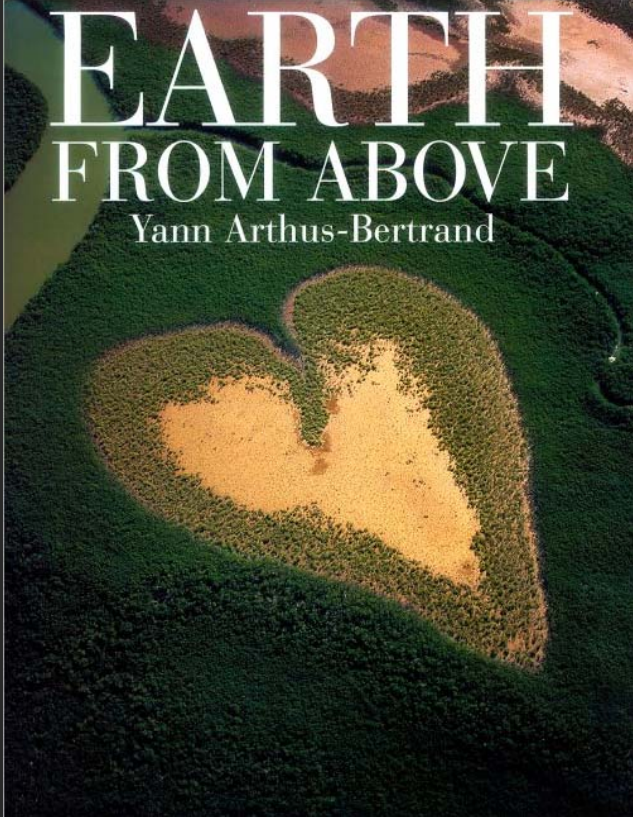


Science from Above

Dr. Katy Börner

Cyberinfrastructure for Network Science Center, Director
Information Visualization Laboratory, Director
School of Library and Information Science
Indiana University, Bloomington, IN
katy@indiana.edu

*3rd Annual iFQ Conference: Foresight - Between Science and Fiction
Center of Advanced European Studies and Research (CAESAR), Bonn, Germany
December 11th, 2008*



**EARTH
FROM ABOVE**
Yann Arthus-Bertrand

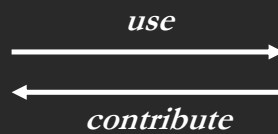
The Problem: Being Lost in (Knowledge) Space

15th Century: One person can make major contributions to many areas of science

Mankind's Knowledge



Amount of knowledge
on brain can mänge



Human Brain



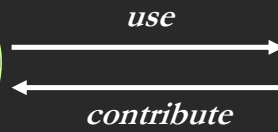
Leonardo Da Vinci
(1452-1519)

20th Century: One person can make major contributions to a few areas of science

Mankind's Knowledge



Amount of knowledge
on brain can mänge



Human Brain



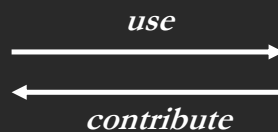
Albert Einstein
(1879-1955)

21st Century: One person can make major contributions to a specific area of science

Mankind's Knowledge



Amount of knowledge
on brain can mänge

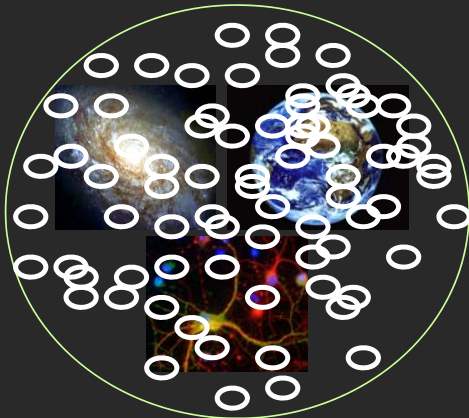


Human Brain

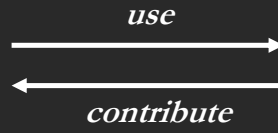


21th Century: One person can make major contributions to a specific area of science

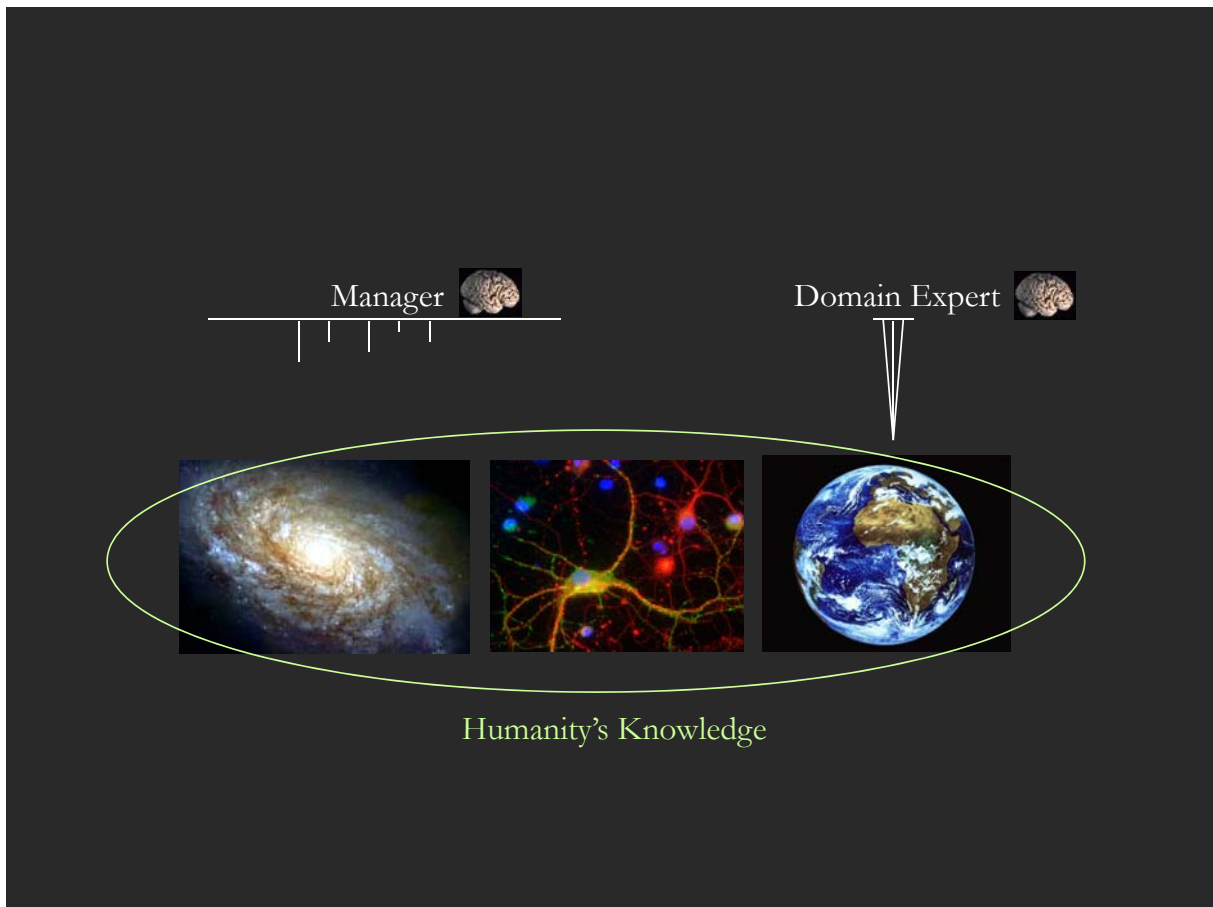
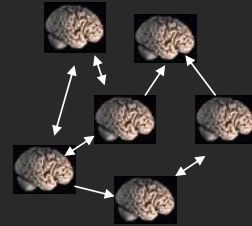
Mankind's Knowledge

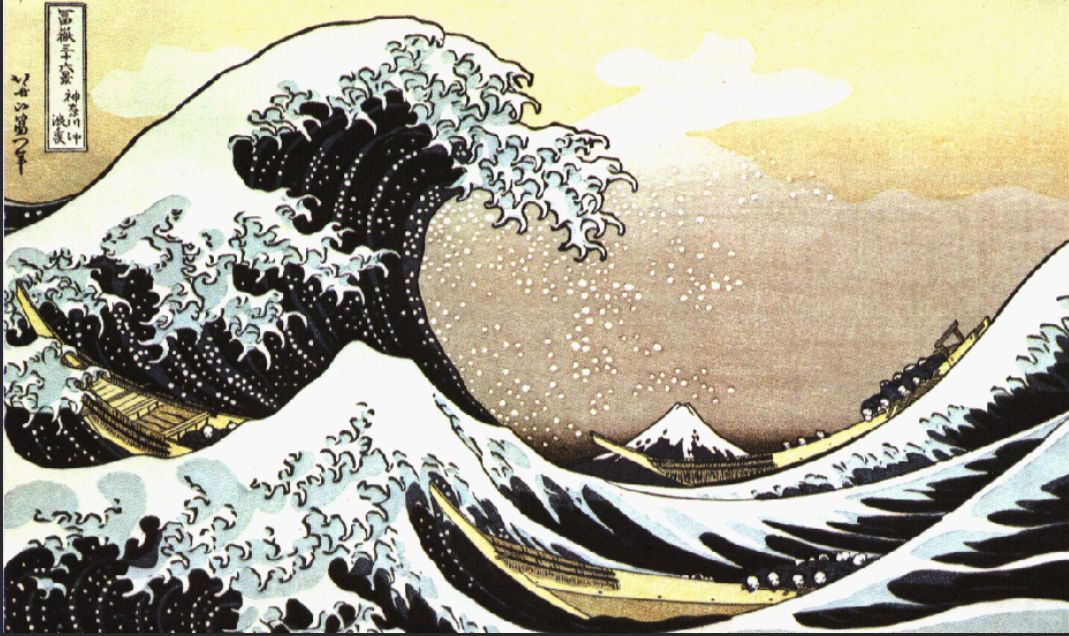


Amount of knowledge on brain can mänge



Human Brains

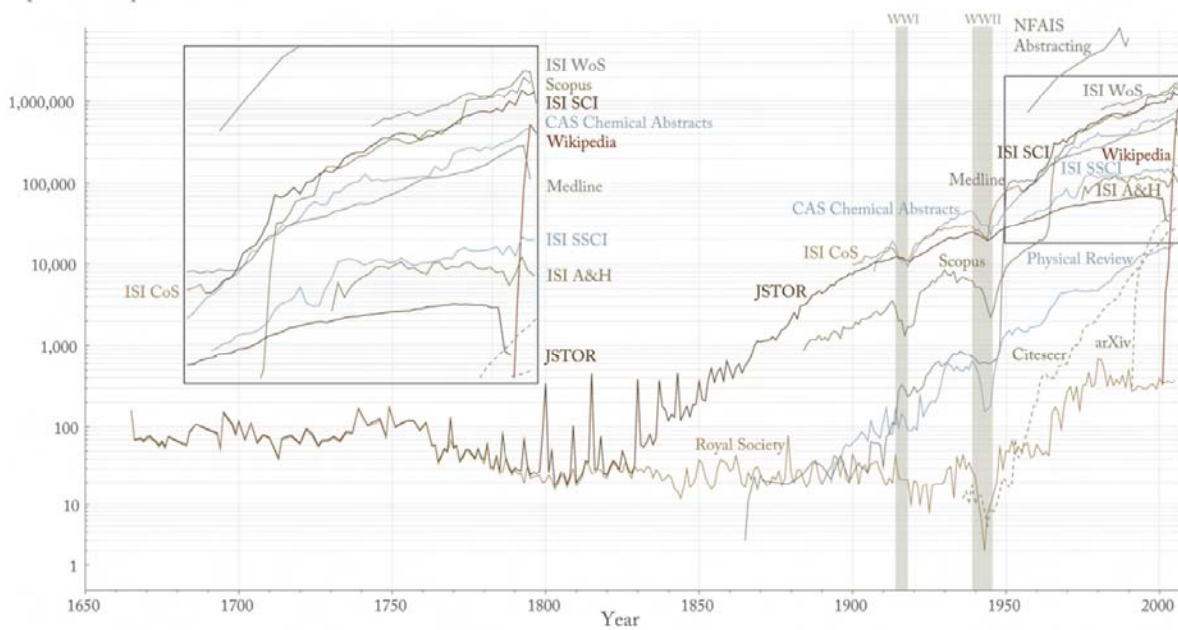




The Great Wave Off Kanagawa (Katsushika Hokusai, 1760-1849)

Growth of Scientific Knowledge, 1665 to 2006

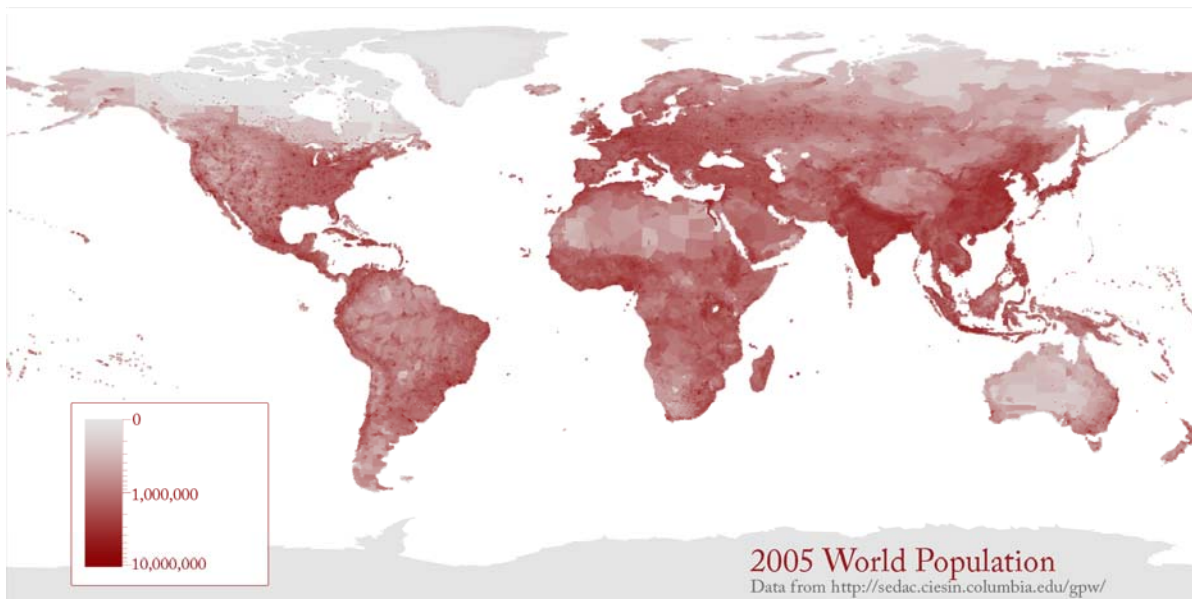
Papers & Wikipedia Entries



Atlas of Science: Guiding the Navigation and Management of Scholarly Knowledge, Part E: The Rise of Science and Technology. Chart showing the number of papers/Wikipedia entries for different databases and publication years. Contact Katy Borner <katy@indiana.edu> or Elisha Hardy <ehardy@indiana.edu> for details.

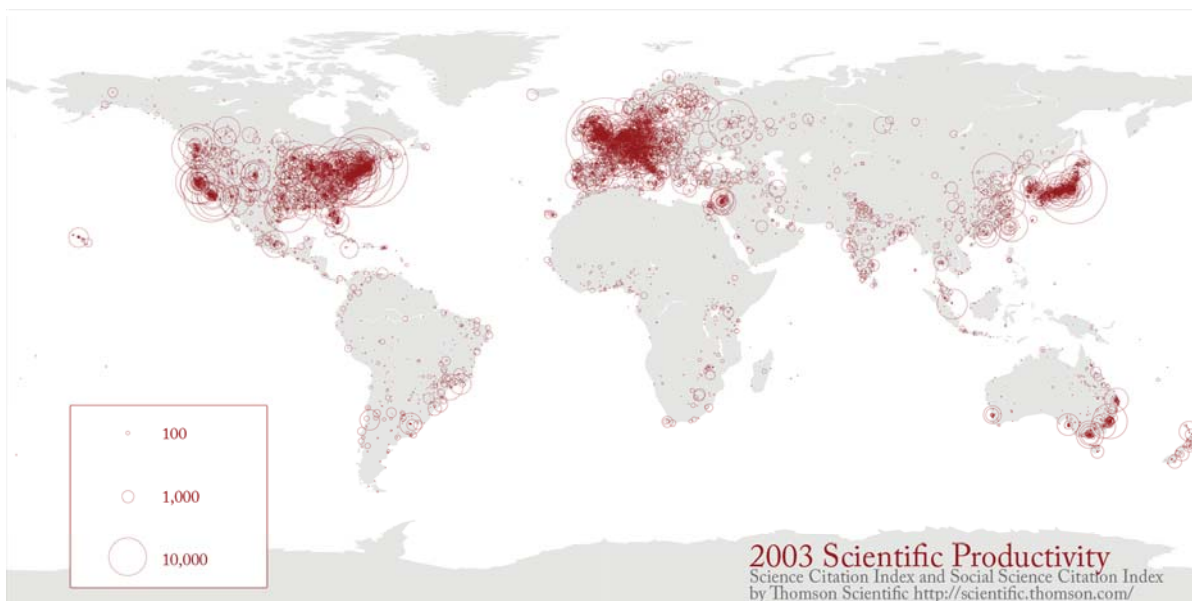
2005 World Population

The population map uses a quarter degree box resolution. Boxes with zero people are given in white. Darker shades of red indicate higher population counts per box using a logarithmic interpolation. The highest density boxes appear in Mumbai, with 11,687,850 people in the quarter degree block, Calcutta (10,816,010), and Shanghai (8,628,088).



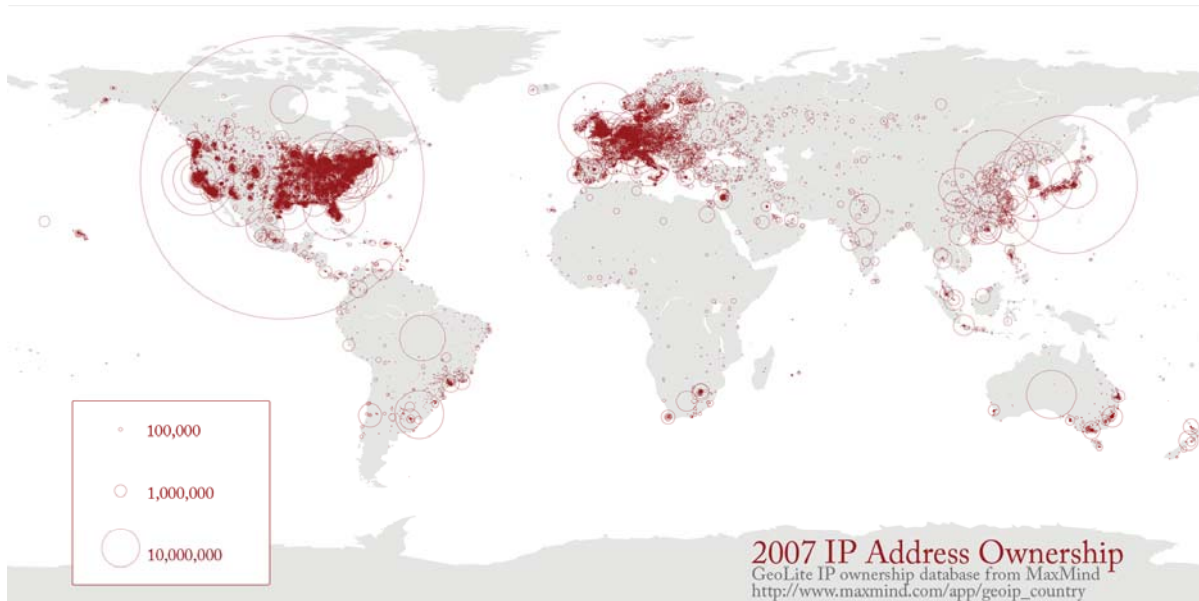
2003 Scientific Productivity

Shown is where science is performed today. Each circle indicates a geographic location at which scholarly papers are published. The larger the circle the more papers are produced. Boston, MA, London, England, and New York, NY are the top three paper production areas. Note the strong resemblance with the Night on Earth and the IP Ownership maps and the striking differences to the world population map.



2007 IP Address Ownership

This map shows IP address ownership by location. Each owner is represented by a circle and the area size of the circle corresponds to the number of IP addresses owned. The largest circle denotes MIT's holdings of an entire class A subnet, which equates to 16,581,375 IP addresses. The countries that own the most IP addresses are US (560 million), Japan (130 million), Great Britain (47 million).



Mapping Science Exhibit



places & spaces

Cartography of the Physical and the Abstract

An exhibition created for the conference "Mapping Humanity's Knowledge and Expertise in the Digital Domain" at the 2005 Meeting of the American Association of Geographers that is updated regularly with new maps and explanations.

Home
Browse Maps
Compare & Contrast Maps
Connect

Home



Exhibit Purpose and Goals

The Places & Spaces exhibit has been created to demonstrate the power of maps.

An initial theme of this exhibit is to compare and contrast first maps of our entire planet with the first maps of all of science as we know it.

Come see with your own eyes the extent to which maps can be employed to help make sense of the flood of information we are confronted with and how domain maps can be used to locate complex and beautiful information.

This online part of the exhibit provides links to a selected series of maps and their makers along with detailed explanations of why these maps work. The physical counterpart supports the close inspection of high quality reproductions for display at conferences and education centers. It is meant to inspire cross-disciplinary discussion on how to best track and communicate human activity and scientific progress on a global scale.



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)



The Power of Reference Systems (2006)



The Power of Forecasts (2007)



Exhibit has been shown in 49 venues on four continents.



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)

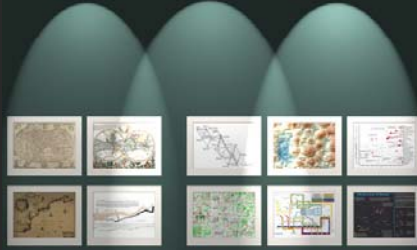
Science Forecasts (2013)

How to Lie with Science Maps (2014)



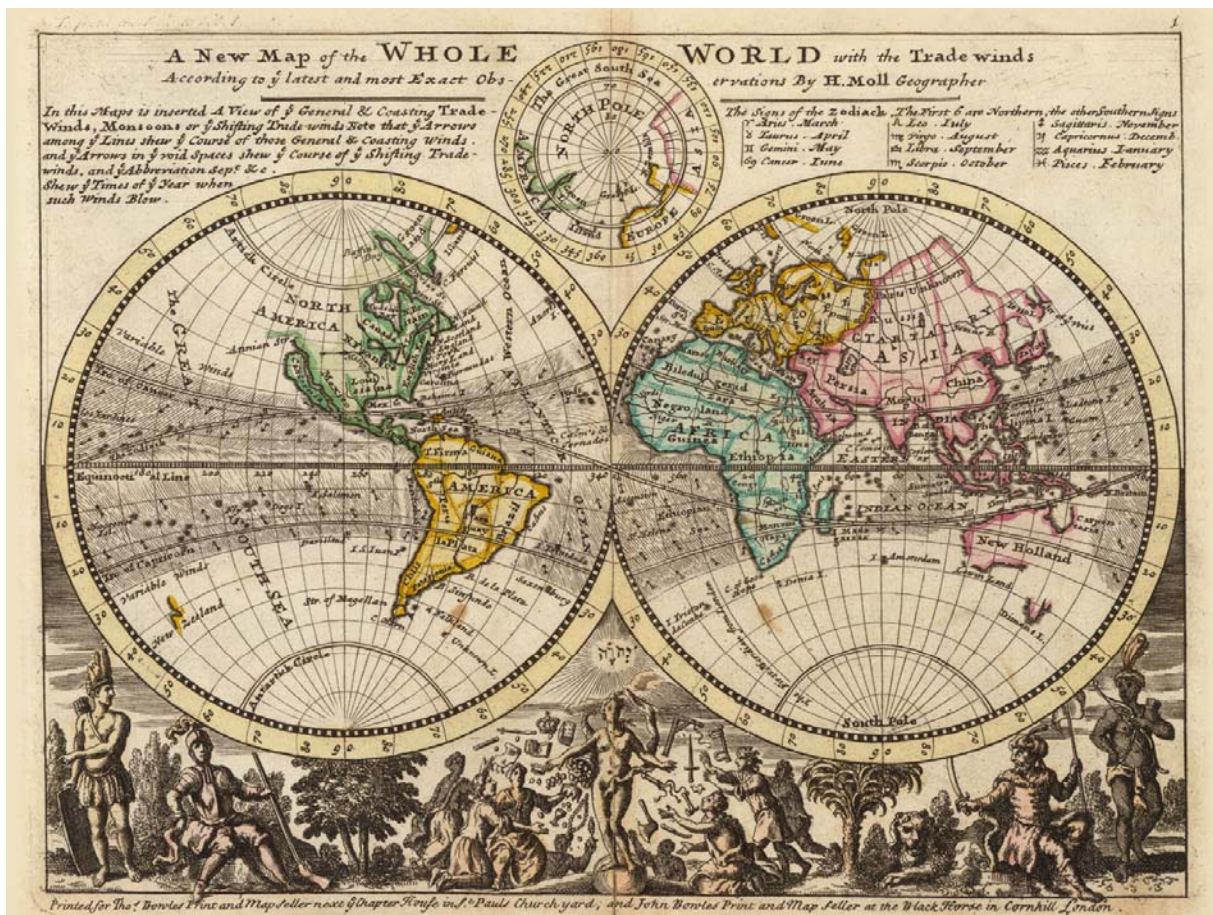
The Power of Maps

Four Early Maps of Our World VERSUS Six Early Maps of Science



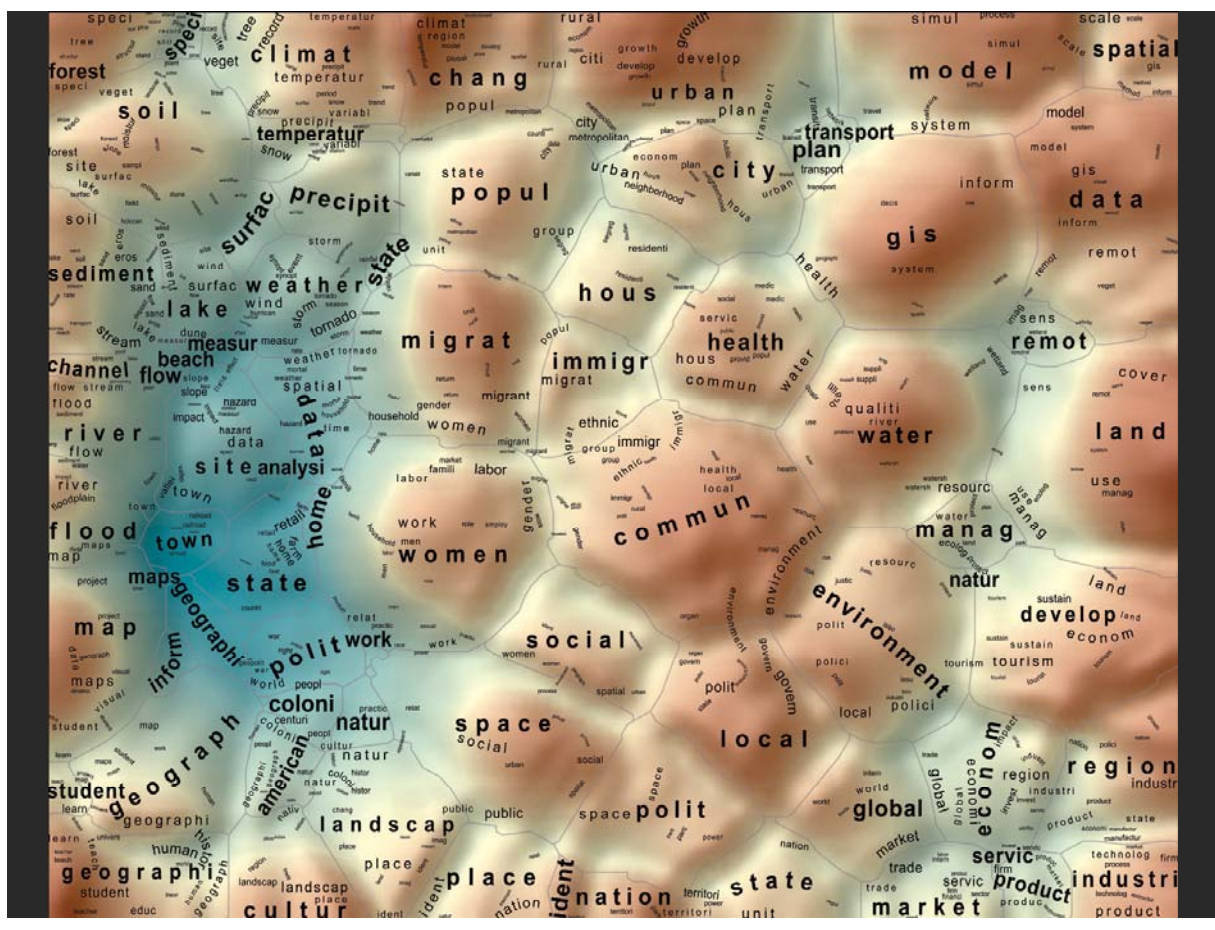
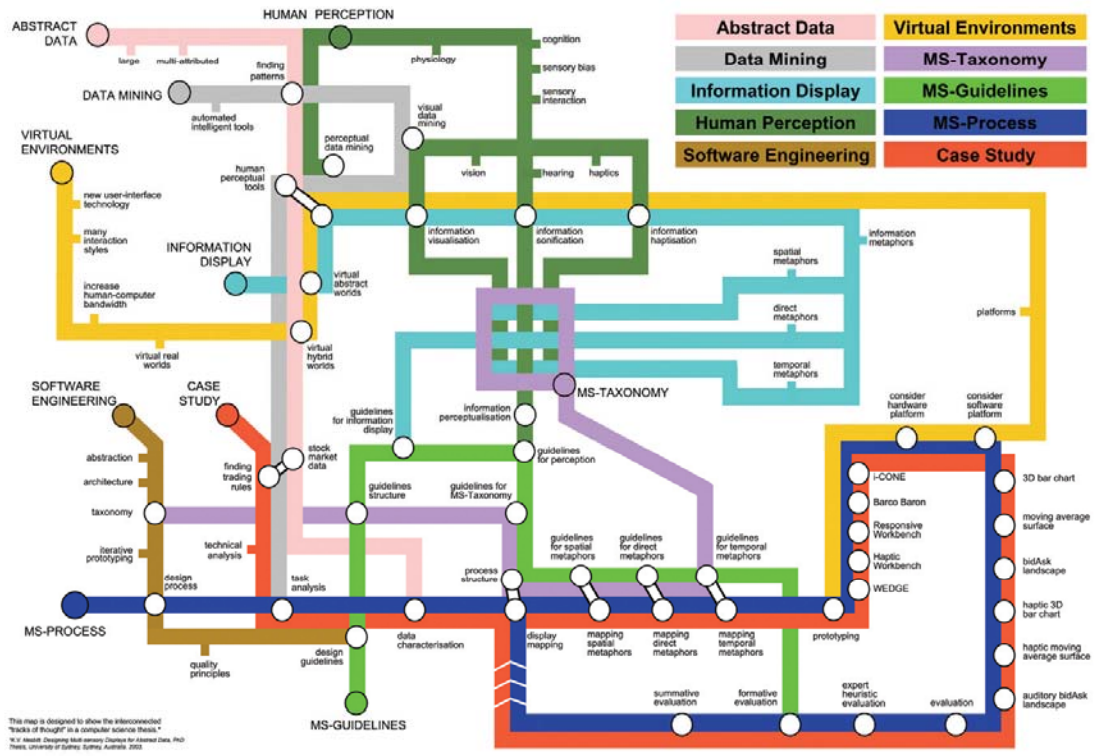
(1st Iteration of Places & Spaces Exhibit - 2005)



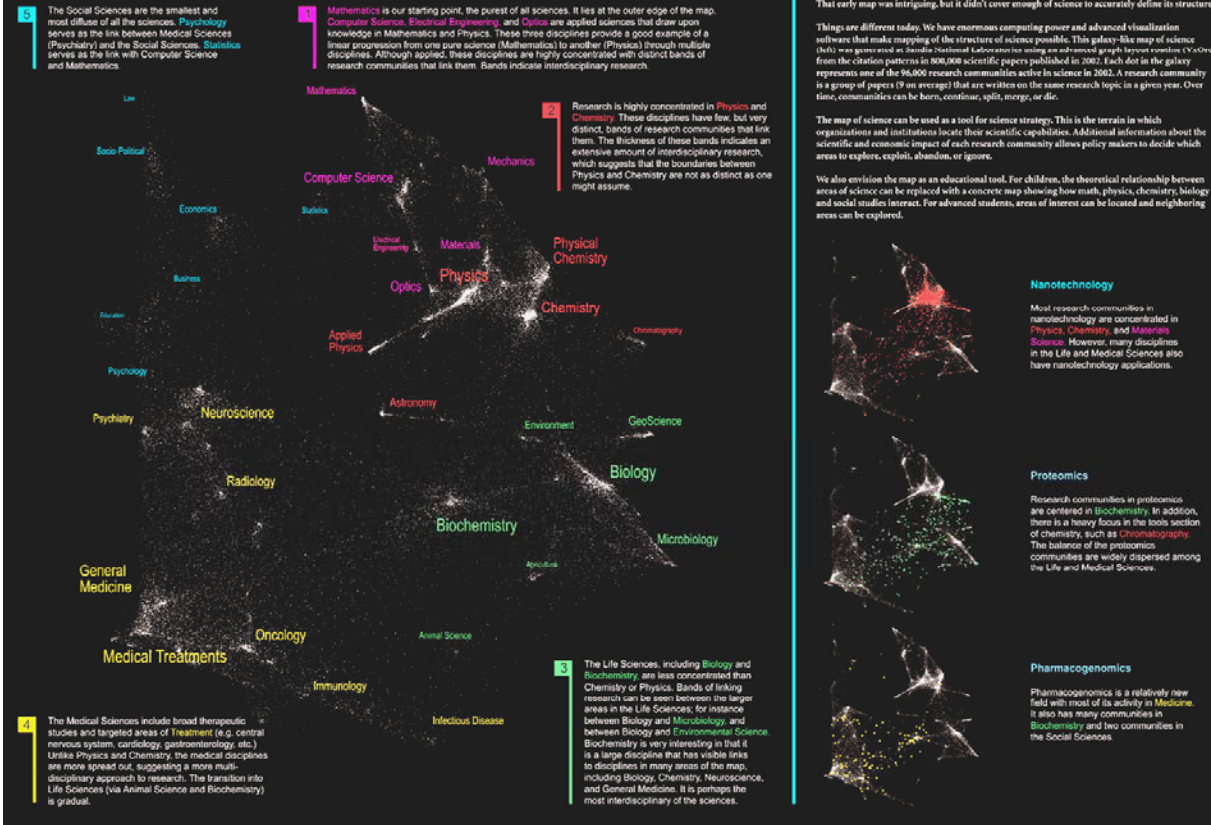


How would a map of science look?

What metaphors would work best?

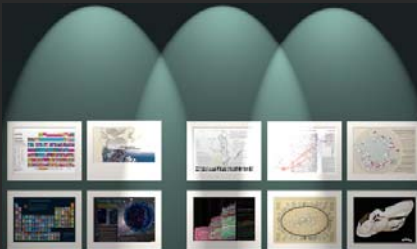


The Structure of Science



The Power of Reference Systems

Four Existing Reference Systems VERSUS Six Potential Reference Systems of Science



(2nd Iteration of Places & Spaces Exhibit - 2006)

The Visual Elements Periodic Table



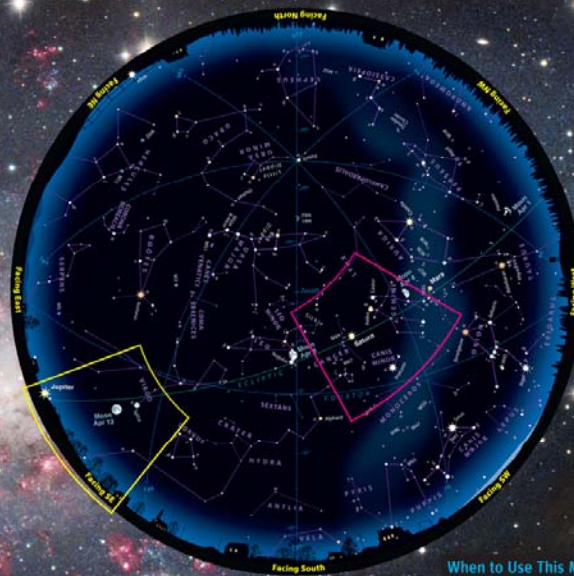
Evening Stars

The Big Dipper floats high in the northeast these early spring evenings, while Orion sinks low in the southwest. These are just a few of the celestial sights you can find on any clear evening in April using a sky map like the one shown here.



How to Use a Sky Map

- Check the dates and times at night.** Take your map out under the night sky around the right time, and bring along a flashlight to read it by. It helps to attach a piece of red paper over the front or to use a flashlight with red LEDs; the dim red light won't spoil your night vision.
- Outside, you need to know which direction you're facing.** (If you're unsure, just note where the Sun sets; that's west.) Whichever way you're facing, make sure the corresponding yellow label along the curved edge of the map is at the bottom, right side up. This curved edge represents the horizon. The stars above it on the map match the stars in front of you. The further up from the map's edge they appear, the higher they'll be in the sky. The center of the map is the zenith (straight overhead). So a star halfway from the edge of the map to the center will appear halfway from straight ahead to straight up. Ignore all the parts of the map above horizons you're not facing.
- Let's give it a try!** Pretend you're facing the southwest horizon (labeled "Facing SW"). Just a little way up (that is, a little way in from the edge of the map) is Sirius, the brightest star in the night sky, in the constellation Canis Major. Farther up, nearly halfway overhead, is the star Procyon in Canis Minor. Still farther up is the ringed planet Saturn. Go out at the right time, face southwest, and look up into the sky — there they are!



When to Use This Map
Early April: 10 pm (daylight-saving time)
Late April: Dusk

Tips

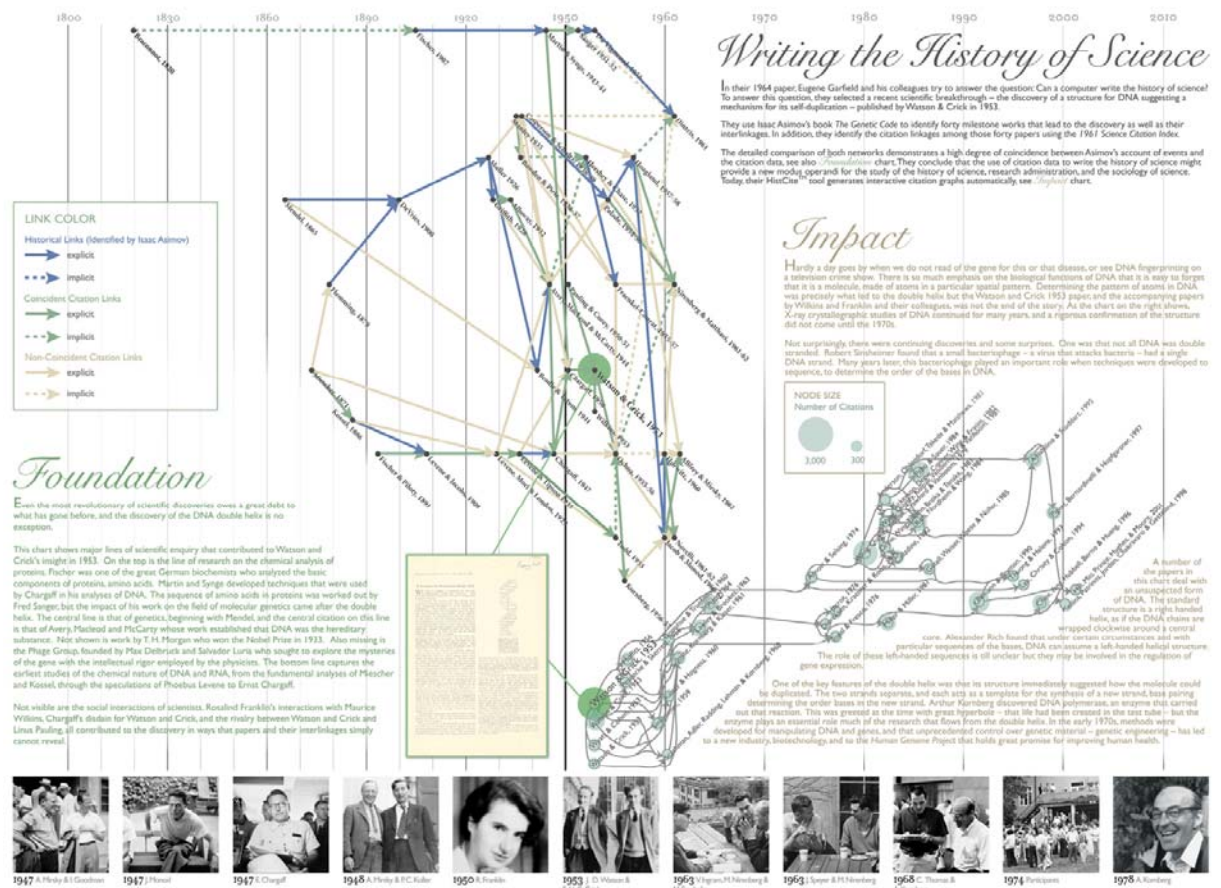
A couple of tips: Look for the brightest stars and constellations first; light pollution or moonlight may mask out the fainter ones. And remember that star patterns in the sky will look a lot bigger than they do here on paper. With a map like this, you can identify celestial sights all over the sky. Go out the next clear night and make some stargazing!

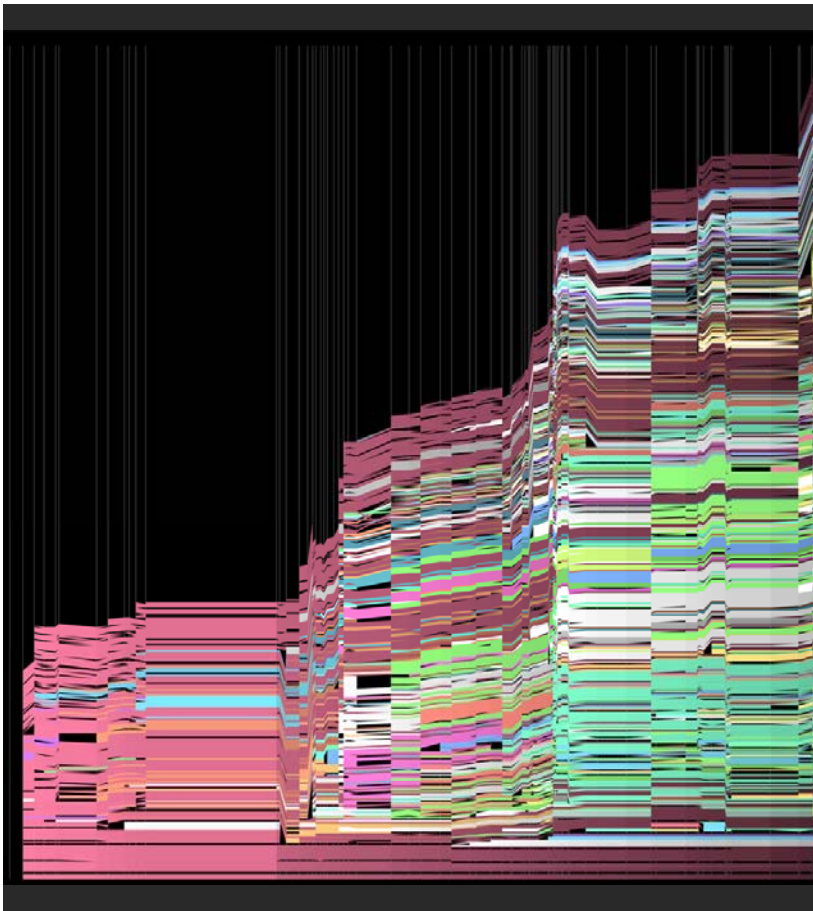
You can customize a night-sky map for any time and place at SkyandTelescope.com.



How would a reference system for all of science look?

What dimensions would it have?





Evolution - Wikipedia

[Main Page](#) | [Recent changes](#) | [Edit this page](#) | [Page history](#)
[Printable version](#) | [Current revision](#)

Not logged in
[Log in](#) | [Help](#)
[Evolution](#)

Other languages: [Deutsch](#) | [Español](#) | [Français](#) | [Italiano](#) | [Nederlands](#) | [Português](#) | [Română](#) | [Slovenščina](#) | [Tagalog](#) | [Türkçe](#) | [Українська](#) | [Yorùbá](#)

(Revision as of 07:17, 16 Jul 2003)

Evolution is any process of growth, change or development. The word stems from the Latin *evoluere* meaning "unfolding" and prior to the late 1800s was confined to referring to goal-directed, pre-programmed processes such as embryological development. A pre-programmed task, as in a military maneuver, using this definition, may be termed an "evolution." One can also speak of stellar evolution, chemical evolution, cultural evolution or the evolution of an idea. Other kinds of evolution include evolutionary algorithms which attempt to mimic processes similar to biological evolution in a computer program, most frequently as an optimization technique and as an experimental framework for the computational modelling of evolution.

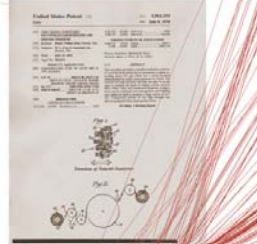
In the 19th century the word "evolution" was identified with improvement. It was clear to European thinkers at that time -- in the wake of the Enlightenment and the French Revolution -- that human societies evolved; many people have claimed the same about the evolution of biological species. In the 20th century, most social scientists came to reject the strict identification of social and cultural change with improvement (see also social evolution and cultural evolution); Most interpretations of Darwin's account of evolution similarly argue against identifying biological changes with improvement.

Since the 19th century, "evolution" is generally used in reference to biological evolution, changes in allele frequencies in a population from one generation to another. Often it is shorthand for the modern

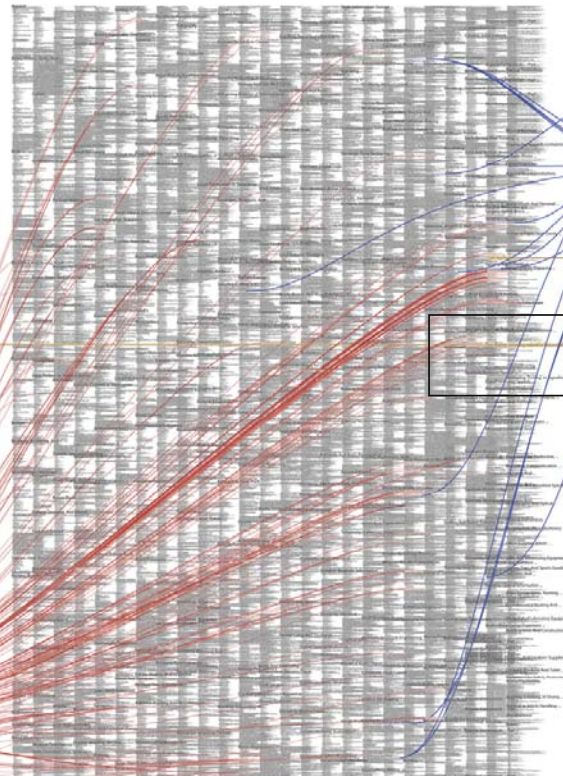
Impact

The United States Patent and Trademark Office does scientists and industry a great service by granting patents to protect inventions. Inventions are categorized in a taxonomy that organizes patents by industry or use, proximate function, effect or product, and structure. At the time of this writing there are 165,523 categories in a hierarchy that can get as deep as 13 levels. We display the first three levels (13,329 categories) at right in what might be considered a virtual map of inventions. Patent applications are required to be unique and non-obvious, partially by revealing any previous patents that might be similar in nature or provide a foundation for the current invention. In this way we can trace the impact of a single patent, seeing how many patents and categories it affects.

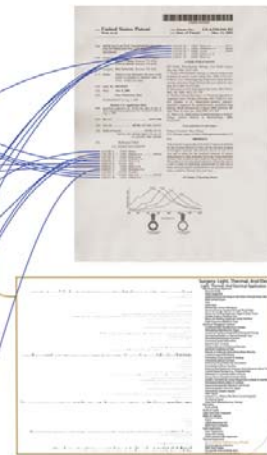
The patent on Gore-tex—a lightweight, durable synthetic fiber—is an example of one that has had significant impact. The box below enlarges the section of the hierarchy where it fits, and the red lines (enlarged to start along a time line from 1981 to 2000) point to the 131 categories that contain 182 patents, from waterproof clothing to surgical conelets, implants, that mention Gore-tex as prior art.



US Patent Hierarchy



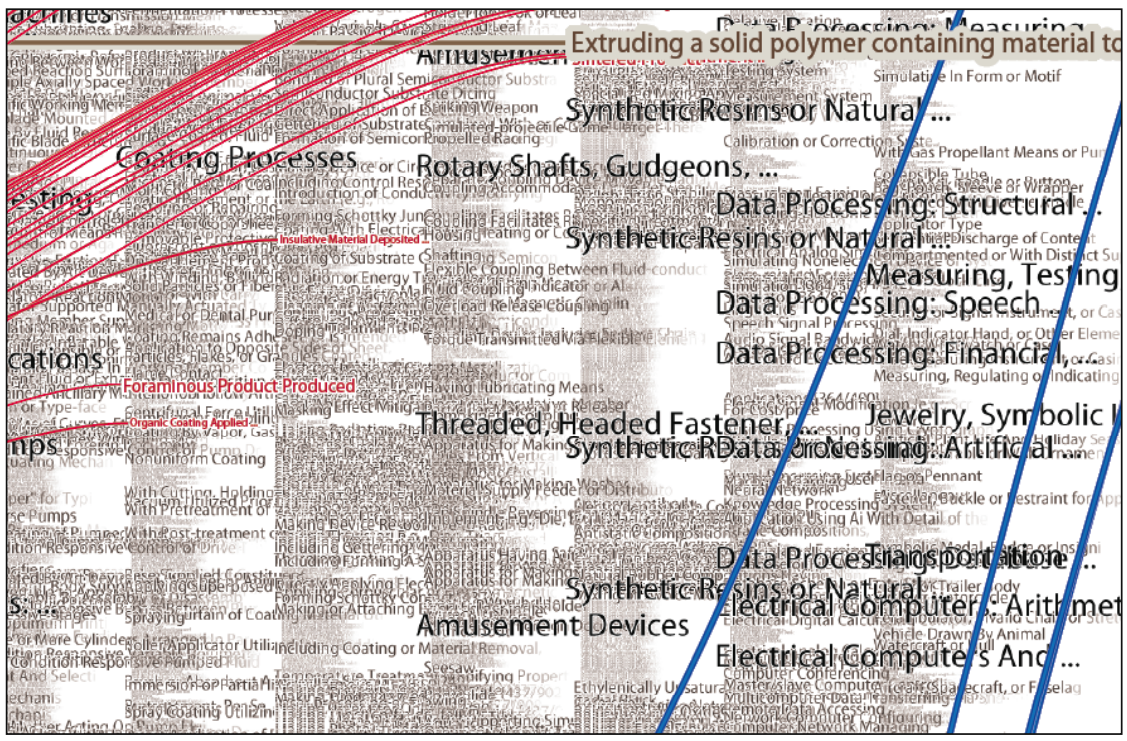
Prior Art



New patents often build on older ideas from many categories. Here, blue lines originate in various different categories that contain the patents cited as prior art for a patent on "gold nanoshells." Gold nanoshells are a new invention: tiny spheres (with a diameter ten million times smaller than a human hair) that can be used to make tumors more visible in infrared scans, and have even helped cause complete remission of tumors in tests with laboratory mice. The blue lines show that widely separated categories provided background for this invention.

Keeping categories understandable is an important part of maintaining any taxonomy, including the patent hierarchy. Categories are easier to understand, search, and maintain if they contain elements (patents in this case) that fit well within the definition of the category. The box above shows a tiny bar chart, part of a "Taxonomy Validator" that helps people decide whether categories are good ones.

Categories can be redefined or combined, and sometimes need to be split when they become too large, a constant problem shared by many classification systems in this information-rich century. But how can we determine exactly where to split a category in two, for example—if there are hundreds or thousands of elements in it? The Taxonomy Validator measures a "distance to prototype" (how far each element is from an idealized "prototype" element for each bucket. This can be based on statistics, computational comparisons of words, or even human judgements. A single bar chart can then show how good a category is. A good category has lots of small bars, a generally ragged category is one that might need scrutiny or reorganization; while one that has only one or two tall bars may just mean that one or two elements don't belong. Even simple visualizations like this can ease knowledge work by showing the eye much more than can fit into memory as words, focusing people on just the right issues, and providing a vastly broader background to support more informed judgements.



Impact

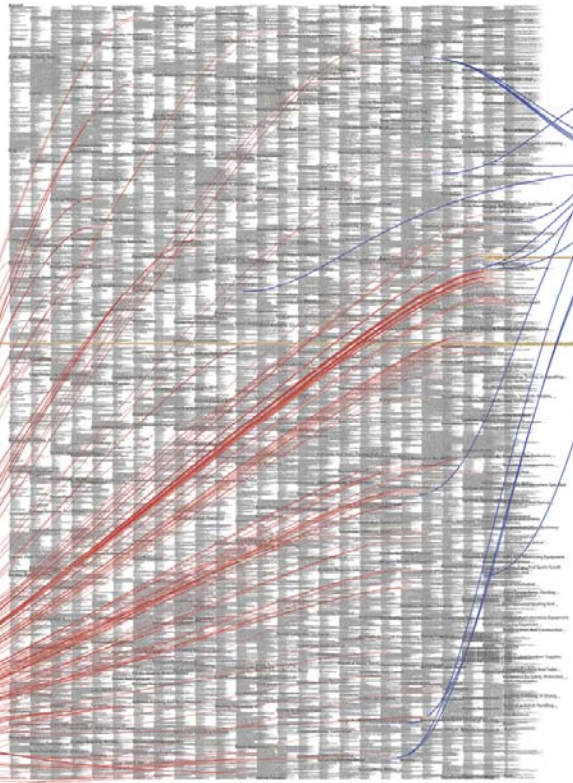
The United States Patent and Trademark Office does scientists and industry a great service by granting patents to protect inventions. Inventions are categorized in a taxonomy that groups patents by industry or use, proximate function, effect or product, and structure. At the time of this writing there are 160,523 categories in a hierarchy that can get as deep as 15 levels. We display the first three levels (13,529 categories) at right in what might be considered a visual map of inventions.

Patent applications are required to be unique and non-obvious, partially by revealing any previous patents that might be similar in nature or provide a foundation for the current invention. In this way we can trace the impact of a single patent, seeing how many patents and categories it affects.

The patent on Gore-tex—a lightweight, durable synthetic fiber—is an example of one that has had significant impact. The box below enlarges the section of the hierarchy where it is filed, and the red lines (arranged to start along a time line from 1981 to 2006) point to the 130 categories that contain 182 patents, from waterproof clothing to surgical cosmetic implants, that mention Gore-tex as prior art.



US Patent Hierarchy



Prior Art



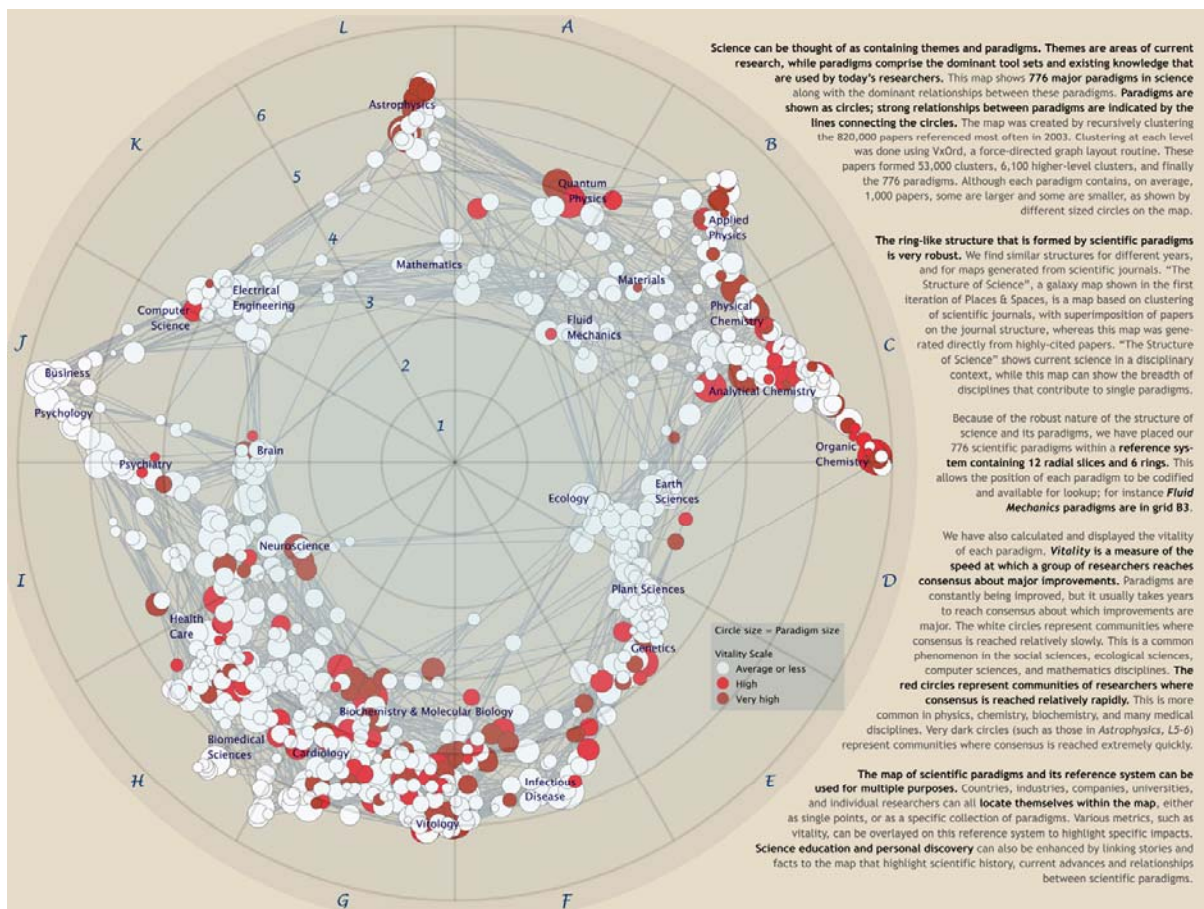
New patents often build on older ideas from many categories. Here, blue lines originate in sixteen different categories that contain the patents cited as prior art for a patent on "gold nanoshells." Gold nanoshells are a new invention: tiny spheres (with a diameter ten million times smaller than a human hair) that can be used to make tumors more visible in infrared scans, and have even helped cause complete remission of tumors in tests with laboratory mice. The blue lines show that widely separated categories provided background for this invention.

Keeping categories understandable is an important part of maintaining any taxonomy, including the patent hierarchy. Categories are easier to understand, search, and maintain if they contain elements (patents in this case) that fit well within the definition of the category. The box above shows a tiny bar chart, part of a "Taxonomy Validator" that helps people decide whether categories are good ones.

Categories can be redefined or combined, and sometimes need to be split when they become too large, a constant problem shared by many classifications systems in this information rich century. But how can we determine exactly where to split a category in two, for example—if there are hundreds or thousands of elements in it?

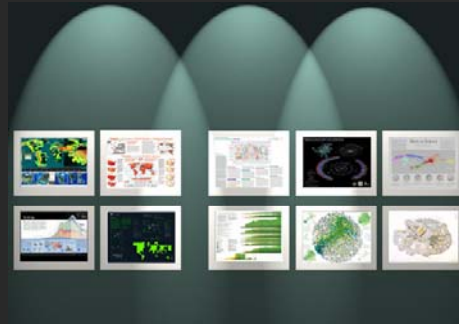
The Taxonomy Validator measures a "distance to prototype" how far each element is from an idealized "prototype" element for each bucket. This can be based on statistics, computational comparisons of words, or even human judgement. A simple bar chart can then show how good a category is. A good category has lots of small bars: a generally rigged category is one that might need accuracy or reorganization, while one that has only one or two tall bars may just mean that one or two elements don't belong. Even simple visualizations like this can ease knowledge work by showing the eye much more than can fit its memory as words, focusing people on just the right issues, and providing a vastly broader background to support more informed judgments.

	Synthetic Resins or Natural Rubber
	Ion-exchange Polymer or Process of Preparation
	Process of Regenerating Membrane or Process of Preparing Previously Formed Solid Ion-exchange Polymer Admixed With Membrane
	Polymer Characterized By Defined Size or Shape Other than Bead
	Chemically Treated Solid Polymer
	Solid Polymer Derived From Ethylenically Unsaturated Reactant
	Solid Polymer Derived From At Least One 1,2-epoxy Containing Reactant
	Solid Polymer Derived From Aldehyde or Derivative
	From Ethylenically Unsaturated Reactant Only
	From Aldehyde or Derivative
	Process of Treating Scrap or Waste Product Containing At Least One Polymer
	Process of Treating Scrap or Waste Product Containing At Least One Treating Rubber (or Rubberlike Materials) or Polymer Derived From Treating Polymer Derived From A Monomer Containing Only One Treating Polymer Derived From Hydrocarbon Monomers Only
	Treating Polysiloxane
	Treating Polyester
	Treating With Alcohol
	Treating Polyurethane, Polyurea (excluding Urea-formaldehyde)
	Treating With Alcohol or Amine
	Treating Polycarbonamide
	Cellular Products or Processes of Preparing Cellular Product Derived From Two or More Solid Polymers or From At Least One Polymer Is Derived From Reactant Containing Two
	At Least One Polymer Is Derived From An Aldehyde or Derivative
	At Least One Polymer Is Derived From A $-n=c=x$ Reactant Where n Is



The Power of Forecasts

Four Existing Forecasts
VERSUS
Six Potential Science 'Weather' Forecasts

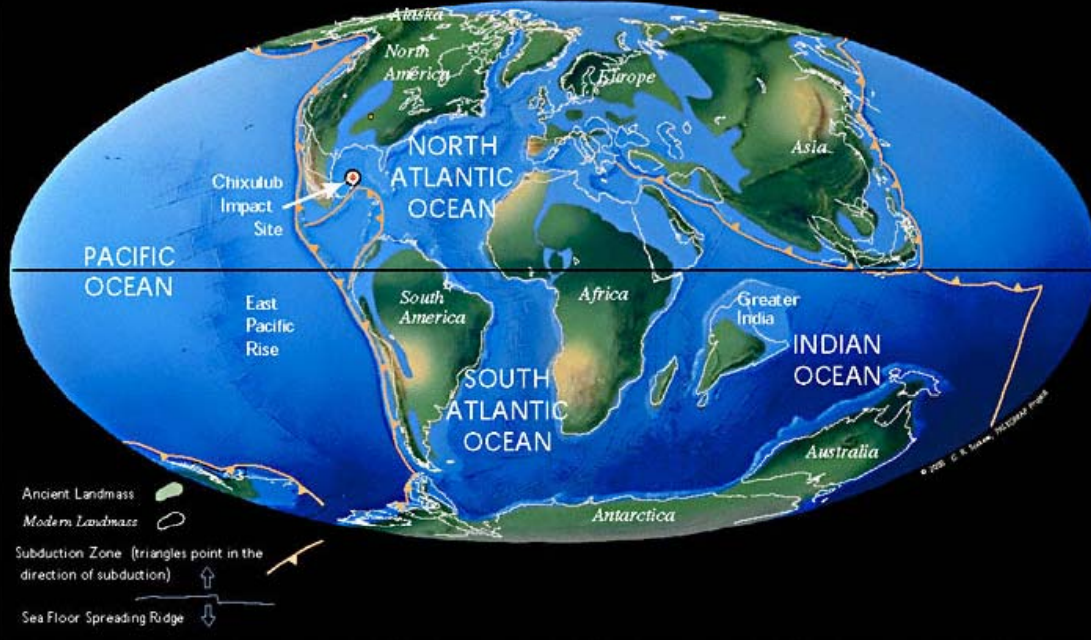


(3rd Iteration of Places & Spaces Exhibit - 2007)

Can one forecast science?

What 'science forecast language' will work?

K/T Boundary 66 Ma



<http://www.scotese.com/>

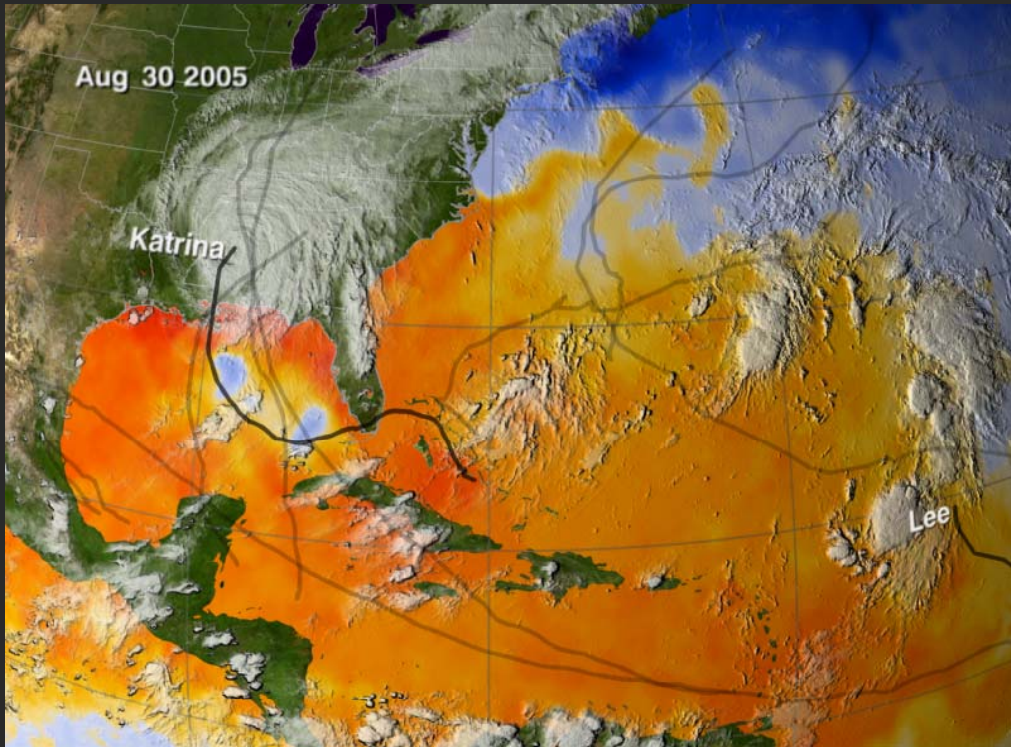
Warnings & Forecasts Graphical Forecasts National Maps Radar Rivers Air Quality Satellite Climate

To view local information, select area of interest and click on the image below.



Weather Forecast for Tuesday, April 18, 2006
DOC/NOAA/NWS/NCEP/Hydro-meteorological Prediction Center
Prepared by Fries based on HPC, SPC, and TPC forecasts.

<http://www.weather.gov>



Named Storms, available online at <http://svs.gsfc.nasa.gov/vis/a000000/a003200/a003279>

Science Maps for Economic Decision Making

Four Existing Maps
VERSUS
Six Science Maps



(4th Iteration of Places & Spaces Exhibit - 2008)

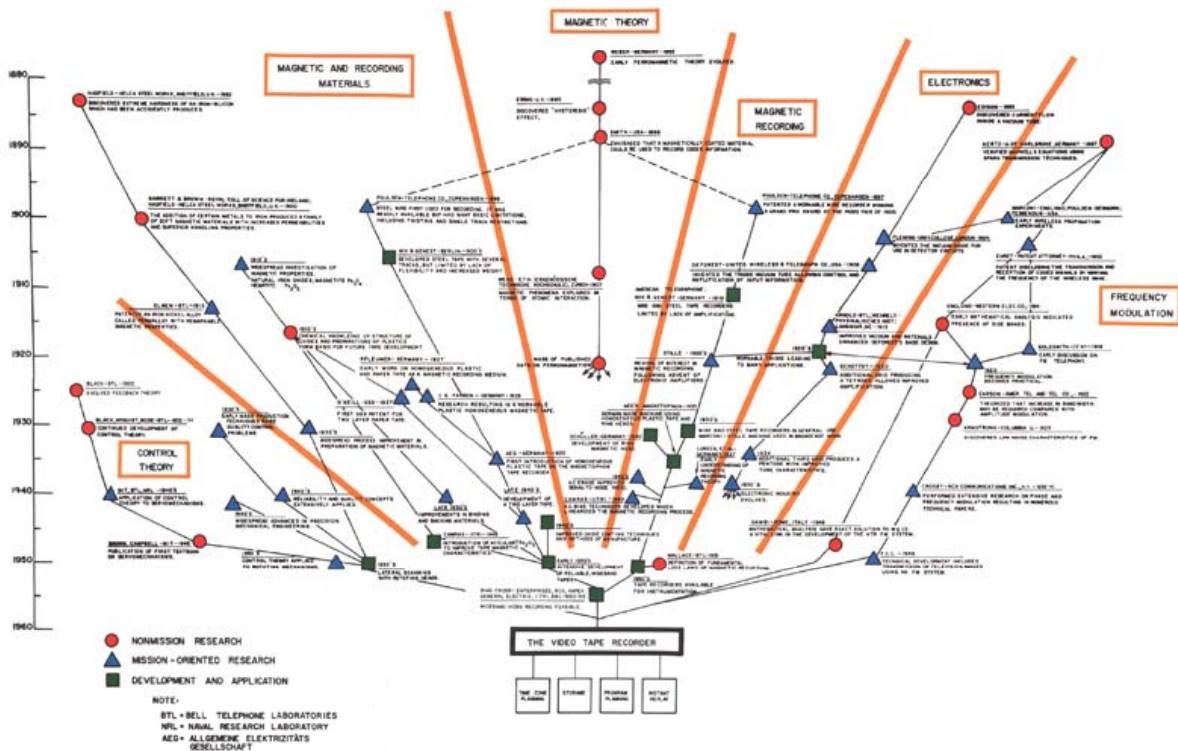
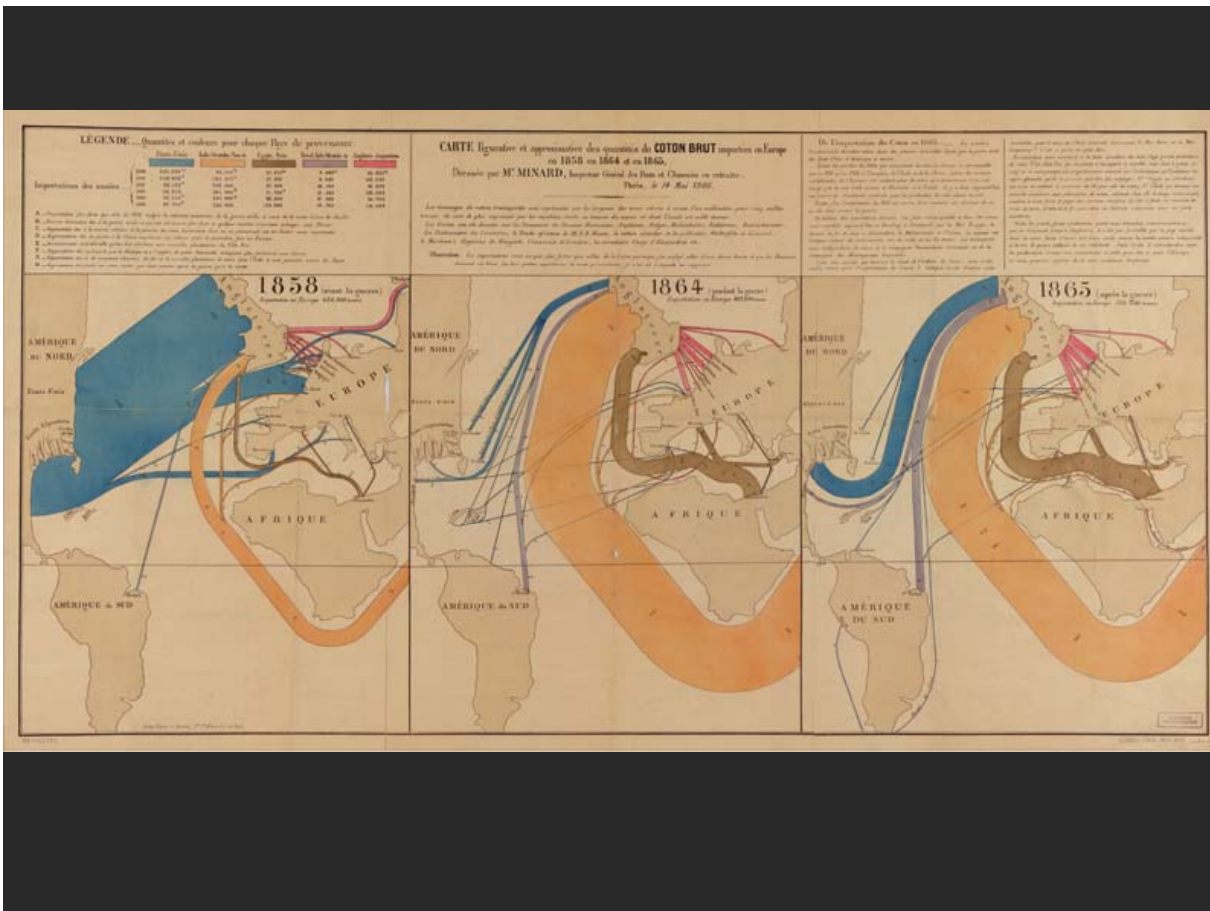
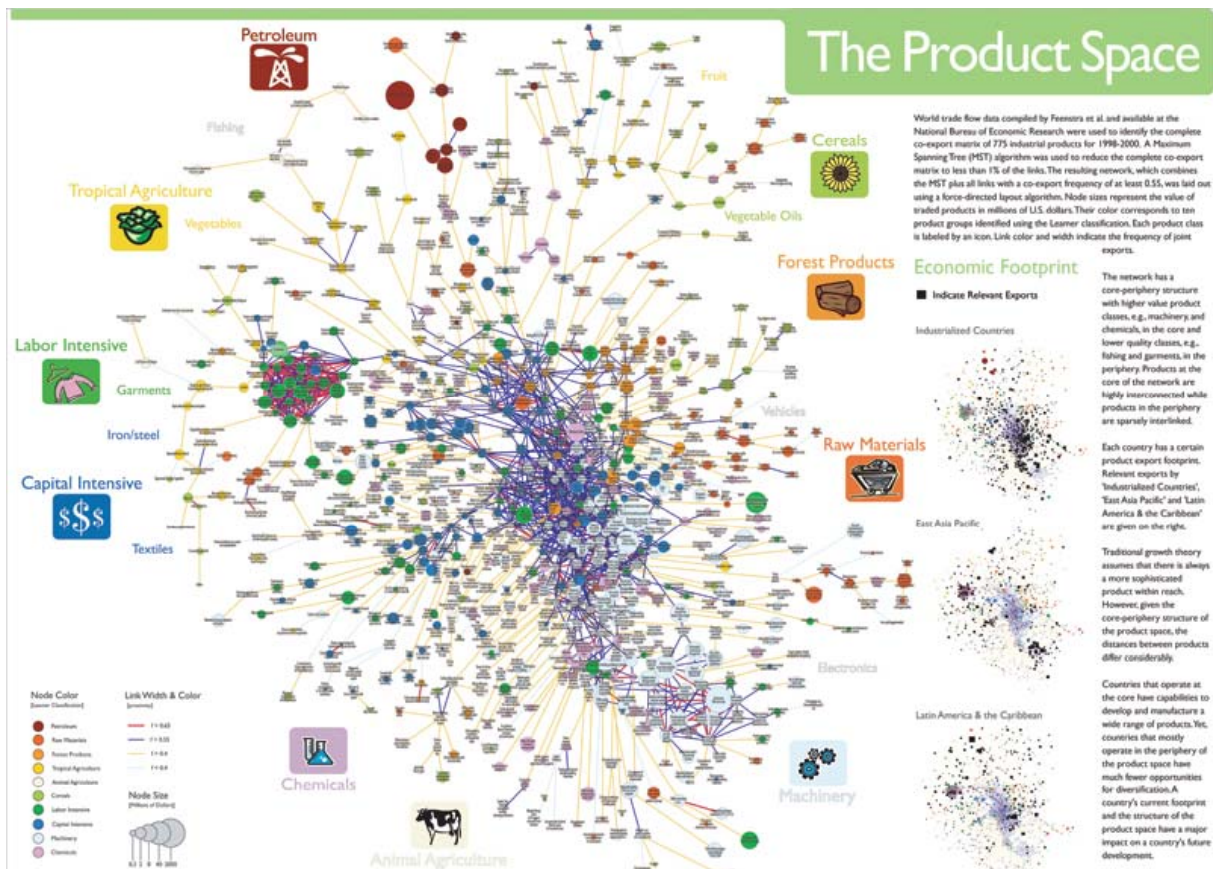


FIG. 7. THE VIDEO TAPE RECORDER

What insight needs to economic decision makers have?

What data views are most useful?



Happiness Depends on Various Factors

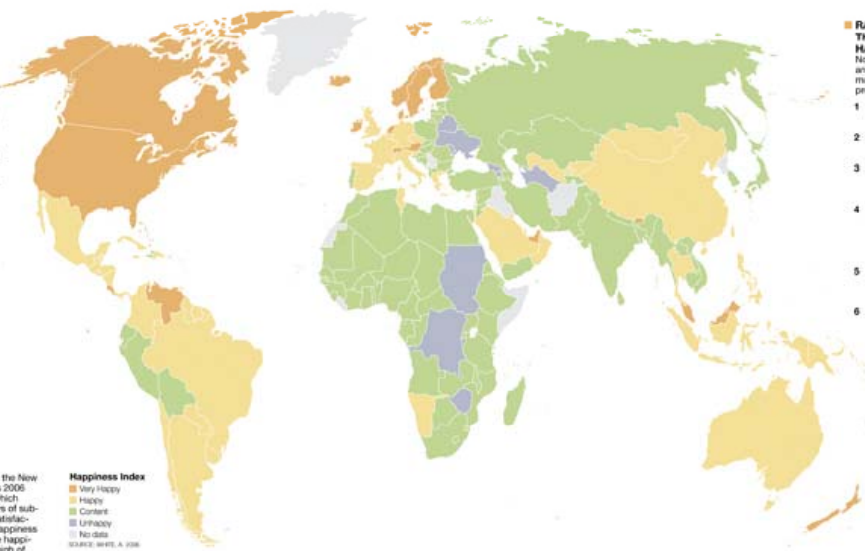
Social scientists are starting to include relative happiness with hard data on economic status, health, and other factors as they assess quality of life. They rely on surveys of "subjective well-being"—how good people feel about their lives. A world map of one "happiness index" shows many, but not all, wealthy northern countries faring well. Residents of sub-Saharan Africa and the former Soviet Union, meanwhile, report particularly low levels of contentment.

Any attempt to measure happiness will fall short—each life is a series of joys, struggles, and sorrows, and satisfaction can depend as much on outlook as on circumstances. Averages obscure the happy moments in struggling nations, as well as people who suffer from poor health, poverty, or discrimination in countries that rank high. Still, happiness indices can help researchers move beyond simple economics as they track progress—or backsliding—over time.

MEASURING THE INTANGIBLE

The map is derived from the New Economics Foundation's 2006 "Happy Planet Index," which drew on over 100 surveys of subjective well-being. Its "satisfaction with life scale"—a happiness index—ranks the relative happiness of nations, from a high of 273 (Denmark and Switzerland) to a low of 100 (Burundi).

Happiness Index
 ■ Very Happy
 ■ Happy
 ■ Content
 ■ Unhappy
 ■ No data
SOURCE: WIRE, A 2006



- RANKING THE WORLD'S HAPPIEST PLACES**
 Northern Europe, North America, and several wealthy countries make the list, but so do many less prosperous island nations.
- 1 DENMARK
SWITZERLAND
 - 2 AUSTRIA
ICELAND
 - 3 BAHAMAS
FINLAND
SWEDEN
 - 4 BHUTAN
BRUNEI
CANADA
IRELAND
LUXEMBOURG
 - 5 COSTA RICA
MALTA
NETHERLANDS
 - 6 ANTIQUA AND BARBUDA
MALAYSIA
NEW ZEALAND
NORWAY
SEYCHELLES
ST. KITTS AND NEVIS
UNITED ARAB EMIRATES
UNITED STATES
VANUATU
VENEZUELA

DEFINING WELL-BEING

By comparing the happiness index to data from the UN, the CIA, and other sources, a U.K. psychologist determined that good health and health care, enough money for fundamental needs, and access to basic education are the most important factors for subjective well-being. European countries top all three measures.



HEALTH

Japan boasts the world's longest life expectancy—one measure of overall health. Swaziland, at the other end of the scale, is plagued by poverty, disease, and violence. Disparities in access to health care divide many countries into haves and have-nots.



WEALTH

Money still can't buy love, or happiness, and wealthier people aren't always more content. Still, tiny Luxembourg, which takes top rank in per capita Gross Domestic Product (GDP), also rates a 253 on the happiness index. Real poverty means real misery, a fate shared by billions.



EDUCATION

Residents of Australia can expect to spend more time in school—an average of almost 21 years—than citizens of any other country. But only a basic education is needed to see a significant jump in overall happiness. Around the world, hundreds of millions lack even that.

Science Maps for Science Policy Makers

Call For Maps for 5th Iteration of Exhibit

- | | |
|----------------------------------|--------------------|
| Submit initial entry: | January 9th, 2009 |
| Notification to mapmakers: | January 31st, 2009 |
| Submit final entries: | March 31, 2009 |
| 5th Iteration ready for display: | April 30th, 2009 |

See <http://scimaps.org/cfs.php> for details on how to submit.

Visit <http://scimaps.org/host> for info on how to host exhibit.

Additional Elements of the Exhibit

Illuminated Diagram Display

Hands-on Science Maps for Kids

Worldprocessor Globes

Illuminated Diagram Display

*W. Bradford Paley, Kevin W. Boyack, Richard Kalvans, and Katy Börner (2007)
Mapping, Illuminating, and Interacting with Science. SIGGRAPH 2007.*

Questions:

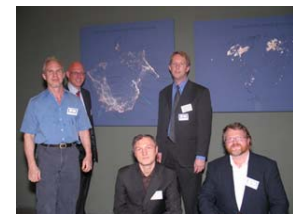
- Who is doing research on what topic and where?
- What is the ‘footprint’ of interdisciplinary research fields?
- What impact have scientists?

Contributions:

- Interactive, high resolution interface to access and make sense of data about scholarly activity.

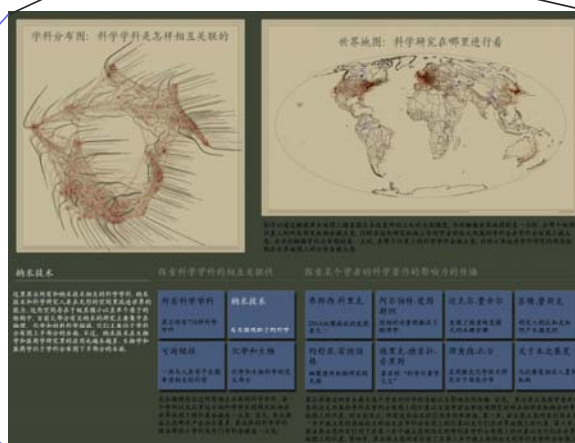


W. Bradford Paley
Scientific Mapmaker
Digital Image Design Incorporated
Dept. of Computer Science, Columbia University

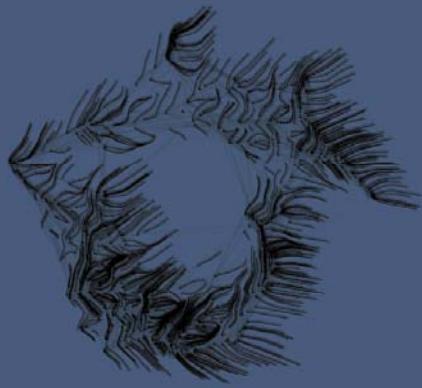


Large-scale, high resolution prints illuminated via projector or screen.

Interactive touch panel.



TOPIC MAP: HOW SCIENTIFIC PARADIGMS RELATE



GEOGRAPHIC MAP: WHERE SCIENCE GETS DONE



You may run your finger over each of these maps to control the lighting on the other: touching a place on the world map will light up topics studied in that place; touching a paradigm on the topic map will light up the places that study that topic.

Nanotechnology

This overlay shows the distribution of nanotechnology within the paradigms of science. The majority of current work in nanotechnology takes places in physics, chemistry, and materials science, at the upper right portion of the map. However, an increasing amount of nanotechnology is being applied in the biological and medical sciences, at the lower right.

All Topics

Sweep through all 376 scientific paradigms

Nanotechnology

Science on the tiny scale of molecules

Francis H. C. CRICK

Co-discovered DNA's double helix

Albert EINSTEIN

Revitalized physics with Relativity theories

Michael E. FISHER

Models critical phase transitions of matter

Susan T. FISKE

Connects perception and stereotypes

Sustainability

The science behind our long-term hopes

Biology & Chemistry

The interface between these two vital fields

Joshua LEDERBERG

Pioneer in bacterial genetic mechanisms

Derek J. de Solla PRICE

Known as the "Father of Scientometrics"

Richard N. ZARE

Uses laser chemistry in molecular dynamics

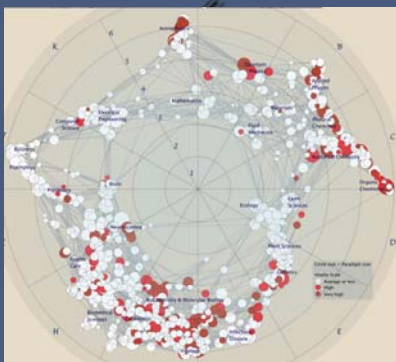
About this display

People & organizations that helped create it

We sweep slowly through adjoining related topics, lighting up the places in the world that study each topic. You may select a subset of the topics that deal with these three interesting subjects by touching it.

A single person's spreading influence is shown as a series of four snapshots. First, we light only topics and places relating to that person's papers—papers that are still highly cited today. The second lights everything that cites that original work. Note that this first-generation impact extends to far more topics than did the original work. The third snapshot lights science that cites the second, and the fourth lights science that cites the third.

TOPIC MAP: HOW SCIENTIFIC PARADIGMS RELATE



GEOGRAPHIC MAP: WHERE SCIENCE GETS DONE



You may run your finger over each of these maps to control the lighting on the other: touching a place on the world map will light up topics studied in that place; touching a paradigm on the topic map will light up the places that study that topic.

Nanotechnology

This overlay shows the distribution of nanotechnology within the paradigms of science. The majority of current work in nanotechnology takes places in physics, chemistry, and materials science, at the upper right portion of the map. However, an increasing amount of nanotechnology is being applied in the biological and medical sciences, at the lower right.

All Topics

Sweep through all 376 scientific paradigms

Nanotechnology

Science on the tiny scale of molecules

Francis H. C. CRICK

Co-discovered DNA's double helix

Albert EINSTEIN

Revitalized physics with Relativity theories

Michael E. FISHER

Models critical phase transitions of matter

Susan T. FISKE

Connects perception and stereotypes

Sustainability

The science behind our long-term hopes

Biology & Chemistry

The interface between these two vital fields

Joshua LEDERBERG

Pioneer in bacterial genetic mechanisms

Derek J. de Solla PRICE

Known as the "Father of Scientometrics"

Richard N. ZARE

Uses laser chemistry in molecular dynamics

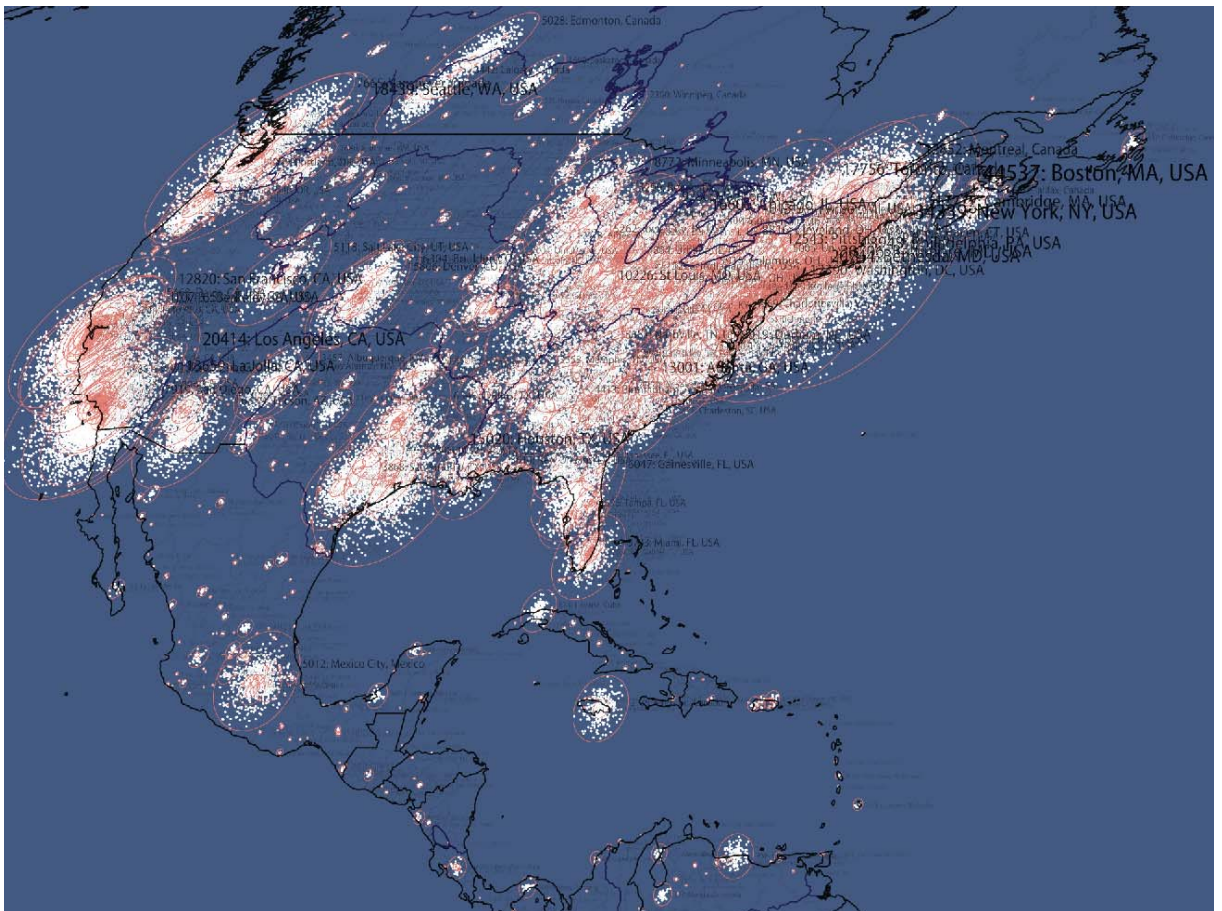
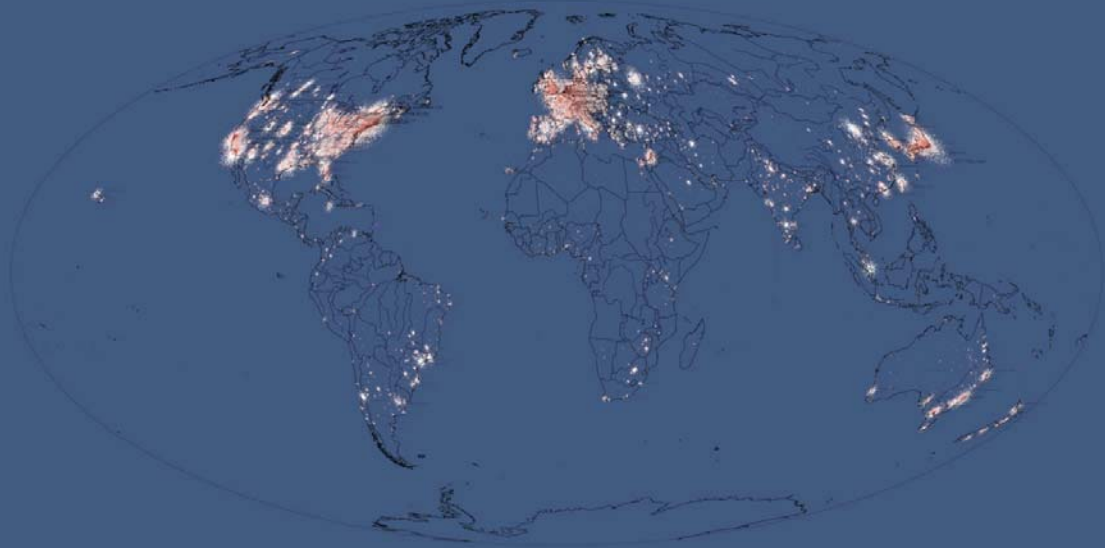
About this display

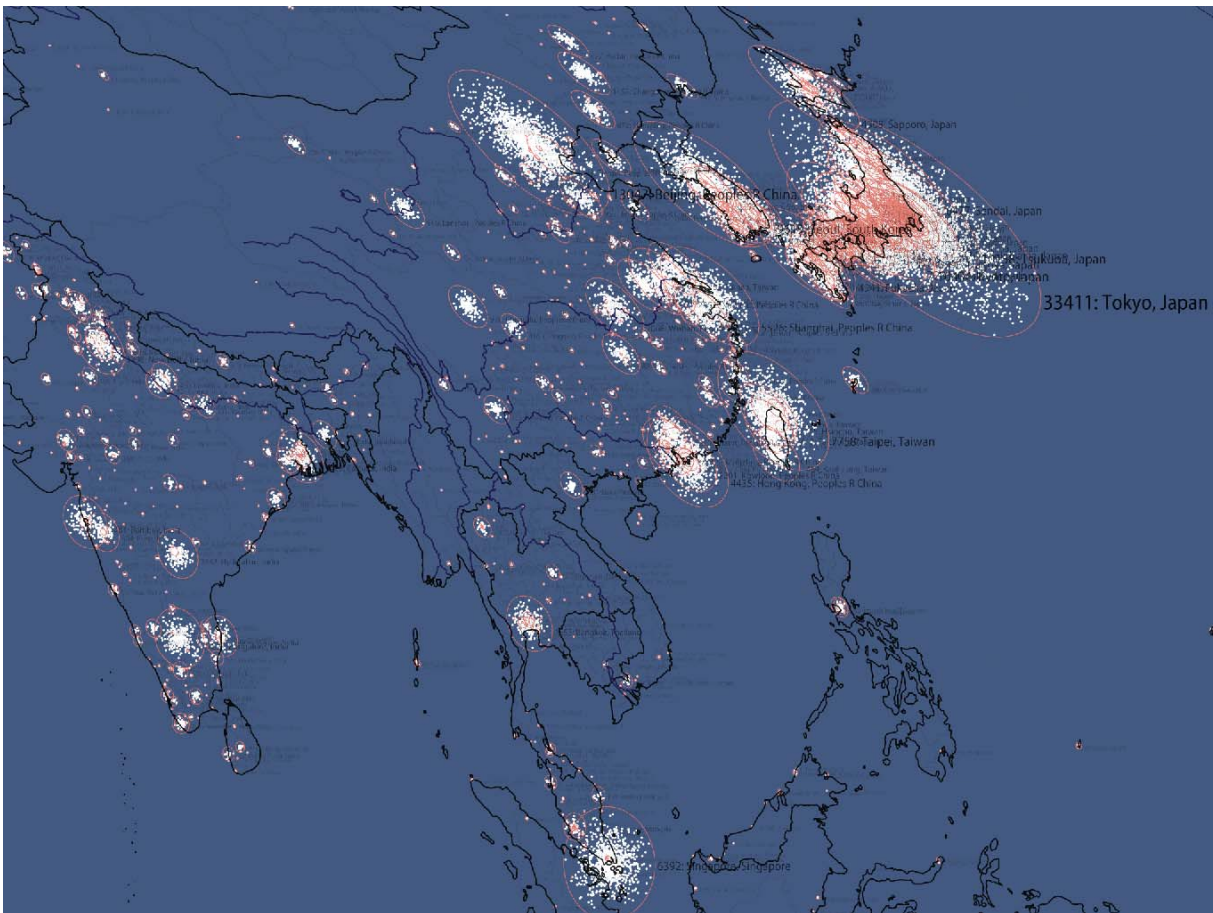
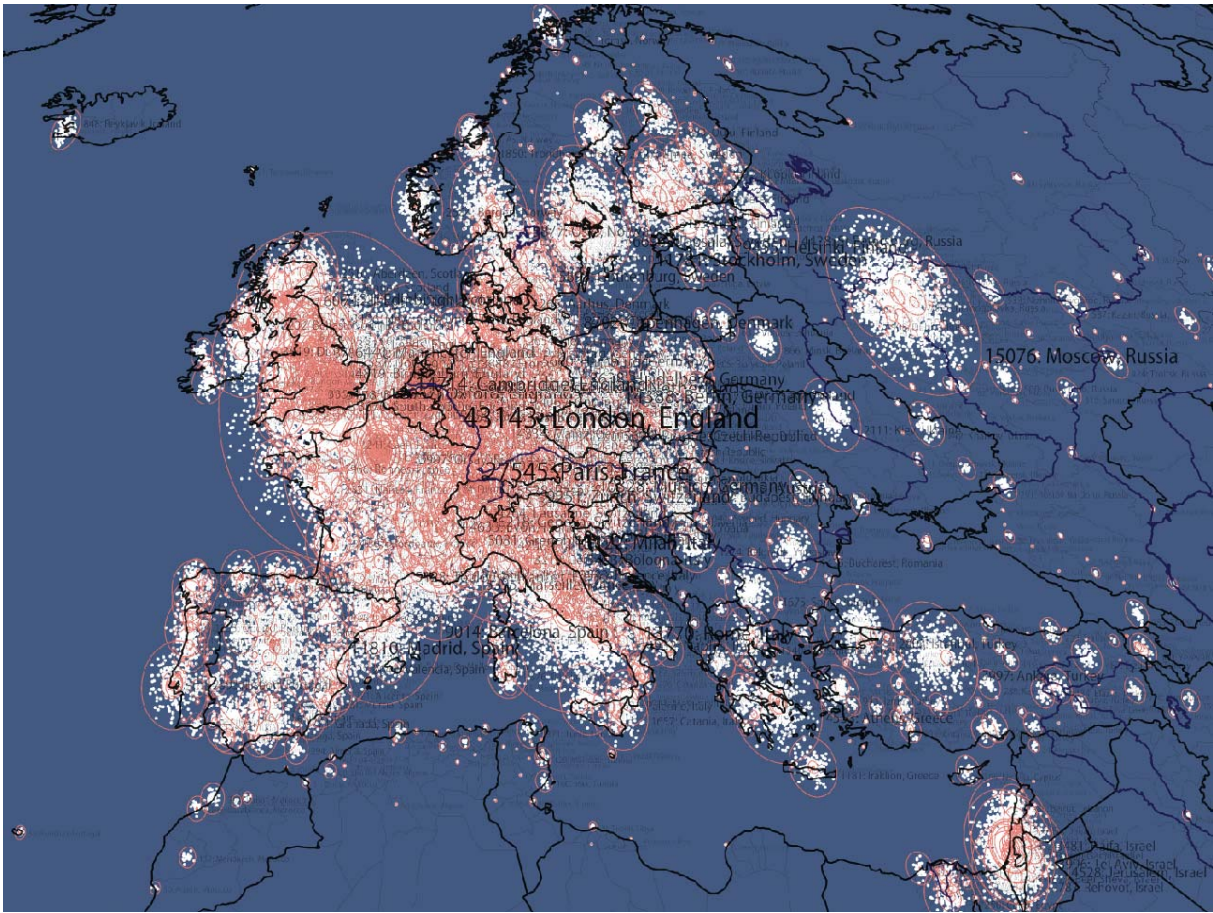
People & organizations that helped create it

We sweep slowly through adjoining related topics, lighting up the places in the world that study each topic. You may select a subset of the topics that deal with these three interesting subjects by touching it.

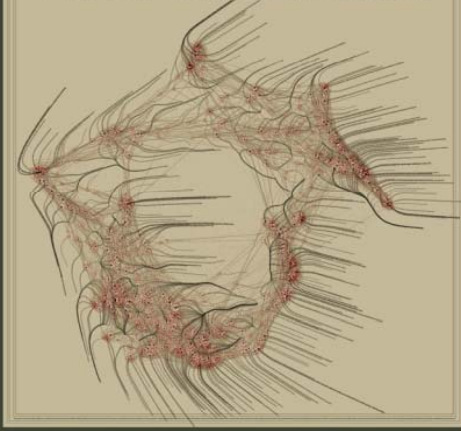
A single person's spreading influence is shown as a series of four snapshots. First, we light only topics and places relating to that person's papers—papers that are still highly cited today. The second lights everything that cites that original work. Note that this first-generation impact extends to far more topics than did the original work. The third snapshot lights science that cites the second, and the fourth lights science that cites the third.

GEOGRAPHIC MAP: WHERE SCIENCE GETS DONE

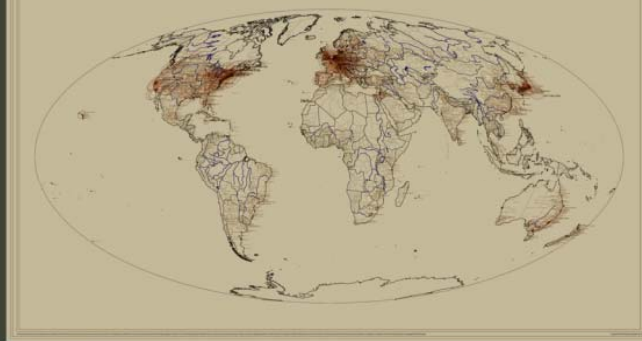




学科分布图：科学学科是怎样相互关联的



世界地图：科学研究在哪里进行着



你可以通过触摸屏在地图上随意指点来改变所到之处的光亮强度。当你触摸世界地图的某一点时，在那个地理位置上的所有研究机构会被点亮。同时在这些研究机构工作的学者的论文所属的学科会在学科分布图上被点亮。而当你触摸学科分布图的某一点时，在那个位置上的科学学科会被点亮，同时从事这些学科研究的研究机构在世界地图上的分布会被点亮。

纳米技术

这里显示所有和纳米技术相关的科学学科。纳米技术和科学研究人类在无形的空间里改造世界的的能力。这些空间存在于极其微小以至单个原子的结构中。目前大部分有关纳米的研究主要集中在物理、化学和材料科学领域。它们主要位于学科分布图上半部分的右面。不过，纳米技术在生物学和医药学研究里的应用也越来越多。生物学和医药学位于学科分布图下半部分的右面。



探索科学学科的相互关联性

所有科学学科 显示所有776种科学学科	纳米技术 有关微观粒子的科学
可持续性 一些与人类寄予长期希望相关的科学	化学和生物 化学和生物科学的交叉部分

光柱缓慢的扫过所有相互关联的科学学科，每一个学科以及从事这方面科学研究的研究机构在世界地图上的位置会被逐一点亮。首先，显示屏会点亮那些产出论文最多、最活跃的科学学科，然后那些小学科或冷门学科会被逐一点亮。

探索某个学者的科学著作的影响力的传播

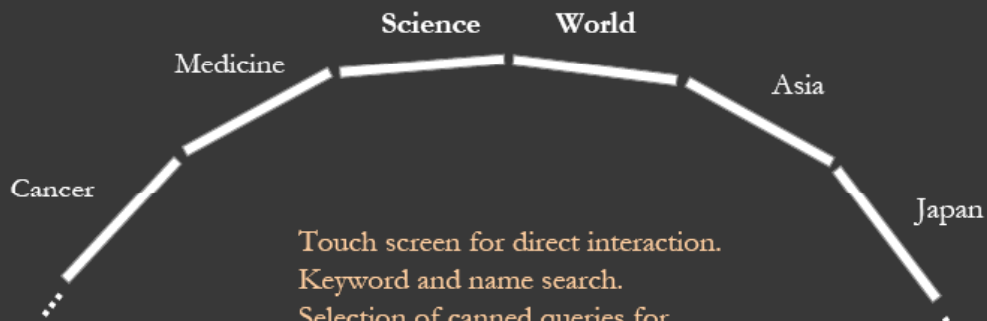
弗郎西·科里克 DNA双螺旋结构的发现者之一	阿尔伯特·爱因斯坦 用相对论重新激活了物理学	迈克尔·费舍尔 发现了物质转变模式的关键步骤	苏珊·费斯克 研究人的认知是如何产生偏见的
约舒亚·雷德伯格 细菌遗传机制研究先驱	德里克·德索拉·普里斯 著名的“科学计量学之父”	理查德·扎尔 采用激光化学技术研究分子动态分布	关于本次展览 与此展览相关人员和机构

显示屏通过四步来展示某个学者对科学的贡献以及影响力的传播。首先，显示屏点亮该学者所发表的论文所属的学科在学科分布图上的位置以及该学者从事这项研究所在的研究机构在世界地图上的位置。到目前为止，所有这些论文的引用率仍然很高。第二步，显示屏点亮所有引用在第一步中被点亮的原始论文的论文在学科分布图上的位置以及它们在世界地图上的位置。第三步，显示屏点亮所有引用了在第二步中被点亮的论文的论文在学科分布图上的位置以及它们在世界地图上的位置。第四步，显示屏点亮所有引用了在第三步中被点亮的论文的论文在学科分布图上的位置以及它们在世界地图上的位置。

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.



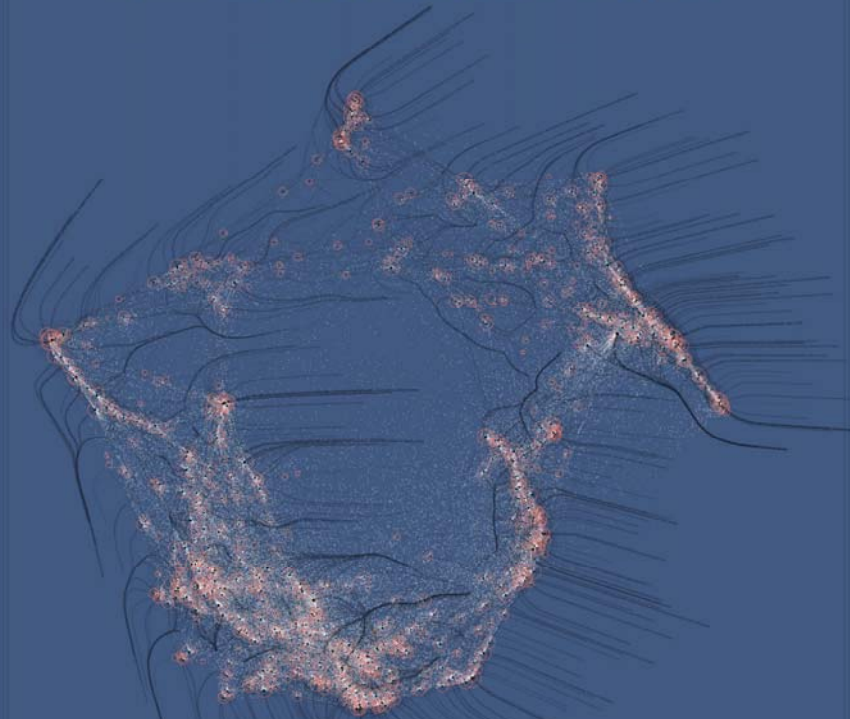
Hands-on Science Maps for Kids



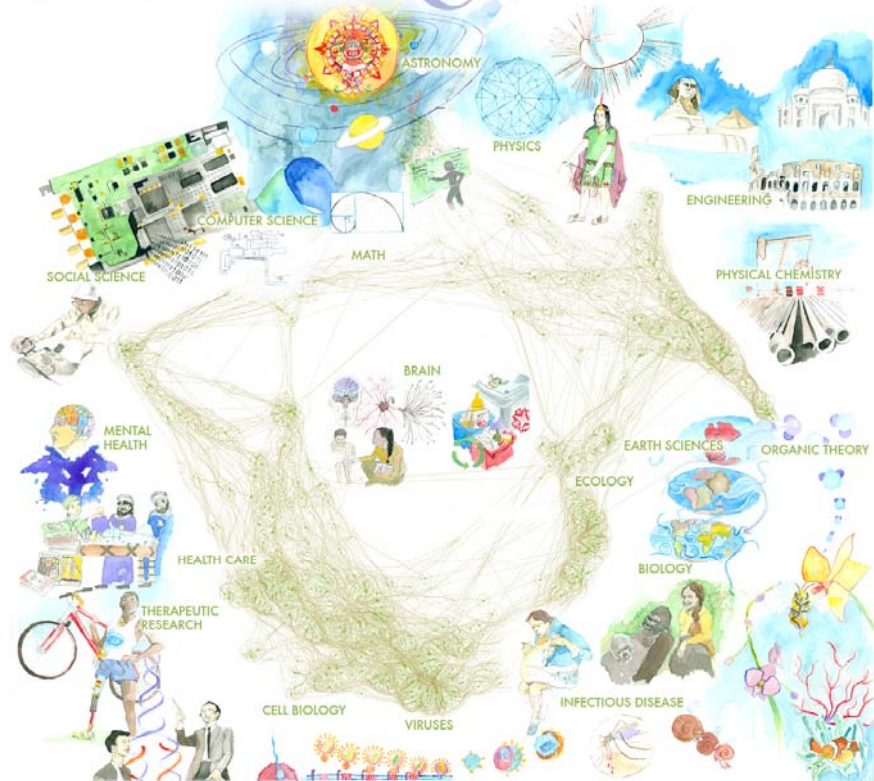
All maps of science are on sale via
<http://scimaps.org/ordermaps/>



TOPIC MAP: HOW SCIENTIFIC PARADIGMS RELATE



Inventors & Inventions



Hands-On Science Maps for Kids, by Alieve Palmer (Illustrations), Julie Smith (Data Acquisition), Eloha Hardy and Katy Blener (Graphic Design), BLOOMINGTON, IN, 2006. Courtesy of Indiana University. Learn more at www.indiana.edu/~scimaps/. This map plots the locations of where scientific papers were published; each light green dot represents 1000 paper papers; they are scattered around the exact location for visibility, within a labelled green circle whose size is proportional to the number of papers published in that place. The base map is part of an "illuminated diagram" shell that is used as a computer and two projectors, projecting spots of light on the walls to highlight different kinds of scientific research, using a glowing map of scientific paradigms and the areas in the world where such





My Science Story
By _____

There are seven main fields of science. They are...

social science, mathematics, physics, chemistry, earth science, medicine, and psychology. I like to study earth science.

Color earth science green.

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.

Color in the insect.

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?

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

Butterfly

Bee

Hister guodermaculatus

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

For more information about the map of science for kids on this exercise, please contact Katy Borner (katy@indiana.edu) or Nikki Roberg (nroberg@indiana.edu) at the School of Library and Information Science, Indiana University.
These materials were compiled by Nikki Roberg in 2008.

What is Science?

KIDS DRAWING CONTEST

WHAT
What is Science? Who does Science? What is Science to you? Design a picture of your favorite scientist or science experiment and tell us about it!

WHEN
October 1st - 30th: Submit entries
November 5th: Winners notified
November 5th - 30th: Winning entries and Top 50 on display at the American Museum of Science and Energy.

Judging Criteria

- 25% Appropriateness of contest theme
- 25% Creativity and quality of drawing
- 25% Originality of the story
- 25% Spokenness of drawing and story

Requirements

Kids ages 4-15 are invited to submit their hand-drawn illustrations on 8.5 x 11 paper with a typed story of 25-100 words explaining their drawing and discussing their favorite scientist or experiment.

PRIZES

- 1 year family membership & Science Kit from AMSE
- Science Kit from the AMSE Discovery Shop
- Science Book from the AMSE Discovery Shop

Bring in your contest submission and get into AMSE for FREE

Consent

Required: Parental signatures granting consent for child to enter contest and agreement that the submitted material will not be returned and will become the property of the Places & Spaces Mapping Science exhibit.

Submitting

Mail submissions to:
The American Museum of Science and Energy
c/o Ken Payes
300 S. Tulane Ave
Oak Ridge TN 37830

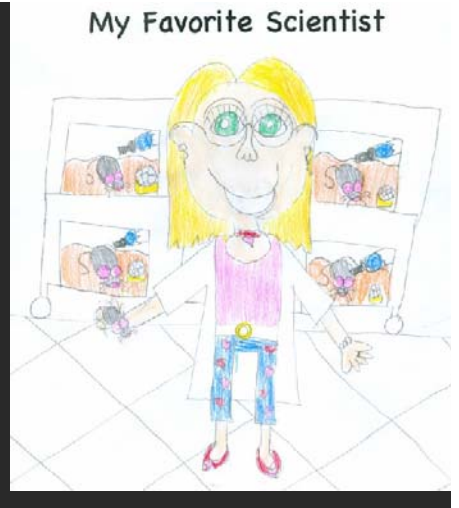
You may also bring in your submission to The American Museum of Science and Energy.

QUESTIONS? Ask Ken Payes (kenpayes@amse.org) | Phone 865-574-9584

Please attach this form to the back of submission

PLACES & SPACES

Artist's Name _____ Age _____ Parent's Name _____ Phone Number _____



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.

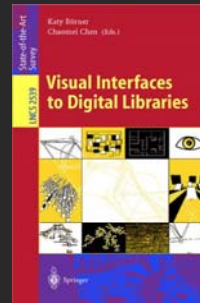
Where to go from here?



Contact the map makers via the exhibit curators:

Katy Börner (katy@indiana.edu) and Elisba Hardy (efhardy@indiana.edu)

Computational Scientometrics: Studying Science by Scientific Means



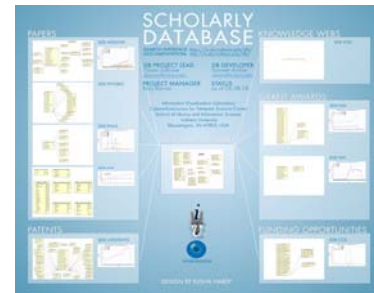
- Börner, Katy, Chen, Chaomei, and Boyack, Kevin. (2003). *Visualizing Knowledge Domains*. In Blaise Cronin (Ed.), *Annual Review of Information Science & Technology*, Medford, NJ: Information Today, Inc./ American Society for Information Science and Technology, Volume 37, Chapter 5, pp. 179-255. <http://ivl.slis.indiana.edu/km/pub/2003-borner-arist.pdf>
- Shiffrin, Richard M. and Börner, Katy (Eds.) (2004). *Mapping Knowledge Domains*. *Proceedings of the National Academy of Sciences of the United States of America*, 101(Suppl_1). http://www.pnas.org/content/vol101/suppl_1/
- Börner, Katy, Sanyal, Soma and Vespignani, Alessandro (2007). *Network Science*. In Blaise Cronin (Ed.), *Annual Review of Information Science & Technology*, Information Today, Inc./ American Society for Information Science and Technology, Medford, NJ, Volume 41, Chapter 12, pp. 537-607. <http://ivl.slis.indiana.edu/km/pub/2007-borner-arist.pdf>
- *Places & Spaces: Mapping Science* exhibit, see also <http://scimaps.org>.

Cyberinfrastructures for a Science of Science



Scholarly Database of 18 million scholarly records

<https://sdb.slis.indiana.edu>



Information Visualization Cyberinfrastructure

<http://iv.slis.indiana.edu>



Network Workbench Tool and Community Wiki

***NEW* Scientometrics plugins**

<http://nwb.slis.indiana.edu>



Epidemics Cyberinfrastructure

<http://epic.slis.indiana.edu/>



73

Science of Science Cyberinfrastructure — P O R T A L —

Provided by the [Cyberinfrastructure for Network Science Center](#) at Indiana University.

Introduction
E. O. Wilson writes in *Consilience: The Unity of Knowledge* (1998): "Features that distinguish science from pseudoscience are repeatability, economy, mensuration, heuristics, and consilience." Please see Börner's [recent presentation](#) at the *A Deeper Look at the Visualization of Scientific Discovery* NSF Workshop for a general introduction of the needs and the resources provided here.

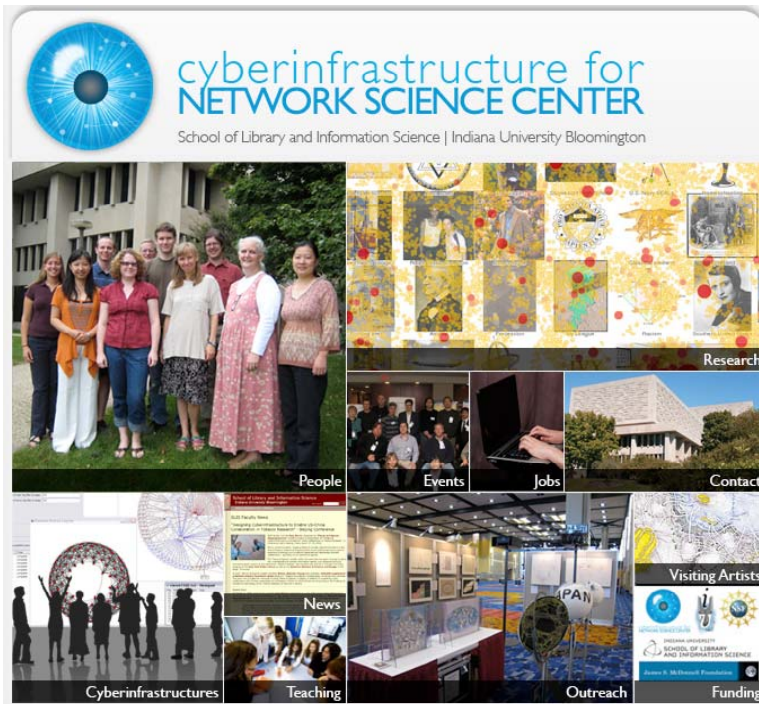
Needs Analysis
As part of the "TLS: Towards a Macroscopic for Science Policy Decision Making" NSF SBE-0738111 award, interviews with science policy makers are conducted to identify what science of science research results and tools might be most desirable and effective. So far, 30 formal, one-hour interviews have been conducted with science policy makers at university campus level, program officer level, and division director level for governmental, state, and private foundations. Data compilation will start in October 2008 and resulting report can be ordered by sending a request to Mark Price (maaprice@indiana.edu).

Conceptualization of Science
A science of science requires a theoretically grounded and practically useful conceptualization of the structure and evolution of science. A special journal issue entitled "Science of Science: Conceptualizations and Models of Science" edited by [Katy Börner](#), Indiana University & [Andrea Scharnhorst](#), Royal Netherlands Academy of Arts and Sciences invites contributions on this topic. It will be published in the *Journal of Informetrics* 3(1) in January 2009.

Scholarly Database
The [Scholarly Database \(SDB\)](#) at Indiana University aims to serve researchers and practitioners interested in the analysis, modeling, and visualization of large-scale scholarly datasets. The database currently provides access to over 20 million papers, patents and grants. Resulting datasets can be downloaded in bulk. Register for free access at <https://sdb.slis.indiana.edu/>.

Cyberinfrastructures
The Scientometrics filling of the [Network Workbench \(NWB\) Tool](#) provides a unique distributed, shared resources environment for large-scale network analysis, modeling, and visualization. Thomson Scientific/ISI, Scopus and Google Scholar data, EndNote and Bibtext files, or NSF awards can be read and diverse networks can be extracted and studied. Download [User Manual with focus on Scientometrics](#).

<http://sci.slis.indiana.edu>



<http://cns.slis.indiana.edu>

Merry Christmas and Happy New Year! 2009

The Wreath of Science

Katy Börner

Elisha F. Hardy

Patrick Phillips

Angela Zoss

Ying Ding

Peter A. Hook

Patrick Phillips

Timothy Ke...

Shown is the UCSD Map of Science created by Klavans and Boyack based on 7.2 million papers and over 16,000 separate journals, proceedings, and series from Thomson Reuters and Scopus™ published from 2001-2005. The 13 major areas of science are color-coded and labeled.

Stacy Kowalczyk

Russell Duhon

Micah Linnemeier

Overlaid are the Top 3 journals in each area of science with the highest Impact Factor for Scientific Journals 2007. The journals with the highest impact factor per area are labeled.

Copyright © 2008
The Regents of the University of California

<http://scimaps.org/>

<http://cns.slis.indiana.edu/>

<http://ella.slis.indiana.edu/~katy>

<http://scimaps.org>

<http://cns.slis.indiana.edu>

The End.