

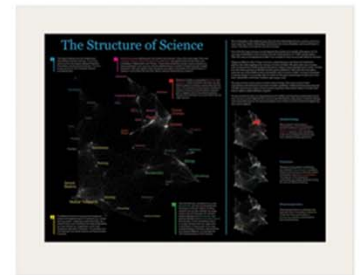
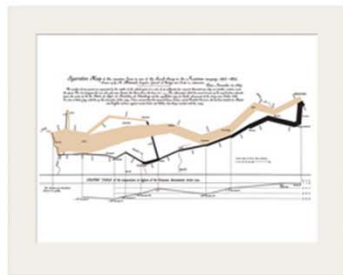
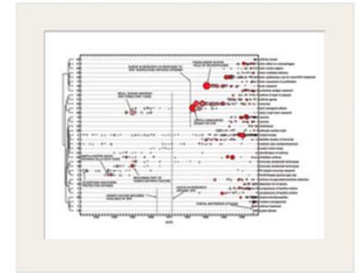
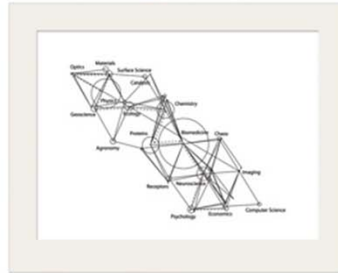


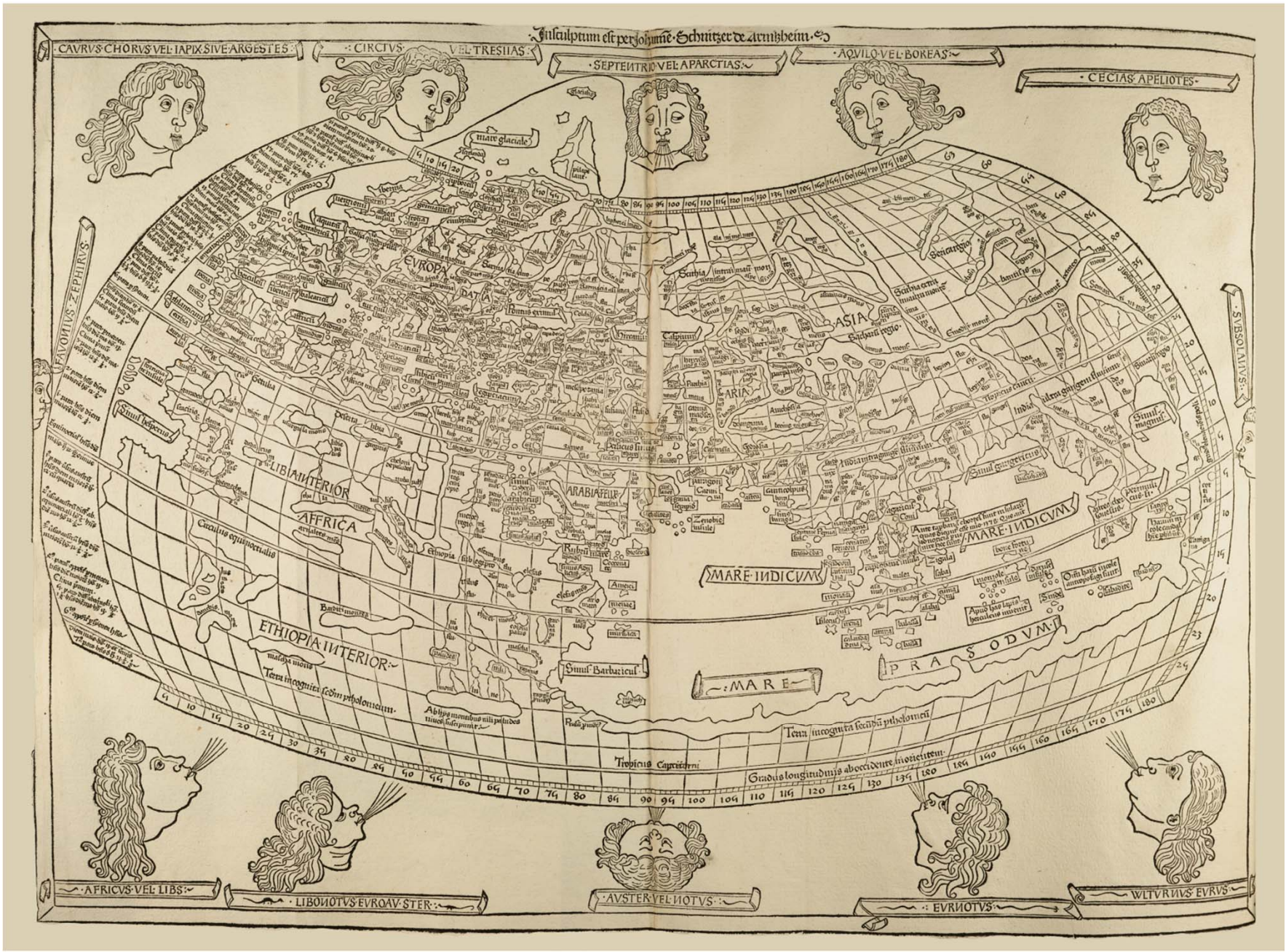
# PLACES & SPACES

MAPPING SCIENCE EXHIBIT

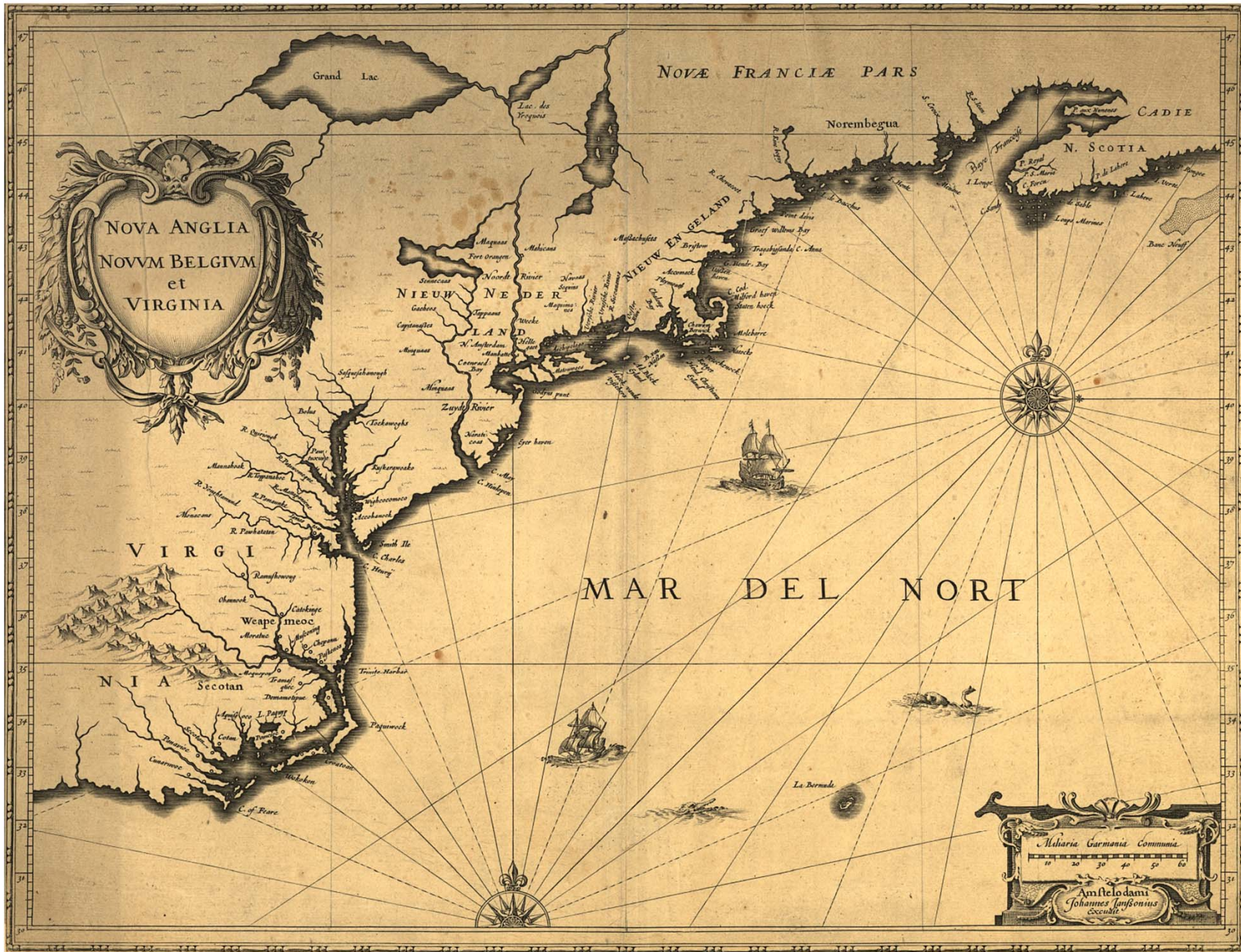
[scimaps.org](http://scimaps.org)

# THE POWER OF MAPS 2005





Cosmographia World Map - Claudius Ptolemy - 1482

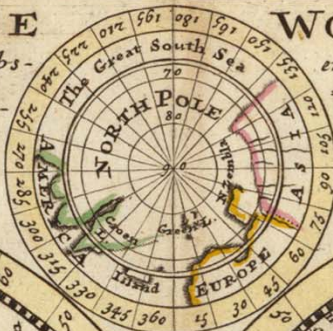


Nova Anglia, Novvm Belgivm et Virginia - Jan Jansson - 1642

A New Map of the **WHOLE**  
According to y<sup>e</sup> latest and most Exact Obs-

**WORLD** with the Trade winds  
ervations By H. Moll Geographer

In this Maps is inserted A View of y<sup>e</sup> General & Coasting Trade Winds, Monsoons or y<sup>e</sup> Shifting Trade winds Note that y<sup>e</sup> Arrows among y<sup>e</sup> Lines shew y<sup>e</sup> Course of those General & Coasting Winds. and y<sup>e</sup> Arrows in y<sup>e</sup> void Spaces shew y<sup>e</sup> Course of y<sup>e</sup> Shifting Trade winds, and y<sup>e</sup> Abbreviation Sep<sup>r</sup> &c. Shew y<sup>e</sup> Times of y<sup>e</sup> Year when such Winds Blow.



The Signs of the Zodiac. The First 6 are Northern, the other Southern Signs  
 ♈ Aries . March  
 ♉ Taurus . April  
 ♊ Gemini . May  
 ♋ Cancer . June  
 ♌ Leo . July  
 ♍ Virgo . August  
 ♎ Libra . September  
 ♏ Scorpio . October  
 ♐ Sagittarius . November  
 ♑ Capricornus . Decemb.  
 ♒ Aquarius . January  
 ♓ Pisces . February



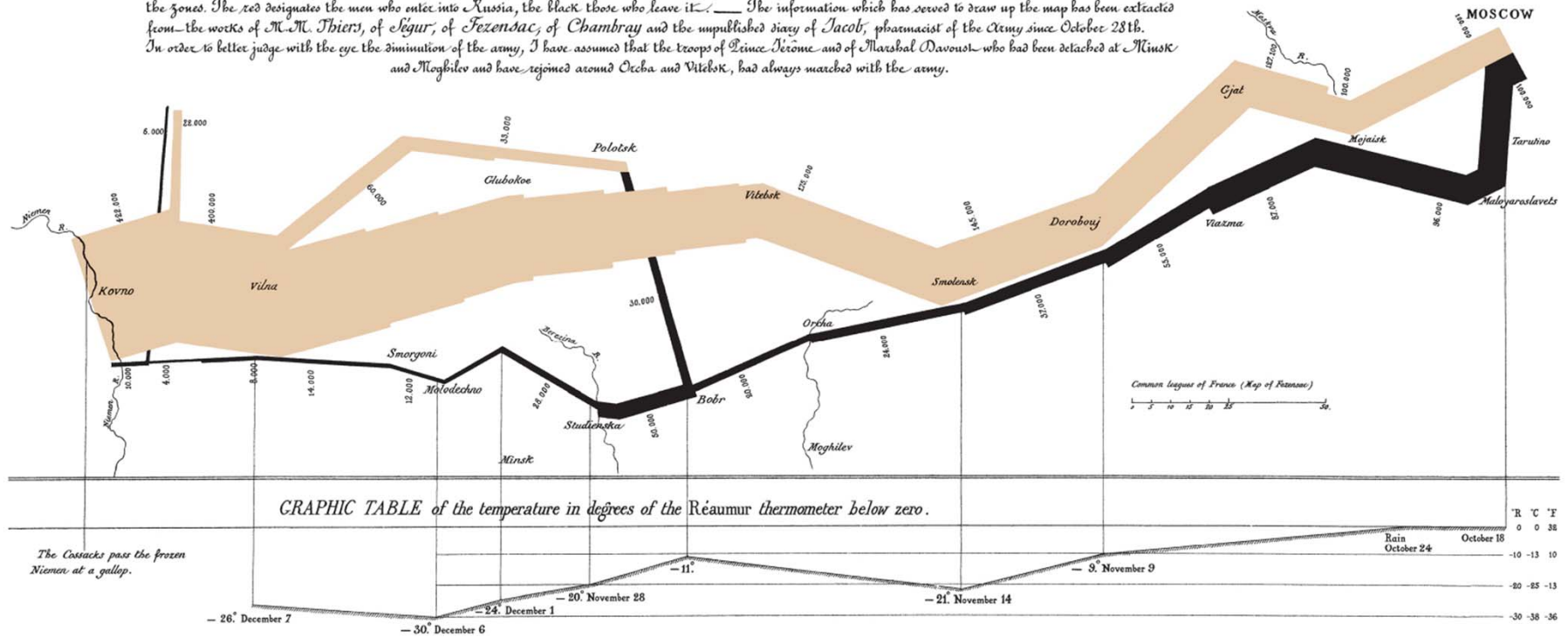
Printed for Tho<sup>s</sup> Bowles Print and Map Seller next y<sup>e</sup> Charter House in S<sup>t</sup>. Pauls Church yard; and John Bowles Print and Map Seller at the Black Horse in Cornhill London.

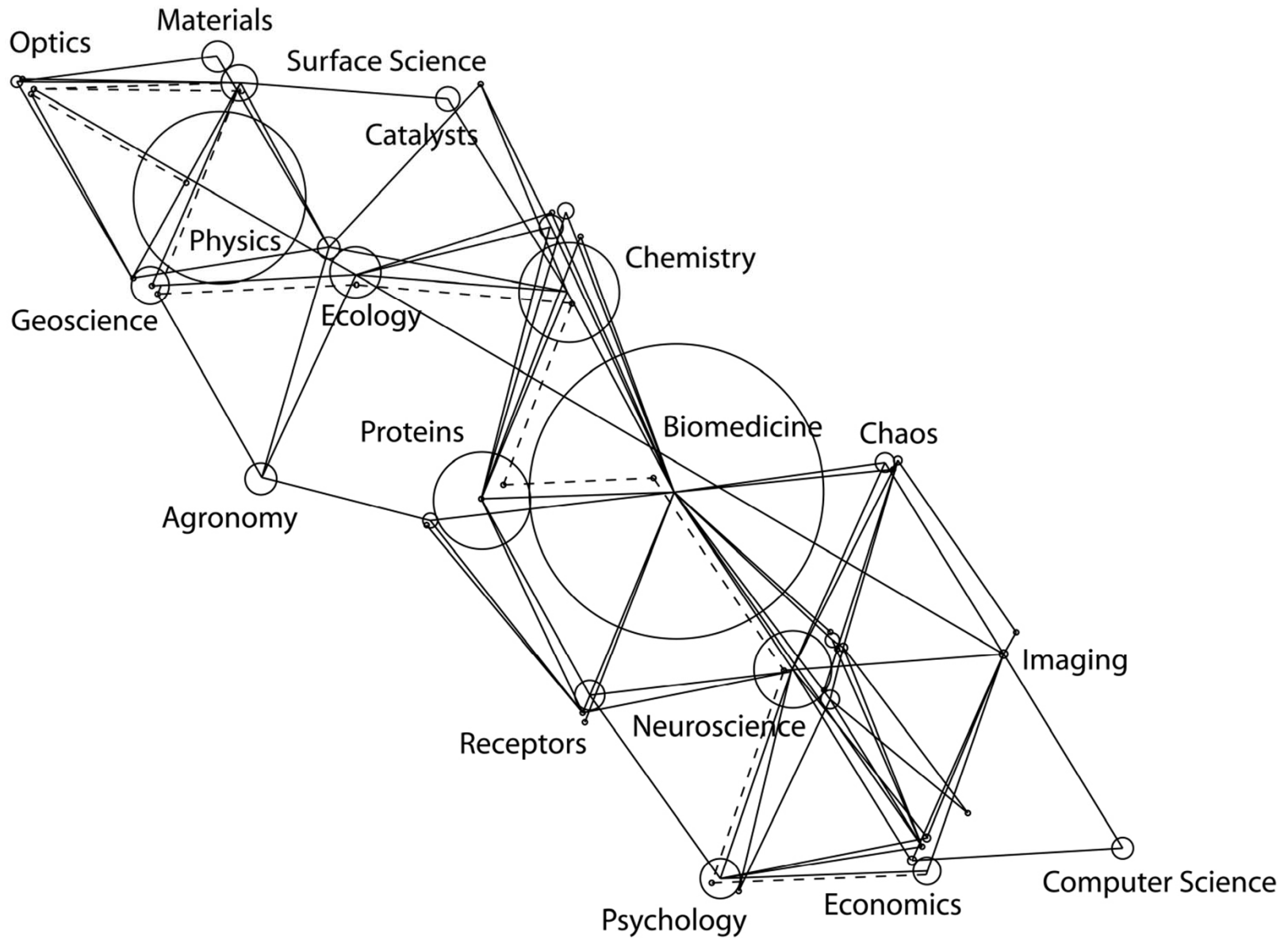
A New Map of the Whole World with Trade Winds According to the Latest and Most Exact Observations - Herman Moll - 1736

## Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812-1813.

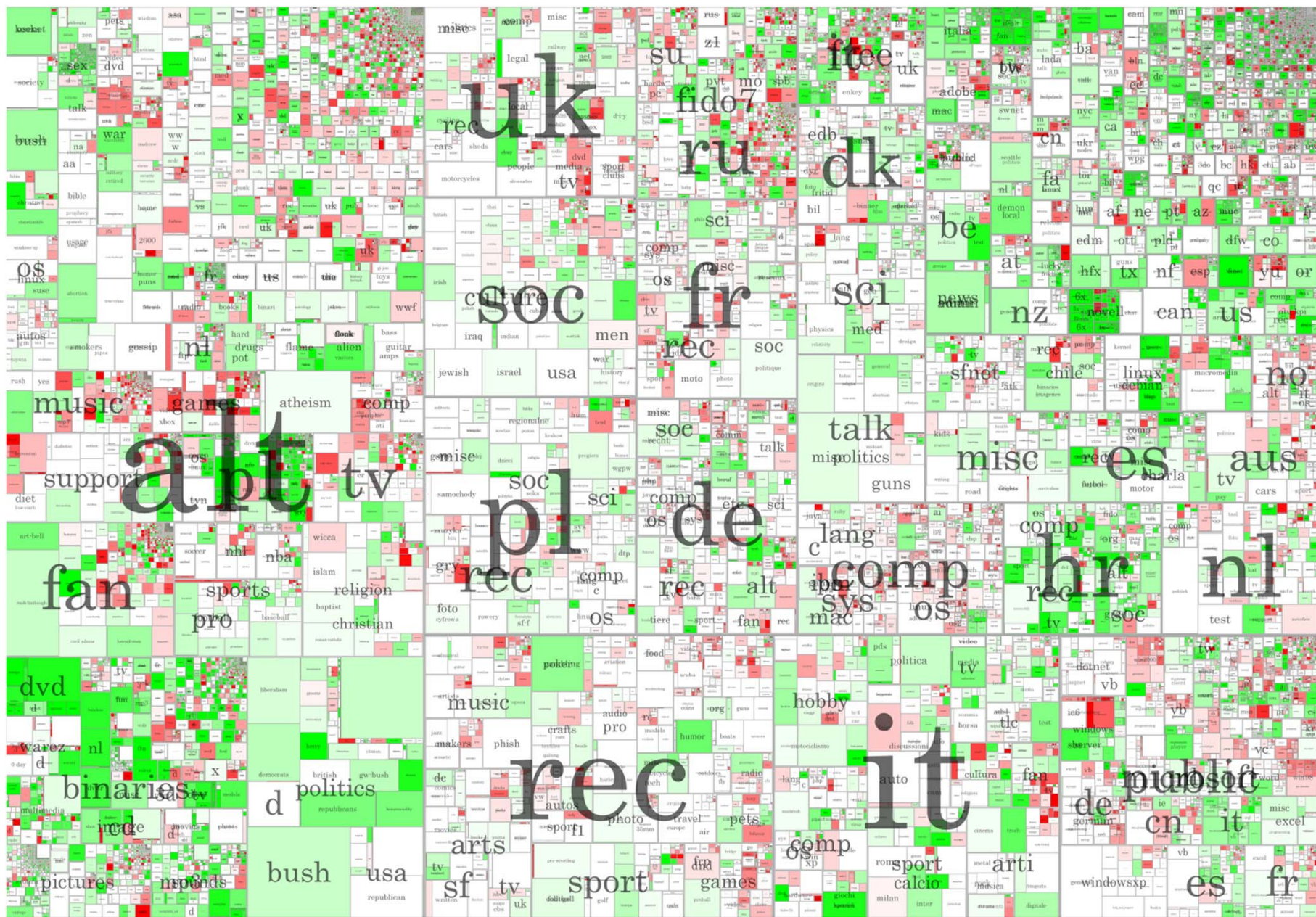
Drawn up by M. Minard, Inspector General of Bridges and Roads in retirement. Paris, November 20, 1869.

The numbers of men present are represented by the widths of the colored zones at a rate of one millimetre for every ten thousand men; they are further written across the zones. The red designates the men who enter into Russia, the black those who leave it. — The information which has served to draw up the map has been extracted from the works of M. M. Thiers, of Legur, of Fezensac, of Chambray and the unpublished diary of Jacob, pharmacist of the Army since October 28th. In order to better judge with the eye the diminution of the army, I have assumed that the troops of Prince Jérôme and of Marshal Davout, who had been detached at Minsk and Moghilev and have rejoined around Oecha and Vittebk, had always marched with the army.





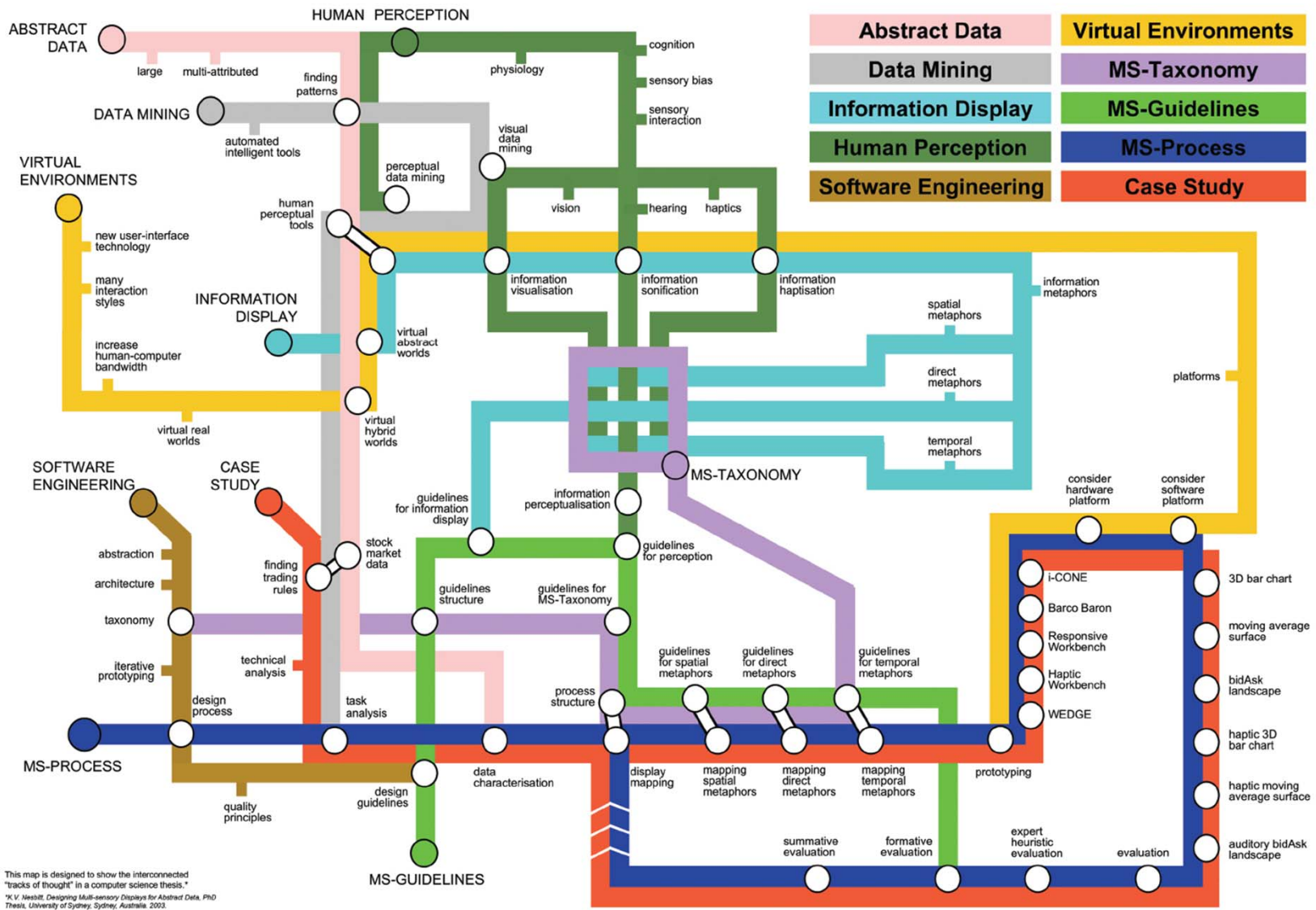
*A Network Representation of the 43 Fourth Level Clusters Based on Data from the 1996 Science Citation Index - Henry Small - 1999*



Treemap View of 2004 Usenet Returns - Marc Smith, Danyel Fisher, Tony Capone - 2005

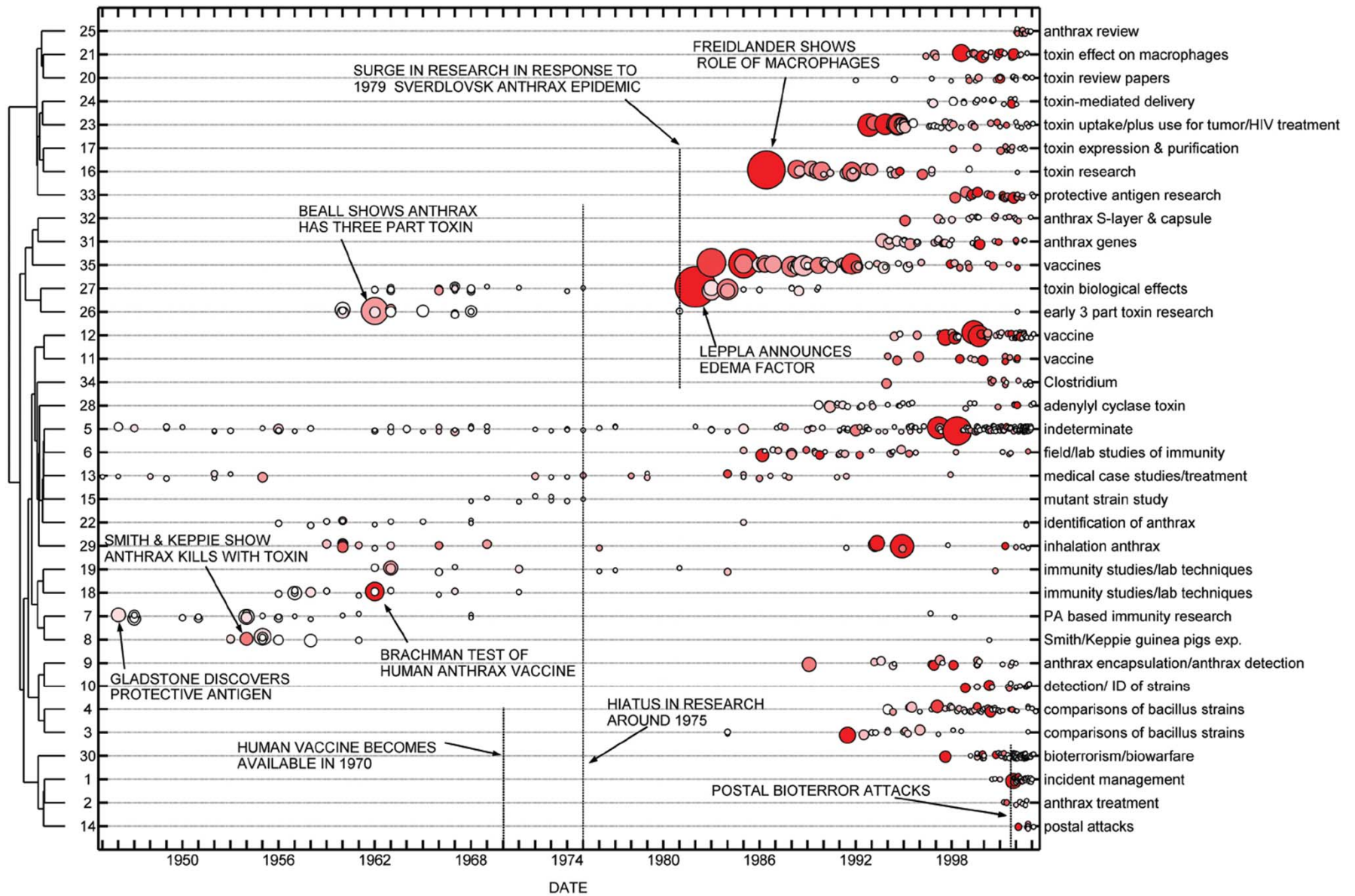






This map is designed to show the interconnected "tracks of thought" in a computer science thesis.  
 \*K. V. Nesbitt, Designing Multi-sensory Displays for Abstract Data, PhD Thesis, University of Sydney, Sydney, Australia, 2003.

Ph.D. Thesis Map - Keith B. Nesbitt - 2004



Timeline of 60 Years of Anthrax Research Literature - Steven Morris - 2005

# The Structure of Science

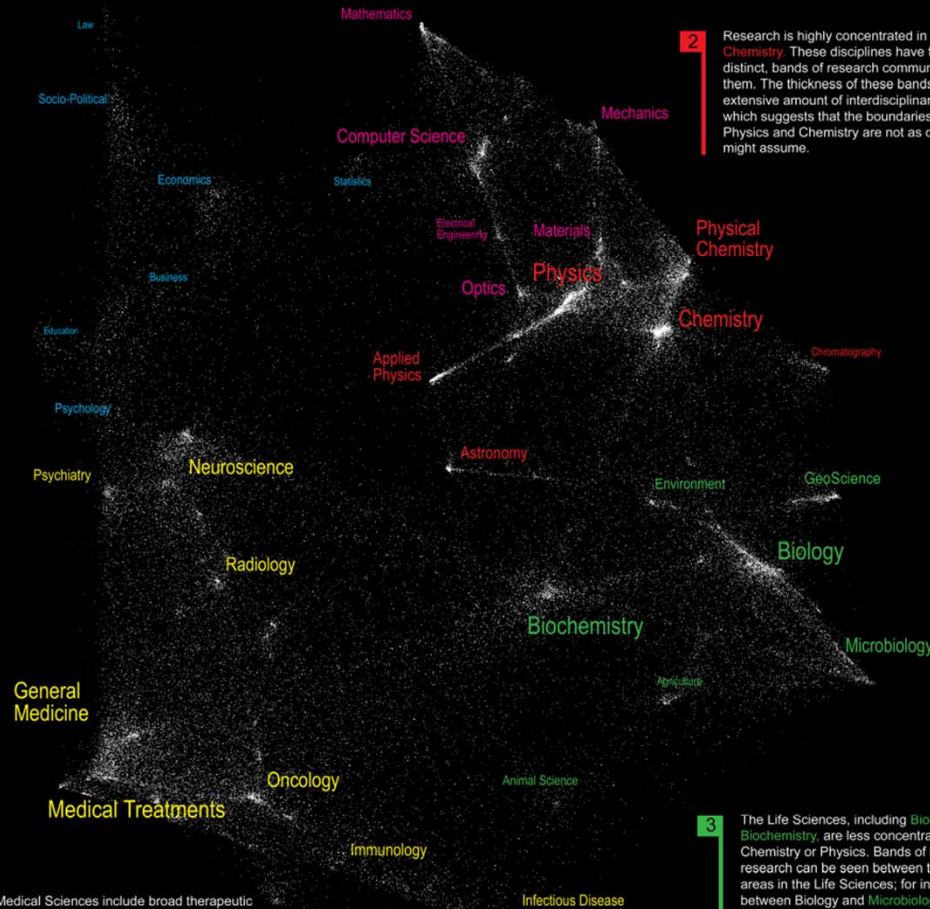
**5** The Social Sciences are the smallest and most diffuse of all the sciences. *Psychology* serves as the link between Medical Sciences (Psychiatry) and the Social Sciences. *Statistics* serves as the link with Computer Science and Mathematics.

**1** Mathematics is our starting point, the purest of all sciences. It lies at the outer edge of the map. *Computer Science*, *Electrical Engineering*, and *Optics* are applied sciences that draw upon knowledge in Mathematics and Physics. These three disciplines provide a good example of a linear progression from one pure science (Mathematics) to another (Physics) through multiple disciplines. Although applied, these disciplines are highly concentrated with distinct bands of research communities that link them. Bands indicate interdisciplinary research.

**2** Research is highly concentrated in *Physics* and *Chemistry*. These disciplines have few, but very distinct, bands of research communities that link them. The thickness of these bands indicates an extensive amount of interdisciplinary research, which suggests that the boundaries between Physics and Chemistry are not as distinct as one might assume.

**3** The Life Sciences, including *Biology* and *Biochemistry*, are less concentrated than *Chemistry* or *Physics*. Bands of linking research can be seen between the larger areas in the Life Sciences; for instance between *Biology* and *Microbiology*, and between *Biology* and *Environmental Science*. *Biochemistry* is very interesting in that it is a large discipline that has visible links to disciplines in many areas of the map, including *Biology*, *Chemistry*, *Neuroscience*, and *General Medicine*. It is perhaps the most interdisciplinary of the sciences.

**4** The Medical Sciences include broad therapeutic studies and targeted areas of *Treatment* (e.g. central nervous system, cardiology, gastroenterology, etc.) Unlike *Physics* and *Chemistry*, the medical disciplines are more spread out, suggesting a more multi-disciplinary approach to research. The transition into Life Sciences (via *Animal Science* and *Biochemistry*) is gradual.



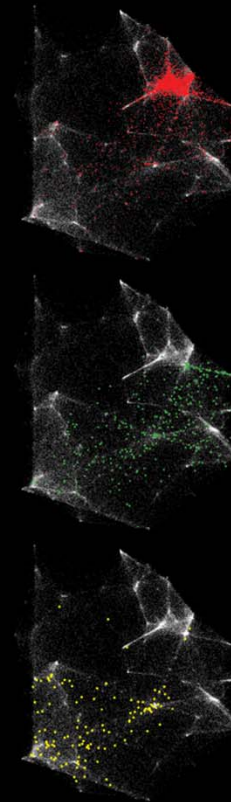
We are all familiar with traditional maps that show the relationships between countries, provinces, states, and cities. Similar relationships exist between the various disciplines and research topics in science. This allows us to map the structure of science.

One of the first maps of science was developed at the Institute for Scientific Information over 30 years ago. It identified 41 areas of science from the citation patterns in 17,000 scientific papers. That early map was intriguing, but it didn't cover enough of science to accurately define its structure.

Things are different today. We have enormous computing power and advanced visualization software that make mapping of the structure of science possible. This galaxy-like map of science (left) was generated at Sandia National Laboratories using an advanced graph layout routine (VxOrd) from the citation patterns in 800,000 scientific papers published in 2002. Each dot in the galaxy represents one of the 96,000 research communities active in science in 2002. A research community is a group of papers (9 on average) that are written on the same research topic in a given year. Over time, communities can be born, continue, split, merge, or die.

The map of science can be used as a tool for science strategy. This is the terrain in which organizations and institutions locate their scientific capabilities. Additional information about the scientific and economic impact of each research community allows policy makers to decide which areas to explore, exploit, abandon, or ignore.

We also envision the map as an educational tool. For children, the theoretical relationship between areas of science can be replaced with a concrete map showing how math, physics, chemistry, biology and social studies interact. For advanced students, areas of interest can be located and neighboring areas can be explored.



## Nanotechnology

Most research communities in nanotechnology are concentrated in *Physics*, *Chemistry*, and *Materials Science*. However, many disciplines in the Life and Medical Sciences also have nanotechnology applications.

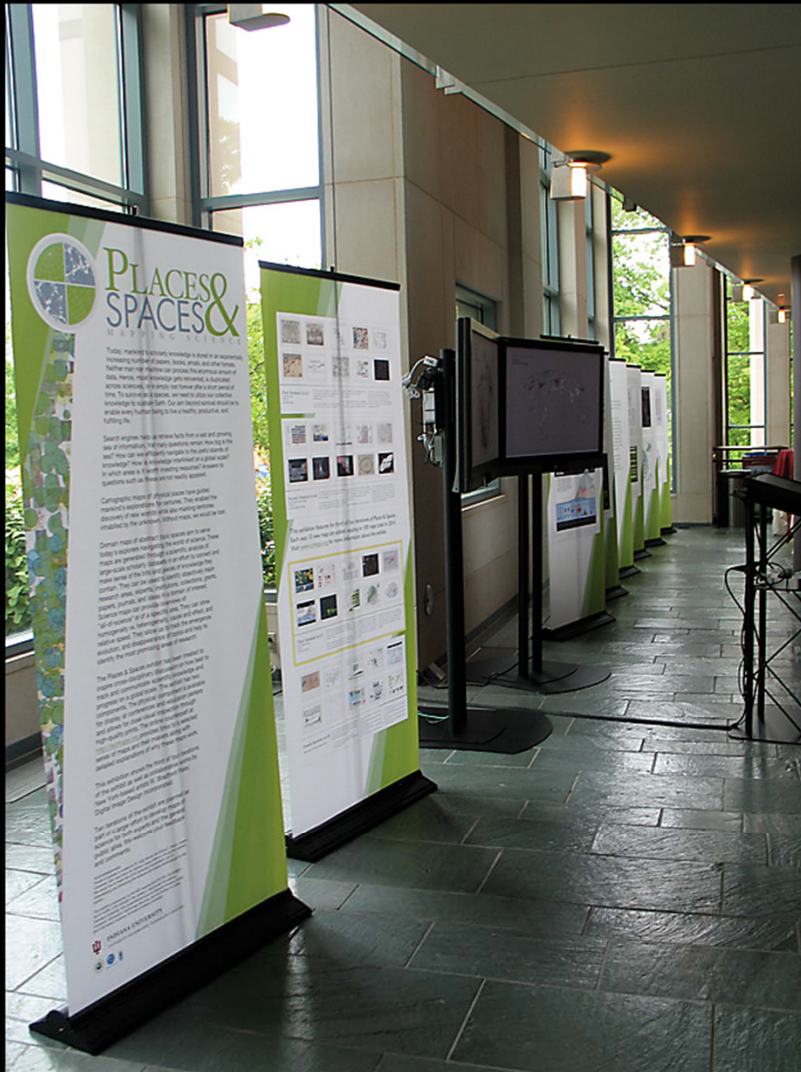
## Proteomics

Research communities in proteomics are centered in *Biochemistry*. In addition, there is a heavy focus in the tools section of chemistry, such as *Chromatography*. The balance of the proteomics communities are widely dispersed among the Life and Medical Sciences.

## Pharmacogenomics

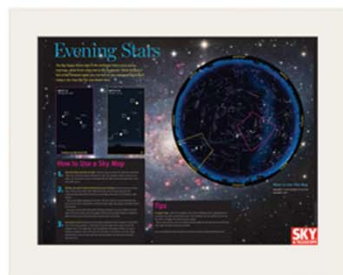
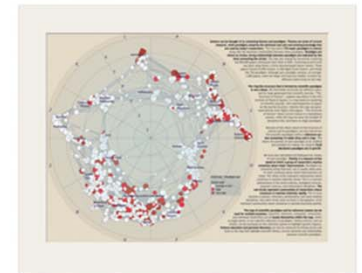
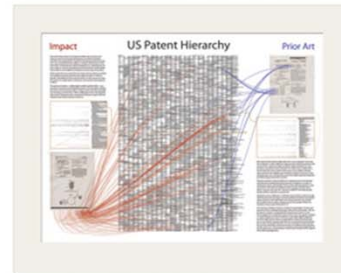
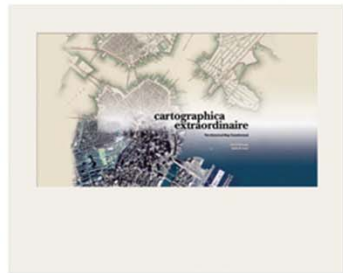
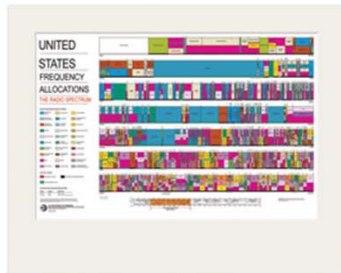
Pharmacogenomics is a relatively new field with most of its activity in *Medicine*. It also has many communities in *Biochemistry* and two communities in the Social Sciences.

# Want to host the **Places & Spaces** Exhibit?



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**[scimaps.org](http://scimaps.org)** for  
more information.

# THE POWER OF REFERENCE SYSTEMS 2006



# UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

## RADIO SERVICES COLOR LEGEND

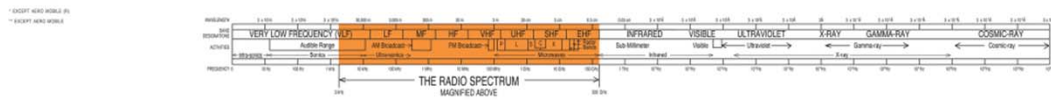

## ACTIVITY CODE


## ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters

This chart is a graphic representation of the portion of the Table of Frequency Allocations used by the FCC and ITU. As such, it does not completely reflect all results, i.e., treaties and future changes made to the Table of Frequency Allocations. Therefore, for complete accuracy, users should consult the Table to determine the current status of U.S. allocations.

**U.S. DEPARTMENT OF COMMERCE**  
National Telecommunications and Information Administration  
Office of Spectrum Management  
October 2003



PLEASE NOTE: THE SPACING ALLOTTED THE SERVICES IN THE SPECTRUM CHART IS ONLY FOR REPRESENTATIVE PURPOSES AND IS NOT PROPORTIONAL TO THE ACTUAL AMOUNT OF SPECTRUM ALLOCATED.

U.S. Frequency Allocations Chart - National Telecommunications and Information Administration - 2003

# The Visual Elements Periodic Table



This chart shows the 111 currently known and officially named elements that comprise the Periodic Table (IUPAC 2004). Each element is represented visually by an image produced for the Visual Elements project.

The Periodic Table is an arrangement of all known elements in order of increasing atomic number. The Periodic Table fits all the elements, with their widely diverse physical and chemical properties, into a logical pattern. There are eighteen vertical columns in the table which divide the elements into groups. Elements within a group have closely related physical properties. Horizontal rows list the elements in order of their increasing mass and are called series or periods. Properties of elements change in a systematic way through a period.

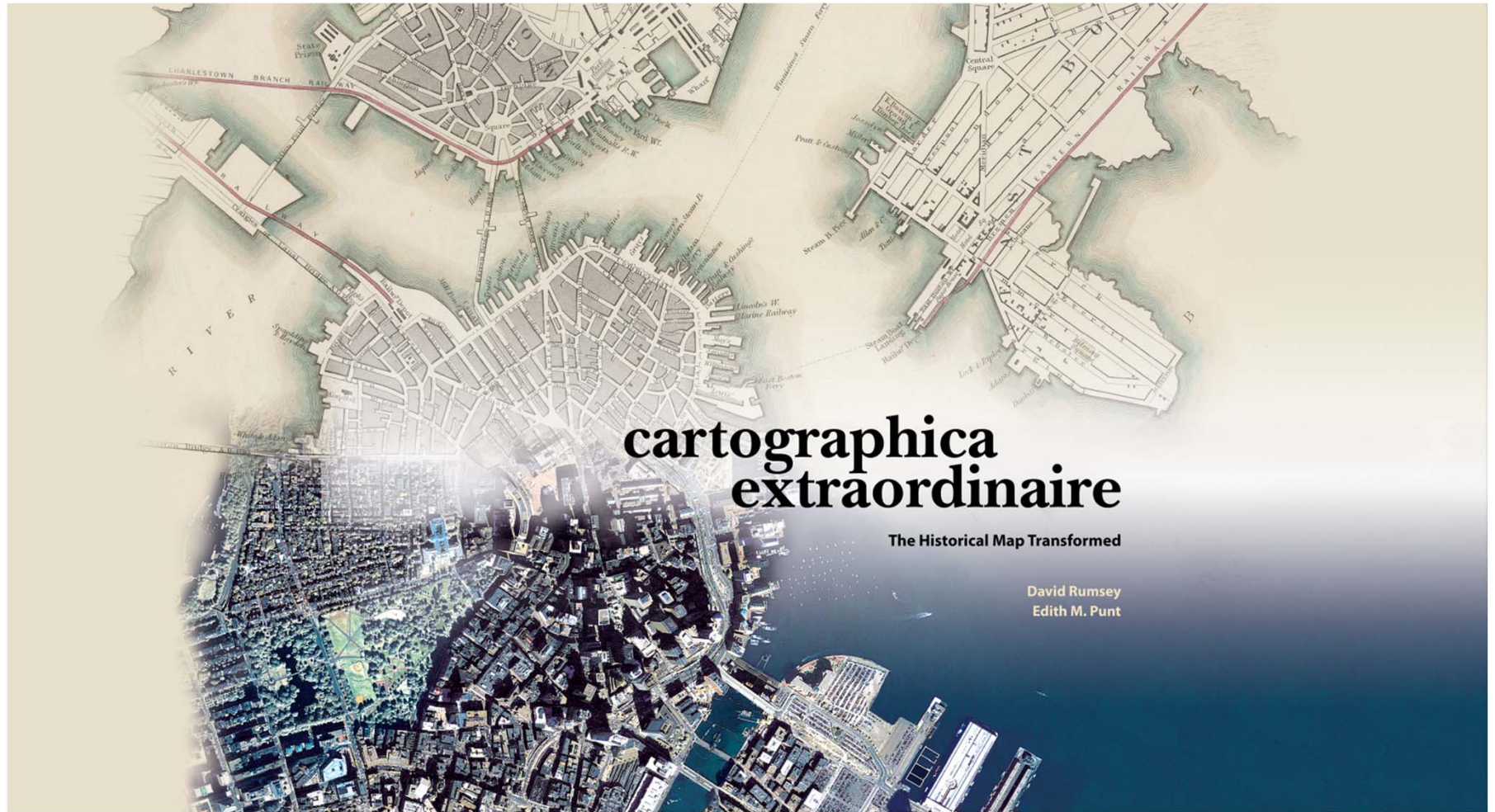
1 H Hydrogen																	2 He Helium						
3 Li Lithium	4 Be Beryllium																	5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium																	13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton						
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon						
55 Cs Caesium	56 Ba Barium	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium							
87 Fr Francium	88 Ra Radium	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium							

Visual Elements is an arts and science collaborative project supported by the Royal Society of Chemistry which aims to explore and reflect upon the diversity of elements that comprise matter in as unique and innovative manner as possible. All the images displayed here, together with screensavers, postcards and chemical data for each element can be viewed on the Visual Elements web site, hosted by the RSC.

Visit the periodic table on the web at:  
[www.chemsoc.org/viselements](http://www.chemsoc.org/viselements)

© Murray Robertson/Royal Society of Chemistry 1999-2006

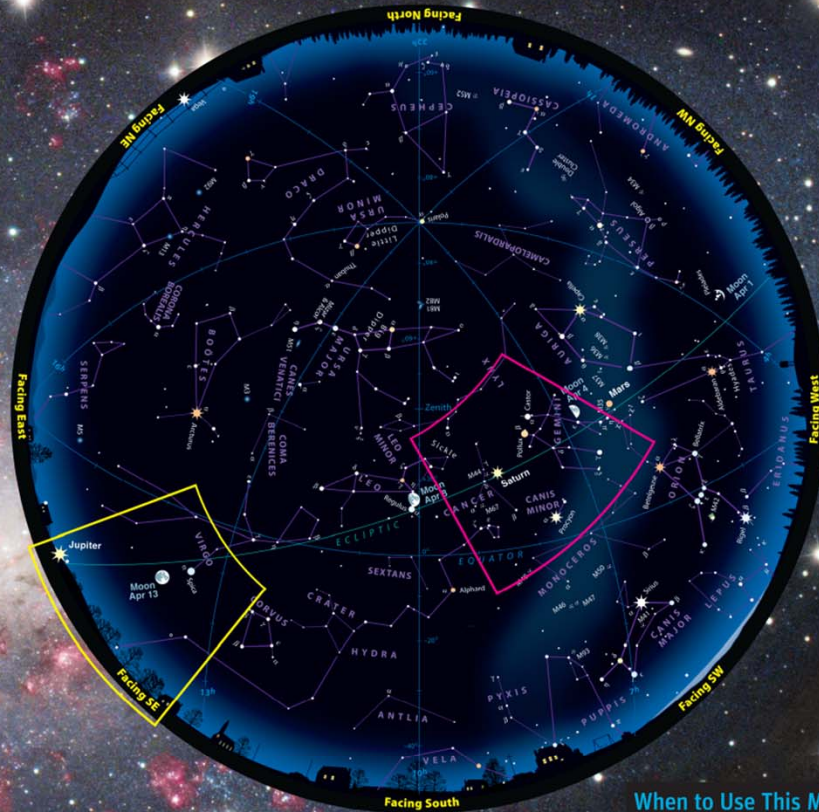




*Cartographica Extraordinaire: The Historical Map Transformed* - David Rumsey, Edith M. Punt - 2004

# 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

- 1. Check the dates and times at right.** 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.
- 2. 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 farther 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.
- 3. 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!

## Tips

**A couple of tips:** Look for the brightest stars and constellations first; light pollution or moonlight may wash 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 stary friends!

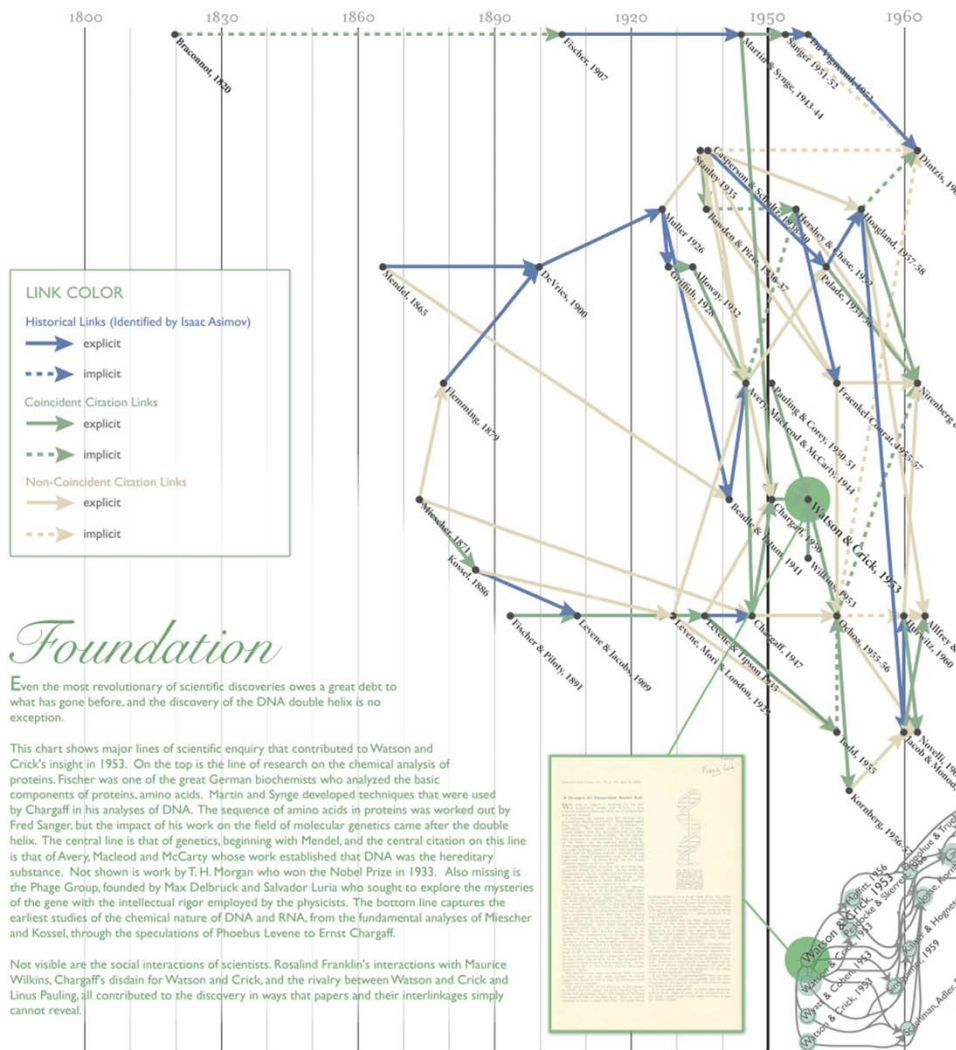
You can customize a night-sky map for any time and place at [SkyandTelescope.com](http://SkyandTelescope.com).

## When to Use This Map

Early April: 10 pm (daylight-saving time)  
Late April: Dusk

PHOTO COURTESY OF RUBEN GENDLER

**SKY**  
& TELESCOPE



## Foundation

Even the most revolutionary of scientific discoveries owes a great debt to what has gone before, and the discovery of the DNA double helix is no exception.

This chart shows major lines of scientific enquiry that contributed to Watson and Crick's insight in 1953. On the top is the line of research on the chemical analysis of proteins. Fischer was one of the great German biochemists who analyzed the basic components of proteins, amino acids. Martin and Sygne developed techniques that were used by Chargaff in his analyses of DNA. The sequence of amino acids in proteins was worked out by Fred Sanger, but the impact of his work on the field of molecular genetics came after the double helix. The central line is that of genetics, beginning with Mendel, and the central citation on this line is that of Avery, Macleod and McCarty whose work established that DNA was the hereditary substance. Not shown is work by T.H. Morgan who won the Nobel Prize in 1933. Also missing is the Phage Group, founded by Max Delbruck and Salvador Luria who sought to explore the mysteries of the gene with the intellectual rigor employed by the physicists. The bottom line captures the earliest studies of the chemical nature of DNA and RNA, from the fundamental analyses of Miescher and Kossel, through the speculations of Phoebus Levene to Ernst Chargaff.

Not visible are the social interactions of scientists. Rosalind Franklin's interactions with Maurice Wilkins, Chargaff's disdain for Watson and Crick, and the rivalry between Watson and Crick and Linus Pauling, all contributed to the discovery in ways that papers and their interlinkages simply cannot reveal.



## Writing the History of Science

In their 1964 paper, Eugene Garfield and his colleagues try to answer the question: Can a computer write the history of science? To answer this question, they selected a recent scientific breakthrough – the discovery of a structure for DNA suggesting a mechanism for its self-duplication – published by Watson & Crick in 1953.

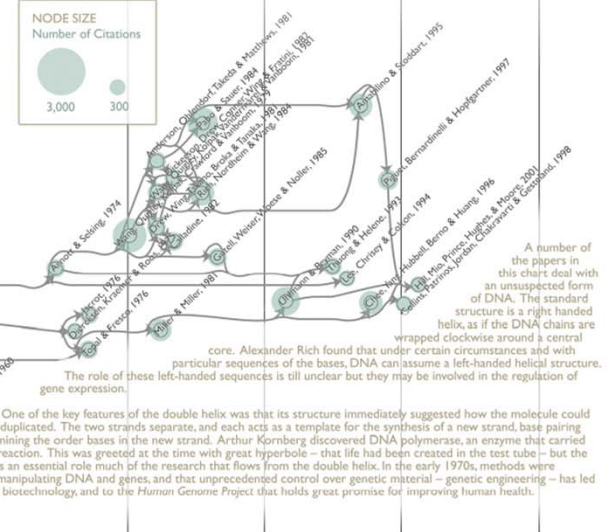
They use Isaac Asimov's book *The Genetic Code* to identify forty milestone works that lead to the discovery as well as their interlinkages. In addition, they identify the citation linkages among those forty papers using the 1961 Science Citation Index.

The detailed comparison of both networks demonstrates a high degree of coincidence between Asimov's account of events and the citation data, see also *Foundation* chart. They conclude that the use of citation data to write the history of science might provide a new *modus operandi* for the study of the history of science, research administration, and the sociology of science. Today, their HistCite™ tool generates interactive citation graphs automatically, see *Impact* chart.

## Impact

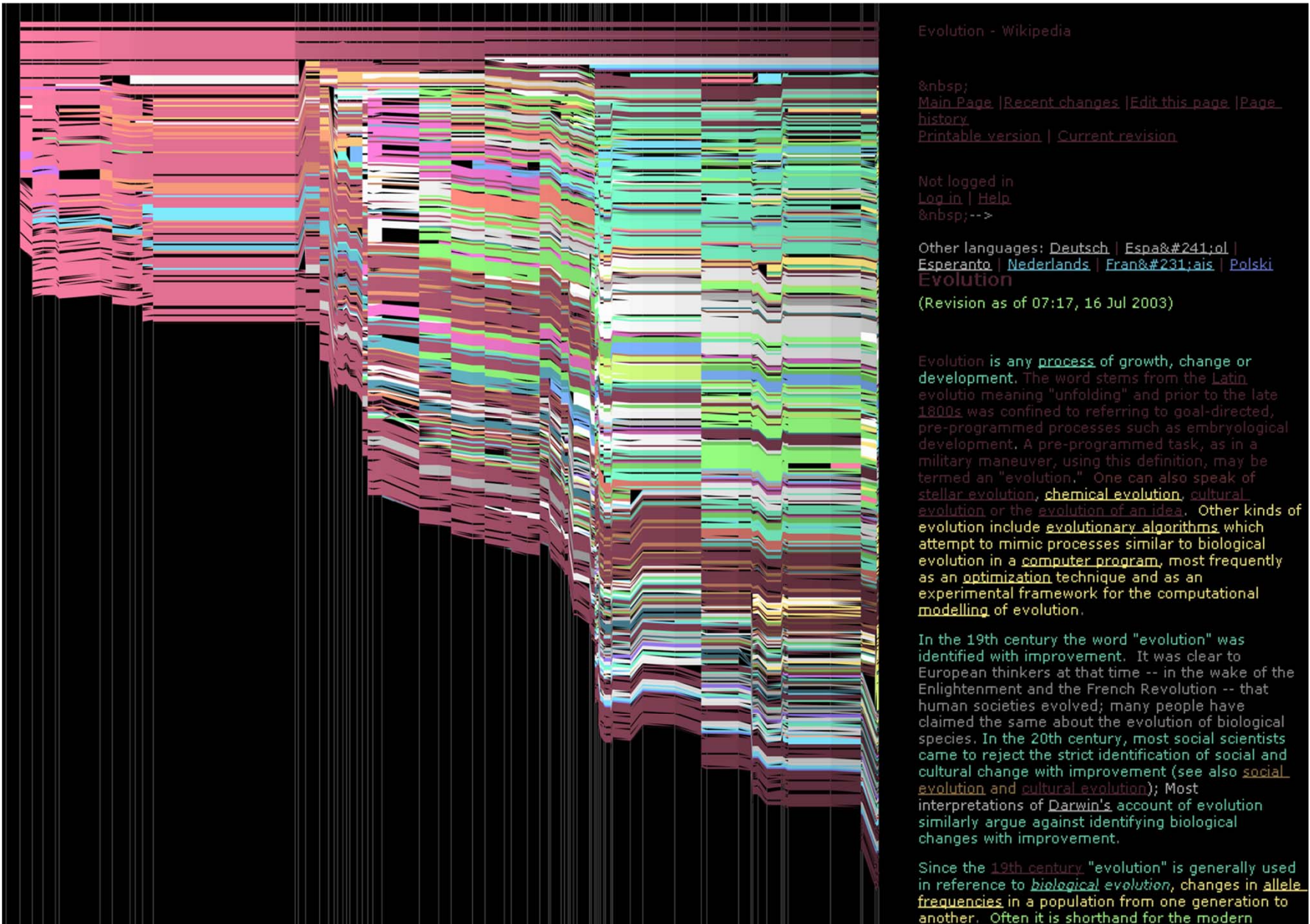
Hardly a day goes by when we do not read of the gene for this or that disease, or see DNA fingerprinting on a television crime show. There is so much emphasis on the biological functions of DNA that it is easy to forget that it is a molecule, made of atoms in a particular spatial pattern. Determining the pattern of atoms in DNA was precisely what led to the double helix but the Watson and Crick, 1953 paper and the accompanying papers by Wilkins and Franklin and their colleagues, was not the end of the story. As the chart on the right shows, X-ray crystallographic studies of DNA continued for many years, and a rigorous confirmation of the structure did not come until the 1970s.

Not surprisingly, there were continuing discoveries and some surprises. One was that not all DNA was double stranded. Robert Sinsheimer found that a small bacteriophage – a virus that attacks bacteria – had a single DNA strand. Many years later, this bacteriophage played an important role when techniques were developed to sequence, to determine the order of the bases in DNA.



A number of the papers in this chart deal with an unsuspected form of DNA. The standard structure is a right handed helix, as if the DNA chains are wrapped clockwise around a central core. Alexander Rich found that under certain circumstances and with particular sequences of the bases, DNA can assume a left-handed helical structure. The role of these left-handed sequences is still unclear but they may be involved in the regulation of gene expression.

One of the key features of the double helix was that its structure immediately suggested how the molecule could be duplicated. The two strands separate, and each acts as a template for the synthesis of a new strand, base pairing determining the order bases in the new strand. Arthur Kornberg discovered DNA polymerase, an enzyme that carried out that reaction. This was greeted at the time with great hyperbole – that life had been created in the test tube – but the enzyme plays an essential role much of the research that flows from the double helix. In the early 1970s, methods were developed for manipulating DNA and genes, and that unprecedented control over genetic material – genetic engineering – has led to a new industry, biotechnology, and to the Human Genome Project that holds great promise for improving human health.



History Flow Visualization of the Wikipedia Entry on Evolution - Martin Wattenberg, Fernanda Viegas - 2006

# Impact

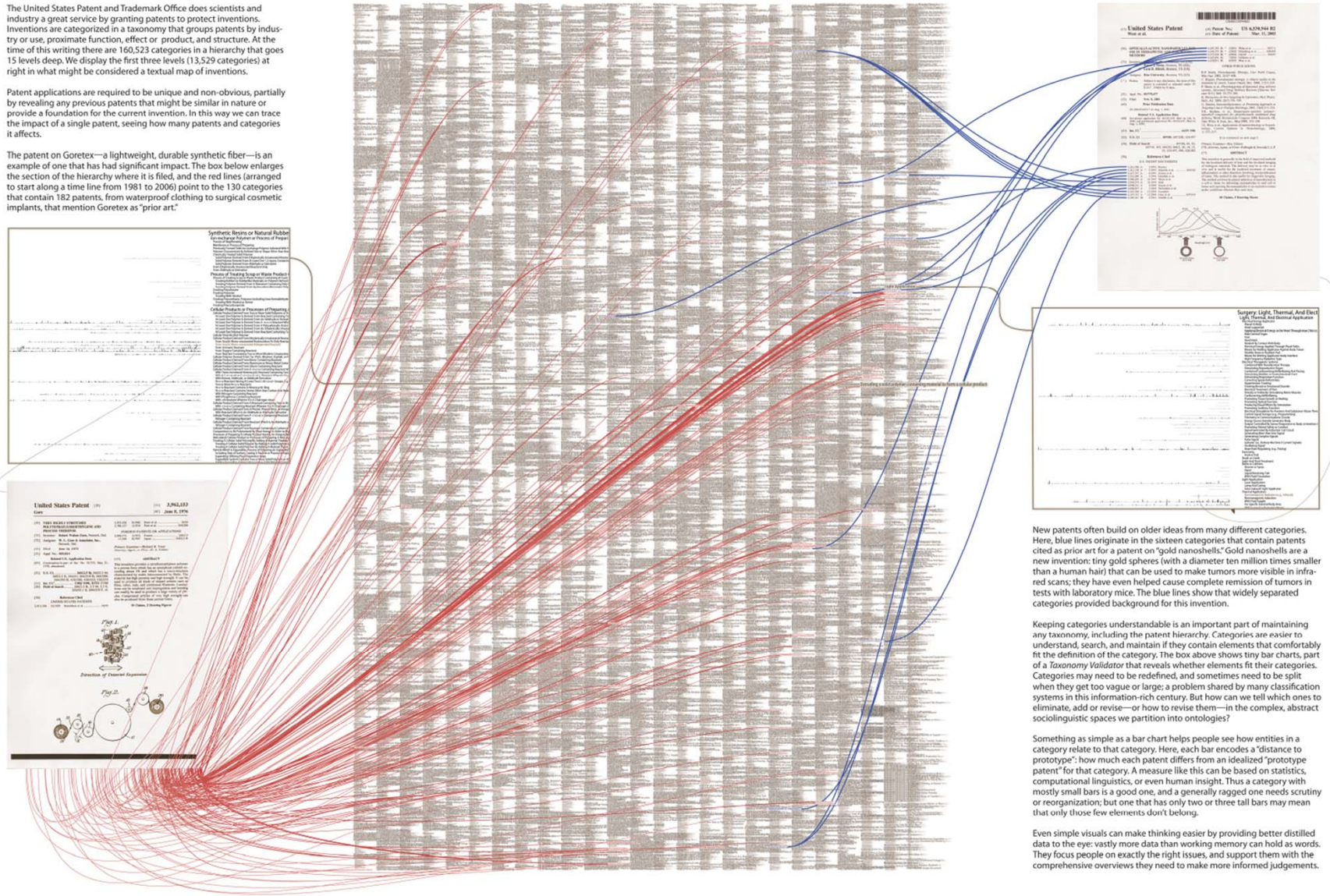
The United States Patent and Trademark Office does scientists and industry a great service by granting patents to protect inventions. Inventions are categorized in a taxonomy that groups patents by industry or use, proximate function, effect or product, and structure. At the time of this writing there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

# The US Patent Hierarchy

# Prior Art



New patents often build on older ideas from many different categories. Here, blue lines originate in the sixteen categories that contain patents cited as prior art for a patent on 'gold nanoshells.' Gold nanoshells are a new invention: tiny gold spheres (with a diameter ten million times smaller than a human hair) that can be used to make tumors more visible in infrared scans; they 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.

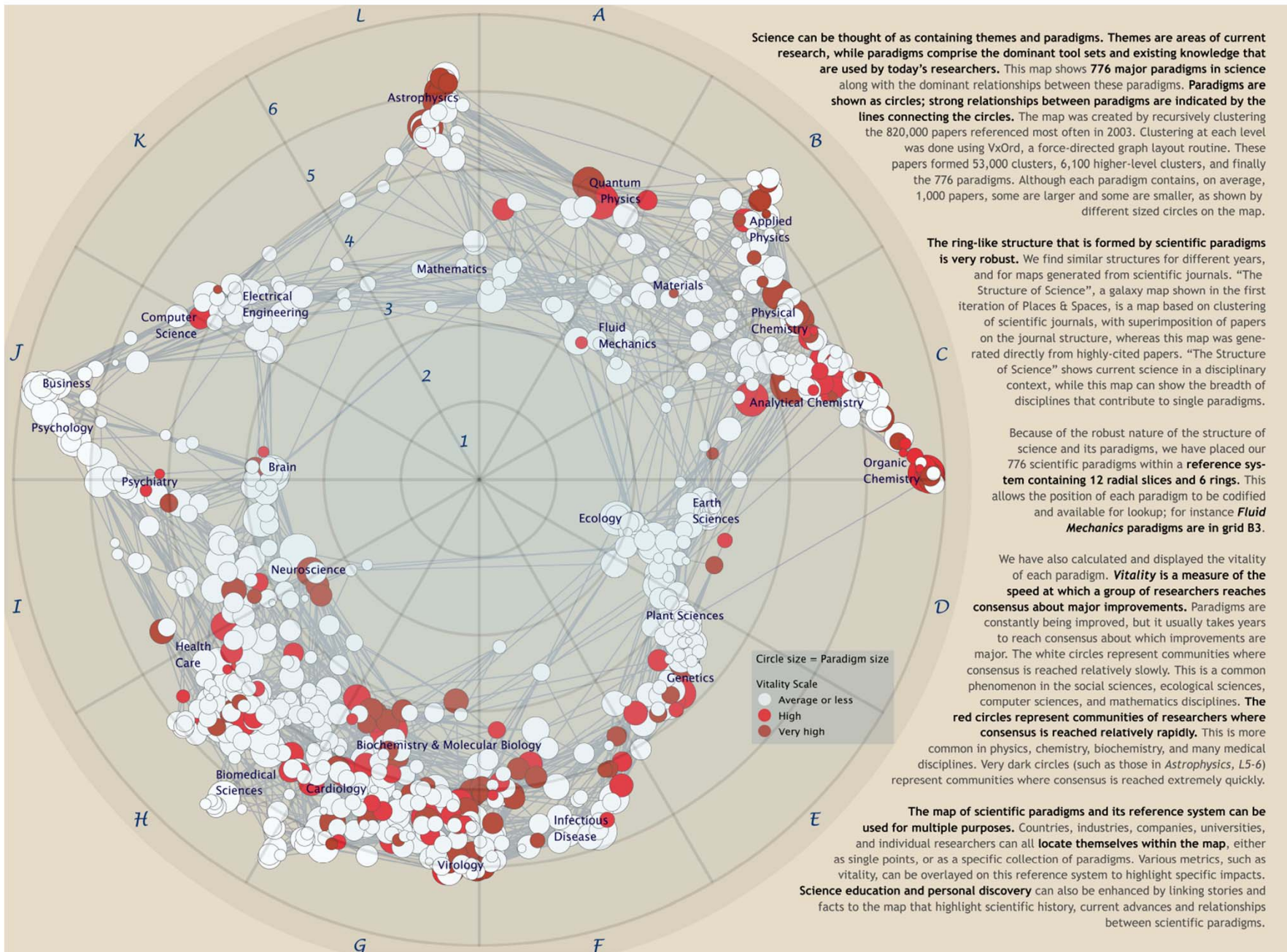
Keeping categories understandable is an important part of maintaining any taxonomy, including the patent hierarchy. Categories are easier to understand, search, and maintain if they contain elements that comfortably fit the definition of the category. The box above shows tiny bar charts, part of a *Taxonomy Validator* that reveals whether elements fit their categories. Categories may need to be redefined, and sometimes need to be split when they get too vague or large; a problem shared by many classification systems in this information-rich century. But how can we tell which ones to eliminate, add or revise—or how to revise them—in the complex, abstract sociolinguistic spaces we partition into ontologies?

Something as simple as a bar chart helps people see how entities in a category relate to that category. Here, each bar encodes a "distance to prototype": how much each patent differs from an idealized "prototype patent" for that category. A measure like this can be based on statistics, computational linguistics, or even human insight. Thus a category with mostly small bars is a good one, and a generally ragged one needs scrutiny or reorganization; but one that has only two or three tall bars may mean that only those few elements don't belong.

Even simple visuals can make thinking easier by providing better distilled data to the eye: vastly more data than working memory can hold as words. They focus people on exactly the right issues, and support them with the comprehensive overviews they need to make more informed judgements.

Taxonomy Visualization of Patent Data - Katy Borner, Elisha Hardy, Bruce Herr, Todd Holloway, Bradford Paley - 2006





Map of Scientific Paradigms - Kevin W. Boyack, Richard Klavans - 2006



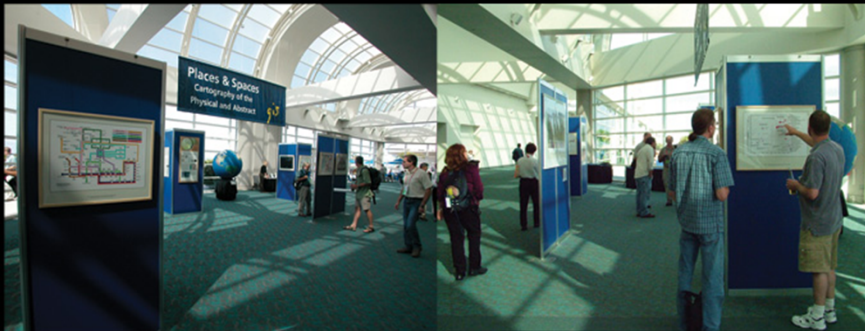
Zones of Invention: Patterns of Patents - Ingo Gunther - 2006



# Exhibit Venues



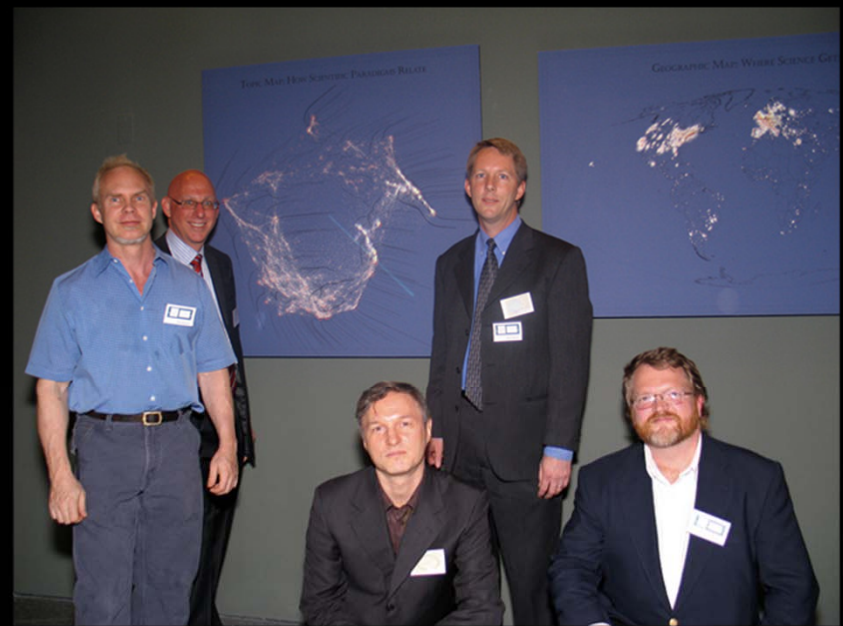
101st Annual Meeting of the Association of American Geographers, Denver, CO.  
April 5th - 9th, 2005 (First showing of Places & Spaces)



ESRI International User Conference, San Diego Convention Center in San Diego, CA.  
July 25th - 29th, 2005

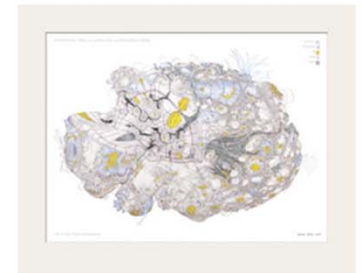
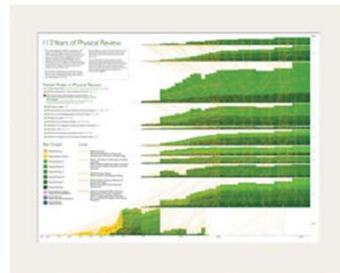
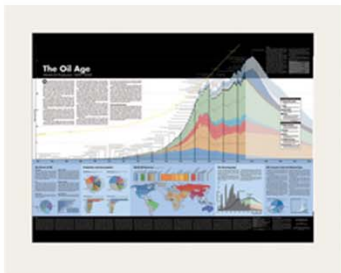
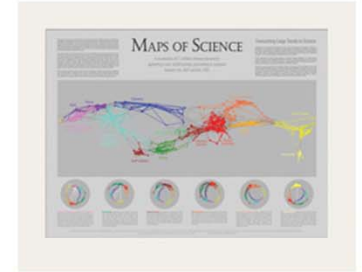
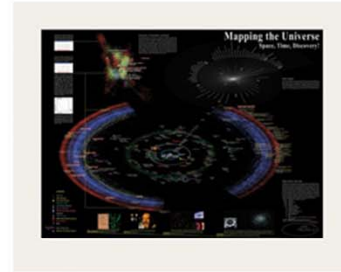
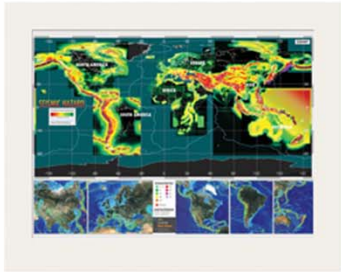


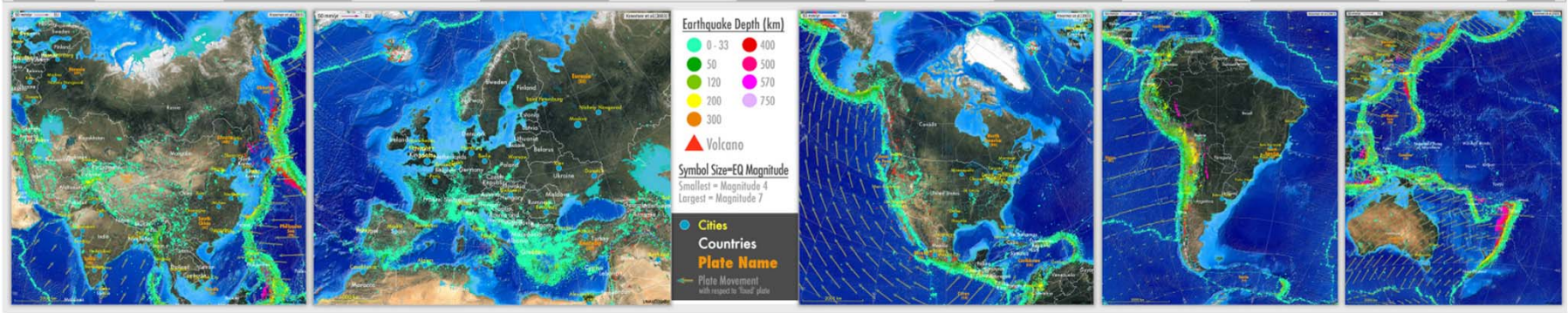
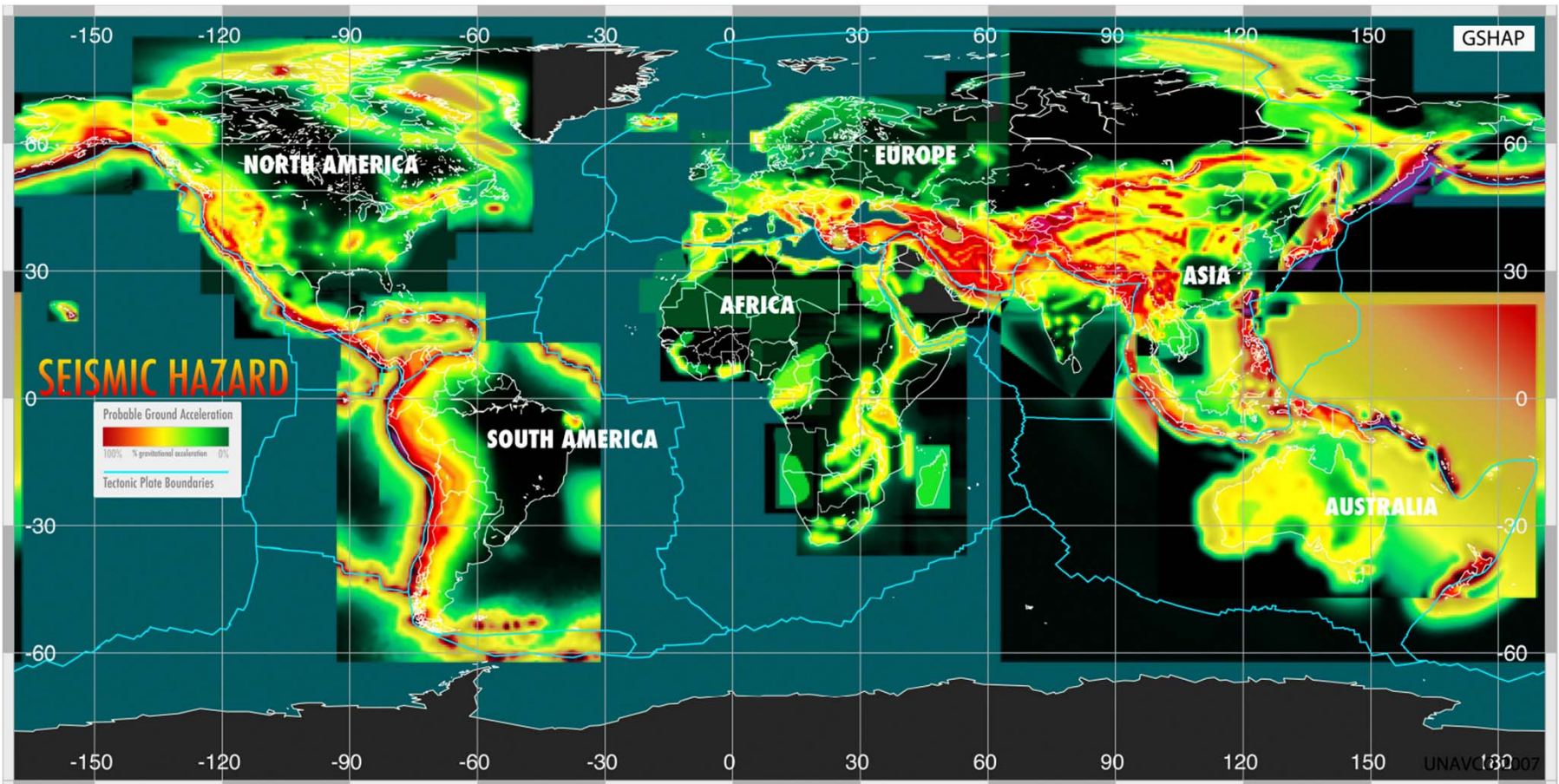
New York Hall of Science, Queens, NY  
December 9th, 2006 - February 25th, 2007



Science, Industry and Business Branch of The New York Public Library, New York City  
April 3rd - August 30th, 2006

# THE POWER OF FORECASTS 2007



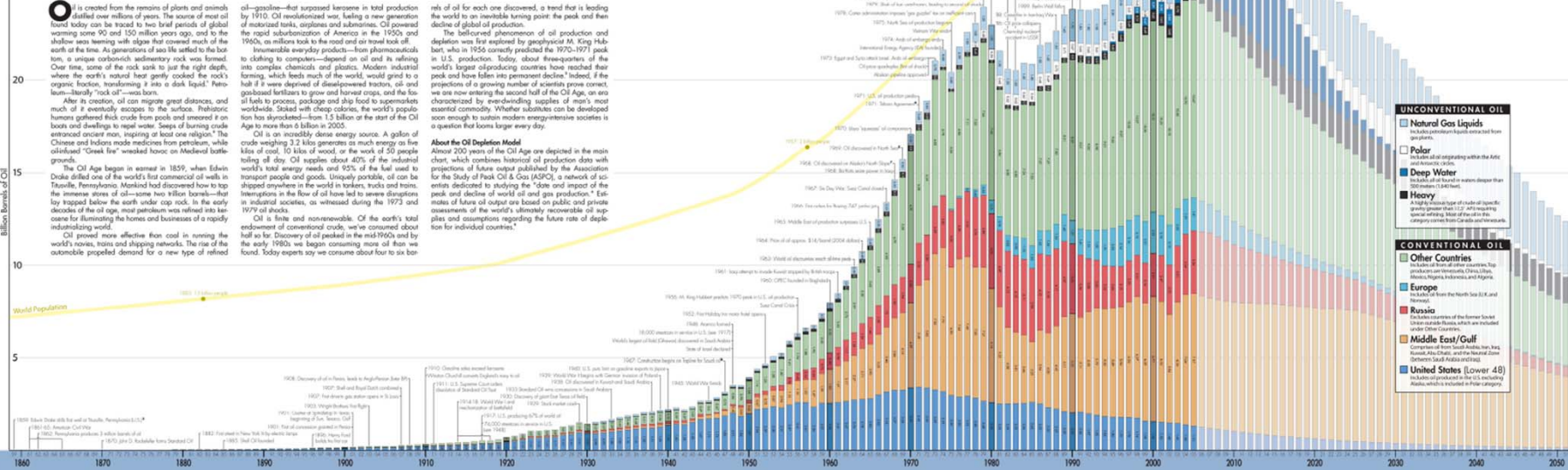


Tectonic Movements and Earthquake Hazard Predictions - Martin W. Hamburger, Lou Estey, Chuck Meertens, Elisha Hardy - 2005

# The Oil Age

## World Oil Production 1859 - 2050

**Peak Oil**  
The oil age peak of global production is a complex phenomenon, the history of the world's oil production is a story of discovery and innovation. The oil age peak is a complex phenomenon, the history of the world's oil production is a story of discovery and innovation. The oil age peak is a complex phenomenon, the history of the world's oil production is a story of discovery and innovation.



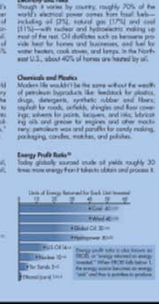
### The Power of Oil

**Transportation**  
About 25% of all goods to power the world's auto, truck, airplane, train, and ship, together with 500 million of the world's population, are transported by oil. The world depends on oil for its transportation energy needs.

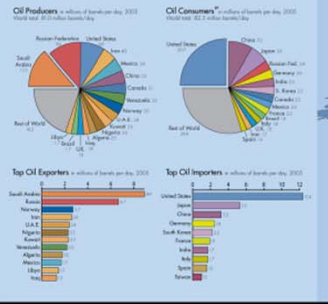
**Food**  
We estimate that people in the industrial world consume about 100 million tons of oil for every calorie they eat. Oil powers the tractors and combines that plant the crops and harvest them. It provides the fertilizer and herbicides that increase yields. Without these fuels, food supplies would drop 50% or more, severely weakening the world's food supply.

**Energy Sources**  
Nearly 40% of the world's energy comes from oil, and more than 80% comes from fossil fuels, natural gas, and coal.

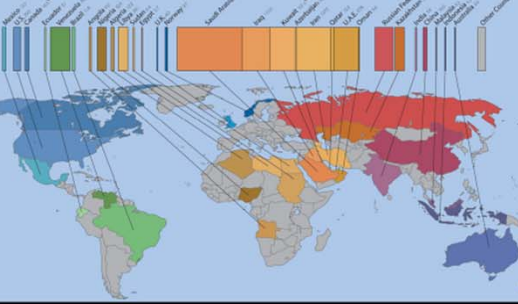
### Production and Consumption



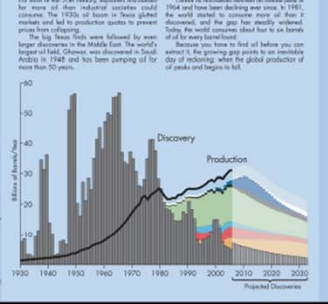
### World Oil Reserves



### The Growing Gap



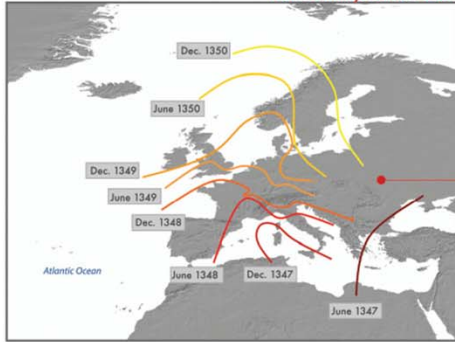
### Oil's Cousins: Coal and Natural Gas



**Notes**  
1. The oil age peak is a complex phenomenon, the history of the world's oil production is a story of discovery and innovation. The oil age peak is a complex phenomenon, the history of the world's oil production is a story of discovery and innovation. The oil age peak is a complex phenomenon, the history of the world's oil production is a story of discovery and innovation.

# Impact OF Air Travel ON Global Spread OF Infectious Diseases

14th Century: Black Death

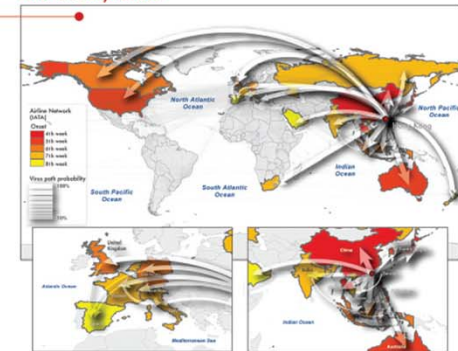


Epidemic spreading pattern changed dramatically after the development of modern transportation systems.

In pre-industrial times disease spread was mainly a spatial diffusion phenomenon. During the spread of Black Death in the 14th century Europe, only few traveling means were available and typical trips were limited to relatively short distances on the time scale of one day. Historical studies confirm that the disease diffused smoothly generating an epidemic front traveling as a continuous wave through the continent at an approximate velocity of 200-400 miles per year.

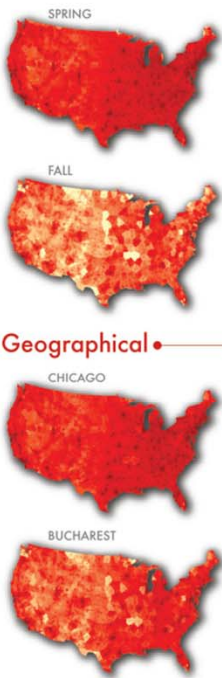
The SARS outbreak on the other hand was characterized by a patched and heterogeneous spatio-temporal pattern mainly due to the air transportation network identified as the major channel of epidemic diffusion and ability to connect far apart regions in a short time period. The SARS maps are obtained with a data-driven stochastic computational model aimed at the study of the SARS epidemic pattern and analysis of the accuracy of the model's predictions. Simulation results describe a spatio-temporal evolution of the disease (color coded countries) in agreement with the historical data. Analysis on the robustness of the model's forecasts leads to the emergence and identification of epidemic pathways as the most probable routes of propagation of the disease. Only few preferential channels are selected (arrows; width indicates the probability of propagation along that path) out of the huge number of possible paths the infection could take by following the complex nature of airline connections (light grey, source: IATA).

21st Century: SARS



## Forecasts OF THE Next Pandemic Influenza

### Seasonal



Forecasts are obtained with a stochastic computational model which explicitly incorporates data on worldwide air travel and detailed census data to simulate the global spread of an influenza pandemic.

The modeling approach considers infection dynamics (i.e., virus transmission, onset of symptoms, infectiousness, recovery, etc.) among individuals living in urban areas around the world, and assumes that individuals are allowed to travel from one city to another by means of the airline transportation network.

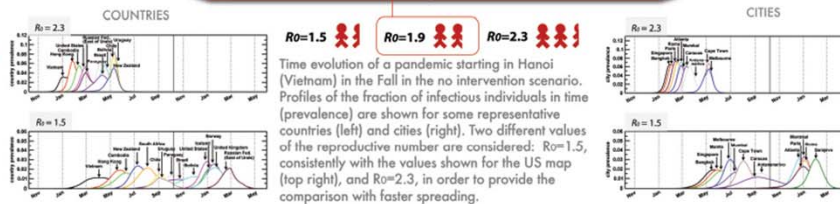
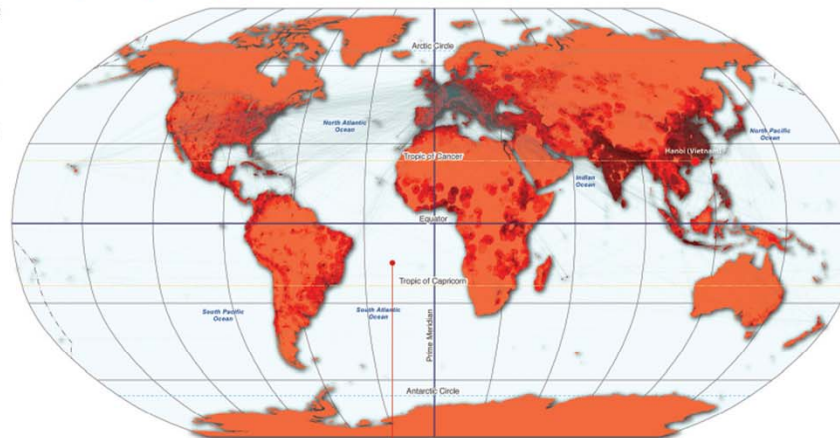
### Geographical

Numerical simulations provide results for the temporal and geographic evolution of the pandemic influenza in 3,100 urban areas located in 220 different countries. The model allows to study different spreading scenarios, characterized by different initial outbreak conditions, both geographical and seasonal.

The central map represents the cumulative number of cases in the world after the first year from the start of a pandemic influenza with  $R_0=1.9$  originating in Hanoi (Vietnam) in the Spring.



The US maps focus on the situation in the US after one year, and show the effect of changes in the original scenario analyzed. Different color coding is used for the sake of visualization.

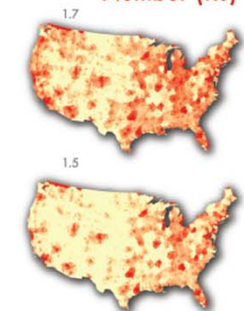


The model includes the worldwide air transportation network (source: IATA) composed of 3,100 airports in 220 countries and E=17,182 direct connections, each of them associated to the corresponding passenger flow. This dataset accounts for 99% of the worldwide traffic and is complemented by the census data of each large metropolitan area served by the corresponding airport.

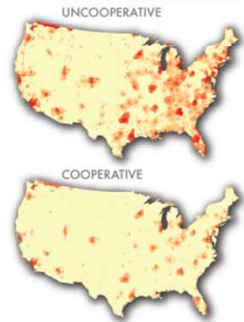
Additional spreading scenarios can be obtained by modeling different levels of infectiousness of the virus, as expressed in terms of the reproductive number  $R_0$ , representing the average number of infections generated by a sick person in a fully susceptible population.


Intervention strategies modeling the use of antiviral drugs can be considered. Two scenarios are compared: an uncooperative strategy in which countries only use their own stockpiles, and a cooperative intervention which envisions a limited worldwide sharing of the resources.

### Reproductive Number ( $R_0$ )



### Intervention





**logicaland**

PARTICIPATIVE GLOBAL SIMULATION  
WWW.LOGICALAND.NET

[./LOGICALAND] IS A PROJECT STUDY FOR VISUALIZING OUR WORLD'S COMPLEX ECONOMICAL, POLITICAL AND SOCIAL SYSTEMS.

[./LOGICALAND] V0.1 IS THE FIRST ATTEMPT TO REALIZE A PROTOTYPE OF A GLOBAL SIMULATION THAT IS TO BE CONTROLLED BY A COMMUNITY OF UNLIMITED PARTICIPANTS. IT IS BASED ON A GLOBAL WORLD MODEL DEVELOPED IN THE 1970S THAT HAS BEEN TAKEN OUT OF ITS ORIGINAL CONTEXT AND ADAPTED INTO A PARTICIPATIVE ONLINE GAME. IN ROUNDS OF PLAY LASTING UP TO 22 HOURS, FINANCIAL AND NATURAL RESOURCE ENDOWMENTS OF 185 STATES CAN BE MANIPULATED IN AN INTERDEPENDENT WORLD SYSTEM. THE SIMULATION STARTS WITH "REAL" VALUES FROM THE YEAR 2001, TAKEN FROM THE STATISTICS CONTAINED IN THE "CIA WORLD FACT BOOK".

THE PARAMETER CHANGES MADE BY PARTICIPANTS BECOME "VOTES" THAT ARE POLLED BY THE SERVER AND FED BACK INTO THE SIMULATION.

GLOBAL WORLD MODELS CAN BE UNDERSTOOD AS "COMPUTER PROGRAMS THAT SIMULATE THE WORLD IN VERY BROAD, COMPREHENSIVE MANNER. GEOGRAPHICALLY, THEY ENCOMPASS THE ENTIRE WORLD OR AT LEAST A MAJOR PORTION OF IT. MORE IMPORTANTLY, THEY EXPLICITLY LINK TOGETHER A NUMBER OF COMPONENTS OR ASPECTS OF OUR WORLD SUCH AS ECONOMICS, DEMOGRAPHICS, POLITICS, AND THE ENVIRONMENT. BECAUSE OF THESE TRAITS, INTEGRATED GLOBAL MODELS CAN BE AND ARE USED AS TOOLS TO HELP US UNDERSTAND PROCESSES WHOSE EFFECTS CROSS NATIONAL BORDERS AND WHOSE STUDY CROSSES DISCIPLINARY BOUNDARIES." (PETER BRECKE)

[./LOGICALAND] IS A PARTICIPATIVE WORLD SYSTEM IDEA / CONCEPT / REALIZATION:  
RESEARCHERS: VIKTORIA, AUSTRIA  
MICHAEL ASHAUER, MAIA GUSBERTI, NIK THOENEN, IN COLLABORATION WITH SEPP DERHOFER AND THE SUPPORT OF SILVERSERVER

**ACTUAL YEAR**

THE PROGRESS BAR indicates time left (!!!) year changes (next round starts)

**FED PANEL**  
write absolute values of some parameters for currently selected region (for the world, if no region is selected)

**PARAMETER MENU**  
choose the parameter you want to be displayed on the map and the graph.

**MAP MENU**  
choose your preferred type of visualization between WORLD MAP (abstracted geographic world map currently selected parameter is transposed to country size), "classical" BAR CHART, NORTH/SOUTH (abstracted geographic world-wide map measures and draws distinctions between regions as north/south divide).

all values are normalized and indicate relative proportions.

**BRICK INFO**  
[./ logicaland] may be seen as a "long-run strategic simulation game", one round lasts for 22 hours. one round matches one year. any user from anywhere can submit/propose changes (granted that he/she has internet access). only one submission per round and user is permitted the calculated average of all user's propositions are accounted for the simulation.

**FORUM**  
[./ logicaland]'s communication tool from users to users, post, read, discuss etc.

**WORLD**  
the online version of this hour's.

**STATS**  
[./ logicaland] graphical statistics rank and numbers of the world, its internal access distribution and where logicaland's users come from - visualized in the same time as the game.

**EXIT**  
logout and exit here !!!

**GRAPH**  
display selected value of current region (or world) as a function of time:  
1. past  
2. actual year  
3. future (prognosis)

**CONTROL PANEL**  
edit and change parameters of currently selected region (actual year).  
settable parameters are:  
**TARGET INVESTMENT DISTRIBUTION**  
indented distribution of investment on the sectors industry, agriculture, hightech and other.  
**FOOD AID**  
percentage of food surplus that will be provided as (development) aid.  
**FINANCIAL AID**  
percentage of utilities surplus that will be provided as (development) aid.

green bar indicates your proposed value  
gray bar indicates present value calculated by all user's contributions.


all values are (immediately) recalculated after release of the mouse button. to examine possible effects on one of the world maps (or bar charts), your default year must be set within the prognosis period. (see timeline).

**RESET BUTTON**  
resets all changes you have done.

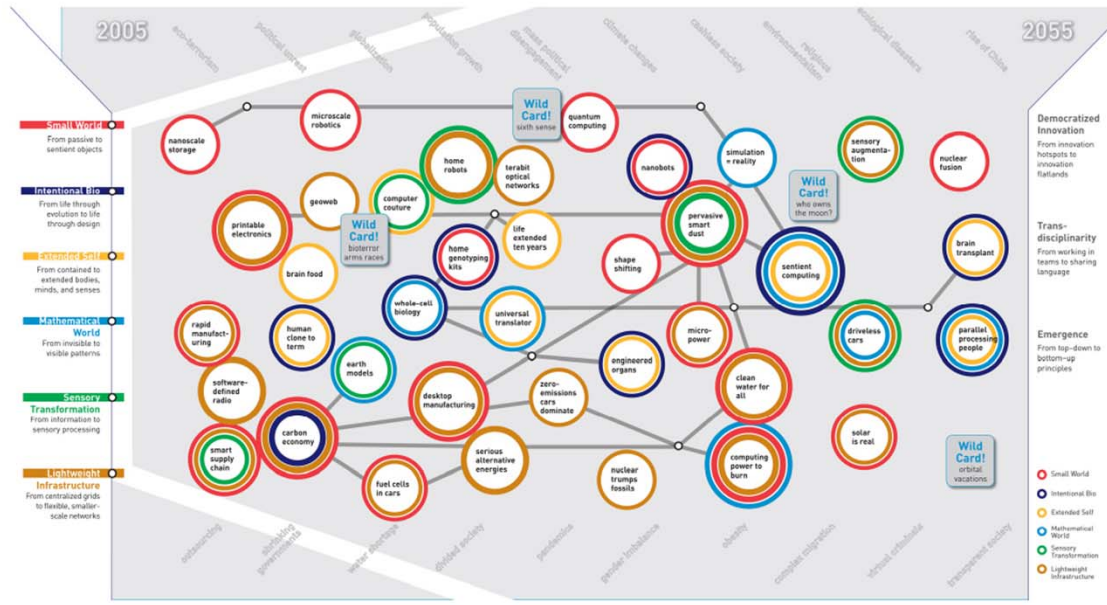
**REPORT BUTTON**  
sends your proposed values to the server - only one submission per round and user is allowed.

**WORLD MAP**   **BAR CHART**   **NORTH/SOUTH**

**INTERNET-ACCOUNTS 2001**



Logicland Participative Global Simulation - Michael Ashauer, Maia Gusberti, Nik Thoenen - 2002



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A map is a tool for navigating an unknown terrain. In the case of this map, **Science & Technology Outlook: 2005–2055**, the terrain we’re navigating is the uncharted territory of science and technology (S&T) in the next 50 years. However, the map of the future is not a tool for prediction or, for that matter, the product of predictions. Nor is it comparable to modern navigation techniques in which we rely on a shrinking number of strong signals, like GPS coordinates, to show the right path. Rather, it’s more akin to classical low-tech navigational techniques with their reliance on an array of weak signals such as wind direction, the look and feel of the water, and the shape of cloud formations. Taken together, these signals often prove more useful for navigation than high-tech methods because, in addition to aiding travelers in selecting the “right” path, the signals contextualize information and reveal interdependencies and connections between seemingly unrelated events, thus enriching our understanding of the landscape. That’s precisely the intention of this map of the future of S&T—to give the reader a deeper contextual understanding of the landscape and to point to the intricacies and interdependencies between trends.

While developing the map, the **Institute for the Future (ITFF)** team listened for and connected a variety of weak signals, including those generated during interviews and workshop conversations involving more than 100 eminent U.K. and U.S. experts in S&T—academicians, policymakers, journalists, and corporate researchers. The ITFF team also compiled a database of outlooks on developments that are likely to impact the full range of S&T disciplines and practice areas over the next 50 years. We also relied on ITFF’s 40 years of experience in forecasting S&T developments to create the map and an accompanying set of **S&T Perspectives** that discuss issues emerging on the S&T horizon and are important for organizations, policymakers, and society-at-large to understand.

On this map, six themes are woven together across the 50-year horizon, often resulting in important breakthroughs. These are supported by key technologies, innovations, and discoveries. In addition to the six themes, three meta-themes—democratized innovation, transdisciplinarity, and emergence—will overlay the future S&T landscape influencing how we think about, learn about, and practice science. Finally, S&T trends won’t operate in a vacuum. Wider social, demographic, political, economic, and environmental trends will both influence S&T trends and will be influenced by them. Some of these wider trends surround the map to remind us of the larger picture.

**MAP THEMES**

**Small World**

After 20 years of basic research and development at the 100-nanometer scale, the importance of nanotechnology as a source of innovations and new capabilities in everything from materials science to medicine is already well-understood. Three trends, however, will define how nanotechnology will unfold, and what impacts it will have. First, nanotechnology is not a single field with a coherent intellectual program; it’s an opportunistic hybrid, shaped by a combination of fundamental research questions, promising technical applications, and venture and state capital. Second, nanotechnology is moving away from the original vision of small-scale mechanical engineering—in which assemblers build mechanical systems from individual atoms—toward one in which molecular biology and biochemistry contribute essential tools (such as proteins that build nanowires). Finally, nanotechnology will also serve as a model for transdisciplinary science. It will support both fundamental research and commercially oriented innovation, and it will be conducted not within the boundaries of conventional academic or corporate research departments, but in institutional and social milieus that emphasize heterogeneity.

**Intentional Biology**

For 3.6 billion years, evolution has governed biology on this planet. But today, Mother Nature has a collaborator. Inexpensive tools to read and rewrite the genetic code of life will bootstrap our ability to manipulate biology from the bottom up. We’ll not only genetically re-engineer existing life but actually create new life forms with purpose. Still, we will not be blind to what nature has to teach us. Evolution’s elegant engineering at the smallest scales will be a rich source of inspiration as we build the bio-nanotechnology of the next 50 years.

**Extended Self**

In the next 50 years, we will be faced with broad opportunities to remake our minds and bodies in profoundly different ways. Advances in biotechnology, brain science, information technology, and robotics

will result in an array of methods to dramatically alter, enhance, and extend the mental and physical hand that nature has dealt us. Wielding these tools on ourselves, humans will begin to define a variety of different “transhumanist” paths—that is, ways of being and living that extend beyond what we today consider natural for our species. In the very long term, following these paths could someday lead to an evolutionary leap for humanity.

**Mathematical World**

The ability to process, manipulate, and ultimately understand patterns in enormous amounts of data will allow decoding of previously mysterious processes in everything from biological to social systems. Scientists are learning that at the core of many biological phenomena—reproduction, growth, repair, and others—are computational processes that can be decoded and simulated. Using techniques of combinatorial science to uncover such patterns—whether these are physical, biological, or social—will likely occupy an increasing share of computing cycles in the next 50 years. Such massive computation will also make simulation widespread. Computer simulation will be used not only to help make decisions about large complex scientific and social problems but also to help individuals make better choices in their daily lives.

**Sensory Transformation**

In the next ten years, physical objects, places, and even human beings themselves will increasingly become embedded with computational devices that can sense, understand, and act upon their environment. They will be able to react to contextual clues about the physical, social, and even emotional state of people and things in their surroundings. As a result, increasing demands will be placed on our visual, auditory, and other sensory abilities. Information previously encoded as text and numbers will be displayed in richer sensory formats—as graphics, pictures, patterns, sounds, smells, and tactile experiences. This enriched sensory environment will coincide with major breakthroughs in our understanding of the brain—in how we process sensory information and connect various sensory functions.

Humans will become much more sophisticated in their ability to understand, create, and manage sensory information and ability to perform such tasks will become keys to success.

**Lightweight Infrastructure**

A confluence of new materials and distributed intelligence is pointing the way toward a new kind of infrastructure that will dramatically reshape the economics of moving people, goods, energy, and information. From the molecular level to the macro-economic level, these new infrastructure designs will emphasize smaller, smarter, more independent components. These components will be organized into more efficient, more flexible, and more secure ways than the capital-intensive networks of the 20th century. These lightweight infrastructures have the potential to boost emerging economies, improve social connectivity, mitigate the environmental impacts of rapid global urbanization, and offer new future paths in energy.

**META-THEMES**

**Democratized Innovation**

Before the 20th century, many of the greatest scientific discoveries and technical inventions were made by amateur scientists and independent inventors. In the last 100 years, a professional class of scientists and engineers, supported by universities, industry, and the state, pushed amateurs aside as a creative force. At the national scale, the capital-intensive character of scientific research made world-class research the property of prosperous advanced nations. In the new century, a number of trends and technologies will lower the barriers to participation in science and technology again, both for individuals and for emerging countries. The result will be a renaissance of the serious amateurs, the growth of new scientific and technical centres of excellence in developing countries, and a more global distribution of world-class scientists and technologists.

**Transdisciplinarity**

In the last two centuries, natural philosophy and natural history fractured into the now-familiar disciplines of physics, chemistry, biology, and so on. The sciences evolved into their current form in response to intellectual and professional opportunities, philanthropic priorities, and economic and state needs. Through most of the 20th century, the growth of the sciences, and academic and career pressures, encouraged ever-greater specialization. In the coming decades, transdisciplinary research will become an imperative. According to Howard Rheingold, a prominent forecaster and author, “transdisciplinarity goes beyond bringing together researchers from different disciplines to work in multidisciplinary teams. It means educating researchers who can speak languages of multiple disciplines—biologists who have understanding of mathematics, mathematicians who understand biology.”

**Emergence**

The phenomenon of self-organizing swarms that generate complex behavior by following simple rules—will likely become an important research area, and an important model for understanding how the natural world works and how artificial worlds can be designed. Emergent phenomena have been observed across a variety of natural phenomena, from physics to biology to sociology. The concept has broad appeal due to the diversity of fields and problems to which it can be applied. It is proving useful for making sense of a very wide range of phenomena. Meanwhile, emergence can be modeled using relatively simple computational tools, although those models often require substantial processing power. More generally, it is a richly suggestive way of thinking about designing complex, robust technological systems. Finally, emergence is an accessible and vivid metaphor for understanding nature. Just as classical physics profited from popular treatments of Newtonian mechanics, so too will scientific study and technical reproductions of emergent phenomena likely draw benefits from the popularization of its underlying concepts.

# 113 Years of Physical Review

This visualization aggregates 389,899 articles published in 720 volumes of 11 journals between 1893 and 2005. The 91,362 articles published from 1893 to 1976 take up the left third on the map. In 1977, the Physical Review introduced the Physics and Astronomy Classification Scheme (PACS) codes, and the visualization subdivides into the top-level PACS codes. The 217,503 articles from 1977 to 2000, for which good citation data is not available, occupy the middle third on the map. The 80,634 articles from 2001 to 2005, for which good citation data is available, fill the last third of the map.

Each vertical bar is subdivided vertically into the journals that appear in it with height proportional to the number of papers, and each journal is subdivided horizontally into the volumes of the journal appearing in the column.

On top of this base map, all citations from the papers in every top-level PACS code in 2005 are overlaid and then drawn from the source area to the individual volumes containing papers cited.

The small Nobel Prize medals indicate the 24 volumes containing the 26 papers appearing in Physical Review for 11 Nobel prizes between 1990 and 2005. Each year, Thomson ISI predicts three Nobel Prize awardees in physics based on citation counts, high impact papers, and discoveries or theories worthy of special recognition. Correct predictions by Thomson ISI are highlighted.

## Nobel Prizes in Physical Review

Year of Nobel Prize Winners Publication Year(s) (indicated by Nobel Prize medals on the right)

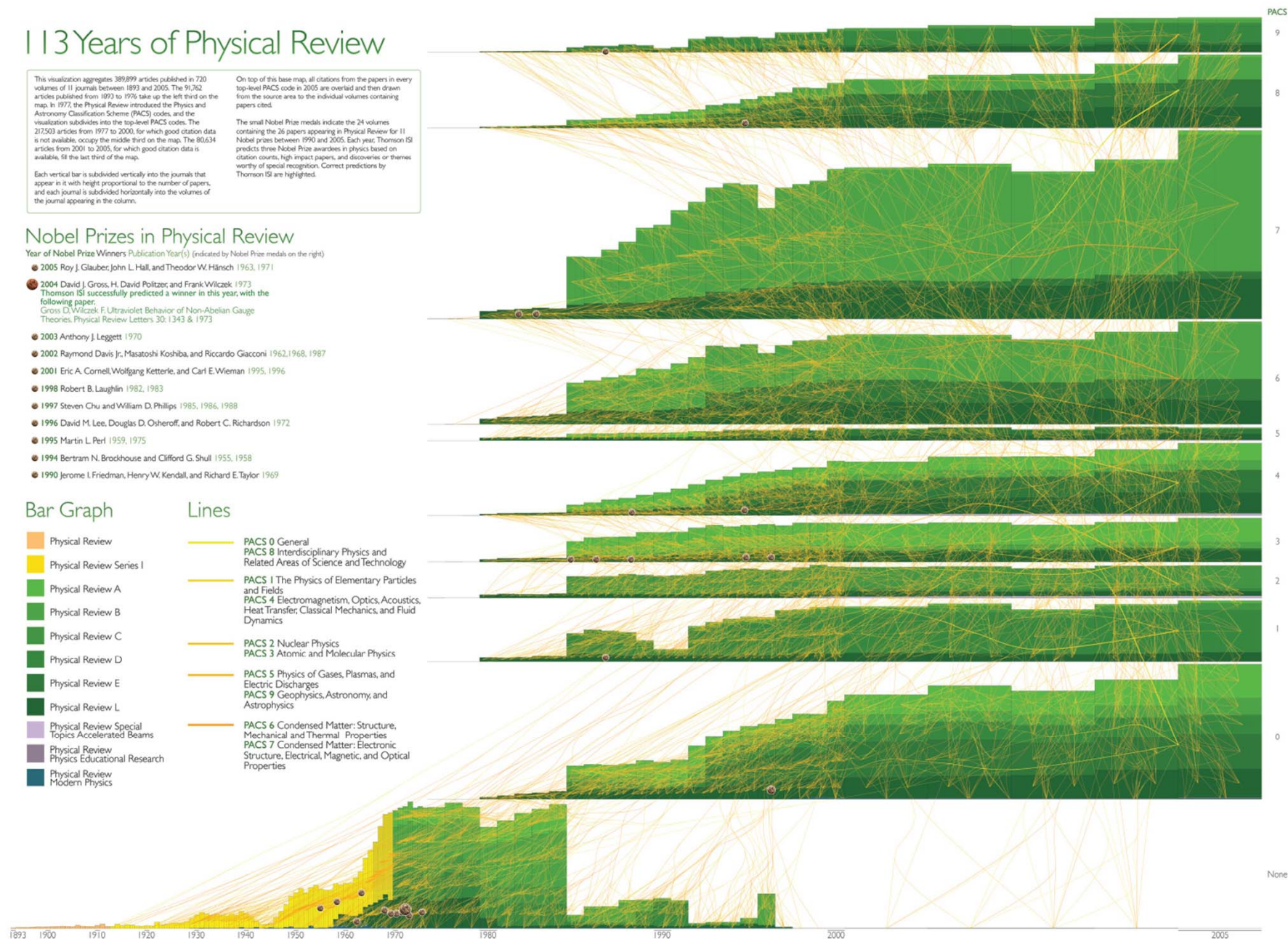
- 2005 Roy J. Glauber, John L. Hall, and Theodor W. Hänsch 1963, 1971
- 2004 David J. Gross, H. David Politzer, and Frank Wilczek 1973  
Thomson ISI successfully predicted a winner in this year, with the following paper:  
Gross D, Wilczek F. Ultraviolet Behavior of Non-Abelian Gauge Theories. *Physical Review Letters* 30: 1343 & 1973
- 2003 Anthony J. Leggett 1970
- 2002 Raymond Davis Jr., Masatoshi Koshiba, and Riccardo Giacconi 1962, 1968, 1987
- 2001 Eric A. Cornell, Wolfgang Ketterle, and Carl E. Wieman 1995, 1996
- 1998 Robert B. Laughlin 1982, 1983
- 1997 Steven Chu and William D. Phillips 1985, 1986, 1988
- 1996 David M. Lee, Douglas D. Osheroff, and Robert C. Richardson 1972
- 1995 Martin L. Perl 1959, 1975
- 1994 Bertram N. Brockhouse and Clifford G. Shull 1955, 1958
- 1990 Jerome I. Friedman, Henry W. Kendall, and Richard E. Taylor 1969

## Bar Graph

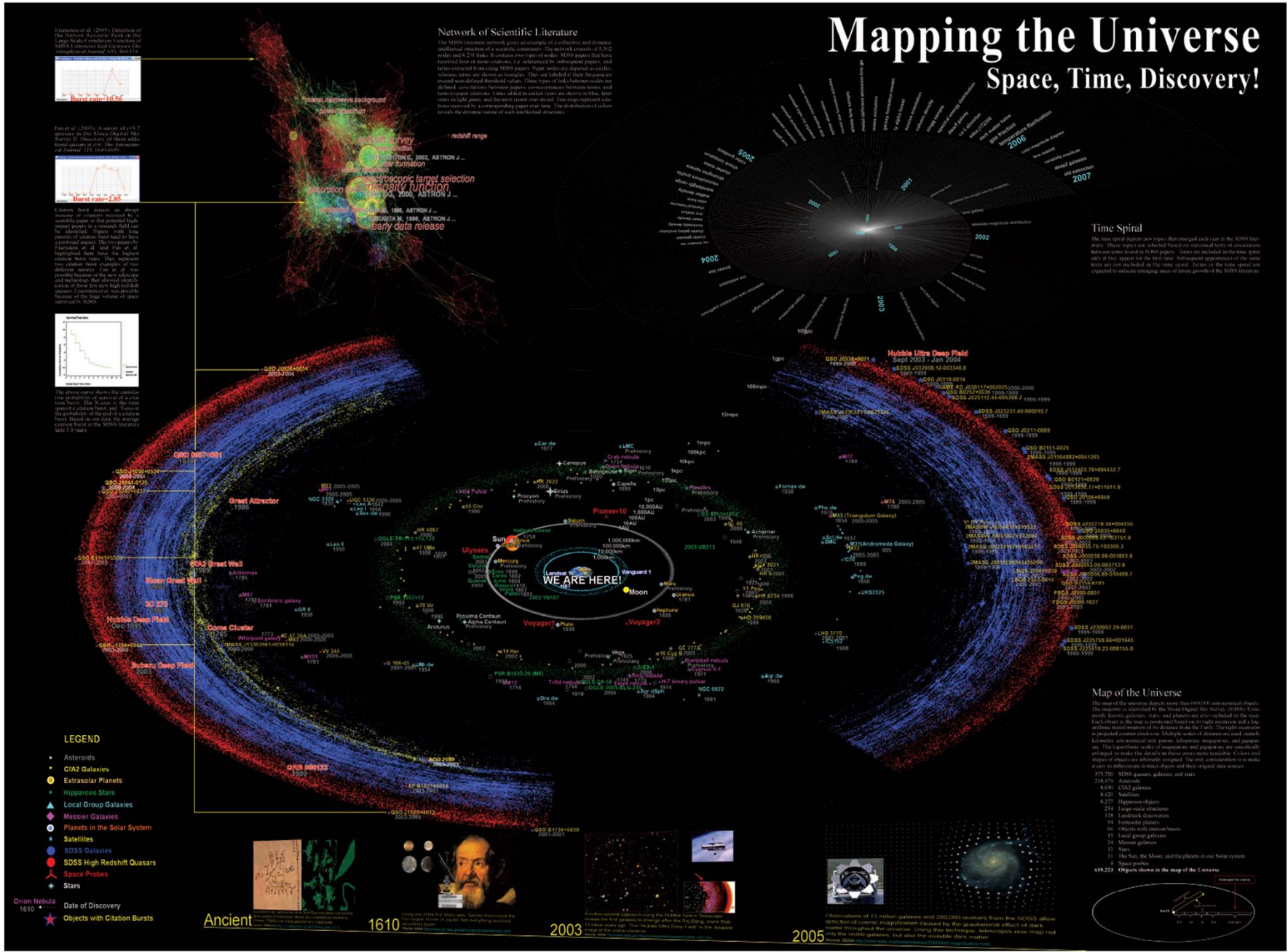
- Physical Review
- Physical Review Series I
- Physical Review A
- Physical Review B
- Physical Review C
- Physical Review D
- Physical Review E
- Physical Review L
- Physical Review Special Topics Accelerated Beams
- Physical Review Physics Educational Research
- Physical Review Modern Physics

## Lines

- PACS 0 General
- PACS 8 Interdisciplinary Physics and Related Areas of Science and Technology
- PACS 1 The Physics of Elementary Particles and Fields
- PACS 4 Electromagnetism, Optics, Acoustics, Heat Transfer, Classical Mechanics, and Fluid Dynamics
- PACS 2 Nuclear Physics
- PACS 3 Atomic and Molecular Physics
- PACS 5 Physics of Gases, Plasmas, and Electric Discharges
- PACS 9 Geophysics, Astronomy, and Astrophysics
- PACS 6 Condensed Matter: Structure, Mechanical and Thermal Properties
- PACS 7 Condensed Matter: Electronic Structure, Electrical, Magnetic, and Optical Properties







Mapping the Universe: Space, Time, Discovery! - Choumei Chen, Jian Zhang, Michael S. Vogele, J. Richard Gott III, Mario Juric, Lisa Kershner - 2007

# Science related Wikipedian ACTIVITY

This visualization explores the activity of science, math, and technology (SMT) related articles in the English-language Wikipedia (<http://en.wikipedia.org>). The central image shows 659,388 articles (circles). Overlaid is a 37 x 37 grid of relevant half-inch sized images.

Blue, green, and yellow circles represent the 3,599 math, 6,474 science, and 3,164 technology related articles respectively. The larger the size of a circle the higher the likelihood it is that type of article. The four corners show activity patterns of SMT articles.

## Article Edit Activity

Articles are size coded based on how frequently they have been edited from Feb. 6, 2001 to April 6, 2007. More consideration is given to current and major edits. Larger circles have been edited more frequently than smaller circles.

## 2007 Major Edits

Articles are size coded based on how many major edits they received from January 1st, 2007 to April 6th, 2007. Larger circles have received more edits than smaller circles. The highest number of major edits was 2,627.

For the central image, each article is size coded based on the likelihood that it is math, science, or technology related.

- 0%
- 50%
- 100%

All five images are color coded based on type. Transparency is used for legibility, and creates different colors when nodes overlap.

- Math
- Science
- Technology

## Article Popularity

Articles are size coded based on the number of Wikipedia articles referencing it. Larger circles are receiving more links from other articles than smaller circles. The highest number of references to an article was 142,602.

## Number of Bursts

Articles are size coded based on the number of bursts, i.e. sudden increases, of edit activity that occurred during the article's lifetime. Larger circles have had more bursts in activity than smaller circles. The most bursts an article had was 9.

# MAPS OF SCIENCE

## Forecasting Large Trends in Science

This map of science was constructed by sorting more than 16,000 journals into disciplines. Disciplines, represented as circles, are sets of journals that cite a common literature; links (the lines between disciplines) are pairs of disciplines that share a common literature. A three-dimensional model was used to determine the position of each discipline on the surface of a sphere based on the linkages between disciplines. The model treats links like rubber bands attempting to bring two disciplines close to each other. Pairs of disciplines without links tend to end up on different sides of the map.

The spherical map, which is not shown here, was unrolled in a mercator projection (the same one used to show the continents of the earth on a two-dimensional map) to give the large map shown below. This projection allows inspection of the entire map of science at once. Note that the disciplines tend to string along the middle of the map - if this were a map of the earth it would be like a single continent undulating along the equator. There are no disciplines at the top (north pole) or the bottom (south pole). Mercator projections also introduce distortions. We tend to forget that the left side is connected to the right side, and assume that the middle is most important. In this map, the social sciences (yellow) on the right connect with the computer sciences (pink) on the left in one continuous swath.

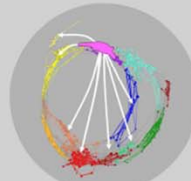
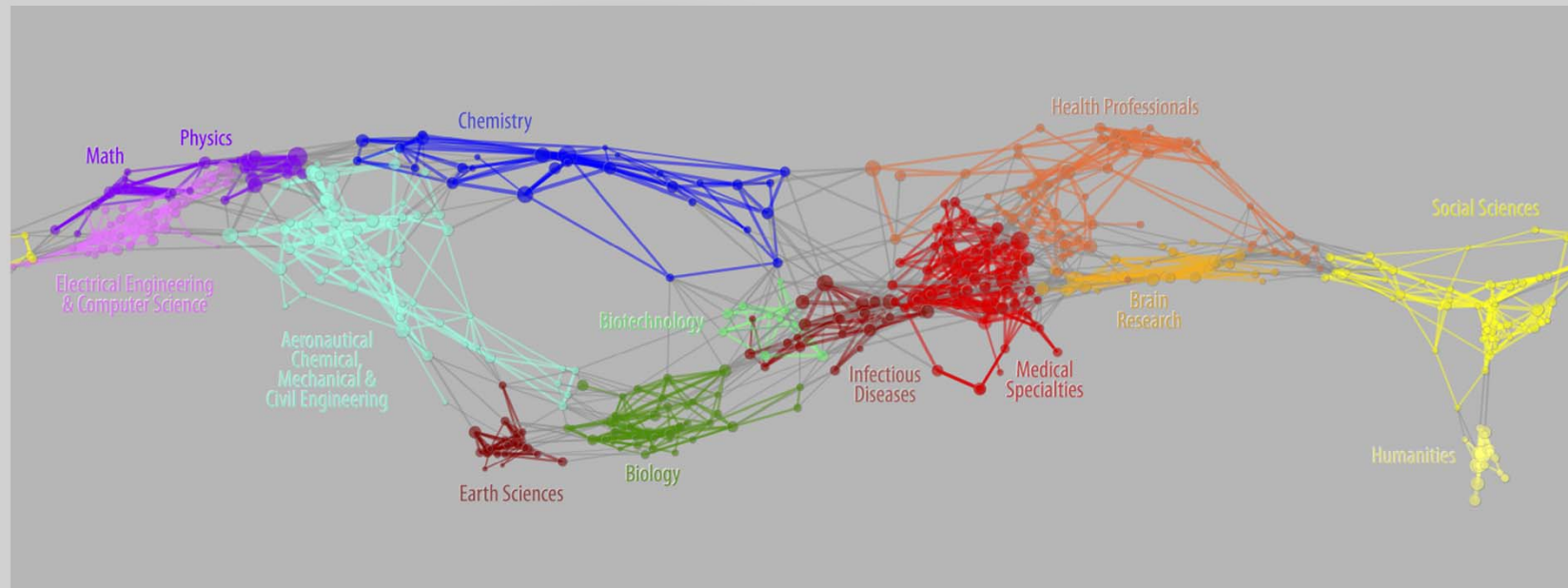
The six map projections shown at the bottom are images of what one would see if looking directly down at the south pole of the map, at six different rotations. When viewed this way, the map looks like a wheel with an inner ring and outer ring. This wheel of science corresponds very closely with the two-dimensional maps we have previously produced.

A visualization of 7.2 million scholarly documents  
appearing in over 16,000 journals, proceedings or symposia  
between Jan, 2001 and Dec, 2005

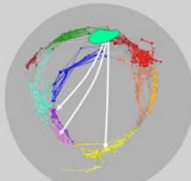
Calculations were performed using the large colored groupings of disciplines (fields) to determine if any of them were likely to cause large scale changes in the structure of science over time. Connectedness coefficients between fields were calculated for each individual year, 2001-2005. A simple regression analysis was conducted to see if there were significant changes in these connectedness coefficients from year-to-year.

If the structure of science shown below is moving toward stability, we would expect connectedness between neighboring fields to increase, and connectedness between distant fields to decrease. We found the opposite, suggesting that the underlying structure is unstable and likely to change dramatically over the next decade.

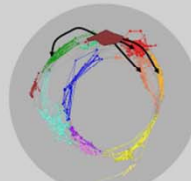
Six stories, representing how the structure is likely to change, are provided below. Maps with white arrows represent instances of distant fields that are likely to be pulled closer to each other in the future. Maps with dark arrows represent fields that are currently close-knit, that are likely to become more dispersed. We expect that future maps of science will show changes in structure corresponding to these observations. Medicine will disperse slightly, while the physical sciences will tighten and draw closer to the medical fields.



**Electrical Engineering & Computer Science (EE/CS)**, indicated by the pink shape in the view above, is a field whose connectedness has been increasing much more rapidly (15%) than expected. Connectedness has increased between EE/CS and all other fields from 2001-2005. The connections with the largest annual increases (>10%) are shown by white arrows. Over time, these stronger connections will distort the map, and may bring EE/CS into a more central position.



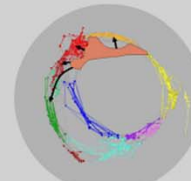
**Biotechnology**, indicated by the light green shape above, has the largest overall increase in connectedness with other fields (16%). It has relatively few connections with the EE/CS, Math & Physics, and Social Sciences fields, but these three connections had the largest fractional increase. The connection with EE/CS, which had the single largest growth rate (21% of any connection, reflects recent growth in the area of bioinformatics).



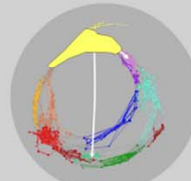
**Infectious Diseases**, indicated by the dark red shape above, has an overall decrease in connectedness (2%) with other fields. Decreases in connection strength between this field and the fields of Biology, Medical Specialties, Health Professionals and Brain Research (all >3%) are shown as black arrows, and will drive a slow dispersion of the medical fields compared to the current structure.



**Medical Specialties**, indicated by the red shape above, has an overall decrease in connectedness (2%) with other fields. This is dominated by decreasing connection strength to the other medical fields and biology, as shown by the black arrows. The only connection increasing in strength is the one to EE/CS, which is not shown here, but was shown as a white arrow in the first story.



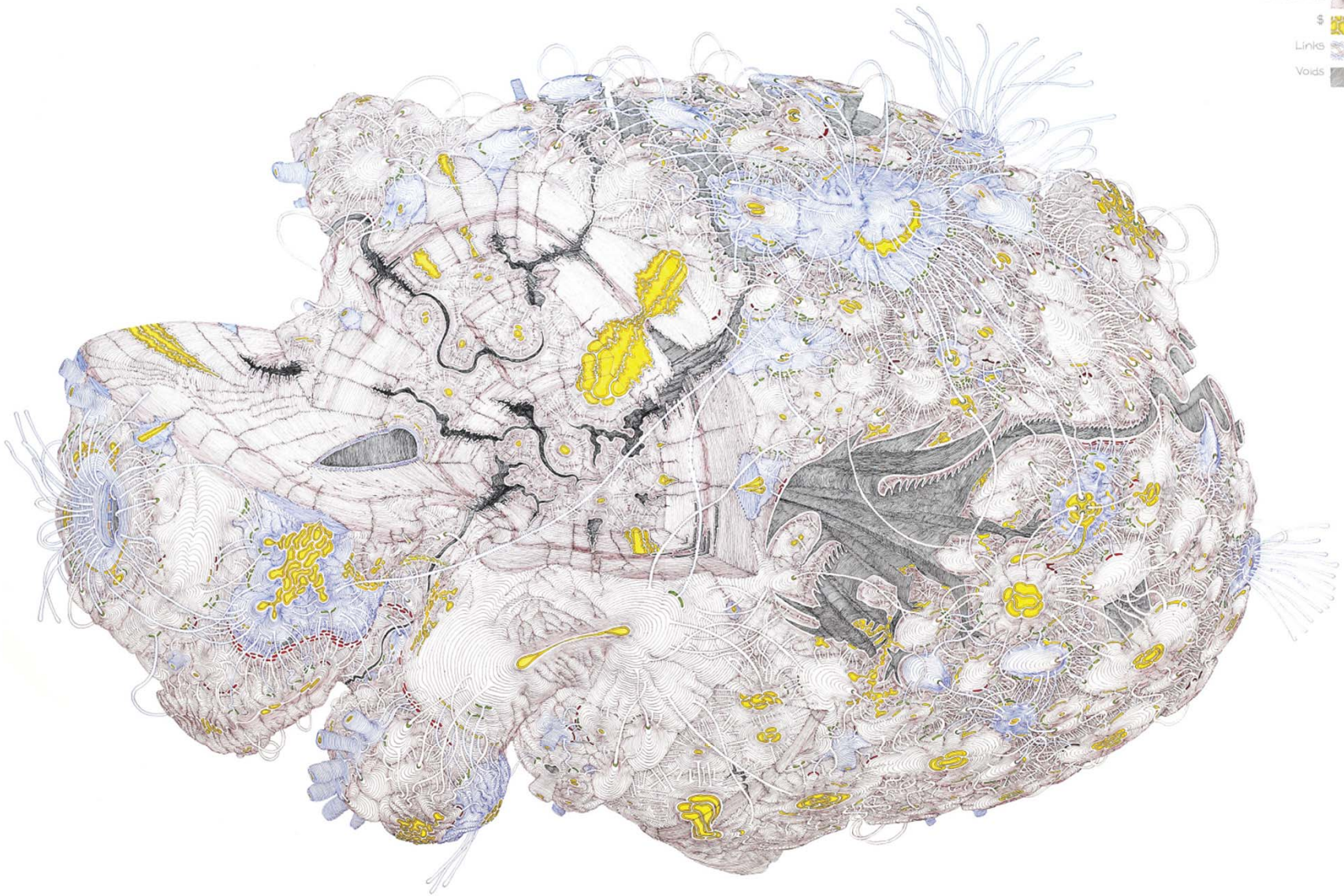
The **Health Professionals** field, indicated by the orange shape above, has the largest overall decrease in connectedness (4%) to other fields. As with the other medical fields, its connection strength with medicine and biology is decreasing in all cases, as shown by the black arrows. With the decreasing connection strengths throughout medicine, we expect the map structure in these areas to relax slightly over time.



The **Social Sciences**, indicated by the yellow shape above, had an overall increase in connectedness (9%) with other fields. Although its greatest connectedness gains were with EE/CS and Biotechnology (see white arrows), it also had consistent connection increases with nearly all the other fields. In general the fields of EE/CS, Biotechnology, and the Social Sciences are becoming more connected, and are pulling on the physical sciences as well.

Source: University of California, San Diego Knowledge Mapping Laboratory. Color Images: © Regents of the University of California. The underlying data came from two sources: Thomson ISI and Scopus. Mapping methodology and descriptive text by Dick Klavans, President, SciTech Strategies, Inc., and Kevin Boyack, Sandia National Laboratories. Graphics & Typography by Ethan Mellier and Mike Patak. Special acknowledgements to Katy Borner, Ari Elib, W. Bradford Paley, Len Simon, and Henry Small. ©2007 by Dick Klavans, all rights reserved.

- Emerging
- Established
- Links
- Voids



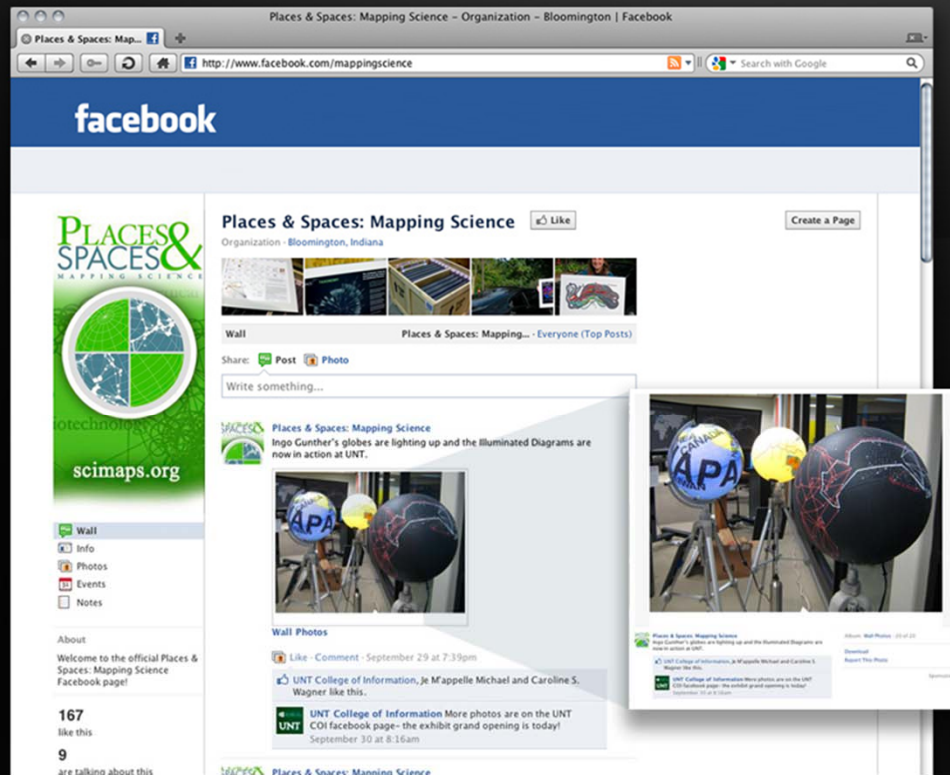
One of Many Possible Interpretations

Daniel Zeller 2007



# PLACES & SPACES

## MAPPING SCIENCE

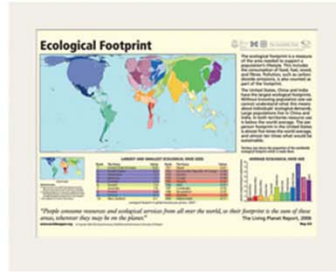
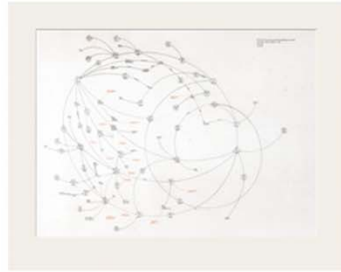
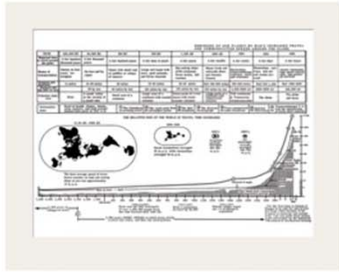
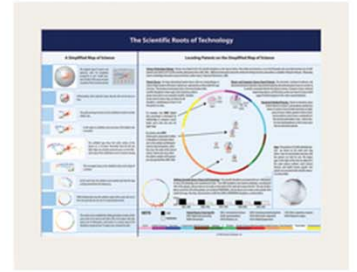
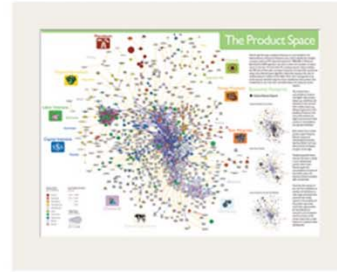
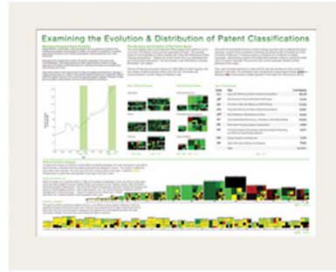
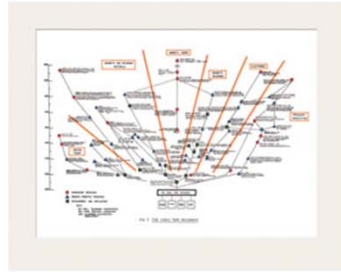


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# SCIENCE MAPS FOR ECONOMIC DECISION MAKERS 2008



LÉGENDE. — Quantités et couleurs pour chaque Pays de provenance.

	Etats-Unis	Inde (Soudan, Chine)	Egypte, Syrie	Inde (Indes-Orientales)	Asie (Sud)
1858	532 100 <sup>h</sup>	187 100 <sup>h</sup>	21 200 <sup>h</sup>	8 400 <sup>h</sup>	63 500 <sup>h</sup>
1864	246 100 <sup>h</sup>	107 500 <sup>h</sup>	27 200 <sup>h</sup>	18 100 <sup>h</sup>	112 100 <sup>h</sup>
1865	18 100 <sup>h</sup>	181 000 <sup>h</sup>	71 700 <sup>h</sup>	19 100 <sup>h</sup>	102 100 <sup>h</sup>
1866	12 100 <sup>h</sup>	130 500 <sup>h</sup>	36 000 <sup>h</sup>	10 100 <sup>h</sup>	14 700 <sup>h</sup>
1867	14 100 <sup>h</sup>	246 500 <sup>h</sup>	173 000 <sup>h</sup>	10 700 <sup>h</sup>	119 500 <sup>h</sup>

- A. — Importation des fibres qui ont été de 1858, malgré les mesures militaires de la guerre civile, à cause de la route de la mer du Nord.
- B. — Routes commerciales de la guerre civile qui ont été coupées plus tard et qui ont été remplacées par des routes maritimes, échappant aux blocs.
- C. — Aggravation due à la guerre civile de la provenance des routes commerciales, dont on ne peut pas dire qu'elles soient interrompues.
- D. — Aggravation due au passage de la Chine vers l'Inde par le passage par le Soudan.
- E. — Aggravation due à la guerre civile de la provenance des routes commerciales, dont on ne peut pas dire qu'elles soient interrompues.
- F. — Aggravation due au passage de l'Inde vers l'Inde par le passage par le Soudan.
- G. — Aggravation due à la guerre civile de la provenance des routes commerciales, dont on ne peut pas dire qu'elles soient interrompues.
- H. — Aggravation due à la guerre civile de la provenance des routes commerciales, dont on ne peut pas dire qu'elles soient interrompues.

CARTE figurative et approximative des quantités de COTON BRUT importées en Europe en 1858 en 1864 et en 1865.

Dressée par M. MINARD, Inspecteur Général des Ponts et Chaussées en retraite.  
Paris, le 14 Mai 1866.

Les courbes de coton transportées sont représentées par les largeurs des zones colorées à raison d'un millimètre pour cinq mille tonnes, et sont de plus exprimées par les nombres écrits en toutes les zones et dans l'unité de mille tonnes.

Les Courbes ont été dressées sur les Documents des Douanes Françaises, Anglaises, Belges, Néerlandaises, Prussiennes, Autrichiennes.

Les Documents des Douanes, le Trade Journal de M. E. A. Mason, le même ouvrage et la publication hebdomadaire de Liverpool, le Merchants Magazine de Liverpool, l'Annuaire de Commerce, les annuaires, les journaux et les revues.

Observations: Les importations sont un peu plus fortes que celles de la Carte parce que j'ai ajouté celles d'une douane brève et que les Douanes donnaient en blanc les fibres importées de tous provenances, je n'ai pu les représenter.

De l'importation du Coton en 1865.

Les quantités importées de coton en 1865 ont été de 1 000 000 de quintaux métriques.

Les quantités importées de coton en 1865 ont été de 1 000 000 de quintaux métriques.

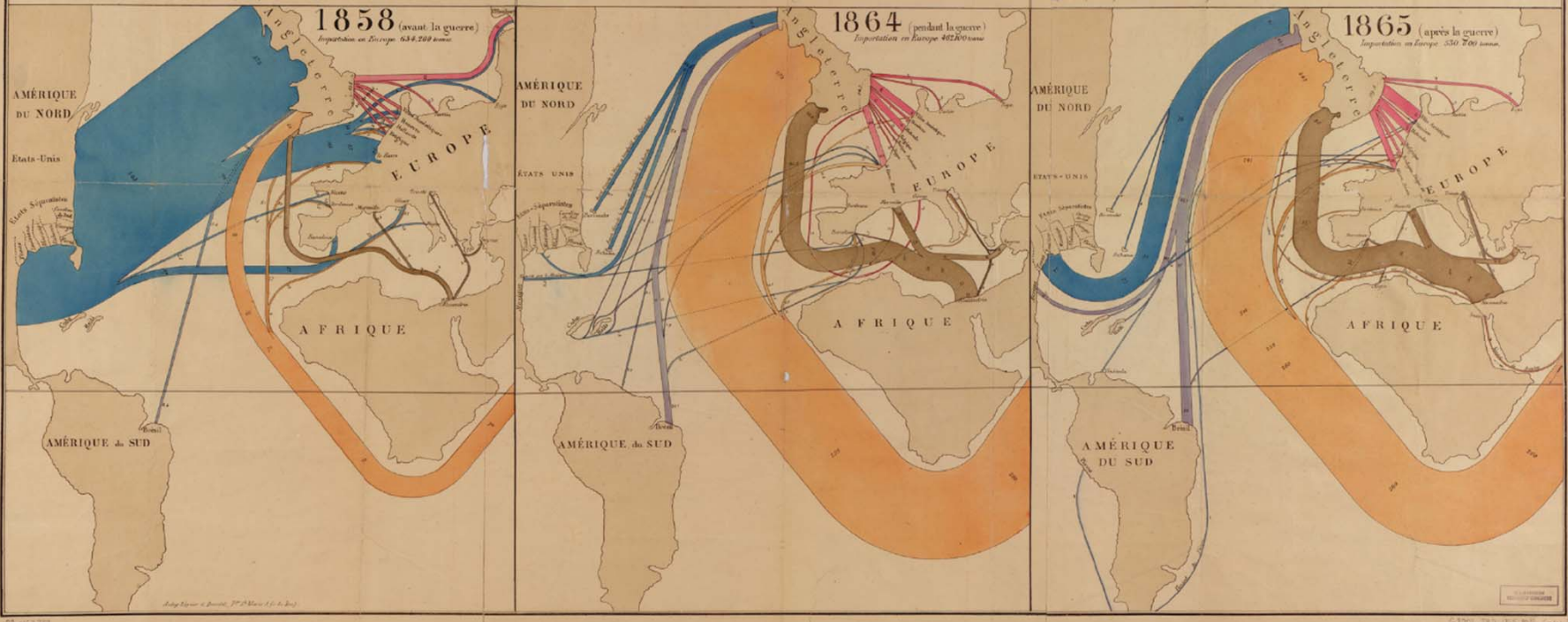
Les quantités importées de coton en 1865 ont été de 1 000 000 de quintaux métriques.

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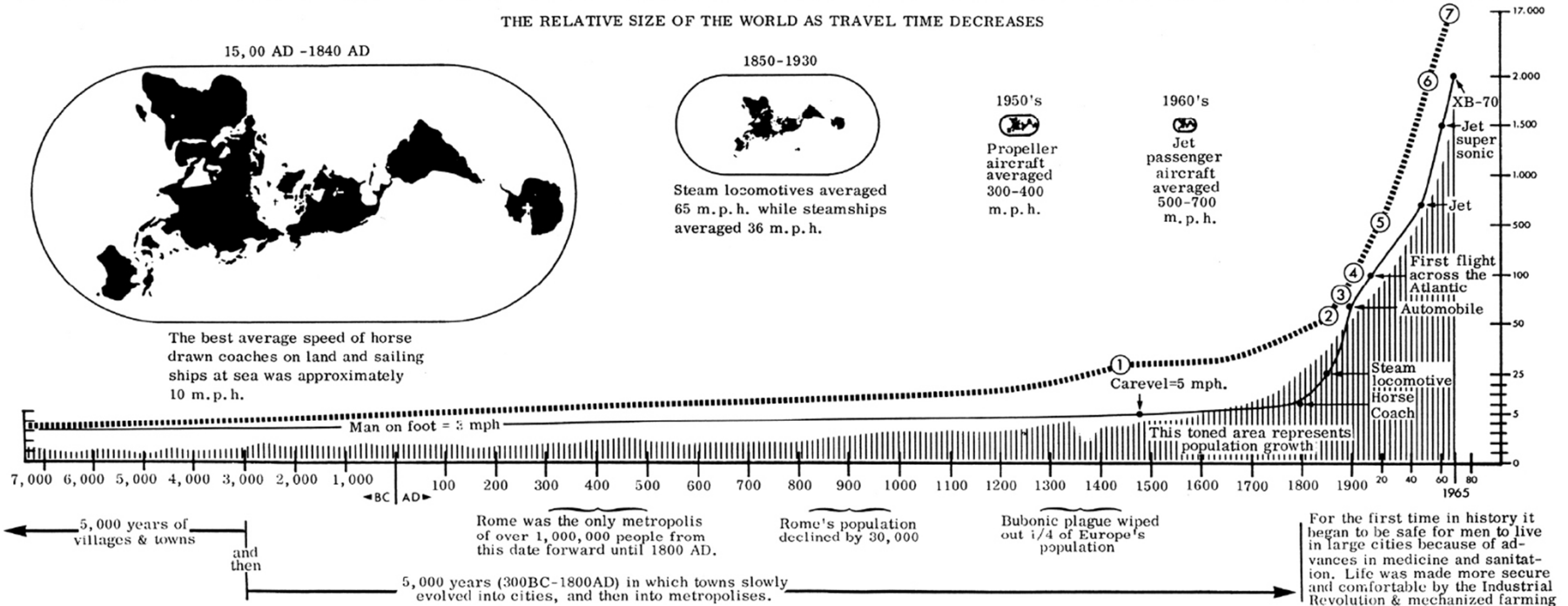
Europe Raw Cotton Imports in 1858, 1864 and 1865 - Charles Joseph Minard - 1866

SHRINKING OF OUR PLANET BY MAN'S INCREASED TRAVEL AND COMMUNICATION SPEEDS AROUND THE GLOBE

YEAR	500,000 BC	20,000 BC	300 BC	500 BC	1,500 AD	1900 AD	1925	1950	1965
Required time to travel around the globe	A few hundred thousand years	A few thousand years	A few hundred years	A few tens of years	A few years	A few months	A few weeks	A few days	A few hours
Means of transportation	Human on foot (over, ice bridges)	On foot and by canoe	Canoe with small sail or paddles or relays of runners	Large sail boats with oars, pack animals, and horse chariots	Big sailing ships (with compass), horse teams, and coaches	Steam boats and railroads (Suez and Panama Canals)	Steamships, transcontinental railways, autos, and airplanes	Steamships, rail-ways, auto jet and rocket air-craft	Atomic steamship, high speed railway auto, and rocket-jet aircraft
Distance per day (land)	15 miles	15-20 miles	20 miles	15-25 miles	20-25 miles	Rail 300-900 miles	400-900 miles	Rail 500-1,500	Rail 1000-2000
Distance per day (sea or air)		20 by sea	40 miles by sea	135 miles by sea	175 miles by sea	250 miles by sea	3,000-6000 air	6000-9500 air	408,000 air
Potential state size	None	A small valley in the vicinity of a small lake	Small part of a continent	Large area of a continent with coastal colonies	Great parts of a continent with trans-oceanic colonies	Large parts of a continent with transoceanic colonies	Full continents & Transocean Commonwealths	The Globe	The globe and more

Communications	Word of mouth, drums, smoke, relay runners, and hand printed manuscripts prior to 1441 A. D.	① The Gutenberg 1441 printing press	② The rapid print Web 1863 newspaper press	③ The Bell 1876 telephone	④ The Marconi 1895 telegraph	⑤ First commercial 1920 radio broadcast	⑥ National 1950 Television	⑦ Transcontinental T. V. with the introduction of Early Bird satellite 1965
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THE RELATIVE SIZE OF THE WORLD AS TRAVEL TIME DECREASES





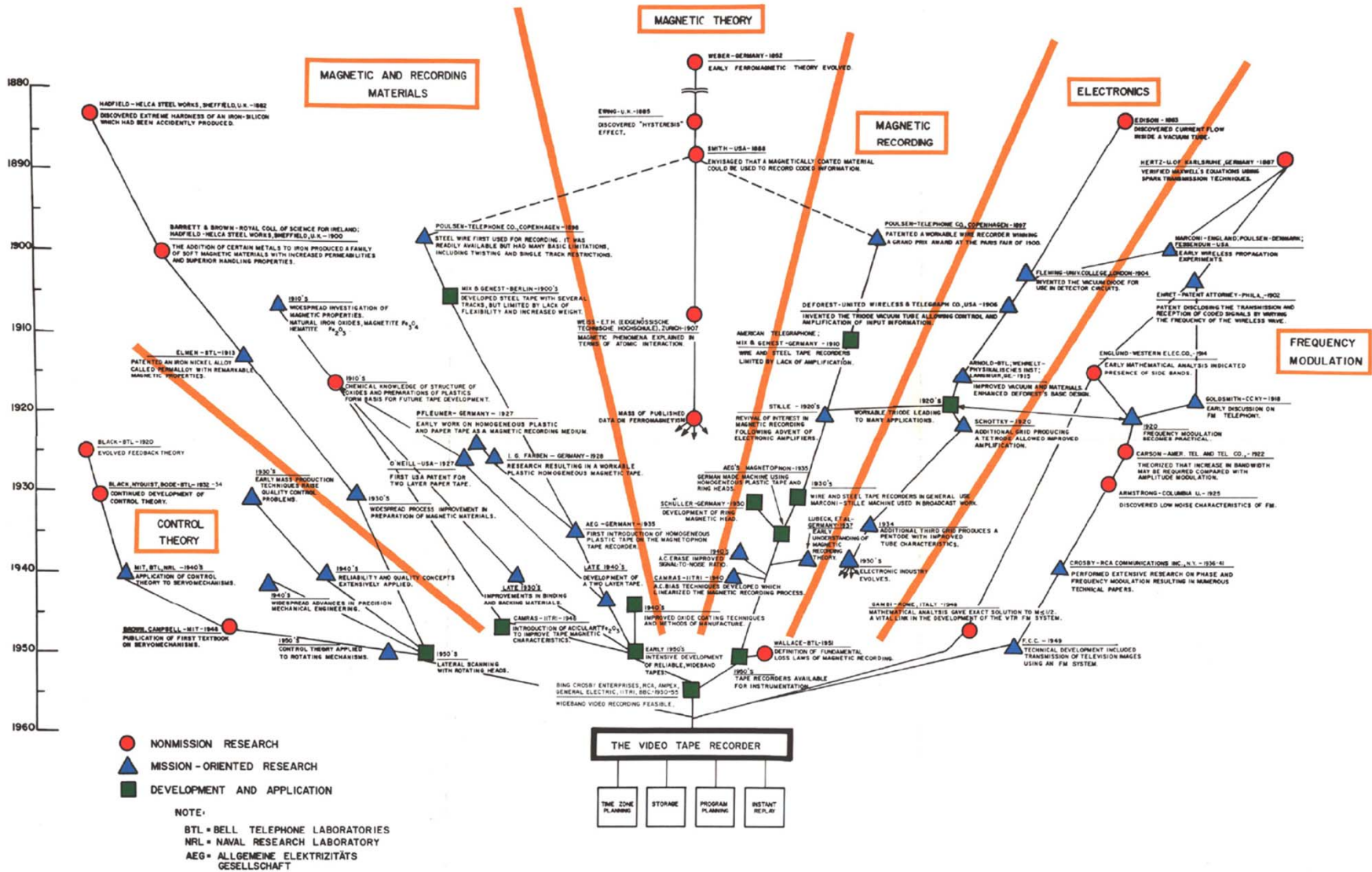
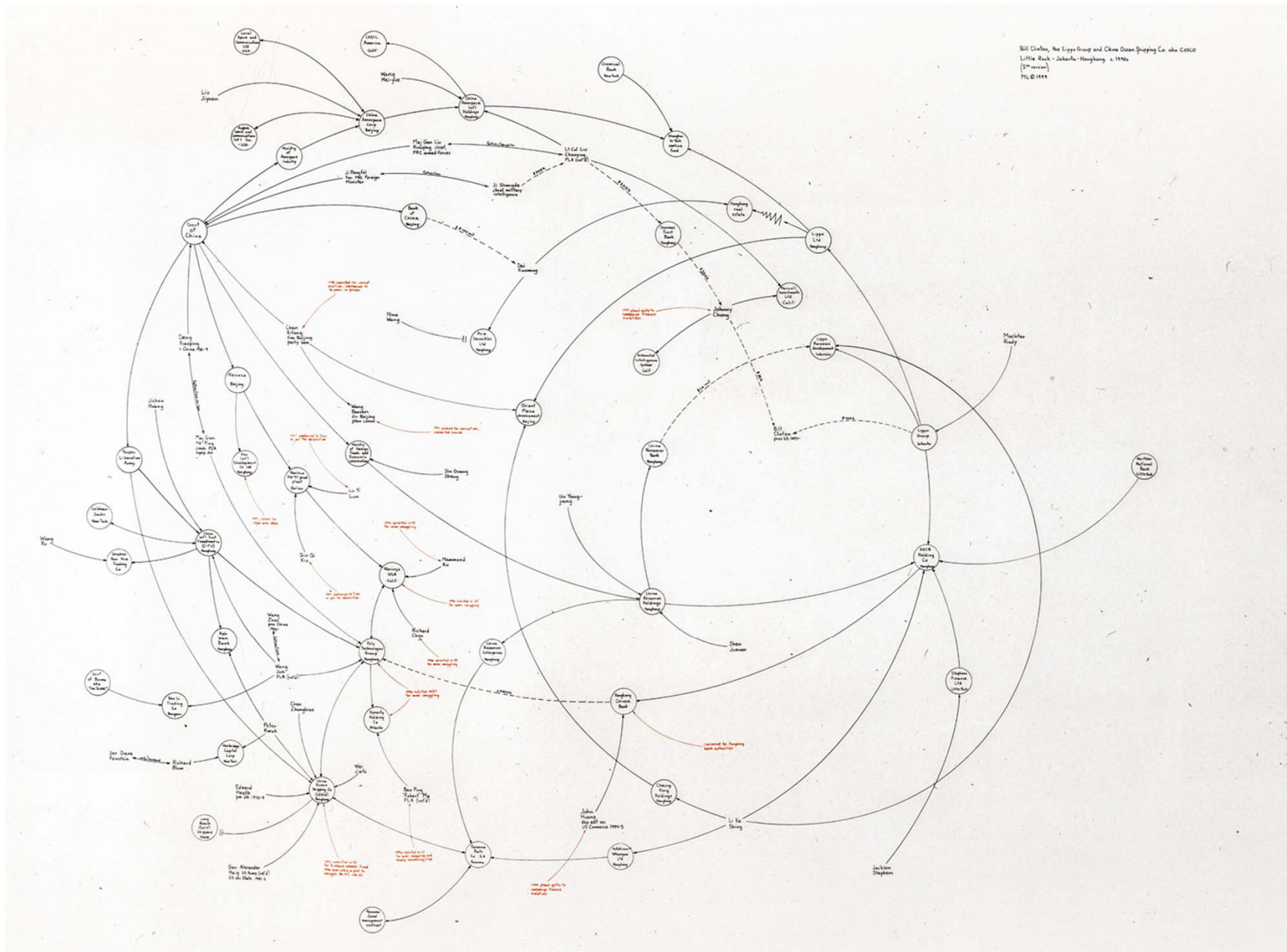


FIG. 7. THE VIDEO TAPE RECORDER

Tracing of Key Events in the Development of the Video Tape Recorder - Mr. G. Benn, Francis Narin - 1968



Bill Clinton, the Lippo Group and China Ocean Shipping Co. aka COSCO  
 Little Rock - Jakarta - Hong Kong. c. 1990s  
 5th version  
 ML © 1999

Bill Clinton, the Lippo Group, and China Ocean Shipping Co. a.k.a. COSCO, Little Rock—Jakarta—Hong Kong, ca. 1990s - Mark Lombardi - 1999

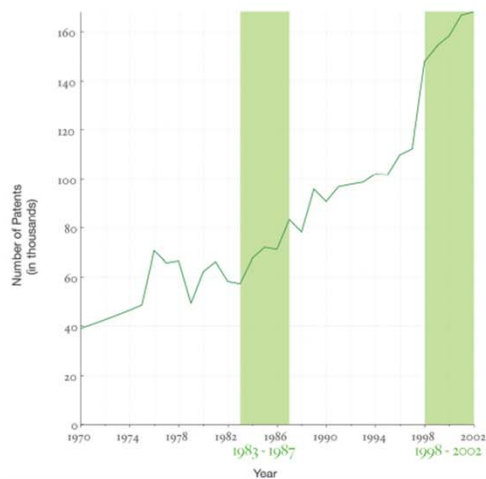
# Examining the Evolution & Distribution of Patent Classifications

## Managing Growing Patent Portfolios

Organizations, businesses, and individuals rely on patents to protect their intellectual property and business models. As market competition increases, patenting innovation and intellectual property rights becomes ever more important.

Managing the staggering number of patents demands new tools and methodologies. Grouping patents by their classifications offers an ideal resolution for better understanding how intellectual borders are established and change over time.

The charts below show the annual number of patents granted from January 1, 1976 to December 31, 2002 in the United States Patent and Trademark Office (USPTO) patent archive; slow and fast growing patent classes; the top-10 fast growing patent subclasses; and two evolving patent portfolios.



## The Structure and Evolution of the Patent Space

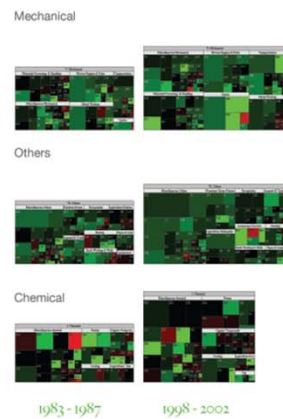
The United States Patent and Trademark Office assigns each patent to one of more than 450 classes covering broad application domains. For example, class 514 encompasses all patents dealing with 'Drug, Bio-Affecting and Body Treating Compositions.' Classes are further broken down by subclasses that have hierarchical associations. As one example, class 455 features subclass 99 entitled "with vehicle."

The top-10 fast growing patent classes for 1998-2002 are listed together with the number of patents granted. Most come from the 'Computer and Communications' and the 'Drugs and Medical' area.

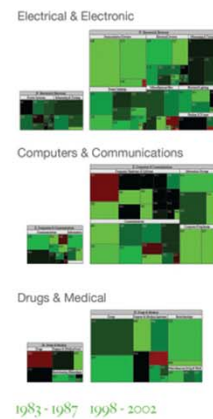
The evolving hierarchical structure of patent classes and their sizes is represented using treemaps, a space-filling visualization technique developed by Ben Shneiderman at the University of Maryland. A treemap presents a hierarchy as a collection of nested rectangles—demarcating a parent-child relationship between nodes by nesting the child within the parent rectangle. The size and color of each rectangle represent certain attributes of the nodes.

Here, each rectangle represents a class and the area size denotes the total number of patents in that class. The rectangle's color corresponds to percentage increase (green) or decrease (red) in the number of patent granted in that class from the previous interval.

### Slow Growing Classes



### Fast Growing Classes



### Top-10 Subclasses

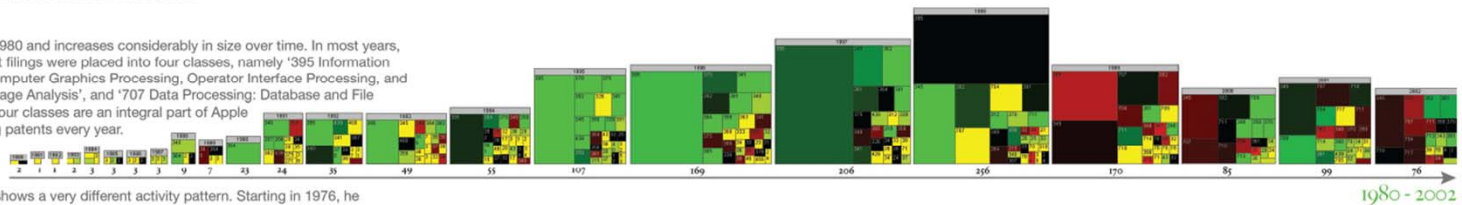
Class	Title	# of Patents
514	Drug, Bio-Affecting and Body Treating Compositions	18,778
438	Semiconductor Device Manufacturing:Process	17,775
435	Chemistry: Molecular Biology and Microbiology	17,474
424	Drug, Bio-Affecting and Body Treating Compositions	13,637
428	Stock Material or Miscellaneous Articles	13,314
257	Active Solid-State Devices (e.g., Transistors, Solid-State Diodes)	12,924
395	Information Processing System Organization	9,955
345	Computer Graphics Processing, Operator Interface Processing, and Selective Visual Display Systems	9,510
359	Optical: Systems and Elements	9,151
365	Static Information Storage and Retrieval	8,392
Total		13,0910

## Patent Portfolio Analysis

A longitudinal analysis of portfolios reveals different patenting strategies. For each year (given in gray above each treemap), a treemap of all new patents granted to the assignee is shown. The number of patents is given below each treemap. The same size and color coding as above was used. In addition, yellow indicates that no patent has been granted in that class in the last 5 years.

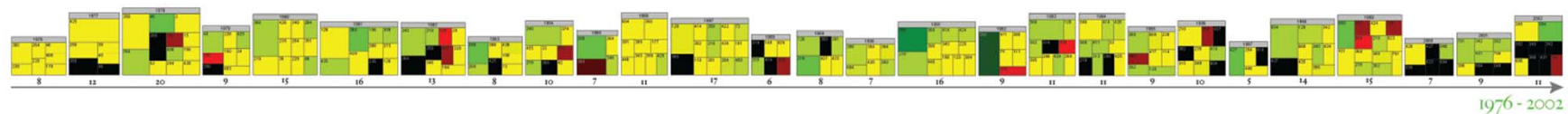
### Apple Computer, Inc.

Apple Computer, Inc.'s portfolio starts in 1980 and increases considerably in size over time. In most years, more than half of Apple Computer's patent filings were placed into four classes, namely '395 Information Processing System Organization', '345 Computer Graphics Processing, Operator Interface Processing, and Selective Visual Display Systems', '382 Image Analysis', and '707 Data Processing: Database and File Management or Data Structures'. These four classes are an integral part of Apple Computer, Inc.'s patent portfolio, receiving patents every year.

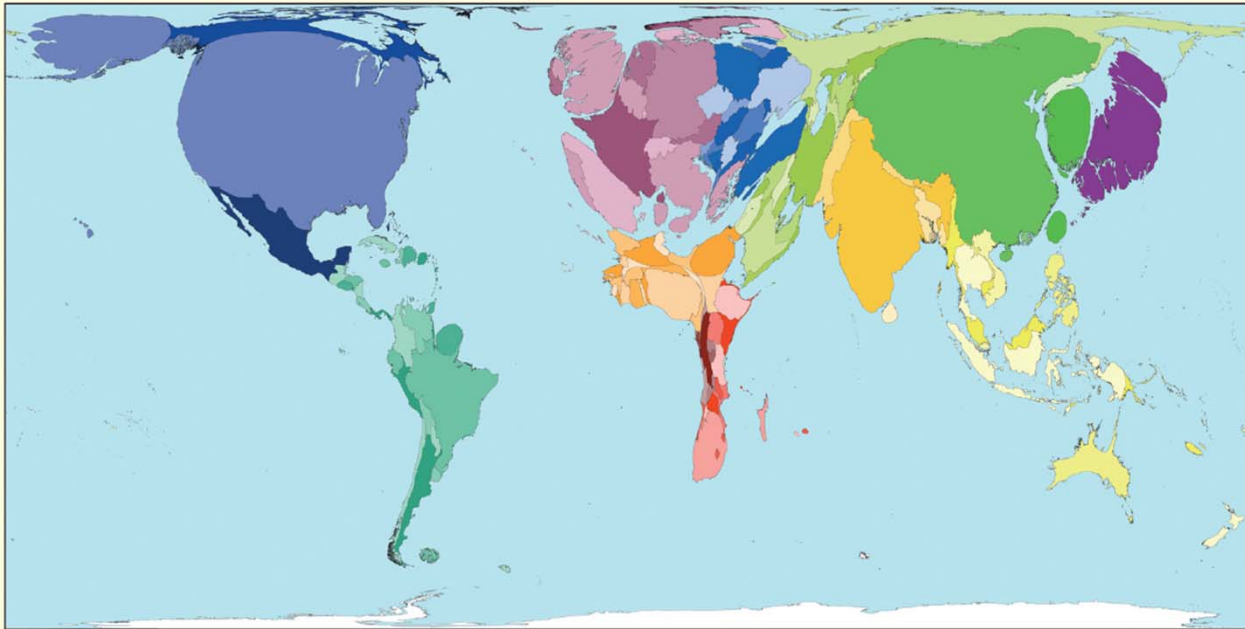


### Jerome Lemelson

The patent portfolio of Jerome Lemelson shows a very different activity pattern. Starting in 1976, he publishes between 6-20 patents each year. However, the predominance of yellow shows that there is little continuity from previous years in regards to the classes into which patents are filed. No class dominates. Instead, more and more new intellectual space is claimed.



# Ecological Footprint



The ecological footprint is a measure of the area needed to support a population's lifestyle. This includes the consumption of food, fuel, wood, and fibres. Pollution, such as carbon dioxide emissions, is also counted as part of the footprint.

The United States, China and India have the largest ecological footprints. Without knowing population size we cannot understand what this means about individuals' ecological demands. Large populations live in China and India. In both territories resource use is below the world average. The per person footprint in the United States is almost five times the world average, and almost ten times what would be sustainable.

Territory size shows the proportion of the worldwide ecological footprint which is made there.



Land area

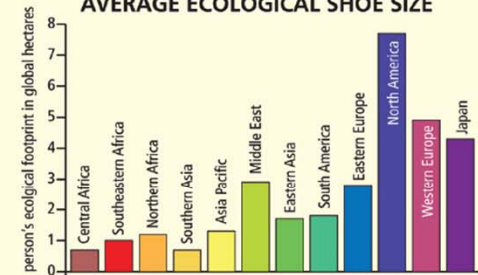
- Technical notes**
- Data are from the WWF (Worldwide Fund for Nature) International and Institute of Zoology.
  - Ecological footprint is measured in global hectares. One global hectare is an area that has the world average biological productivity of one hectare.
  - See website for further information.

## LARGEST AND SMALLEST ECOLOGICAL SHOE SIZES

Rank	Territory	Value	Rank	Territory	Value
1	United Arab Emirates	10.6	191	Nepal	0.61
2	United States	9.7	192	Democratic Republic of Congo	0.58
3	Greenland	7.7	193	Zambia	0.58
3	Bahamas	7.7	194	Congo	0.58
5	Canada	7.5	195	Malawi	0.57
6	Kuwait	7.4	196	Haiti	0.57
7	Australia	7.0	197	Cambodia	0.55
8	Finland	6.8	198	Bangladesh	0.47
9	Estonia	6.1	199	Somalia	0.23
10	New Zealand	6.1	200	Afghanistan	0.11

ecological footprint in global hectares per person, 2002\*

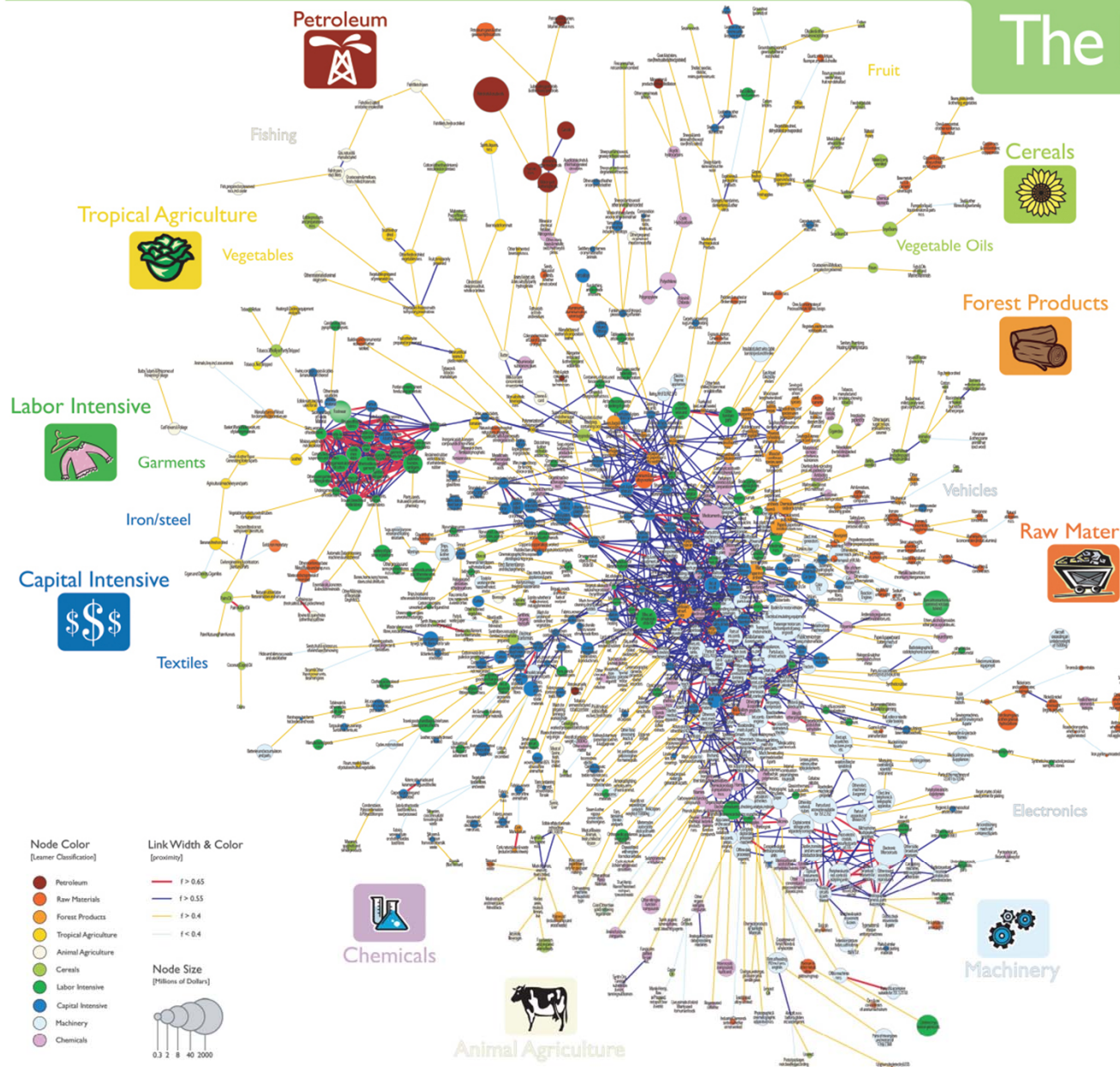
## AVERAGE ECOLOGICAL SHOE SIZE



*“People consume resources and ecological services from all over the world, so their footprint is the sum of these areas, wherever they may be on the planet.”*

The Living Planet Report, 2006

# The Product Space



World trade flow data compiled by Feenstra et al. and available at the National Bureau of Economic Research were used to identify the complete co-export matrix of 775 industrial products for 1998-2000. A Maximum Spanning Tree (MST) algorithm was used to reduce the complete co-export matrix to less than 1% of the links. The resulting network, which combines the MST plus all links with a co-export frequency of at least 0.55, was laid out using a force-directed layout algorithm. Node sizes represent the value of traded products in millions of U.S. dollars. Their color corresponds to ten product groups identified using the Leamer classification. Each product class is labeled by an icon. Link color and width indicate the frequency of joint exports.

## Economic Footprint

■ Indicate Relevant Exports

Industrialized Countries



The network has a core-periphery structure with higher value product classes, e.g., machinery and chemicals, in the core and lower quality classes, e.g., fishing and garments, in the periphery. Products at the core of the network are highly interconnected while products in the periphery are sparsely interlinked.

East Asia Pacific



Each country has a certain product export footprint. Relevant exports by 'Industrialized Countries', 'East Asia Pacific' and 'Latin America & the Caribbean' are given on the right.

Latin America & the Caribbean



Traditional growth theory assumes that there is always a more sophisticated product within reach. However, given the core-periphery structure of the product space, the distances between products differ considerably.

Latin America & the Caribbean



Countries that operate at the core have capabilities to develop and manufacture a wide range of products. Yet, countries that mostly operate in the periphery of the product space have much fewer opportunities for diversification. A country's current footprint and the structure of the product space have a major impact on a country's future development.



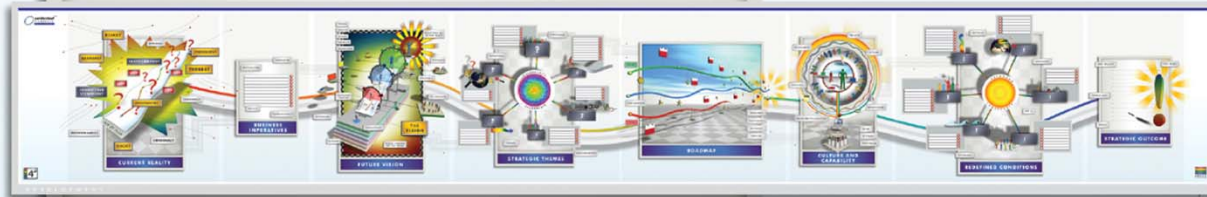
**GROUP PARTNERS**  
4D™. THE STRUCTURED APPROACH TO BUSINESS ISSUE RESOLUTION



SVT ANALYSIS



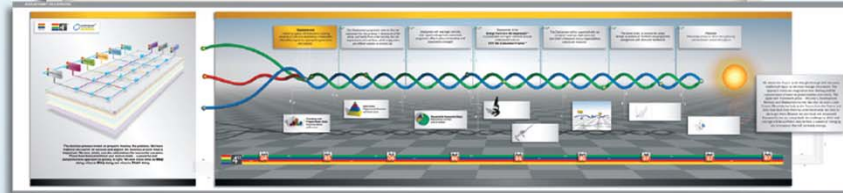
D1 DISCOVERY



D2 DEVELOPMENT



D3 DECISION



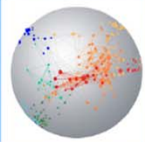
D4 DEPLOYMENT



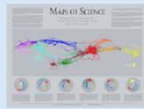
SVT DIGITAL SYSTEM

# The Scientific Roots of Technology

## A Simplified Map of Science



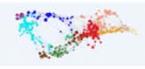
The original map of science was spherical, with 554 disciplines comprised of over 16,000 journals. Details of this map are given in another Places & Spaces poster.



Unfortunately, with a spherical map, only one side can be seen at a time.



This spherical map of science can be unfolded in order to see the hidden side.



As the sphere is unfolded, more and more of the hidden side is revealed.



The unfolded map shows the entire surface of the sphere on a 2-D plane. Remember that the left and right edges are actually connected, just as in the Mercator maps of the world that we are so used to viewing.



This rectangular map can be refolded to take on the shape of a cylinder.



At the same time, the cylinder can be rotated such that the map is being viewed from the bottom up.



When looking down into the cylinder, nodes of the same color are in the same general area, but are not sequentially located.



The model can be simplified by shifting disciplines (nodes) of the same color to be next to each other. This can be done with only minor loss of information, and results in a circular map of 554 disciplines organized into 13 major areas, denoted by color.

## Locating Patents on the Simplified Map of Science

**Science-Technology Linkage:** Patents were linked to the 554 scientific disciplines on the map of science. These links were based on a set of 18,250 people who were both inventors (on 55,400 patents) and authors (of 132,600 scientific publications) from 2002-2006. Additional information about the method for linking inventors and authors is available in Boyack & Klavans, "Measuring science-technology interaction using rare inventor-author names," *Journal of Informetrics*, 2008.

**Patent Classes:** Ten large international patent classes with very strong linkages to science (large numbers of inventor-authors) are represented as circles inside the map of science. The location of each patent class is the mean location of the scientific disciplines it draws upon. Each colored ray within a patent circle points to an associated scientific discipline on the circle of science. Rays are shown for all disciplines contributing to at least 1% of the patents in a class.

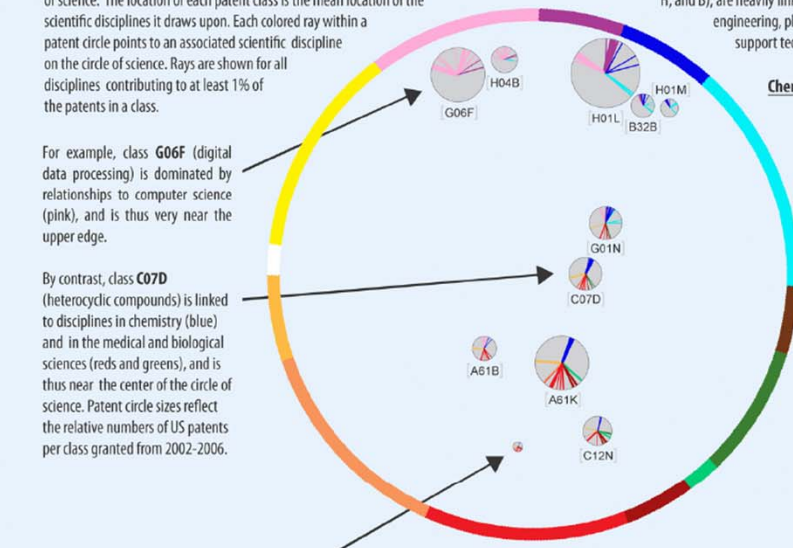
For example, class **G06F** (digital data processing) is dominated by relationships to computer science (pink), and is thus very near the upper edge.

By contrast, class **C07D** (heterocyclic compounds) is linked to disciplines in chemistry (blue) and in the medical and biological sciences (reds and greens), and is thus near the center of the circle of science. Patent circle sizes reflect the relative numbers of US patents per class granted from 2002-2006.

**Physics and Computer Science Based Patents:** The electronics, hardware & software, and telecommunications industries (represented mainly by international patent classes in sections G, H, and B), are heavily linked to the physical sciences. Computer science, electrical engineering, physics, and chemistry are the core areas of science which support technical progress in the above-named industries.

**Chemical & Medical Patents:** Patents in chemistry (mainly from classes in section C) and medicine (mainly from classes in section A) do not build exclusively on single areas of science. Rather, patents in these classes tend to build on science from a combination of the chemical and medical areas, and are thus far more interdisciplinary in their science base than are electronics patents.

**Gaps:** The positions of 20,000 individual patents are shown on the small circle map below. Areas of concentration and areas with few patents can both be seen. The largest gaps at the edges of the circle are adjacent to the social sciences (yellow), earth sciences (brown), and health services (peach). Few patents are associated with scientific advances in these fields.



**Shifting Scientific Roots of Stem Cell Technology:** The scientific disciplines associated with over 1,800 patents in stem cell technology were examined over time. Four CORE disciplines were found to dominate, accounting for 48% of the patents, and are shown as tic marks on the inside of the small circle map to the left. The next 20 disciplines account for 36% of the patents, are considered PERIPHERAL, and are shown as tic marks on the outside of the small circle map. Over time, there has been a shift from CORE to PERIPHERAL disciplines, as shown below.



### KEYS

■ CORE  
□ PERIPHERAL

**Patent Classes: From top left**  
G06F: Digital data processing  
H04B: Transmission

H01L: Semiconductor devices  
B32B: Layered products  
H01M: Batteries, etc.

G01N: Analyzing material properties  
C07D: Heterocyclic compounds  
A61K: Medical preparations

C12N: Micro-organisms; enzymes  
A61B: Diagnosis; surgery

CS; EE | Math; Physics | Chemistry | Engineering | Earth Sciences | Biology | Biotech | Infect Disease | Med Specialties | Health Services | Brain Research | Humanities | Social Sciences

# Happiness Depends on Various Factors

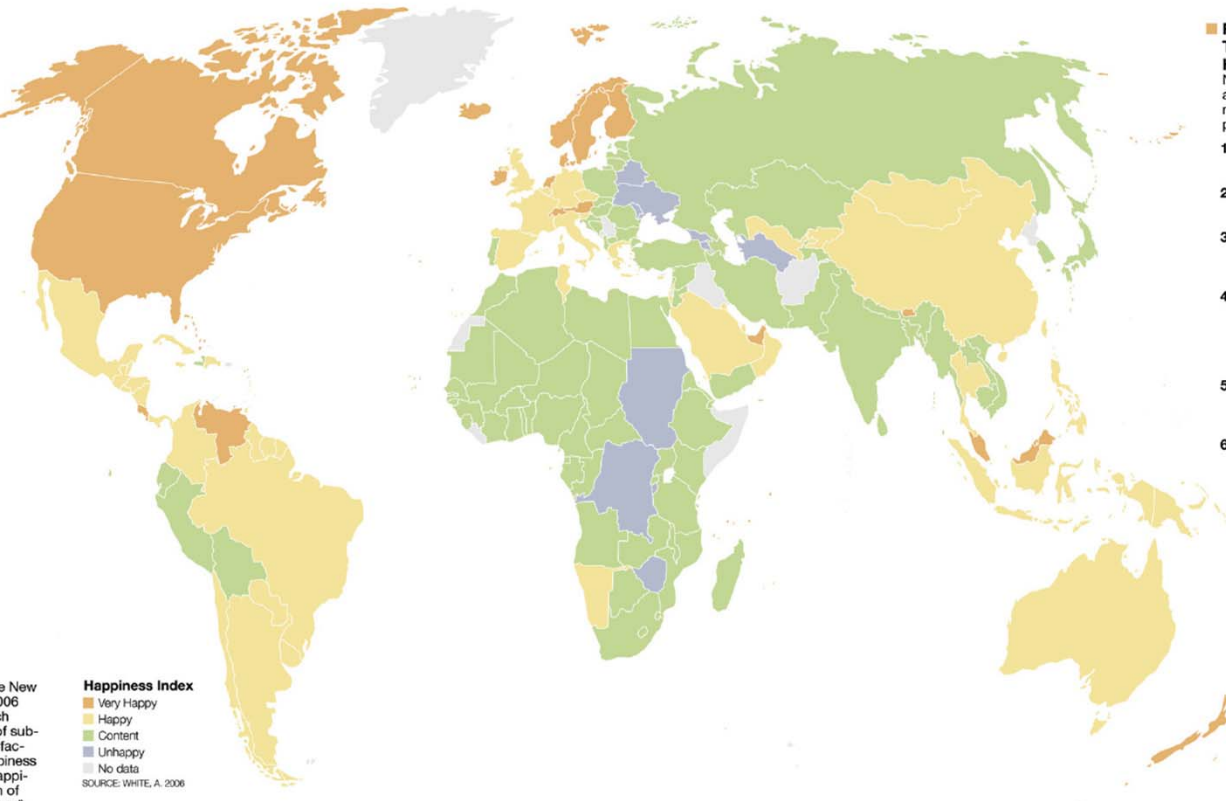
Social scientists are starting to include relative happiness with hard data on economic status, health, and other factors as they assess quality of life. They rely on surveys of "subjective well-being"—how good people feel about their lives. A world map of one "happiness index" shows many, but not all, 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: WHITE, A. 2008



## 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 ANTIGUA 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.

\*Photos different than those used in EarthPulse publication

"It's time we admitted there's more to life than money."  
 - David Cameron, U.K. leader of the opposition, 2006



# Check out our **Zoom Maps** online!

VII.10  
History of Science Fiction, by Ward Shellee

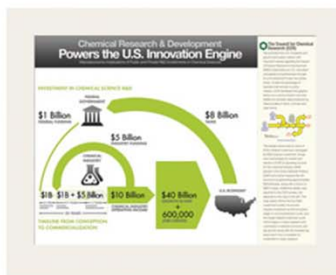
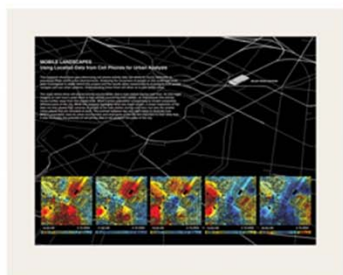
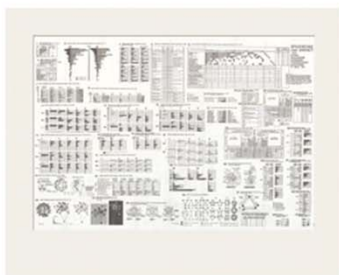
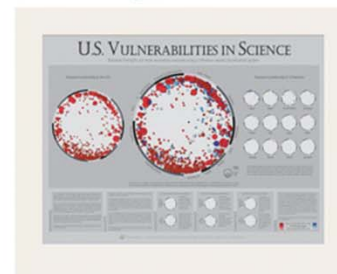
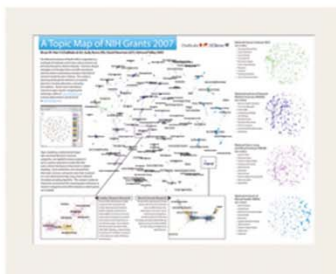
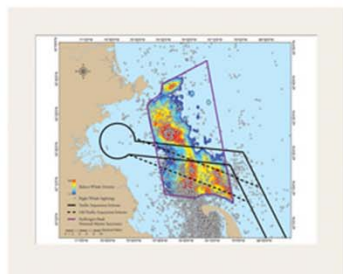
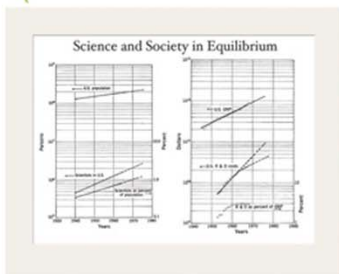
BROOKLYN, NY, 2011  
Courtesy of Ward Shellee Studios

Ward Shellee is an artist identified with the Williamsburg scene in Brooklyn, New York, about art and culture. This map plots the science fiction literary genre from its nascent emerging out of the data, here the narrative structure precedes and organizes the data. The monster whose tentacles are like trace roots to pre-historical sources and whose body is Romanticism, which birthed public fiction, source not only of Sci-Fi, but also of crime, progressed through a number of distinct periods, which are charted, citing hundreds of

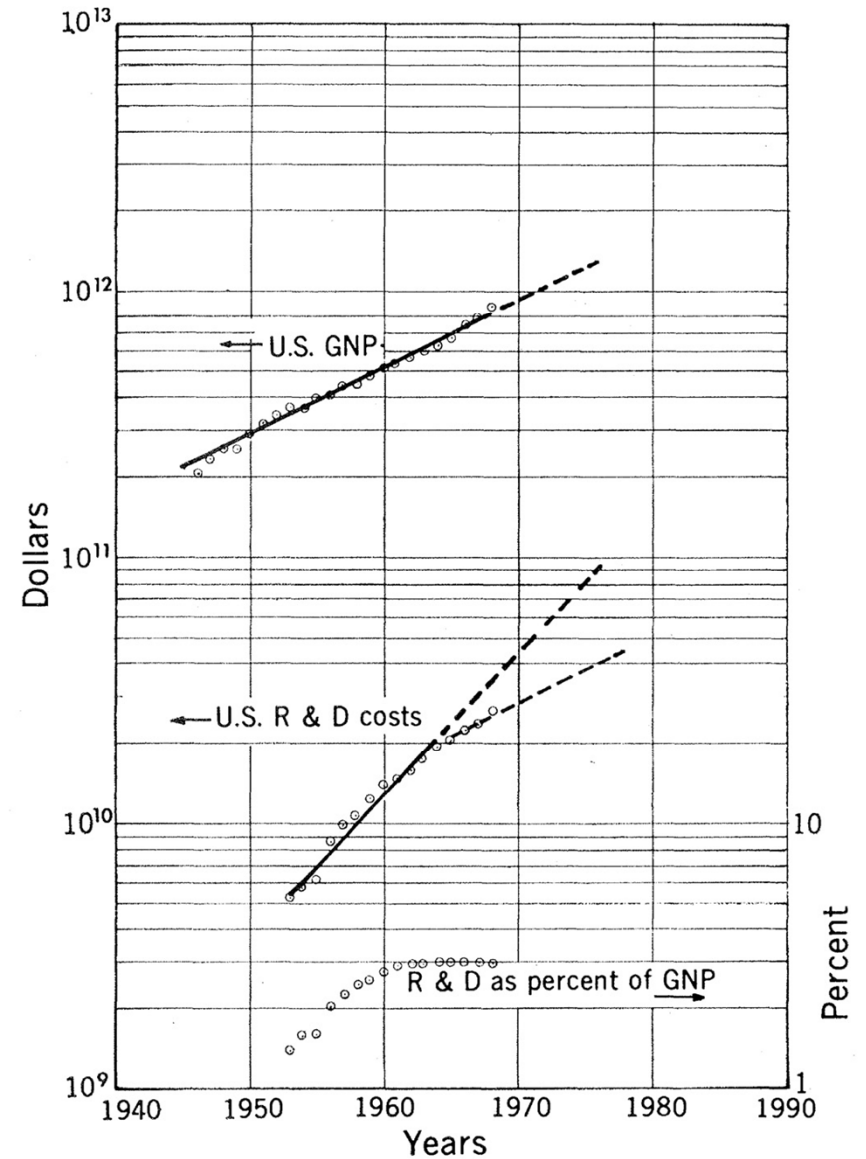
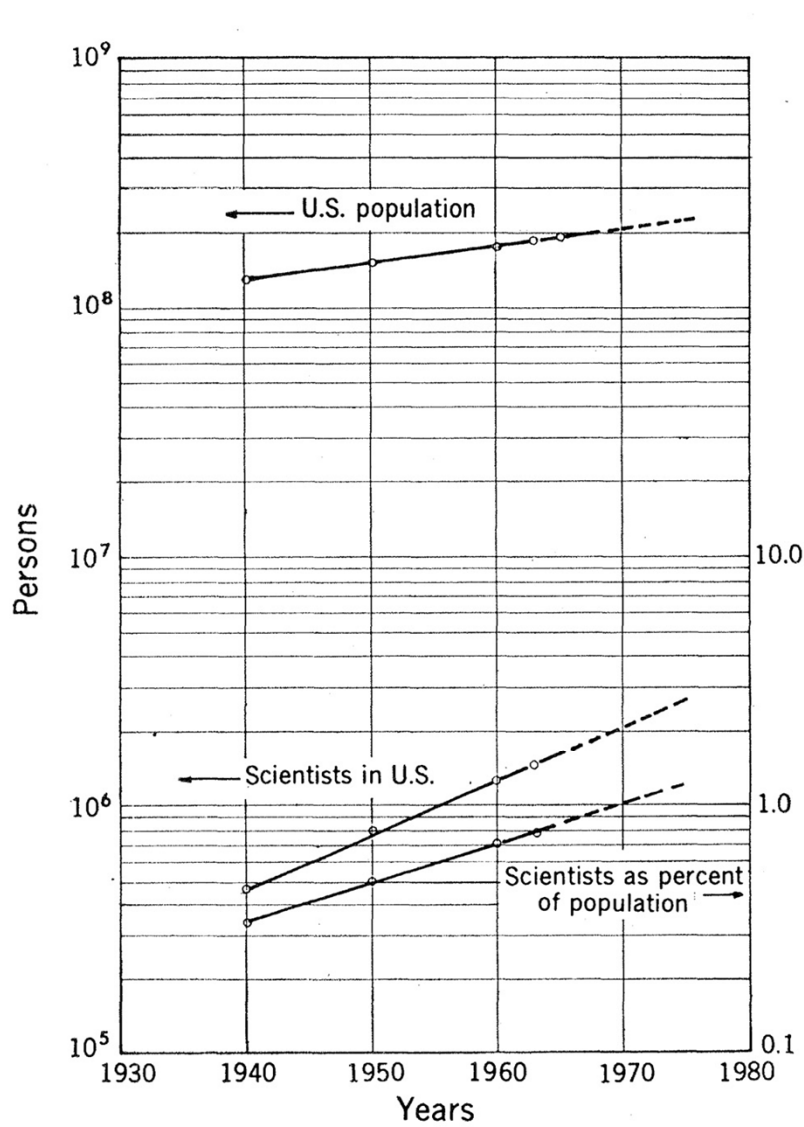
PLACES & SPACES & MAPS ONLINE  
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# SCIENCE MAPS FOR SCIENCE POLICY MAKERS 2009



# Science and Society in Equilibrium



**ПРИЛОЖЕНИЕ**  
 К книге Дюментона Г.  
 «Сети научных коммуникаций и организационных исследований»  
 М., «Наука», 1987.

Этот раздел книги является приложением к главному тексту и содержит дополнительные материалы, которые могут быть полезны для читателей. В нем представлены различные таблицы, диаграммы и схемы, иллюстрирующие методы исследования сетей научных коммуникаций. Все материалы подготовлены автором и предназначены для использования в научных целях.

**1** Матрица сопоставления на 2 (1967-1977...) и 11 (1978-1987) годов

**2** Схемы сопоставления в исследовании сетей научных коммуникаций в 1967-1977 гг. и в 1978-1987 гг.

**3** Структуры сетей научных коммуникаций в высшей школе в 1967-1977 гг. и в 1978-1987 гг.

**4** Структура сетей научных коммуникаций в высшей школе в 1967-1977 гг. и в 1978-1987 гг.

**5** Структуры (субструктуры) сетей научных коммуникаций в высшей школе в 1967-1977 гг. и в 1978-1987 гг.

**6** Структуры сетей научных коммуникаций в высшей школе в 1967-1977 гг. и в 1978-1987 гг.

**7** Структуры сетей научных коммуникаций в высшей школе в 1967-1977 гг. и в 1978-1987 гг.

**8** Структуры сетей научных коммуникаций в высшей школе в 1967-1977 гг. и в 1978-1987 гг.

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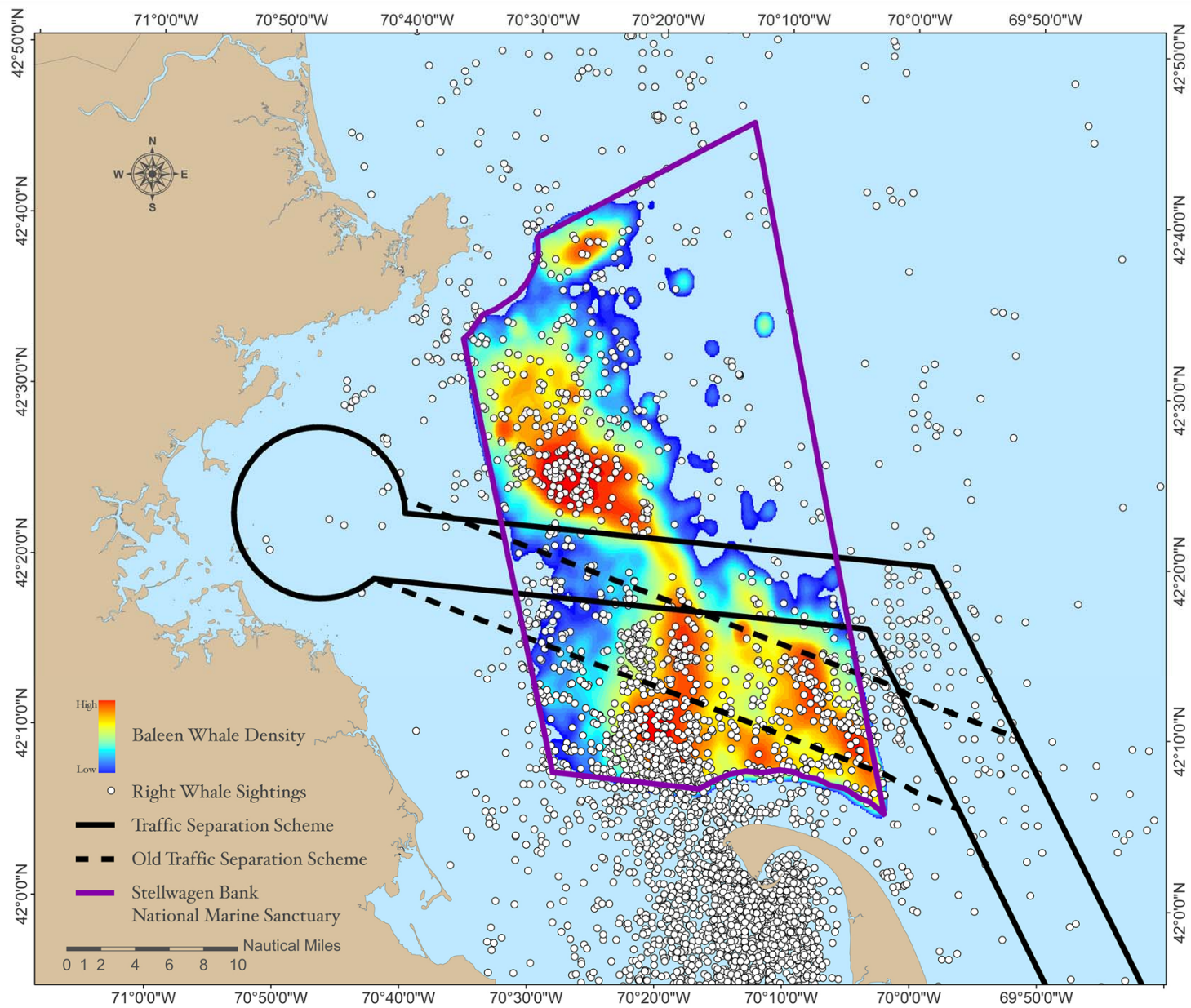
**37** Структуры сетей научных коммуникаций в высшей школе в 1967-1977 гг. и в 1978-1987 гг.

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**41** Структуры сетей научных коммуникаций в высшей школе в 1967-1977 гг. и в 1978-1987 гг.



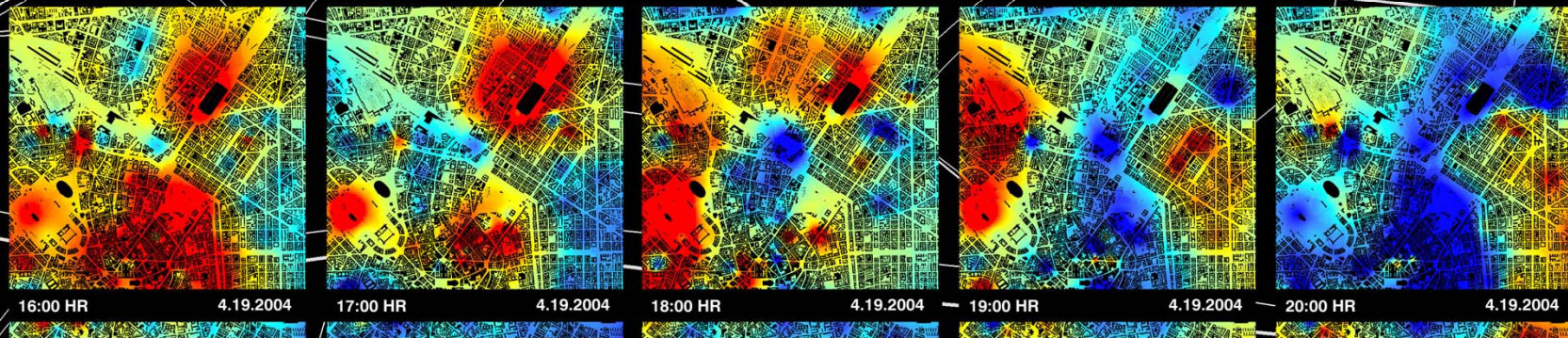
*Realigning the Boston Traffic Separation Scheme to Reduce the Risk of Ship Strike to Right and Other Baleen Whales*  
 David N. Wiley, Michael A. Thompson, and Richard Merrick - 2006

## MOBILE LANDSCAPES Using Location Data from Cell Phones for Urban Analysis

This research shows how geo-referencing cell phone activity data can allow for hourly estimates of population flows within urban environments. Analyzing the movement of people on this scale had never been investigated in depth before this project and the results allow researchers to investigate how people navigate and use urban systems. Understanding these flows will allow us to plan better cities.

The maps below show cell phone activity around Milan, Italy's train station during rush hour. As one might imagine at rush hour's peak there is high activity around the train station, as time passes this activity moves further away from this transit node. Milan's urban population is beginning to inhabit completely different parts of the city. While this analysis highlights what one might expect, a closer inspection of the data not only shows high volumes of people at the train station during rush hour, but also the smaller urban plazas that are activated at dusk. The contrast between day and night helps to illustrate how Milan's population uses its urban environment and what parts of the city are important to their daily flow. It also illustrates the potential of cell phone data to tell us about the pulse of the city.

MILAN TRAIN STATION

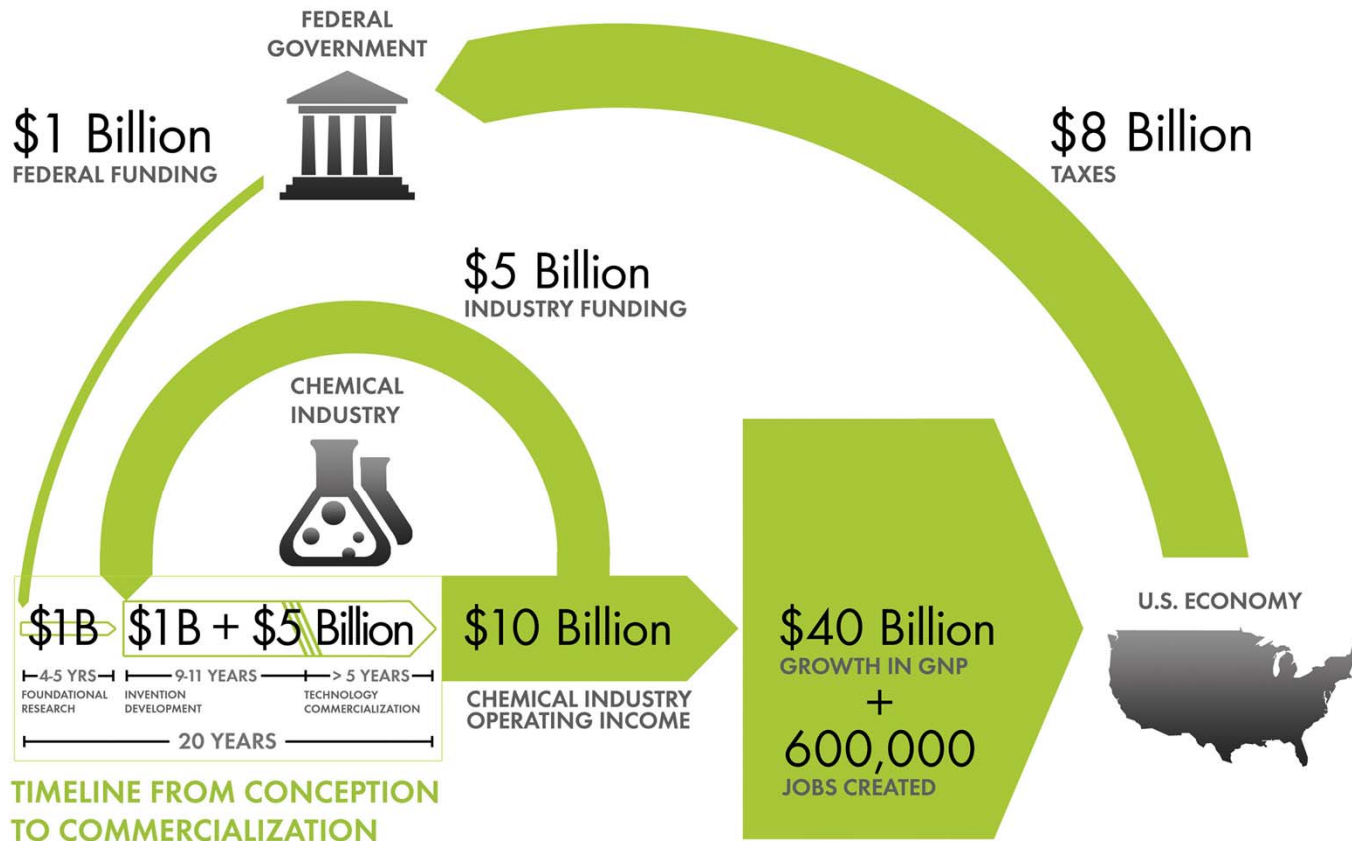




# Chemical Research & Development Powers the U.S. Innovation Engine

Macroeconomic Implications of Public and Private R&D Investments in Chemical Sciences

## INVESTMENT IN CHEMICAL SCIENCE R&D



## The Council for Chemical Research (CCR)

has provided the U.S. Congress and government policy makers with important results regarding the impact of Federal Research & Development (R&D) investments on U.S. innovation and global competitiveness through its commissioned 5-year two phase study. To take full advantage of typically brief access to policy makers, CCR developed the graphic below as a communication tool that distills the complex data produced by these studies in direct, concise and clear terms.



The design shows that an input of \$1B in federal investment, leveraged by \$5B industry investment, brings new technologies to market and results in \$10B of operating income for the chemical industry, \$40B growth in the Gross National Product (GNP) and further impacts the US economy by generating approximately 600,000 jobs, along with a return of \$8B in taxes. Additional details, also reported in the CCR studies, are depicted in the map to the left. This map clearly shows the two R&D investment cycles; the shorter industry investment at the innovation stage to commercialization cycle; and the longer federal investment cycle which begins in basic research and culminates in national economic and job growth along with the increase tax base that in turn is available for investment in basic research.

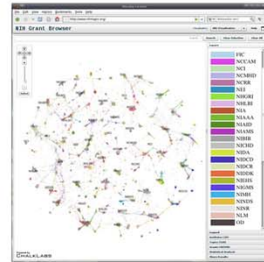


# A Topic Map of NIH Grants 2007

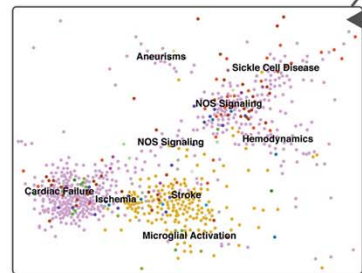
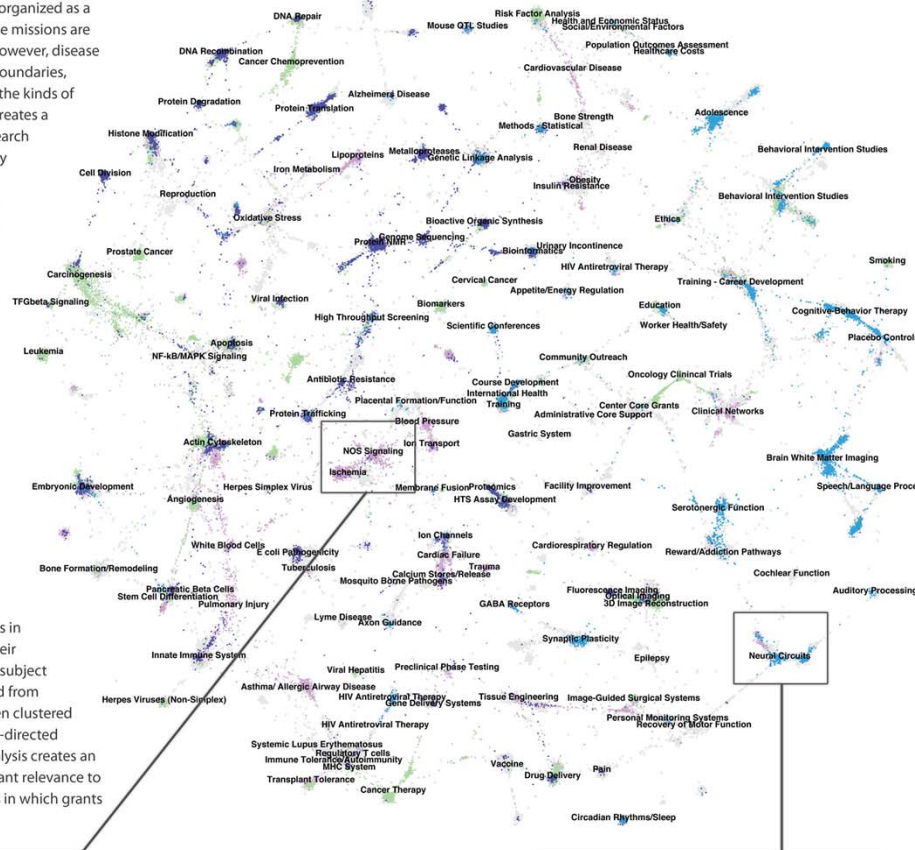
ChalkLabs  UCI IRVINE 

Bruce W. Herr II (Chalklabs & IU), Gully Burns (ISI), David Newman (UCI), Edmund Talley (NIH)

The National Institutes of Health (NIH) is organized as a multitude of Institutes and Centers whose missions are primarily focused on distinct diseases. However, disease etiologies and therapies flout scientific boundaries, and thus there is tremendous overlap in the kinds of research directions, funding allocations, and policy formulations. Shown here is devised an interactive topic map for navigating this landscape, online at [www.nihmaps.org](http://www.nihmaps.org). Institute abbreviations can be found at [www.nih.gov/icd](http://www.nih.gov/icd).

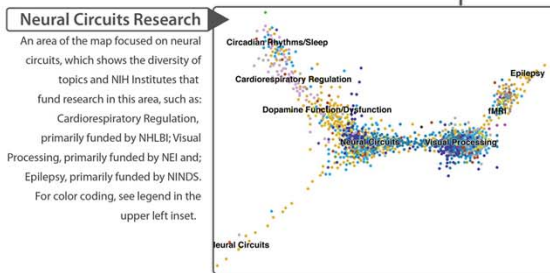


Topic modeling, a statistical technique that automatically learns semantic categories, was applied to assess projects in terms used by researchers to describe their work, without the biases of keywords or subject headings. Grant similarities were derived from their topic mixtures, and grants were then clustered on a two-dimensional map using a force-directed simulated annealing algorithm. This analysis creates an interactive environment for assessing grant relevance to research categories and to NIH Institutes in which grants are localized.



### Cardiac Diseases Research

An area of the map focused on cardiovascular function and dysfunction. Cardiac Failure (primarily funded by NHLBI) is typically clustered next to Stroke (NINDS), since these are the two major medical emergencies associated with ischemia, which results from a restricted blood supply. Also localized in this area are grants focused on Nitric Oxide (NOS) Signaling, a major biochemical pathway for vasodilation, and grants on Hemodynamics, Sickle Cell Disease and Aneurysms.



### Neural Circuits Research

An area of the map focused on neural circuits, which shows the diversity of topics and NIH Institutes that fund research in this area, such as: Cardiorespiratory Regulation, primarily funded by NHLBI; Visual Processing, primarily funded by NEI and; Epilepsy, primarily funded by NINDS. For color coding, see legend in the upper left inset.

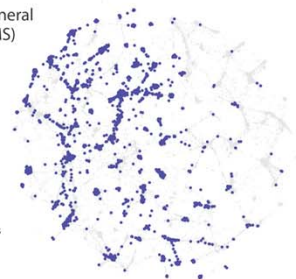
### National Cancer Institute (NCI)

- TOP 10 TOPICS
- 1 Oncology Clinical Trials
  - 2 Cancer Treatment
  - 3 Cancer Therapy
  - 4 Carcinogenesis
  - 5 Risk Factor Analysis
  - 6 Cancer Chemotherapy
  - 7 Metastasis
  - 8 Leukemia
  - 9 Prediction/Prognosis
  - 10 Cancer Chemoprevention



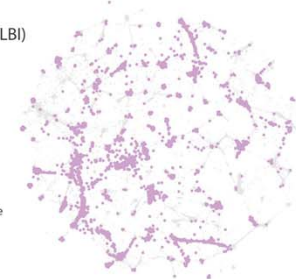
### National Institute of General Medical Sciences (NIGMS)

- TOP 10 TOPICS
- 1 Bioactive Organic Synthesis
  - 2 X-ray Crystallography
  - 3 Protein NMR
  - 4 Computational Models
  - 5 Yeast Biology
  - 6 Metalloproteases
  - 7 Enzymatic Mechanisms
  - 8 Protein Complexes
  - 9 Invertebrate/Zebrafish Genetics
  - 10 Cell Division



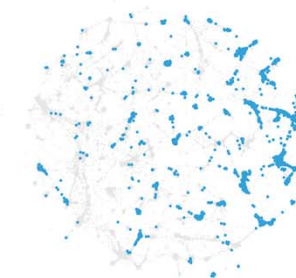
### National Heart, Lung, and Blood Institute (NHLBI)

- TOP 10 TOPICS
- 1 Cardiac Failure
  - 2 Pulmonary Injury
  - 3 Genetic Linkage Analysis
  - 4 Cardiovascular Disease
  - 5 Atherosclerosis
  - 6 Hemostasis
  - 7 Blood Pressure
  - 8 Asthma/ Allergic Airway Disease
  - 9 Gene Association
  - 10 Lipoproteins



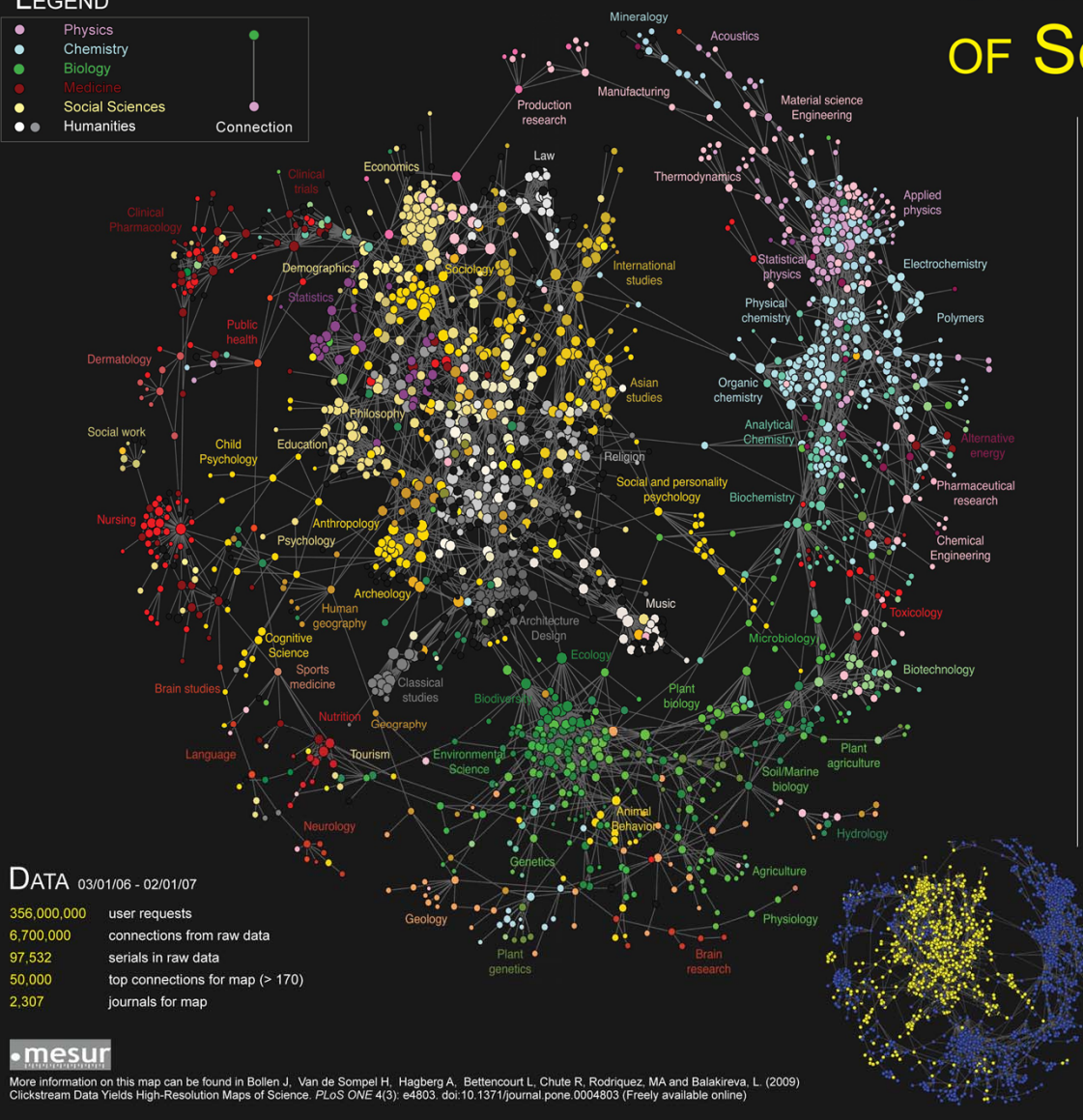
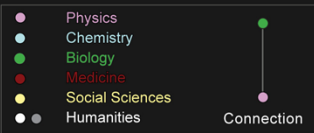
### National Institute of Mental Health (NIMH)

- TOP 10 TOPICS
- 1 Mood Disorders
  - 2 Schizophrenia
  - 3 Behavioral Intervention Studies
  - 4 Mental Health
  - 5 Depression
  - 6 Cognitive-Behavior Therapy
  - 7 AIDS Prevention
  - 8 Genetic Linkage Analysis
  - 9 Adolescence
  - 10 Childhood



# CLICKSTREAM MAP OF SCIENCE

## LEGEND



This is the first map created from large-scale, world-wide, scholarly usage data. It visualizes the collective flow of scientists' movements from one journal to another in their online navigation behavior.

The MESUR project ([www.mesur.org](http://www.mesur.org)) collected a database of nearly 1 billion user requests recorded by the web portals of some of the world's most significant publishers, aggregators and large university consortia, among them Thomson Scientific (Web of Science), Elsevier (Scopus), JSTOR, Ingenta, University of Texas (9 campuses, 6 health institutions), and California State University (23 campuses). All usage logs acquired by the MESUR project contain session identifiers that identify the individual clickstreams of individual scientists navigating from one article to the next.

Pairs of journals are connected when they have a high probability of being followed by each other in users' clickstreams. The circles represent individual journals. A line between two circles indicates that they are strongly connected in either direction. The colors indicate the scientific domain a journal belongs to according to their Dewey Decimal and JCR classification codes that were mapped into the Getty Research Center's Arts and Architecture Taxonomy (AAT) to allow classifications at various levels of detail. The size of circles corresponds to the strength (degree centrality) of a journal's connections in the map. The map is arranged by the Fruchterman-Reingold algorithm that treats connections like springs; connected journals are drawn together, but they are not allowed to get too close.

This map is derived from usage data and therefore also reflects the actions of those who read the literature but rarely publish themselves, e.g. practitioners and laypersons. As a result practitioner-driven domains such as nursing, social work, and tourism studies are prominently featured. The natural sciences vs. the social sciences and humanities emerge as two distinct clusters that are connected via various specific interdisciplinary spokes. Most domains are highly interdisciplinary, but this is more so the case for the social sciences and humanities. Surprisingly, mathematics and computer science are not represented as one specific cluster, but spread-out through the map.

Like citation maps, this map is based upon a particular sample of the scientific community, albeit one that includes non-publishing scientists and practitioners and a much greater sample of publications. From MESUR's database of 1 billion user events, we created a matrix of 6 million connections between approximately 100,000 serials. From that matrix we selected only 50,000 connections with the highest number of observations, ranging from approximately 40,000 to 170 observations. This subset of connections pertained to the 2,307 most used journals. This procedure may introduce specific biases which require investigation. This map should therefore not be construed as a final map of scientific activity, but as a showcase for the feasibility of tracking scientific activity from usage data. We hope this methodology will provide unique insights into the real-time structure of scientific activity as it can be observed from scholarly clickstream data.

When we cut the AAT taxonomy at the top level, only two distinctions remain: natural science (blue nodes) vs. the social sciences and humanities (yellow nodes). Some journals along the spokes of the wheel have classifications (colors) that do not correspond to their location in the map. This indicates either that journal in question is highly interdisciplinary, and/or has been assigned a classification that does not correspond to how scientists actually use the particular journal.

**DATA** 03/01/06 - 02/01/07

356,000,000	user requests
6,700,000	connections from raw data
97,532	serials in raw data
50,000	top connections for map (> 170)
2,307	journals for map



More information on this map can be found in Bollen J., Van de Sompel H., Hagberg A., Bettencourt L., Chute R., Rodriguez, MA and Balakireva, L. (2009) Clickstream Data Yields High-Resolution Maps of Science. *PLoS ONE* 4(3): e4803. doi:10.1371/journal.pone.0004803 (Freely available online)

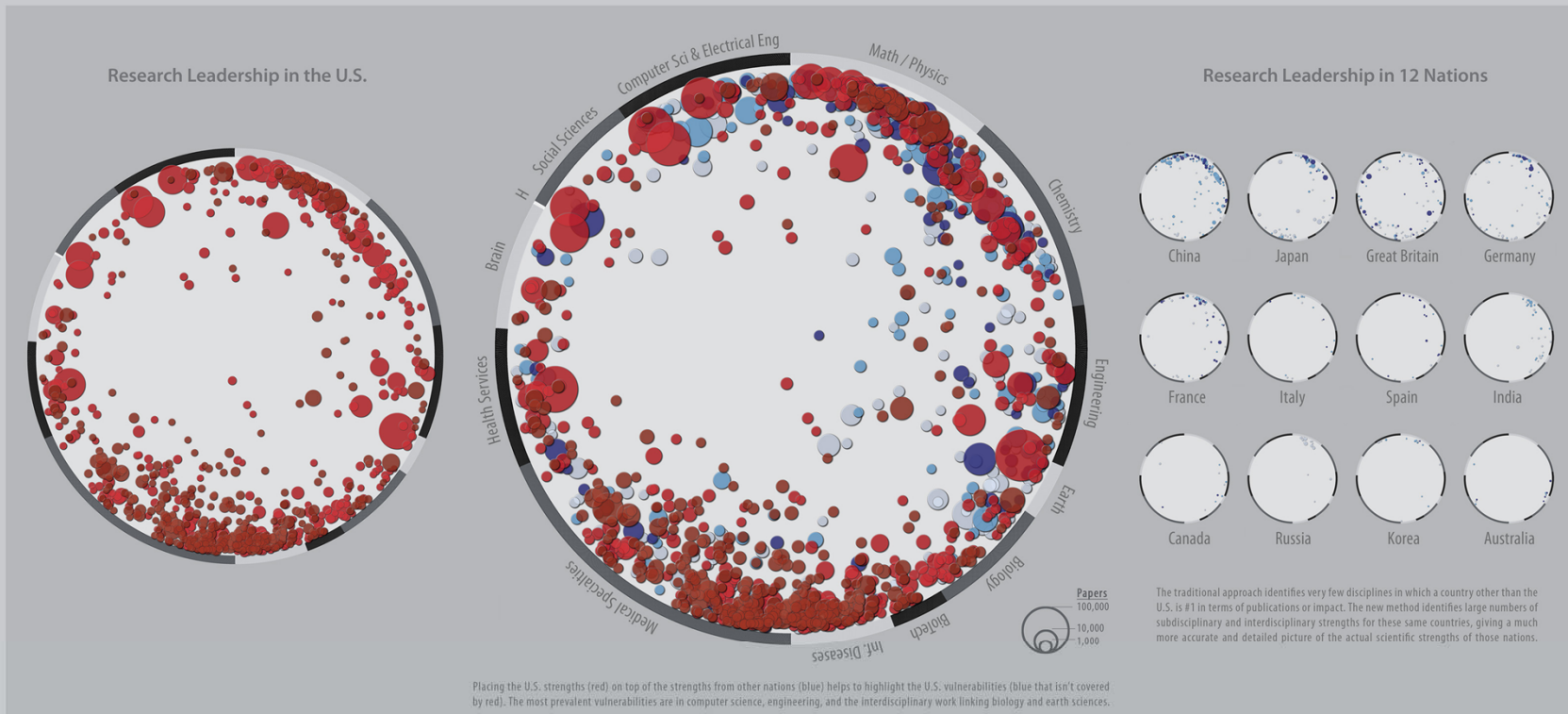
Design layout by: Jeremy D. Chacon

## A Clickstream Map of Science

Johan Bollen, Herbert Van de Sompel, Aric Hagberg, Luis M. A. Bettencourt, Ryan Chute, Marko A. Rodriguez, and Lyudmila Balakireva - 2008

# U.S. VULNERABILITIES IN SCIENCE

National Strengths are more accurately assessed using a reference-based classification system.



**methodology**

A new reference-based classification system has been generated using the Scopus database. Over 2.1 million highly cited references, and over 5.6 million articles (2003-2007) that cite these references, have been assigned to over 80,000 categories (called paradigms) using co-citation methods.

This new classification system is used to identify national strengths from the unique point of view of each nation. Paradigms in which a nation has a high publication share are clustered based on the idiosyncratic publication activity in that nation. Each red or blue circle shown in these maps represents a cluster of paradigms where the nation is a research leader.

The layout of these maps is based on ordering disciplines (and corresponding paradigms) sequentially around the perimeter of a circle. Related paradigms (and disciplines) tend to be near each other. The ordering of disciplines is based on a consensus from 20 maps of science.

Disciplinary research is located on the periphery. Interdisciplinary research is closer to the center.

**accuracy**

Traditional methods for determining national leadership were compared to this new method.

The traditional method assigned the same literature to disciplines. We used the journal-disciplinary classification system that was developed for the University of California at San Diego. The same 5.6 million articles and 2.1 million highly cited references were assigned to 534 disciplines. Common criteria were used to determine the three types of leaders.

Our new method requires that the same literature is first clustered using co-citation analysis into over 80,000 paradigms. These paradigms are then clustered further, based only on the publication activity in that nation. Nation-specific clusters were excluded if they did not meet the same criteria of size (at least 1000 papers) for leadership.

The improvements in accuracy can be seen in the three examples shown on the right.

**comparison**

The results for Great Britain were quite different.

**Traditional Method**

A disciplinary approach suggests that Great Britain is particularly strong in a series of social sciences and in health services.

**New Method**

The new method consolidates the social science and health services into interdisciplinary programs. GB also has strengths in the upper right and lower quadrants.

**comparison**

The results for Germany were quite different.

**Traditional Method**

A disciplinary approach suggests that Germany only has two areas of leadership: surgical endoscopy and waste management.

**New Method**

The new method shows the diversified strengths in Germany, with a strong concentration around the physics disciplines.

**comparison**

The results for Spain were quite different.

**Traditional Method**

A disciplinary approach suggests that Spain has two areas of leadership: hypertension and (primarily eastern european) clinical medicine.

**New Method**

The new method shows a diversified set of strengths for Spain. Almost all of these strengths were not identified using the traditional methods.

**coding**

We focused on three types of leadership. The most common measure is publication leadership (PUB). This is defined as having the largest number of publications in a discipline or strength. The second is reference leadership (REF), having the largest number of highly cited references in a discipline or strength. The third, and perhaps most important, is state of the art leadership (SOA). This category is reserved for those disciplines or strengths where the researchers build on the more recent discoveries in their field. SOA leaders must have at least a 0.8 PUB ratio (80% as large as the leader in the discipline or strength) to qualify.

The intensity of color (red for the US, blue for the 12 nations) is an indication of:

- All three strengths (PUB and REF and SOA)
- Two of the three strengths
- Only one strength (PUB or REF or SOA)



# A Global Agenda to End Poverty



## The Millennium Development Goals: A Partnership for Progress

The Millennium Development Goals (MDGs) are a challenge the global community has set for itself. They are a challenge to poor countries to demonstrate good governance and a commitment to reducing poverty. They are also a challenge to wealthy countries to keep their promise to support economic and social development. For rich and poor countries alike, the MDGs are measurable goals for making progress around the world.

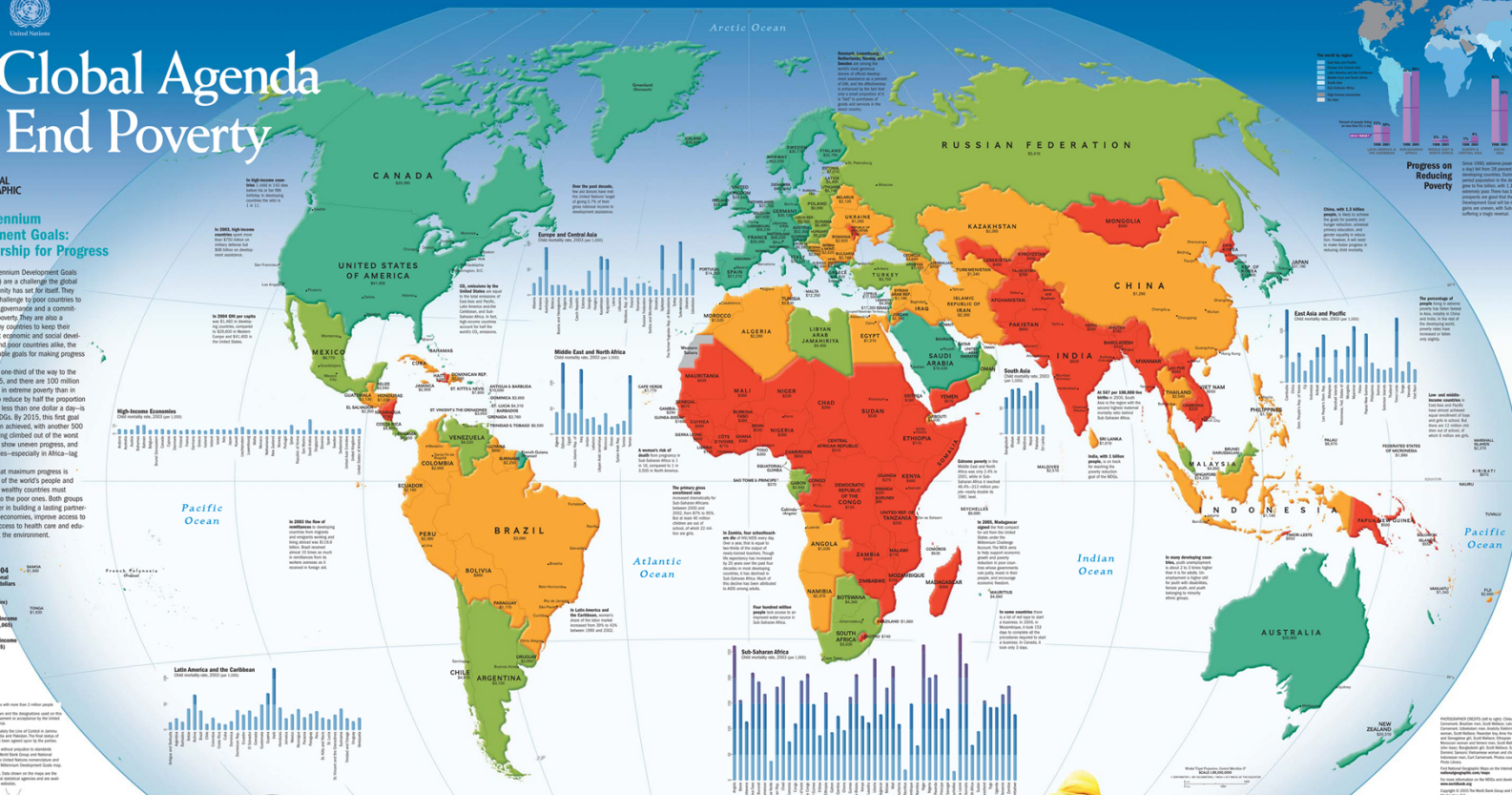
We are now one-third of the way to the target date of 2015, and there are 100 million fewer people living in extreme poverty than in 1990. This goal—to reduce by half the proportion of people living on less than one dollar a day—is the first of eight MDGs. By 2015, this first goal will likely have been achieved, with another 500 million people having climbed out of the world poverty. But trends show uneven progress, and the poorest countries—especially in Africa—lag behind.

To ensure that maximum progress is made, and that all of the world's people and regions share in it, wealthy countries must increase their aid to the poor ones. Both groups need to work harder in building a lasting partnership to strengthen economies, improve access to markets, expand access to health care and education, and protect the environment.

**KEY**  
**World Income, 2004**  
 Per capita gross domestic product (GDP) in U.S. dollars

- High-income (USA or more)
- Upper-middle income (113,254 to 319,346)
- Lower-middle income (1995 to 11,231)
- Low-income (1993 or less)
- No data

China's rapid economic growth will take her 31 million people out of poverty and into the middle class by 2015. India's growth will take 100 million more people out of poverty and into the middle class by 2015. The world's population is growing rapidly, and the world's resources are being used at an unsustainable rate. The world's population is projected to reach 9 billion by 2050. The world's population is projected to reach 9 billion by 2050. The world's population is projected to reach 9 billion by 2050.

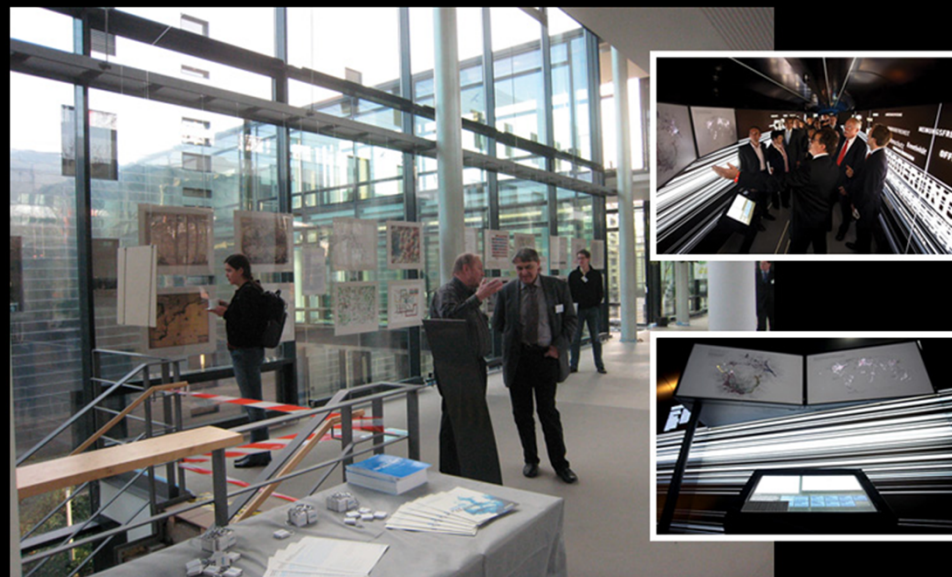


### The Millennium Development Goals and their human impact

- 1 End poverty and hunger**  
 Reduce by half, between 1990 and 2015, the proportion of people living on less than \$1 a day.  
 ■ Reduce by half the proportion of people who suffer from hunger.
- 2 Education for all**  
 Ensure that by 2015 children everywhere, boys and girls alike, will be able to complete a full course of primary schooling.
- 3 Equality for women**  
 Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015.
- 4 Save children's lives**  
 Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate.
- 5 Make motherhood safe**  
 Reduce the maternal mortality ratio by three-quarters between 1990 and 2015.
- 6 Stop HIV/AIDS, malaria and other diseases**  
 Have halted by 2015 and begin to reverse the spread of HIV/AIDS. ■ Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases.
- 7 Protect the environment**  
 Integrate the principles of sustainable development into country policies and programs, and reverse the loss of environmental resources. ■ Reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation. ■ Achieve significant improvement in the lives of at least 100 million slum dwellers by 2020.
- 8 Build a global partnership for development**  
 Address needs of the least developed countries. ■ Further develop an open trading and financial system. ■ Deal comprehensively with developing countries' debt. ■ Develop job strategies for youth. ■ Provide access to affordable essential drugs in developing countries. ■ Make available new technologies, especially information and communications.

The Millennium Development Goals Map - The World Bank and National Geographic - 2006

# Exhibit Venues



December 11-19, 2008, Center of Advanced European Studies and Research, Bonn, Germany

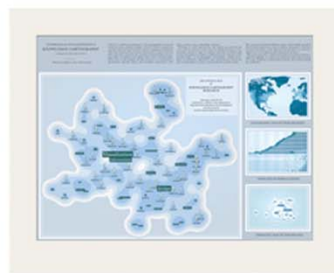
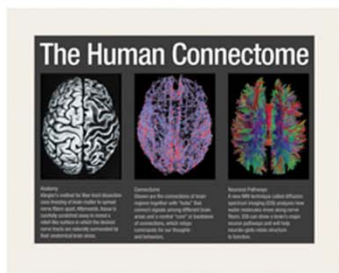
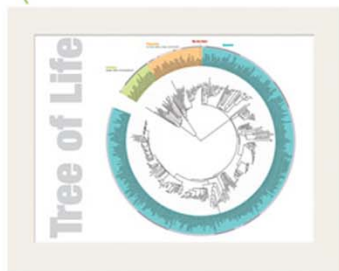


April 15 - December 18, Stanford University, Stanford, CA. May 18 - debut of 5th iteration. Courtesy of Media X, Stanford University

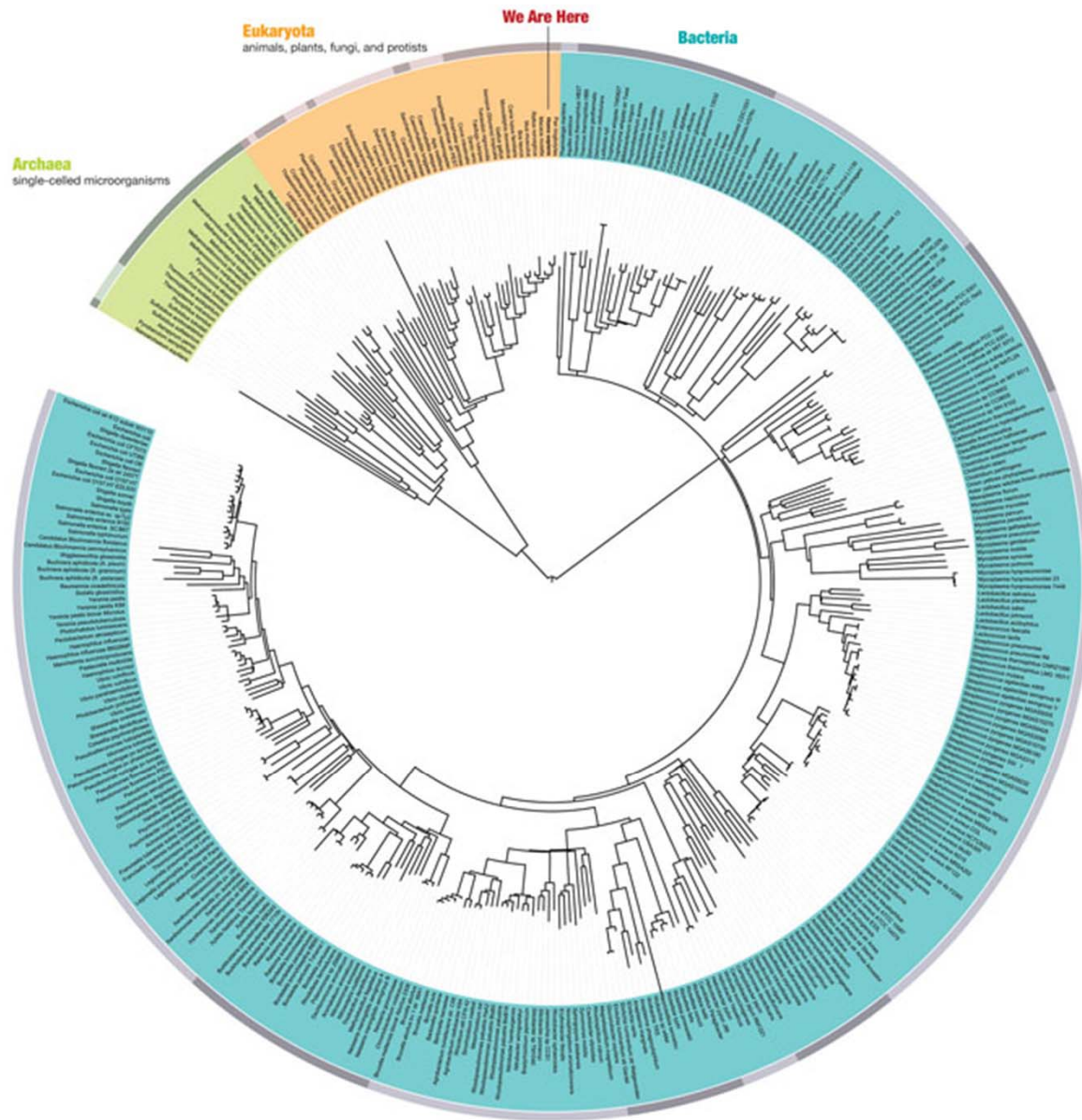


2005 - Present  
1st iteration on display at NSF, Washington, D.C.

# SCIENCE MAPS FOR SCHOLARS 2010



# Tree of Life



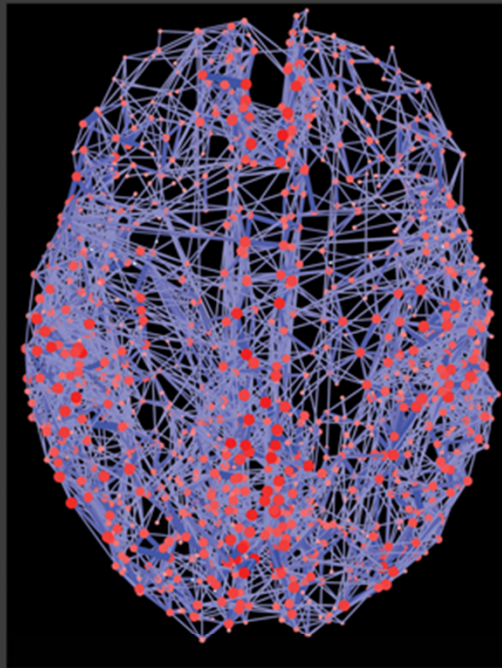
*Tree of Life* - Peer Bork, Francesca Ciccarelli, Chris Creevey, Berend Snel & Christian von Mering - 2006

# The Human Connectome



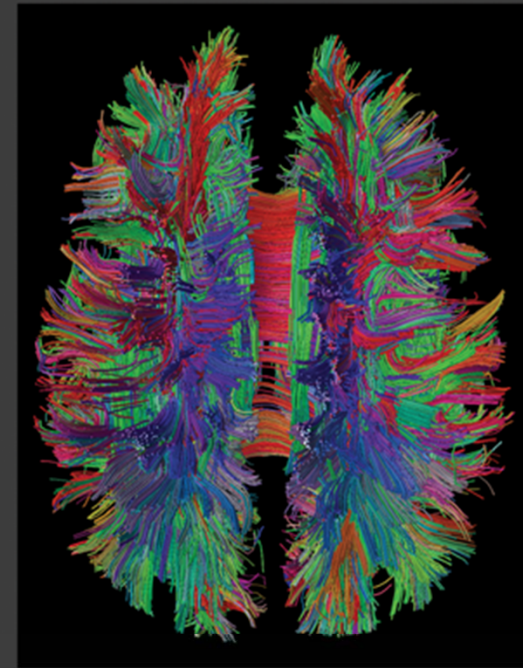
## Anatomy

Klingler's method for fiber tract dissection uses freezing of brain matter to spread nerve fibers apart. Afterwards, tissue is carefully scratched away to reveal a relief-like surface in which the desired nerve tracts are naturally surrounded by their anatomical brain areas.



## Connectome

Shown are the connections of brain regions together with "hubs" that connect signals among different brain areas and a central "core" or backbone of connections, which relays commands for our thoughts and behaviors.



## Neuronal Pathways

A new MRI technique called diffusion spectrum imaging (DSI) analyzes how water molecules move along nerve fibers. DSI can show a brain's major neuron pathways and will help neurologists relate structure to function.





# Diseasome

## The Human Disease Network

Explore online at <http://diseasome.eu>

### Statistics

# of Nodes: 516  
# of Edges: 1188  
Density: 0,0089  
Average Degree: 9,20  
Diameter: 15  
Average Shortest Path: 6,5

### Top 5 Diseases

1. Deafness
2. Leukemia
3. Colon Cancer
4. Retinitis Pigmentosa
5. Diabetes Mellitus

### Top 5 Genes

1. TP53
2. PAX6
3. FGFR2
4. RTN
5. MSH2

### Description

The map presents a network of 526 diseases linked by 1188 known disorder-gene associations, indicating the common genetic origin of many diseases.

#### MAP VISUAL CLUES

The map offers a rapid visual reference of the genetic links between disorders and a valuable global perspective for physicians, genetic counselors, and biomedical researchers alike. This new approach may lead to entirely different insights regarding the actual causes of disease, improve the understanding of the causes of disease, and the functions of particular genes.

#### NETWORK RESOLUTION VISUAL CLUES

The map was done using the force-directed layout algorithm ForceAtlas in Gephi. Node color corresponds to the disorder class to which the disease belongs, and the size is proportional to its node degree, the overall number of links. Link's width is proportional to the number of genes that are involved in both diseases and colored with the average color between source and target nodes. Isolated diseases are not shown and only the largest component has been kept. The Clusters Menu may label most remarkable disorder clusters and shows largest visual clusters.

The Disorder Class Interactions graph below shows the interaction level between disorder classes, representing the number of shared genes, up to 80.

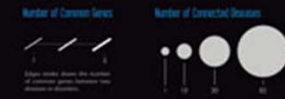
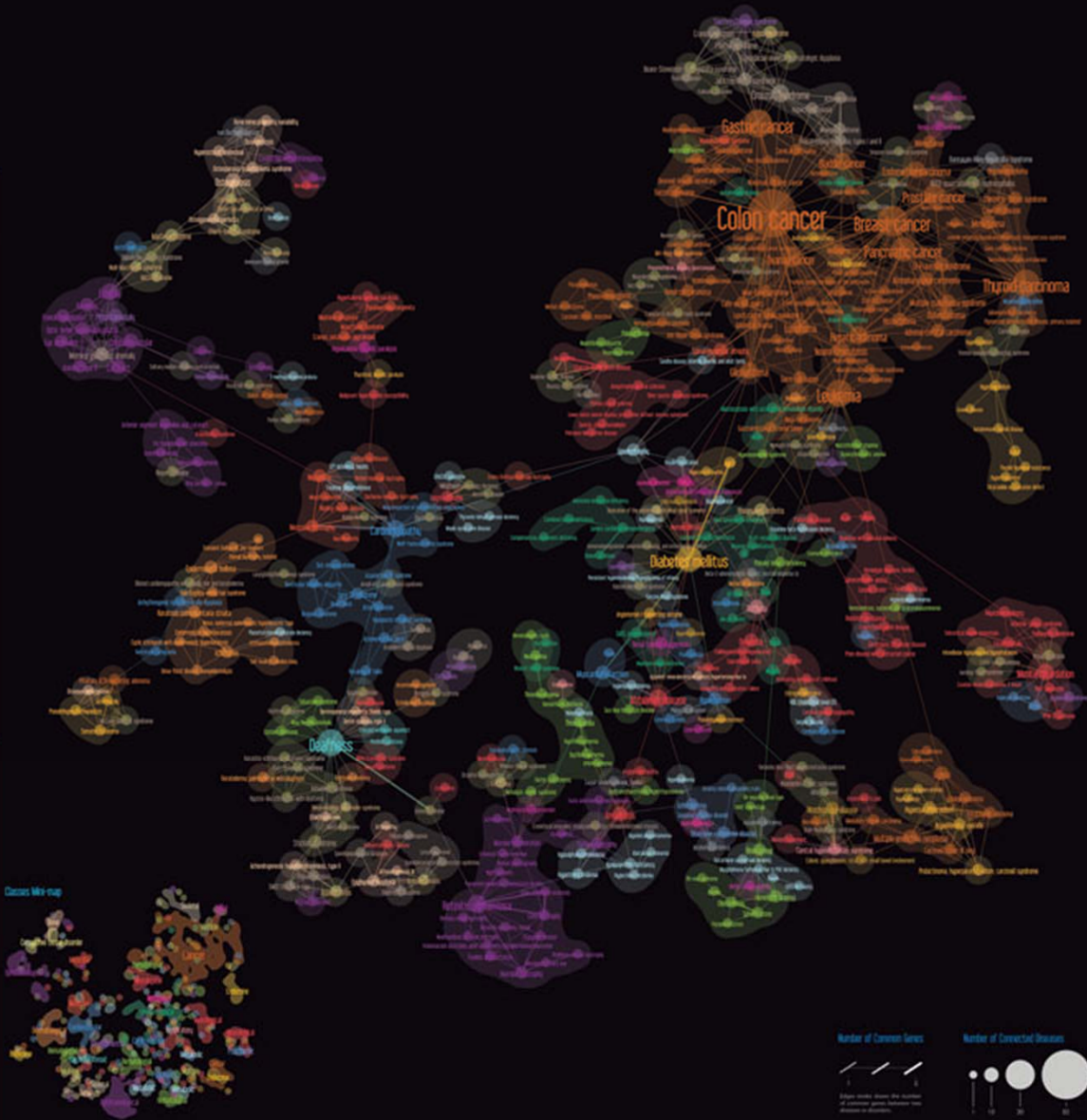
#### NOTES

The Human Disease Network  
Mathieu Bastian, Mathieu Heymann, Sébastien Heymann  
Bast M, Heymann M, Heymann S. *Nature Reviews Genetics* 8:4 (2007)  
First published online 2007-04-23

### Disorder Class

- Cancer
- Endocrine
- Ear, Nose, Throat
- Ophthalmological
- Neurological
- Hematological
- Cardiovascular
- Muscular
- Immunological
- Dermatological
- Nutritional
- Connective Tissue Disorder
- Renal
- Psychiatric
- Metabolic
- Bone
- Skeletal
- Developmental
- Gastrointestinal
- Respiratory
- Multiple
- Unclassified

### Disorder Class Interactions



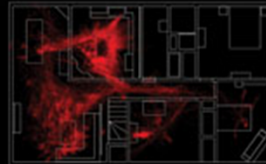
# HUMAN SPEECH HOME PROJECT



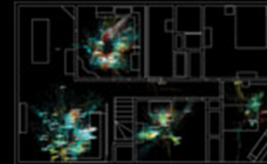
Camera locations



Views from 9 cameras



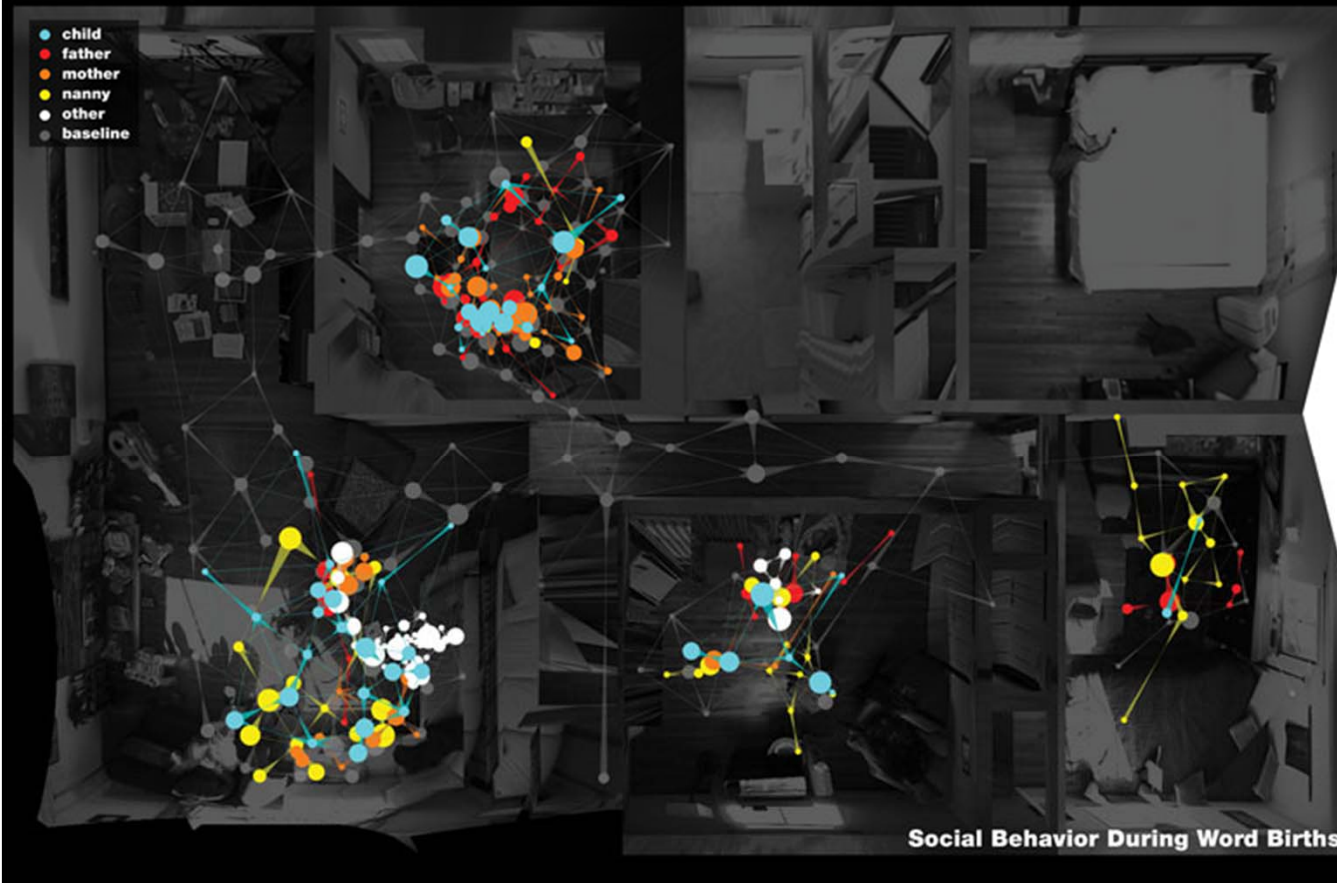
Individual movement traces



50 word birth locations and tracks



Baseline movement patterns throughout the home



Social Behavior During Word Births

Language is one of the defining features of the human species, unique in its compositional structure and referential capacity, critical for creation and transmission of cultural knowledge, devastating to an individual when impaired or lost. For all that is at stake, our current understanding of how children learn language is grounded in surprisingly incomplete and biased observational data. As a consequence, many promising theories of language acquisition remain vaguely articulated, contradictory, and untested. More precise and empirically validated theories would shed light on central aspects of human cognition, guide new ways for children to learn, and lead to effective treatment of language disorders.

A critical bottleneck in the study of language acquisition is the quality of naturalistic observational recordings of child development available to researchers. Although young children's language skills change rapidly from day to day, typical naturalistic studies of child development are based on observations spaced weeks or months apart. Furthermore, most home recordings of child development consist of speech recordings and/or speech transcriptions but lack any record of non-linguistic situational context. Children of course learn language by connecting words to the people, things, and activities around them. Thus, recording only speech produces an incomplete picture.

To address these concerns, four years ago we launched the Human Speechome Project with the goal of making a comprehensive and unbiased record of one child's development at home. We have completed the recording phase of the project, yielding the Speechome corpus of approximately 90,000 hours of video and 140,000 hours of audio recordings spanning the child's life from birth to age three. Analysis is currently underway, and the images shown here represent a small piece of this early analysis.

**Camera locations.** Shown are the locations in the home (second floor only) of 6 (of 11) video cameras.

**Views from 9 cameras.** Cameras utilize fisheye lenses for full coverage of the space.

**Individual movement traces.** Objects in the video are tracked automatically, with their locations stored over time.

**50 word birth locations and tracks.** A word birth occurs each time the child produces a word for the first time. Tracks are classified automatically as to the identity of the subject being tracked. With transcripts of what was said in the house correlated with identified tracks, word birth locations can be derived.

**Baseline movement patterns throughout the home.** This image shows a "star graph," a visualization intended to capture the behavioral topology of a subject's movement through a space. The star graph here represents the aggregate movement patterns of all people in the home during approximately 1000 minutes of video.

**Social behavior during word births.** The behaviors, in particular the movement of caregivers in relation to the child during word births might lead to a better understanding of the dynamics of these word births. By overlaying star graphs for each of the people present in the home during word births, we can get a sense of the social dynamics surrounding the acquisition of a new word by the child. The large image shows star graphs generated for the child, 3 caregivers, and all other adults present during 50 word births. We can see, for example, that the child learned many words in the kitchen while in the presence of his mother and father, and moved around little during these events. In the living room, however, the child moved around more freely, and was more often in the presence of the nanny during word births.

# MAPPING THE ARCHIVE: PRIX ARS ELECTRONICA

<http://vis.mediaartresearch.at>

## SUBMISSIONS



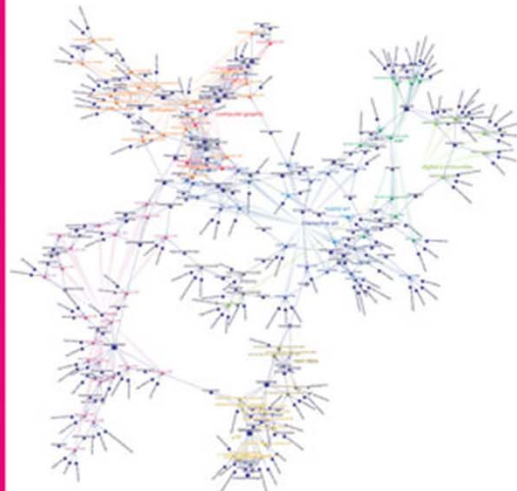
Hier präsentieren wir die Gesamtheit aller 37.432 Werke, die jemals zum Prix Ars Electronica von Künstlern aus aller Welt eingereicht worden sind. Nur die wenigsten haben freilich einen Preis gewonnen, der Rest verschwand im Archiv. Wir haben diese wertvollen Daten jetzt aufbereitet und zugänglich gemacht.

Die Zuordnung der Einreichungen zu den sich über die Jahre ändernden Prix Kategorien, den Heimatländern der Künstler und den Prix Jahrgängen erlaubt es nicht nur, die Historie des Preises Revue passieren zu lassen, sondern auch Hypothesen über die Mechanismen der "Welt der Ars" zu generieren.

Here we present the entire number of 37,432 art works and projects that have been submitted to the Prix Ars Electronica by artists from all over the world. Obviously only a fraction was awarded and the rest has disappeared in the archive. We have examined and edited this valuable data and made it accessible.

The assignment of the submissions to the Prix categories (which have changed over the years), to the countries of residence, and the Prix years, allows not only for a review of the history of the Prix, but reveals also hypotheses on the mechanisms of the "Ars world".

## JURY PROCESS



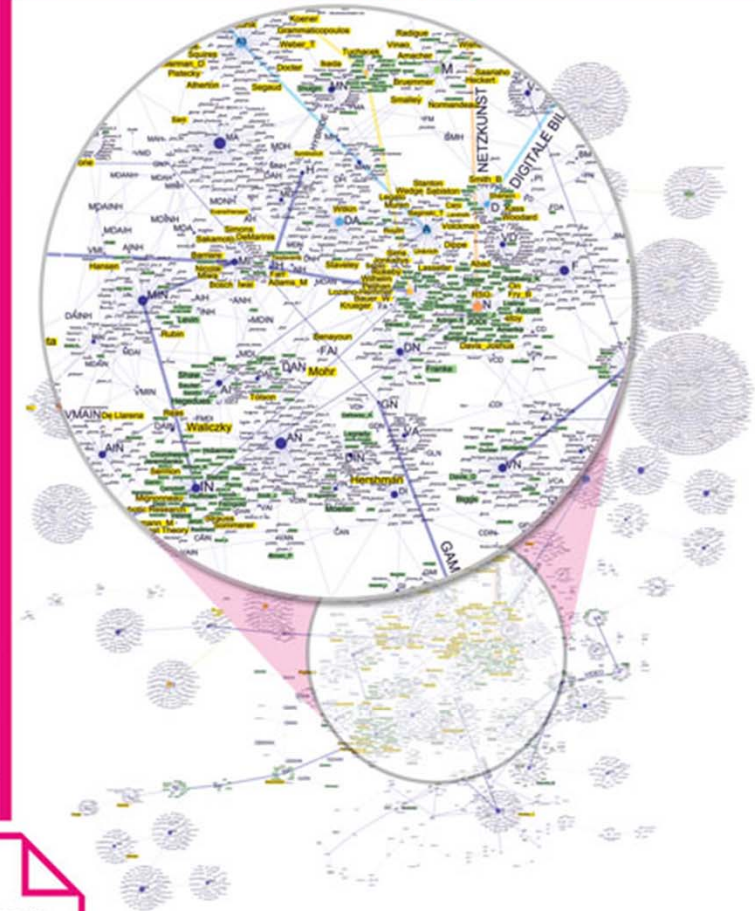
In den Jurysitzungen zur Ermittlung der Gewinnerprojekte sieht man jedes Jahr neue und altbekannte Gesichter, und oft werden auch ausgezeichnete Künstler in den folgenden Jahren als Juroren eingeladen. Ein Blick auf das entstandene soziale Netzwerk enthält so manche Erkenntnis.

Weiters verfasst die Jury für jedes Gewinnerprojekt ein Jurystatement – diese Statements sind über die Jahre zu einer großen Textsammlung angewachsen, die wir ebenfalls untersucht haben.

Each year a combination of new and recurrent jury members meet to identify the winning projects. Often the awarded artists from the previous year are invited as jury members. A social network has evolved over the years, which is here on display.

Furthermore the jury writes a statement for each winning project. Over the years, these statements have been growing into a large collection of texts, which are analyzed here.

## WINNERS



Besondere Aufmerksamkeit verdienen die Gewinner aus 23 Jahren Prix Ars Electronica - hier geht es nicht nur um Goldene Nicas, auch Honorary Mentions, Distinctions oder Special Prizes werden verliehen. Auch hier bergen die Daten aus dem Archiv bisher unbekannt Strukturen. Unsere Visualisierungen laden dazu ein, Verbindungen zwischen den Künstlern oder Ähnlichkeiten zwischen Kunstwerken zu entdecken.

The winning projects from 23 years of Prix Ars Electronica deserve special attention. It is not only about the Golden Nica but also Honorary Mentions, Distinctions and special prizes that have been awarded. The data from the archive conceal so far unknown structures. Our visualizations invite to explore connections between artists as well as similarities between art works.

## about

Das Projekt präsentiert die Ergebnisse einer interdisziplinären Untersuchung des Prix Ars Electronica Archivs in Form interaktiver und statischer Informationsvisualisierungen. Das Archiv wird dabei auf drei Ebenen betrachtet: zunächst die Gesamtheit der Einreichungen seit 1987 als quantitative Analyse (links), weiters der Juryprozess als soziale Netzwerkanalyse (mitte), schließlich die Gewinnerprojekte und ihre kunstwissenschaftliche Kontextualisierung (rechts). Das Projekt ist eine Zusammenarbeit des Ludwig Boltzmann Instituts für Medien.Kunst.Forschung und der Ars Electronica.

The project presents the result of a interdisciplinary study on the Prix Ars Electronica archive in the form of interactive and static visualization of information. The archive is examined on three different levels: at first a quantitative analysis of the entries at large since 1987 (left), then the jury process as a social network analysis (middle), and finally the winning projects in their art historic conceptualization (right). This project is a collaboration between the Ludwig Boltzmann Institute Media.Art.Research, and the Ars Electronica.

## legend

<span style="color: green;">■</span> Digital Communities	<span style="color: blue;">■</span> Interactive Art
<span style="color: green;">■</span> Net	<span style="color: brown;">■</span> uTS
<span style="color: orange;">■</span> Animation	<span style="color: brown;">■</span> Next Idea
<span style="color: red;">■</span> Computer Graphic	<span style="color: purple;">■</span> Music
<span style="color: blue;">■</span> Hybrid Art	<span style="color: darkgreen;">■</span> Theorie

FIGURES from an ATLAS of RESEARCH in  
**KNOWLEDGE CARTOGRAPHY**

as designed by MARCO QUAGGIOTTO

Politecnico di Milano, Italy. INDACO Dept.

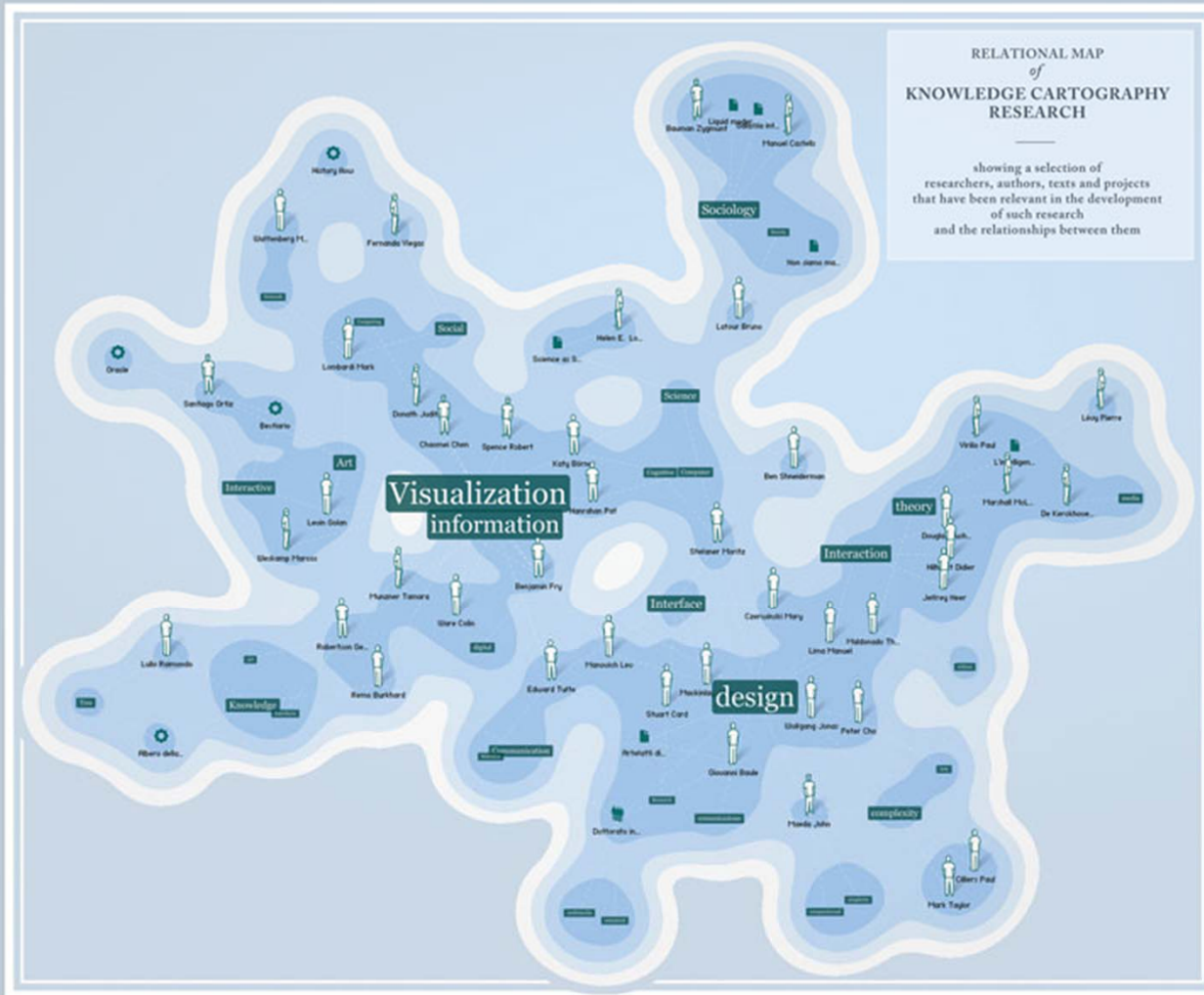
ATLAS is a software prototype for the management of research resources (texts, people, projects, events), aimed at supporting common tasks of research such as survey, mapping and analysis. The social nature of the software allows user to share resources with each other, discover the existence of potentially interesting studies or authors and explore other users' research maps. Every user of the system can add resources to a personal or shared list, describe them, and establish connections with

other resources (eg. authorship, citation).

Working on such repositories, the system can provide the users with an ATLAS of their research. Relational maps of researchers, thematic maps of authors, timelines of themes and events and maps of academic collaboration are only few of the possible maps. As in geographic cartography, careful operations of selections, disposition and representation allows the user-cartographer to create custom maps for specific needs.

The connection between different maps, traditionally served by print-based mechanisms such as indexes, geographic reference systems and tables, in the digital atlas becomes a set of techniques for the navigation and exploration of space.

This poster presents a selection of maps of research in Knowledge Cartography. As with every representation, none of them are either complete or absolutely accurate, all of them should be insightful.

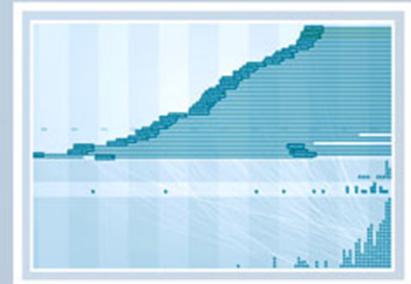


RELATIONAL MAP  
of  
KNOWLEDGE CARTOGRAPHY  
RESEARCH

showing a selection of  
researchers, authors, texts and projects  
that have been relevant in the development  
of such research  
and the relationships between them



GEOGRAPHIC MAP OF RESEARCHERS



TIMELINE OF PUBLICATIONS



THEMATIC MAP OF DISCIPLINES



# The EMERGENCE of NANOTECHNOLOGY

## MAPPING THE NANO REVOLUTION

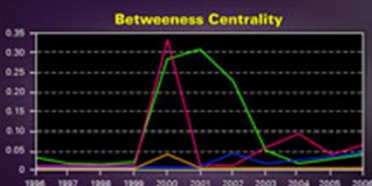
The emergence of nanotechnology has been one of the major scientific-technological revolutions in the last decade and it led to a structural reorganization of major fields of science. Price (1965) showed that fields of science and their development can be mapped using aggregated citations among the journals in the fields and their relevant environments.

The frames to the right show the evolving journal citation network for the years 1998-2003. Distances are proportional to cosine values between the citation patterns of the respective journals. Textual descriptions of key events during the development of *Nanotechnology* are given below each frame. Most notably, leading papers in *Science* and *Nature* catalyzed the breakthrough around 2000.

## CHANGING ROLES OF DIFFERENT JOURNALS

The interdisciplinarity of a journal can be measured using betweenness centrality (BC)—journals that occur on many shortest paths between other journals in a network have higher BC value than those that do not. In the maps, sizes of nodes are proportional to the betweenness centrality of the respective journal in the citation network.

From being a specialist journal in applied physics, the journal *Nanotechnology* obtains a high BC value in the years of the transition, ca. 2001. This is preceded by the "intervention" of *Science*. After the transition, the new field of nanotechnology is established, new journals such as *Nano Letters* published by the influential American Chemical Society take the lead, and a new specialty structure with low BC value journals results.



An animated sequence of this evolution is at: <http://www.leydesdorff.net/journals/nanotech>.

## References

Laydesdorff, L. and T. Schank, 2008. Dynamic Animations of Journal Maps: Indicators of Structural Change and Interdisciplinary Developments. *Journal of the American Society for Information Science and Technology*, 59(11), 1810-1818.

Price, Derek J. de Solla (1965). Networks of scientific papers. *Science*, 149, no. 3683, 510-515.

**1998**

During the period 1996-2000, the journal *Nanotechnology* is part of a group of journals in applied physics.

**1999**

Increasingly, chemistry journals play a role in the citation impact environment of the journal *Nanotechnology*.

## LEGEND

- Science
- Nature
- Nanotechnology
- Nano Letters

## Values

- 0.8
- 0.22
- 0.33

**2003**

The journal *Science* is relevant in the citation impact environment, but now functions as one of the specialist journals in nanotechnology. *Nanoscience* further develops as an increasingly integrated network of journals.

**2002**

Other journals in nanoscience and technology begin to emerge, and the bridging role of the journal *Nanotechnology* gradually subsides. *Nano Letters* and the *Journal of Nanoscience and Nanotechnology* join the new field of nanotechnology.

**2000**

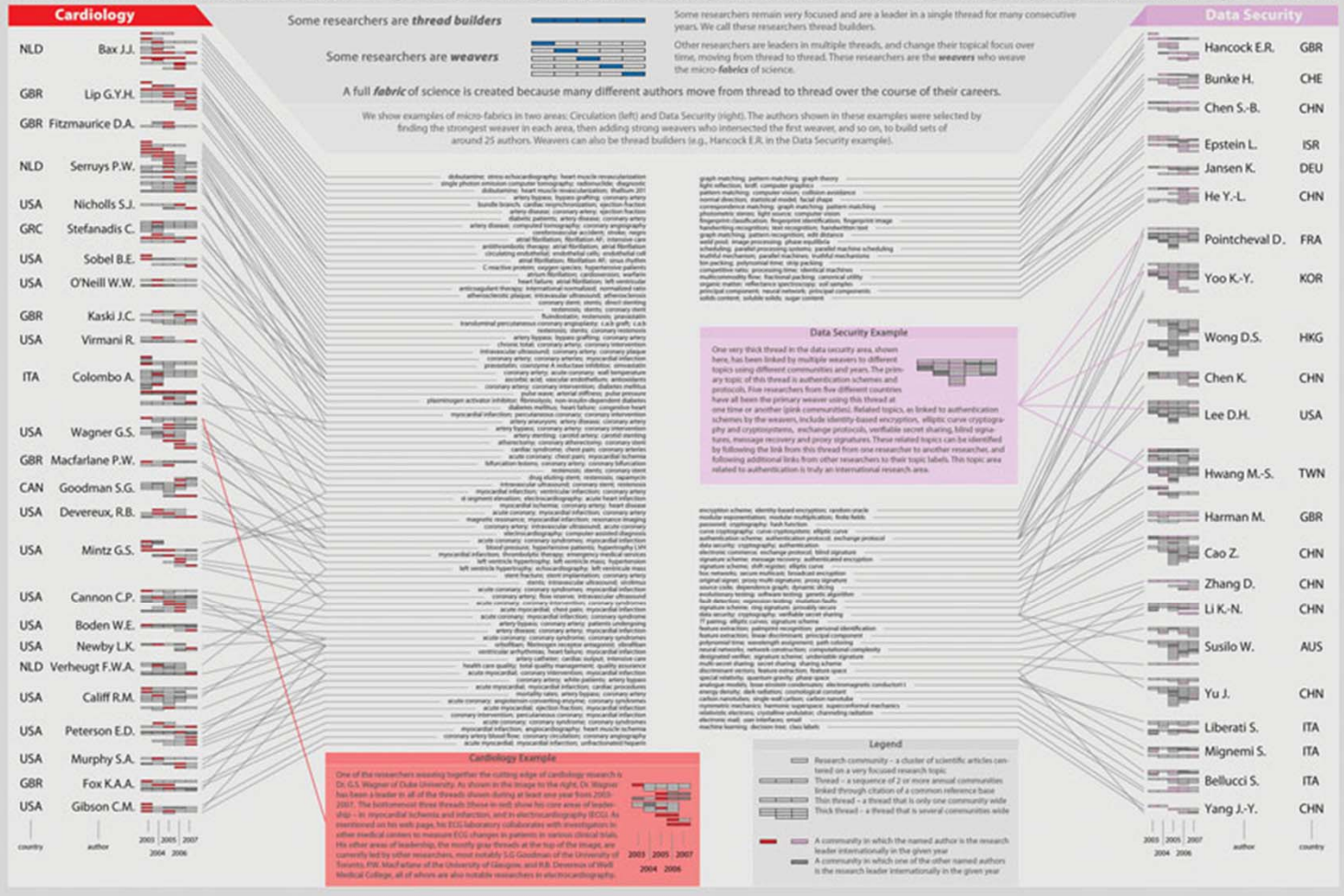
The journal *Science* interfaces with relevant journals in both sets: chemistry and applied physics. *Nanotechnology* emerges as core journal.

**2001**

The journal *Nanotechnology* now provides the interface between chemistry and physics. The "intervention" by *Science* is no longer needed.

# WEAVING THE FABRIC OF SCIENCE

Many people assume that there is a web of science. Our analysis illustrates that the structure of science is much more like a fabric than a web. This conclusion is based on an analysis of the scientific literature: we model how science is structured and how it changes over time. Using co-citation analysis, we create annual models of science. Each annual model clusters around 2 million reference papers, and then assigns the articles from that year and the four previous years to those clusters. Each annual model contains 80 to 90 thousand such clusters, and around 6 million recent articles. Each cluster is called a research community. To create the fabric of science we link or weave research communities in two different ways. First, communities from annual models are linked sequentially in time using overlap of common references. These common references are like **fibers** that can be twisted together into **threads**; this is what researchers do inherently through their citing practices. Our time-linked sets of communities are called **threads**, and are shown as the sequences of linked rectangles in the images to the left and right. Threads can be thin or thick depending on the citation structure. The second way we link communities is longitudinally by leading researchers. We identify the leading researchers in each thread.



## Labor Statistics

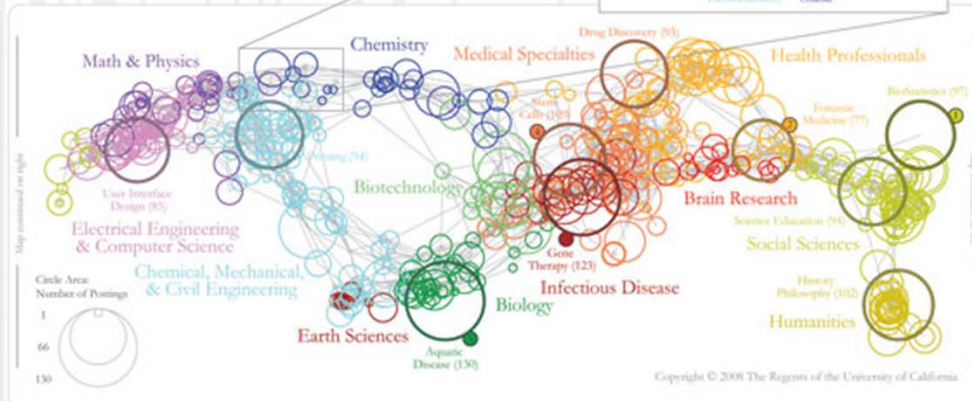
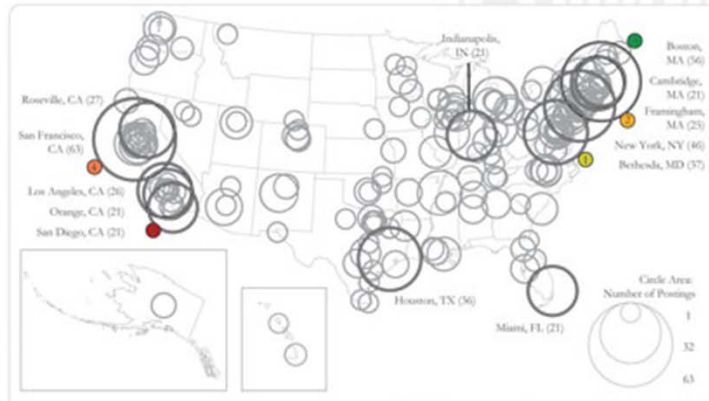
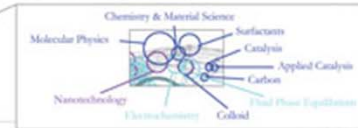
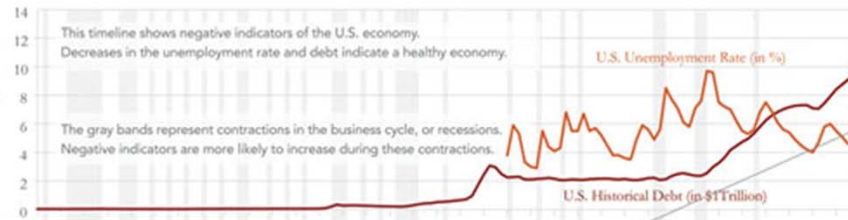
From the start of the recession in December 2007 through the end of 2009, more than 8 million jobs were lost in the United States. In October 2009, the U.S. unemployment rate peaked at 10.1 percent (after adjustment for seasonal variations). In April 2010, unemployment was still at 9.9 percent. In May 2010, about 6.8 million individuals, or 46 percent of those unemployed, had been unemployed for at least 27 weeks. Each month, 100,000 people enter the U.S. labor market—including high school and college graduates. They join 15 million Americans looking for work.

Unemployment rates are calculated and adjusted by the Bureau of Labor Statistics within the U.S. Department of Labor and reported in their monthly Economic News Release on the Employment Situation. Historical employment data, including unemployment rates with and without seasonal adjustment and divided by individual characteristics and employment sectors, are also available from the Bureau of Labor Statistics.

# U.S. Job Market: Where are the Academic Jobs?

## General Trends

The charts to the left show annual national economic indicators. These indicators serve as background data; they flow beneath and around more specific analyses of the job market. Business cycle data come from the National Bureau of Economic Research. Historical debt data come from the U.S. Department of Treasury. Unemployment rates come from the Bureau of Labor Statistics. GDP data come from the Bureau of Economic Analysis. Stock Price Index data come from the research of Dr. Robert Shiller at Yale University Department of Economics. Individual conversion factors (compiled from Bureau of Labor Statistics Consumer Price Indices by the Oregon State University Political Science Department) were applied where appropriate.



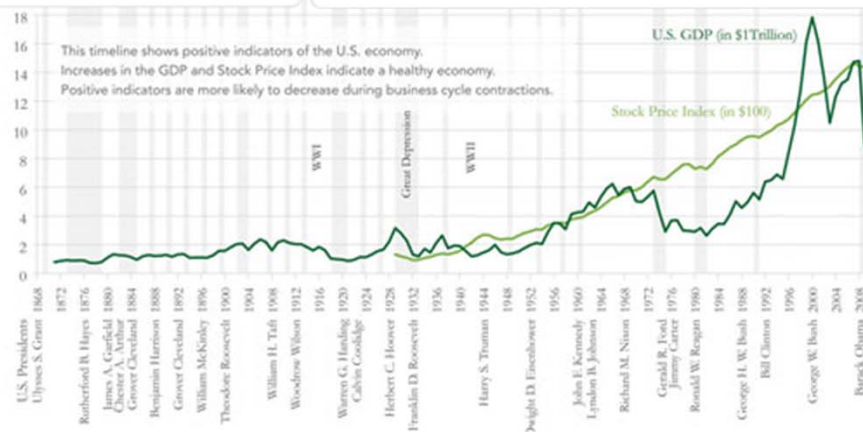
- Sample Jobs**
- Bioinformatics Programming Support NIH NIGMS (Bioinformatics, Bethesda, MD)
  - Boston Site Lead Musculoskeletal Diseases (Genetic Medicine, Boston, MA)
  - Associate Scientist II Mouse Neuron Genomics (Gene Therapy, San Diego, CA)
  - Scientist Early Stage Cell Culture (Stem Cells, San Francisco, CA)
  - Post doctoral Training in Mammalian Genetics (Aquatic Disease, Bar Harbor, ME)

## Geospatial Map

Using U.S. city and state information, circles are placed over the location of the job postings and are sized in relation to the number of postings listed for that location. The top-10 cities with the highest number of postings are labeled, and the number of postings is given in parentheses.

## Where are the Academic Jobs?

Over 3,500 jobs posted between July 2008 and February 2009 on Nature Jobs were collected and analyzed. The two maps above show the 1,037 job postings located in the U.S. and represent a directed study of the job market that sits on top of larger trends over time.



## Topic Map

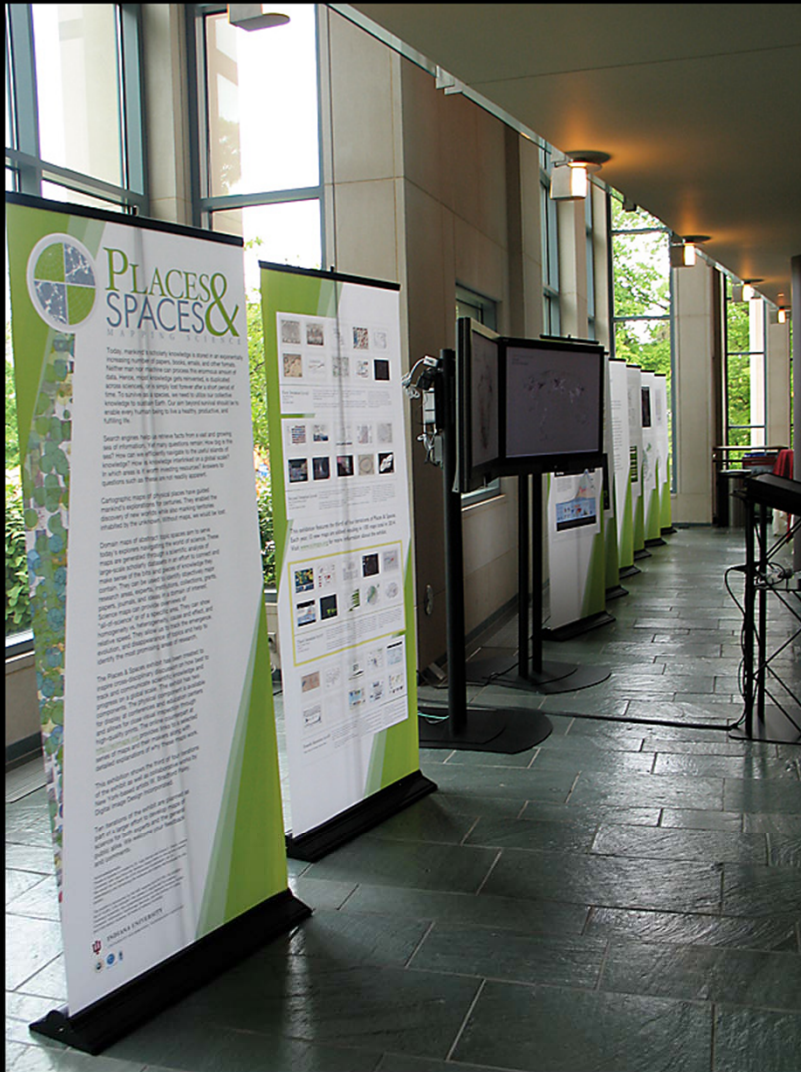
How many and what jobs are available in which scientific area? The UCSD Map of Science used here was created by analyzing 7.2 million papers published in over 16,000 separate journals, proceedings, and series from Thomson Scientific and Scopus over the five year period from 2001 to 2005.

Using a hierarchical, multi-step clustering procedure, journals were grouped into 554 clusters based on common word usage and shared references (bibliographic coupling). In the map, each cluster is represented by a node, and links denote strong bibliographic coupling relations. The 554 clusters are further grouped into 13 color coded scientific disciplines.

The 1,037 jobs were overlaid based on word matches in their description and keywords associated with each of the 554 nodes. Like in the geospatial map, circle area sizes correspond to the number of jobs posted.

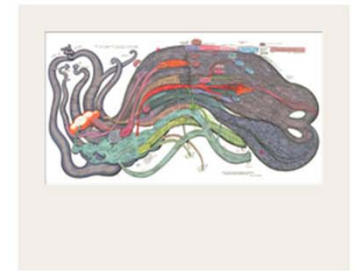
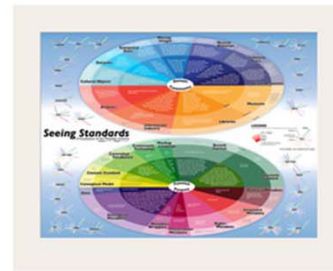
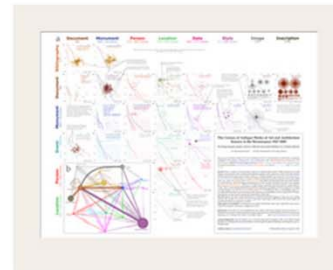
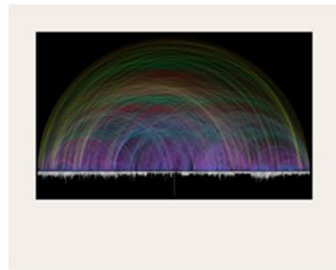


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**[scimaps.org](http://scimaps.org)** for  
more information.

# SCIENCE MAPS AS VISUAL INTERFACES TO DIGITAL LIBRARIES 2011



# MONDOTHÈQUE

A MULTIMEDIA DESK IN A GLOBAL INTERNET

Paul Otlet (1868-1944), visionary Belgian lawyer fascinated by the problems of access to global knowledge, is often acknowledged as a pioneer of the Internet. His design of 1936 for a multimedia desk for home use, the Mondothèque, integrated access to new documentary formats including multimedia substitutes for traditional books involving all available communications technologies such as microfilm, gramophone, radio and TV. A major resource was a new form of visual encyclopedia, the Encyclopedia Universalis Mundaneum. Connected by the Mondothèque to a network of global collections (Species Mundaneum), the user could access and engage in the international production and dissemination of knowledge.

**Paul Otlet  
Mondothèque**  
June 8, 1936 | 64 x 67 cm  
Pen and ink on transparent paper  
EUM Affiches 8141  
© Mundaneum Mons Belgium

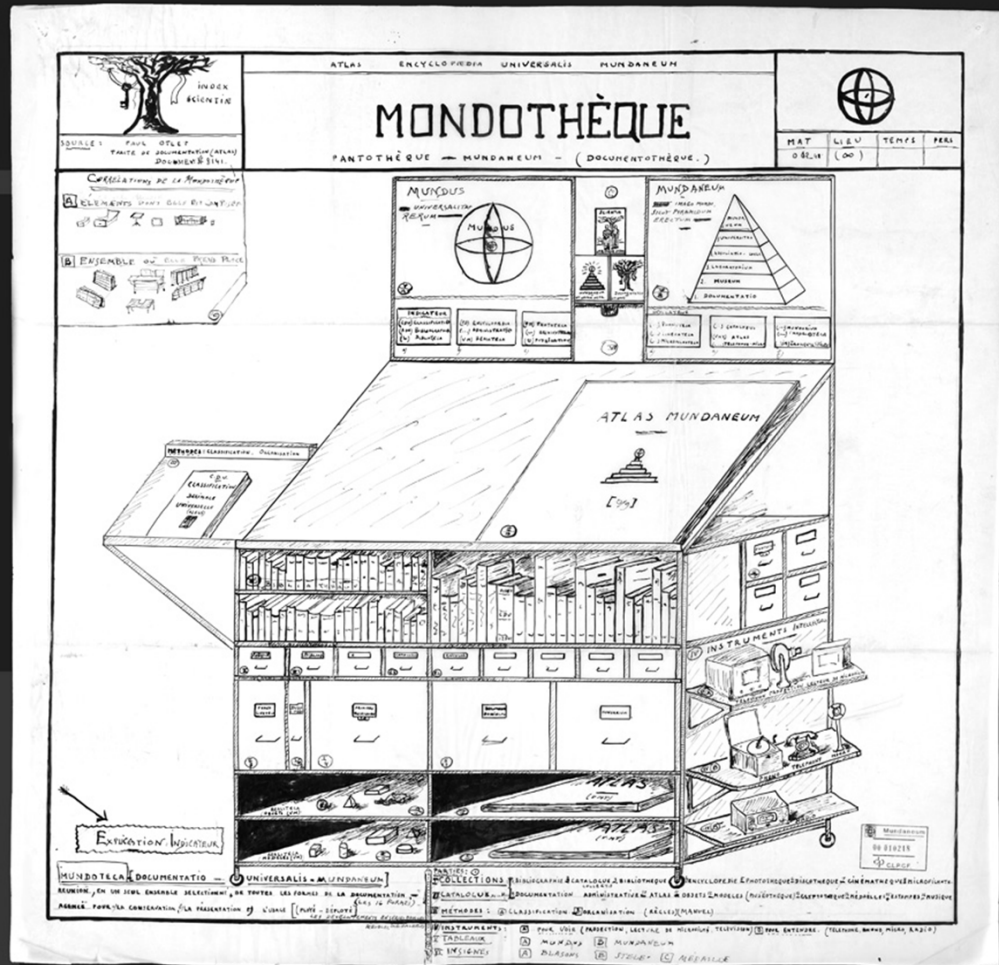
The Mondothèque is a multimedia desk with spaces for essential books, with atlases in the form of visual encyclopedia, for small (museum) objects and with drawers for bibliographical cards and microfilms ordered according to the rules of his Universal Decimal Classification system. On its shelves sit communication and broadcasting instruments, such as radio, telephone, television and film equipment.

\*Otlet's original drawing is on light grey tracing paper. It has been lightened here for legibility and printing purposes.



**Paul Otlet  
Species Mundaneum**  
January 16, 1937 | 21 x 28 cm  
pen and ink on transparent paper  
EUM 8504  
© Mundaneum Mons Belgium

Text: Mondothèque. A multimedia desk in a global internet  
Charles van den Heuvel, Huygens ING (KNAW), The Hague & W. Boyd Raymond, University of Illinois, Urbana-Champaign  
Acknowledgment: Stéphanie Manfroid, Mundaneum, Mons  
Graphic Design: Janet Armstrong BNO | Armstrong Design, Maastricht, NL with the collaboration of Michael J. Stamper



## MUNDOTECA [Documentatio-Universalis-Mundaneum]

BRINGING TOGETHER OF ALL KINDS OF DOCUMENTATION - (THE 16 KINDS) IN A SINGLE ORDERED GROUPING  
An agency for a) conservation, b) presentation, c) use (specific or general) - systematic developments in furniture, buildings, galleries.

### COMPONENTS

- I. COLLECTIONS: 1 Bibliography • 2 Union Catalogue • 3 Library • 4 Encyclopedia • 5 Photographic library • 6 Music library • 7 Film library • 8 Microfilm library • 9 Administrative Documentation • 10 Atlas [collection of maps, engravings, charts, graphic representations] • 11 Objects • 12 Models [library of museum objects] • 13 Sculpture collection • 14 Medals • 15 Prints • 16 Music
- II. CATALOGUES: of the Mundaneum for all 16 kinds of documentation
- III. METHODS: A Classification • B Organisation (Rules, Manual)
- IV. INSTRUMENTS: A To see with [Projection, Microfilm reader, Television] • B To hear with [Telephone, Phonograph, Microphone, Radio]
- V. CRAFTS and LABELS: A Mundus • B Mundaneum
- VI. INSIGNIA: A Coats of Arms • B Stele [Stone monuments] • C Coins

# TWO CHARTS ILLUSTRATING SOME OF THE RELATIONS BETWEEN THE BRANCHES OF NATURAL SCIENCE & TECHNOLOGY BY H.J.T. ELLINGHAM. 1948



FIGURE PAGE 402 OVERLAY 1

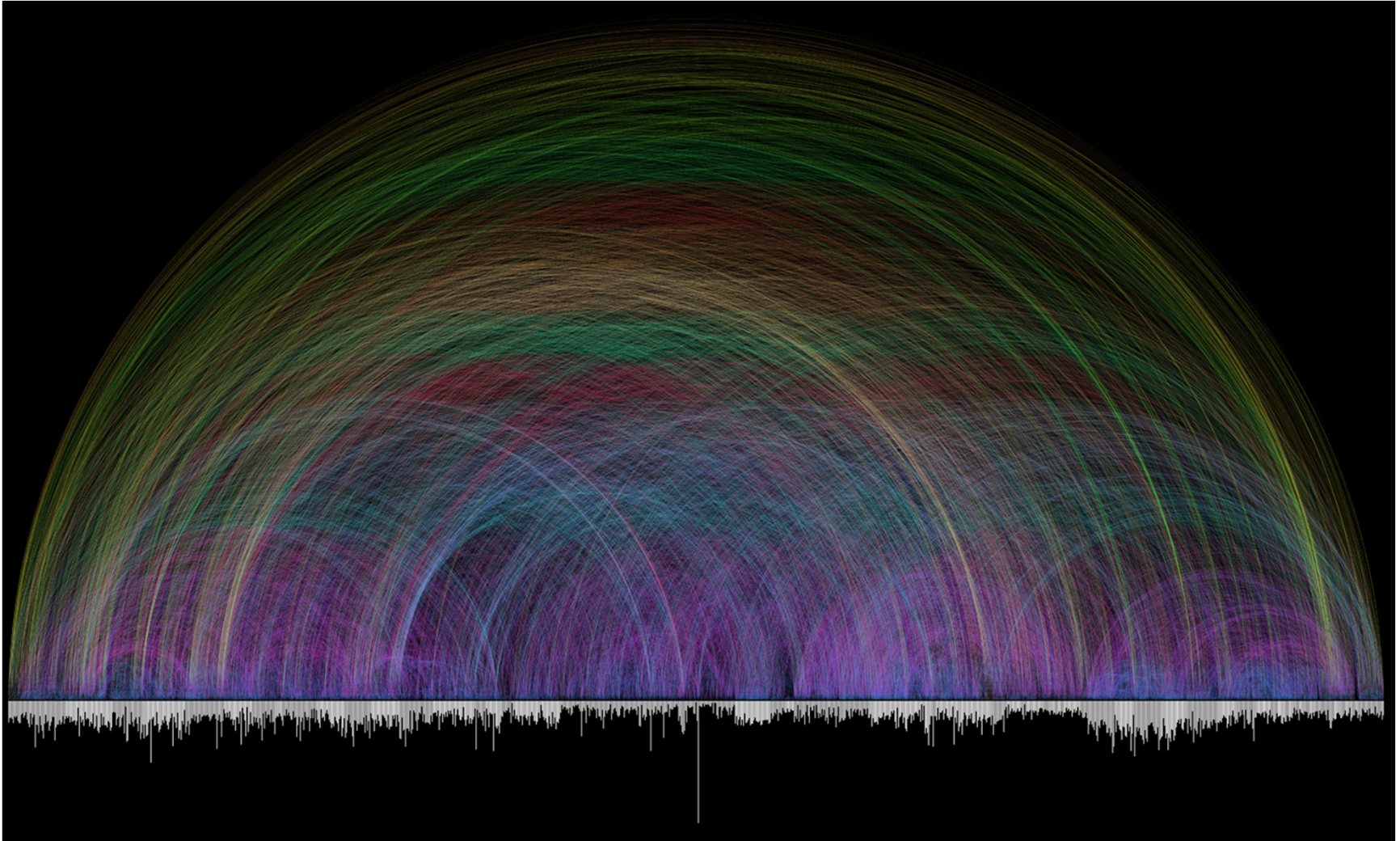
- ABSTRACTS OR GROUPS OF ABSTRACTS COVERING A VERY WIDE FIELD (OVERLAY 1)**
- Science Abstracts (Joint Board of the Institution of Electrical Engineers and the Physical Society).
    - Physics Abstracts.
    - Electrical Engineering Abstracts.
  - British Abstracts (The Bureau of Abstracts representing the Chemical Society, the Society of Chemical Industry, the Pharmaceutical Society, the Institution of Chemical Engineers, the Institution of Mechanical Engineers, the Institution of Civil Engineers and the Institution of Chemical Engineers).
    - General, Physical and Organic Chemistry.
    - Applied Chemistry.
    - Physical Chemistry, Biochemistry, Analytical Chemistry.
    - Chemical Engineering and Industrial Processes, including Metallurgy.
    - Industrial Paper Chemistry.
    - Agriculture, Food and Nutrition.
    - Analysis and Assays.
  - Commonwealth Agricultural Bureau Abstracts (Separate Abstracts for the individual sets of Abstracts—usually under a Country Code).
    - United Kingdom (Commonwealth Bureau of Soil Science).
    - Plant Breeding, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Pathology, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Physiology, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Production, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Nutrition, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Diseases, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Insects, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Pathology, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Physiology, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Production, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Nutrition, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Diseases, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
    - Plant Insects, Abstracts (Commonwealth Bureau of Plant Breeding and Genetics).
  - Engineering Abstracts (Division of Civil Engineers with the co-operation of other engineering institutions in Great Britain and the Dominion).
    - Engineering Abstracts for Abstracts since 1939-40.
    - Abstracts Engineering for Abstracts since 1939-40.
    - Abstracts Engineering for Abstracts since 1939-40.
    - Abstracts Engineering for Abstracts since 1939-40.



FIGURE PAGE 401 OVERLAY 2

- OTHER SETS OF ABSTRACTS (OVERLAY 2)**
- Journal of the Institute of Biology.
  - Journal of the Institute of Physics.
  - Journal of the Institute of Chemistry.
  - Journal of the Institute of Mechanical Engineers.
  - Journal of the Institute of Civil Engineers.
  - Journal of the Institute of Chemical Engineers.
  - Journal of the Institute of Electrical Engineers.
  - Journal of the Institute of Mining Engineers.
  - Journal of the Institute of Agricultural Engineers.
  - Journal of the Institute of Veterinary Surgeons.
  - Journal of the Institute of Forestry.
  - Journal of the Institute of Horticulture.
  - Journal of the Institute of Botany.
  - Journal of the Institute of Zoology.
  - Journal of the Institute of Medicine.
  - Journal of the Institute of Surgery.
  - Journal of the Institute of Pharmacy.
  - Journal of the Institute of Biochemistry.
  - Journal of the Institute of Microbiology.
  - Journal of the Institute of Pathology.
  - Journal of the Institute of Anatomy.
  - Journal of the Institute of Physiology.
  - Journal of the Institute of Nutrition.
  - Journal of the Institute of Food Science.
  - Journal of the Institute of Food Technology.
  - Journal of the Institute of Food Preservation.
  - Journal of the Institute of Food Packaging.
  - Journal of the Institute of Food Distribution.
  - Journal of the Institute of Food Consumption.
  - Journal of the Institute of Food Safety.
  - Journal of the Institute of Food Quality.
  - Journal of the Institute of Food Security.
  - Journal of the Institute of Food Stability.
  - Journal of the Institute of Food Shelf Life.
  - Journal of the Institute of Food Spoilage.
  - Journal of the Institute of Food Preservation.
  - Journal of the Institute of Food Packaging.
  - Journal of the Institute of Food Distribution.
  - Journal of the Institute of Food Consumption.
  - Journal of the Institute of Food Safety.
  - Journal of the Institute of Food Quality.
  - Journal of the Institute of Food Security.
  - Journal of the Institute of Food Stability.
  - Journal of the Institute of Food Shelf Life.
  - Journal of the Institute of Food Spoilage.

A Chart Illustrating Some of the Relations between the Branches of Natural Science and Technology - H.J.T. Ellingham - 1948



*Visualizing Bible Cross-References* - Chris Harrison and Christoph Römheld - 2008

# Finding RESEARCH LITERATURE on Autism

## A Comparison of Four Bibliographic Databases

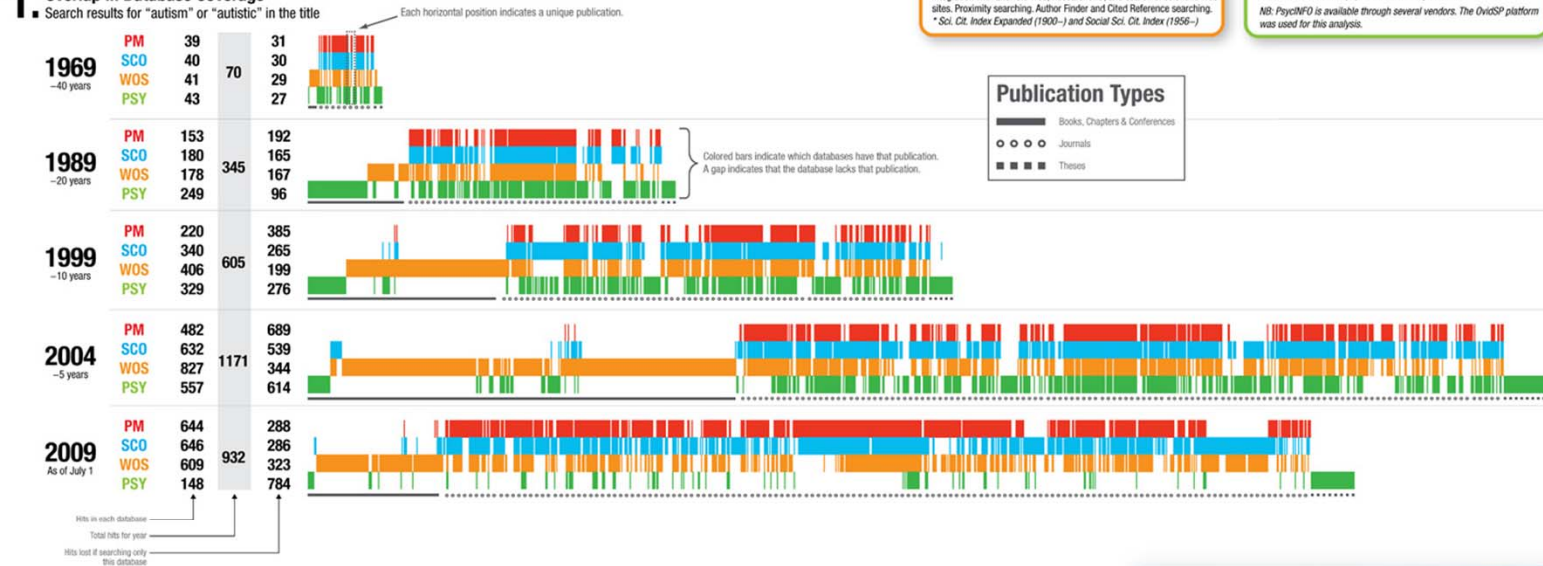
**PubMed® (PM)**  
**Records:** 19 million  
**Scope:** Emphasis on biomedicine and health journals. Primarily MEDLINE database plus selected other records, 1949–present.  
**Producer:** National Center for Biotechnology Information, National Library of Medicine, NIH  
**Selected features:** Free. Links to other NCBI resources (e.g., Entrez Gene), MeSH indexing, Automatic mapping of queries to MeSH terms and narrower concepts.

**Scopus™ (SCO)**  
**Records:** 38 million  
**Scope:** Multi-disciplinary, primarily life, health, social, and physical sciences. Journals, books, conferences, et al. back to 1823.  
**Producer:** Elsevier  
**Selected features:** References and citation counts (post-1996). Searches scientific web sites and patents. Proximity search. Author and affiliation identifier tool. Author details page with citations, affiliations, h-index, etc.

**Web of Science® (WOS)**  
**Records:** 39 million\*  
**Scope:** Wide variety of sciences and social sciences\*. Journals, book reviews, meeting abstracts, etc.  
**Producer:** Thomson Reuters  
**Selected features:** References and citation counts and h-index. Integration with EndNote Web, ResearcherID, and search of scientific web sites. Proximity searching, Author Finder and Cited Reference searching. \*Sci. Cit. Index Expanded (1900–) and Social Sci. Cit. Index (1956–)

**PsycINFO® (PSY)**  
**Records:** 2.7 million  
**Scope:** Psychological literature. Journals, books, dissertations, et al. 1836 to present.  
**Producer:** American Psychological Association produces the database and Wolters Kluwer Health produces the Ovid interface.  
**Selected features:** Mapping to thesaurus of terms. Specialized fields: test names, methods, population. Proximity search.  
*NB: PsycINFO is available through several vendors. The OvidSP platform was used for this analysis.*

### 1. Overlap in Database Coverage



### 2. Differences in Journal Coverage

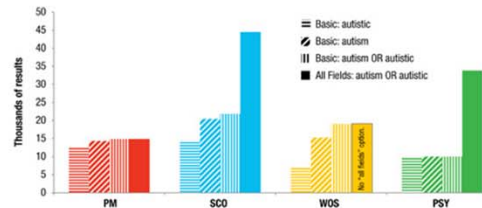
Portion of journals' autism publications in each database. Journals ≥ 1% of the total research publications



The four databases were compared in their coverage of the 11 journals with the most publications in Part 1. Although each database had most of the publications in these journals, there were gaps. Databases may exclude some types of publications (e.g., editorials, letters) or may have indexed the journal in different years.

### 3. How Search Terms Are Processed

Word variants and "Basic search"



The basic, default search in each database was used for the terms autistic, autism, and autism OR autistic. The latter search was repeated in all searchable fields. Some databases search for word variations but others do not. The default search may not include all possible fields though not all fields may be relevant.

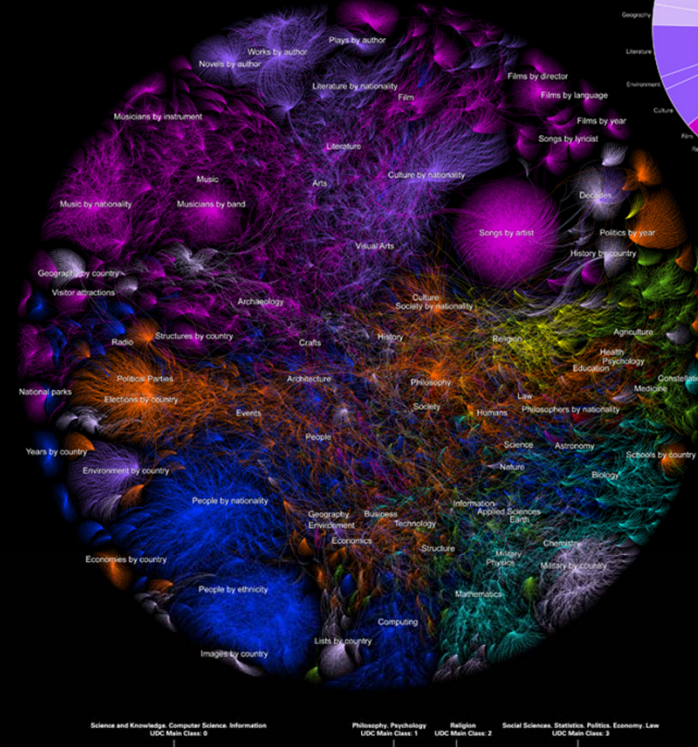
### 4. Conclusions

- No one database contains everything. Similar numbers of results is no indication of how similar the search results themselves are. Using multiple databases is important for doing a comprehensive search.
- Databases have different results because they include different journals, different years, and different types of publications.
- They also process a search differently, by looking in different fields or whether they automatically search for word variations and synonyms.
- Despite their differences, each database includes nearly all the journals that publish the most autism publications.
- This comparison is merely a broad overview of the content and one aspect of functionality of the databases. It cannot say which one is "best" for all purposes. Learn which resources are available to you, which tool fits which job, and how to use them.

# DESIGN VS. EMERGENCE: VISUALIZATION OF KNOWLEDGE ORDERS

## WIKIPEDIA'S CATEGORY STRUCTURE

The Wikipedia category structure was extracted from the January 2008 dump by Wikimedia Foundation. Wikipedia has two different types of pages: article and category pages. Only category pages are used here. To layout the main structure, we forced the directed category network (with loops) into a quasi-hierarchical, acyclic network using "Category:Main topic classifications" as a root and removing all links that do not agree with the shortest distance-to-root-hierarchy. The resulting structure comprises all 234,960 categories organized up to a depth of 12 with the root node having 43 children nodes. The network visualization is limited to the first four levels of the hierarchy consisting of 61,726 nodes and 98,214 edges. Initial network layout was calculated using DFL (VxO) in Sci2, the final layout was rendered using the Fruchterman-Reingold layout in Gephi.

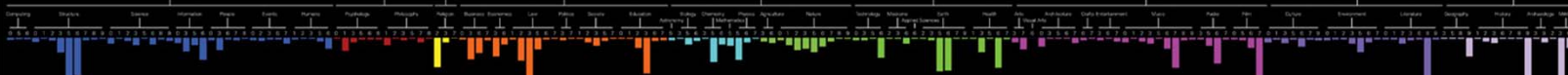
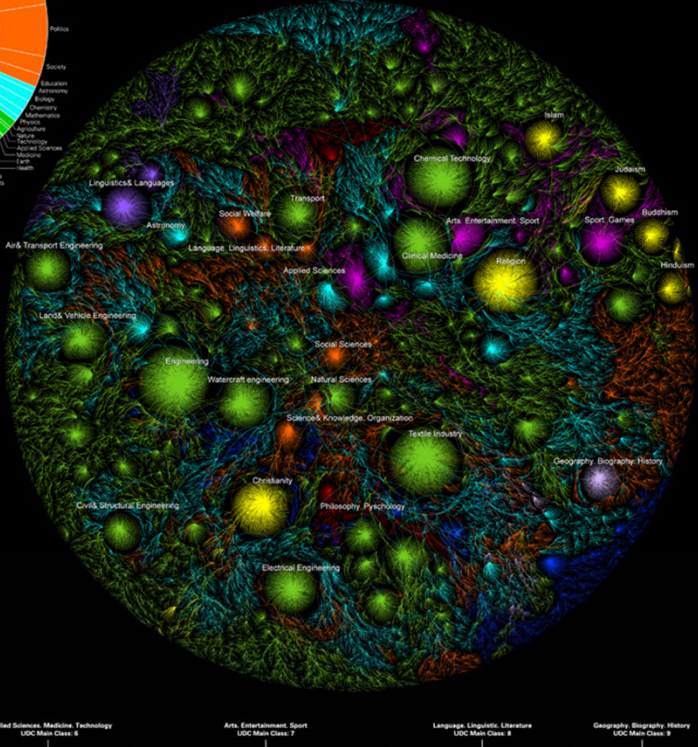


## CATEGORY DISTRIBUTION OF WIKIPEDIA & UDC

This donut chart shows the distribution of the nine UDC categories (inner ring) and the 43 top Wikipedia categories (outer ring). Wikipedia categories are further assigned to corresponding UDC classes, and colored accordingly. About 72% of UDC categories belong to Sciences (22% Natural Sciences and 50% Applied Sciences). Wikipedia's 43 top categories, however, are distributed in a much more balanced fashion, with many categories found under Arts, Entertainment & Sports, followed by Science, Knowledge, Organization, and Social Sciences. A large part, 17%, of Wikipedia categories are tagged as 'ambiguous'.

## UNIVERSAL DECIMAL CLASSIFICATION

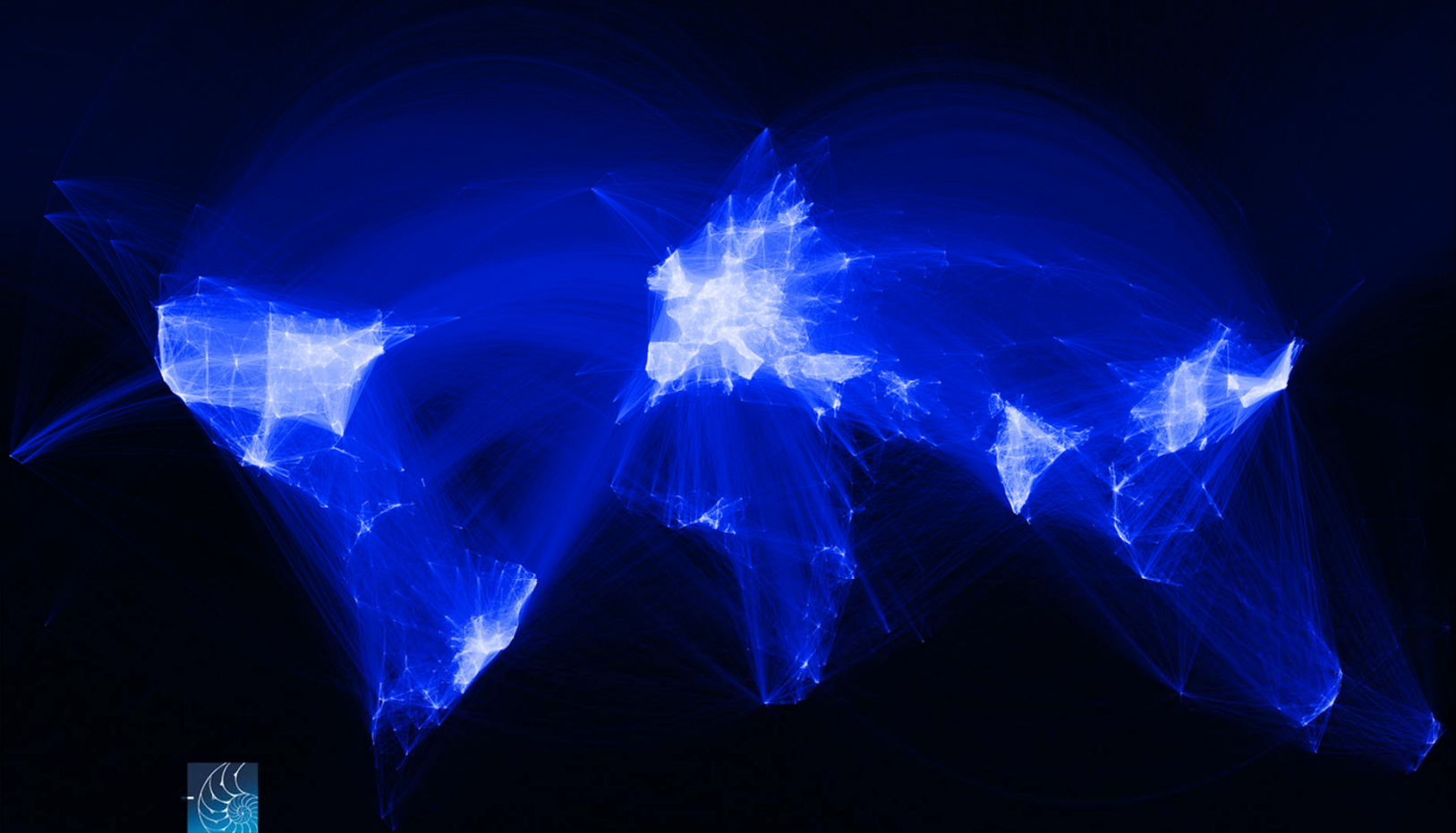
The UDC was created in 1905 by Paul Otlet and Henri-Marie La Fontaine in an attempt to organize all existing knowledge. The early versions of the UDC were much more balanced in the distribution of the subclasses in contrast to the version of today. Our data stems from a 2008 Master Reference File (MRF) of UDC and has a total of 68,546 classes organized in a tree layout branching out to the depth of nine, organized under nine main classes. The visualization shown here covers the whole UDC network except the auxiliaries, which consists of 55,304 nodes and 55,303 edges. Initial network layout was calculated using DFL (VxO) in Sci2, the final layout was rendered using the Fruchterman-Reingold layout in Gephi.



## WIKIPEDIA TO UDC: BAR CHART

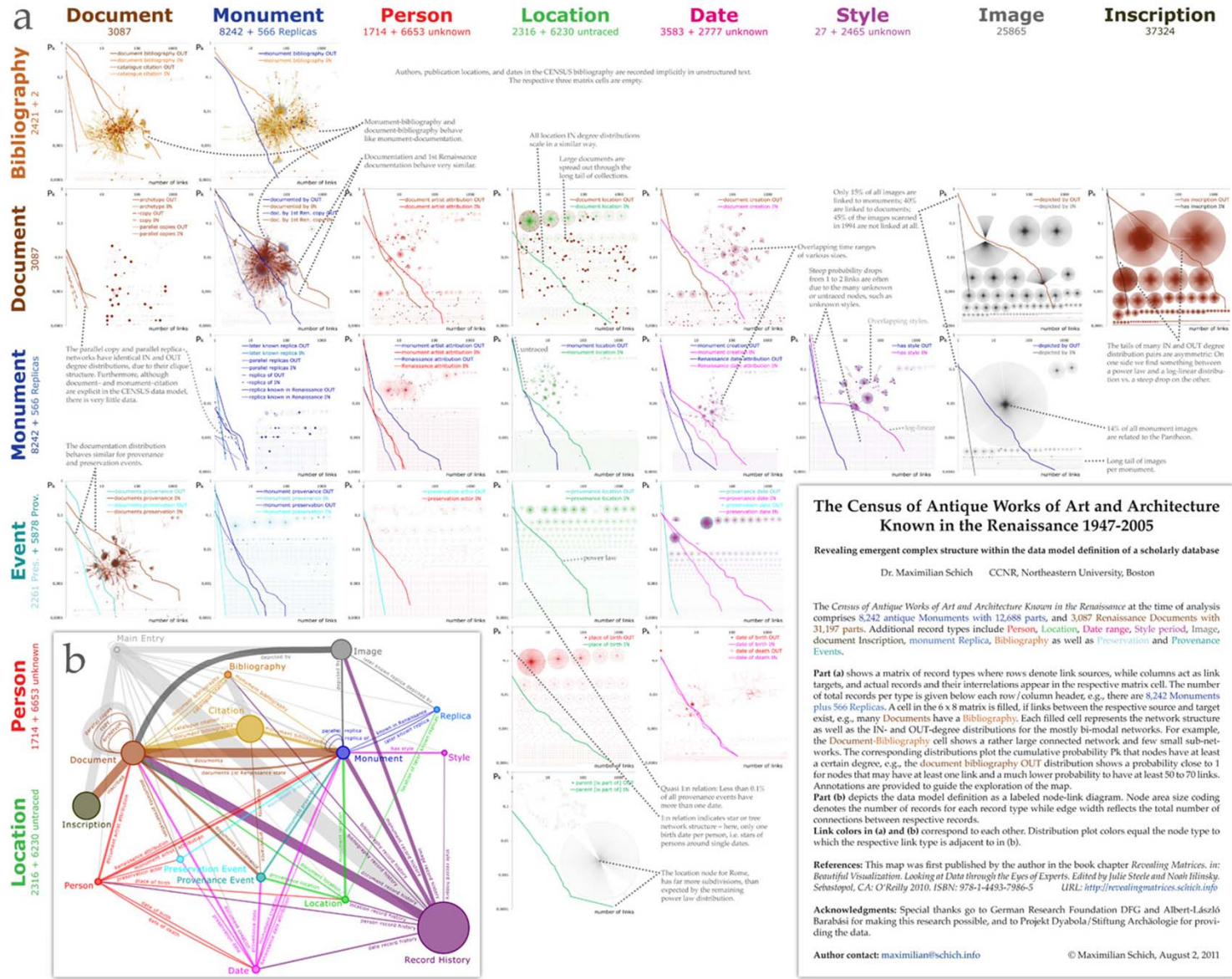
This bar chart—created with MagnaView—shows the distribution of Wikipedia's top category terms among the UDC classes. The length of a bar corresponds to how many times a category term is found in a UDC main class. Some terms have strong connection with a single UDC class. For example, "Mathematics" appears only in class 5, whereas some terms like "Nature" are distributed among all classes. The assignment process starts first by mapping the terms in the 43 top categories of Wikipedia to the nine UDC main classes, second by searching for UDC top class terms in Wikipedia category names, and third by inspecting the context of terms through cosine reading. To this end, we have located Wikipedia's top category terms in the MRF's explanation table, and verified that they match contextually. Each one of the 43 top categories of Wikipedia is mapped to one UDC class only, and not to multiple classes.

# Map of Scientific Collaborations from 2005-2009

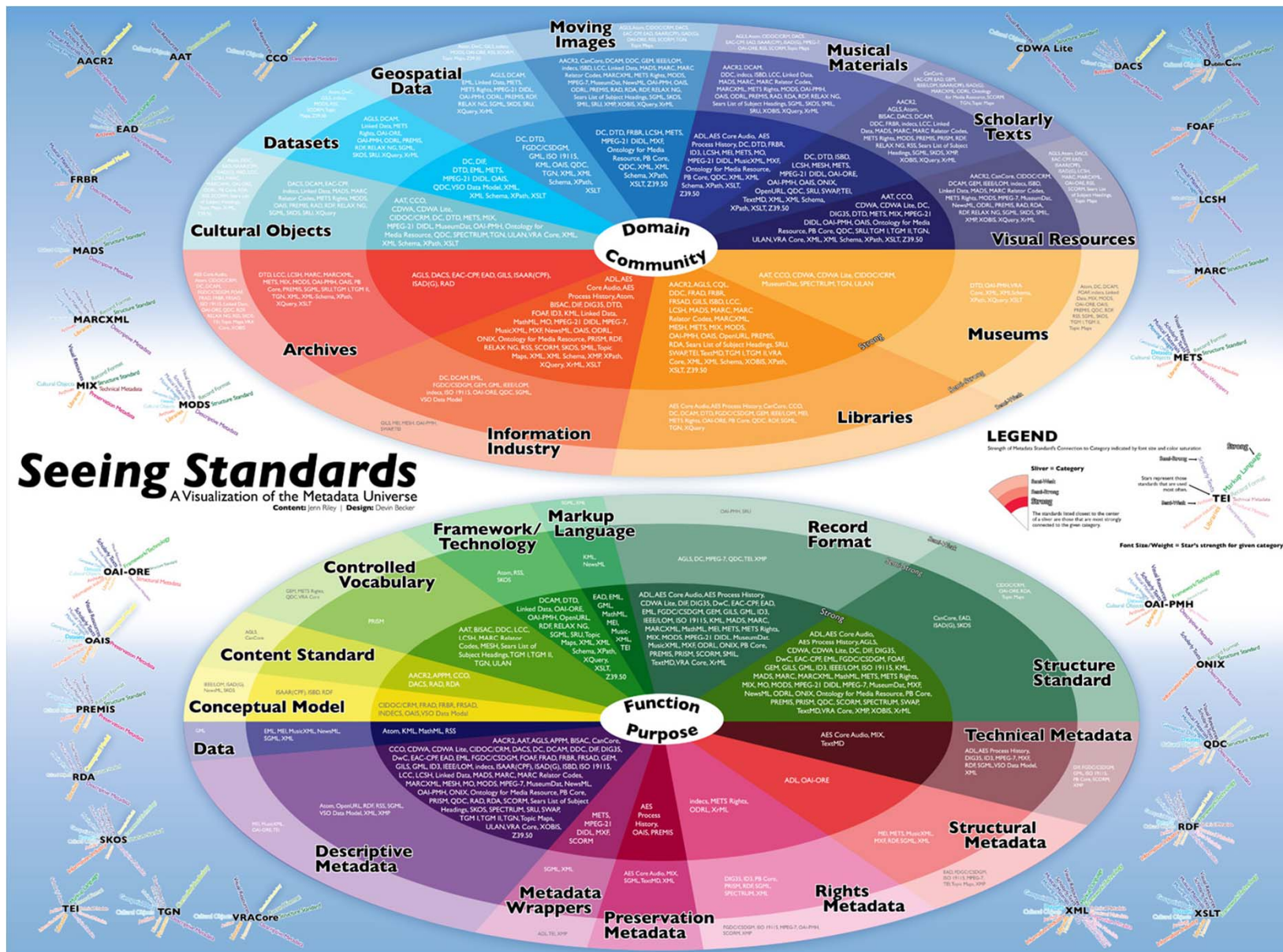


Science-Metrix, Inc.  
Computed Using Data from Elsevier's Scopus





The Census of Antique Works of Art and Architecture Known in the Renaissance, 1947-2005 - Maximilian Schich - 2011



Seeing Standards: A Visualization of the Metadata Universe - Devin Becker and Jenn Riley - 2009-2010

MACE

Metadata for  
Architectural Contents  
in Europe

# TAXONOMY

This visualization reveals the structure and usage patterns of a classification taxonomy.

It is developed and used in the MACE project, which aims at providing better access to digital resources for teaching and learning about architecture.

The diagram shows the structure of the vocabulary used for tagging resources. Currently, it comprises over 2800 concepts, many of which have labels in German, English, Spanish, French, and other languages.

The layout is based on the radial layout mechanism introduced in [1], and provides a birds-eye view of the whole taxonomy tree, with the root placed at the center of the graphic, and each path to the outside representing one "route of specialization".

Accordingly, we can see how the vocabulary is organized in broad categories like *Technical Design*, *Conceptual Design*, or *Theories and Concepts* closer to the center, which contain multiple levels of sub-categories located on rings on the periphery.

In addition, circle overlays indicate the number of resources tagged with the respective term (or any child term), providing hints about the usage patterns of the taxonomy. The exact number of resources for some selected concepts can be found below the text label.

<http://www.mace-project.eu>

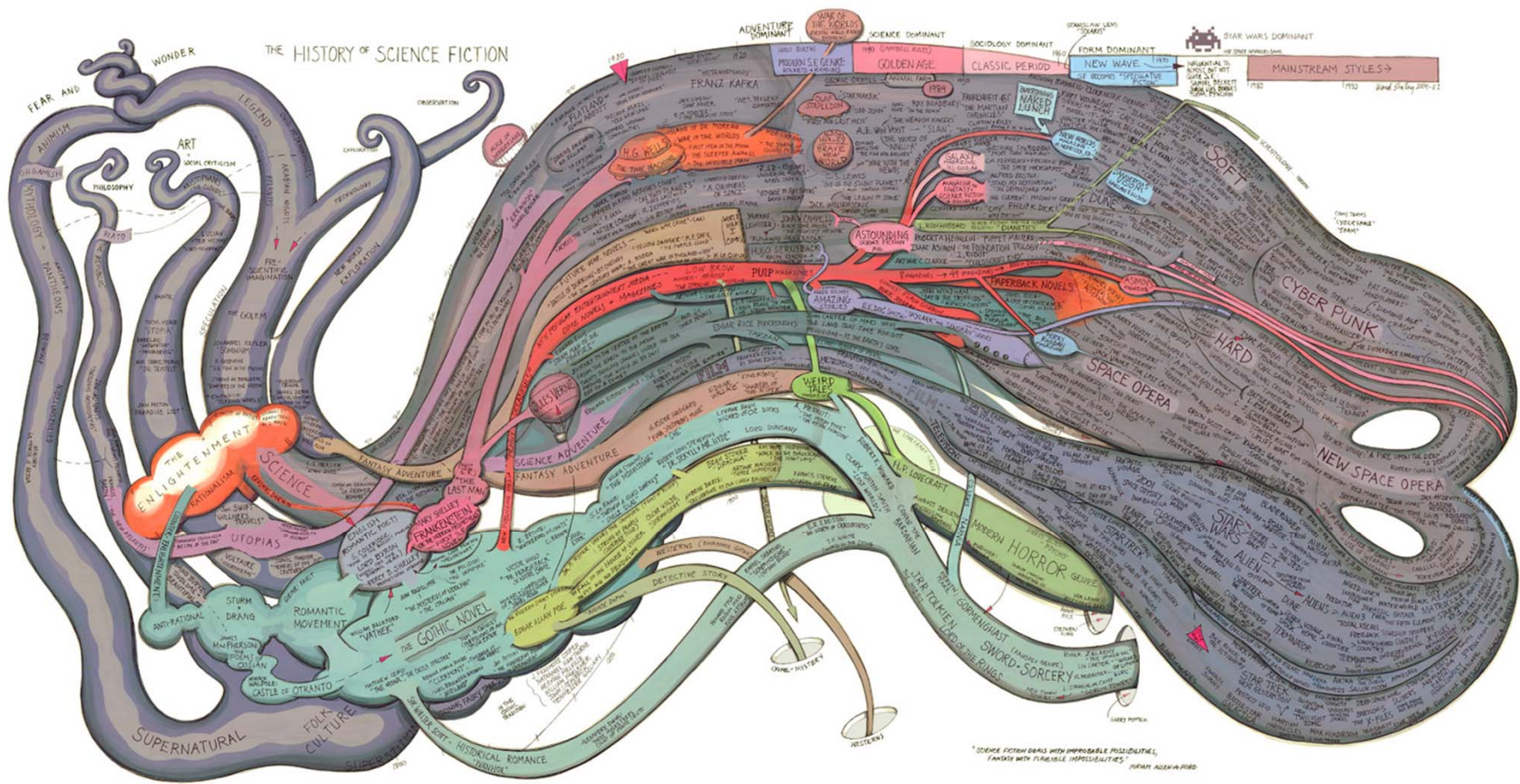
[1] Yee, K.-P., Fisher, D., Dhamija, R. and Heast, M. (2001) 'Animated exploration of dynamic graphs with radial layout', IEEE Symposium on Information Visualization, INFOVIS '01, San Diego, USA, pp.43-50.

Thanks to the MACE team for compiling the taxonomy and providing the technical infrastructure as well as the MACE users for providing the metadata.

The MACE project was co-funded by the European commission under contract number ECP 2005 EDU 038098 in the eContentplus programme.



Visualization designed and developed by  
**Moritz Stefaner** (<http://moritz.stefaner.eu>)  
while working at the Interaction Design Lab, FH Potsdam

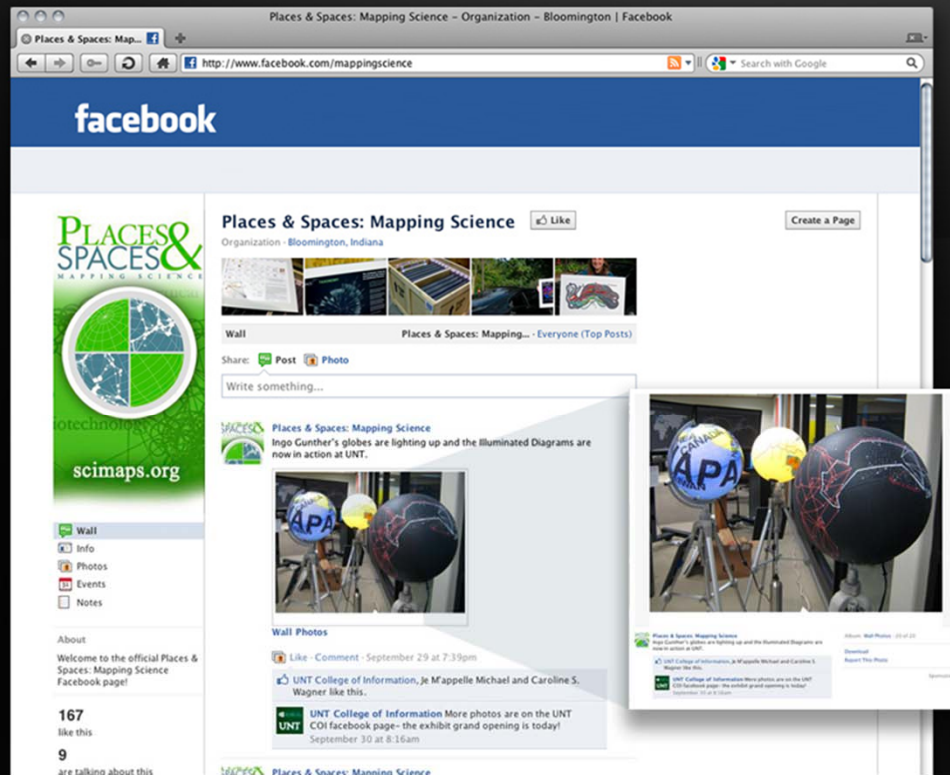


History of Science Fiction - Ward Shelley - 2011



# PLACES & SPACES

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