

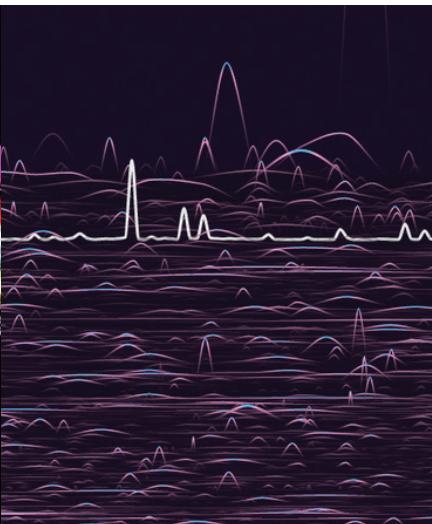
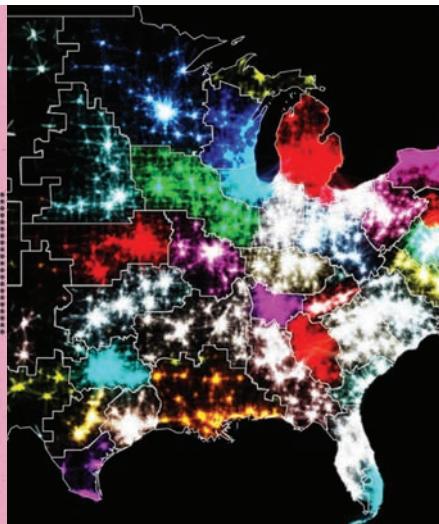
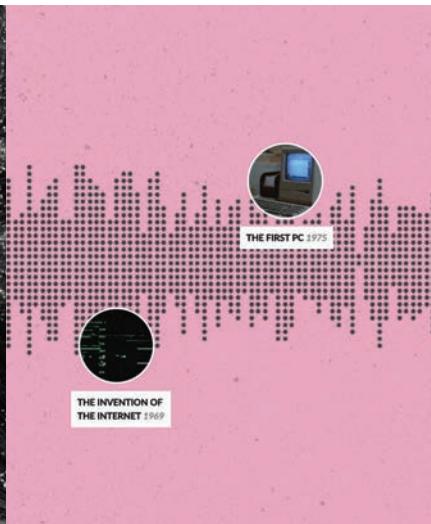


# PLACES & SPACES

MAPPING SCIENCE

## PLAYING WITH SCALE

ANNUAL REPORT 2017



# Letter from the Curators



Curators Katy Börner (right) and Lisel Record (left)

Think back to the first map you ever looked at as a child. Was it a map of the country you called home or of the wider world you were eager to travel? Was it a map of the stars in their heavens or of the oceans in their depths? Regardless of what kind of map you first encountered, it no doubt led to an important realization: The world is vast and complicated, but it is not an utter mystery. With effort, care, and ingenuity, the world can be explored, measured, and charted.

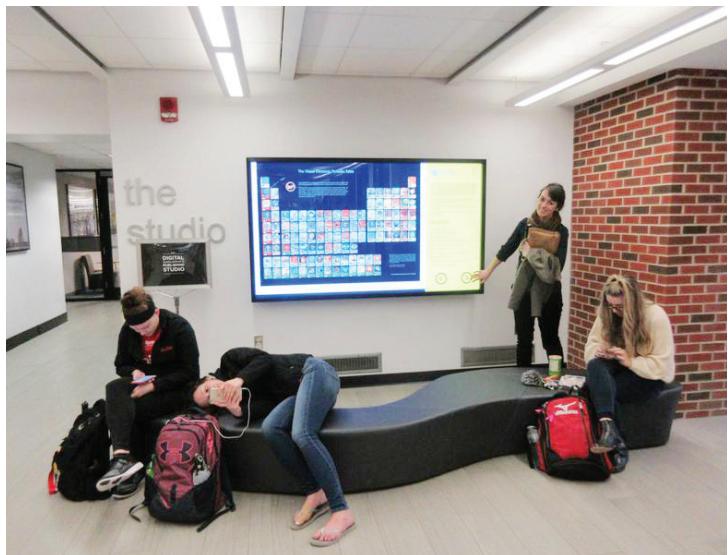
Today, maps of science can provide us with the same intellectual joy that comes with comprehending other things that are vast and complex. Science maps provide us with a guide to the landscape of human thought and achievement. In them, we can see well-traveled territories, recently discovered lands bursting with activity, and areas imperfectly understood and ripe for exploration.

As curators of *Places & Spaces*, we are guided by three interwoven imperatives. First, we seek to demonstrate the power of science maps to render data into actionable knowledge. Second, we work to strengthen data visualization literacy so that individuals will be able to read, absorb, and apply the rich insights that science maps have to offer. And finally, we strive to empower people to create their own science and technology maps, using data to help them identify novel solutions to their professional and personal challenges.

We are privileged to work with many people who share our belief in the power and potential of science mapping. Our thanks go out to the exhibit's advisory board for their expert guidance, to the exhibit ambassadors for their promotion of science mapping and macroscope tools, and to the 2017 exhibit venues for their support and hospitality. *Places & Spaces* is enriched beyond measure by all of your contributions.

# 2017 Macroscopes

The *Places & Spaces: Mapping Science* exhibit operates as an outreach activity of the **Cyberinfrastructure for Network Science Center (CNS)**, a research center within the **School of Informatics, Computing, and Engineering at Indiana University**. While the first decade of the exhibit collected 100 of the most insightful maps of science, the next decade turns the spotlight on innovative macroscopes—software tools that allow users to find meaningful patterns by visualizing vast sets of data.



The exhibit visits the University of Iowa Main Library

The thirteenth iteration of *Places & Spaces* is called “Macroscopes for Playing with Scale.” As the title indicates, an essential feature of microscope tools is their ability to navigate through data at different scales. Macroscopes can give us a wide-angle view of a subject in all its complexity, or they can zoom in to focus on a single point of interest. The word “play” in the title, however, points to another important feature of macroscopes that we hope does not get overlooked: they invite playful exploration. The exceptional macroscopes presented in this iteration are informative, evocative, and beautifully designed. They are also a lot of fun to use!

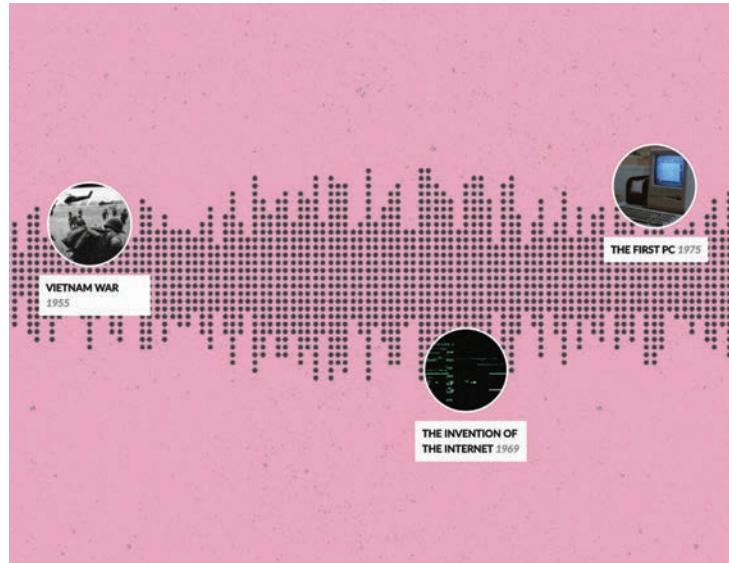


The exhibit response board at Virginia Tech



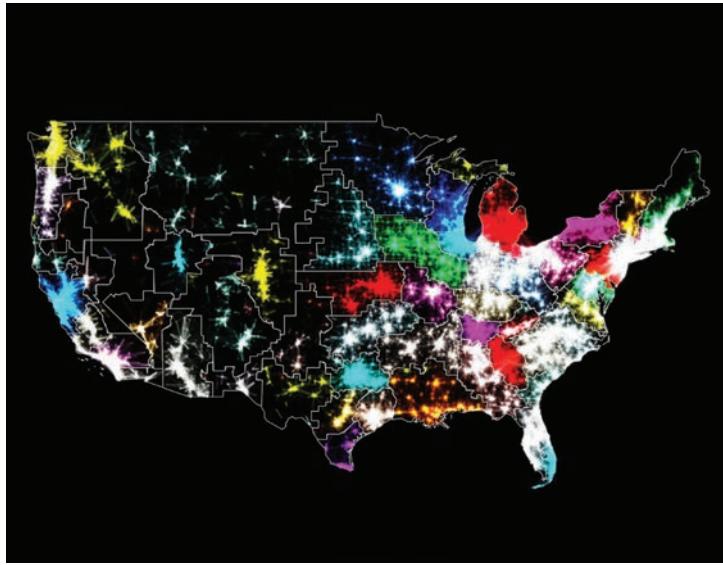
## The Cosmic Web

Created at Northeastern University's Center for Complex Network Research by information designer Kim Albrecht, network science pioneer Albert-László Barabási, and a team of astronomers, *The Cosmic Web* builds upon our sense of wonder and immerses us directly in a network of galaxies. The visualization's three relational models support different views of one massive dataset containing 24,000 galaxies and more than 100,000 connections. Through them, we begin to see the universe not as a collection of separate galaxy clusters but as a fully interconnected network.



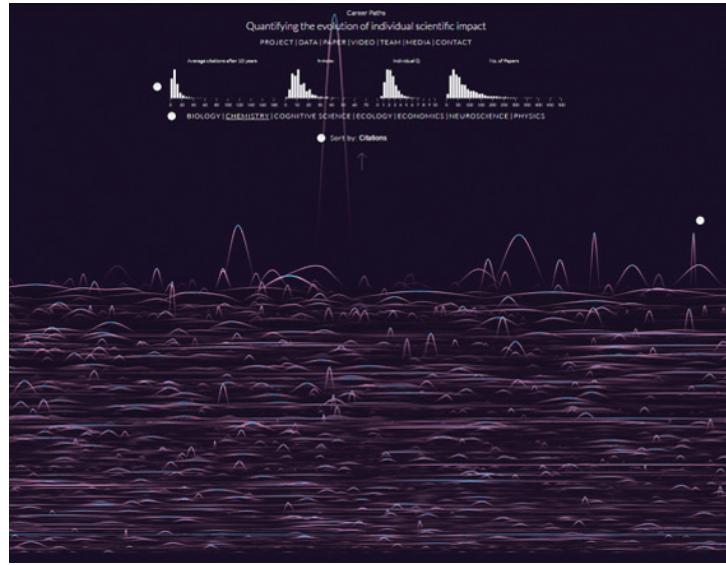
## Histogramy

Created while a student at Bezalel Academy of Arts and Design in Jerusalem, interactive designer Matan Stauber's *Histogramy* is an award-winning interactive timeline that draws historical events from Wikipedia. Users can adjust the parameters to take in history in million-year gulps or in single-year sips. You can also narrow the subject matter to find out, say, what important women's rights event occurred in 1754 (Dorothea Erxleben became the first female doctor in Germany).



## Megaregions of the US

*Megaregions of the US* is the work of historical geographer Garrett Dash Nelson, a postdoctoral researcher at Dartmouth College, and Alasdair Rae, an urban and regional data analyst at the University of Sheffield in England. It presents a United States made up of large areas of shared economic transfer, vocational movement, and networks of commuting patterns. Using an innovative algorithm for identifying communities, traditional state boundaries are replaced by megaregions such as “DC-Baltimore,” “Corn Belt,” and the “Columbia Plateau”—cartographic divisions that reflect real community clusterings based on commuting patterns.



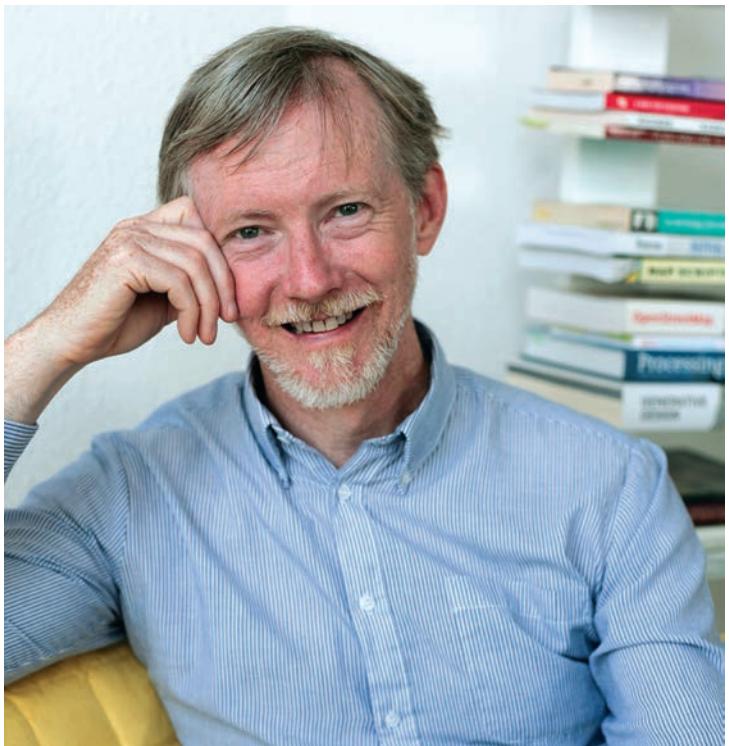
## Science Paths

Do scientists publish their most impactful work straight out of the gate, after a lifetime of study, or somewhere in the middle? This is the question explored by Kim Albrecht and Albert-László Barabási, both from Northeastern University’s Center for Complex Research, and Roberta Sinatra, a theoretical physicist from Budapest, in *Science Paths*. This interactive visualization lays out the publication histories of over 10,000 exceptionally successful scientists. As users will find, any hypotheses about when scientists reach their peak is challenged by the randomness of when high-impact papers appear along career trajectories.

# Exhibit Advisors

Advisory board members review exhibition submissions and provide their expertise and guidance to the exhibit on many levels.

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Places & Spaces exhibit advisor Francis Harvey

The newest member of the advisory board, **Francis Harvey**, is head of the Department of Cartography and Visual Communication at the **Leibniz Institute for Regional Geography** and professor of Visual Communication in Geography at the **University of Leipzig**, Germany. His research and teaching activities center around geographic information systems (GIS), particularly their technologies, applications, ethical dimensions, and societal implications. Harvey's *Primer of GIS: Fundamental Geographic and Cartographic Concepts* (Guilford, 2015), now in its second edition, is a must-read for students preparing to understand and work with GIS. Harvey is also the editor of *Are There Fundamental Principles in Geographic Information Science?* (AAG, 2012), a collection of writings designed to stimulate discussions of GIScience principles.

While Harvey is interested in bringing fresh perspectives to the fundamentals of GIScience, he is also excited about using processing and D3 to develop new approaches to geospatial visualization and mapping research. All of this, Harvey maintains, is to adapt to and prepare for the vast changes that 21st century mapping is already experiencing. Such changes, Harvey writes, start with "the basic meaning of maps." Unlike the "static and linear resources" of the last century, today's maps are "dynamically embedded in our activities...and involve regularly bridging the physical environment and virtual environment." These sentiments echo the *Places & Spaces* exhibit's future-oriented and challenge-accepting ethos, and we are very pleased to have the insight and guidance of Francis Harvey on our journey.



**Gary Berg-Cross** is a cognitive psychologist (PhD, SUNY-Stony Brook) who has taught at a number of institutions over his career (SUNY, Widener, University of Delaware, George Washington, George Mason University, and others). Currently, Berg-Cross is a Co-Principal Investigator on a four-year, NSF-sponsored study entitled Spatial Ontology Community of Practice: An Interdisciplinary Network to Support Geospatial Data Sharing, Integration and Interoperability (SOCoP-INTEROP Project). [Potomac, MD, USA]



**Donna J. Cox** is the first Michael Aiken Chair, director of the Advanced Visualization Laboratory (AVL) at the National Center for Supercomputing Applications, and director of the Illinois eDream Institute, all at the University of Illinois at Urbana-Champaign. She is a recognized pioneer in Renaissance Teams and supercomputer visualizations for public outreach, and in 2006 she was selected by the Chicago Museum of Science as one of 40 modern-day Leonardo da Vinci's. [Urbana-Champaign, IL, USA]



**Bonnie DeVarco** is a Media X Distinguished Visiting Scholar at Stanford University. She writes and lectures on design science, virtual worlds, next-generation geographic information systems, information visualization, and the culture of cyberspace. Currently, DeVarco is completing a book on Buckminster Fuller entitled *Invisible Architecture II*, co-authoring *Shape of Thought*, a work on the history and evolution of visual language, and co-editing a book on Ludic Cartography. [Palo Alto, CA, USA]



**Peter A. Hook** is an assistant professor of library and information science at Wayne State University in Detroit, MI. He received his doctorate from the School of Informatics and Computing at Indiana University where his primary research focus was information visualization, particularly the visualization of knowledge organization systems, concept mapping, and the spatial navigation of bibliographic data in which the underlying structural organization of the domain is conveyed to the user. [Detroit, MI, USA]



**Lev Manovich** is professor at the City University of New York (CUNY) Graduate Center and author of several books on digital culture, including the recent *Software Takes Command* (Bloomsbury Academic, 2013). In 2007, Manovich founded the Software Studies Initiative in order to develop a new paradigm of Cultural Analytics through data analysis and interactive visualization of patterns and trends in media and visual cultures. [New York, NY, USA]



**André Skupin**, professor of geography at San Diego State University, is interested in the application of geographic metaphors, cartographic principles, and computational methods to the visualization of non-geographic information. His research is interdisciplinary, aimed at increased cross-fertilization between geography, information science, and computer science. Recent work includes novel methods for visualizing human movement and demographic change as trajectories in n-dimensional attribute space. [San Diego, CA, USA]



**Moritz Stefaner** is a freelance designer on the crossroads of data visualization, information aesthetics, and user interface design. With a background in cognitive science and interface design, Stefaner's work beautifully balances analytical and aesthetic aspects in mapping abstract and complex phenomena. In 2010, he was nominated for the Design Award of the Federal Republic of Germany, and his work has been exhibited at SIGGRAPH and Ars Electronica. Portfolio at moritz.stefaner.eu. [Lilienthal, Germany]



**Olga Subirós** is an architect and exhibition designer. One of her most notable exhibition design projects revolved around the creative process of Chef Ferran Adrià and elBulli restaurant for an exhibition presented at Somerset House London, the Science Museum in Boston, and Fundación Telefónica in Madrid. Subirós has also designed award-winning exhibitions for some of Spain's leading museums and cultural institutions, including Museu d'Art Contemporani de Barcelona (MACBA) and the Centre de Cultura Contemporànea de Barcelona (CCCB). [Barcelona, Spain]



**Stephen Uzzo** is vice president of science and technology for the New York Hall of Science where he works on exhibit and program development projects related to STEM learning, scientific visualization, sustainability, and network science. Uzzo also serves on the faculty of the New York Institute of Technology Graduate School of Education, where he teaches STEM teaching and learning. [Queens, NY, USA]



**Benjamin Wiederkehr** is founding partner and managing director of the Zürich-based design and data visualization studio, Interactive Things. He is also part of the Open Government Data task force in Switzerland and helps to facilitate open access to government data for everyone. On [Datavisualization.ch](#), Wiederkehr provides insight into his research and working process and documents topical use cases in the field of data visualization. [Zürich, Switzerland]

# Venues & Events

At the beginning of 2017, the *Places & Spaces* exhibit enjoyed a successful installation at **Vanderbilt University's** iconic Central Library. Curators Lisel Record and Katy Börner were on hand to open the exhibit and to mark the gallery premiere of the exhibit's 12th iteration, "Macroscopes for Making Sense of Science." During its three-month stay, the exhibit was the occasion of several workshops, panel discussions, and a data visualization contest.

In August, the exhibit took up a three-month residence at **Virginia Tech's** Newman Library. Katy Börner delivered the keynote address and unveiled the exhibit's 13th iteration, "Macroscopes for Playing with Scale." The exhibit's opening coincided with the dedication of the Newman Library's **Data Viz Studio**, an education hub



Vanderbilt University



Virginia Tech

where students can practice the craft of information visualization. According to Michael J. Stamper, former exhibit designer and new Data Visualization Designer at Virginia Tech, *Places & Spaces* supports the Studio's mission because it "exemplifies the variety, beauty, and cross-disciplinary nature of art, design, and science."

Early in the year, an all-digital version of *Places & Spaces* captured the curiosity of students visiting the Learning Commons of **University of Iowa's** Main Library. Culminating with a closing lecture by Katy Börner, the month-long event used the exhibit's interactive appeal to promote science communication.

The exhibit also traveled to several important conferences and workshops in 2017. The exhibit was represented at the **Science Centre World Summit** in Tokyo, Japan, and at the **European Summer School in Logic, Language and Information** in Toulouse, France.

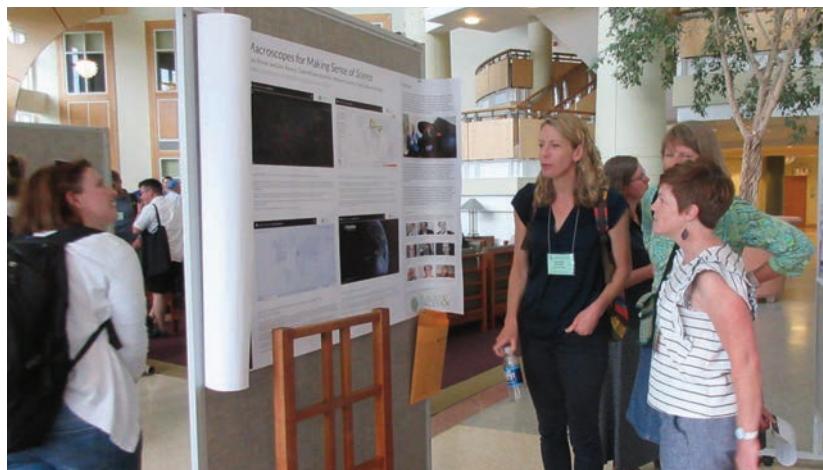
Stateside, the exhibit informed the **Gordon Research Conference**'s theme of "Scientific Visualization for Decision Making" in Lewiston, Maine, and complemented **Practice & Experience in Advanced Research Computing**'s conference focus on "Sustainability, Success, and Impact" in New Orleans, Louisiana. It also provided topical and illustrative material for Katy Börner's talk at the Office of Naval Research in Arlington, Virginia. *Places & Spaces* was also integral to several workshops, science events, and children's museum activities at the exhibit's institutional home of Indiana University and in the wider Bloomington community.



University of Iowa



Office of Naval Research, Arlington, Virginia



Gordon Research Conference

# Research



Promoting data visualization literacy at Science Fest 2017, Indiana University

Helping to understand and promote data visualization literacy is the goal of **Data Visualization Literacy: Research and Tools that Advance Public Understanding of Scientific Data**, an NSF-funded project that teams CNS with science museums in Ohio, Minnesota, and New York and with Dr. Kylie Peppler's learning science team at **Creativity Labs, Indiana University**. The project is driven by the assumption that in the digital information age, being able to create and interpret data visualizations is an important literacy for anyone—experts and the public. The research aims to define, measure, and advance data visualization literacy. The project will engage the public in using the xMacroscope at the **Science Museum of Minnesota** and at the **Center of Science and Industry's (COSI)** science museum and research center in Columbus, Ohio. Work on the project began in August and will continue for the next three years.

In July, curator Lisel Record traveled to Des Moines, Iowa, for the **Association of Midwest Museums Conference**. While there, she shared "Scoping Out the Macroscopes: Defining and Measuring Success for a Digital Interactive." Record outlined the methods and results of studies conducted to see how exhibit visitors interacted with the macroscopes. The goal of the research was to go beyond simply measuring the amount of time visitors spent with the macroscopes to get at how individuals were engaging with the content and increasing their data visualization literacy. Such research allows our exhibit team to better recognize and address the needs of our visitors.

During the month of October, Katy Börner co-organized a workshop titled "Reproducible Scientometrics Research: Open Data, Code, and Education." Held in Wuhan, China, during the **International**

**Conference on Scientometrics and Informetrics**, the workshop goal was to discuss challenges to the reproducibility of research in the field of scientometrics and develop key actions to improve reproducibility. The exhibit aims to set de facto standards that support rigorous and reproducible research.

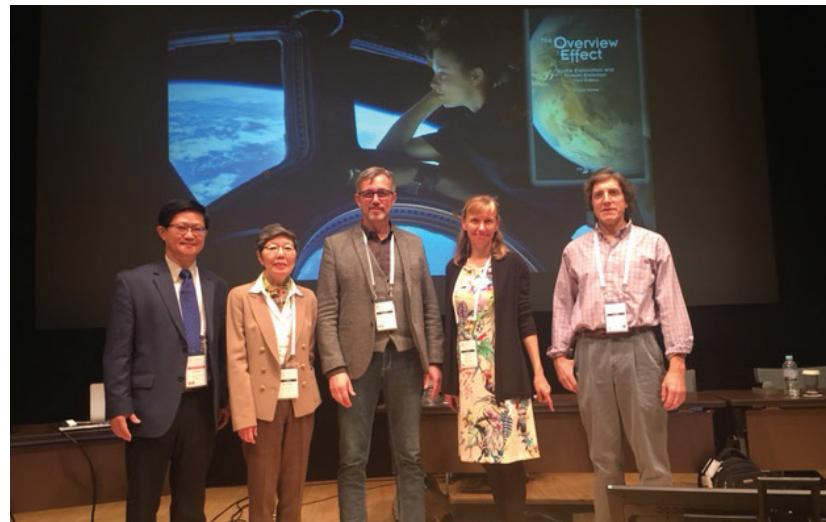
In November, top minds from the fields of biomedicine, cybersecurity, renewable energy, and data visualization converged upon Indiana University for the **2017 IEEE Engineering Conference (EnCON)**. Designed for engineers, students, and academic researchers, the conference provided a glimpse of the future through talks by innovative thinkers and demonstrations of cutting-edge technology.



IEEE EnCON, Indiana University

At the same time, workshops and discussions also addressed the more immediate concerns of securing grant funding for projects and navigating the job market. The active participation of the exhibit team in hosting, organizing, and panel leading made the conference a wonderful showcase for visualization work at CNS.

The theme for this year's **Science Centre World Summit**, "Connecting the World for a Sustainable Future," informed the panel session led by Katy Börner at the Tokyo event. Börner and colleagues Stephen Uzzo, Yuko Harayama, Lim Tit Meng, and Hans Gubbels connected the importance of visualization literacy to understanding developments in science, technology, engineering, arts, and



Science Centre World Summit in Tokyo, Japan

mathematics (STEAM). Panelists discussed the best ways to use big data and the ever-evolving set of data mining and visualization tools to inform and empower diverse stakeholders in their efforts to achieve sustainability.

The **Arthur M. Sackler Colloquia**, sponsored by the **United States National Academy of Sciences**, are widely known for addressing timely scientific topics of broad interest that cut across traditional disciplinary boundaries. “Modeling and Visualizing Science and Technology Developments” exemplified that spirit as it brought together researchers and practitioners from multiple disciplines



The Arthur M. Sackler Colloquium on Modeling and Visualizing Science and Technology Developments

to present, discuss, and advance computational models and visualizations of science and technology (S&T). Co-organized by Katy Börner, the colloquium addressed the vital question of how advances in data visualization can best communicate actionable knowledge and key insights to diverse stakeholder groups. All talks from this event are available on the NAS Colloquia YouTube channel.



Indy Big Data Conference, Indianapolis, Indiana

# Host the Exhibit

Put your institution on the map by hosting *Places & Spaces*. The exhibit consists of 100 framed, high-resolution maps, and twelve interactive macroscopes that travel on a touchscreen kiosk. Ingo Günther's *WorldProcessor Globes*, hands-on science maps for kids, the *Illuminated Diagram*, and the award-winning film *Humanexus* are also included. Give your audience the chance to play with data and make sense of science.

The *Places & Spaces* exhibit travels in a variety of formats to fit every space and budget. Explore our all-digital options, purchase individual maps, or purchase a poster version of the exhibit. Our digital display is a high-resolution slide show of 100 exhibit maps, optimized for showing the full breadth of the exhibit on one screen. The majority of our exhibit maps are also available for individual purchase or as an archival set. All maps are 24" x 30" (61 x 76 cm) and can be ordered as inkjet prints, high-quality archival prints, and framed prints. Visit our website to explore the many ways you can bring the exhibit to your space ([scimaps.org/store](http://scimaps.org/store)).

Contact us at [recorde@indiana.edu](mailto:recorde@indiana.edu) for a quote and to check availability for your exhibition dates.

You can also find *Places & Spaces* in the archives of the **New York Public Library, Stanford University, American University of Beirut, US Library of Congress, University of Michigan, and Indiana University**.



Framed maps on display at Vanderbilt University



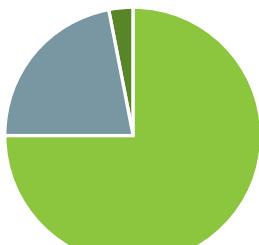
"Shape of Science," one of three *World Processor Globes* in the exhibit

# Exhibit in Numbers

## Finances

Exhibit finances are managed by the Cyberinfrastructure for Network Science Center at the School of Informatics, Computing, and Engineering at Indiana University. Shown below are exhibit income expenditures for January 1–December 31, 2017.

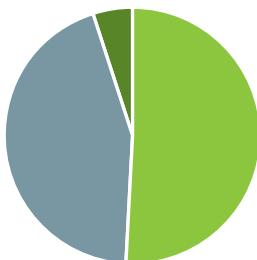
2017 EXPENSES



Total: \$37,524

Salaries	\$28,174
Design & Venue Acquisition	\$8,249
Workshops & Events	\$1,101

2017 REVENUE



Total: \$37,524

CNS Support	\$19,093
Venue Contributions & Other Revenue	\$16,610
Map Sales	\$1,821

100

### MAPS

in large format, full color, and high resolution.

215

### MAPMAKERS

from fields as disparate as art, urban planning, engineering, and the history of science.



30



### MACROSCOPE MAKERS

including one whose job title is “Truth and Beauty Operator.”

12

### MACROSCOPES

for touching all kinds of data.

375

### DISPLAY VENUES

from the Cannes Film Festival to the World Economic Forum.



221

### PRESS ITEMS

including articles in *Nature*, *Science*, *USA Today*, and *Wired*.

# Resources

## Books, Essays, and Websites

Börner, Katy. 2010. *Atlas of Science: Visualizing What We Know*. Cambridge, MA: The MIT Press. ([scimaps.org/atlas1](http://scimaps.org/atlas1))

Börner, Katy. 2015. *Atlas of Knowledge: Anyone Can Map*. Cambridge, MA: The MIT Press. ([scimaps.org/atlas2](http://scimaps.org/atlas2))

Börner, Katy, and David E. Polley. 2014. *Visual Insights: A Practical Guide to Making Sense of Data*. Cambridge, MA: The MIT Press.

Börner, Katy, and Adam Maltese, Russell Nelson Balliet, and Joe Heimlich. 2015. "Investigating Aspects of Data Visualization Literacy Using 20 Information Visualizations and 273 Science Museum Visitors." *Information Visualization* 15 (3): 198-213.

Boyack, Kevin W., and Katy Börner, eds. 2014. "Mapping Science." Special issue, *Bulletin of the Association for Information Science and Technology* 41 (2).

Scharnhorst, Andrea, Katy Börner, and Peter van den Besselaar, eds. 2012. *Models of Science Dynamics: Encounters Between Complexity Theory and Information Sciences*. Berlin: Springer-Verlag.

Shiffrin, Richard M., and Katy Börner, eds. 2004. "Mapping Knowledge Domains." Special issue, *PNAS* 101 (Suppl. 1).

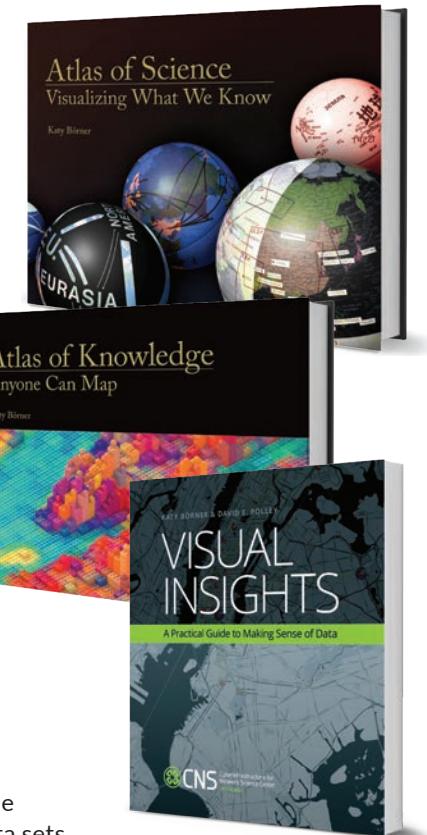
YouTube. NAS Colloquia Channel. ([youtube.com/user/SacklerColloquia](https://youtube.com/user/SacklerColloquia))

## Tools

Science of Science (Sci2) Tool ([sci2.cns.iu.edu](http://sci2.cns.iu.edu)) is a desktop application that was specifically designed for the study of science. It supports the temporal, geospatial, topical, and network analysis and visualization of data sets at the micro (individual), meso (local), and macro (global) levels.

## Courses

The IVMOOC ([ivmooc.cns.iu.edu](http://ivmooc.cns.iu.edu)) course provides an overview about the state of the art in information visualization. It teaches the process of producing effective visualizations that take the needs of users into account.





*Places & Spaces: Mapping Science*

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