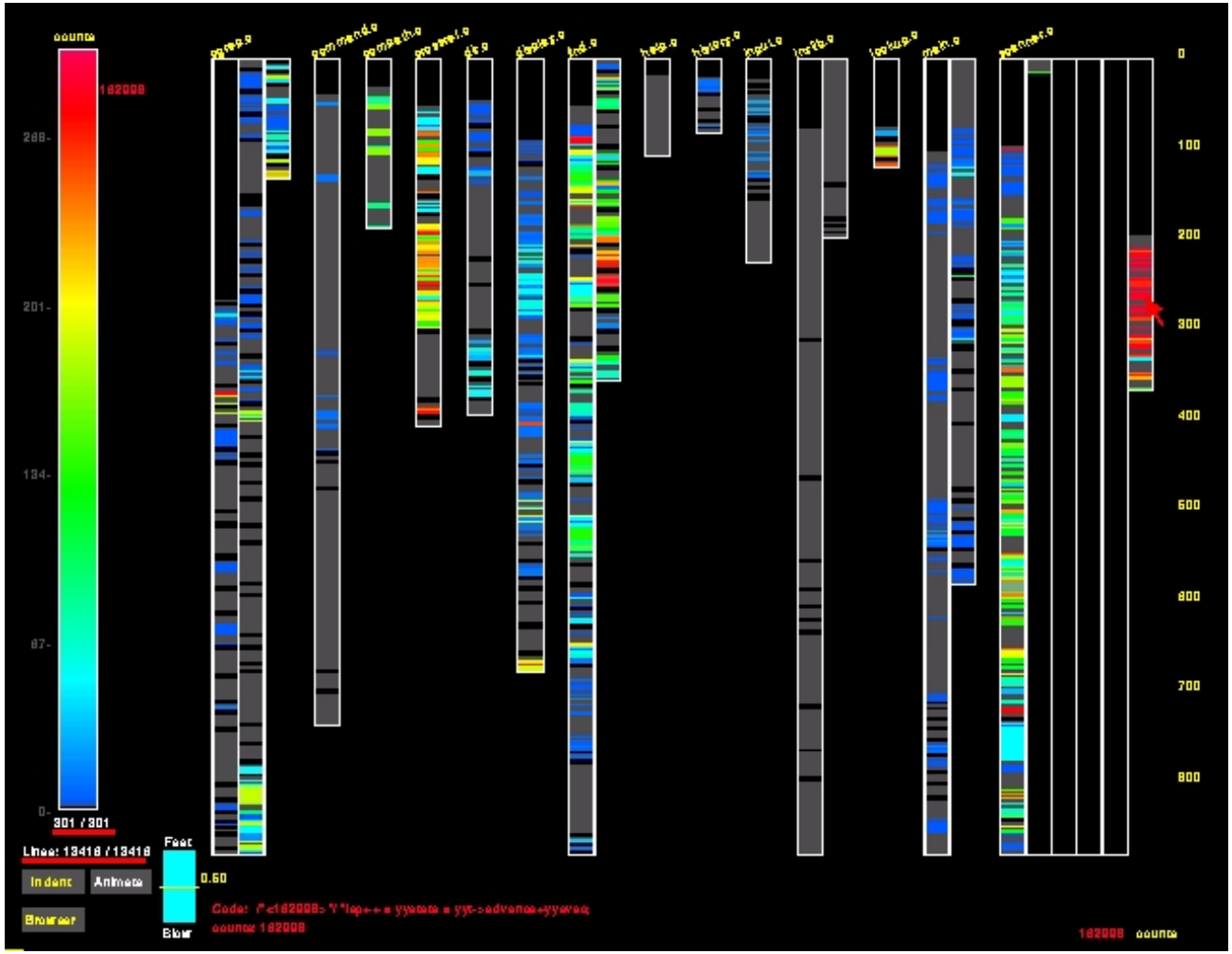

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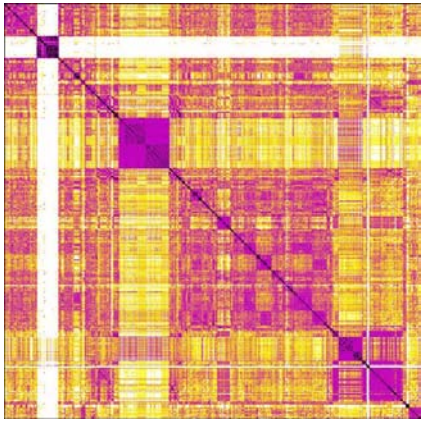
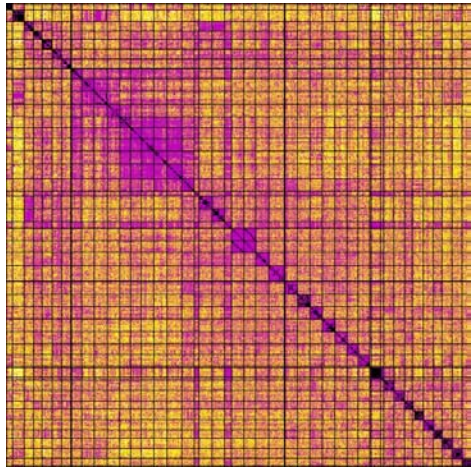
Information Visualization

Left: 2 Million Lines of C

Right: 290,000 Filenames

Bottom: Complete Works of Shakespeare





Church & Helfman, Dotplot: A program for exploring self-simularity in millions of lines of Text and Code, Journal of Computational and Graphical Statistics, 153-174, 1993.

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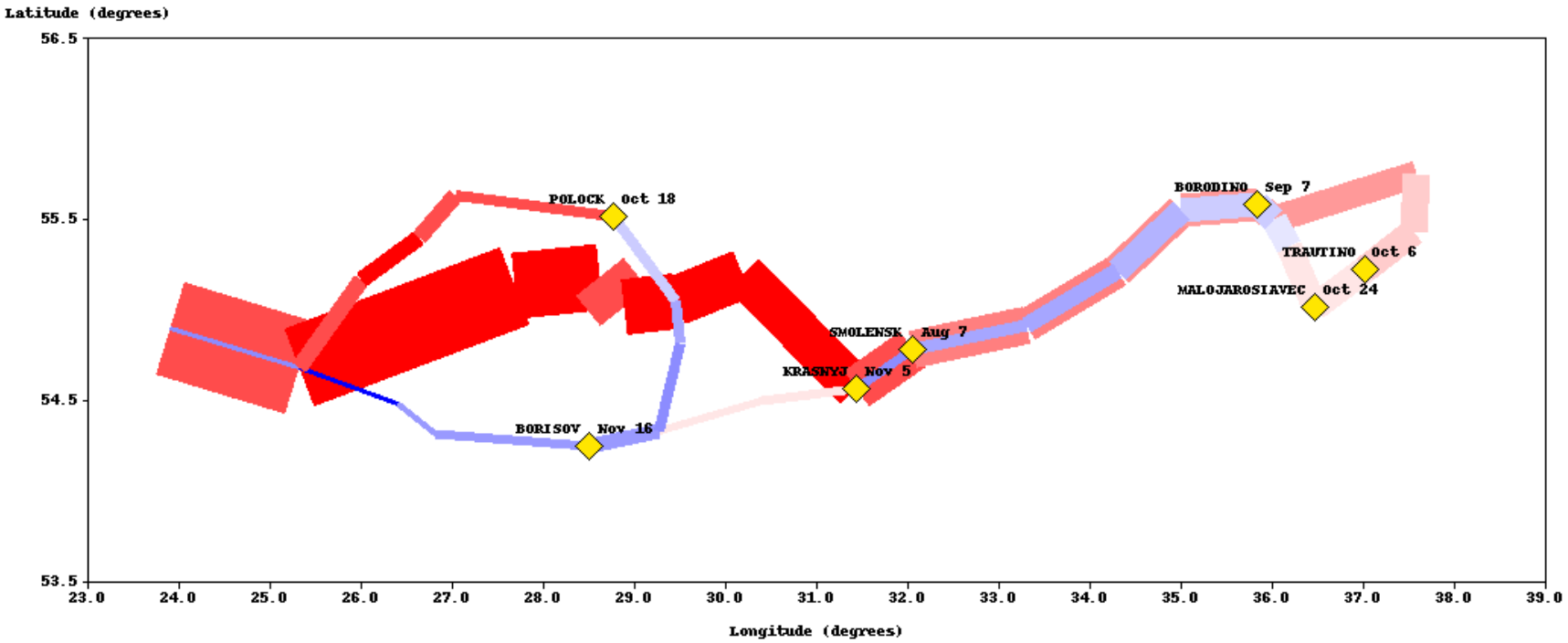
Information Visualization

Sage Version of Minard Graphic of Napoleon's 1812 Russian Campaign



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Information Visualization

- **Pointcast**
- **Financial Visualizations**

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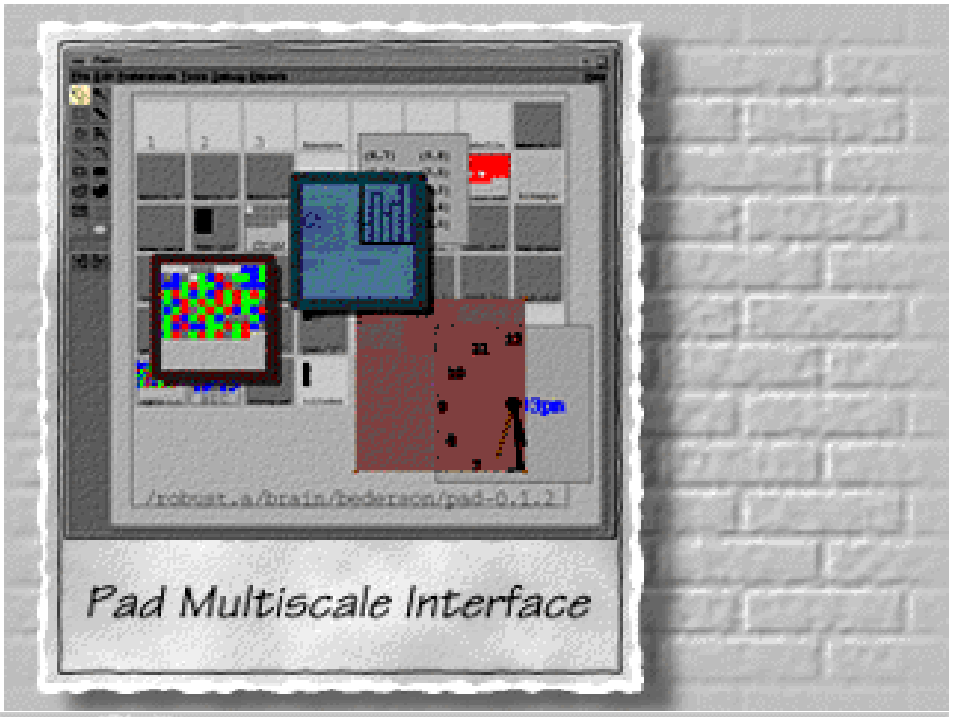
Information Visualization

- **Dynamic Multiscale Interfaces**
- **Infinite Resolution Paper Metaphor**
- **Lenses and Portals**
- **Information Physics**

Bederson, Hollan, Perlin, Meyer, Bacon, & Furnas, Pad++: A Zoomable Graphical Sketchpad for Exploring Alternate Interface Physics, Journal of Visual Languages and Computing, 3-31, 1996.



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Information Visualization

Passive Surfing

Helfman

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Motivation

- **Military Tasks Increasingly Information Intensive**

We live in an age that is driven by information…changing the face of war and how we prepare for it - William Perry 5/94

- **Information Warfare** (Two sides: Protecting and Exploiting)
- **Visualization:** A Key Technology For Leveraging Information-Based Resources
- **Visualizing Information Spaces More Difficult Than Physical Spaces**
- **New Metaphors May Be Required**
- **Information Has A Cost Structure**
- **Being Behind Means Being Mired in the Information Cost Structures of the Past:** Unlikely to Survive and Flourish

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Trends

Connectivity → Compatibility → Coordination

Hardware → Software → Human Interface

First Era Focus: Techniques To Abstract The World and Represent In Computers
(Driven By Traditional Computer Science: Programming Languages, Operating Systems, Databases…) *"Getting The Bits In"*

Next Era Focus: Techniques To Change Information Cost Structure and Facilitate Collaboration (Driven By New Computer Science: HCI, Visualization, Information Filtering and Navigation, Security, Collaboration) *"Getting Right Bits To Right People At Right Time"*

Dynamic Collaborative Task-Relevant Information

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Information Cost Structure

One Key to Improving Cost Structure: Perceptualization
Turn Inferences Into Direct Perceptions

Make Abstract Things Perceptually Knowable

Make The Invisible Visible

Make The Abstract Concrete

Make The Complex Simple

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Need for Visualization

- **We Are Fundamentally Perceptual Creatures**
- **Change Cost Structure of Information**
  Value of Information Must Be Greater Than Cost of Obtaining and Managing It
  More is Not Better; Less but Relevant Information Is Best
- **Examples Are "Islands" of Work (Point Solutions)**
- **Need Coherent Framework for Visualization Addressing the Full Information-Requirements of the Military**
- **Bottleneck Is Task-Specific Impedence Match With Users and Their Work**
- **New Workspaces: Not Only See Relationships But Also Manipulate, Communicate, Collaborate, and Control Applications**

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- **Need Human-Centered Information Services**
  - Coherent Framework for Visualization Research Addressing the Full Information Requirements of the Military
  - Task Models and tools that exploit these models to bridge the gap from a human effort to simple, clear, and processable underlying structures
  - Tools for task switching and domain switching to simple task models become composable
  - Clear mapping of explicit models and their resutls into cognitively effective representations.

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Why Visualization Is So Difficult

Disappearing Boundaries

- **Between Applications: Support Real Tasks**
- **Between Machines: Distributed Computing**
- **Between Media: Video, Film, Sound, Graphics, Communications, and Computation**
- **Between People: Support Organizations, CSCW, Distributed Cognition**

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Visualization

- **Scientific Visualization**

example images

- **Information Visualization**

example images

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Strategic Issues

- **New Theoretical Frameworks and Representations**
- **New Metaphors**
- **Paradigm Shifts**
  - windows to persistent objects
  - individuals to collaboration
  - security
- **Tension Between Commercial and Research Communities**
- **Software Design Environments**
- **Understanding Scale of Activity**
- **Collaboration**

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Study Questions

- **Can information spaces best be visualized using old metaphors or do wholely new approaches basked upon informational physics hold more promise?**
- **What techniques and key technologies might enable automatic generation of appropriate visualizations of information spaces based upon knowledge of tasks, about humans in general, about preferences of specific users, and about the artifacts, processess, and relationships to be viewed?**
- **What are realistic scenarios and applications that will benefit most from enhanced methods to visualize information spaces?**

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Study Questions

- **What aspects of information spaces must (can) be viewable?**
- **What roles can advanced technologies, such as projecting 3D data into viewing spaces or projecting images directly onto the retina, play in enhancing our ability to visualize information spaces?**
- **Can we find methods to present data perceptually where there is no obvious mapping into 2-D opr 3-D space?**
- **How can people intereact with information and with each other in a distributed and shared information space?**
- **How can all human senses be exploited to perceive information spaces?**

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Study Questions

- **How can multiple modes of visualization be integrated to enhance a user's ability? For example, can a 3-D image of a body have information attached from many sources (e.g. for a human body, blood tests, vital signs, etc.) to places where a user might intuitively expect to find them (e.g. blood pressure in the wrist artery, serium calcium value in the parathyroid hormone, etc.)?**

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Goals for Study

- **Characterize Current State of Information Visualization**
  - Computer Science
  - Cognitive Science
- **Identify *Classes* of Important Research Problems and Common Underlying Bootlenecks and Technology Gaps**
- **New Metaphors For Active Information**
  - Biological
  - Physics
- **Methods To Allow Fully Exploiting Computrons**
- **How To Crystalize Sharing and Development of Common Tools and Environments**

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Why Now?

- **Enormous Push (industry, gov, and military) To Use All Their Information (track inventory, people, and resources worldwide); Need Mature Visualization Research and Design Database To Do It Effectively**
- **Computrons**
  - Moore's Law, Multiprocessing, Networks of Workstations
- **New Inexpensive Hardware**
  - PCs
  - New Graphics Boards
- **Possibility of Common Research and Delivery Platforms**
- **Maturing Techniques**

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Related Studies

P1000 Science and Technology Strategy for Information Visualization: A Roadmap To Provide Information Visualization Technology Broadly Within The Intelligence Community

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Study Participants

Stu Card (Xerox Parc)

George Furnas (Michigan)

Pat Hanrahan (Stanford)

Ed Hutchins (UCSD)

Hiroshi Ishii (MIT Media Lab)

Chris Johnson or Chuck Hansen (Utah)

Bill Lorensen (GE)

Don Norman (Apple)

Steve Roth and Randy Pausch (CMU)

Terry Winograd (Stanford)

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