Envisioning and Communicating Science

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Places & Spaces: Mapping Science
a science exhibit that introduces people to maps of sciences, their makers and users.

Exhibit Curators:
Dr. Katy Börner & Elisha Hardy
http://scimaps.org
Mapping Science Exhibit – 10 Iterations in 10 years

http://scimaps.org/

The Power of Maps (2005)

Science Maps for Economic Decision Makers (2008)


Science Maps for Science Policy Makers (2009)
Science Maps for Scholars (2010)
Science Maps as Visual Interfaces to Digital Libraries (2011)
Science Maps for Kids (2012)
Science Forecasts (2013)

The Power of Forecasts (2007)

How to Lie with Science Maps (2014)

Exhibit has been shown in 72 venues on four continents. Currently at
- NSF, 10th Floor, 4201 Wilson Boulevard, Arlington, VA
- Wallenberg Hall, Stanford University, CA
- Center of Advanced European Studies and Research, Bonn, Germany
- Science Train, Germany.

Science Maps in “Expedition Zukunft” science train visiting 62 cities in 7 months, 12 coaches, 300 m long. Opening was on April 23rd, 2009 by German Chancellor Merkel, [http://www.expedition-zukunft.de](http://www.expedition-zukunft.de).

**Computational Scientometrics:**

**Studying Science by Scientific Means**

- **Places & Spaces: Mapping Science** exhibit, see also [http://scimaps.org](http://scimaps.org).
Science Maps

➢ For Science Navigation & Management (2005)
➢ As Reference System (2006)
➢ As Forecasts (2007)
Science Maps

- For Economic Decision Makers (2008)
- For Science Policy Makers (2009)
- For Scholars (2010)
- As Visual Interfaces to Digital Libraries (2011)
- For Kids (2012)
- As Science Forecasts (2013)

2002 ‘Base Map’ of Science


- Uses combined SCI/SSCI from 2002
  - 1.07M papers, 24.5M references, 7,300 journals
  - Bibliographic coupling of papers, aggregated to journals
- Initial ordination and clustering of journals gave 671 clusters
- Coupling counts were reaggregated at the journal cluster level to calculate the
  - (x,y) positions for each journal cluster
  - by association, (x,y) positions for each journal
Science map applications: Identifying core competency

**Funding patterns of the US Department of Energy (DOE)**

![Diagram of US Department of Energy funding patterns](image1)

**Funding Patterns of the National Science Foundation (NSF)**

![Diagram of National Science Foundation funding patterns](image2)
Science map applications: Identifying core competency

Funding Patterns of the National Institutes of Health (NIH)

Topical Composition and Knowledge Flow Patterns in Chemistry Research for 1974 and 2004
Kevin W. Boyack, Katy Börner, & Richard Klavans (2007)

Chemistry - Biology Interface

1974

2004

Number of papers by cluster
Fraction of papers by cluster
Knowledge flows cluster to cluster
Science Maps

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Mapping the Evolution of Co-Authorship Networks
Studying the Emerging Global Brain: Analyzing and Visualizing the Impact of Co-Authorship Teams


Research question:
- Is science driven by prolific single experts or by high-impact co-authorship teams?

Contributions:
- New approach to allocate citational credit.
- Novel weighted graph representation.
- Visualization of the growth of weighted co-author network.
- Centrality measures to identify author impact.
- Global statistical analysis of paper production and citations in correlation with co-authorship team size over time.
- Local, author-centered entropy measure.
Spatio-Temporal Information Production and Consumption of Major U.S. Research Institutions


Research questions:
1. Does space still matter in the Internet age?
2. Does one still have to study and work at major research institutions in order to have access to high quality data and expertise and to produce high quality research?
3. Does the Internet lead to more global citation patterns, i.e., more citation links between papers produced at geographically distant research institutions?

Contributions:
- Answer to Qs 1 + 2 is YES.
- Answer to Qs 3 is NO.
- Novel approach to analyzing the dual role of institutions as information producers and consumers and to study and visualize the diffusion of information among them.

Illuminated Diagram Display


Questions:
- Who is doing research on what topic and where?
- What is the ‘footprint’ of interdisciplinary research fields?
- What impact have scientists?

Contributions:
- Interactive, high resolution interface to access and make sense of data about scholarly activity.
Re-implementation of Illuminated Diagram Software
by Advanced Visualization Lab, Indiana University

Drives unlimited number of ID screens.

Touch screen for direct interaction.
Keyword and name search.
Selection of canned queries for:
- interdisciplinary research areas
- famous people
- activity patterns, e.g., bursts, trends, etc.

Geographic Map: Where Science Gets Done
TOPIC MAP: HOW SCIENTIFIC PARADIGMS RELATE
Science Maps

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- For Kids (2012)
- As Science Forecasts (2013)
Teaching Children the Structure of Science

- How can children start to understand the complex interplay of the different sciences?
- How can they get an intuitive understanding of the importance of math and how much it is needed to succeed in many if not all of the other sciences?
- What does it mean for teaching, learning, and job opportunities if the biomedical sciences account for 50% of all sciences?
- Can we make them see the central position of computer science and its evolving symbiosis with all other aptly named ‘computational X’ sciences?
- Can we offer them a means to see the emergence and evolution of new sciences, e.g., nano* or neuro*?
- How can we empower them to search for a certain expertise in the correct scientific discipline?
- How can we teach them to appreciate the very diverse cultures, research approaches, and languages that exist in the different sciences and enable them to ‘speak’ more than one science in order to collaborate across scientific boundaries?
- Last but not least, how can we engage children in the work of real scientists, have them share the excitement of discovery, and allow them to find their own ‘place’ in science?
Activities:
Solve the puzzle.
Navigate to 'Earth Science'.
Identify major inventions.
Place major inventors.
Find your dream job on the map.
Why is mathematics important?

There are seven main fields of science. They are:
- Social Science
- Mathematics
- Physics
- Chemistry
- Earth Science
- Biology
- Geology

Earth scientists study the weather, plants and trees, marine life, insects, and much more.

I like insects. They are interesting to look at and study.

There are many types of insects in the world. Bees, butterflies, and beetles are just a few.

I want to be an entomologist when I grow up. Then I can study insects all the time.

Winners @ AMSE
JoHanna Sanders, age 12, a picture of someone enjoying nature and a theme that science is all around us.
Sascha Richey, age 8, drew a picture of her mother and explained why her mother is her favorite scientist.
Science Maps

➢ As Conceptualization and Model of Science


Authors are mortal. Papers are immortal. Monsters = 'the unknown' or voids. Impact of funding on science (yellow). Good and bad years.
Science of Science Cyberinfrastructures

 Scholarly Database of 23 million scholarly records
 http://sdb.slis.indiana.edu

 Information Visualization Cyberinfrastructure
 http://iv.slis.indiana.edu

 Network Workbench Tool and Community Wiki
 Over 120 plugins, ca. 45 Scientometrics plugins
 http://nwb.slis.indiana.edu

 Epidemics Cyberinfrastructure
 http://epic.slis.indiana.edu/
Papers, maps, cyberinfrastructures, talks, press are linked from

http://sci.slis.indiana.edu
This talk draws on the works of several science map makers, see http://scimaps.org for details.

This is the only mockup in this slide show. Everything else is available today.
The End.