Mapping Science

Katy Börner
CNS, SLIS, IU, Bloomington, IN
katy@indiana.edu | http://cns.iu.edu

60 Engineering and Architecture High School Students Encounter
University of North Texas, Denton ,TX
September 30, 2011

Mapping Science Exhibit – 10 Iterations in 10 years

http://scimaps.org/

The Power of Maps (2005)

Science Maps for Economic Decision Makers (2008)

The Power of Reference Systems (2006)

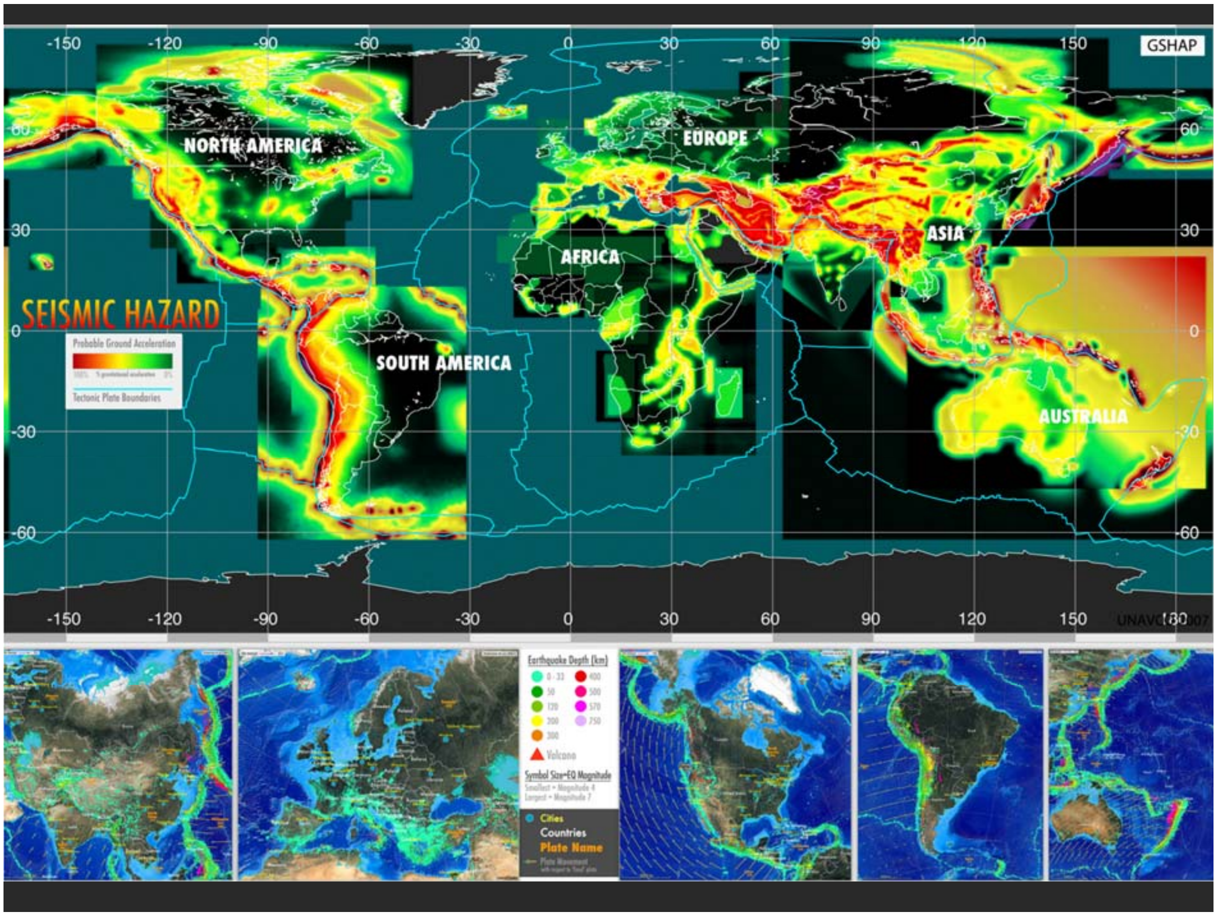
Science Maps for Science Policy Makers (2009)

The Power of Forecasts (2007)

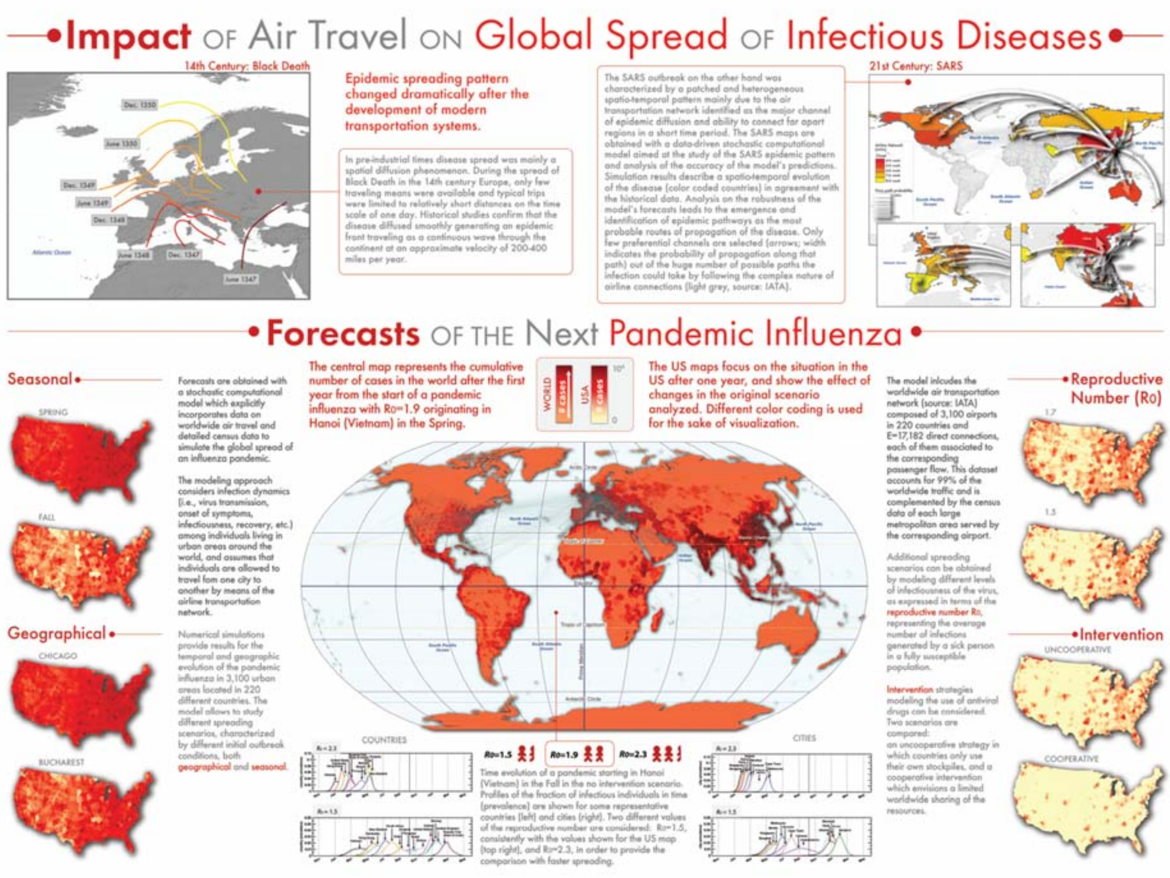
Science Maps for Scholars (2010)
Science Maps as Visual Interfaces to Digital Libraries (2011)
Science Maps for Kids (2012)
Science Forecasts (2013)
How to Lie with Science Maps (2014)

Exhibit has been shown in 72 venues on four continents. Currently at
- NSF, 10th Floor, 4201 Wilson Boulevard, Arlington, VA
- Center of Advanced European Studies and Research, Bonn, Germany
- Science Train, Germany
- Cultural Dimensions of Innovation, UCD Conference, Dublin, Ireland

ORDER MAPS



GSHAP
NORTH AMERICA
EUROPE
ASIA
AFRICA
SOUTH AMERICA
AUSTRALIA
SEISMIC HAZARD
Probable Ground Acceleration
Tectonic Plate Boundaries
Earthquake Depth (km)
Volcano
Symbol Size=EQ Magnitude
Cities
Countries
Plate Name



Impact of Air Travel on Global Spread of Infectious Diseases
14th Century: Black Death
Dec. 1350
June 1350
Dec. 1349
June 1349
Dec. 1348
June 1348
Dec. 1347
June 1347
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
SPRING
FALL
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 fom one city to another by means of the airline transportation network.
Geographical
CHICAGO
BUCHAREST
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 R0=1.9 originating in Hanoi (Vietnam) in the Spring.
WORLD
cases
USA
cases
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.
COUNTRIES
CITIES
R0=1.5
R0=1.9
R0=2.3
Time evolution of a pandemic starting in Hanoi (Vietnam) in the Fall in the no intervention scenario. Profiles of the fraction of infectious individuals in time (prevalence) are shown for some representative countries (left) and cities (right). Two different values of the reproductive number are considered: R0=1.5, consistently with the values shown for the US map (top right), and R0=2.3, in order to provide the comparison with faster spreading.
The model inlcudes 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 R0, 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 (R0)
1.7
1.5
Intervention
UNCOOPERATIVE
COOPERATIVE

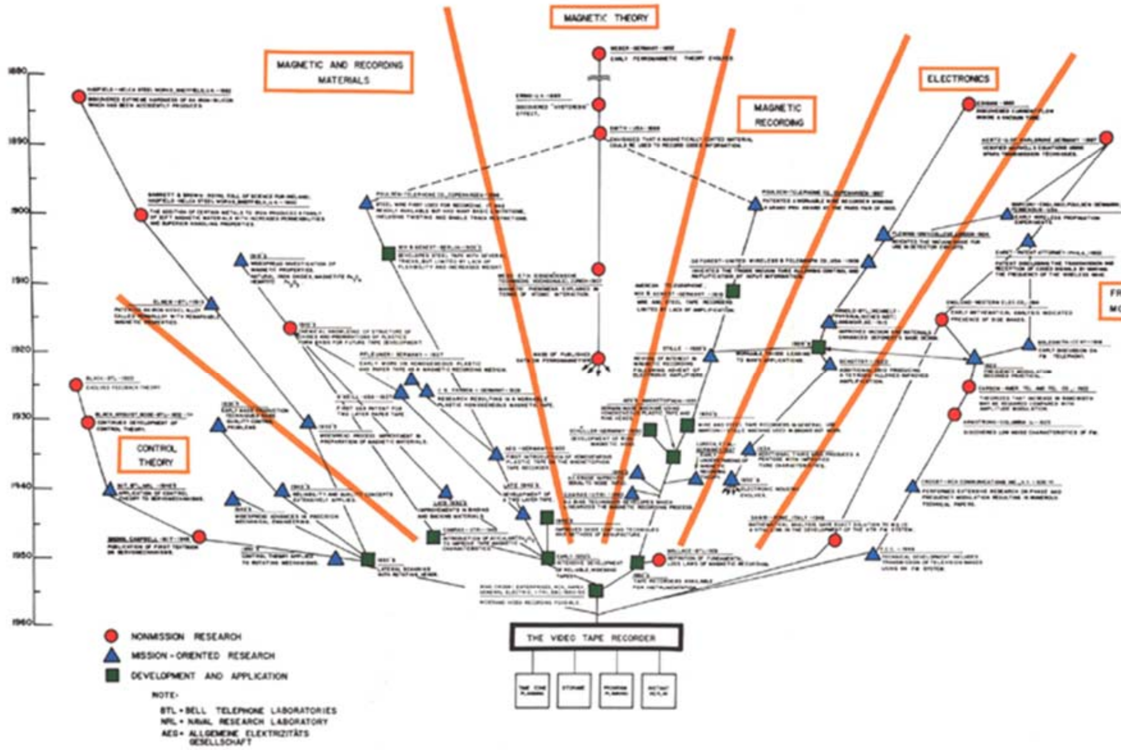
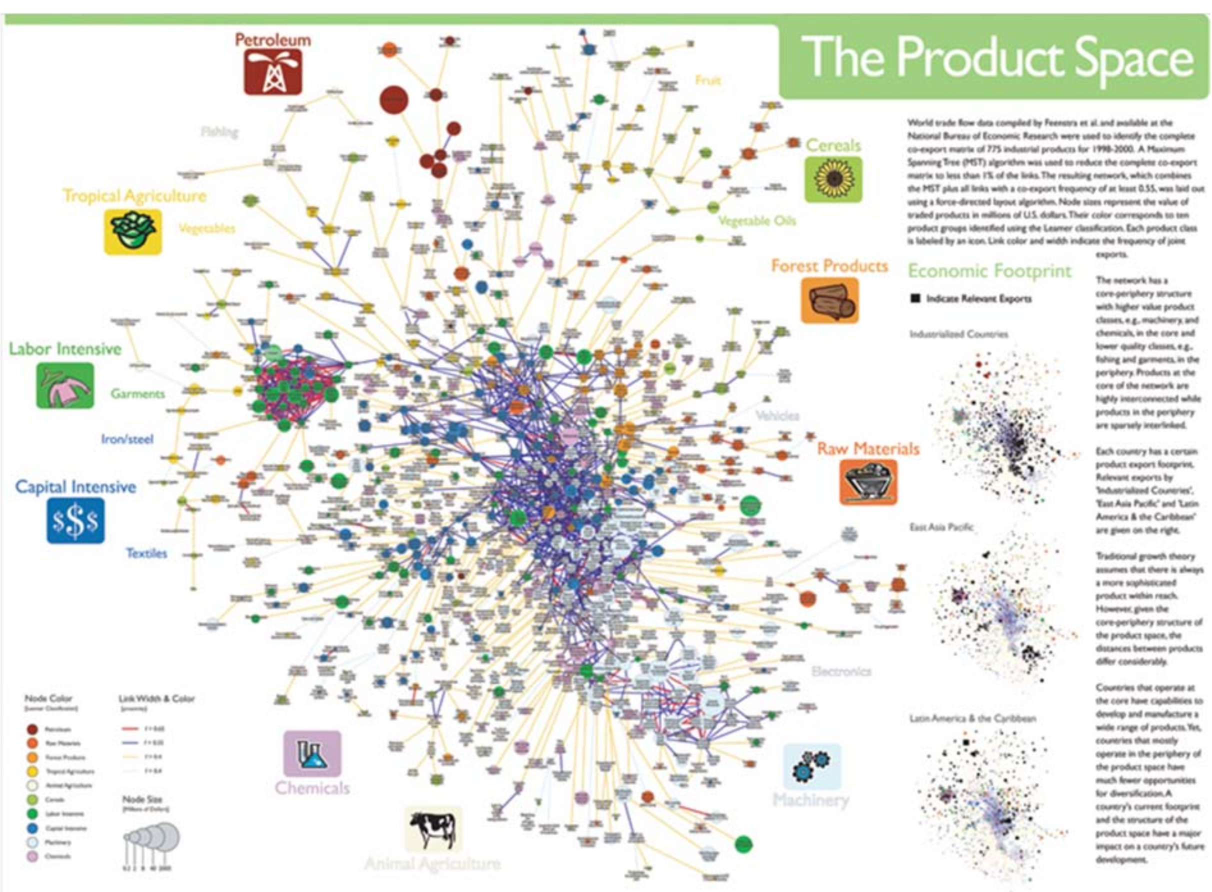
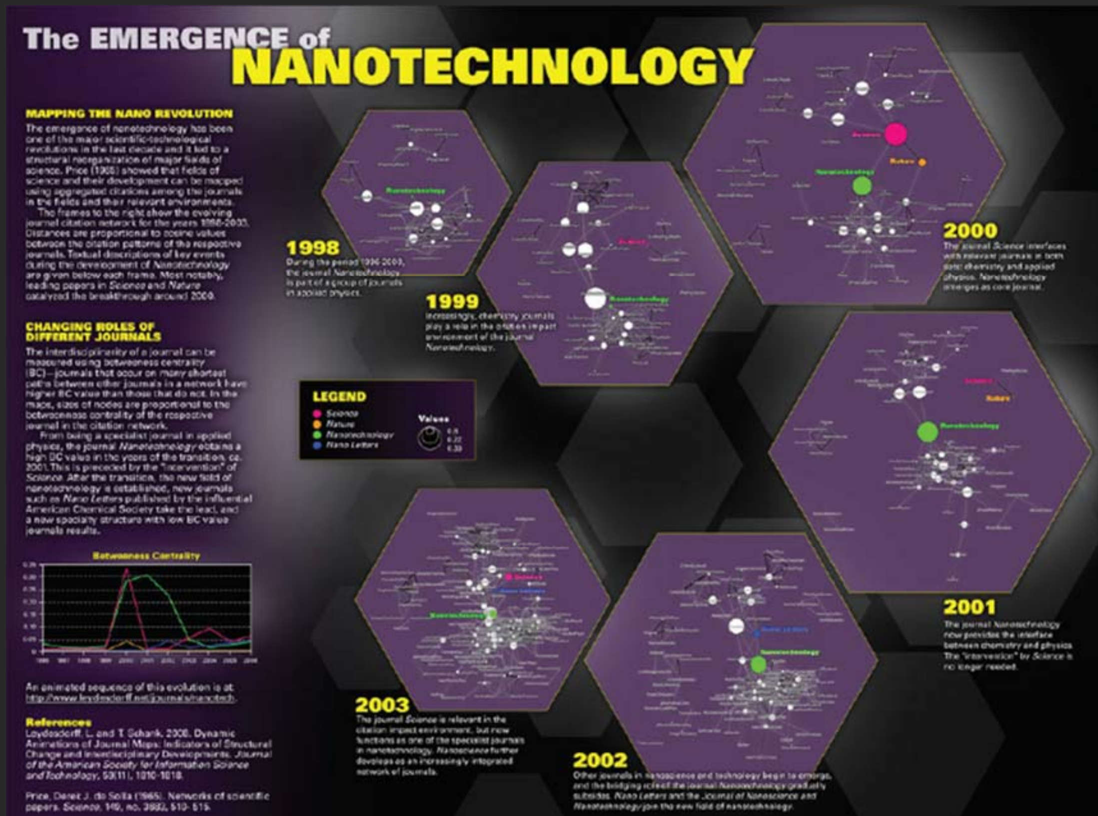
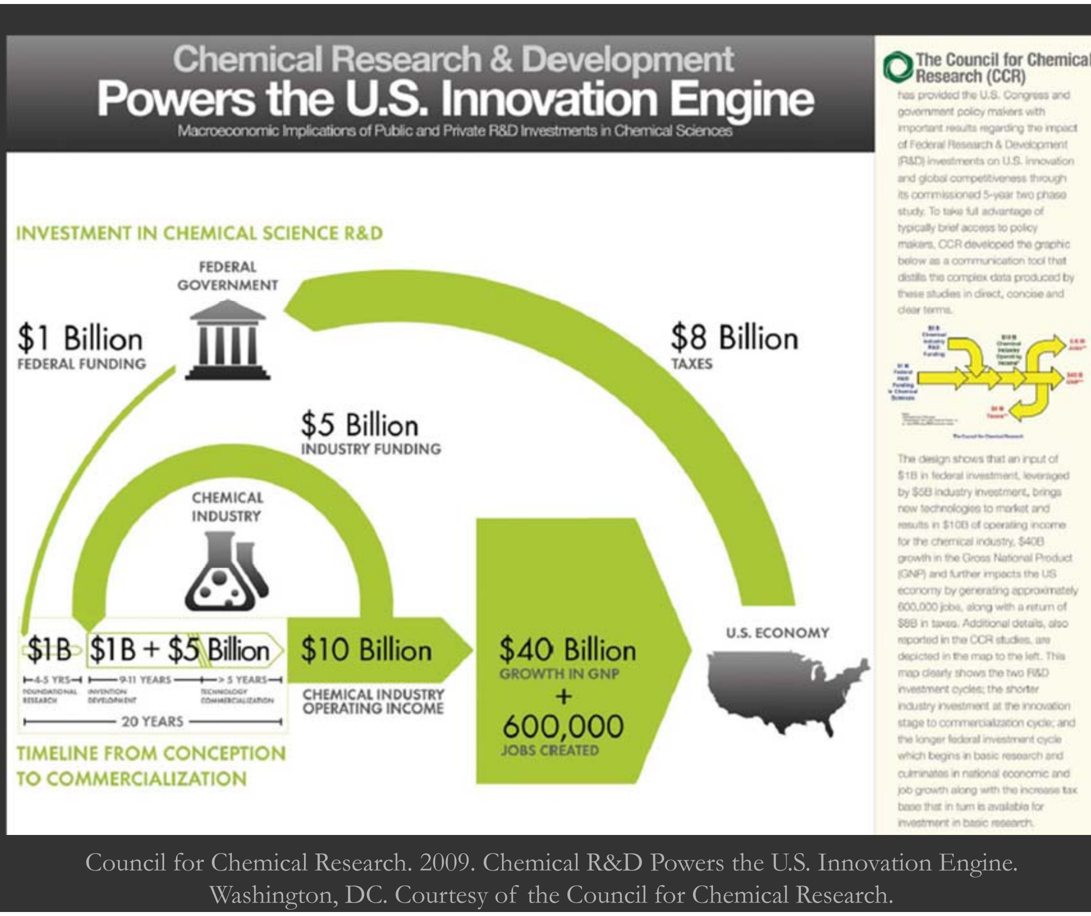


FIG. 7. THE VIDEO TAPE RECORDER





Loet Leydesdorff, Thomas Schank and the Journal of the American Society for Information Science and Technology. 2010. The Emergence of Nanoscience & Technology.



Council for Chemical Research. 2009. Chemical R&D Powers the U.S. Innovation Engine. Washington, DC. Courtesy of the Council for Chemical Research.

Debut of 5th Iteration of the Mapping Science Exhibit at MEDIA X was in 2009 at Wallenberg Hall, Stanford University, http://mediax.stanford.edu, http://scaleindependentthought.typepad.com/photos/scimaps

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