

# MAKING SENSE OF SCIENCE

ANNUAL REPORT 2016

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# Letter from the Curators



Lisel Record and Katy Börner. Photo courtesy of Jon Erickson, Vanderbilt University.

For centuries, maps of earth, water, and sky have guided human exploration. They have marked the border between the known and the unknown, firing the imagination and fueling the desire for new knowledge and experiences. Today, science maps serve as visual interfaces to immense amounts of data. They depict information in ways that let us discern outliers, clusters, and trends. *Places & Spaces* features 100 maps of science and eight interactive data visualizations, called macrosopes, that travel to museums, universities, and libraries with the goal of opening people's hearts and minds to the value, complexity, and beauty of data.

As curators of *Places & Spaces*, we are privileged to work with those who believe that data visualization literacy is a critical skill and that visualizations are a highly effective way to render data into actionable knowledge. Every year we select submissions from experts around the globe and work with them to present maps and macrosopes that both inspire and inform.

Thanks are due to a number of exceptional people who have worked very hard to bring the 12<sup>th</sup> iteration of the exhibition to fruition, beginning with those who have graciously allowed us to include their work in the exhibit. Additionally, we are deeply grateful to the women and men who serve on the Advisory Board or as exhibit ambassadors throughout the world. This effort is larger than each one of us, and we could not do it without you.



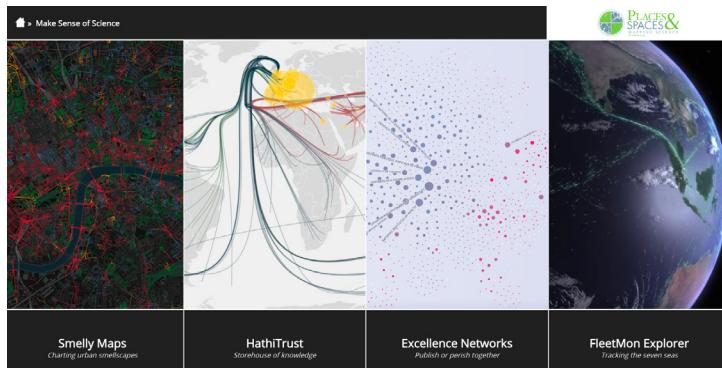
Discussing the macrosopes at ASTC in Tampa, Florida.

# 2016 Macroscopes

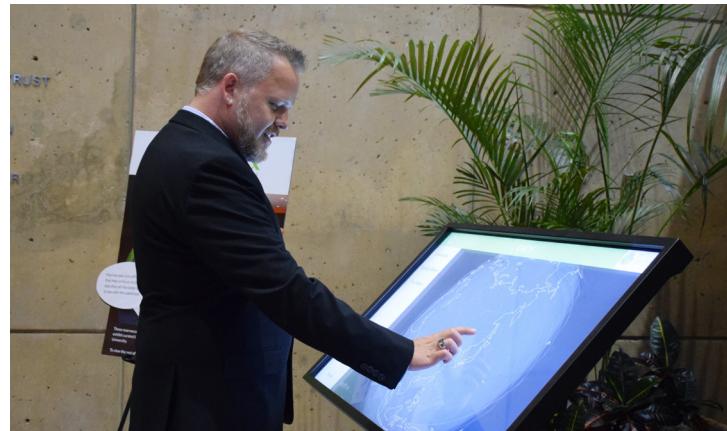
## Introduction

The *Places & Spaces: Mapping Science* exhibit, which operates as an outreach activity of the Cyberinfrastructure for Network Science Center (CNS), arises from CNS's core belief that the ability to make sense of data is as critical as the ability to read and write. New tools to assist people in this endeavor are continually evolving, and this progress is evident in the quality of interactive science visualizations being developed today.

The exhibit continues to evolve each year. It includes 100 maps of science, eight interactive macroscopes, three of Ingo Günther's *WorldProcessor Globes*, two hands-on science maps for kids, the *Illuminated Diagram*, and the award-winning film *Humanexus. Places*



The four macroscopes added in 2016.



Exploring the microscope kiosk at the Eskenazi Museum of Art in Bloomington, Indiana.

& Spaces was first shown at the annual meeting of the Association of American Geographers in 2005. Since then, the exhibition has traveled to 354 venues in 28 countries on 6 continents, showcasing the work of 215 mapmakers and 24 microscope makers.

## Macroscopes

Macroscopes are software tools that help people focus on patterns in data that are too large or complex to see unaided. The world is a complex place, and macroscopes help us understand and manage that complexity. They are visual lenses we can use to see patterns and trends in large volumes of data.

The four macroscopes chosen for inclusion in the exhibit in 2016 use data that varies tremendously in terms of subject matter and method



Attendees at 2016 Supercomputing Conference explore *Smelly Maps* to see how London smells. Photo courtesy of Mike Boyles.

of collection: city smells derived from social media posts, metadata from a digital library, institutional collaborations revealed through publications, and ships tracked by satellite. Each showcases a different approach for mapping data over time and space and for guiding interactive data exploration.

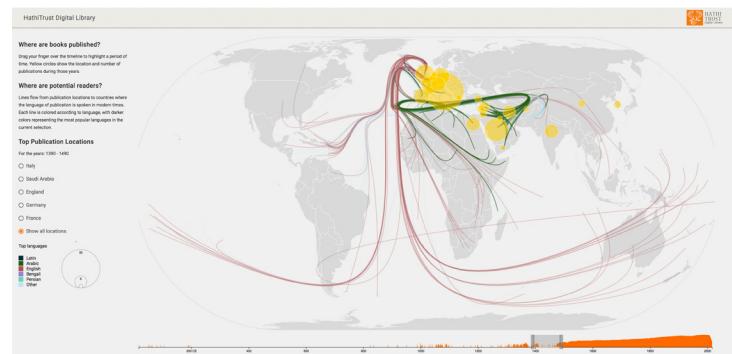
In creating *Smelly Maps*, the Good City Life team tapped into people's noses as a unique source of data. The team created a lexicon of smell-related words and then mapped geotagged social media posts containing smell-related terms to create smellscapes for 12 different cities. Users can click on a street to see how it smells.

*HathiTrust* explores the collective "elephant's memory" or storehouse of knowledge that is the HathiTrust Digital Library. Run by a

consortium of international research libraries, it serves as a shared and growing repository for digital copies of more than 14 million publications that span 2000 years. The temporal and linguistic diversity of the collection is made visible using freely available metadata.

While it may be simple to estimate which research institutions are at the top of their game, it is hard to create a statistical model to measure and map this. *Excellence Networks* illustrates how universities and other research institutions collaborate. The resulting networks show how successfully—in terms of citations—an institution has collaborated with others working in the same field.

The *FleetMon Explorer* tool maps data for use by the maritime industry and amateur ship spotters. Many ships carry transponders that transmit their location in real time. The exhibit now includes an animation created using *FleetMon Explorer* that shows one week of global ship traffic as seen from space.



The *HathiTrust* visualization draws connections between publishers and readers across the globe and over 2000 years.

# Venues & Events

## Envisioning Public Health

The David J. Sencer CDC Museum in Atlanta, Georgia, welcomed the *Places & Spaces* exhibit for nearly five months in 2016. CDC curator Louise Shaw worked with a team of scientists to add data visualizations created and used by CDC in the prevention of diseases and the management of public health. A scientific symposium with an inaugural lecture by Dr. Börner kicked off the exhibit opening. The symposium brought government, industry, and academic researchers together around the common theme of using visualization as a means of communicating threats and formulating responses in a public health context.



Representatives from Thomson Reuters, CDC, and *Places & Spaces* celebrate the opening of the exhibit.



Multimedia, multi-floor exhibit display at CDC.



Exhibit Ambassador Andrea Scharnhorst, Katy Börner, and Cassidy Sugimoto at the Deutsche Physikalische Gesellschaft Conference in Regensburg, Germany.

## Where in the World?

With 39 different *Places & Spaces* related talks, events, and exhibit venues in 2016, the exhibition has found itself in a variety of settings. On any given day, you might find the *Places & Spaces* macroscopes on display at the **Office of Economic Co-operation and Development's Blue Sky conference** in Ghent, Belgium, where policy makers, data users, and providers set long-term agendas for science, technology, and innovation. Or perhaps you will encounter a touch table showing the exhibit maps at the **National Institutes of Health** in Bethesda, Maryland. Complete archival collections of the printed maps now reside at the **American University of Beirut**, **US Library of Congress**, **University of Michigan**, and **Indiana University**. The digital exhibit appeared at **Dalhousie University** in Halifax, Canada, and the poster

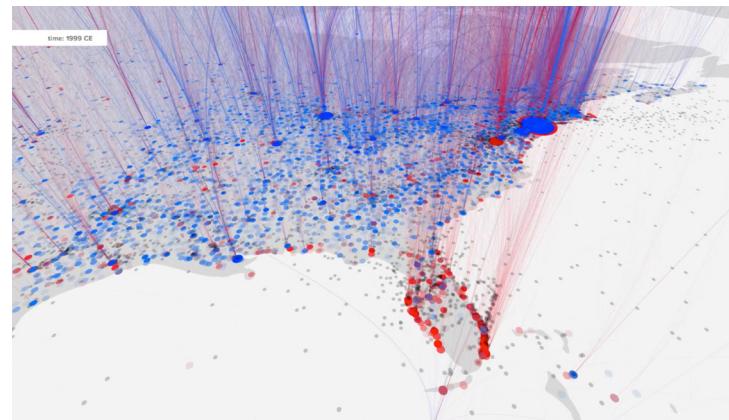
version at the **Institute of Complex Systems** in Paris, France, and at the **Universität Leipzig** in Germany. Pop-up versions of the microscope kiosk made appearances at the **Monroe County Public Library** and the **First Thursdays Art Festival** in Bloomington, Indiana.



Poster exhibit on view at the Global Tech Mining conference in Valencia, Spain.

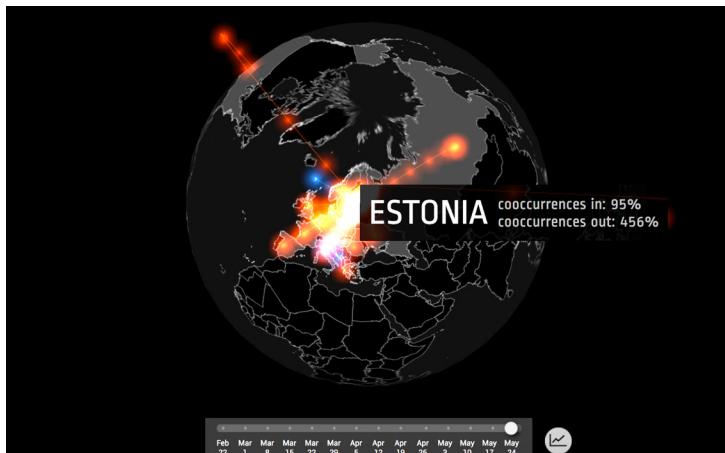
## Talking with Map and Macroscope Makers

The Indiana University Consortium for the Study of Religion, Ethics, and Society (CSRES) is an interdisciplinary association of scholars, academic programs, and research centers from the eight campuses of Indiana University. Support from CSRES provided the opportunity to launch a series of talks which brought macroscope makers and mapmakers to Bloomington, Indiana, during the spring of 2016. **Kalev Leetaru**, creator of the *Mapping Global News* macroscope and leader of the GDELT Project, talked about the challenges and excitement of “computing on the whole world.” **Mauro Martino**, an Italian data visualization expert based at IBM Watson’s Cognitive Visualization Lab, discussed the changing aesthetics of science and the revival of beauty in scientific research. Artist and Indiana University East art



*Charting Culture*, created by Maximilian Schich and Mauro Martino, illustrates the growth of Florida as a retirement destination.

professor **Carrie Longley** led a presentation and group brainstorm on artistic representations of data and the growth of science. A fourth talk by **Marc Smith**, sponsored by the Indiana University Data Science program, covered his work on mapping social media networks at the Social Media Research Foundation. All four talks provided rich



*Mapping Global News* shows connections between countries in the news.



*Information visualization is one of the most humanist corners of the computer sciences because it inherently is about the delivery of information to a human being.*

**Marc Smith, Sociologist, Social Media Research Foundation**





Kalev Leetaru, creator of the *Mapping Global News* macroscope, prepares for his interview.

opportunities for artists, scientists, and data specialists to gather around a common topic and to discuss using data visualization as a tool for gaining a new perspective on the world in which we all live.

Writer and former curator Todd Theriault took the opportunity to sit down with a number of map and macroscope makers to discuss their work, inspiration, and storytelling process. The resulting video interviews with **Kalev Leetaru**, **Mauro Martino**, and **Marc Smith** provide insight into the why behind their work and bring a human face to the exhibit. In a related project, doctoral student and filmmaker Andreas Bueckle interviewed **Carrie Longley**, creating a video featured on the public television show *Broad & High*. All of these videos are now viewable on the redesigned mapmakers page at [scimaps.org](http://scimaps.org).

## Map & Macroscope Makers

Since 2005, the exhibit has featured the imaginative and inspiring work of more than 250 artists, macroscope makers and mapmakers. A few of them have graciously agreed to take a few moments to discuss their work, how they got involved with the exhibit, and walk us through their creative processes.



Carrie Longley on communicating science through sculpture



Marc Smith: Taking snapshots of virtual communities.



Kalev Leetaru on how news stories create unlikely communities



How Mauro Martino uses dots and arcs to tell stories about culture



Ying-Fang Shen: Cultural History as personal memory



Ingo Günther: Artist of spherical information



Ward Shelley's work gives curious shape to cultural history



Andrea Scharnhorst: Classifying knowledge in the age of Wikipedia



Visit the gallery: A guided tour of *Places & Spaces* and the *Illuminated Diagram*

A glimpse of the newly designed map and macroscope makers page on [scimaps.org](http://scimaps.org).

# Artist Collaboration

With the idea of making the history of science tangible, curator Katy Börner and artist Carrie Longley collaborated on the creation of a 3-foot tall, clay sculpture that gives science a physical, three-dimensional form which invites playful interaction.

The sculpture embodies the idea that science, like mushrooms, can grow in many directions. Mushroom-shaped shelves represent different areas of science—from philosophy and astronomy at the base to neuroscience,

nanoscience, and other areas on top. There are five main branches of science and many shelves span multiple branches, symbolizing interdisciplinary connections. As time progresses upwards, science grows in scope and activity. There is growth to the future and erosion to the past. Ideas serve as nutrients, spawning new outgrowths. Shelves differ in size, indicating the volume of scientific research in that area.

Pathways tunnel through the sculpture so visitors can trace the evolution of scientific ideas back to their origins using marbles. Simply place a marble at the contemporary, top level and observe areas of science it travels through before it reaches the bottom. Since many sciences draw



Artist Carrie Longley at work in her Brookville, Ohio, studio. Photo courtesy of Andreas Bueckle.



Collaborations at the intersection of art and science take center stage at the Grunwald Gallery of Art.

on more than one area of research, different runs will result in alternative marble trajectories. Some intellectual journeys are gentle, steady paths while others make for wild rides.

The sculpture was displayed as part of *[RE]imagining Science*, an exhibit at the Grunwald Gallery of Art at Indiana University that featured a number of artist/scientist collaborations.



Visitors use yellow marbles to trace the evolution of scientific ideas in this 3D representation of the history of science.

# Research

While the exhibit endeavors to share forward-thinking visualization efforts with a broad audience, many exhibit contributors are also at the forefront of related research efforts, shaping the future of Science and Technology (S&T) studies and interactive visualization development.

In February 2016, Katy Börner presented an invited talk for the *New Science Roadmaps for Global Research* symposium at the **AAAS Annual Meeting** in Washington, DC. Ben Shneiderman organized the symposium. Rita R. Colwell, former Director of the National Science Foundation, and James Hendler, one of the originators of the Semantic Web, also spoke.



Joe Heimlich, Katy Börner, Peggy Monahan, Andee Rubin, and Bryan Kennedy after their panel on data visualization literacy.



Rita Colwell, Ben Shneiderman, James Hendler, Katy Börner, and Peter Arzberger at the AAAS Annual Meeting.

Several mapmakers and exhibit advisors presented at the **Institute for Pure & Applied Mathematics (IPAM)** workshop on *Culture Analytics and User Experience Design*. Recorded presentations by Philip Beesley, Sara Fabrikant, Danyel Fisher, Ingo Günther, Eric Rodenbeck, Andre Skupin, Stephen Uzzo, and many others can be found at [tinyurl.com/kvpjtsn](http://tinyurl.com/kvpjtsn).

Both exhibit curators attended the annual **Association of Science-Technology Centers** annual meeting to present maps and macrosopes and to lead a panel on *Data Visualization Literacy: Assessing and Improving Visitors' Abilities to Read and Make Data Visualizations*. Panelists from the New York Hall of Science, the Science Museum of Minnesota, the Center of Science and Industry, and the Technical Education Research Centers shed light on data visualization literacy in a science center setting. Slides can be found at [cns.iu.edu/workshops/event/160924.html](http://cns.iu.edu/workshops/event/160924.html).

Katy Börner and fellow Indiana University informatics professor Staša Milojević organized an agenda-setting conference on **Modelling Science, Technology & Innovation** ([modsti.cns.iu.edu](http://modsti.cns.iu.edu)) at the National Academy of Sciences. The conference brought together leading experts from economics, social science, scientometrics, bibliometrics, information science, physics, and science policy that develop a variety of mathematical, statistical, and computational models. The final report ([modsti.cns.iu.edu/report](http://modsti.cns.iu.edu/report)) summarizes opportunities and challenges associated with using models in science, technology, and innovation for decision making.

As the year came to a close, the IU team co-organized a workshop on the **Web of Science as a Research Dataset** ([cns.iu.edu/workshops/event/161114.html](http://cns.iu.edu/workshops/event/161114.html)) with colleagues from the University of



Staša Milojević and Katy Börner at the Modelling Science, Technology & Innovation conference in May. Photo courtesy of Andreas Bueckle.



The ModSTI Conference at the National Academy of Sciences in Washington, DC. Photo courtesy of Andreas Bueckle.

Chicago and Clarivate Analytics, formerly Thomson Reuters. The workshop brought together data scientists and data stewards from research centers that are using the Web of Science at scale. Future technical, research, and community hackathons on this and other key datasets are planned.

*We define data visualization literacy as the ability to make meaning from and interpret patterns, trends, and correlations in visual representations of data.*

Katy Börner, Adam Maltese, Russell Nelson Balliet, and Joe Heimlich, 2015

# Exhibit Advisors

Advisory board members review exhibition submissions and provide their expertise and guidance to the exhibition on many levels. Meet the newest advisory board member, who joined the board earlier this year:



**Olga Subirós** is a curator specializing in projects that take an integrative approach to 21st century culture and the far-reaching transformations of the digital age. With José Luis de Vicente, she recently co-curated *Big Bang Data*, a major exhibition of different kinds of data-driven artworks and objects that offer an insight into the world of big data. *Big Bang Data* has been exhibited in Santiago de Chile, London, Buenos Aires, and Madrid. It will travel to Mexico City and Prague in 2017.

Subirós is also 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. She was the architect for the Dora García installation at the Spanish Pavilion at the 2011 Venice Biennale, and for the set of the television programme Die Klau Mich Show, featuring Dora García (Documenta 13, Kassel 2012). 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).



**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]



**Bob Bishop** is chairman and founder of BBWORLD Consulting Services Sàrl and president and founder of the ICES Foundation. In addition, Bishop is involved in a range of global initiatives: he is a Fellow of the Australian Davos Connection (ADC), an elected member of the Swiss Academy of Engineering Sciences (SATW), and serves on the advisory panels for the École Polytechnique Fédérale de Lausanne's Blue Brain Project and Human Brain Project. [Geneva, Switzerland]



**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]



**Sara Irina Fabrikant** is a professor of geography and head of the Geographic Information Visualization and Analysis (GIVA) group at the GIScience Center at the Geography Department of the University of Zürich, Switzerland. She is the elected chair of the Cognitive Visualization Commission of the International Cartographic Association, and she serves on the editorial boards of eight of the leading journals in GIScience and cartography. [Zürich, Switzerland]



**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]



**Eric Rodenbeck** is founder and creative director of the San Francisco-based design and technology studio, Stamen Design. Since 1997, he has worked with interactive design to extend the boundaries of online media and live information visualization. In 2008, he was named one of *Esquire* magazine's "Best and Brightest" new designers and thinkers, and one of *i-D* magazine's top 40 designers to watch. [San Francisco, CA, 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]



**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]



**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]



**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]

# Looking Forward

The exhibit continues to grow and change, which is fitting given the fast pace of science and technology development and steady advances in data visualization. The variety of hardware solutions for sharing innovative data visualizations continues to expand and improve and we look forward to touching data in new ways, both physically and virtually in three dimensions.

Collaborations involving augmented reality and the living architectures of Philip Beesley are in the planning stages. Beesley's team in Toronto, Canada, creates installations that sense and respond to visitors. The CNS team is developing augmented reality overlays for these smart environments to allow visitors to see sensors, actuators, and signal flows within the installations.



Philip Beesley talks about his Living Architecture installation at the National Academy of Sciences. Photo courtesy of Andreas Bueckle.



The Science Centre World Summit will take place in Tokyo, Japan, in 2017.

In June 2017, the exhibit will be on display at the **NetSci Conference**, Indianapolis, Indiana. Dr. Börner will deliver talks at the **NetSciEd6: Network Science and Education and Knowledge Networks in Science and Technology** satellite symposia. In July, curator Lisel Record will be sharing strategies for defining and measuring the success of digital interactives at the **Association of Midwest Museums** in Des Moines, Iowa. In November, Dr. Börner is co-organizing a panel titled **Visualizing STEAM Data in Support of Smart Decision Making** at the **Science Centre World Summit** in Tokyo, Japan.

Drs. Börner, Rouse, and Stanley are organizing a December 2017 Sackler colloquium on **Modelling and Visualizing Science and Technology Developments** sponsored by the National Academy of Sciences. Sackler colloquia facilitate discussions among experts on topics of broad and current interest, cutting across disciplinary boundaries. Registration for the event in Irvine, California, will open in August 2017.

# Host the Exhibit

## Bring *Places & Spaces* to Your Institution

Put your institution on the map by hosting *Places & Spaces*. The exhibit consists of 100 framed, high-resolution maps, and eight 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 touch data and make sense of science.

*Share these educational science maps with your whole institution by becoming an official exhibit host!*

The exhibit typically requires 250 linear feet of wall space and 350 square feet of floor space, but can be modified for a variety of spaces and budgets. Contact us at [recorde@indiana.edu](mailto:recorde@indiana.edu) for a quote and to check availability for your exhibition dates.

## Think Outside the Frame!

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)).

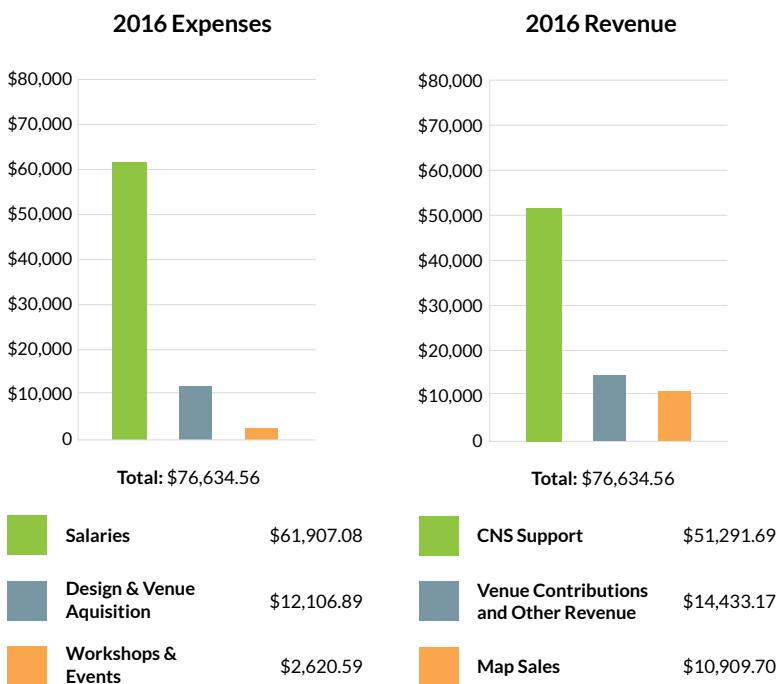


Maps on display at the University of Miami. Photo courtesy of the University of Miami.

# Exhibit in Numbers

## Finances

Exhibit finances are managed by the Cyberinfrastructure for Network Science Center at the School of Informatics and Computing, Indiana University. Shown below are exhibit expenses and revenue for January 1 - December 31, 2016.



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.



24



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

8

**MACROSCOPES**  
for touching all kinds of data.

354

**DISPLAY VENUES  
AND EVENTS**  
from the Cannes Film Festival  
to the World Economic Forum.



214

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

5



**NEW CITIES**  
visited in 2016 including Ghent,  
Belgium, and Valencia, Spain.

4,378,916

**WEBSITE VISITS**  
to [scimaps.org](http://scimaps.org) since 2005.

# Resources

## Books & Essays

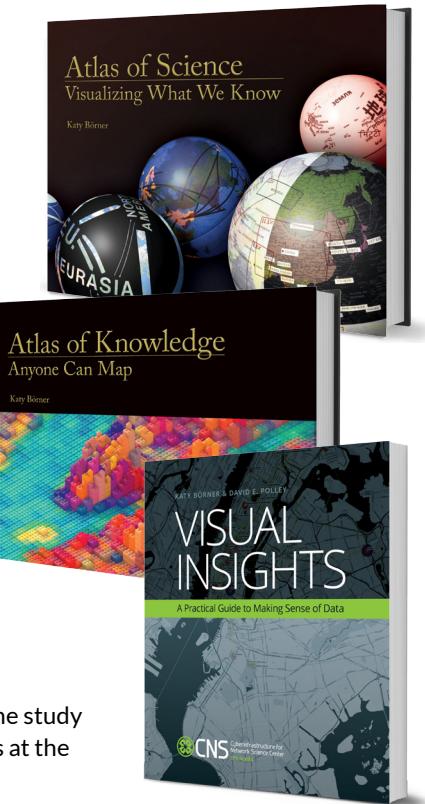
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## Tools

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 of current practices in information visualization.





*Places & Spaces: Mapping Science*

Cyberinfrastructure for Network Science Center (CNS)

School of Informatics and Computing

Indiana University

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

 /mappingscience

 @mappingscience

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James S. McDonnell Foundation

