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***Nanoscale Science and Engineering Center***

at University of California, Santa Barbara

**Final Report**

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### **3. PROJECT SUMMARY**

Funded by the NSF in 2005, the Center for Nanotechnology in Society at UCSB (CNS-UCSB), along with its sister CNS at ASU, has constituted an unparalleled national commitment to upstream societal research and education to enhance responsible development of a new suite of sophisticated materials and technologies central to the nation's economic development plans. As we reach the 11-year conclusion of this effort, this enterprise provides abundant proof of concept via an unrivaled set of scholarly, educational, and societal outcomes that serve as a solid framework for future social science/science & engineering (S&E) collaborations at center scale.

#### **Mission and Goals**

CNS-UCSB has been dedicated to understanding the relationship between technological innovation and social change and to advancing a role for the social, economic, and behavioral sciences in promoting development of equitable and sustainable technological innovation. We argue that successful development of the transformative and beneficial technologies anticipated by the country's leaders depends on systematic knowledge about complex societal as well as technical factors, situated within a dynamic global system of innovation, production, and consumption, and on development of new research-based approaches to governance, democratic participation, safety, and risk.

The global vision for nanotechnology to mature into a transformative technology that furthers social aims in tandem with economic goals depends on an array of complex and interconnected factors situated within a rapidly changing international economic, political, and cultural environment. The NSF Center for Nanotechnology in Society at UCSB has pursued an integrated portfolio of interdisciplinary societal research on the challenges to the successful, responsible development of nanotechnology in N America, Europe, Asia, and Latin America at a time of sustained technological innovation. The Center has incorporated education for a new generation of social science and nanoscience professionals as it has fostered research on the innovation and development systems for nanoscale technoscience across space and time, in conjunction with analysis of the societal meanings attributed to such emergent technologies by diverse stakeholders. CNS-UCSB contributes to responsible development by engaging with those key stakeholders: scientists, toxicologists, policymakers and regulators, EH&S personnel, nanomaterials industries, public and public interest groups, and journalists in the global North and South.

#### **Intellectual Merits**

CNS-UCSB has leveraged UCSB's renowned interdisciplinary climate to integrate the work of leading nanoscale scientists and engineers with social scientists studying responsible development of nanotechnologies. The Center's research focuses on highly iterative approaches to: 1) the effects of industrial policies and international collaboration on the globalization of nanotechnology, particularly in the US, Asia and Latin America; 2) expert and public perceptions of nanotechnologies' benefits and risks, and methods to advance public participation; and 3) the historical and institutional origins of the nano-enterprise. Crosscutting initiatives have targeted nanotech applications for solar and other renewable energies, environment, water, health, food, and the global value chain. These three research groups, along with seed grantees and strategic projects, have made over 1188 total presentations (748 of them in this award, 432 to scholarly social science and science and society audiences) and

generated almost 600 publications (305 in this award and another 197 in the pipeline), which lay the groundwork for understanding the development of emerging technologies. Our researchers have achieved over 300 honors and awards (212 in this award), and have extended the impact of NSF's 10-year investment of \$13,099,715 (\$7,077,759 in the current award) by raising over \$26 million in leverage in this award alone with an additional \$2,272,372 in cost sharing and other institutional support in this award (total \$4,178,065 over the life of the Center).

The Center's research program was designed as a systematic analysis of contemporary and historical aspects of nanoscale science and engineering (NSE) policy and innovation systems for successful commercialization, globalization as a key factor in comparative economic development in the United States, China, Korea, Japan, Europe, and Latin America, and emerging perceptions of and regulatory actions on nanotechnologies as media and diverse publics become aware of them. The critical organizing frame for CNS-UCSB is that of *socially and environmentally sustainable innovation*, in which we integrate historical, global economic, and social and psychological factors in formative analysis of the nano-enterprise and other emerging technologies in relation to these goals. Research in the current award has been organized into three interdisciplinary research groups (IRGs): **IRG 1 – *Origins, Innovations, and Institutions*** has sought to develop a rich understanding of the historical underpinnings of the current landscape of the nano-enterprise; **IRG 2 – *Globalization and Nanotechnology*** examined nanotechnology development under differing governmental approaches in China, Japan, and Korea, the United States, and in Latin America, to ask how different industrial policies, investment strategies, and labor practices in combination with international cooperation and collaboration among researchers, shape distinctive nanoscience and industry outcomes across nations; **IRG 3 – *Risk Perception and Social Response***—focused on understanding the dynamic nature of publics' and experts' perceptions and social intelligence about nanotechnologies and comparative other emerging technologies, social amplification and attenuation of risk, and methods for effective and equitable public engagement and deliberation. In addition, **X-IRG projects** have addressed strategic topics that span and integrate IRGs (e.g., nano solar energy, the global value chain project on nano industry, media framing of nanotech, nano lab ethnography). **Seed Projects** have brought two new sets of societal researchers into dialogue with CNS as the Center's maturing research portfolio expanded to include comparative analysis of other emerging technologies for energy, water, food, and health development.

Together the results of this integrated research program provide a comprehensive understanding of current processes and societal interactions for economically successful and socially responsible development, commercialization, and global distribution of nanotechnologies. CNS-UCSB has used a strategic mixture of social, cultural, historical, economic, political, psychological, and bibliographic methods to address these issues at different scales, temporal frames, and resolutions. The composite picture of the growing nano-enterprise and other emerging technologies rendered by CNS-UCSB's research portfolio identifies and analyzes the critical issues for the safe, successful, *responsible and sustainable development* of nanotechnologies in the global society. Important features of our collective approach are an integrated, participatory relationship with nanoscientists and engineers; a focus on specific nanotechnologies such as nanoelectronics, nanoparticles such as quantum dots, thin films, and nanoporous materials; comprehensive consideration of their applications in industries like electronics, energy, environmental, food, and health; developing understanding of views of multiple stakeholders as critical to societal outcomes and public participation; employment of advanced spatial analytic methods; a global framework for analysis; and expanding the societal initiative on emerging technologies into other emerging technologies.



In addition to extensive dissemination of CNS research at scholarly conferences and workshops (657 academic presentations, 432 in this award), synthesis of CNS-UCSB research has culminated in a series of volumes and publications now in print or in progress. First was a book for a wider public audience developed from the CNS-UCSB NanoEquity conference in Washington DC, *Can Emerging Technologies Make a Difference in Development?* edited by Parker and Appelbaum, Routledge, 2012. *The Social Life of Nanotechnology*, edited by Harthorn & Mohr with a foreword by Board co-Chair John Seely Brown, was published by Routledge in July 2012 and integrates all three research groups' work in a social science and historical analysis of innovation, public perception, and governance. In addition IRG 3 leaders Pidgeon, Harthorn & Satterfield co-edited a special issue of the leading journal, *Risk Analysis* (Nov 2011) of new research from the IRG 3 nanotech risk perception specialist meeting in Santa Barbara, CA in Jan 2010. IRG 1 researchers have produced a stellar series of award-winning books, e.g., Mody's *Instrumental Community: Probe Microscopy and the Path to Nanotechnology* (2011) and McCray's *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (2012). Appelbaum, and fellow IRG 2 researchers are far along in production of a new volume on *Technology and Innovation in China: China's Evolving Role in the Global Science and Technology System*. And Harthorn, Engeman, Appelbaum, and Han are developing a volume from the *Democratizing Technologies: Assessing the Role of NGOs in Shaping Technological Futures* conference (Nov 2014) that integrates scholarly and practitioner perspectives, in addition to their Report on the conference (Han, Engeman, Appelbaum and Harthorn 2015) (available for download at: <http://www.cns.ucsb.edu/demtech2014/welcome>).

In advancing a role for the social, economic and behavioral sciences in understanding and promoting development of equitable and sustainable technological innovation, CNS-UCSB serves as a solid framework for future social science/science & engineering (S&E) collaborations at the national center scale. Indeed, successful development of the transformative technologies anticipated by the country's leaders depends on systematic knowledge about complex societal as well as technical factors.

To this purpose, at the sunset of the CNS at UCSB, each of the three IRGs has generated a *Synthesis Report* on the main cumulative scholarly results and broader impacts of their nearly 11 years of programmatic research, education and engagement. All three are available for download from the CNS website: <http://www.cns.ucsb.edu/irg-synthesis-reports>

Each synthesis report includes a short, concise section on recommendations to policymakers, based on the research findings. The three are titled:

Appelbaum, Richard P. (2016) *CNS Synthesis Report on IRG 2: **Globalization and Nanotechnology: The Role of State Policy and International Collaboration***, (CNS-UCSB, Santa Barbara, CA), August, 2016

Harthorn, Barbara Herr, Nick Pidgeon and Terre Satterfield. (2016) *CNS Synthesis Report on IRG 3: **Understanding Nanotechnologies' Risks and Benefits: Emergence, Expertise & Upstream Participation***, (CNS-UCSB, Santa Barbara, CA), August, 2016

McCray, W. Patrick, Cyrus Mody, Amy Slaton, and Brian Terrell. (2016) *CNS Synthesis Report on IRG 1: **Exploring Nanotechnologies' Origins, Institutions, and Community: A Ten Year Experiment in Large Scale Collaborative STS Research***, (CNS-UCSB, Santa Barbara, CA), August, 2016

## Broader Impacts

**Education and Outreach programs at CNS-UCSB** have aimed to nurture an interdisciplinary community of nano scientists, social scientists, humanists, and educators who collaborate in CNS IRGs and achieve *broader impacts* through informed engagement of diverse audiences in dialogue about new technologies and society.

CNS-UCSB education has fostered a diverse and highly collaborative community of cross-disciplinary scholars, while consistently producing excellent outcomes for its participants. CNS's centerpiece graduate fellowship program has trained over 137 graduate and postdoctoral scholars (94 in the renewal award) from both social sciences and S&E in societal research, while mentoring 33 community college interns from underserved communities (17 in this award). The CNS seminar has drawn participants from over 30 disciplines, while outreach activities have engaged multiple audiences in over 536 outreach presentations (316 this award), reached 1000's of diverse public audiences, and included keynote addresses and expert testimony to dozens of governmental, intergovernmental and policymaking bodies in over 25 countries, many receiving media coverage. The Center has co-founded a thriving new international scholarly organization, and CNS has convened a series of influential major international conferences and specialist workshops on East and West Coasts to address leading edge technology in society concerns.

**Education.** CNS-UCSB's education and outreach programs, which are central to its mission, include a diverse range of students and participants. Beginning in 2008 CNS-UCSB has provided 3-5 postdoctoral researcher positions per year. A hallmark of CNS-UCSB education has been the introduction of scientists- and engineers-in-training into the methods and practices of societal research and their use to address responsible development. Graduate Fellowships and researcher positions for social science and NSE grads have enabled them to participate jointly in CNS IRG research and education. A CNS 8-week intensive summer undergraduate internship program run for 9 times over the duration of the CNS awards has successfully integrated diverse California community college students, many from lesser-served communities, into CNS research. Through a year-round bi-weekly seminar program, a speakers series, conferences and workshops large and small, visiting scholars, informal science education events for the public, new media dissemination, numerous public events with community members, and dedicated outreach to key sectors of government, industry, and NGOs, the CNS maintained a steadily increasing following of campus, local, and national and international media, and interest by government, industry, NGOs, and the general public.

The Center has provided novel interdisciplinary educational opportunities for a new generation of social science, humanities and nanoscience professionals via graduate fellowships (17 in the current award, 40 total since 2006, split almost evenly between the social sciences and NSE); graduate research assistantships at UCSB and across our collaborating institutions (71 total, 51 in this award); undergraduate summer research internships to regional community college students (17 in the current award, 40 overall) and undergrads at UCSB and partner institutions (26 in the current award, 30 total) who are mentored at UCSB by graduate students (17 mentorships in this award), and 3-5 interdisciplinary social science/humanities postdoctoral researchers per year (26 total, 23 in this award). CNS showed its commitment to educating a new generation of socially attuned researchers by convening a year-round graduate research seminar for credit that included scholarly discussion, professional training and development, research colloquia, and other activities for center graduate students, along with participation by postdocs, undergrads, visitors, faculty researchers and others. In the renewal award CNS

integrated content based on Center research into 80 courses for undergraduate and 40 for graduate students in all aspects of science, technology, and society education, has contributed to online course materials in the UC CEIN and the NSF NACK center at Penn State, and has developed and piloted a model curriculum for community college science and society education, a primary population for nano workforce development. In its final year CNS has conducted a focused research project to document and disseminate lessons learned from the novel S&E Fellows program that embeds S&E grads in the societal implications research enterprise, with one publication resulting (Fastman, Metzger and Harthorn 2016) and another in preparation.

Throughout these programs, CNS-UCSB has maintained that engaging with diversity is an ethical good, but that it is also a fundamental necessity in innovation and in disentangling the complicated social relations that surround an increasingly technological world.

**Outreach and Engagement.** CNS has aimed to disseminate both technological and social scientific findings related to nanotechnology in society to the wider public and to facilitate public participation in the nanotechnological enterprise through public engagement in dialogue with academic researchers from diverse disciplines. We have co-hosted NanoDays events every year for the past 10 years in the Santa Barbara community, with 1475 adults and children participating in the most recent. In addition, CNS also has participated in NanoDays at the Science Center of LA. CNS-UCSB has committed significant resources to conferences and workshops for diverse audiences, alternating smaller, more specialized meetings for researchers, including most recently, (*Emerging Technologies*, 2013) with larger-scale international conferences and workshops (*Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures* held at UCSB in Nov 2014, and partnered with local and national/international NGOs). In addition to its co-founding role in the S.NET, CNS serves as a key connection hub in the nano in society network, via speaker series, short- and medium-term visiting scholars, and as a dissemination point for research results (as requested by Chemical Heritage Foundation, UC Center for the Environmental Implications of Nanotechnology, and other partners). Outreach to still wider publics and interested parties has taken place via electronic forms such as the CNS-UCSB webpage [cns.ucsb.edu](http://cns.ucsb.edu), CNS-UCSB Facebook, Twitter, and RSS feeds, contributions to leading blogs such as *Science Progress*, *2020 Science*, and *Huffington Post*, podcasts of interviews with researchers, and media briefings, and research developing new media methods using Twitter and exploring online deliberation. The CNS also has engaged with and informed policymakers and governmental agencies (e.g., Appelbaum with OECD on global economic development, Block to Congress on similar issues, Harthorn in the ACS Congressional Briefing program, the US Presidential Commission on Bioethics, NNCO/NNI stakeholder meetings, the EU, the NPEC working group of the NNI and NNCO personnel as well as NAS, NIOSH and California's DTSC; Pidgeon on an ongoing basis to the UK House of Commons Science & Technology Select Committee inquiry on the Regulation of Geoengineering, and Energy Future (in which he draws on CNS nano research); and McCray to the World Economic Forum. CNS researchers have contributed to the UC CEIN evidence-based knowledge of the public, emerging views of nanotechnologies, and past risk controversies for use in developing risk reduction and risk management strategies with regulators and industry. Results of CNS research have been disseminated to wider audiences via traditional media as well as through concerted efforts to use new media (e.g., contributions of research and commentary to high impact and open access science journals that reach a wide array of industry, policy, and academic audiences, and also posts to the prominent blog, *Science Progress*, and *The Blog --Huffington Post*; development of online course materials; and interviews with nano and other science journalists.

#### 4. PARTICIPANTS

##### 4A. CENTER PARTICIPANTS

**Bold indicates Active**

<i>University of California, Santa Barbara (*co-funded)</i> <i>Senior Personnel</i>			
Name	Title	Department	Organization
<b>*Peter Alagona</b>	<b>Associate Professor</b>	<b>History &amp; Environmental Studies</b>	<b>UC Santa Barbara</b>
<b>Sarah Anderson</b>	<b>Associate Professor</b>	<b>BREN School of Environmental Science &amp; Management</b>	<b>UC Santa Barbara</b>
<b>Richard Appelbaum</b>	<b>Research Professor</b>	<b>Sociology, Global &amp; International Studies</b>	<b>UC Santa Barbara</b>
David Awschalom	Professor Director	Physics California NanoSystems Institute	UC Santa Barbara
<b>Javiera Barandiaran</b>	<b>Assistant Professor</b>	<b>Global &amp; International Studies</b>	<b>UC Santa Barbara</b>
<b>Edwina Barvosa</b>	<b>Associate Professor</b>	<b>Feminist Studies</b>	<b>UC Santa Barbara</b>
<b>Bruce Bimber</b>	<b>Professor</b>	<b>Political Science, Communication</b>	<b>UC Santa Barbara</b>
Tim Cheng	Professor	Electrical & Computer Engineering	UC Santa Barbara
Brad Chmelka	Professor	Chemical Engineering	UC Santa Barbara
Jennifer Earl	Professor	Sociology	UC Santa Barbara
William Freudenburg	Professor (deceased)	Environmental Studies	UC Santa Barbara
Fiona Goodchild	Education Director (Retired)	California NanoSystems Institute	UC Santa Barbara
Michael Goodchild	Professor (Retired)	Geography	UC Santa Barbara
<b>Barbara Herr Harthorn</b>	<b>Professor Director</b>	<b>Anthropology CNS-UCSB</b>	<b>UC Santa Barbara</b>
<b>Craig Hawker</b>	<b>Professor Director  Director</b>	<b>Chemical Engineering Materials Research Laboratory, MRSEC California Nano Systems Institute</b>	<b>UC Santa Barbara</b>
<b>Patricia Holden</b>	<b>Professor</b>	<b>BREN School of Environmental Science &amp; Management</b>	<b>UC Santa Barbara</b>

Name	Title	Department	Organization
George Legrady	Professor	Media Arts & Technology Program	UC Santa Barbara
<b>John Majewski</b>	<b>Professor Interim Dean</b>	<b>History Humanities and Fine Arts College of Letters &amp; Science</b>	<b>UC Santa Barbara</b>
<b>W. Patrick McCray</b>	<b>Professor</b>	<b>History of Science</b>	<b>UC Santa Barbara</b>
<b>Aashish Mehta</b>	<b>Associate Professor</b>	<b>Global &amp; International Studies</b>	<b>UC Santa Barbara</b>
<b>Miriam Metzger</b>	<b>Professor</b>	<b>Communication</b>	<b>UC Santa Barbara</b>
<b>John Mohr</b>	<b>Professor</b>	<b>Sociology</b>	<b>UC Santa Barbara</b>
Meredith Murr	Director	Research Development	UC Santa Barbara
Christopher Newfield	Professor	English	UC Santa Barbara
<b>David Novak</b>	<b>Associate Professor</b>	<b>Music</b>	<b>UC Santa Barbara</b>
<b>Lisa Parks</b>	<b>Professor Director</b>	<b>Film &amp; Media Studies Center for Information Technology &amp; Society (CITS)</b>	<b>UC Santa Barbara</b>
<b>Casey Walsh</b>	<b>Associate Professor</b>	<b>Anthropology</b>	<b>UC Santa Barbara</b>

<i>Sub-Award PIs</i>			
Name	Title	Department	Organization
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Joseph Conti	Assistant Professor	Sociology & Law	University of Wisconsin
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<b>Gary Gereffi</b>	<b>Professor</b>	<b>Sociology, Center for Globalization, Governance &amp; Competitiveness (CGGC)</b>	<b>Duke University</b>
<b>Robin Gregory</b>	<b>Senior Researcher</b>	<b>Psychology</b>	<b>Decision Research</b>
<b>Timothy Lenoir</b>	<b>Professor</b>	<b>New Technologies in Society, Literature &amp; Computer Science</b>	<b>Duke University</b>
	<b>Chair</b>	<b>Kimberly J. Jenkins for New Technologies in Society</b>	
<b>Cyrus Mody</b>	<b>Associate Professor</b>	<b>History &amp; Technology Studies</b>	<b>Rice University</b>
<b>Nicholas Pidgeon</b>	<b>Professor</b>	<b>Social Psychology</b>	<b>Cardiff University, United Kingdom</b>

Name	Title	Department	Organization
<b>Terre Satterfield</b>	<b>Professor / Director</b>	<b>Institute for Resources, Environment &amp; Sustainability (IRES)</b>	<b>University of British Columbia, Canada</b>
<b>Paul Slovic</b>	<b>President</b>	<b>Psychology</b>	<b>Decision Research</b>
<b><i>COLLABORATORS &amp; Other Funded Participants</i></b>			
Name	Title	Department	Organization
Nick Arnold	Professor	Physics & Engineering	Santa Barbara City College
David Azoulay	Managing Attorney	Environmental Law	The Center for International Environmental Law
Peter Asaro	Assistant Professor and Director of Graduate Programs	Philosopher of Science, Technology and Media	The New School, Campaign to Stop Killer Robots
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Sean Becker	Undergrad	Sociology	University of Wisconsin-Madison
Romanus Berg	Leadership Group Member & CIO	Information & Communication Technology	Ashoka: Innovators for the Public
Sebastian Bordirsky	Independent Consultant	Videographer	Berlin, Germany
Daryl Boudreaux	President	Commercialization	Boudreaux & Associates
Rebecca Braslau	Professor	Physical & Biological Sciences	UC Santa Cruz
Francesca Bray	Professor & Chair	Social Anthropology	University of Edinburgh
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Angelina Callahan	Postdoctoral Scholar	History, Sociology of Technology & Science	Georgia Institute of Technology

Name	Title	Department	Organization
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<b>Cong Cao</b>	<b>Professor, Head of SCCS</b>	<b>Sociology</b>	<b>University of Nottingham, Ningbo China</b>
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Jennifer Earl	Professor	Sociology	University of Arizona
Brenda Egolf	Research Scientist	Journalism	Lehigh University
Matthew Eisler	Lecturer	Engineering & Society	University of Virginia
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<b>Guillermo Foladori</b>	<b>Professor</b>	<b>Sociology</b>	<b>Universidad Autonoma de Zacatecas, Mexico</b>
Rider Foley	PhD Candidate	School of Sustainability	Arizona State University
John Gallo	Senior Scientist	Environmental Reserch & Policy	Conservation Biology Institute

Name	Title	Department	Organization
Jim Gimzewski	Professor	Chemistry & Biophysics	Design Media Arts, UC Los Angeles
Maryse de la Giroday	Independent Scholar	Science Communications	Vancouver, Canada
Nachshon Goltz	PhD Candidate	Law / Technology Regulation	York University, Canada
Jose Gomez-Marquez	Director	International Design Centre	Massachusetts Institute of Technology
Elizabeth Grossman	Journalist, Author	Environmental and Science Issues	Independent Journalist
Julia Guivant	Professor	Sociology & Political Science	Federal University of Santa Catarina, Brazil
M. Paz Gutierrez	Associate Professor	Architecture & Environmental Design	UC Berkeley
Hillary Haldane	Associate Professor	Anthropology	Quinnipiac University
Matthew Harsh	Assistant Professor	Engineering & Computer Science	Concordia University, Canada
<b>Jennifer Hawken</b>	<b>Consultant</b>	<b>Transcription</b>	<b>Independent Consultant</b>
Amy Heibel	Vice President	Technology, Web & Digital Media	Los Angeles County Museum of Art
Patrick Herron	Researcher	Data Mapping & Visualization	Duke University
Kenneth Hough	Graduate Student	History	UC Santa Barbara
Noela Invernizzi	Professor	Science & Technology Policy	Federal University of Parana, Brazil
Jacqueline Isaacs	Professor	Mechanical & Industrial	Northeastern University
Kirk Jalbert	PhD Candidate & Visiting Research Scientist	Science & Technology	Rensselaer Polytechnic Institute / FracTracker Alliance
Mikael Johansson	Faculty Program Director	Global Studies	University of Gothenburg, Sweden
Richard John	Professor	Graduate School of Journalism	Columbia University
Ann Johnson	Associate Professor	History of Science & Technology, Modern Europe	University of South Carolina
Matthew Jones	Associate Professor / Chair	Contemporary Civilization	Columbia University



Name	Title	Department	Organization
Dan Kahan	Elizabeth K. Dollard Professor of Law & Professor	Law & Psychology	Yale Law School
<b>Milind Kandlikar</b>	<b>Professor</b>	<b>Science Policy &amp; Regulation</b>	<b>University of British Columbia, Canada</b>
Sarah Kaplan	Associate Professor	Strategic Management	University of Toronto, Canada
Gul Karagoz-Kizilca	Assistant Professor	History	Ankara University, Turkey
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Matthew Keller	Assistant Professor	Sociology	Southern Methodist University
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David Kirby	Senior Lecturer	Science Communication Studies	University of Manchester
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Todd Kuiken	Senior Program Associate	Science and Technology Innovation Program	Woodrow Wilson International Center for Scholars
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Stuart Leslie	Professor	History of Science	John Hopkins University

Name	Title	Department	Organization
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Yasuyuki Motoyama	Senior Scholar	City & Regional Planning	Kauffman Foundation
Nadezhda M. Murray	Independent Consultant	Transcriber	Japan
Moses Kizza Musaazi	Senior Lecturer	Electrical & Computer Engineering	Technology for Tomorrow Ltd.
Maria Teresea Napoli	Evaluation Coordinator	Center for Science & Engineering Partnerships (CNSI)	UC Santa Barbara
Marian Negoita	Researcher	Sociology	Social Policy Research Associates
Rachel Nelson	PhD Candidate	Institute of the Arts and Science	UC Santa Cruz
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Joseph November	Associate Professor	History	University of South Carolina
Ari Olmos	Vice President of Operations	Global Operations & Worker Safety	LaborVoices
Andie Diane Palmer	Associate Professor	Civil & Environmental Engineering	University of Alberta
Poonam Pandey	Phd Candidate	Nanobiotechnology & Technology	Jawaharlal Nehru University, New Delhi

Name	Title	Department	Organization
Howard Park	Independent Consultant	Music	Santa Barbara, California
<b>Rachel Parker</b>	<b>Director of Research Programs</b>	<b>Sociology</b>	<b>Canadian Institute For Advance Research</b>
Eric Paulos	Assitant Professor	New Media Arts	UC Berkeley
Marko Peljhan	Assitant Professor	Medai Arts & Technology	UC Santa Barbara
Flavio Orlando Plenz	General Coordinator	Micro & Nanotechnology	Brazilian Ministry of Science, Brazil
Aida Ponce Del Catillo	Senior Researcher	Occupational Health & Safety	European Trade Union Institute, Belgium
Joel Primack	Professor	Astrophysics	UC Santa Cruz
Mathieu Quet	Researcher	Communication	IRD-IFRIS, France
Enrico Ramirez-Ruiz	Executive Director, Associate Professor	Astronomy & Astrophysics	UC Santa Cruz
Karen Reilly	Development Director	Inoformation Technology & Services	The TOR Project
Margaret Rhee	Graduate Student	History	UC Berkeley
Dorothy Roberts	Professor	Law & Sociology	University of Pennsylvania Law School
Patrick Roberts	Associate Professor	Public Administration & Policy	Virginia Tech
Mark Robinson	Assistant Professor	Anthropology, Science & Technology Studies/Ethics	DePaul University
Trust Saidi	PhD Candidate	Traveling Nanotechnologies	Maastricht University, Zimbabwe
Andrew Schroeder	Director of Research and Analysis	Geographic Information Systems	Direct Relief
Maya Schweizer	Independent Consultant	Videographer	Berlin, Germany
Jill Scott	Professor, Director of Studies	Art and Science Research	Institute for Cultural Studies in the Arts / Swiss artists-in-lab
Pankaj Sekhsaria	PhD Candidate	Nanotechnology Research	Maastricht University, India
Bhavna Shamasunder	Assistant Professor	Urban & Environmental Policy	Occidental College

Name	Title	Department	Organization
Philip Shapira	Professor	Public Policy	Georgia Institute of Technology / University of Manchester
Linsey Shariq	PhD Candiate	Civil & Environmental Engineering	UC Davis/Environmental Hazard Assessment at the California EPA
Asif Siddiqi	Associate Professor	History	Fordham University
Lawrence Siegel	Executive Director	Environmental - Water Safety	Safe Water International
<b>Denis Simon</b>	<b>Executive Vice Chancellor</b>	<b>Political Science</b>	<b>Duke Kunshan University</b>
Darius Sivin	Industrial Hygienist	Occupational & Environmental Health	United Auto Workers
<b>Amy Slaton</b>	<b>Professor</b>	<b>History &amp; Politics</b>	<b>Drexel University</b>
Marilynn Spaventa	Acting Executive VP	Sciences/Mathematics/ School of Modern Language	Santa Barbara City College
Andrew Stirling	Professor	Science & Technology Policy	University of Sussex, United Kingdom
<b>Galen Stocking</b>	<b>Research Associate</b>	<b>Political Science</b>	<b>PEW Research Center</b>
Kara Swanson	Assoc. Professor	Law	Northeastern University
Virginia Teige	PhD Candidate	Chemistry	UC Berkeley
Steve Usselman	Professor, Chair	School of History	Georgia Institute of Technology
Tarun Wadhwa	Writer, Researcher & Entrepreneur	Technology, international development, and public policy	Independent Journalist
Vivek Wadhwa	Fellow, Arthur & Toni Rembe Rock Center for Corporate Governance	Emerging Technologies	Stanford University
John Weber	Director	Institute of the Arts and Science	UC Santa Cruz
Amy K. Wolfe	Group Leader	Environmental Science	Oak Ridge National Laboratory
Jeffrey Womack	Masters Student	History	University of Houston
Thomas Woodson	Assitant Professor	Public Policy	Stony Brook University

Name	Title	Department	Organization
Xinyue Ye	Assistant Professor	Geography	Kent State University
Jan Youtie	Manager, Policy Services	Political Science	Georgia Institute of Technology
<b>Edgar Zayago Lau</b>	<b>Senior Researcher</b>	<b>Development Studies</b>	<b>Universidad Autonoma de Zacatecas, Mexico</b>
YanXiang Zhang	Associate Professor	New Media & Science Communication	University Science and Technology of China, P.R.China
Donghua Zhu	Vice Dean	Management & Economics	Beijing Institute of Technology, P. R. China

<b><i>UCSB Postdoctoral Researchers ( *co-funded)</i></b>			
Name	Title	Department	Organization / Co-Funding
*Mary Collins	Postdoctoral Researcher	Environmental Science & Management	UC Santa Barbara / UC CEIN
Meredith Conroy	Postdoctoral Researcher	Political Science	UC Santa Barbara
<b>*Lauren Copeland</b>	<b>Postdoctoral Researcher</b>	<b>Political Science</b>	<b>UC Santa Barbara / UC CEIN</b>
*Gwen D'Arcangelis	Postdoctoral Researcher	Women's Studies	UC Santa Barbara / UC CEIN
Matthew Eisler	Postdoctoral Researcher	History	UC Santa Barbara
<b>Xueying (Shirley) Han</b>	<b>Postdoctoral Researcher</b>	<b>Ecology, Evolution, &amp; Marine Biology</b>	<b>UC Santa Barbara</b>
Shannon Hanna	Postdoctoral Researcher	Environmental Science & Management	UC Santa Barbara
Mikael Johansson	Postdoctoral Researcher	Social Anthropology	UC Santa Barbara
<b>Luciano Kay</b>	<b>Postdoctoral Researcher</b>	<b>Public Policy</b>	<b>UC Santa Barbara</b>
Yasuyuki Motoyama	Postdoctoral Researcher	City & Regional Planning	UC Santa Barbara
<b>Tristan Partridge</b>	<b>Postdoctoral Researcher</b>	<b>Social Anthropology</b>	<b>UC Santa Barbara</b>
*Christine Shearer	Postdoctoral Researcher	Sociology	UC Santa Barbara / Harthorn-Deliberation
James Walsh	Postdoctoral Researcher	Sociology	UC Santa Barbara

Name	Title	Department	Organization
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***Non-UCSB Postdoctoral Researchers (\*co-funded)***

Name	Title	Department	Organization
<b>*Mary Collins</b>	<b>Postdoctoral Scholar</b>	<b>Environmental Studies</b>	<b>University of Maryland</b>
Adam Corner	Postdoctoral Researcher	Social Psychology	Cardiff University, United Kingdom
Christina Demski	Postdoctoral Researcher	Psychology	Cardiff University, United Kingdom
<b>*Darrick Evensen</b>	<b>Postdoctoral Researcher</b>	<b>Psychology</b>	<b>Cardiff University, United Kingdom</b>
<b>*Stacey Frederick</b>	<b>Postdoctoral Researcher</b>	<b>Textile Management</b>	<b>Duke University</b>
Matthew Keller	Postdoctoral Researcher	Sociology	UC Davis
Marian Negoita	Postdoctoral Researcher	Sociology	UC Davis
<b>*Anton Pitts</b>	<b>Postdoctoral Researcher</b>	<b>Risk Science</b>	<b>University of British Columbia</b>
*Christine Shearer	Postdoctoral Researcher	Earth Science & Sociology	UC Irvine
<b>*Merryn Thomas</b>	<b>Postdoctoral Researcher</b>	<b>Psychology</b>	<b>Cardiff University, United Kingdom</b>
James Walsh	Postdoctoral Researcher	Sociology	University of Pennsylvania

***UCSB Graduate Fellows***

Name	Title	Department	Organization
Peter Burks	Research Fellow, Science & Engineering	Chemistry, BioChemistry	UC Santa Barbara
Amanda Denes	Research Fellow, Science & Engineering	Communication	UC Santa Barbara
Roger Eardley-Pryor	Research Fellow, Social Science	History	UC Santa Barbara
Cassandra Engeman	Senior Research Fellow, Social Science	Sociology	UC Santa Barbara
<b>Ingrid Feeney</b>	<b>Research Fellow, Social Science</b>	<b>Anthropology</b>	<b>UC Santa Barbara</b>
Amy Foss	Research Fellow, Social Science	Chicano/a Studies	UC Santa Barbara

Name	Title	Department	Organization
<b>Matthew Gebbie</b>	<b>Research Fellow, Science &amp; Engineering</b>	<b>Materials Department</b>	<b>UC Santa Barbara</b>
<b>Laura Halcomb</b>	<b>Research Fellow, Social Science</b>	<b>Sociology</b>	<b>UC Santa Barbara</b>
Xueying (Shirley) Han	Research Fellow, Science & Engineering	Ecology, Evolution & Marine Biology	UC Santa Barbara
Shannon Hanna	Research Fellow, Science & Engineering	Bren School of Environmental Science & Management	UC Santa Barbara
<b>Bridget Harr</b>	<b>Research Fellow, Social Science</b>	<b>Sociology</b>	<b>UC Santa Barbara</b>
<b>Ariel Hasell</b>	<b>Research Fellow, Social Science</b>	<b>Communication</b>	<b>UC Santa Barbara</b>
Zachary Horton	Research Fellow, Social	English	UC Santa Barbara
Tyronne Martin	Research Fellow, Science & Engineering	Chemistry	UC Santa Barbara
<b>Louise Stevenson</b>	<b>Research Fellow, Science &amp; Engineering</b>	<b>Ecology, Evolution &amp; Marine Biology</b>	<b>UC Santa Barbara</b>
<b>Galen Stocking</b>	<b>Research Fellow, Social Science</b>	<b>Political Science</b>	<b>UC Santa Barbara</b>
<b>Brian Tyrrell</b>	<b>Research Fellow, Social Science</b>	<b>History (Environmental History)</b>	<b>UC Santa Barbara</b>

***UCSB Graduate Student Researchers & Research Assistants (\*co-funded)***

Name	Title	Department	Organization
*Lynn Baumgartner	Grad Student Researcher	Environmental Science & Management	UC Santa Barbara
<b>Rosie Bermudez</b>	<b>Grad Student Researcher</b>	<b>Chicano/a Studies</b>	<b>UC Santa Barbara</b>
*Erin Calkins	Grad Student Researcher	Chemistry, Biochemistry	UC Santa Barbara
<b>Clayton Caroon</b>	<b>Grad Student Researcher</b>	<b>Global &amp; International Studies</b>	<b>UC Santa Barbara</b>
*Benjamin Carr	Grad Student Researcher	Environmental Science & Management	UC Santa Barbara
*Mary Collins	Grad Student Researcher	Environmental Science & Management	UC Santa Barbara
Lauren Copeland	Grad Student Researcher	Political Science	UC Santa Barbara
Rachel Cranfill	Grad Student Researcher	Linguistics	UC Santa Barbara

Name	Title	Department	Organization
John V. Decemvirale	Grad Student Researcher	History of Art & Architecture	UC Santa Barbara
<b>Chloe Diamond-Lenow</b>	<b>Grad Student Researcher</b>	<b>Feminist Studies</b>	<b>UC Santa Barbara</b>
<b>Jacqueline Dodd</b>	<b>Grad Student Researcher</b>	<b>Economics</b>	<b>UC Santa Barbara</b>
Karin Donhowe	Grad Student Researcher	Economics	UC Santa Barbara
<b>Rachel Drew</b>	<b>Grad Student Researcher</b>	<b>Global &amp; International Studies</b>	<b>UC Santa Barbara</b>
<b>*Kieran Findlater</b>	<b>Postdoctoral Researcher</b>	<b>Institute for Resources, Environment &amp; Sustainability (IRES)</b>	<b>University of British Columbia</b>
*Allison Fish	Grad Student Researcher	Environmental Science & Management	UC Santa Barbara
Angus Forbes	Grad Student Researcher	Media Arts & Technology	UC Santa Barbara
Sheetal Gavankar	Grad Student Researcher	Environmental Science & Management	UC Santa Barbara
<b>Lisa Han</b>	<b>Grad Student Researcher</b>	<b>Film &amp; Media Studies</b>	<b>UC Santa Barbara</b>
Sarah Hartigan	Grad Student Researcher	Global & International Studies	UC Santa Barbara
Ariel Hasell	Grad Student Researcher	Communications	UC Santa Barbara
Abigail Hinsman	Grad Student Researcher	Film & Media Studies	UC Santa Barbara
Zachary Horton	Grad Student Researcher	English	UC Santa Barbara
Pehr Hovey	Grad Student Researcher	Media Arts & Technology	UC Santa Barbara
Indy Hurt	Grad Student Researcher	Geography, Geographic Information Science	UC Santa Barbara
Qiao Li	Grad Student Researcher	Global & International Studies	UC Santa Barbara
*John Meyerhofer	Grad Student Researcher	BREN School of Environmental Science & Management	UC Santa Barbara
Quinn McCreight	Grad Student Researcher	Global & International Studies	UC Santa Barbara
Zong (Zach) Miao	Grad Student Researcher	Computer Engineering	UC Santa Barbara
Margaret Moody	Grad Student Researcher	Education	UC Santa Barbara
Kristen Nation	Grad Student Researcher	UCSC	UC Santa Barbara
<b>Isabel Ochoa</b>	<b>Grad Student Researcher</b>	<b>Global &amp; International Studies</b>	<b>UC Santa Barbara</b>



Name	Title	Department	Organization
Lumari Pardo-Rodriguez	Grad Student Researcher	Global & International Studies	UC Santa Barbara
Shadi Roshandel	Grad Student Researcher	Education	UC Santa Barbara
<b>Alexander Scarlett</b>	<b>Grad Student Assistant</b>	<b>Latin American &amp; Iberian Studies</b>	<b>UC Santa Barbara</b>
Elizabeth Sciaky	Grad Student Researcher	Education	UC Santa Barbara
<b>Marissa Taggart</b>	<b>Grad Student Researcher</b>	<b>Global &amp; International Studies</b>	<b>UC Santa Barbara</b>
<b>Caitlin Vejby</b>	<b>Grad Student Researcher</b>	<b>Global &amp; International Studies</b>	<b>UC Santa Barbara</b>
Adélaïde Veyre	Grad Student Researcher	Political Science	UC Santa Barbara
Anna Walsh	Grad Student Researcher	Global & International Studies	UC Santa Barbara
David Weaver	Grad Student Researcher	Political Science	UC Santa Barbara
Christopher Wegemer	Grad Student Researcher	Global & International Studies	UC Santa Barbara
Rong Yang	Grad Student Researcher	Department of Education	UC Santa Barbara

<b><i>Non-UCSB Graduate Student Researchers</i></b>			
Name	Title	Department	Organization
Jennifer Bayzick	Grad Student Researcher	Journalisim & Communication	Lehigh University
Parul Baxi	Grad Student Researcher	Sociology	UC Davis
Christian Beaudrie	Grad Student Researcher	Institute for Resources, Environment & Sustainability (IRES)	University of British Columbia, Canada
Megan Callahan	Grad Student Researcher	Institute for Resources, Environment & Sustainability (IRES)	University of British Columbia, Canada
Laura DeVries	Grad Student Researcher	Institute for Resources, Environment and Sustainability (IRES)	University of British Columbia, Canada
Lanceton Mark Dsouza	Grad Student Researcher	Jenkins Collaboratory	Duke University
<b>Maery Kaplan-Hallam</b>	<b>Grad Student Researcher</b>	<b>Institute for Resources, Environment &amp; Sustainability (IRES)</b>	<b>University of British Columbia, Canada</b>
Matthew Keller	Grad Student Researcher	Sociology	UC Davis

Name	Title	Department	Organization
<b>Chaerean Kim</b>	<b>Grad Student Researcher</b>	<b>Institute for Resources, Environment &amp; Sustainability (IRES)</b>	<b>University of British Columbia, Canada</b>
Aaron McGuire	Grad Student Researcher	Jenkins Collaboratory	Duke University
Miguel Ruiz	Grad Student Researcher	Sociology	UC Davis
<b>Laura Saldivar-Tanaka</b>	<b>Grad Student Researcher</b>	<b>Anthropology</b>	<b>Colegio de Mexico</b>
Matthew Thomas	Grad Student Researcher	Jenkins Collaboratory	Duke University
Brittany Shields	Grad Student Researcher	History & Sociology	University of Pennsylvania

<b><i>Undergraduate, High School Interns &amp; Researchers (UCSB, Community Colleges &amp; High Schools)</i></b>			
Name	Title	Department	Organization
Brent Boone	Undergrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara
Angela Burger	Undergrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Sergio Cardenas	Undergrad Student Researcher	CNS-UCSB / IRG1	College of the Canyons
Cecilia Choi	Undergrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara
Hannah Cruz	Undergrad Student Researcher	CNS-UCSB / IRG3	Dos Pueblos High School
Andi Docktor	Undergrad Student Researcher	CNS-UCSB / IRG2	UC Santa Barbara
Andi Diaz	Undergrad Student Researcher	CNS-UCSB / IRG2	UC Santa Barbara
<b>Jesus Diera</b>	<b>Undergrad Student Researcher</b>	<b>CNS-UCSB / IRG2</b>	<b>UC Santa Barbara</b>
<b>Catherine Enders</b>	<b>Undergrad Student Researcher</b>	<b>CNS-UCSB / IRG3</b>	<b>UC Santa Barbara</b>
<b>Katrina Fernandez</b>	<b>Undergrad Student Researcher</b>	<b>CNS-UCSB</b>	<b>UC Santa Barbara</b>
Gianna Haro	Undergrad Student Researcher	CNS-UCSB / IRG1	Santa Barbara City College
Katherine He	Undergrad Student Researcher	CNS-UCSB / XIRG	UC Santa Barbara

Name	Title	Department	Organization
Simone Jackson	Undergrad Student Researcher	CNS-UCSB / IRG3	Allan Hancock College
Paul Kovacs	Undergrad Student Researcher	CNS-UCSB / IRG1	Santa Barbara City College
Megan Kelley	Undergrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Kelly Landers	Undergrad Student Researcher	CNS-UCSB / IRG2	Santa Barbara City College
Alexander Lyte	Undergrad Student Researcher	CNS-UCSB / IRG3	Santa Barbara City College
Kristen Nation	Undergrad Student Researcher	CNS-UCSB / IRG3	UC Santa Cruz
Emily Nightingale	Undergrad Student Researcher	CNS-UCSB / IRG2	UC Santa Barbara
Bryan Phillips	Undergrad Student Researcher	CNS-UCSB / XIRG	Santa Barbara City College
Kelli Pribble	Undergrad Student Researcher	CNS-UCSB / IRG3	Victor Valley College
Srijay Rajan	Undergrad Student Researcher	CNS-UCSB / IRG2	Moorpark College
William Reynolds	Undergrad Student Researcher	CNS-UCSB / IRG3	Ventura College
Nicholas Santos	Undergrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Andreea Larisa Sandu	Undergrad Student Researcher	CNS-UCSB / Education	UC Santa Barbara
Merisa Stacy	Undergrad Student Researcher	CNS-UCSB / IRG2	Santa Barbara City College
Eddie Triste	Undergrad Student Researcher	CNS-UCSB / IRG3	Allan Hancock College
Julie Whirlow	Undergrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara
Sabrina Wu	Undergrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Joy Yang	Undergrad Student Researcher	CNS-UCSB / IRG2	UC Santa Barbara

Name	Title	Department	Organization
Maria Yopez	Undergrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara

***Non-UCSB Undergraduate Researchers***

Name	Title	Department	Organization
Sean Becker	Undergrad Student Researcher	CNS-UCSB / IRG3	University of Wisconsin, Madison
Rachel Bowley	Undergrad Student Researcher	CNS-UCSB / IRG3	Duke University
Kevin He	Undergrad Student Researcher	CNS-UCSB / IRG2	Duke University
Christine McLaren	Undergrad Student Researcher	CNS-UCSB / IRG3	Lehigh University
Amber Schrum	Undergrad Student Researcher	CNS-UCSB / IRG3	Lehigh University
Ryan White	Undergrad Student Researcher	CNS-UCSB / IRG3	Lehigh University
Yilun Zhou	Undergrad Student Researcher	CNS-UCSB / IRG2	Duke University
Alexander Zook	Undergrad Student Researcher	CNS-UCSB / IRG3	Lehigh University

***UCSB Staff & Technical Support***

Name	Title	Department	Organization
<b>Shawn Barcelona</b>	<b>Center Administrator</b>	<b>CNS-UCSB / Admin</b>	<b>UC Santa Barbara</b>
Cathy Boggs	Education Coordinator	CNS-UCSB / Ed & Outreach	UC Santa Barbara
Sage Briggs	Purchasing/Travel Coordinator	CNS-UCSB / Admin	UC Santa Barbara
Joshua Dean	Education Admin Assistant	CNS-UCSB / Ed & Outreach	UC Santa Barbara
Julie Dilleuth	Education Director	CNS-UCSB	UC Santa Barbara
<b>Brandon Fastman</b>	<b>Education Coordinator</b>	<b>CNS-UCSB / Ed &amp; Outreach</b>	<b>UC Santa Barbara</b>
Barbara Gilkes	Assistant Director	CNS-UCSB / Admin	UC Santa Barbara
Cory Jones	Education Admin Assistant	CNS-UCSB / Outreach	UC Santa Barbara
Monica Koegler-Blaha	Payroll Support	ISBER / CNS-UCSB / Admin	UC Santa Barbara
<b>Valerie Kuan</b>	<b>Purchasing/Travel Coordinator</b>	<b>CNS-UCSB / Admin</b>	<b>UC Santa Barbara</b>

Name	Title	Department	Organization
Diane Laflamme-McCauley	Artist	CNS-UCSB / Admin	UC Santa Barbara
<b>Brendy Lim</b>	<b>IT Support</b>	<b>ISBER / CNS-UCSB / Tech</b>	<b>UC Santa Barbara</b>
<b>Enrique Macias (Rick)</b>	<b>IT Support</b>	<b>ISBER / CNS-UCSB / Tech</b>	<b>UC Santa Barbara</b>
<b>Bonnie (Lanthier) Molitor</b>	<b>Assistant Director</b>	<b>CNS-UCSB / Admin</b>	<b>UC Santa Barbara</b>
Emily Nightingale	Staff Reseach Assistant	CNS-UCSB / IRG2	UC Santa Barbara
Kiyomitsu Odai	Staff Reseach Assistant	CNS-UCSB / Seed Grant DN	UC Santa Barbara
<b>Deborah Pierce</b>	<b>Staff Reseach Assistant</b>	<b>CNS-UCSB / Seed Grant JM</b>	<b>UC Santa Barbara</b>
Stacy Rebich-Hespanha	Education Coordinator	CNS-UCSB / Education	UC Santa Barbara
Laura Saldivar-Tanaka	Staff Reseach Assistant	CNS-UCSB / Seed Grant CW	UC Santa Barbara
Andreea Larisa Sandu	Admin Assistant	CNS-UCSB / Education	UC Santa Barbara
James Walsh	Staff Research Associate	CNS-UCSB / IRG2	UC Santa Barbara
David Weaver	Web Assistant	CNS-UCSB / Outreach	UC Santa Barbara
Maria Yepez	Admin/Research Assistant	CNS-UCSB / IRG3 Research	UC Santa Barbara

***Non-CNS-UCSB Staff & Researchers (\*Unfunded)***

Name	Title	Department	Organization
<b>Edgar Arteaga</b>	<b>Reseach Assistant</b>	<b>CNS-UCSB / IRG2</b>	<b>Universidad Autonoma de Zacatecas, Mexico</b>
*Adam Corner	Postdoctoral Researcher	Social Psychology	Cardiff University, United Kingdom
Evan Donahue	Reseach Assistant	CNS-UCSB / IRG2	Duke University
Jordan Herman	Reseach Assistant	CNS-UCSB / IRG2	Duke University
Kate North-Lewis	Reseach Assistant	CNS-UCSB / IRG3	Cardiff University, United Kingdom
Joshua Lynn	Reseach Assistant	CNS-UCSB / IRG3	Lehigh University
Jan Pachon	Reseach Assistant	CNS-UCSB / IRG2	Duke University
Lesley Strabel	Reseach Assistant	CNS-UCSB / IRG3	Cardiff University, United Kingdom
Ben Weiss	Reseach Assistant	CNS-UCSB / IRG2	Duke University

Name	Title	Department	Organization
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<i><b>Affiliated Participants (Not receiving Center support)</b></i> <i><b>UCSB</b></i>			
Name	Title	Department	Organization

Kevin Almeroth	Professor	Computer Science	UC Santa Barbara
Javiera Barandiaran	Assistant Professor	Global Studies	UC Santa Barbara
Melissa Bator	PhD Candidate	Department of Communication	UC Santa Barbara
<b>Heather Hodges</b>	<b>PhD Candidate</b>	<b>Political Science</b>	<b>UC Santa Barbara</b>
Andrew Flanagin	Professor	Communication	UC Santa Barbara
Nelson Lichtenstein	Professor	History	UC Santa Barbara
Tal Margalith	Executive Director	Technology of SSLEEC	UC Santa Barbara
Miriam Metzger	Associate Professor	Communication	UC Santa Barbara
Lisa Parks	Professor & Director	Film & Media Studies Center for Information Technology & Society (CITS)	UC Santa Barbara
Simone Pulver	Associate Professor	Environmental Science	UC Santa Barbara
Mark Rodwell	Professor & Director	Electrical & Computer Engineering, NNIN	UC Santa Barbara
Ram Seshadri	Professor	Materials, Chemistry & Biochemistry	UC Santa Barbara
Greg Siegel	Associate Professor	Film & Media Studies	UC Santa Barbara
Cynthia Stohl	Professor	Department of Communication	UC Santa Barbara
Sangwon Suh	Associate Professor	Environmental Science & Management	UC Santa Barbara
<b>Barbara Walker</b>	<b>Director, Research &amp; Development, Social Science, Humanities</b>	<b>Office of Research</b>	<b>UC Santa Barbara</b>
Janet Walker	Professor & Chair	Film and Media Studies	UC Santa Barbara

<i><b>Affiliated Participants (Not receiving Center support)</b></i> <i><b>Other Institutions (Unfunded Collaborators &amp; Other Participants)</b></i>			
Name	Title	Department	Organization

<b>David Azoulay</b>	<b>Managing Attorney</b>	<b>Environmental Law</b>	<b>The Center for International Environmental Law</b>
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Name	Title	Department	Organization
Ted Barthell	Communication Coordinator	Environmental Issues - Water	Santa Barbara Channelkeeper
Daryl Boudreaux	President	Commercialization	Boudreaux & Associates
Francesca Bray	Professor	Gender & Technology	Edinburgh University, United Kingdom
Jennifer Brown	Assistant Professor	Sociology	Long Island University
Karl Bryant	Associate Professor	Sociology & Women's Studies	SUNY New Paltz
<b>Jenny Chan</b>	<b>Senior Lecturer</b>	<b>Chinese Studies</b>	<b>Oxford University</b>
Hyungsub Choi	Professor	History of Science	Seoul National University, South Korea
Mary Collins	Postdoctoral Scholar	Environmental Studies	University of Maryland
Meredith Conroy	Assistant Professor	Politics	Occidental College
<b>Katie Davis</b>	<b>Co-Founder</b>	<b>Environmental Advocate</b>	<b>Santa Barbara County Water Guardians</b>
Brian Davison	Associate Professor	Computer Science & Engineering	Lehigh University
Magali Delmas	Associate Professor	Corporate Environmental Management	UC Los Angeles
<b>Christina Demski</b>	<b>Lecturer</b>	<b>Psychology</b>	<b>Cardiff University, United Kingdom</b>
<b>Jennifer Earl</b>	<b>Professor</b>	<b>Sociology</b>	<b>University of Arizona</b>
<b>Brenda Egolf</b>	<b>Research Scientist</b>	<b>Journalism</b>	<b>Lehigh University</b>
<b>Cassandra Engeman</b>	<b>Visiting Researcher</b>	<b>Sociology</b>	<b>Social Science Research Center, Berlin (WZB)</b>
Bill Felstiner	President	Nonprofit Organization	Chad Relief Foundation
Edward France	Executive Director	Alternative Transportation	Santa Babara Bike Coaliton
Geoff Green	Chief Executive Officer	Philanthropy	The Fund for Santa Barbara
<b>Elizabeth Grossman</b>	<b>Journalist, Author</b>	<b>Environmental and Science Issues</b>	<b>Independent Consultant</b>
Sarah Kaplan	Associate Professor	Business	University of Toronto, Canada

Name	Title	Department	Organization
<b>Karen Henwood</b>	<b>Professor</b>	<b>Social Sciences</b>	<b>Cardiff University, United Kingdom</b>
<b>Patrick Herron</b>	<b>Researcher</b>	<b>Data Mapping &amp; Visualization</b>	<b>Duke University</b>
Phoebe Hitchman	Manager of Corporate Relations	Nonprofit Organization	Vitamin Angels
<b>Noela Invernizzi</b>	<b>Professor</b>	<b>Science &amp; Technology Policy</b>	<b>Federal University of Parana, Brazil</b>
<b>Kirk Jalbert</b>	<b>Manager Visiting Research Professor</b>	<b>Science &amp; Technology Studies</b>	<b>FracTracker Alliance Drexel University</b>
<b>Mikael Johansson</b>	<b>Faculty Program Director</b>	<b>Global Studies</b>	<b>University of Gothenburg, Sweden</b>
Matthew Keller	Assistant Professor	Sociology	Southern Methodist University
<b>Lotte Krabbenborg</b>	<b>Postdoctoral Researcher</b>	<b>Humanities &amp; Political Philosophy</b>	<b>Radboud University, Netherlands</b>
Sharon Ku	Assistant Research Professor	History & Politics	Drexel University
Jens-Uwe Kuhn	Assistant Professor	Global & International Studies	Santa Barbara City College
<b>Todd Kuiken</b>	<b>Senior Program Associate</b>	<b>Science and Technology Innovation Program</b>	<b>Woodrow Wilson International Center for Scholars</b>
<b>Jennifer Kuzma</b>	<b>Professor</b>	<b>Genetic Engineering &amp; Society</b>	<b>North Carolina State University</b>
Edgar Zayago Lau	Professor	Development Studies	Universidad Autonoma de Zacatecas, Mexico
Erica Lively	Associate	Electrical Engineering	Exponent
<b>Graham Long</b>	<b>Partner</b>	<b>Environmental Technology</b>	<b>Compass Resource Management, Canada</b>
Ephraim Massawe	Assistant Professor	Computer Science & Industrial Technology	Southeastern Louisiana University
Mara Mills	Assistant Professor	Media, Culture & Communication	New York University
<b>Moses Kizza Musaazi</b>	<b>Founder</b>	<b>Electrical &amp; Computer Engineering</b>	<b>Technology for Tomorrow Ltd.</b>



Name	Title	Department	Organization
André Nel	Professor, Director, Physician	UC Los Angeles CEIN UC Los Angeles Medical School	UC Los Angeles
<b>Graham Long</b>	<b>Partner</b>	<b>Environmental Technology</b>	<b>Compass Resource Management, Canada</b>
<b>Joseph November</b>	<b>Associate Professor</b>	<b>History</b>	<b>University of South Carolina</b>
Dawn O'Bar	President	Nonprofit Organization	Unite to Light
Miriam O'Donnell	Account Manager	Nonprofit Organization	Vitamin Angels
Mathieu O'Neil	Associate Professor	Computer Science & Sociology	Australian National University
Casey O'Toole	Project Director	Nonprofit Organization	Hands 4 Others (H4O)
Takushi Otani	Associate Professor	History & Philosophy of Technology	Kibi International University, Japan
Luis Perez	Director of International Operations	Nonprofit Organization	Surgical Eye Expeditions (SEE) International
Marshall Pittman	Presidnt, UCSB Chapter	Nonprofit Organization	Engineers Without Borders
Ismael Rafols	Researcher	Science Policy	Sussex University
Gurumurthy Ramachandran	Professor	Environmental Science & Engineering	University of Minnesota
Shyama Ramani	Researcher	Development Economics	Ecole Polytechnique, INRA, France
Alain Rieu	Professor	Philosophy	Université Lyon 3, France
Kalpana Sastry	Principal Scientist	Agriculture	Nt'l Academy of Agricultural Research Management, India
<b>Andrew Schroeder</b>	<b>Director of Research and Analysis</b>	<b>Geographic Information Systems</b>	<b>Direct Relief</b>
<b>Bhavna Shamasunder</b>	<b>Assistant Professor</b>	<b>Urban &amp; Environmental Policy</b>	<b>Occidental College</b>
<b>Philip Shapira</b>	<b>Professor</b>	<b>Public Policy</b>	<b>Georgia Institute of Technology / University of Manchester</b>
<b>Christine Shearer</b>	<b>Research Fellow</b>	<b>Earth Science &amp; Sociology</b>	<b>CoalSwarm</b>

Name	Title	Department	Organization
Brittany Shields	Doctoral Candidate	Humanities & Social Thought	University of Pennsylvania
Rachel Siegel	International Operations Manager	Nonprofit Organization	Surgical Eye Expeditions (SEE) International
<b>Darius Sivin</b>	<b>Industrial Hygienist</b>	<b>Occupational &amp; Environmental Health</b>	<b>United Auto Workers</b>
Joseph Summers	Test Development Engineer	Electrical Engineering	Infinera
Thomas Tighe	President / CEO	Nonprofit Organization	Direct Relief
<b>Jennifer Woolley</b>	<b>Associate Professor</b>	<b>Management</b>	<b>Santa Clara University</b>
Tim Wilson	Associate	Geospatial Analysis	Compass Resource Management, Canada
<b>Jan Youtie</b>	<b>Manager, Policy Services</b>	<b>Political Science</b>	<b>Georgia Institute of Technology</b>
<b>Tarun Wadhwa</b>	<b>Writer, Researcher &amp; Entrepreneur</b>	<b>Technology, international development, and public policy</b>	<b>Independent Journalist</b>
Stephen Zehr	Professor	Sociology	University of Southern Indiana

<i>Visiting Scholars &amp; Seminar Speakers</i>			
Name	Title	Department	Organization
Ivan Amato	Science & Technology Writer/ Journalist-in-Residence	Kavli Institute for Theoretical Physics	Dalian Institute of Chemical Physics, China
Xinhe Bao	Professor	Engineering	Dalian Institute of Chemical Physics, China
Francesca Bray	Professor	Gender & Technology	Edinburgh University, United Kingdom
<b>Karl Bryant</b>	<b>Assistant Professor</b>	<b>Sociology &amp; Women's Studies</b>	<b>SUNY New Paltz</b>
<b>Mary Collins</b>	<b>Assistant Professor</b>	<b>Environmental Studies</b>	<b>SUNY-ESF</b>
Martin Collins	Curator	History	Smithsonian Ntl Air & Space Museum
Erik Conway	Historian	Defense & Space	Cornell University
Sarah Davies	Postdoctoral Scholar	Department of Media, Cognition & Communication	University of Copenhagen, Denmark

Name	Title	Department	Organization
Jorge Gardea-Torresdey	Dudley Chair	Environmental Chemistry	Utrecht University, Netherlands
<b>Karen Henwood</b>	<b>Professor</b>	<b>Social Sciences</b>	<b>Cardiff University, United Kingdom</b>
Jacqueline Isaacs	Professor	Mechanical & Industrial Engineering	Northeastern University
Ann Johnson	Associate Professor	History of Science & Tech, Modern Europe	University of South Carolina
Dan Kahan	Elizabeth K. Dollard Professor of Law & Professor	Law & Psychology	Yale Law School
Sarah Kaplan	Associate Professor	Strategic Management	University of Toronto
Ronald Kline	Professor	Science & Technology Studies	Cornell University
Sharon Ku	Postdoctoral Scholar	History & Philosophy of Science	University of Southern Indiana
Edgar Zayago Lau	Senior Researcher	Development Studies	Universidad Autonoma de Zacatecas, Mexico
Harro van Lente	Professor	Innovation Studies	Utrecht University, Netherlands
Stuart Leslie	Professor	History of Science	John Hopkins University
Cyrus Mody	Associate Professor	History, Technology Studies	Rice University
Kalpana Sastry	Principal Scientist	Agriculture	Nt'l Academy of Agricultural Research Management, India
Amy Slaton	Postdoctoral Scholar	History & Politics	Drexel University
Steve Usselman	Professor, Chair	School of History	Georgia Institute of Technology
Vivek Wadhwa	Vice President	Academic & Innovation	Singularity University
Bart Walhout	Postdoctoral Researcher	Science, Technology and Policy Studies	University of Twente, Netherlands
Guoyu Wang	Professor	Philosophy	Dalian University of Technology, China
Amy K. Wolfe	Group Leader	Environmental Sciences	Oak Ridge National Laboratory

Name	Title	Department	Organization
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<b><i>Nanotechnology in Society Network Lead Partners</i></b>			
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Name	Title	Department	Organization
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Davis Baird	Provost & Vice President for Academic Affairs	Philosophy	Clark University
Chris Bosso	Professor	Political Science	Northeastern University
David Guston	Director & Professor	Politics & Global Studies	CNS-ASU, Arizona
Alfred Nordmann	Professor	Philosophy	Darmstadt University, Germany

#### **4B. EXTERNAL ADVISORY BOARD**

<b>Ann Bostrom (Board Co-Chair)</b>	Weyerhaeuser Professor of Environmental Policy, Daniel J. Evans School of Public Affairs, University of Washington
<b>John Seely Brown (Board Co-Chair)</b>	Independent Co-Chairman, Deloitte's Center for the Edge; Visiting Scholar and Advisor to the Provost, University of Southern California
<b>Craig Calhoun</b>	Director, London School of Economics, London, United Kingdom
<b>Vicki Colvin</b>	Brown University, Kenneth S. Pitzer-Schlumberger Professor of Chemistry, Chemical & Biomolecular Engineering, and Materials Science & Nanomaterials Engineering
<b>Ruth Schwartz Cowan</b>	Professor Emerita, Department of History and Sociology of Science, University of Pennsylvania
<b>Susan Hackwood</b>	Professor of Electrical & Computer Engineering; Executive Director of the California Council on Science and Technology (CCST), University of California Riverside
<b>Willie Pearson, Jr.</b>	Professor of Sociology, School of History Technology and Society, Georgia Institute of Technology; Chair; Committee on Equal Opportunities in Science and Engineering (CEOSE)
<b>Robert Westervelt</b>	Mallinckrodt Professor of Applied Physics & Physics, Harvard University; Director, Harvard Center for Nanoscale Systems
<b><i>Former Members:</i></b>	
Thomas Kalil (Board Chair Emeritus, 2007-2008)	Deputy Director for Policy, the White House Office of Science & Technology Policy; Senior Advisor for Science; Technology & Innovation for the National Economic Council
Julia A. Moore (Board Chair Emerita, 2006-2009)	Senior Scholar, Director of Research, Pew Health Group at The Pew Charitable Trusts
Martin Moskovits	Worster Professor Chemistry & Biochemistry, College of Letters & Science, MLPS, UCSB (Chair)

#### 4C. PARTICIPATING ACADEMIC INSTITUTIONS

Allan Hancock Community College  
Arizona State University  
Australian National University, Australia  
Baldwin Wallace University  
Bangkok Thonburi University, Thailand  
Beijing Institute of Technology, China  
Bowling Green State University  
California Polytechnic State University, San Luis Obispo  
Cardiff University, United Kingdom  
Centre National de la Recherche Scientifique(CNRS), France  
Clark University  
College of the Canyons  
Columbia University  
Cooper Union  
Cornell University  
Cuesta Community College  
Darmstadt University, Germany  
Drexel University  
Duke University  
Ecole Polytechnique, France  
Federal University of Parana, Brazil  
Federal University of Santa Catarina, Brazil  
Fordham University  
Georgia Institute of Technology  
IRD-IFRIS, France  
Jackson State University  
Johns Hopkins University  
Kent State University  
Kibi International University, Japan  
Lehigh University  
Long Island University  
Maastricht University, The Netherlands  
Maastricht University, India  
Maastricht University, Zimbabwe  
Mississippi State University  
Moorpark College  
New York University  
Northeastern University  
North Carolina State University  
Occidental College  
Oxford University  
Oxnard Community College  
Quinnipiac University  
Radhound University  
Rensselaer Polytechnic Institute  
Rice University  
Santa Barbara City College  
Seoul National University, South Korea  
Singularity University  
Southeastern Louisiana University  
Southern Methodist University  
State University of New York College of Environmental Science and Forestry (SUNY-ESF)  
State University of New York (SUNY), New Paltz

State University of New York, Levin Institute  
Texas A&M University  
Universidad Autonoma de Zacatecas, Mexico  
Université de Lyon 2, France  
Université de Lyon 3, France  
University of Arizona  
University of British Columbia, Canada  
University of California, Berkeley  
University of California, Davis  
University of California, Los Angeles  
University of California, Santa Cruz  
The University of Edinburgh, United Kingdom  
University of Exeter, United Kingdom  
University of Gothenburg, Sweden  
University of Houston  
University of Manchester, United Kingdom  
University of Maryland  
University of Minnesota-Twin Cities  
University of New Mexico  
University of Nottingham, Ningbo  
University of Pennsylvania  
University of South Carolina  
University of Southern Indiana  
University of Toronto, Canada  
University of Twente, Netherlands  
University of Virginia  
University of Washington  
University of Wisconsin-Madison  
Ventura College  
Yale Law School  
York University, Canada

**4D. PARTICIPATING INDUSTRIAL INSTITUTIONS /**  
**4E. PARTICIPATING NON-ACADEMIC INSTITUTIONS**

American Bar Foundation  
American Institute of Physics  
Ashoka: Innovators for the Public  
Boudreaux & Associates  
Brazilian Ministry of Science, Brazil  
Canadian Institute For Advanced Research  
Center for International Environmental Law  
Chad Relief Foundation  
Chemical Heritage Foundation  
Chicago Art Institute  
Compass Resource Management, Canada  
Conservation Biology Institute  
Decision Science Research Institute, Inc., d.b.a. Decision Research  
DIYbio.org  
Direct Relief  
Engineers Without Borders (UCSB Chapter)  
Environmental Defense Fund  
European Trade Union Institute, Belgium  
Facts 'N Figures  
FracTracker Alliance  
Hands 4 Others (H4O)  
Infinera  
International Committee for Robot Arms Control & Campaign to Stop Killer Robots  
International Risk Governance Council, Switzerland  
Kauffman Foundation  
Knowledge Networks  
LaborVoices  
Latin American Network of Nanotechnology and Society (ReLANS), Mexico  
Los Angeles County Museum of Art  
Meridian Institute  
Nanoscale Informal Science Education Network (NISE)  
Natl Academy of Agricultural Research Management, India  
PEW Research Center  
Project on Emerging Nanotechnologies  
Safe Water International  
Santa Babara Bicycle Coalition  
Santa Barbara Channelkeeper  
Santa Barbara County Water Guardians  
Santa Barbara Museum of Natural History  
Santa Monica Public Library  
Science and Technology Policy Institute (STPI)  
Silicon Valley Toxics Coalition  
Smithsonian National Air & Space Museum  
Social Policy Research Associates  
Berlin Social Science Research Center (WZB)  
Students & Scholars Against Corporate Misbehavior, Hong Kong, China  
Surgical Eye Expeditions International  
Technology for Tomorrow Ltd, Africa



The Energy & Resource Institute, India  
The Fund for Santa Barbara  
The TOR Project  
United Auto Workers  
Unite to Light  
US Agency for International Development  
Vitamin Angels  
Woodrow Wilson International Center for Scholars  
YouGov America Inc.

#### 4. PARTICIPANTS

##### 4F. List of Graduate Students Received Ph.D.

UCSB Graduate Fellows				
Name	Title	Faculty Advisor		Employment Status
Peter Burks	Director of Market Development	Rich Appelbaum	Industry	ActiveLife Scientific
Amanda Denes	Assistant Professor & Director of Graduate Studies	Barbara Harthorn	Academia	University of Connecticut
Roger Eardley-Pryor	Research Fellow	Patrick McCray	Other	Chemical Heritage Foundation
Cassandra Engeman	Visiting Researcher	Barbara Harthorn	Academia	University of Uppsala
Matthew Gebbie	Postdoc	Rich Appelbaum	Academia	Stanford University
Ariel Hasell	Postdoc	Barbara Harthorn Bruce Bimber Miriam Metzger	Academia	University of Pennsylvania
Zachary Horton	Assistant Professor	Chris Newfield	Academia	University of Pittsburgh
Louise Stevenson	Postdoc	Barbara Harthorn	Academia	EEMB, UC Santa Barbara
Galen Stocking	Research Associate	Rich Appelbaum	Other	Pew Research Center
*Lynn Baumgartner	Program Director	Barbara Harthorn Patricia Holden	Other	Sierra Nevada Alliance
*Benjamin Carr	Researcher	Barbara Harthorn Patricia Holden	Government	U.S. Environmental Protection Agency
*Allison Fish	Environmental Scientist	Barbara Harthorn Patricia Holden	Government	California Department of Pesticide Regulation
Sheetal Gavankar	Lecturer President	Sarah Anderson	Academia Industry	UC Santa Barbara Mitr Consulting Corporation
Pehr Hovey	R&D Imagineer	Chris Newfield	Industry	Walt Disney Imagineering
Indy Hurt	Data Scientist	Barbara Harthorn	Industry	Mapzen

Qiao Li		Richard Appelbaum		
		Xueying Han		
*John Meyerhofer	Environmental Scientist	Barbara Harthorn Patricia Holden	Industry	Carollo Engineers
Quinn McCreight	Program Manager	Aashish Mehta	Other	Vitamin Angels
Zong (Zach) Miao	Software Engineer	Richard Appelbaum	Industry	Bloomberg LP
		Luciano Kay		
Isabel Ochoa	Grad Student Researcher	Aashish Mehta	Unknown	Global & International Studies
Marissa Taggart	Office of Student Experience Coordinator	Aashish Mehta	Academia	St. Jerome University
Caitlin Vejby	Legislative Assistant to Supervisor Norman Yee	Aashish Mehta	Government	City and County of San Francisco
David Weaver	Instructor	Bruce Bimber	Academia	Boise State University

<i>Non-UCSB Graduate Student Researchers</i>				
Name	Title	Faculty Advisor	Employment Status	
Parul Baxi	Lecturer	Richard Appelbaum	Academia	UC Davis
Christian Beaudrie	Associate	Terre Satterfield	Industry	Compass Resource Management Ltd
Megan Callahan	Grad Student Researcher	Milind Kandlikar Terre Satterfield	Institute for Resources, Environment & Sustainability (IRES)	University of British Columbia, Canada
Laura DeVries	Associate	Terre Satterfield	Industry	McCarthy Tétrault
Lanceton Mark Dsouza	Grad Student Researcher	Tim Lenoir	Jenkins Collaboratory	Duke University
Matthew Thomas	Grad Student Researcher	Tim Lenoir	Jenkins Collaboratory	Duke University

#### 4. PARTICIPANTS

##### 4F. List of Graduate Students Received Ph.D.

<i>UCSB Postdoctoral Researchers (*co-funded)</i>				
Name	Title	Faculty Advisor		Employment Status
*Mary Collins	Assistant Professor	Barbara Harthorn William Freudenburg	Academia	State University of New York College of Environmental Science and Forestry
Meredith Conroy	Assistant Professor	Bruce Bimber	Academia	CSU San Bernardino
*Lauren Copeland	Assistant Professor Associate Director, Community Research Institute	Bruce Bimber Barbara Harthorn	Academia	Baldwin Wallace University
*Gwen D'Arcangelis	Assistant Professor	Barbara Harthorn Terre Satterfield	Academia	Cal Poly Pomona
Matthew Eisler	Visiting Assistant Professor	Patrick McCray	Academia	James Madison University
Xueying (Shirley) Han	Postdoctoral Researcher	Rich Appelbaum	Academia	UC Santa Barbara
Shannon Hanna	Research Biologist	Barbara Harthorn	Government	National Institute of Standards and Technology (NIST)
Mikael Johansson	Researcher	Patrick McCray Barbara Harthorn	Academia	Gothenburg Research Institute
Luciano Kay	Postdoctoral Researcher	Rich Appelbaum	Academia	UC Santa Barbara
Yasuyuki Motoyama	Director in Research & Policy	Rich Appelbaum	Other	Kauffman Foundation
Tristan Partridge	Postdoctoral Researcher	Barbara Harthorn	Academia	UC Santa Barbara
*Christine Shearer	Program Director	Barbara Harthorn	Other	CoalSwarm
James Walsh	Assistant Professor	Rich Appelbaum	Academia	University of Ontario Institute of Technology

<i>Non-UCSB Postdoctoral Researchers (*co-funded)</i>				
Name	Title	Faculty Advisor		Employment Status
Adam Corner	Affiliate	Nick Pidgeon	Other	Tyndall Centre for Climate Change Research
Christina Demski	Lecturer	Nick Pidgeon	Academia	Cardiff University
*Darrick Evensen	Postdoctoral Researcher	Nick Pidgeon	Academia	Cardiff University, United Kingdom
*Stacey Frederick	Postdoctoral Researcher	Gary Gereffi	Academia	Duke University
Matthew Keller	Associate Professor	Fred Block	Academia	Southern Methodist University
Marian Negoita	Senior Associate	Fred Block	Industry	Social Policy Research Associates
*Anton Pitts	Postdoctoral Researcher	Terre Satterfield	Risk Science	University of British Columbia
*Merryn Thomas	Postdoctoral Researcher	Nick Pidgeon	Psychology	Cardiff University, United Kingdom

## 5. QUANTIFIABLE OUTPUTS

Table 1: Quantifiable Outputs								
Outputs	Reporting Year 6 2011	Reporting Year 7 2012	Reporting Year 8 2013	Reporting Year 9 2014	Reporting Year 10 2015	Reporting Year 11 2016	Final (NCE) 3/16/16 - 8/31/16	Total
<b>Publications that acknowledge NSF NSEC Support</b>								
In Peer-Reviewed Technical Journals: Primary	24	17	13	18	8	20	3	103
In Peer-Reviewed Technical Journals: Leverage	0	7	13	9	14	25	9	77
Books / Chapters or sections in books: Primary	61	36	22	10	10	11	6	156
Books / Chapters or sections in books: Leverage	0	6	4	3	10	15	3	41
Other: Primary	9	0	0	0	0	0	0	9
Other: Leverage	0	0	0	0	0	0	0	0
<b>Total Publications</b>	<b>94</b>	<b>66</b>	<b>52</b>	<b>40</b>	<b>42</b>	<b>71</b>	<b>21</b>	<b>386</b>
With Multiple Authors	36	54	30	24	26	46	12	228
Multiple Authors: Co-Authored with NSEC Faculty	33	50	26	22	18	34	13	196
<b>Publications that do not acknowledge NSF NSEC Support</b>								
In Peer-Reviewed Technical Journals	0	0	1	0	0	0	0	1
<b>NSEC Technology Transfer</b>								
Inventions Disclosed	0	0	0	0	0	0	0	0
Patents Filed	0	0	0	0	0	0	0	0
Patents Awarded	0	0	0	0	0	0	0	0
Patents Licensed	0	0	0	0	0	0	0	0
Software Licensed	0	0	0	0	0	0	0	0
Spin-off Companies Started (if applicable)	0	0	0	0	0	0	1	1
<b>Degrees to NSEC Students</b>								
Bachelor's Degrees Granted	0	3	1	2	2	0	1	9
Master's Degrees Granted	5	0	1	1	1	0	0	8
Doctoral Degrees Granted	8	2	3	5	4	3	3	28
<b>NSEC Graduates Hired by</b>								
Industry	0	1	0	0	0	0	0	1
NSEC Participating Firms	0	0	0	0	0	0	0	0
Other U.S. Firms	0	1	0	0	1	0	0	2
Government	1	0	0	2	1	1	0	5
Academic Institutions	5	1	6	7	3	4	5	31
Other	1	0	0	0	4	2	1	8
Unknown	0	3	0	0	0	0	0	3
<b>NSEC Influence on Curriculum (if applicable)</b>								
New Courses Based on NSEC Research	8	9	0	6	7	12	1	43
Courses Modified to Include NSEC Research	10	13	14	23	16	8	2	86
New Textbooks Based on NSEC Research	2	16	11	13	13	5	5	65
Free-Standing Course Modules or Instructional CDs	0	0	0	1	0	0	0	1
New Full Degree Programs	0	0	0	0	0	0	0	0
New Degree Minors or Minor Emphases	0	0	0	1	0	1	0	2
New Certificate	0	0	0	0	0	0	0	0
<b>Information Dissemination/Educational Outreach</b>								
Workshops, Short Courses to Industry	6	6	5	9	2	1	1	30
Workshops, Short Courses to Others	15	21	16	21	17	18	7	115
Seminars, Colloquia, etc.	137	165	131	125	93	47	23	721
World Wide Web courses	1	1	1	9	1	1	0	14

## 6. RESEARCH PROGRAM, ACCOMPLISHMENTS, AND PLANS

### IRG 1: Origins, Institutions, and Communities

#### ***Faculty and Senior Participants***

<u>W. Patrick McCray</u> , Leader	History	UC Santa Barbara
<u>David Brock</u>	History	Chemical Heritage Foundation
<u>Hyungsub Choi</u>	History	Seoul National University
<u>Ann Johnson</u>	History	University of South Carolina
<u>Sarah Kaplan</u>	Business	University of Toronto
<u>Sharon Ku</u>	History	Drexel University
<u>Mara Mills</u>	History	New York University
<u>Cyrus Mody</u>	History	Rice University/Maastricht Univ
<u>Joseph November</u>	History	Univ. of South Carolina
<u>Takushi Otani</u>	History	Kibi International University, Japan
<u>Amy Slaton</u>	History	Drexel University

#### ***Postdocs, Graduate Students, Undergraduate Students, Technical Staff***

Postdoctoral Researchers (1):	Matthew Eisler
Graduate Students (4):	Roger Eardley-Pryor, Summer Gray, Brittany Shields, Brian Tyrrell
Undergraduate Students (7):	Angela Burger, Sergio Cardenas, Gianna Haro, Megan Kelley, Paul Kovacs, Nick Santos, Sabrina Wu,

### 1. Introduction

IRG 1, with its focus on Origins, Institutions, and Communities, establishes the historical contexts for the emergence of nanotechnology as a research field, a component of US science policy, and as a site for the formation of new research communities. Together with funded colleagues at places such as Rice University, the University of South Carolina, the Chemical Heritage Foundation, and Seoul National University, between 2010-2016 members of IRG 1 explored a variety of topics related to nanotech's history. These included research policies for micro/nanoelectronics, what is the historical context for interdisciplinary research in American nanotech labs, how federal research policies have helped foster new areas of research that bridge the physical and life sciences, the training of a nanotech-oriented workforce, and the emergence of a research community centered around DNA nanotechnology

### 2. Goals

Our group's fundamental assumption is that reliable and usable knowledge about nanotechnology's contemporary social, economic, and policy implications must be based on a comprehensive and robust understanding of its past. Nanotechnology borrows heavily from people, organizations, and methods that pre-date the founding of the National Nanotechnology Initiative. Scientists, policymakers, and the public borrow on long-standing viewpoints in evaluating nanotechnology's potential. Those borrowings have shaped how nanotechnology is done, perceived, and regulated. Our work continues to examine these historical underpinnings at multiple levels – scientists' careers, institutions, research communities, instrumentation, national and state policy, and the public's evolving perception of nanotechnology. By investigating the "deep history" of a broad set of communities and institutions will help us understand the resources available to the early nano-proponents, and ultimately allow us to understand how those resources constrained and enabled particular aspects of the nano-enterprise. Since 2010,

IRG 1 has analyzed and integrated a diverse range of historical sources in order to understand specific and carefully chosen facets of the nano-enterprise's history.

### **3. Organization and Approach**

History is a science in a broad, qualified sense, though not an exact science. Its empirical method makes history a social science, and its critical narrative aligns history with the humanities. Academics view history as a dynamic process and interpret history as a story of the past that remains in constant dialogue with the present. IRG 1's methods combine qualitative and quantitative research. These include exhaustive searches for sources of information, especially primary sources typically found through archival research; the study of the information in those sources; the critical evaluation of the information, an active process to comprehend motives and judge actions; the final synthesizing of material and recasting it according to personal judgment in a narrative.

IRG 1, due in part to the high geographic dispersal of its members, functioned in a semi-autonomous manner. Group leader McCray maintained oversight of all research projects via regular email and phone exchanges with Project leaders as well as mentorship of IRG 1 grad fellows and postdocs. We freely share information/research resources and meet as a group at least once a year, typically in conjunction with one of the annual professional society meetings.

In the past five years, our group continued its focus on three interrelated themes: origins, institutions, and communities. We interpreted these as the resources from which scientists, businesspeople, and policy makers fashioned today's nano-enterprise. Broadly defined, these resources included not only scientific and technical knowledge, but also scientific communities and institutions, visionary scientists, organizational practices in universities, corporations, and government agencies, and broader contexts such as international security threats and industrial competition.

### **4. Major Accomplishments, 2010-2016**

Although the size of IRG 1 began shrinking as the CNS neared its sunset date, the group remains as a group devoted to the historical and humanistic study of nanotechnology in the world. It is the only humanities-oriented working group at either of the two NSF-funded CNSs. This kind of team-oriented research is extremely rare in the humanities. In fact, this alone stands out as one of the major achievements of the CNS in that the sort of team-oriented research IRG 1 does would not have been possible outside of the CNS framework.

Our collaborations took many forms. We commented on drafts of each other's articles and books, and in a few cases dyads and triads within IRG 1 co-wrote articles. We wrote grants together, mostly successfully. We organized a workshop on Emerging Technologies as well as panels at a wide variety of academic meetings. Perhaps our most important innovation was that we shared archival materials, such that a document by one researcher would be used in an article by another – and vice versa. Finally, through frequent correspondence, collaboration, and face-to-face meetings in Santa Barbara and at conferences, we each became knowledgeable about each other's work and perspectives on nanotechnology, such that any one of us could present to outside audiences at least an approximation of the expertise of any other member of the group. That kind of networked expertise is common among European historians (e.g., the "Tensions of Europe" project), but almost unheard of in the North American branch of the discipline.

Throughout IRG 1 lifespan, its members made a concerted effort to connect their scholarship to a diverse set of audiences. The motivation was simple – given the considerable resources devoted by the NSF to this collaborative project, it was seen as both necessary as well as professionally



responsible to demonstrate the value of humanities scholarship in general and the histories of science and technology specifically to as wide a group of people as possible. The success we had in this effort is borne out by both the number and range of venues in which we presented in our work.

The most obvious audience for our work was naturally our home communities in the history and STS fields. However, because of our close interactions with scientists and engineers as both historical actors and interview subjects, we consciously placed articles in venues such as *Nature Nanotechnology* and *Physics Today*. In a similar vein, Slaton's work found traction with people in the STEM and education diversity community. Casting their focus more broadly, IRG 1 members communicated their ideas and findings to a wider audience of business leaders, via venues such as the World Economic Forum, *Science Progress*, and the Center for Equitable Development. Finally, we made efforts to engage with the general public. In 2012, for example, McCray started a blog as an offshoot of his *Visioneers* book. To date, over 75,000 people have visited it.

Rather than reprise all of the various research initiatives that IRG 1 members have undertaken since 2010, we wish to instead highlight two main efforts:

**DNA Nanotechnology:** For more than two years, IRG 1 researcher and CNS graduate student fellow, Brian Tyrrell, studied the effects that the commercialization of HGP technologies had on the field of structural DNA nanotechnology. Sequencers read the precise ordering of DNA's base pairs, and synthesizers could create custom sequences of DNA. Between the early 1980s and 2006, the cost of ordering DNA from commercial suppliers declined precipitously, and researchers from fields including chemistry, physics, and computer science found easy access to custom-made DNA strands. The interdisciplinary approach conceived by these researchers led to a reevaluation of DNA. Researchers could think about the molecules as bricks rather than blueprints, and DNA became an engineering material. With new laboratory practices, the multi-disciplinary researchers who populated the discipline developed techniques to create increasingly elaborate structures using DNA. DNA nanotechnology researchers focused their energy on scaling up the production of DNA nanostructures by creating programs to streamline their design. Using DNA from commercial suppliers, researchers created a system of mass-produced nanostructures. Tyrrell's research suggests a continuity between the HGP and later federal initiatives funding nanotechnology research.

**(Nano)Technological Enthusiasm and the Public Imagination:** Work on this topic started as early in 2008 but reached its fruition in the 2010-2016 period. This project utilized historical case studies to explore how public perceptions of nanotechnology were influenced by its connections with earlier expressions and advocacy of technological enthusiasm in the 1970s and expressions of technological utopias, and how public imaginings of future technologies have intersected with public policy. By examining the political and social context of several exploratory or even fringe technologies—the distinction often rests with the beholder—and the communities of the scientists, technologists, and futurists who advocated them, this project explicated a clearer understanding of how modern technological utopias emerge, which clearly carries implications for the contemporary nanotechnology regime. The primary result of this project was the completion and publication of McCray's book *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (Princeton, 2013). This book won two international awards when it appeared including the Watson and Helen Miles Davis Prize (best book for general audience) from the History of Science Society.

## **5. Implications of IRG 1 Research for CNS Mission**

In the past six years, IRG 1 has contributed to the larger social history of nanotechnology and its ancillary institutional, instrumental, and intellectual adjuncts. Work done in the contributed to a more comprehensive narrative of nanotech's trajectory. As noted above, we believe research on nanotechnology (or any other emerging technology) must be grounded in an understanding of its origins and historical context. Our scholarship made serious strides in tracing the 50+ year arc of nanotechnology's history from origins in the materials science community in the 1950s and 1960s. It followed this through new instrumental developments at corporate labs in the 1970s to major discoveries in the 1980s like the invention of the buckyball and the STM and, eventually, the creation of a vast transnational infrastructure for doing interdisciplinary research in the 21st century.

IRG 1's scholarship has proven accessible, valuable and relevant not only to our CNS colleagues but also to scientists, engineers, and policy makers. Finally, and perhaps most importantly, IRG 1 has pioneered a team-based approach to humanities research. It has developed new methodologies for a group-oriented approach to the history and sociology of science and technology while training a cohort of younger scholars in those methods.

Our combined research efforts revealed that, despite its seeming novelty, nanotechnology is not a new area of technological development but rather one that continued and built upon existing institutions, research tools, and discoveries. Seen most broadly, our group explored and established the historical contexts for the emergence of nanotechnology as a research field, a component of US science policy, and an element in popular imaginings of future technologies. At the same time, we remained sensitive to the "hidden histories" of nanotechnology that did not appear in the standard narrative of its development. We saw a continual need to move away from the limitations of this basic story toward more complex and nuanced understandings of nanotechnology's past and current context.

Finally, it should be noted that the work of historians of science and technology departs at times from that of other humanities or social science researchers who study these sectors (say, sociologists and anthropologists) in tracing larger cultural contexts and causalities, and of course, in trying to explain change over time. That is: A particular technology or scientific priority, in a given historical setting, may shed light on much larger cultural undertakings, such as those associated with industrialization, democratization or globalization. The projects developed by IRG 1 thus demonstrate that the historical study of nanotechnology may well inform practices within nano-focused STEM realms, but also offer analyses applicable to the wider history of American education and labor, and also to a critical history of technical standards and related topics such as maintenance, environmental health, and circulations of scientific knowledge.

## IRG 2: Globalization and Nanotechnology

### ***Faculty and Senior Participants***

<u>Rich Appelbaum</u> , Leader	Sociology, Global & Int'l Studies	UC Santa Barbara
<u>Fred Block</u>	Sociology	UC Davis
<u>Cong Cao</u>	Contemporary Chinese Studies	Univ of Nottingham, UK
<u>Guillermo Foladori</u>	Sociology	Univ Autónoma de Zacatecas, Mexico
<u>Gary Gereffi</u>	Sociology	Duke Univ
<u>Noela Invernizzi</u>	Anthropology	Federal Univ of Parana, Brazil
<u>Matthew Keller</u>	Sociology	Southern Methodist Univ
<u>Timothy Lenoir</u>	Technology Studies	Duke Univ
<u>Aashish Mehta</u>	Global & Int'l Studies	UC Santa Barbara
<u>Yasuyuki Motoyama</u>	Regional Planning	Kauffman Foundation
<u>Rachel Parker</u>	Director of Research Programs	Canadian Inst for Advanced Research, Canada
<u>Philip Shapira</u>	Public Policy	Georgia Inst. of Technology & Univ of Manchester, UK
<u>Denis Simon</u>	Political Science	Duke Kunshan Center, China
<u>Jennifer Woolley</u>	Business	Santa Clara Univ
<u>Xinyue Ye</u>	Geography	Kent State Univ
<u>Jan Youtie</u>	Enterprise Research Inst	Georgia Inst. of Technology
<u>Edgar Záyago Lau</u>	Development Studies	Latin Amer Nanotech & Society Network (ReLans)

### ***Affiliates***

Emily Nightingale	Science Policy	Science & Tech. Policy Inst.
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### ***Postdocs, Graduate Students, Undergraduate Students, Technical Staff***

Postdoc Researchers (6):	Stacey Frederick (XIRG), Shirley Han, Luciano Kay, Yasuyuki Motoyama, Marian Negoita, James Walsh
Graduate students (17):	*Edgar Ramón Arteaga, Parul Baxi, *Peter Burks, Lanceton Mark Dsouza, *Matthew Gebbie, *Shirley Han, Sarah Hartigan, Matthew Keller, Qiao Li, Rachel Parker, Miguel Ruiz, *Claron Ridge, Galen Stocking, Matthew Thomas, Anna Walsh, James Walsh, Rong Yang
Undergrad students (10):	Rachel Bowley, Cece Choi, Jesus Diera, Andi Doktor, Kevin He, Emily Nightingale, Sri Jay Rajan, Marisa Stacy, Joy Yang, Yilun Zhou
Others (5):	Evan Donahue, Jordan Herman, *Patrick Herron, Jan Pachon, Ben Weiss

\* Co-funded or fully funded from another source

## **1. Introduction**

The overarching goal of IRG 2 has been to better understand the importance of both state policies and international collaboration in fostering research, development, and commercialization of nanotechnology, through a comparative study of the U.S., China, Japan, India, Korea, and selected Latin American countries.

## **2. Goals**

Since the beginning of CNS, and throughout this award, the principal goals of IRG 2 have been to answer two overarching questions: Where do efforts to develop nanotechnology – and, by inference, other emerging technologies that hold the promise of fostering significant economic gains – fall in terms of industrial policy? How can the study of international nanotechnology research collaborations shed light on the connections between national policies and the evolution of international scientific networks? To accomplish these goals, IRG 2 has engaged in a number of interrelated projects and activities that draw on field interviews, documentary analysis, and quantitative bibliometric studies.

### **3. Organization and approach of the IRG**

The activities of IRG 2, as indicated above, have been designed to assess the role of state policy and international collaboration in the development and diffusion of nanotechnology – from basic research to commercialization. With regard to state policy, we have been especially interested in understanding how state policy at all levels can enable an early-stage technology (such as nano) navigate through the “valley of death” – the inevitable funding gap between a promising idea and successful commercialization. With regard to international collaboration, we are focused on first chronicling the extent of such collaboration, then examining its direction and impact. IRG 2’s core efforts are located at UCSB, where Appelbaum has met regularly with his graduate fellows. During our final, no-cost extension year, Stocking has graduated and now has a position with Pew Research in D.C., although he is still involved in revising papers under submission; Gebbie received his PhD from the Materials Department fall 2015, but also remains involved in revising papers under submission; and Han, formerly a fellow, is now an IRG 2 postdoc who assists in overseeing the various projects as well as taking the lead in several, as indicated. Our research also includes UCSB’s development economist in Global & International Studies (Mehta) and IRG 2 postdoc Kay. Integration is facilitated through meetings, reading and writing assignments, publications, and conference participation. A number of the core IRG 2 participants are not in Santa Barbara. Parker (Director, Research Programs at Canadian Institute for Advanced Research, Toronto, Canada), Simon (executive vice chancellor of Duke Kunshan University (DKU) in Kunshan, China) and Cao (Professor at the School of Contemporary Chinese Studies, University of Nottingham Ningbo China) were kept in touch via email or phone calls as necessary. As noted above, two UCMEXUDS/CONACyT grants have enabled us to partner with colleagues at the University of Zacatecas in Mexico (Guillermo Foladori and Edgar Zayago Lau), as well as with ReLANS (the Latin American Nanotechnology Network).

### **4. Major IRG 2 accomplishments 2010-2016**

During this period we developed a comparative framework for understanding innovation policies in different countries through an extensive review of the literature on industrial policy; expanded our previous work on Chinese industrial policy by focusing on China’s emphasis on indigenous innovation and its impact on nanotechnology R&D and commercialization, particularly in Shanghai and Suzhou Industrial Park (SIP); conducted research on the development of nanotechnology in Mexico, Brazil, and Argentina through collaborations with the University of Zacatecas through two supporting grants (UC-MEXUS/CONACyT); continued our relationship with ReLANS (the Latin American Network for Nanotechnology and Society); gauged the motivations and potential contributions of foreign-born scientists and engineers to the development of nanotechnology in the United States through a study of nanotechnology graduate students at UCSB and at leading universities throughout the United States; built a nano-firm and organization database incorporating a global value-chain approach, using it to populate a “California in the Nano Economy” website; conducted bibliometric and patent analysis, including through collaborations with scholars at Georgia Tech; and completed a survey of leading

nanotech academic researchers in China (with selected follow-up face-to-face interviews), assessing their perceptions of the strengths and weaknesses of China's educational system and approach to innovation.

IRG 2's research crosscuts with a number of other CNS initiatives and projects. IRG 2 and IRG 1 share an interest in the historical development of national innovation policies focused on nanotechnology. Choi has participated in the work of both IRGs, focusing on Korean nanotech innovation systems. Published research by IRG 2 researchers Motoyama, Parker, and Appelbaum examined the historical origins of the U.S. National Nanotechnology Initiative. IRGs 2 and 3 also collaborate in development of the X-IRG work by Frederick at Duke on the US and global nano industry and Stocking on framing nano in print and social media. IRGs 2 and 3 also jointly planned, administered, and participated in a November 13-15, 2014 conference on "Democratizing Technologies: Assessing the roles of NGOs in shaping technological futures." An IRG 2 conference on nanotech and labor in Curitiba, Brazil, during the previous reporting period (September 5-7, 2013) also contributed to the work of IRG 3.

## **5. Broader Impacts of IRG 2:**

IRG 2 has addressed two key issues resulting from the globalization of nanotechnology (and, indeed, emerging technologies generally): the extent to which national, state-driven policies can make a difference in advancing national goals with regard to R&D and commercialization of nano-enabled products, and – conversely – the extent to which the cosmopolitan nature of science, which increasingly depends and indeed thrives on cross-border collaborations, can enable advances to transcend national boundaries. Another overarching concern of IRG 2 (indeed, of CNS in general) is the use of nanotechnology and other emerging technologies to foster more equitable and sustainable development; this concern is addressed throughout our research.

We conclude that state policies can indeed make a difference in the rate of advance of nanotechnology research and commercialization. China, with its vast resources in foreign reserves and long tradition of state planning, has emerged as a strong global player in nanotechnology. While its overall capacity for innovation remains behind that of the U.S. and other advanced industrial economies, China's trajectory is unmistakable. *Ceteris paribus*, as a growing number of Chinese expatriate scientists and engineers return to China, attracted both by China's growing global prominence and generous incentives provided by national and local governments, we expect this gap to narrow. Yet at the same time, we have found that China's educational system and research environment do not encourage innovative thinking. Rote learning, perceived favoritism in funding and research priorities, shifting government policies, *guanxi*, and corruption all continue to trouble China's efforts to achieve its goal of indigenous innovation. While there are efforts to correct this – in part by repatriating top Chinese scientists and engineers in the U.S. and other countries – China has yet to create a research climate that is comparable to the excellent research infrastructure it has built at leading universities and science parks.

By way of comparison, our research in Latin America finds that Mexico, Brazil, and Argentina, in different ways, lack strong and coherent nanotechnology programs and policies, rendering their efforts to advance economic growth through high-tech development highly dependent on foreign firms and collaborators.

### IRG 3: Risk Perception and Social Response

#### **Faculty and Senior Participants**

<u>Barbara Herr Harthorn</u> , Lead	Medical anthro	UC Santa Barbara
<u>Nick Pidgeon</u> , Co-lead, PI subk	Applied psychology	Cardiff Univ, UK
<u>Terre Satterfield</u> , Co-Lead, PI subk	Environ anthro	Univ of British Columbia, CA
<u>Sarah Anderson</u> (seed grant)	Env Politics, Bren	UC Santa Barbara
<u>Edwina Barvosa</u> (seed grant)	Feminist Studies	UC Santa Barbara
<u>Christian Beaudrie</u>	Env Risk	Compass Resource Management
<u>Bruce Bimber</u>	Political Science	UC Santa Barbara
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<u>William Freudenburg*</u> (deceased)	Env Sociology	UC Santa Barbara
<u>Robin Gregory</u> , Co-PI subk	Env Risk	Decision Research, OR
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<u>Karen Henwood</u>	Sociology	Cardiff Univ
<u>Patricia Holden</u>	Microbiology, Ecol	UC Santa Barbara
<u>Milind Kandlikar</u>	Science policy	University of British Columbia, CA
<u>Miriam Metzger</u>	Communication	UC Santa Barbara
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#### **Affiliates**

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<u>Graham Long</u>	Engineering	Compass Resource Management
<u>Christine Shearer</u>	Env Sociology	CoalSwarm (NGO)

#### **Postdocs, Graduate Students, Undergraduate Students, Others**

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Undergrad students (10):	*Sean Becker, Brent Boone, Catherine Enders, Simone Jackson, Alexander Lyte, Kelli Pribble, William Reynold, Eddie Triste, Julie Whirlow, Maria Yopez	
Others (2):	Kristen Nation, Hannah Cruz (DPHS)	

\*partially or fully co-funded from another source

## 1. Introduction

The overarching goals of IRG 3 have been to generate new knowledge about the perceived risks and benefits of nanotechnologies and other emerging technologies and about social action among multiple stakeholders in the nanoenterprise, and to develop and document methods for public engagement with new technologies in the US and comparative other sites. We also have aimed to contribute to CNS efforts to disseminate the knowledge gained to an array of critical stakeholders, including scientists and engineers in the field, diverse US publics and NGOs, the engineered nanomaterials industry, and policymakers/regulators. Media studies have been pursued to provide critical evidence of risk signal amplification.

## 2. Goals

Will nanotechnologies experience public backlash and stigma when they are developed and disseminated that could limit the realization of their potential economic and/or social benefits? This question and its attendant uncertainties have arguably driven US federal investment in research on the societal implications of nanotechnologies, including in the CNS at UCSB. The answer to this deceptively simple question hinges on a complex and dynamic set of social, political, economic, and cultural factors that past research has identified as likely to drive sustainability and acceptance or controversy and failure of these new technologies. In addition to economic issues such as job creation or loss, we have anticipated primary focal points of public concern to be risk, benefit, regulation, trust, responsibility, and justice, and we have seen the degree to which experts share, anticipate, and address these concerns as a powerful predictor of the likelihood of ensuing controversy. IRG 3 has thus conducted novel social research on formative nanotech (and other emergent technologies) risk and benefit perceptions over time through a well calibrated set of mixed qualitative and quantitative social science research methods aimed at studying the views and beliefs about emerging nanotechnologies by multiple parties. By 'multiple parties' we mean people in numerous different social locations and positions—nanoscale scientists and engineers, nano risk assessment experts, regulators, industry leaders, NGOs or other social action and special interest groups, journalists, and members of the public who differ by gender, race/ethnicity, class, occupation, education, and age, as well as nation. An important aspect of our work is to investigate the diversity and nuances of views both within and across these categories of difference, which we pursue because of the demonstrated importance of democratic participation to the success of the innovation system (cf., Dietz and Stern, NRC, 2008), the ethical imperatives, and the challenges to full participation posed by a large and complex multicultural society such as the US.

The theoretical framework for this suite of research projects at inception of the CNS in 2006 was the Social Amplification of Risk Framework (e.g., Pidgeon, Kasperson & Slovic, 2003), which has been useful in understanding the evolution of past risk controversies. However, as our work has shown (Satterfield et al., 2009, *Nature Nanotech*), nano R&D has evolved with only modest evidence of significant public awareness, amplified risk perception, or media attention, and as a result, IRG 3 research has moved progressively into more experimental research modes in the context of such continuing low ("upstream") public awareness, low risk signal amplification, and resultant conditions of attenuation, even as the technologies themselves are moving downstream into wider commercial production and dissemination. Regulatory action has the potential to impact perceived risk quickly and hence has also been a vital component of research. This unprecedented lengthy opportunity to study emergent attitudes, beliefs and perceptions is a particular attraction of the nanotechnology context for risk analysis, although it has brought unique challenges as well. As the work has progressed, analysis has also focused on

comparative analysis of other emerging technologies with analytically or socially and politically useful similarities and/or differences.

The projects and activities in IRG 3 have been organized around what we conceptualize as the main nodes in the risk amplification framework: scientists, regulators, industry, general publics and more specialized public interest groups, and the media. Specifically, the activities within IRG 3 have been designed to foster a greater understanding of the factors that contribute to the perceptions of different stakeholders regarding the social and physical risks (and benefits) of nanotechnologies and comparative others, of how risk perceptions impact critical behavior, for example attention to safety issues such as industrial EHS practices, and the importance of equitable distribution of both benefit and harm in the development and application of nanotechnologies. As a result, we have conducted ongoing systematic research on critical stakeholder groups – including everyday publics, organized public interest groups, scientists and engineers, industry, environmental health and safety professionals, and regulators. The body of research resulting from this multi-pronged approach is, we believe, unrivaled anywhere in the world. A more comprehensive synthesis of the full sweep of IRG 3 work is available in Harthorn, Pidgeon & Satterfield (2016), available at: <http://www.cns.ucsb.edu/irg-synthesis-reports>

IRG 3 researchers use an array of mixed qualitative and quantitative methods. Quantitative methods include: standard, psychometric, consumer, and experimental decision pathway phone and web-based surveys of demographically diverse and representative US (and other) publics and a range of experts including scientists and engineers, regulators, and industry leaders; experimental research on factors driving group polarization in emerging nanotech debate, and tracking of print and internet media coverage of nanotechnologies. IRG 3 also employs systematic qualitative research methods that provide a substantive basis for and validation of quantitative results and include mental models interviewing, expert interviews, expert structured decision making workshops, ethnographic interviews, and deliberative public engagement workshops and focus groups regarding the risks and benefits of specific applications of nanotechnologies and related new technologies, in addition to media report analysis. In this award, researchers in IRG 3 performed work in the main areas detailed below.

### **3. Rationale, Approach and Organization**

The activities in IRG 3 are designed to comprehensively examine the *situated knowledge, perceptions, and beliefs* of the main actors in the nanoenterprise. By “situated knowledge” we draw on social theory to indicate that knowledge (and imagination) are both shaped and conditioned (but not necessarily determined) by social location and position, and that social values, perception and knowledge production are socially organized and co-produced through dialogue (Stoetzler & Yuval-Davis 2002: 315-16).

In the renewal award IRG 3 has been organized into a set of linked collaborative projects with collaborating teams of researchers, lead institution listed first:

IRG 3-1: Expert studies - UBC, UCSB, Decision Research, Compass Resource

IRG 3-2: Emergent Public Perceptions of Benefits and Risks - UBC, Cardiff, UCSB, Decision Research, SUNY EFS

IRG 3-3: Upstream Public Engagement and Deliberation Research – UCSB, Cardiff, Long Island University, SUNY New Paltz

IRG 3-4: Industry risk perception study (International survey)—UCSB, UBC



IRG 3-5: Framing of Nano and Other Emerging Technologies in Print and Social Media–  
Lehigh Univ [see X-IRG report on Friedman project]; UCSB: Twitter framing [see X-  
IRG report on Stocking/Hasell project]

IRG 3-6: The Politics of Consumer Choice – UCSB, Baldwin Wallace Univ

IRG 3-7: NonGovernmental Organizations and Tomorrow's Nanotechnologies – UCSB, WZB-  
Berlin, Univ of AZ, Long Island Univ, CoalSwarm

#### **4. Major IRG 3 accomplishments**

The risk perception research within IRG 3 develops new knowledge on emergent perceptions, preferences, and practices in societal engagement with new technologies across an array of participants in the nanoenterprise and in related emerging technology fields. This effort contributes to scholarship in a large range of disciplines: anthropology, communication, environmental studies and science, linguistics, materials science, political science, psychology, risk analysis, science and technology studies, science policy, sociology, and women's studies, as well as science and engineering fields. IRG 3 also contributes significantly to the educational and outreach accomplishments of the CNS. In a signal honor, Pidgeon was awarded a MBE in the Queen's Birthday honors list, July 2014, for services to UK climate change and energy security policy, reflecting his deep commitment to educating the public about climate change and energy security policy.

Our primary accomplishments have been to:

- Develop new knowledge about key factors likely to drive critical stakeholder groups' *perceptions of risks and benefits* of specific applications of nanotechnologies, with a particular focus on applications for health and energy. We have pursued this work through a range of studies and methodological approaches and now have a unique body of longitudinal and comparative data.
- Examine emergent perceptions, attitudes and beliefs of the US (and comparative other) publics regarding new technologies. In particular, we have experimentally examined effects on risk versus benefit judgments and acceptability judgments of application characteristics, risk signal effects, knowledge of nano, affective response, vulnerability and other individual characteristics, and conditions under which reversal of preferences take place. A two-stage survey examines environmental risk perception, looking at risk signal sensitivity in relation to application domain and particular engineered nanomaterials, and develops a novel measure of perceived environmental resilience of air, water and soil in interaction with engineered nanomaterials. Midstream/ downstream effects are explored in this survey by examining nano risk perception in relation to consumer product safety attitudes. Another survey examines political consumerism and how perceptions of nanotechnology affect consumers' decisions to deliberately avoid or purchase products with nanomaterials, and how these are related to the other factors driving boycotting and boycotting behavior. Yet another survey employs a novel decision pathway approach to environmental decision making in the US and UK.
- Conduct a series of cross-national and US-focused deliberative workshops focused on depth understanding of emergent public views on nanotech applications in the health and energy. The second set of US workshops focused on gender dynamics in technological knowledge production in the deliberative setting; current work expands the gender focus to look at race and ethnicity and incorporate political theories on participatory democracy, and a new stream of research on comparative environmental risk perception of energy futures involving unconventional oil and gas development.

- Study nanoscientist, nanotoxicologist, and nano regulator judgments on risk across applications and types of nanomaterials used through mixed methods approaches that provide both depth understanding of the processes through which judgments are formed and broader evidence of the variance in aggregate views of different expert populations who are critical decision makers about nano regulation.
- Develop a state-of-the-art structured decision making workshop to engage with a select group of elite scientific experts on nano risk pathways for specific high use applications as a method of bridging the gap between current uncertainty and available quantitative risk assessment (carbon nanotubes, nano silver).
- Identify regulatory challenges across the nanotechnology product life cycle in the US.
- Analyze the international and US-based nanomaterials industry's perceptions of risk and regulation to anticipate their environmental stewardship & workplace safety practices, potential attention to worker safety, and their receptivity to the regulation of engineered nanomaterials (2 international surveys completed, the 1<sup>st</sup> in the 1<sup>st</sup> CNS award).
- Gain understanding of the international landscape for nano-focused collective action. Develop a database and specific organizational profiles with particular focus on environmental, consumer product safety, agricultural, and labor issues. Link research to a large international NGO-engagement event.
- Through X-IRG researcher Friedman, conclude comparative tracking of nano media coverage in print and online sources in the US and UK and final analyses. Add a social media component by IRG 3 researchers Bimber and Hasell and IRG 2 researcher Stocking to track Twitter and other social media views on nano and fracking in the US and UK.
- Convene an international specialist meeting of leading researchers in the field and consolidate that new original research into an edited special issue of the leading risk journal, *Risk Analysis* in 2011.
- Hands on engagement with the nano risk assessment enterprise through direct participation at the leadership level in the UC CEIN. In particular contribute to reflexive practice in the UC CEIN around issues of responsible innovation, ethics, public and multi-stakeholder engagement, decision risk analysis, and risk communication.
- Seed new projects that can extend the aims, diversity, and scope of the group and respond to emerging conditions and challenges.
- Map out new syntheses of the nanotech and larger emerging technology risk perception field, based on the larger body of our work.
- Plan and pilot as possible studies for future fund seeking initiatives to extend the group's work.

### **5. Broader Impacts of IRG 3**

Through the activities in IRG 3, we have demonstrated the importance of surveying critical stakeholders about their perceptions and beliefs, conducting research to understand the factors that contribute to those perceptions and beliefs, and acting upon the insights generated from those studies in the context of developing a large class of new technologies that government and investors wish to be both successful and sustainable. Through risk perception research in the Center, we now have a better understanding of the priorities of critical stakeholders when it comes to both the regulation and deployment of nanotechnology, as well as how to engage with the general public in a way that builds trust both for academic researchers and for nanotechnology. Comparative analysis of other emerging technologies as risk objects is now

adding comparative depth to the nanotechnology work and extending the work both methodologically and substantively.

IRG 3 has contributed to CNS broader impacts through integrated research on and education and outreach to key stakeholders in the nanoenterprise, sharing nano and related emerging technologies ELSI research and implications with: NSE (through partners in the CNS at UCSB, through numerous publication and professional presentation venues, and by incorporating NSE scientists-in-training into our ongoing societal research, education and outreach programs); with nano ecotoxicologists (through our research about their views on risk and regulation, and through a deep and mutually impactful collaboration with the NSF- and EPA-funded UC CEIN); with regulators (through qualitative and quantitative research, and analysis and synthesis of regulatory gaps; through leading the ELSI component of the UC CEIN in its work on safe development of engineered nanomaterials-ENMs; through engagement with California state, national and international regulators and policymakers on responsible development; through dissemination to NPEC, NNCO, PCAST, NAS and other key regulatory actors); with industry (through our novel survey research on the international ENM industry; through outreach and engagement with industry personnel in ours and UC CEIN's national advisory boards; through travel and dissemination of the research to industry audiences in the US, Japan, and Europe); through work with NIOSH on worker safety issues; and to lay audiences through an array of formal and informal events and activities.

IRG 3, along with the rest of CNS, has had highly successful educational outcomes as measured by achieved employment of former fellows (nanoscience and social science) and postdocs in academia, industry, science policy, and NGOs. This contribution to the rising societal implications workforce is substantial and growing. IRG 3 researchers have been active contributors to CNS education and outreach efforts, and CNS IRG 3 research has been integrated into dozens of undergraduate and graduate courses.

## CNS X-IRG AND SPECIAL PROJECTS

### ***Faculty and Senior Participants***

<u>Sarah Anderson</u> , Seed project leader	Environmental politics	UC Santa Barbara
<u>Javiera Barandiaran</u> , Seed project leader	Global studies	UC Santa Barbara
<u>Gerald Barnett</u>	Director	Res Tech Enterprise Initiative
<u>Edwina Barvosa</u> , Seed project leader	Social/political theory	UC Santa Barbara
<u>Daryl Boudreaux</u>	Commercialization	Boudreaux and Associates
<u>Brian Davison</u>	Computer Sci & Eng	Lehigh Univ
<u>Brenda Egolf</u>	Science journalism	Lehigh Univ
<u>Sharon Friedman</u> , PI subaward	Science journalism	Lehigh Univ
<u>Gary Gereffi</u> , PI subaward	Sociology	Duke Univ
<u>Michael Goodchild</u>	Geography	UC Santa Barbara
<u>Mikael Johansson</u>	Anthropology	Gothenburg Univ
<u>George Legrady</u> , Seed project leader	Media Arts & Tech	UC Santa Barbara
<u>John Majewski</u> , Seed project leader	History	UC Santa Barbara
<u>Aashish Mehta</u> , Seed project leader	Economics	UC Santa Barbara
<u>John Mohr</u>	Sociology	UC Santa Barbara
<u>David Mowery</u>	Economics	UC Berkeley
<u>Chris Newfield</u> , Project leader	English	UC Santa Barbara
<u>David Novak</u> , Seed project leader	Ethnomusicology	UC Santa Barbara
<u>Casey Walsh</u> , Seed project leader	Anthropology	UC Santa Barbara

### ***Postdocs, Graduate Students, Undergraduate Students, Technical Staff***

Postdoc Researchers (2): Stacey Frederick (IRG 2), Mikael Johansson (IRG 1)

Graduate Students (21): Jennifer Bayzick, Rosie Bermudez, Clayton Caroon, John V. Decemvirale, Chloe Diamond-Lenow, Jacqueline Dodd, Karin Donhowe, Rachel Drew, Sheetal Gavankar, Lisa Han, Ariel Hasell (IRG 3), Katherine He, Zach Horton, Pehr Hovey, Quinn McCreight, Isabel Ochoa, Lumari Pardo-Rodriguez, Laura Saldivar-Tanaka, Galen Stocking (IRG 2), Marissa Taggart, Caitlin Vejby, Adélaïde Veyre, Christopher Wegemer

Undergrad Students (5): Li Chen, Christine McLaren, Amber Schrum, Ryan White, Alexandra Zook

Others (7): Rachel Bowley, Lea Danilewsky, Jordan Herman, Kiyomitsu Odai, Deborah Pierce, Laura Saldivar-Tanaka, Ben Weiss

\*partially or fully co-funded from another source

In addition to the main body of research work in the CNS conducted within the IRGs, a number of strategic and seed projects have been initiated in this renewal award period that span two or more IRGs or represent special initiatives designed to respond to rapidly emerging issues of interest in technology and society or develop tools and resources for the CNS. These “Cross-IRG” (X-IRG) projects contribute to the integration of efforts across the IRGs and to the synthesis of key interests.

In this award these projects have included:

**X-IRG 1:** The Social Life of Nanotechnology

**X-IRG 2:** Solar Futures: Science and Business Life in the Race against Climate Change

**X-IRG 3:** Global Value Chain for Nanotechnology

**X-IRG 4:** Nanotech in the Print Media (completed in prior year)

**X-IRG 5:** Ethnographic Explorations of Nanoscience and Nanotoxicology Laboratories

**X-IRG 6:** Framing Nanotech in Social Media

**X-IRG 7-1 to 7-8:** *CNS Faculty Seed Grants on Societal Issues for New Technologies*

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**X-IRG 1:** *The Social Life of Nanotechnology*: Barbara Harthorn, John Mohr, Editors. Book published by Routledge June 2012.

The Social Life of Nanotechnology is an edited volume published by Routledge in June, 2012 and co-edited by anthropologist/CNS Director Harthorn and sociologist and cultural theory expert Mohr, a collaborator in the CNS; CNS Board Co-Chair Seely Brown authored a foreword for the volume. The volume is an integrated product reflecting the full range CNS-UCSB nanotechnology in society work from the first 5 years of research, a unique product in the nanotechnology in society publication realm. To quote from the text: “*The Social Life of Nanotechnology* starts from the basic premise, developed throughout the text, that nanotechnologies have an under-theorized and often invisible social life that starts with the very concept of ‘nanotechnology’ itself which, as we show in the volume, takes on a wide range of socio-historically specific meanings around the globe, across multiple localities, institutions and collaborations, through diverse industries, research labs, and government agencies and on into a variety of discussions within the public sphere itself. The volume looks at this process through the lenses of the social and cultural sciences, revealing a surprisingly complicated social milieu where a series of traditionally modernist scientific projects have been (and are continuously being) re-assembled into new configurations that are sharply marked by their emergence within a rapidly changing, increasingly globalized, and decidedly postmodern world. As the authors in this volume explain, this results in a series of unique contradictions, tensions and unexpected developments.” We highlighted three dimensions of this process in the organization of the volume: the early origins of nanotechnologies, questions about the social (and political) organization of the field, and studies concerned with the cultural and subjective meanings ascribed to nanotechnologies in social settings.

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**X-IRG 2:** Solar Futures: Science and Business Life in the Race against Climate Change; States of Innovation; Christopher Newfield, Daryl Boudreaux, David Mowery, Gerald Barnett, 2 graduate student researchers (Zach Horton, Adélaïde Veyre).

This Strategic Project, led by innovation system scholar Newfield, combined a new and evolving innovation model with broad sector analysis of solar trends and norms, with empirical case studies of particularly innovative organizations. Newfield’s team first developed a “Lyon Model” for post-linear national innovation systems, based on an international workshop they convened in Lyon, France in April 2010 with leading experts from around the world on impediments to national innovation systems. They have disseminated the model through a range of publications and an innovation theory website (<http://innovate.ucsb.edu/>) which is linked to the main CNS website.

They have then embarked on a full spectrum review of nano-scale solar energy research and development in the context of solar R&D, policy, and production in the US and EU based on the Lyon Model. Out of this research they have a number of preliminary conclusions:

- \* Nano-enabled solar technology has had major ups and downs. Stagnation was triggered by the crisis in equity markets in the fall of 2008 that endangered funding for all of the emerging-technology operators in the sector. However, stagnation in the NST-related solar sector was then being enforced by ordinary investor decisions rather than economic crisis.
- \* Markets do not see nanoscale innovation (or other emerging solar technologies) as assets
- \* Solar practitioners are innovating in their own organizations but do not have many ideas for modifications of the overall solar innovation system
- \* 2nd and 3rd generation solar is stuck in an industry that is trapped in an “innovator’s dilemma”: rapid market expansion is combined with widespread manufacturer / supplier contraction.
- \* Neither a given U.S. solar firm, nor the national sector as a whole, can solve the innovator’s dilemma. A large-scale public intervention in solar markets is required, but the team argues this will require a post-linear NIS and significant change in US economic culture.

The project concludes that for NST to obtain its full potential, the U.S. needs a paradigm shift in its innovation system. They have identified specific issues above. The single core takeaway is that NST, under the auspices of the NNI, has been struggling for over a decade to develop public-purpose technology without a developed public infrastructure. NST will reach its potential only when advocates focus unambiguously on developing public infrastructure (large R&D funding, profit partnerships, IP pools, procurement programs) at least to a Cold War level. Our analysis supports the creation of programs that will develop a public innovation ecosystem, and technocultural innovation education, which would require cross-training in STEM and socio-cultural fields.

\* \* \*

**X-IRG 3:** Spatial Analysis and the Global Value Chain for Nanotechnology/Nano in California; Stacey Frederick, Gary Gereffi, Rich Appelbaum, Barbara Herr Harthorn; Postdoc Researcher (1) Graduate Student Researchers (2)

This project has entailed value chain mapping of California and the United States in the global nanotechnology economy. Objectives include identifying firms working in each stage of the supply chain from nanomaterials through end-markets, analyzing the impact of value chain dynamics in each stage such as policies, risk, perception, and competitiveness factors, and evaluating how these are linked together in California and how California compares to competing geographies. Outcomes include the California in the Nanotechnology Global Economy website accessible at: <http://californiananoeconomy.org/>

Although California as a base for nanotechnology business was the initial focus of the project, data collection has sought to encompass firms in all states (~1,500 locations). This has included for more than 100 products for California companies. Consistent with global value chain (GVC) approaches, forward and backward linkages were made for all categories for each stage, sector and sub-sector in the nano value chain, and important global/national firms and supporting organizations outside California were also added for each stage, sector & sub-sector. Investor information was added to the website, including affiliated firms with sources of funding (SBIR, Venture Capital, etc.). The site includes GIS data and map visualizations. This is primarily a research tool rather than an outcome in itself, and the data on has been used by IRG 2 and IRG 3

researchers, resulting in publications and research proposals for projects in development. It is also publically accessible (with NSF acknowledgement and disclaimer on the home page). Project researchers will continue to update the site as possible, and it will be hosted indefinitely by Duke University where it currently resides. During this award publications relating to this project have resulted, and presentations and workshops on the work have been made around the US. The data in this provide the basis for a current project proposal in development by IRG 3 researchers Harthorn and Collins on risk perception mapping.

Google Analytics cumulative user statistics from the site launch on November 1, 2012 through March 31, 2016 show 29,137 total site visits/visitors of which 25,990 were unique visitors. Total pages visited: 66,868; Geography of visitors: USA: 52% (16,970 visits, of which 6,112 are California, followed by NC at 1,066); followed by India (4.8%) and Japan (4.4%)

Usage for the last year is up from the previous year. Between March 31, 2015 and March 31, 2016 there were 13,634 visitors and 25,036 total pages visited. For the year prior, there were 9,131 visitors and 17,843 total pages visited.

\* \* \*

#### **X-IRG 4:** Nanotech in Print Media; Sharon Friedman, Brenda Egolf

The study of print media framing of nano in the renewal award period has been conducted primarily by collaborator Friedman at Lehigh University and her team. Friedman and Egolf have developed an extensive coding system for analyzing print media coverage of nano. Friedman supplements the print media report analysis with depth interviews with journalists to provide depth understanding of the changing media environment for risk reporting and communication of scientific uncertainty, and new analysis of Google News and an online media source (the New Haven Independent) that has had a particular focus on nano risk issues. During this award, the team has published 3 papers (Friedman and Egolf 2011, 2012, 2015), with another 2 under review, and given annual presentations on the work.

Friedman is extending these methods in several new research projects on earthquakes and fracking as risk communication issues.

\* \* \*

#### **X-IRG 5:** Ethnographic Explorations of Nanoscience and Nanotoxicology Laboratories: Mikael Johansson.

From 2009-2010, CNS Postdoctoral Researcher, Mikael Johansson, worked with IRG 1 and IRG 3 leaders McCray and Harthorn and conducted extensive laboratory ethnographic research in nanoscience and nanotoxicology labs in the US, a comparative base for his doctoral research in nanoscience laboratories in Sweden. During, while reentering his professional obligations in Sweden at the Gothenburg University, Johansson continued analysis of the extensive ethnographic field data collected during his postdoc at CNS 2009-2010. He is in progress writing a book about the life worlds of nanoscientists and toxicologists studying the adverse effects of nano particles.

Based on his CNS research anthropologist Johansson initiated a new collaboration with anthropologist Åsa Boholm (Professor in Social Anthropology, Dept. of Global Studies at Gothenburg University, Sweden) and has received a substantial 2.5 year grant from the Swedish

Research Council to pursue a nanotechnology risk project with Professor Boholm. In Sept 2015 he began new ethnographic research among nanoscientists specialized in graphene.

\* \* \*

**X-IRG-6: Framing Nanotechnology in Social Media: Galen Stocking (IRG 2), Ariel Hasell (IRG 3)**

In this project, graduate students Stocking and Hasell have sought to measure how much public engagement related to nanotechnology occurs on social media. Social media has had an increased role as a conduit for delivering information to the public, but it also provides new opportunities for bi-directional communication between the science community and science-interested publics. It also creates opportunities for individuals uninterested in nanotechnology to be exposed to it incidentally. Finding new ways to effectively engage with the public is an important goal of both CNS and the NSF.

There are several components to this research: measuring agendas, investigating the nature of interaction, and describing the language used. They use population-scale data on Tweets across American Twitter related to nanotechnology and similar terms. This research is conducted using data provided by Crimson Hexagon, a social media and news database provider that includes several tools for analysis. Upon acquiring this data, the researchers use statistical time series methods to describe the results.

They are disseminating results in publications (Hodges and Stocking 2015), and at conferences. They are also using the tools developed for the CNS project to conduct broader research on social media and emerging technologies. With a collaborator, they are also investigating Twitter activity around the oil industry. This project intersects closely with IRG 3 and IRG 2.

\* \* \*

**X-IRG 7: CNS Faculty Seed Grants on Societal Issues for New Technologies**

In order to generate new research and/or engagement projects that will involve new UCSB faculty participants in the CNS who will contribute to furthering the mission of the CNS, CNS has been awarded 2 Supplements, in 2012 and 2013, to fund 2 waves of a seed grant program at UCSB. The first round of competition in Fall, 2012, resulted in 4 projects awarded in Spring 2013 that most closely met the aims of the program, for a total of \$240,706, including indirect costs. Four additional seed grants were awarded in the 2<sup>nd</sup> round in Spring 2014, for a total of \$224,087.

**Round 1 CNS Faculty Seed Grant Projects (2013-14)**

**X-IRG-7-1:** Characterization of uncertainties in the life cycle assessments and risk assessments of nanotechnology; Sarah Anderson, Sheetal Gavankar.

In order to assess and improve uncertainty communication in Life Cycle Analyses (LCAs) of emerging technologies, this project aimed to:

1) Derive criteria for effective communication of uncertainty to public audiences from the social science literature



- 2) Use existing methods to evaluate location and type of uncertainty reported in LCAs of engineered nano-materials
- 3) Design new measures corresponding to criteria from 1) above
- 4) Recommend improvements (including tools) for uncertainty communication
- 5) Prepare manuscript for publication to capture the above

The project completed all aims. They have derived criteria for communication of uncertainty, used the Walker-Harremöes framework to evaluate location and degree of uncertainty, and designed a new matrix to evaluate the location of reporting of uncertainty, whether likelihoods were associated with scenario analysis, and the use of subjective researcher evaluation of uncertainty.

Findings indicate that while there is much discussion of uncertainty, researchers do not provide likelihoods associated with scenarios or an overall evaluation of uncertainty. Reporting of uncertainty is most often in the text, rather than in locations more accessible to a lay audience.

Also, there is no unified way of presenting non-statistical, epistemic uncertainty. Finally, discussion of uncertainty lacks the contextualization necessary to make it accessible. The project has published these findings (Gavankar, Anderson & Keller 2014), along with the recommendations for improving uncertainty reporting.

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**X-IRG-7-2:** Bringing Science to Life: CNS Engagement Seed Grant; George Legrady, John V. Decemvirale.

This project positions scientific research into the public domain by transforming the museum into a living lab, allowing the public to see the methods and processes by which scientists develop their work. The project features 5 to 10 UCSB Lab-based scientific projects that have used this opportunity to develop new methods to engage the public to contribute to the research in direct and tangential ways. Each sub-theme has been assigned to one or more scientific research project, and is situated in contrast, comparison, or collaboration with one or more artistic research work, or a scientist and artist may decide to explore a particular theme together. This seed grant contributes to the Public Outreach and Engagement program at CNS.

The Spring 2014 symposium, *Interrogating Methodologies: Exploring Boundaries in Art & Science*, was the first public iteration and presentation of the project's work and ideas, gathering (for eventual publication purposes) a list of previous exhibitions both national and international where science has been exhibited within the museum, researching possible grants to approach for funding and researching exhibition techniques for increasing viewer participation with scientific material. The symposium was held April 18-19 2014 and brought over 40 scholars, artists, students and scientists together at the UCSB campus for the 2-day meeting/workshop. Topics included: data visualization (how do we visualize data?), Chaos, Symmetry and Granualization, How does Science ask questions? How do we discover? the current relationship of art and science, strategies for presenting scientific research to the public. This symposium was intended to be an important first step toward the upcoming exhibition on the same topic, as well as an opportunity for our questions and ideas to be discussed and debated in public. The group is proceeding with the proposed planning of the exhibition in the UCSB Art Museum which will consist of bringing science research into the museum to compare methodologies and

approaches. There may also be artistic/architectural collaboration. The symposium is posted online at <http://interrogating-methodologies.org/> with all the presentations so that anyone can visit the site and review the presentations.

Seed grantee Legrady has made numerous presentations on his work in galleries and museums around the world (Paris, Bogota, Ottawa, LA, Nantes, Dubai), and just received a Guggenheim award on this

\* \* \*

**X-IRG-7-3:** Public Sentiment and the Performance of Protest in Japan's Antinuclear Movement  
David Novak

This project's research aims have included two distinct goals: continuing gathering of information and background material about the past 3 years of antinuclear activity and arts and culture in response to the Fukushima Daiichi nuclear accident, in order to best understand the range of responses and actions that have taken place, and secondly to discover via ethnographic research how music is used to gather audiences for antinuclear festivals and to galvanize public protest events.

First, the project gathered information on the general activities of the antinuclear movement in Japan over the past two years, including translating and summarizing news reports and government statements on Fukushima Daiichi as well as materials published by activists and musicians about specific antinuclear protest actions and activities. Second, they traveled to Japan for a month-long project to conduct ethnographic fieldwork, including audio and video documentation, of antinuclear events in Fukushima, Tokyo, and Osaka during August 2013, and other environmental music festivals, and interviews with activists and artists. These included Project Fukushima!, a festival in Fukushima City, Hello 816!, a second Project Fukushima related music concert in Koriyama city, weekly protests in front of the Prime Minister's residence in Tokyo, and the Goodbye Nukes antinuclear concert and lecture in Hibiya Park. Third, the project spent the fall 2014 translating and preparing notes on documents gathered during fieldwork, as well as continuing to connect to virtual events (such as the Dommune Project Fukushima! Roundtable broadcast on streaming weblink).

There have been a number of publications from this project. A research article entitled "The Politics of Festival in Japan's Antinuclear Movement" is under review; a short piece entitled "Disturbance" was published in the bilingual volume *To See Once More the Stars: Living in a Post-Fukushima World* (ed. D.Naito et al., New Pacific Press) in 2014. Novak also gave a presentation on the work, "The Politics of Festival in Japan's Nuclear Village" at the Center for Ethnomusicology, Columbia University in March 2015.

This project's main research data collection is complete, and Novak is currently engaged in disseminating results via presentations. The PI additionally received a short-term Research Fellowship for Summer 2015 from the Japan Foundation. The main project outcome planned is a book-length publication, in progress. Novak also received an Academic Senate Faculty Research Grant of \$10,000 to extend work on the project.

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**X-IRG-7-4:** Filtering out the Social: Nanotechnology and Water Treatment in Mexico: Casey Walsh, Laura Saldivar-Tanaka

The goals of this project were to acquire a general knowledge of the nanotechnology sector in Mexico, including a) research/science, b) government, and c) business and to interview key personnel in these three sectors. In addition, the project aimed to acquire a detailed knowledge of the application of nanotechnology to water, landfill waste, and wastewater treatment sectors, based on extensive interviews with key participants.

Using ethnographic methods, the project aimed to measure the degree to which water systems managers are adopting nanotechnology, whether these systems are more public/social or more private/individual, and the overall balance and relation between nanotech filtration and purification techniques and efforts to decrease the production of contaminants and their intrusion into water commons. To move beyond the local scale of analysis and gain a general perspective on the water sector in Mexico. Research was conducted in various sites in Mexico (Guadalajara, Monterrey, San Luis Potosi, Mexico City, Guanajuato, Puebla, Morelos, and Chihuahua) among a range of social actors (Enterprise, Academics, Government, Non Governmental Organizations, General Public).

As a result of the seed grant Walsh has continued to conduct research on water quality and filtration systems in Mexico. Project research assistant, Saldivar, has continued to do research on the regulation of nanomaterials and water quality in Mexico, and Walsh is collaborating with her on that. Saldivar has entered a PhD Program at the Colegio de Mexico that builds on her seed grant work, with the research project "Environmental Regulation of Nanosilver in Mexico." Walsh will continue to advise her on this project as it develops. He has also explored the possibilities of continuing research on nanotechnology and water with Gian Carlo Delgado, of the Center for Interdisciplinary Research in Science and the Humanities, at the National Autonomous University of Mexico (CIIECH) UNAM.

In addition to these educational and networking outcomes, the project has resulted so far in 1 publication in Spanish in *Mundo Nano* (Saldivar and Walsh 2015), a workshop convened by Walsh in Mexico in June, 2014, a keynote address in Hidalgo, Mexico, and 3 additional conference presentations.

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## **Round 2 CNS Faculty Seed Grant Projects 2014-16**

**X-IRG-7-5:** Driving Development: The Lithium Trade in Bolivia, Argentina and Chile; Barandiaran, Pardo-Rodriguez, Caroon

In the high Andes between these countries are found the world's largest lithium reserves. This project investigates how Bolivia, Argentina and Chile are participating in the creation and deployment of an emerging technology: lithium batteries, used in electric vehicles, laptops, mobile phones, MP3s, and energy storage for solar power plants. This project contributes to CNS IRG 2 research on Latin American development and new technologies and builds on STS scholar Barandiaran's dissertation research on environmental policies and development in Chile.

The initial aims of this project were to: 1) gather basic information on the lithium market and prepare research materials; 2) conduct archival research on the regulation, infrastructure and market strategies employed to extract and commercialize lithium in each country, with the aim of answering basic questions about these aspects and identifying the scope and potential of different sources of information for further research; 3) establish contacts with informants in each

country who work in the lithium industry; and 4) establish contacts with scholars in each country who do research on lithium and related resources.

With the help of 2 graduate student researchers (Pardo-Rodriguez and Caroon), Barandiaran has pursued all of these. She spent part of summer 2014 in Chile and Argentina conducting preliminary research on lithium. In Chile, she interviewed seven individuals involved with lithium regulation and production and examined archival material at the national geology and mining agency, the national production agency, and the national archive. In Argentina, she interviewed eleven individuals involved with lithium regulation and production and examined some archival material at the national geology agency and the provincial libraries of Salta and Jujuy. She obtained valuable material regarding the history of lithium extraction and interview material that is relevant to understanding current debates, and she made many valuable contacts with people who work in the lithium industry, including with one business consultant, two companies, and two geology consultants. She also has made contacts with researchers in Chile and Argentina who work on different aspects of lithium research that she anticipates may lead to future collaborations.

Additional research on this project in 2015 led her to the archives of Chile's geology agency (Sernageomin) and development agency (Corfo); visiting Argentina's Atomic Energy Agency to investigate the background of military operations regarding lithium, and revisit the national geology agency (Segemar); and investigating the history and presence of R&D efforts regarding lithium in each country, including Bolivia.

In addition, Barandiaran received 3 small grants in 2014-2015 related to this project, a Research Clusters grant from the Orfalea Center for Global Studies, an Interdisciplinary Humanities Center Research Faculty Group award, and a Letters and Science award at UCSB to organize an interdisciplinary group of faculty around the idea of "Energy Challenges in the Developing World." The funds supported regular meetings among members and several events, including an Open House for graduate students (Feb. 2015) and a day-long workshop on "Energy Challenges in the Developing World" held Feb 20 2015, with keynote speaker, historian Gabrielle Hecht (U. Michigan), that included a presentation by Barandiaran on this project, and presentations by 2 other CNS research projects (Newfield X-IRG 2; Partridge IRG 3-3).

Barandiaran gave 3 additional presentations on this work: at the Latin American Studies Association Conf in May 2015 in San Juan, PR; at the Universidad Austral, Valdivia, Chilean in July 2015; and at the University of Santiago, Chile also in July 2015. She incorporated material on her lithium research into Global 173 "Energy in Global Societies," Winter 2015, an upper-level undergraduate course. About 5% of the course content was related to her CNS work.

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**X-IRG-7-6:** Theorizing the Underlying Cognitive Mechanisms of Upstream Public Deliberation: Neuroscience, Identity Formations & Unconscious Bias; Edwina Barvosa, Rosie Bermudez, Chloe Diamond-Lenow

This project in applied theory builds on IRG 3 empirical research findings in public deliberation on nanotechnology, showing that public deliberation can be an effective means for the critical consideration of science governance policies. This project has had three aims: 1) to extend understanding of public deliberation by theorizing the underlying cognitive mechanisms operating in staged and on stage deliberative practices, 2) to develop case studies and data-driven examples to illustrate these underlying mechanisms, 3) to theorize how, if at all, the underlying

cognitive mechanisms of public deliberation can serve to disrupt or reassert unconscious bias—a factor increasingly recognized as an obstacle to just and evidence-based policymaking in science governance and beyond. This project utilizes IRG 3 data and other research in public deliberation.

With seed grant support, Barvosa completed research on two case studies in public deliberative systems—specifically on gender economic inequality, and climate change (the third based on research conducted by IRG 3 collaborator Pidgeon). All three are factors that arise in the IRG 3 deliberation research. These form the basis of theoretical work outlined in aims 1 and 3 above. Diamond-Lenow and Bermudez have assisted extensively in this work. This research has been completed and analyzed and is written in a book manuscript that is currently under peer review with Cambridge University Press.

Barvosa has integrated theoretical analysis developed into an article in *Journal of Environmental Studies and Sciences* (Barvosa 2015). This research proposes a theoretical approach by which attitudinal ambivalences found in public engagement research might be analytically mapped. This mapping can in turn be used to identify areas of compromise, qualification, and conditions of public acceptance for potentially disruptive new technologies such as fracking.

Barvosa has 2 additional related articles in preparation out of this work. In addition, this work has contributed to her active expert witness work on aspects of unconscious bias in local court cases.

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**X-IRG-7-7** Democratization of Creativity and the Growth of Inequality in 19th-Century America: Explaining the Origins of America's 21st-Century Economy; John Majewski, Deborah Pierce

A large part of this book-length project documents the processes which first produced widespread economic creativity and technological change. The explosion in patenting before the Civil War, for example, is a complicated story, involving the rise of markets and economic incentives, the expansion of public education, the dissemination of knowledge through libraries and other civic institutions, and the growth of “habits of mind” that emphasized curiosity and valorized innovation. This seed grant contributes to CNS IRG 1 on the history of innovation.

The main aims for the seed project have been to: Identify Relevant Statistical Databases and Sources for Nineteenth-Century U.S.; analyze the statistical relationship between educational achievement, geography, institutions (especially slavery) and various economic variables; to construct a “Creativity Index” in which measures a county's ability to support and develop creative activity in 1850--this index includes economic variables (urbanization, access to markets), civic development (libraries and scientific organizations), and educational outcomes (percentage of children attending school, local investment in public education); to relate the “Creativity Index” to other variables, such as the relationship between creative potential and inequality? What was the relationship between creative potential and slavery?; and to relate the Creativity Index of 1850 to long-term trends in creative activity, asking such questions as: Do counties with high scores for creative potential in 1850 have higher levels of creativity in the 21<sup>st</sup> century? This is a good test of the degree of path dependence in creative economic activity.

The project has already generated many interesting results. The research team has used quantitative data and GIS mapping techniques to determine the extent of education (as measured by the number of children attending school) and economic creativity (as measured by patents). They have found the geography makes a difference--in rural areas, in particular, the number of

free residents per square mile makes a big difference. Even more important than slavery, however, is the presence of slavery. Where slavery was legal--even if the actual number of slaves owned was minimal--there was a big drop off in school attendance and creative activity. Majewski's initial hypothesis was that slavery contributed to inequality that decreased investment in education. The evidence now indicates something somewhat different: slavery created conservative gender and cultural norms that discouraged the democratization of education and creativity. Even a "little" slavery made a big difference in outcomes.

More recently the key goal has been analyzing a database of some 3,000 patents issued from 1848 to 1852 and then analyzing another database of patents from 1860. The team then wanted to map each database using GIS techniques on a county by county level. They then wanted to relate patenting to slavery: Did slavery result in less patenting? The key finding was that even a small number of slaves tended to dramatically decrease inventive activity.

The project, presented preliminary findings in presentations in May 2015 at Augustana College, IL, and to a range of scholars and policymakers at the Washington Center of Equitable Growth. An additional presentation was made at the Yale University Economic History Workshop also in May 2015.

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**X-IRG-7-8** Does the US Nanotechnology Sector Suffer a Skills Gap? Aashish Mehta, Stacey Frederick, Rachel Parker, Jacqueline Dodd, Rachel Drew, Isabel Ochoa, Marissa Taggart, Caitlin Vejby

This project investigates whether there is an unmet demand for highly skilled STEM workers in the nanotechnology sector, and, if so, what the missing skills are. This will help to shed light on the existence of a skills gap, and also on why technology professionals and social scientists disagree about this. Existing nationally representative datasets do not provide adequate information to answer these questions because they do not provide detailed measures of the skills workers possess, where/how they acquired them, or what skills employers are looking for. This project will contribute to IRG 2 on workplace effects of emerging technologies.

The project aims to answer the following questions, all of which are geared towards understanding how serious US scientific skill gaps is, why industry and social science studies do not agree on this point, and what types of national human resources policies might be called for:

1. What skills are required of workers in small nanotechnology firms?
2. Are employers able to find workers with these skills at prevailing wages?
3. Could they find such workers at higher wages, and if so, what prevents them from offering these wages?
4. Where did those workers possessing the requisite skills acquire them?
5. What types of skills do employers find are in short supply, and why does this happen, even as the relative pay of stem majors is not increasing rapidly?

The team has conducted roughly 35 interviews with managers at California technology firms. Securing these interviews took a long time and a lot of effort. Interviews were semi-structured. They are currently processing interview results using a carefully devised economic rubric, to shed light on each of the above questions. Findings so far indicate that gaps exist for very specific STEM skills, and often appear to be a function of the off-shoring of manufacturing and prototyping jobs. This leaves gaps in particular, interdisciplinary skills that have always been picked up by workers in firms, but that firms are now looking the universities to fill. Thus, there are gaps, but filling them is not a numbers game (barring a few new areas, like machine learning). We have

confirmed some of these interview findings in data from the Annual Community Survey, and are in the process of checking others.

The team has produced one directly relevant publication (under review) on the impact of national nanoscience diversification strategies. Aashish Mehta advised the Asian Development Bank on a large report on skill gaps in Asia. Aashish Mehta has continued to work on projects involving industrial employment creation in India, and a study studying the role of education in industrial upgrading around the world. He also has guest-lectured at Santa Barbara City College, and regularly incorporates material regarding industrial policy, derived from his work on CNS projects, into his undergraduate courses - Global 130: Economy and Development (Spring & Fall 2015), and Global 136: Global Economic Imbalances (Fall 2015); and his graduate course - Global 236: The Global Economy (Spring 2015).

TABLE 2: NSEC Personnel - US Citizens and Permanent Residents

Year of annual report	Total										Women										AA-NA-PI										Hispanic										Disabled																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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AA-NA-PI

AA

NA

PI

Africa American / Black

Native American / Alaska Native

Native Hawaiian or Other Pacific Islander

A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands



## 7. CENTER DIVERSITY - PROGRESS AND PLANS

The CNS-UCSB community has recognized from experience that diversity strengthens the quality of research and the capacity to disseminate results to a wide range of audiences. CNS-UCSB has maintained that engaging with diversity is an ethical good, but that it is also a fundamental necessity in innovation and in disentangling the complicated social relations that surround an increasingly technological world. Our diversity mission has been focused on creating a community comprised of outstanding researchers, staff, and advisors from different gender, racial, ethnic, disciplinary, family, and educational backgrounds that represent and reflect the communities we serve. Additionally, the Center has broadened participation by seeking out researchers and participants in other countries across North America, Europe, Asia and Africa, including increasing numbers in the Global South.

Because CNS-UCSB has operated for the past year on limited carry forward funds and our focus has been on tapering activity, we have added few new participants. We have made every effort, however, to sustain diversity in our center and to embed it as a value in our work. At the close of the CNS, we reflect on which aspects of our program have been most productive of such diversity.

As we do so, one noteworthy qualification to the cumulative diversity data reported in Table 2 is that it is based entirely on our participants' self reported data, and we have found that many social science students and faculty from diverse backgrounds, particularly those involved in research on issues of equity and difference, decline to self-report such requested diversity data on political or ethical grounds, or because they disagree with the categories as defined. So, this table should be understood to underrepresent the actual diversity of the center's personnel.

### Undergraduates

Undergraduate interns for our 8-week Summer Internship Program were recruited in years 6-8 (years 1-3 of the current award) through a partnership with UCSB's California NanoSystems Institute's (CNSI) INSET summer program, an institutional REU program funded by NSF that recruited students from California community colleges with an emphasis on diversity. Between 2002 and 2010, the entire group of CNSI INSET interns was 45% minority, 42% female and 3% disabled (diversity data are not available for individuals over this full period). Participating in this recruitment network has enhanced CNS-UCSB's diversity and its research enterprise. In Year 6, additional summer interns were recruited from among UCSB undergraduates through a broad, campus-wide call, with email announcements and flyers distributed to all academic departments. Additional announcements were sent to our contacts in the SACNAS and Los Ingenieros student organizations. During the current award, out of 10 INSET CNS interns, half (5, 50%) were minority (including African American, Asian, Latino/a, Mixed Native American and Pacific Islander identification). Four (40%) were female.

In addition to the summer internship program, CNS-UCSB engages undergraduates throughout the year directly in the research process and/or in research administration, at UCSB and our partner institutions. They are exposed to cross-disciplinary investigation and research methodologies. Selected via targeted or open recruitment, these students contributed to the Center's diversity. A total of 26 other undergraduate students participated in the Center in this award, 18 (69%) of whom were female, 6 (23%) of whom reported African American/Black or Native American/Alaska Native or Native Hawaiian/Pacific Islander, 11 (42%) reported Hispanic ethnicity. The academic majors of undergraduate participants included Accounting,

Biochemistry, Chemistry, Chinese, Computer and Electrical Engineering, Economics, Environmental Studies, Geography, Global Studies, History, Linguistics, Psychology, Sociology, and Women's Studies.

### **Graduate Students**

The CNS-UCSB Graduate Research Fellowship program has recruited all doctoral student participants through an open, highly competitive application process. We hold open recruitments to award both Social Science/Humanities and Science/Engineering Graduate Fellows. The search is well publicized and targeted through email announcements, including a diversity statement, sent to graduate advisors in all academic departments on campus; by posting to the UCSB student fellowship opportunities board; by posting flyers on campus kiosks and in academic departments; and by posting the job announcements on the Center website front page during the application period. As mentioned above, due to continuing Fellows from the prior year, we did not recruit any new Fellows this year, and within the reporting year, several Fellows have successfully completed the program, graduated and moved on to new professional employment opportunities and others are preparing to follow in their steps this academic year.

Since the beginning of the current award, a total of 17 students have participated as CNS Graduate Research Fellows. Five of the 17 (29%) were from the Sciences/Engineering, and 12 (71%) from the Social Sciences/Humanities. Nine (53%) were female and 8 (47%) were male. Almost 30% (n=5 or 29%) reported minority identity (African American, mixed Native American, Asian, and Hispanic ethnicities), and 1 of the 17 reported a disability. Several chose not to report race and/or ethnicity data. Their areas of study were: Anthropology; Black Studies; Chemistry; Chicana and Chicano Studies; Communication; Ecology, Evolution, and Marine Biology; Ecotoxicology; English; History; Materials Science; Political Science; and Sociology.

### **Non-Fellow Graduate Student Researchers**

CNS-UCSB employs a number of graduate student researchers beyond the fellowship program, as do our partners. Forty-one graduate students from UCSB and 10 at our partner institutions participated in the Center in these roles during the reporting period. 31 (60%) were female, and 20 (40%) were male. As with the Fellows, almost one-third (n=15 or 29%) identified as being of African American, mixed Native American, Asian, or mixed White and Asian, race and/or of Hispanic ethnicity. A number declined to identify.

Year 6-11 graduate students researchers (non-fellows) have come from fields including Anthropology; Biochemistry; Chemistry; Chicana/o Studies; Communication; Computer Engineering; Economics; Education; English; Environmental Science & Management; Feminist Studies; Film & Media Studies; Geography; Global & International Studies; History; History of Art & Architecture; Linguistics; Materials/Risk Science; Media Arts & Technology; Political Science; Risk Science; Sustainability Science; and Science Journalism.

### **Postdoctoral Scholars and Researchers**

CNS-UCSB began its postdoctoral program at UCSB in Fall 2008. As in our other programs, we strive for a diverse and excellent applicant pool through an open, competitive recruitment process, and CNS-UCSB full-time multi-year postdoctoral positions are normally recruited following this protocol. We have aimed postdoctoral scholars recruitment at a national and international audience through extensive advertising in topical nano, STS, disciplinary, and other listservs, professional organizations, bulletin boards and other avenues, and have distributed calls through our partner organizations, including CNS-ASU's listserv. We also have distributed announcements through the S.NET conference listserv and at their conferences. In

recruiting for open or new positions, in addition to the traditional networks, listservs, and professional organizations (above), we have sent our advertisements to specialty groups serving women and minorities in order to to expand our connections with as diverse a group of potential applicants as possible.

The 23 CNS-UCSB affiliated and active postdocs at all institutions in this award included 11 females (48%). Two were of Hispanic ethnicity, and 4 reported minority status (Mixed Native American, Asian). Five postdocs did not report race or ethnicity data.

### **Leadership: PIs, Advisory Board, Senior Personnel**

At all junctures in its development, CNS-UCSB has recruited staff and participants with attention to diversity of ethnicity, gender, and experience. The Center Director and PI is a woman, a Professor of Anthropology, affiliated faculty in Feminist Studies and Sociology, a past longtime member of the governing boards of the UCSB Institute for Chicano Studies and the UCSB Center for Black Studies, a past member of the Advisory Committee for the Center for Latina/o Health, Education & Research as well as a 3-year appointed past member of the AAAS' Committee on Opportunities in Science (COOS), whose role is to enhance the participation nationally in Science and Engineering of women, people of color, and people with diverse disabilities, sexual orientations, and other needs. The CNS-UCSB Executive Committee has a strong record of gender balance. Four of the eight members at the closing of the award are women (Harthorn, Holden, Metzger, and Parks). In addition, Assistant Director Molitor serves as an *ex officio* member, adding additional gender diversity. Another *ex officio* member and staff member, Fastman, is a first generation college graduate. As noted in prior reports, we have been less successful in creating ethnic diversity on the leadership team, although one of the founding PIs was Asian, and one *ex officio* member identifies as mixed race heritage. Throughout the Center's existence, we actively recruited Senior Personnel of diverse gender, racial and ethnic backgrounds from within the UCSB research community to increase the range of inputs into our programs and to create the basis for increased future leadership diversity; this is particularly evident in the Seed Grant program.

The CNS-UCSB administrative, technical and research staff also reflects a commitment to diversity. In the renewal award, 3 (60%) of the 5 administrative and research staff members were female, 4 (80%) reported minority status (3 mixed race and 1 Asian), and 2 were of Hispanic ethnicity.

In addition to racial, ethnic and gender diversity, disciplinary diversity has been a hallmark of CNS-UCSB, as shown above by the backgrounds of our student and postdoctoral participants. Our participants have represented a wide breadth of educational backgrounds and disciplinary experience. Departments represented by members of our Executive Committee, including those with which they hold affiliate positions, include Anthropology, the Bren School of Environmental Science & Management, Chemistry/Biochemistry and Materials, Communication, Feminist Studies, Film and Media Studies, Global and International Studies, History, Political Science, and Sociology. Senior Personnel at UCSB, including those in our Seed Grant program, expand that list to include: American Studies, Chicana/o Studies, Economics, Engineering, English, Environmental Studies, Environmental Politics, Ethnomusicology, Geography, Global Economics, Media Arts & Technology, Microbiology, and Physics. And our collaborators at other universities and settings add Asian Studies, Business, Economics, Law, Risk Science, Science Journalism, Science Policy, Social Psychology, and Visual Studies.

The CNS National Advisory Board was recruited with attention to diversity by gender, ethnicity, and interest in the equity issues that are likely to accompany emerging nanotechnologies. The

Board is nearly 50% women, including the Board Co-Chair Ann Bostrom, who is the Weyerhaeuser Endowed Professor in Environmental Policy at the Evans School of Public Affairs, University of Washington; Vicki Colvin, Kenneth S. Pitzer-Schlumberger Professor of Chemistry, Professor of Chemical & Biomolecular Engineering and Materials Science and Nanomaterials Engineering at Brown University (also former Director of the NSEC, CBEN, at Rice University); Susan Hackwood, the Executive Director of the California Council on Science and Technology and Professor of Electrical Engineering at UC Riverside; and Ruth Schwartz Cowan, Professor Emerita in the History and Sociology of Science department at the University of Pennsylvania and a leading scholar on the gendered history of science and technology. Board member Willie Pearson is African-American, a very active participant in NSF EHR and also contributes strongly to CNS goals of improving diversity.

Senior personnel from CNS-UCSB's collaborating institutions, many of them international, have contributed to the cultural diversity of the CNS; and contribute to gender/ethnic/racial diversity. Of the 25, 8 (32%) collaborators are female, 3 are of Asian heritage, 1 reports a mixed race identity, and three identify as Hispanic.

### **Visiting Researchers**

The CNS Visiting Researcher program has attracted scholars that contribute to the Center's diversity, especially because many have come from abroad. Recent visiting scholars include 2 female, 5 junior scholars, 3 Asians, and 1 Mexican.

### **Engaging Diverse Publics**

In addition to its robust program of outreach activities, CNS-UCSB research has pioneered methods for engaging with publics and understanding their dynamics. The public risk perception work of IRG 3 especially has honed its methods for conducting public deliberations about nanotechnology and other emerging technologies (for example, see [Pidgeon](#), [Harthorn](#) et al. 2009); added to the literature of democratic participation (see e.g., [Corner & Pidgeon](#) 2012); and developed theories about the cognitive dimensions of risk (see e.g., [Satterfield](#) et al. in preparation re: the White Male Effect). Via global value chain analysis, domestic and international surveys and interviews of technologists, and the analysis of data on foreign and domestic STEM workers – also of interest to IRG 1 – IRG 2 has directly addressed the interactions of an increasingly diverse and global workforce. ***CNS-UCSB has maintained that engaging with diversity is an ethical good, but that it is also a fundamental necessity in innovation and in disentangling the complicated social relations that surround an increasingly technological world.***

### **Pedagogy**

The largest impact of CNS-UCSB, however, will be in the classroom as CNS-produced research makes its way into curricula across disciplines and countries. Fortunately, UCSB and the California Central Coast area in which it is located are highly diverse, particularly reflecting the growing Latina/o population, but also in having significant Native American, Asian American, and African American population bases. As a rising Carnegie Research University/Very High research activity campus in a beautiful coastal setting, UCSB has been successful in recruiting a diverse student body, and in 2015 it became an official Hispanic Serving Institution. With six Nobel Laureates on its faculty and a ranking among the top 10 public universities in the country, ***UCSB is the only HSI in the country that is also a member of the prestigious Association***

**of American Universities.** HSI's are defined as colleges or universities in which Hispanic enrollment comprises a minimum of 25 percent of the total enrollment, which includes undergraduate and graduate students. In conjunction with its HSI status, UCSB is now eligible to apply for grants from the U.S. Department of Education, the National Endowment for the Humanities and the U.S. Department of Agriculture, among others, to fund a variety of initiatives, including support services for all students, faculty development, and the acquisition of scientific or laboratory equipment for teaching. Exploring these opportunities will be part of the CNS researchers' plans as they continue their inquiry into the societal implications of emerging technologies beyond the life of the Center. In addition to being headquartered at a diverse institution, CNS-UCSB's international collaborations in Mexico, Brazil, South Korea, Canada, the UK, and Japan, among others, ensure that the knowledge we have produced has an international reach.

**POSTS:** UCSB has been a partner institution and Director Harthorn a partner faculty member in CNS-ASU's Policy, Science, Technology & Society (POSTS) Scholars Program for the past 3 years, funded by the NSF. Targeting women, minorities and persons with disabilities, this year-and-a-half-long program offers sophomores and juniors from 11 partner institutions a gateway into academic Science & Technology Studies (STS) or professional Science Policy careers. Each selected student has been assigned a faculty mentor who guides them through a personalized course of study and research project. The program also includes two summer workshops in Washington, DC where participants meet key players in science policy and funding. Offered free of charge to participating students, the POSTS Program has been designed to deploy knowledge produced by the two CNS's and collaborators towards increasing diversity in STS and Science Policy fields. UCSB undergraduate researcher Catherine Enders (IRG 3) was a participant in the POSTS program in 2015-2016 under Harthorn's mentorship.

## **Evaluation**

Section 8 described an evaluation of the Science and Engineering Fellows Program that has been undertaken by Coordinator Fastman in collaboration with Center leaders Harthorn and Metzger. One goal of this qualitative study is to investigate how the Program – in which doctoral students in engineering, physical, and life sciences are socialized into research methods and practices in the ethical, legal, and societal implications (ELSI) of nanotechnology development – has influenced the work of young scientists and technologists once they graduate and enter the professional life. A second goal is to understand the strengths and weaknesses of the program. This study will address which elements of the Program appealed to a diverse applicant pool and why. We believe that we have enticed a strong and diverse set of students throughout our existence; however the CNS-UCSB educational program was the first of its kind and any future endeavors to integrate social science and S&E doctoral students within an educational mentorship program can learn from this first example. Therefore, CNS-UCSB finds it responsible to leave behind a record that attends to, among many others, questions of diversity.

## 8. EDUCATION

CNS-UCSB's Education Program established and carried out a highly successful program in the second award period. The following pages provide an overview of CNS-UCSB's Educational Program components, objectives, and metrics; report on our programs for postdoctoral scholars, graduate students, and summer interns; and highlight some of our curricular contributions to teaching the ethical, legal, and societal implications (ELSI) of nanotechnologies in multiple educational environments over Yrs 6-10 plus the NCE of the second award.

### CNS-UCSB Education Program Objectives & Key Programs

The Center brought together researchers and students in the social sciences, humanities, engineering, and sciences to create new, critically-needed collaborative education programs. It sponsored graduate fellowships, graduate student researchers, undergraduate internships, and new curricula. The Education Program provided mentorship and educational opportunities to postdoctoral scholars working with the Center's Interdisciplinary Research Groups (IRGs). CNS also collaborated with education staff from the California NanoSystems Institute (CNSI) and the Bren School of Environmental Science and Management (the institutional home for the main UCSB portion of the UC Center for Environmental Implications of Nanotechnology-UC CEIN) to develop and implement joint education materials and activities. The diagram below summarizes the four main components of the Program and their objectives.



### Education Programs Overview

CNS-UCSB's Education programs were key components for fulfilling our mission to prepare the next generation of scholars to engage in collaborative interdisciplinary research addressing emerging technologies' societal implications. Building on the essential interdisciplinary, collaborative research training received within the IRGs, the Education programs are designed to expand participants' skills by integrating them into the larger Center community through a series of structured programs and activities. All of our education programs were cross-disciplinary and provided opportunities for participants to interact with a mix of social scientists, humanists, scientists, and engineers at the faculty, postdoctoral, graduate, and undergraduate levels. Our Education programs served postdocs, graduate students, and undergraduates.

## **CNS Graduate Research Fellowships in Social Science/Humanities and Science & Engineering; Graduate Student Researchers**

One of CNS-UCSB's most successful features was its integration of graduate students from a range of social science, humanities, science, and engineering disciplines into every facet of our research, education, and outreach programs. Graduate students participated in IRG research through our Graduate Fellowship Program and in Graduate Student Researcher positions. The Education Program provided these students with a variety of interdisciplinary professional and personal development opportunities to supplement their research training. Provided below is a list of students active during the second award followed by descriptions of program activities.

### **CNS UCSB Graduate Fellows and Graduate Student Researchers**

<b>Graduate Fellow (n=17)</b>	<b>Department</b>	<b>Affiliation</b>
Peter Burks*	Chemistry	IRG 2
Amanda Denes	Communication	IRG 3
Roger Eardley-Pryor	History	IRG 1
Cassandra Engeman*	Sociology	IRG 2
Ingrid Feeney	Anthropology	IRG 3
Amy Foss	Chicana/o Studies	IRG 3
Matthew Gebbie*	Materials	IRG 2
Laura Halcomb	Sociology	IRG 3
Xueying (Shirley) Han*	Ecology, Evolution & Marine Biology	IRG 2
Shannon Hanna*	Bren School Env Sci & Management	IRG 3
Bridget Harr	Sociology	IRG 3
Ariel Hasell	Communication	IRG 3
Zachary Horton	English	X-IRG
Tyronne Martin	Chemistry	IRG 3
Louise Stevenson*	Ecology, Evolution & Marine Biology	IRG 3
Galen Stocking	Political Science	IRG 2
Brian Tyrrell	History	IRG 1
<b>Grad Student Researcher (n=41)</b>	<b>Department</b>	<b>Affiliation</b>
Lynn Baumgartner*	Bren School Env Sci & Management	IRG 3
Rosie Bermudez	Chicana/o Studies	Seed Grant
Erin Calkins*	Chemistry, Biochemistry	IRG 3
Clayton Caroon	Global & Int'l Studies	Seed Grant
Benjamin Carr*	Bren School Env Sci & Management	IRG 3
Mary Collins*	Bren School Env Sci & Management	IRG 3
Lauren Copeland	Political Science	IRG 3
Rachel Cranfill	Linguistics	IRG 3
John V. Decemvirale	History of Art & Architecture	Seed Grant
Chloe Diamond-Lenow	Feminist Studies	Seed Grant
Jacqueline Dodd	Economics	Seed Grant
Karin Donhowe	Economics	Seed Grant
Rachel Drew	Global & Int'l Studies	Seed Grant
Yuan-Yi Fan	Education	Education
Allison Fish*	Bren School Env Sci & Management	IRG 3

Angus Forbes	Media Arts & Technology	Seed Grant
Sheetal Gavankar	Bren School Env Sci & Management	Seed Grant
Lisa Han	Film & Media Studies	X-IRG
Sarah Hartigan	Global & Int'l Studies	IRG 2
Abigail Hinsman	Film & Media Studies	X-IRG
Zach Horton	English	X-IRG
Pehr Hovey	Media Arts & Technology	Seed Grant
Indy Hurt	Geography	IRG 3
Qiao Li	Global & Int'l Studies	IRG 2
Quinn McCreight	Global & Int'l Studies	Seed Grant
John Meyerhofer*	Bren School Env Sci & Management	IRG 3
Zong (Zach) Miao	Computer Engineering	Educ & Outreach
Margaret Moody	Education	Educ & Outreach
Kristen Nation	Women's Studies	IRG 3
Isabel Ochoa	Global & Int'l Studies	Seed Grant
Lumari Pardo-Rodriguez	Global & Int'l Studies	Seed Grant
Shadi Roshandel	Education	Educ & Outreach
Alexander Scarlett	Spanish and Portuguese	Seed Grant
Elizabeth Sciaky	Education	Educ & Outreach
Marissa Taggart	Global & Int'l Studies	Seed Grant
Caitlin Vejby	Global & Int'l Studies	Seed Grant
Adélaïde Veyre	Political Science	X IRG
Anna Walsh	Global & Int'l Studies	IRG 2
David Weaver	Political Science	IRG 3
Christopher Wegemer	Global & Int'l Studies	Seed Grant
Rong Yang	Education	IRG 2

\*Indicates partially or fully funded from leveraged sources

The Graduate Fellows Program was the major component of CNS-UCSB's mission to produce and encourage excellent and innovative scholarship addressing the intersection of nanotechnologies with society and contributing to academic workforce development for future nanotechnology research. Fellows took lead roles in the Center's research, education, and outreach initiatives, and were trained within the IRGs in a unique joint context of social science and nanoscale science and engineering research and training where they worked directly with their faculty mentors. Outstanding students were selected for the program through a campus-wide open recruitment that has enhanced diversity in the program. Social Science and Humanities Fellows were funded at a 20-hour per week time commitment, comparable to that required of UCSB teaching assistants. Science and Engineering Fellows were funded for a 10-hour per week commitment, allowing them to continue to participate fully in their laboratory-based research through their home departments. Both Social Science/Humanities and S&E Fellowships are awarded for one-year terms, with possibilities for renewal for up to two additional years. Because we did not want to recruit new Fellows during the NCE, we allowed some Fellows to stay on a third year. One measure of the success of the program is the frequency with which both social science and S&E students have requested renewal appointments, usually truncating only when they graduate.



The CNS Education Program provided Graduate Fellows with many additional professional and personal development activities during the year. A number of these activities were organized under the auspices of the CNS Research Seminar on Emerging Technologies & Society (Sociology 591, Comm 595), which included a mix of public and in-house research lectures by visiting scholars and UCSB-based scholars, professional skills training workshops, opportunities to present and discuss their research, and administrative and informational meetings. The Seminar met 4-5 times each quarter and in summer, beginning the year with an orientation workshop for all new and returning Fellows to introduce them to CNS Fellowship requirements, available Center resources, and each other. The majority of seminar sessions were attended by diverse other members of the CNS-UCSB community in addition to the Graduate Fellows, and, in the case of research lectures, by members of the university and Santa Barbara communities at large.

### *Evaluation*

As part of ongoing formative and summative evaluation, we annually asked current and former Fellows to complete confidential surveys describing their expectations, their general level of satisfaction, and perceived benefits resulting from their Fellowships. Although responses were overwhelmingly positive – on a scale of 1-5, Fellows in year 9 (yr 4 of this award) rated their overall satisfaction with the program 4.7 – we sought more narrative feedback towards the end of the award. Year 10's survey included open-ended questions with the goal of drawing lessons for future interdisciplinary educational endeavors. When Fellows were asked how they might focus resources in their own such program, five categories or themes emerged: regular communication across teams or working groups; seminar frequency and content; career counseling; openness and responsiveness to needs of students by center leaders; maximal opportunities for interdisciplinary immersion.

Students singled out the mentorship provided by CNS-UCSB. One said, "I think CNS has done a terrific job of organizing the education program. I really enjoyed it— very interesting, relevant topics. Over the years that I've been with CNS, the directors of the education and research program have been very open and responsive to our interests, which, I think, is part of the reason they've been so beneficial."

Another said, "My positive experiences of the CNS Education and mentoring program are closely linked to their combination of two key factors that I would hope to recreate in any other similar setting: (i) responsiveness to individual experiences, needs, intellectual interests and career objectives, and (ii) in-depth and wide-ranging familiarity with diverse strategies for negotiating established expectations within academic institutions, and for building constructive, collaborative networks and relations to facilitate, expedite and reassess those processes."

Science and Engineering Fellows did express a desire for their counterparts in the social sciences and humanities to see them in their primary research context. They also said they would have liked more seminar speakers from their home departments, both so that CNS-UCSB researchers would gain more exposure to scientists and so that their own faculty could gain a better appreciation of their work at CNS-UCSB.

In order to conduct a more meaningful investigation into how the Education program has impacted the practice of nanotechnology research and development and how our education program has influenced former participants over time, CNS-UCSB in Year 11 conducted a comprehensive research study to track the career paths of former science and engineering

Fellows, gauge the direction of their research, and measure the secondary effects of Fellows' CNS training as a result of their interactions with STEM colleagues.

This project entailed semi-structured interviews with former Fellows as well as their PIs. The initial results of these interviews, along with an in-depth description of the program, were published as a book chapter in a Springer volume called *Global Perspectives of Nanoscience and Engineering Education* (Fastman, Metzger and Harthorn 2016). The chapter, titled "Forging New Connections Between Nanoscience and Society in the UCSB Center for Nanotechnology in Society" identified three primary impacts of our Fellows Program. These were:

1. Communication: Science and Engineering Fellows reported feeling more comfortable writing and speaking to audiences outside of their primary discipline.
2. Cognitive Biases: They became more attuned to the social construction of their primary research contexts.
3. Epistemology: They gained an appreciation for alternative research methods and the resulting data.

The chapter was co-authored by Coordinator Fastman, Education Director Metzger, and Director Harthorn. The authors plan to submit a fuller analysis of the data to a peer-reviewed journal.

Measured by career trajectory, Fellows have achieved high success in finding positions as university professors and researchers, scientists and engineers at national labs and in private industry, researchers for NGOs, and entrepreneurs. As a few examples, Matt Gebbie and Ariel Hasell are currently postdoctoral researchers at Stanford and the University of Pennsylvania, respectively. Zach Horton and Amanda Denes are tenure track professors at the University of Pittsburgh and the University of Connecticut. Galen Stocking is a research associate at the Pew Research Center. Peter Burks is the CEO of a medical device startup called ActiveLife Scientific, and Xueying (Shirley) Han has accepted a position at the Washington DC science policy shop, Science and Technology Policy Institute.

*Graduate Student Researchers (GSRs):* In addition to the Graduate Fellows Program, CNS-UCSB provided 41 graduate students at UCSB and an additional 10 at our partner institutions with opportunities for involvement in research projects as GSRs. These students were hired by, and worked closely with, faculty researchers on projects for periods of one or more quarters' duration, usually for fewer than 20 hours per week. GSRs were invited, but not required, to participate in all CNS-UCSB activities, including the Research Seminars and graduate student information meetings, and receive regular announcements of professional development opportunities through Center listservs. Like other Education Program participants, GSRs were encouraged to discuss issues of interest and concern with the Education Director and Coordinator.

### **CNS-UCSB Postdoctoral Researchers Program**

CNS-UCSB provided research and training opportunities for 14 postdoctoral scholars based at UCSB and 9 elsewhere in collaborating institutions. The program at UCSB was initiated in 2008 with encouragement from the NSF. Since its inception, postdoctoral researchers have made important contributions to the success of CNS-UCSB programs, including the NanoDays informal science education program at the Santa Barbara Museum of Natural History; CNS Research Summits; the CNS Research Seminar; and conferences and seminars. They have also played key roles in mentoring graduate and undergraduate students in the CNS Graduate Fellows and INSET Summer Internship programs.

CNS sponsored 23 postdoctoral researchers over the course of Yrs 11-15 and the NCE, listed in the following table. Their work, CNS-UCSB's postdoctoral mentorship program, and program evaluation findings are described below.

**CNS Postdoctoral Researchers, Yrs 1-5 + NCE**

<b><i>Postdocs at UCSB (n=14)</i></b>	<b><i>PhD Field, Granting Institution</i></b>	<b><i>Affiliation</i></b>
Mary Collins	Environmental Science & Management, UCSB	IRG 3
Meredith Conroy	Political Science, UCSB	IRG 3
Lauren Copeland*	Political Science, UCSB	IRG 3
Gwen D'Arcangelis*	Women's Studies, UCLA	IRG 3, UC CEIN
Matthew Eisler	History, University of Alberta	IRG 1
Xueying (Shirley) Han	Ecology, Evolution, and Marine Biology, UCSB	IRG 2
Shannon Hanna	Ecology, Evolution, and Marine Biology, UCSB	IRG 3
Mikael Johansson	Anthropology, Gothenburg Univ	IRG 1/IRG 3/X-IRG
Luciano Kay	Public Policy, Georgia Tech	IRG 2
Yasuyuki Motoyama	Planning, UCB	IRG 2
Tristan Partridge	Anthropology, U of Edinburgh	IRG 3
Jennifer Rogers-Brown	Sociology, UCSB	IRG 3
Christine Shearer*	Sociology, UCSB	IRG 3, NSF Delib.
James Walsh	Sociology, UCSB	IRG 2
<b><i>Postdocs Elsewhere (n=9)</i></b>	<b><i>PhD Field; Campus location</i></b>	<b><i>Affiliation</i></b>
Adam Corner*	Social Psychology, Cardiff U.	IRG 3
Christina Demski*	Social Psychology, Cardiff U.	IRG 3
Darrick Evensen*	Technology Studies, Cardiff U	IRG 3
Kieran Findlater*	IRES, UBC	IRG 3
Stacey Frederick*	Textile Mgmt, Duke University	X-IRG
Matthew Keller	Sociology, UC Davis	IRG 2
Marian Negoita	Sociology, UC Davis	IRG 2
Anton Pitts*	Risk Science, U. Brit Columbia	IRG 3, UC CEIN
Merryn Thomas	Cult Geog, Cardiff	IRG 3

\* indicates postdocs funded partially or fully through other awards, but housed in and collaborating with CNS-UCSB

Starting in 2008, the UCSB CNS Postdoctoral Scholars Program has recruited outstanding postdoctoral scholars to spend one to three years as members of IRGs or X-IRG initiatives at UCSB. Participants in this program have come from the U.S., Sweden, Japan, UK, and Canada, in disciplines including City & Regional Planning, History, Political Science, Science & Technology Studies, Sociology, Social Anthropology, Textile Management, and Women's Studies. Several former postdoctoral scholars have gone on to faculty positions while others are working for government or NGOs. Of the postdocs hired after the start of year 6, Shannon Hanna is now a research scientist at NIST, Christine Shearer is Program Director at Coalswarm, Mary Collins is a tenure track professor at the SUNY College of Environmental Science and Forestry, Lauren Copeland is a tenure track professor and Associate Director of the Community Research Institute at Baldwin Wallace University. Shirley (Xueying) Han recently took a position at the Science and Technology Policy Institute. Luciano Kay and Tristan Partridge still hold

researcher positions at UCSB where they continue to pursue lines of research initiated at CNS-UCSB.

CNS-UCSB also supports postdoctoral researchers through our external collaborators. We partially or fully supported the work of 4 postdoctoral researchers with Pidgeon at Cardiff University (Corner, Demski, Evensen, and Thomas), and 2 researchers working with Satterfield and Kandlikar at the University of British Columbia (Findlater and Pitts), as well as 2 postdocs at UC Davis (Keller, Negoita) working with IRG 2 collaborator Block. We have funded a full-time postdoctoral researcher at Duke University (Frederick) who headed the Cross-IRG (X-IRG) global value chain spatial project examining the impact of California nanotechnology in the global economy, so designated because it integrates aspects of work of IRG 2, IRG 3, Education, and Outreach. We integrated off-site postdoctoral researchers with other Center personnel and activities whenever possible. We also included all postdocs to CNS Research Summits and other conferences and IRG meetings. The Center provided postdocs with financial and mentoring support to submit and present papers and research posters at professional conferences, workshops, and meetings. Postdocs also participated in CNS Research Seminar meetings focusing on professional development topics such as presentation skills, the academic publishing process, job hunting and networking tips, proposal-writing and research methods for quantitative and qualitative studies. Postdocs based off-site were encouraged to participate in Seminar meetings via conference call or Skype.

In addition, the Education Program provided postdocs and their faculty mentors with the Individual Development Plan for Postdoctoral Fellows (IDP) developed by the Federation of American Societies for Experimental Biology (FASEB), to identify and meet professional development needs and career objectives. UCSBs Graduate Division provides extensive postdoc mentoring and career development materials at <http://www.graddiv.ucsb.edu/postdoctoralscholars/careers.htm>, and at <http://www.graddiv.ucsb.edu/postdoctoralscholars/mentoring.htm>.

### **CNS-UCSB Undergraduate Summer Internship Program**

From 2006 until 2013, CNS provided 3-4 summer internships to students participating in the NSF-funded Interns in Science, Engineering and Technology (INSET) REU program at the California NanoSystems Institute (CNSI). A total of 33 interns worked with CNS –UCSB researchers, 15 during the second award (note that overlap of the NCE from the 1<sup>st</sup> award with this award understates this number). This program recruited community college students to participate in an 8-week summer research experience on the UCSB campus. As participants in the INSET program, CNS-UCSB interns participated in weekly meetings and special seminars, and were trained in presentation skills alongside REU interns working on experimental science research projects in CNSI laboratories. They were mentored 1-on-1 by a CNS Fellow and informally by the whole IRG, and fully integrated into research projects, but with a specific summer project of their own on which they worked and presented.

In addition to working on individual research projects, interns participated in IRG meetings, attended CNS Graduate Fellows Seminar meetings, and met regularly with Education program staff. At the end of the program, they delivered oral presentations about their research projects to the CNS-UCSB community and to a session attended by other INSET interns and mentors. They also presented their research at a campus-wide research poster colloquium with UCSB interns from the INSET and other summer research programs, and a number went on to present at national venues at minority serving institutions.

### **Undergraduate Student Researchers**

During the second award period CNS-UCSB also hired 18 undergraduate UCSB students during the academic year to aid with research efforts (and 8 at other campuses). Some of these students became exceptional contributors to the Center. Likewise, their experience conducting research at the Center bolstered their own academic performance and influenced their career paths. One, Emily Nightengale, went on to a Fellowship at that Science and Technology Policy Institute in Washington, D.C. after conducting qualitative field research on nanotechnology development in India under the mentorship of IRG 2 Fellow Galen Stocking. Another, Catherine Enders, joined CNS-UCSB in Fall 2014 to aid IRG 3 in the analysis of comparative US and UK deliberations on the the oil and gas extraction technique of hydraulic fracturing or "fracking." For her work at CNS-UCSB, she won the Chancellor's Award for Excellence in Undergraduate Research. She also was awarded a Science Policy Fellowship in CNS-ASU's Program to Increase Science and Diversity Studies in Science and Technology Studies and Science Policy Fields under Harthorn's mentorship and is now pursuing a Master's degree in Public Health at UC Berkeley.

### **Curriculum**

Throughout this award CNS-UCSB routinely began each academic year with a half- or full-day orientation workshop and lunch for the new and returning Graduate Fellows and Postdocs. The orientations were designed to create an interactive discussion of the Center's mission, activities, and policies and procedures, as well as specific background on the IRG research programs. In addition, the orientation included an introduction to nanoscale science and engineering.

The CNS-UCSB Research Seminar on Emerging Technologies & Society (offered quarterly as Sociology 591 BH) was the focal point of the Educational Program's internal activities. The Center found that the regular meetings were essential to developing an interdisciplinary community of scholars with special expertise and help participants learn to communicate effectively across disciplinary boundaries. Seminars addressed a wide range of issues related to emerging nanotechnologies and society, including social science and NSE research methods and ethics, science and technology studies, professional development topics, and substantive research from the IRGs. Students and postdocs share in decision making about the themes, foci and directions of the seminar each quarter and year, and about outside speakers to invite for talks and close discussion. Recent professional development sessions included workshops on writing briefs, preparing grant proposals, and navigating the job market. CNS-UCSB students had the opportunity broaden their formal education in areas related to their IRG research by participating in interdisciplinary doctoral emphases programs offered by UCSB. Three of particular relevance are those in Technology and Society, Feminist Studies, and Global Studies.

**Graduate and undergraduate university curriculum:** Over the course of the second 5 years and NCE, CNS-UCSB faculty and researchers incorporated Center research into 40 graduate and 80 undergraduate university courses. A selected list of examples follows.

#### **Examples of Graduate Level Courses 2011-2016**

- ANTH 219, *Anthropology of Risk* (Harthorn, S 2015)
- SOC 591BH/Comm 595, UCSB, *CNS Research Seminar in Emerging Technologies and Society*, taught 4 quarters/yr. (Harthorn, Metzger)
- HIST 201HS, *Advanced Readings in History of Science & Technology* (McCray W13)
- History 590, *Nanotechnology in Society*, Drexel (Slaton S 2013)

- LING 505, Research Methods in the Digital Humanities, University of South Carolina (November, Summer 2014)
- Global & International Studies 292MD, *Globalization and Development*, UCSB (Appelbaum)
- Resource Management and Environmental Studies 510, *Social Ecological Systems*, University of British Columbia (Satterfield F 2013)
- Resource Management and Environmental Studies 507, University of British Columbia, *Human-Technological Systems* (Satterfield and Kandlikar 2012)
- History 590, *Nanotechnology in Society*, Drexel (Slaton S 2013)
- Environmental Studies 696, *Race, Class, & Environmental Justice*, SUNY-ESF (Collins, 2016)

**Examples of Undergraduate Level Courses 2011-2016:**

- Anthro 104, *Risk & Inequality*, UCSB (Harthorn, Spring 2014, Fall 2015)
- Anthro 157L, *Medical Anthropology*, UCSB (Harthorn, Winter 2015)
- Comm 134, *The Social Construction of News*, UCSB (Hasell, Summer 2014)
- EEMB 120, *Intro to Ecology*, UCSB (Stevenson, Summer 2014)
- Intro to Ecology, UCSB (Stevenson, Summer 2014)
- *Global Engineering Ethics*, Seoul National University (Choi, Spring/Fall 2014)
- *Civil Engineering 202*, University of British Columbia, Civil Engineering II (social context of infrastructure, climate change and energy, leadership, and project management and construction), Department of Civil Engineering (Kandlikar, Beaudrie)
- Jour/ES/STS 323: *Health and Environmental Controversies*, Lehigh University (Friedman)
- English 197, UCSB, *American Literature & Business Culture/Creativity* (Newfield)
- Feminist Studies 186HH, UCSB, *Gender and Society: Risk & Inequality* (Harthorn) (offered W 2012 & W 2013).
- Global & International Studies 130, *Global Economy and Development*, UCSB (Appelbaum, 2014,)
- Global & International Studies 292MD, *Globalization and Development*, UCSB (Appelbaum, 2014)
- History 261, *Environmental History*, Lewis and Clark College (Eardley-Pryor Guest lecture Apr 2013)
- Music 175J/Japan 172, *Music in Modern Japan*, UCSB (Novak W 2014)
- Political Science 114/Feminist Studies 186 GD, *Democracy, Diversity & Gender*, UCSB, (Barvosa W 2013)
- History 233, Rice University, *Science in the Modern World* (Mody)
- History 237/Chemistry 235/Anthropology 235, Rice University (Mody)
- HIST 108, *Science and Technology in World History*, University of South Carolina (November, Spring 2016)

**Reports to the National Advisory Board:** CNS-UCSB faculty and staff report evidence of progress towards completion of the objectives listed above to the National Advisory Board (NAB). In meetings at the close of the first award, the NAB was especially concerned that CNS-UCSB identify new sources of support to maintain and build on the Education Program's successes in training interdisciplinary graduate student and postdoctoral research scholars.

**Website:** The CNS-UCSB website provides information and educational materials on a range of issues and activities connected to societal implications of nanotechnologies. The website

provides specific information about our Education programs, participants, and resources, at <http://www.cns.ucsb.edu/education>. Descriptions of the Postdoctoral Scholars, Graduate Fellows, and Summer Internship Programs provide program overviews, application processes, and short profiles of current and former participants. There is also a list of courses at UCSB that include nano and society content. Resources for educators include course materials for the *Nanoscience in Society* community college course and the *Traveling Technologies* internship project. A “New to Nano” section provides links to resources provided by nano educational organizations such as the Nanoscale Informal Science Education Network (NISE Net), Penn State’s Nanotechnology Applications and Career Knowledge Center (NACK), and the Woodrow Wilson Center’s Project on Emerging Nanotechnologies (PEN). Education Highlights from NSF reports are also posted on the site. News and upcoming events related to the education program are promoted on the website’s front page and archived under the site’s “News” and “Events” tabs. Additional information about Education Program promotion activities can be found in Section 9: Outreach and Knowledge Transfer.

## 9. OUTREACH & KNOWLEDGE TRANSFER

The overall purpose of CNS-UCSB's Outreach and Knowledge Transfer activities has been to create awareness and use of our research findings about the societal implications of nanotechnologies and other emerging technologies among multiple stakeholders at the local, regional, national and international levels, in order to encourage conversations during this “upstream” period that would lead to their responsible and sustainable development, as well as to greater understanding of their historical contexts and innovation system performance. In this section, we offer a brief overview of our approach to public outreach and engagement with diverse publics and other key stakeholders—nanoscientists and engineers, the policy community, industry, other technology and society researchers, NGOs, and members of the general public—who are implicated in and affected by the nano-enterprise.

### *Content and Context: Integrating CNS-UCSB's Research and Outreach Programs*

Addressing the challenges of devising and implementing new methods for learning about and engaging with the full range of stakeholders in the nano enterprise was a critical aspect of the NSEC and NNI mandates for responsible technology development and vital to the economic success of the nano enterprise as well. The core of CNS-UCSB societal implications research focused on understanding and conducting comparative analysis of the views of the multiple stakeholders in the nano enterprise, in order to engage them in mutual analysis, discussion, and, decision making. To that end, CNS-UCSB has pursued a multi-layered outreach and knowledge transfer program designed to integrate our research with our efforts to reach and interact with multiple stakeholders in the expanding nano-enterprise. The term “knowledge transfer” implies a one-way and top-down process of knowledge deposition that is at odds with our scholarly views about the importance of two- or even multi-way interaction between science and society.

CNS has strived to gain the knowledge and lay the foundations necessary to pursue the more difficult mutual, interactive forms of engagement with science and society, including addressing the many interested social actors, as well as those individuals and groups who lack familiarity with nanotechnologies but are implicated in nanotechnologies' futures.

At CNS-UCSB, we have seen our role in facilitating multi-stakeholder participation as having three dimensions. First, we have conducted research that generates necessary new knowledge about the contours and beliefs of upstream perceptions about nanoscale science and technology, and responses to messages about them held by members of the public and of stakeholder groups, which include nanoscale scientists and engineers, nanotoxicologists, regulators, industry, public interest groups, the media, and societal implications researchers. Second, we have sought to disseminate this knowledge through our outreach activities to these various stakeholders. Third, we wanted to use this knowledge to develop replicable models of the type of tailored public participation activities that past studies have shown to be effective. The full range of CNS-UCSB research is thus integral to the Center's outreach and knowledge transfer goals. We believe that our outreach activities must be premised on the understanding that there is no universal, one size fits all approach; rather outreach must be tailored to each party, based on careful assessment and knowledge of their level of (nano) technological awareness and understanding, perceptions (positive, negative, neutral, or ambivalent), and interests (environmental, economic, health,



social, or political, among others). Here we report briefly on the most successful Outreach activities in the CNS since renewal in Fall, 2010.

**NSE Community:** Engagement with nanoscientists and engineers is a central and distinctive aim of the CNS-UCSB, as well as one of our most fruitful areas of activity. We have sought to understand the nano enterprise from its participants' points of view; to foster new opportunities for dialogue and engagement between nano scientists and social scientists for mutual benefit; to develop innovative methods to train a new generation of society-minded scientists and science-minded social scientists; to use the research findings of the CNS to enhance two-way communication between nano-science and society, and 3-way communication among nano-science, social science, and society; and to foster reflexive discussion about the downstream responsibilities to society of the upstream scientific enterprise.

Every aspect of CNS research has had close connections to the NSE community. We have involved leading NSE researchers on our Executive Committee, our National Advisory Board, and even more vitally through our incorporation of NSE graduate students into our research program through the Fellows program. We have also from the start, across the full research initiative of the CNS, actively engaged members of the science and engineering community in our work. Much of this takes the form of direct engagement – attending meetings and conferences; studying scientific research and research practices, conducting interviews, and partnering with NSE on joint initiatives. We have jointly sought funding with NSE on dozens of proposals for research and education and outreach activities, have published results in venues that reach beyond our traditional disciplinary audiences of social scientists, historians and science and technology studies, by disseminating our work to such publications as *Physics Today*, *Chemical Heritage White papers*, *Environmental Science & Technology*, *Journal of Nanoparticle Research*, *Nature*, *Nature Nanotechnology*, *Nature Climate Change*, *Nature Energy*, and *Chemical Engineering*. Our researchers have been invited to attend and make presentations to meetings and conferences for the semiconductor industry, the NNI and its industry participants, and leading economic industry groups, as well as professional meetings of chemists, physicists, materials scientists, toxicologists, and environmental and occupational health and safety experts. We have been invited as research and outreach partners in the UC CEIN as it seeks to characterize nanomaterials' risk potentials and contribute to responsible development.

**Policy Community: Policymakers, Regulators and NGOs:** CNS-UCSB researchers have a strong track record of engaging in dialogue with regulators and policymakers about responsible development and 'moral progress' (see Roco, Harthorn, Guston & Shapira 2011). In the final 6 years, CNS-UCSB researchers have interacted with policymakers at the state, federal, and international levels to share their research and its societal implications. This has included presentations to at least 50 policymaker audiences in key national (OSTP-PCAST, NNI, NNCO, NPEC, NIOSH, EPA, NSF, NSEC, US Congress), international (UK Cabinet, European Commission, OECD, World Bank) and state level organizations (CCST, DTSC, UC Center for Lab Safety). NNCO staff have explicitly stated that CNS-UCSB presentations on public participation in S&T have had an impact that extends into the White House OSTP; PCAST evaluation of the NNI has drawn on CNS IRG 3 industry survey and IRG 2 China nanotech development findings.

During this award, CNS has held a policy briefs workshop to distill and consolidate CNS research results for specific policy maker audiences. The California Research Bureau solicited three policy briefs from CNS-UCSB researchers that were distributed to state lawmakers. Our signal event of the second award was an international conference called *Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures* ([www.cns.ucsb.edu/demtech2014/welcome](http://www.cns.ucsb.edu/demtech2014/welcome)) which we convened at the University of California, Santa Barbara November 11-13, 2014. It focused on NGOs with environmental and social justice concerns regarding new technologies and those using new technologies to enhance their work and asked two key questions: How can NGOs produce more equitable and sustainable outcomes of emerging technologies? What are the implications of NGO participation in governance for democracy and technological advancement?

Global in scope, the conference brought together social scientists, science experts, government regulators, and NGO leaders to consider how NGOs – by engaging broader publics, media and policy makers – can and should influence technological investment, advancement, and regulation within a rubric of “responsible development.” Participants explored these questions as they related to a range of new technologies: nanotechnology, synthetic biology and biotechnology, information technology, spatial analytic technology, and robotics.

Over thirty NGOs and 120 participants, from the local to the international, were represented. With NSF supplement support, CNS-UCSB prepared a report on the conference that was disseminated to policymaking bodies including the NSF.

Most notably, in their final act before the center closed, each of the three primary research groups published and disseminated ***CNS Synthesis Reports*** that bring together important findings from their 11 years of activity and include specific policy recommendations based on these findings. The three reports are available for free download on the CNS website (<http://www.cns.ucsb.edu/irg-synthesis-reports>). Their titles are: *Understanding Nanotechnologies’ Risks and Benefits: Emergence, Expertise and Upstream Participation* (Harthorn, Pidgeon & Satterfield 2016); *Globalization and Nanotechnology: The Role of State Policy and International Collaboration* (Appelbaum 2016); and *Exploring Nanotechnology’s Origins, Institutions, and Communities: A Ten Year Experiment in Large Scale Collaborative STS Research* (McCray et al. 2016).

***US and International Research Communities:*** Building networks of relationships among nanotechnology and society researchers from the US and worldwide has been a primary goal of CNS, and a global, international, and transnational approach to research is welded into the fabric of the Center. IRG 2 is deeply and theoretically oriented to comparative globalization and innovation studies, in which Appelbaum has been a pioneering scholar, with a dedicated focus on nano R&D in China and E. Asia, and Latin America. Along with the Latin American Nanotechnology & Society Network (ReLANS), CNS-UCSB co-hosted the *First International Nanotechnology & Labor Workshop* in Curitiba, Brazil, on September 5-6, 2013, as part of the ReLANS’ annual meeting. Experts on a wide array of issues related to the impacts of nanotechnology on labor presented their research findings.

International collaborations with Canadian and UK researchers have formed the backbone of IRG 3's work, which has been conducted with US/UK/Canada comparative analyses. IRG 1 has also contributed extensively to the scholarship on scientific and technological advances in East Asia and Europe, as well as in North America.

During this award CNS-UCSB researchers, including postdocs and graduate students, made over 748 public presentations to campus, local, regional, and wider audiences about the work of the CNS-UCSB, including 316 presentations or sessions in education and outreach and 432 in scholarly social science and humanities research contexts. Additionally, CNS researchers, including graduate students and postdocs, organized numerous panels in 18 countries, and presented at scholarly conferences in over 25 countries, including the US, Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Denmark, France, Germany, Hungary, India, Ireland, Italy, Japan, Mexico, the Netherlands, South Korea, Spain, Sweden, Switzerland, and the UK.

CNS-UCSB researchers have been active in strengthening existing, and developing new, networks among international researchers studying the societal implications of emerging technologies. Leading examples include:

Nanotechnology in Society Network (NSN): Along with CNS-ASU's director Guston, Harthorn played a prominent role in representing societal dimension issues in numerous meetings, conferences, and sessions with the NSE community regarding values and mechanisms for fulfilling the aims of responsible development of nanotechnologies and other emerging technologies. Conversations begun as part of a community-wide workshop on societal implications of synthetic biology in Nov 2014 continued throughout the reporting period.

S.NET: Harthorn was a founding executive committee member of S.NET (The Society for the Study of Nanoscience and Emerging Technologies), an international professional society for researchers studying nano societal implications. Harthorn also served on the planning committees for the first four annual conferences in Seattle, 2009; Darmstadt, Germany, 2010; Tempe, AZ, 2011 (which CNS-UCSB co-hosted with CNS-ASU and was co-chaired by Guston and Harthorn); and Enschede, The Netherlands, 2012. She consulted extensively with the 2013 conference hosts at Northeastern University in Boston. For the Darmstadt and Enschede meetings, CNS-UCSB worked with the NSF to obtain, award, and administer travel support funds to enhance participation at the S.NET conferences by students, postdocs, and scholars from the developing world. CNS-UCSB faculty and students regularly attend and lead sessions and activities at the S.NET conference. S.NET 2015 took place in Montreal, Canada, and researchers from IRGs 2 (Appelbaum, Han, Kay) and 3 (Hasell, Beaudrie) attended along with Education and Outreach Coordinator Fastman; and Appelbaum presented at S.NET 2016 in Bergen, Norway.

***Public Outreach to UCSB and Santa Barbara Communities:*** CNS-UCSB and its members engaged members of our local campus and Santa Barbara-area communities through multiple venues during the second award, including hosting/co-hosting lectures and public events, informal science education (ISE) events, science cafés, presentations to public and community groups and events, and public deliberation workshops in the local community on new energy technologies. Attendance at such events has varied from a dozen at a workshop to several

thousand at ISE events, and participants ranged from young children to senior citizens. Measures of success have included steadily increasing attendance at annual NanoDays events across the award, ongoing demand for CNS researchers to present on societal aspects of technology R&D, and the enduring partnerships we developed with campus and community.

CNS participated in “NanoDays” events every year of the second award for a total of 10 such events in the life of the CNS. The annual national program coordinated by the NISE Network has included hands-on activities to engage and promote understanding of nanoscale science and nanotechnology among children and members of the general public. At the first Santa Barbara Nanodays, held on campus in 2008, CNS reported 85 attendees. The most recent version in April 2016 was hosted at the Santa Barbara Museum of Natural History and co-sponsored by the California NanoSystems Institute and topped out at over 1,400 visitors. CNS researchers have also used their own research products along with NanoDays materials in other campus public engagement activities, such as ‘International Anthropology Day’ in Feb 2016 where IRG 3 researchers presented a number of their projects.

**Virtual and Media Outreach:** CNS-UCSB has used a number of online tools to reach these stakeholder audiences. The CNS-UCSB website ([www.cns.ucsb.edu](http://www.cns.ucsb.edu)) has been vital to this part of our mission, and we completed several updates over the award to enable better content control, posting links to videos of CNS-UCSB Speakers’ Series events, and updating news and events information. In addition to news, event information, and podcasts of selected lectures by CNS-UCSB faculty and invited speakers, the website provided visitors with a broad overview of our activities: Annual Reports, the new Synthesis Reports, front-page current news and upcoming event teasers; descriptions of the IRGs and their research projects; profiles of CNS-UCSB’s leadership, staff, faculty, postdocs, and graduate fellows; descriptions of our Education programs, as well as course materials and other resources for educators, mostly at the community college level or above; an events archives; a comprehensive list of CNS-UCSB publications dating back to 2006; a list of presentations from the current and former reporting years, among other materials. We are archiving the website so it will continue to be a public resource well beyond the life of the Center itself.

CNS-UCSB researchers also maintained their own online presences via blogs (e.g. McCray’s Leaping Robot), guest blog posts (e.g. Han’s “STEMming Brain Drain” on *The Conversation* and Appelbaum’s “China: Innovator or Follower” on the China Policy Institute blog), and the submission of op-eds to both print and online venues (including *The Chronicle of Higher Education*, *Inside Higher Education*, and *IEEE Spectrum*.)

Along with a focused web presence, we have used traditional media to reach CNS-UCSB’s nano stakeholder audiences. For this purpose, we continued to put out press releases in conjunction with UCSB’s public affairs office, as well as online and through our listservs, and we made our researchers available for interviews with reporters from the local, national, and international press. CNS-UCSB researchers have been quoted, interviewed or discussed in a number of local, national, and international news outlets including *The New Yorker*, NPR, *Forbes*, *Outside*, *MIT Technology Review*, *The Guardian*, and *The Financial Times*, among others. Just this past summer, *CQ Researcher* conducted extensive interviews with Director Harthorn and IRG 2 leader Appelbaum for a report on the role of nanotechnology in the global economy.

## 10. SHARED AND OTHER RESEARCH FACILITIES

CNS-UCSB's infrastructure needs for the societal implications research have been well met through UCSB and partner organizations, and NSEC support has helped forge new spaces at UCSB and at other institutions for science and society research and education.

### 1) CNS-UCSB

CNS was a new entity at the funding of the initial award, so our consolidated research space has resulted entirely from the NSEC. The main facilities for CNS have been a suite of contiguous offices in Girvetz Hall, providing space for all CNS personnel to work in proximity to one another, with ample conference and meeting space for research, education and effective administration. From 2011-2016, the College of Letters and Science generously provided additional contiguous space to accommodate visiting scholars, researchers and seed projects. Additional space for larger meetings, conferences, seminars, and other gatherings has been provided in the **Institute for Social, Behavioral & Economic Research (ISBER)**, Global and International Studies, and other campus locations. ISBER additionally provides computing network infrastructure, secure sites on the server for our collaborative sharing of project data, and many forms of research administration support that augment our administrative capacity.

### 2) California NanoSystems Institute (CNSI) (UCSB)

The CNSI is a state-of-the-art laboratory facility and hub for many of the nanoscientists and engineers working on campus. In its first award, CNS was partially located in the CNSI, and our partnerships with CNSI education personnel developed from co-residence with them for several years has continued, and we continue to use CNSI conference and meeting spaces for seminars, lectures, and other events. CNS Executive Committee member and MRL Director, Hawker, was also appointed Director of the CNSI in 2013, reaffirming our ties with the institute. [www.cnsi.ucsb.edu](http://www.cnsi.ucsb.edu).

### 3) Materials Research Laboratory (MRL) (UCSB)

The MRL was established in September 1992 with funding from the National Science Foundation (NSF), and became a NSF MRSEC in 1996. MRL Director Hawker, is a co-PI of the Center's NSEC award and a member of our Executive Committee. MRL Education staff co-coordinate a campus-wide summer Undergraduate Research Intern Seminar Series, which CNS interns have attended and in which CNS Education staff and faculty have presented. [www.mrl.ucsb.edu](http://www.mrl.ucsb.edu)

### 4) Nanotech: The UCSB Nanofabrication Facility, National Nanotechnology Infrastructure Network (formerly NNIN) (UCSB)

UCSB has extensive facilities and research in nanotechnology. The nanofabrication facility has comprehensive and advanced semiconductor and thin film processing equipment and provides access and professional consultation to industrial and internal and external academic users. The facility includes 12,700 sq ft of clean space. The Nanofabrication Facility has been a resource for CNS ethnographic research of laboratory culture, and partnerships with Education staff that have brought CNS expertise to the Nanotech lab facility on Societal and Ethical Issues education programs. <http://www.nanotech.ucsb.edu/>

### 5) Center for Spatial Studies (spatial@ucsb)/National Center for Geographic Information and Analysis (NCGIA)/Center for Spatially Integrated Social Science (CSISS) (UCSB)

CSISS, NCGIA, and the Spatial Center together form a cluster of internationally renowned knowledge, mapping resources and personnel for spatial analytic scientific work. Given the global scope of CNS' research, the interest in tracking flows, such as the movement of goods

services, and ideas through the global value chain, and the attraction of spatial data visualizations as a means of enhancing participation and knowledge exchange, the spatial resources at UCSB constitute significant resources. CNS has drawn grad researchers from CSS and had advanced cartographic and spatial analysis in the data analysis and data visualization phases of our research. See [spatial.ucsb.edu](http://spatial.ucsb.edu)

#### **6) Center for Information and Technology (CITS) (UCSB)**

CITS is dedicated to research and education about the cultural transitions and social innovations associated with technology. They also work to improve engineering through infusing social insights into the innovative process. CITS thus shares many interests and personnel in common with CNS, including founding director Bimber and recent director Parks who have both served as senior researchers and executive committee members in the CNS. CNS PIs Harthorn and McCray as well as Executive Committee members Bimber and Parks and Education Director Metzger are all affiliated faculty in CITS. The CNS has contributed to the growing community of science and society researchers at UCSB and our collective networks around the globe. See [www.cits.ucsb.edu/](http://www.cits.ucsb.edu/)

#### **7) The University of California Center for Environmental Implications of Nanotechnology (UC CEIN)**

The University of California Center for Environmental Implications of Nanotechnology (UC CEIN) was established in 2008 with funding from the NSF and the EPA to explore the environmental impact of engineered nanomaterials. CNS-UCSB has contributed societal knowledge and capacity via IRG 3 researchers participation in research, education, and the leadership team.

#### **8) Center on Globalization, Governance, and Competitiveness (CGGC) (Duke University)**

This Center, led by CNS IRG 2 collaborator Gereffi, collaborates with IRG 2 on nanotechnology, globalization in E. Asia, and the CNS Global Value Chain project. GVC expertise gained in work with the CGGC with spatial analytic approaches to examine nanotech in the US and California (and across the global value chain). See [www.cggc.duke.edu/](http://www.cggc.duke.edu/)

#### **9) Chemical Heritage Foundation (CHF), Philadelphia**

The CHF is a library, museum, and center for scholars that maintains world-class collections related to the chemical and molecular sciences. CHF has strong connections with CNS IRG 1 collaborators. CHF has partnered in CNS's production of *oral histories* of leading nanoscientists as well as a series of commissioned research briefs, including some involving CNS researchers. [www.chemheritage.org/](http://www.chemheritage.org/)

**10) The Jenkins Collaboratory, Duke University** is IRG 2 collaborator Tim Lenoir's laboratory for developing technologies in contemporary science, engineering, and medicine, and their social and ethical implications. IRG 2 has utilized the professional expertise and infrastructure capabilities of this center to advance analysis of the nano innovation system. [jenkins.duke.edu/](http://jenkins.duke.edu/)

#### **11) Science Journalism program/ Lehigh University**

Through Lehigh University's Journalism & Communication department, CNS collaborator Sharon Friedman directs the Science Writing Program, which prepares bachelor's degree students to write for such science fields as engineering, medicine, scientific research and environmental sciences, and contains a media analysis component. Friedman, along with a professional researcher and student researchers, utilize facilities in Coppee Hall on the Lehigh campus in Bethlehem, PA. [sciencewriting.cas2.lehigh.edu/](http://sciencewriting.cas2.lehigh.edu/)

**13) Decision Research**, Eugene, Oregon, is a non-profit research organization investigating human judgment, decision-making, and risk. DR provides unique expertise on psychometric risk perception and decision risk research. Founded in 1976 by the leading international risk perception researcher, Slovic, their work is based on the premise that “decisions should be guided by an understanding of how people think and how they value the potential outcomes—good and bad—of their decisions.” DR’s research staff includes CNS IRG 3 collaborator, Gregory, an expert on stakeholder participation in environmental decision making. [www.decisionresearch.org/](http://www.decisionresearch.org/)

## **International Facilities**

### **14) Institute for Resources, Environment and Sustainability (IRES) at the University of British Columbia (UBC), Vancouver, Canada**

The Institute for Resources, Environment and Sustainability (IRES) is an internationally acclaimed issue-driven interdisciplinary research institute with interest and expertise in a wide range of environment and sustainability issues. The Institute fosters sustainable futures through integrated research and learning about the linkages among human and natural systems, to support decision making for local to global scales. IRG 3 researchers Satterfield and Kandlikar, , serve as core faculty IRES, along with Gregory. [ires.ubc.ca/](http://ires.ubc.ca/)

### **15) Understanding Risk Research Group at Cardiff University, Wales, UK**

The Understanding Risk group is an interdisciplinary social sciences (psychology, sociology and technology studies, geography) research unit at Cardiff University focusing on the impacts upon individuals and communities, and acceptability to people, of environmental and technological risk within everyday life. IRG 3 collaborator Pidgeon is Director of the Understanding Risk Group, which provides a rich set of collaborators and expertise for the CNS students and postdocs working at Cardiff. [www.understanding-risk.org/](http://www.understanding-risk.org/)

## 11. CENTER MANAGEMENT

CNS-UCSB is organized as a single campus center, based firmly at University of California at Santa Barbara, taking full advantage of its renowned reputation for interdisciplinarity, its stellar materials science and engineering capabilities (MRSEC, top ranking Engineering College, California NanoSystems Institute, past NNIN site, 3 Nobel laureates in the field), dedicated institutional commitment to diversity at all levels of leadership, and a strong team of interdisciplinary social science and humanities scholars to provide the core for CNS. However, its research has expanded outward through an extensive set of national and international collaborations. This has been a stable structure with relatively few changes in personnel over the course of this award.

**Executive Committee:** An active, engaged on-campus CNS Executive Committee has been vital to the management of the CNS at UCSB. Center Director Harthorn has worked collaboratively with the 3 co-PIs (Appelbaum, Hawker, and McCray), Associate Director for Education Metzger and the other faculty members of the UCSB-based Executive Committee (Bimber, Holden, Parks). CNS Assistant Director Molitor and Education Program staff Fastman serve *ex officio*. The 3 IRG leaders (Harthorn, Appelbaum, & McCray) share research space in the CNS and meet frequently with their on campus IRG research teams and remotely with collaborators. Throughout the award period, the Executive committee has met face to face at UCSB on a monthly basis in addition to frequent email consultation as needed. Sub-committees within the Executive committee or with some additional campus participants have been formed as needed to interview job applications, select graduate fellows and postdoc scholars, review seed grant applicants, etc.

**National Advisory Board:** CNS has had since inception an excellent National Advisory Board comprised of leading STS and social science scholars and members from industry, NSE, NGOs, policy, and others (see the full list in Section 4B). Board members Seely Brown and Bostrom have served throughout the current award as Co-Chairs. In this renewal period the board plans have been to meet in biannual meetings with CNS Executive Committee members, staff, researchers, and students to discuss CNS research, education and outreach efforts, assess new opportunities, and consider possible course adjustments in response to them. The board also has provided informal consultation on an as-needed basis to Director Harthorn. Board members have been willing and available for such consultation by phone and e-mail throughout the year, with additional individual face-to-face meetings at national conferences and meetings. In its final meeting in Year 5 (10) in April, 2015, the Board met with Center leaders via video conference to discuss the Center's successes and plans beyond the NSF NSEC funding period.

**Staffing:** Until the final 2015-2016 year of no cost extension, Director Harthorn has been assisted by a faculty Education Director (Center Associate Director Metzger), a 1.0 FTE staff Assistant Director (Molitor), a .75 FTE Education Coordinator (Fastman), a 1.0 FTE Financial Analyst/Events Coordinator (Barcelona), a 1.0 FTE Travel and Purchasing Administrative Assistant (Kuan), and a .25 FTE Computing Specialist (Macias). The staffing profile of the CNS has provided essential expertise and effort in such critical areas as: contracts and grants management, fiscal management and accounting, project management, data archiving and sharing, travel and events coordination, evaluation and synthesis report preparation, and general administrative support. Funding constraints made it necessary to reduce this infrastructure in past year--two CNS positions were reduced or eliminated: Financial Analyst/Events Coordinator (Barcelona) reduced CNS-funded effort from 1.0 FTE to 10%, and



the Computing Specialist position was no longer funded by CNS (although computing infrastructure support continued to be provided by ISBER).

UCSB cash contribution to the CNS has contributed a significant portion of staff salaries and fringe benefits every year of the award. In addition, CNS staff has drawn regularly on the expertise of the ISBER staff for assistance in many administrative aspects of the Center.

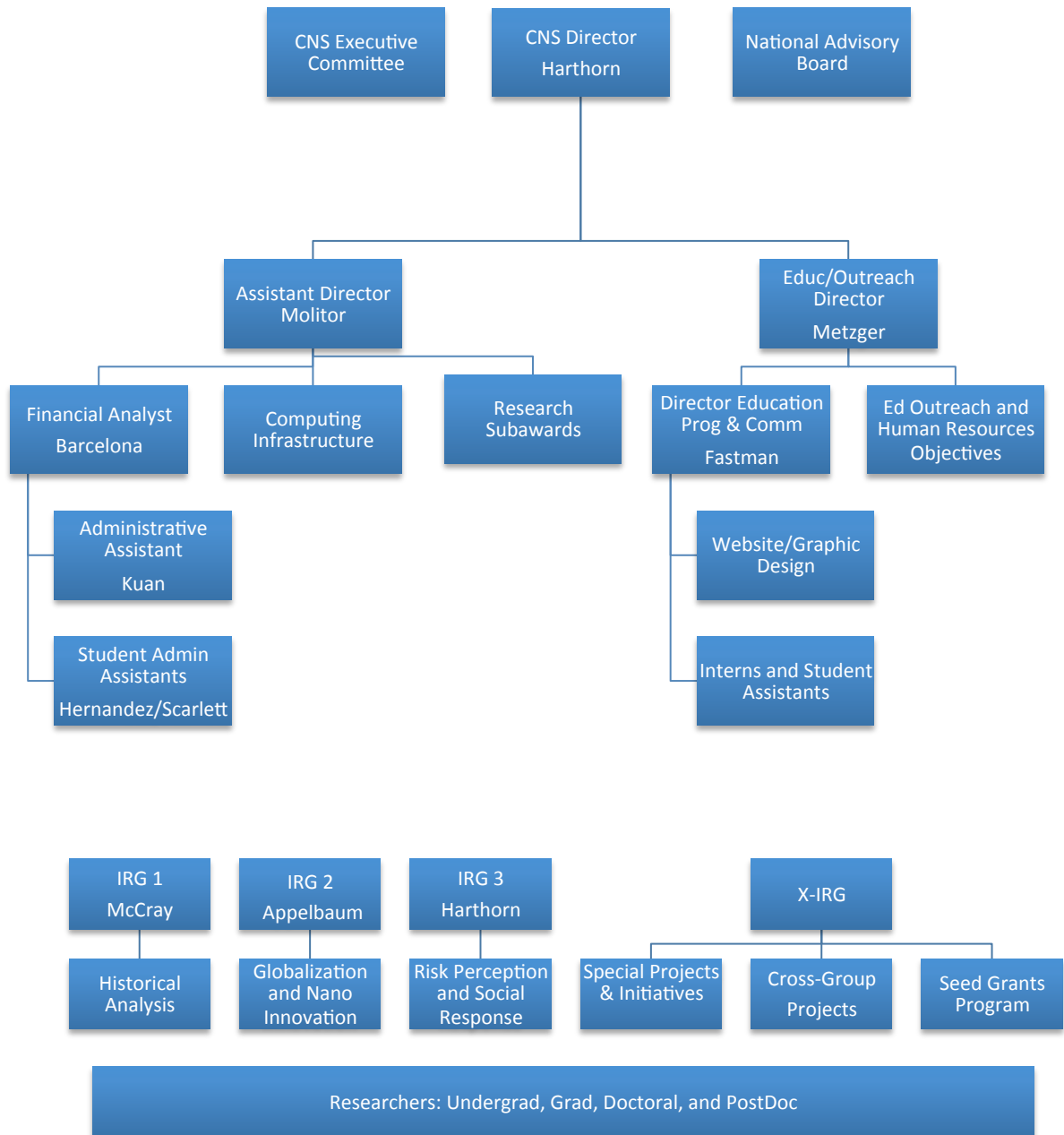
**Management and Operation of Research Program:** CNS has established an effective infrastructure for managing its collaborative research efforts through mandatory semi-annual reporting, and careful oversight of IRB issues. Harthorn has provided annual training on research ethics and IRB and individual consultation on specific projects as needed. CNS uses an annual process for budget review and allocation to ensure that project goals are met. Nonperformance is a basis for discontinuing a project. In addition, funder required annual reporting and site visits provide significant impetus to aggregate and synthesize data within and between research groups and to assess progress toward goals. Annual retreats of the Executive Committee and staff to discuss NSF review results have facilitated group assessment through SWOT analysis and other mechanisms for collective decision-making.

CNS' base on a single campus and the Center's consolidated space arrangements in Girvetz Hall simplified research program operation. Research has been organized through: 1) research group meetings on a roughly weekly basis at UCSB, often dialing in extramural collaborators; 2) the CNS Research Seminar (Soc 591 BH) that has met year-round on a weekly or bi-weekly basis and provided an established forum for sharing of research issues, regular rotating presentations by senior personnel, postdocs, and grads, for discussion and training on research methods, IRB issues, professional development, training of summer interns as well as informal interaction; 3) Grad Fellows and Graduate Student Researchers have worked together in common space, which facilitated information sharing across the groups; 4) Postdoctoral Fellows have worked in shared and adjacent space, which also has served to promote interactions; postdocs have often taken the lead in instituting regular social gatherings that include all CNS researchers and staff in informal exchange; 5) Visiting Scholar/Lecture Series has brought together CNS researchers with extramural visitors for formal and informal interactions, sharing; visitors are selected by grads, researchers, and education program; 6) Research Summit meetings have been held in Santa Barbara on a 1-2-yr interval and allow the free flow of ideas among all CNS collaborators, students, and personnel from the 18 institutions actively involved in core CNS research; 7) a faculty Seed Grant program implemented in Years 2-4 of the current award served to bring 8 additional campus faculty and their science in society projects into the Center; and 8) annual leadership retreats have brought center and interested campus faculty together with the Executive Committee to engage in constructive dialogue about major programmatic development and initiatives.

Finally, the CNS website has been a central repository of data throughout the award, and it is being cleaned and perfected prior to being archived for longterm public and community access.

**Evaluation plan for CNS-UCSB:** The evaluation plan for the CNS-UCSB has been to evaluate performance against our goals in the main functional areas--research, education and outreach, the NSF network with other nanotechnology in society programs, and international collaboration. We have evaluated work using formative and summative processes at several levels of aggregation and at varying intervals. Annual reporting on established metrics have provided an important set of data on the accomplishments of the CNS and are posted annually to the website for open access.

## CNS Organizational Chart



## 12. HONORS AND AWARDS

### 2010

Appelbaum, Richard. Named John D. and Catherine T. MacArthur Foundation Chair of Global Studies, UCSB, for a 5-year term. 2010-2015.

Denes, Amanda. Graduate Collaborative Research Grant, Interdisciplinary Humanities Center at the University of California, Santa Barbara, for collaborative project among doctoral students from Communication, Theater and Dance Studies, and Feminist Studies. 2010.

Denes, Amanda. Top Paper Award, Family Communication Division, National Communication Association (NCA). 2010.

Denes, Amanda. Top Student Paper Award, Interpersonal Communication Division, International Communication Association (ICA). 2010.

Dillemuth, Julie, W. Patrick McCray, Meredith Murr, Eric Bullock, Peter Alagona, Marilyn Spavent. NSF STS Collaborative Grant, Bringing Nanotechnology and Society Courses to California Community Colleges. January-December 2010.

Friedman, Sharon. Elected a Fellow of the Society of Risk Analysis. December 2010.

Goodchild, Michael. National Science Foundation's (NSF) Distinguished Lecture series. November 2010.

Hawker, Craig. Macro Group UK International Medal for Outstanding Achievement. 2010.

Hawker, Craig. Polymer Division Fellow, American Chemical Society. 2010.

Hawker, Craig. American Chemical Society Arthur C. Cope Scholar Award. September 2010.

Jackson, Simone. Invited to present CNS Undergraduate Research results at SACNAS conference in Anaheim, CA. September 2010.

Mody, Cyrus C.M., Mara Mills, and Patrick McCray. ACLS Collaborative Research Fellowship for *Micro-Histories and Nano-Futures: The Co-Production of Miniaturization and Futurism*. 2010.

Mody, Cyrus, Mara Mills, and Patrick McCray. American Council of Learned Societies, collaborative grant, "Micro-Histories and Nano-Futures: The Co-Production of Miniaturization and Futurism," awarded 2010.

Parker, Rachel. Selected Research Staff Member, Science and Technology Policy Institute, Washington, D.C. September 2010.

Rajan, Sri Jay. Invited to present CNS Undergraduate Research results at Sigma Xi conference in Washington, DC. November 2010.

Rogers-Brown, Jennifer, Accepted Assistant Professor position in the Department of Sociology & Anthropology, Long Island University, Post.

## 2011

- Appelbaum, Richard. Elected as a Fellow of the American Association for the Advancement of the Sciences (AAAS). January 2011.
- Beaudrie, Christian. Student Scholarship, Nano OEH Conference, Boston, MA. August 2011.
- Bimber, Bruce. Elected as a Fellow of the American Association for the Advancement of the Sciences (AAAS). January 2011.
- Cranfill, Rachel. Jacob Javits Fellowship, UCSB Department of Linguistics. 2011-12.
- D'Arcangelis, Gwen. Recognized by INSPIRATIONS: Honoring New Women, Appointed Post Docs and Recently Tenured Women at UCSB. January 2011.
- Denes, Amanda. Top Student Paper Award, Interpersonal Communication Division, International Communication Association (ICA). 2011.
- Denes, Amanda. Top Student Paper Award, Organization for Research on Women and Communication, Western States Communication Association (WSCA). 2011.
- Denes, Amanda. Research Grant, Santa Barbara Pro-Choice Coalition. 2011.
- Hawker, Craig. Named Director of the Dow Materials Institute, UCSB (created with a \$15m award from Dow Chemical Company). 2011.
- Hawker, Craig. Named an Arthur C. Cope Scholar, American Chemical Society. 2011.
- Hawker, Craig. Named KFUPM Chair Professor, King Fahd University of Petroleum and Minerals, Saudi Arabia. 2011.
- McCray, W. Patrick. Awarded the 2011-12 Searle Visiting Professorship at Cal Tech and the Huntington Library.
- Mody, Cyrus. NSF Scholars Award for *The Long Arm of Moore's Law: New Institutions for Microelectronics Research, 1966-2004*. Awarded 2011.
- Newfield, Chris. Appointed as Fellow at the Centre for Research in the Arts, Social Sciences and Humanities at Cambridge University (UK). 2011.
- Santos, Nicholas. Invited to present CNS Undergraduate Research results to the Association of American Geographers in Seattle, WA. April 2011.

## 2012

- Beaudrie, Christian. Received Student Merit award from the Society for Risk Analysis, Engineered Nanomaterials Specialty Group. 2012.
- Beaudrie, Christian. Received a Travel Award to the 7th International Conference on the Environmental Effects of Nanoparticles and Nanomaterials, Banff, Alberta. September 10-12, 2012.

Beaudrie, Christian. Awarded 2nd Place, Best Student Oral Presentation at the 7<sup>th</sup> International Conference on the Environmental Effects of Nanoparticles and Nanomaterials, Banff, Alberta. September 10-12, 2012.

Bimber, Bruce. Elected to fellowship, American Association for the Advancement of Science (AAAS). 2012.

Block, Fred. Support from the Ford Foundation to study the financial side of the innovation process in the United States. 2012.

Collins, Mary & Hanna, Shannon. Received the Best Poster award, Society for Risk Analysis Southern California meeting. Spring 2012.

Collins, Mary, Barbara Herr Harthorn & Terre Satterfield. Received the Best Poster award, Society for Risk Analysis Europe conference, Zurich. June 2012.

Collins, Mary. UCSB ISBER Graduate Research Award for Social Science Surveys (GRASSS) and funding match from the Bren School of Environmental Science and Management, UCSB. 2012.

Copeland, Lauren. UCSB Academic Senate's Outstanding Teaching Assistant Award nominee. 2012.

Copeland, Lauren. UCSB Graduate Student Association's Excellence in Teaching Award nominee. 2012.

Copeland, Lauren. Awarded a UCSB Department of Political Science travel grant. 2012.

Copeland, Lauren. Awarded a Doctoral Fee Fellowship, Department of Political Science, UCSB. 2012.

Denes, Amanda. Awarded UCSB Stough Prize, Feminist Studies Department for "Biology as consent: Problematizing the scientific approach to women's bodies." 2012.

Denes, Amanda. Awarded a Kinsey Institute Student Research Grant for "The relationship of oxytocin to conversations after sexual activity." 2012.

Denes, Amanda. Awarded a Foundation for the Scientific Study of Sexuality Student Research Grant. 2012.

Denes, Amanda, Awarded a Graduate Collaborative Research Grant, UCSB Interdisciplinary Humanities Center. 2012.

Denes, Amanda. Received the James J. Bradac Award for Graduate Researcher of the Year, UCSB Department of Communication. 2012.

Denes, Amanda. National Communication Association, Doctoral Honors Seminar Participant at North Dakota State University. 2012.

Denes, Amanda. Received a Santa Barbara Pro-Choice Coalition award. 2012.

Denes, Amanda. Awarded a UC President's Dissertation Fellowship. 2012.

Denes, Amanda. Received a UC Humanities and Social Science Research Grant. 2012.

Eardley-Pryor, Roger. Received a Lawrence Badash Prize for "Better to Cry than Die? The Paradoxes of Tear Gas in the Vietnam Era and Today." 2012.

Eardley-Pryor, Roger. Received the Dick Cook Memorial Award. 2012.

Eardley-Pryor, Roger. Awarded a Rockefeller Foundation Travel Grant. 2012.

Eisler, Matt. Awarded a Postdoctoral Fellowship at the Chemical Heritage Foundation. 2012.

Engeman, Cassandra. Received a Graduate Student Research Grant from the UCSB Department of Sociology. 2012.

Engeman, Cassandra. Awarded a Student Scholarship to Nano OEH Conference, Boston, MA. August 2012.

Engeman, Cassandra. Received a Student Travel Grant to the American Rights at Work conference in Washington DC. 2012.

Engeman, Cassandra. Invited keynote opening plenary presentation: "Regulation, Risk, and the Global Nanotechnology Industrial Workplace." NanoSafe2012, organized by the CEA/LITEN, French Government-funded technological and renewable energy research organizations, Grenoble, France. November 13-15, 2012.

Harthorn, Barbara Herr. Nominated by the Centers for Disease Control to the National Science Board. 2012.

Harthorn, Barbara Herr. Invited testimony, NAS Review panel of the NNI for OSTP, Beckman Center, Irvine, CA. May 15-16, 2012.

Harthorn, Barbara Herr. US delegate to US-EC Workshop on Responsible Development of Converging Technologies; plenary presenter, Leveun, Belgium. September 2012.

Hawker, Craig. Received Centenary Award from the Royal Society of Chemistry. 2012.

Hawker, Craig. Received American Chemistry Society's award in Polymer Chemistry. 2012.

Hawker, Craig. Appointed Merck-Karl Pfisher Lecturer, MIT. 2012.

Hawker, Craig. Appointed Marker Lecturer, Pennsylvania State University. 2012.

Hawker, Craig. Appointed Eastman Lecturer, University of Akron. 2012.

Kandlikar, Milind. Reid Visiting Fellowship, Princeton University. 2012-2013.

Kaplan, Sarah & Vakili, Keyvan, Best Paper award, "Breakthrough Innovations", DRUID conference. 2012.

Landers, Kelly, Poster presentation accepted "Identifying the Role of California in the Nanotechnology Economy," Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference, Seattle, WA. October 11-14, 2012.

McCray, W. Patrick. Elected as a Fellow of the American Association for the Advancement of Science (AAAS) in the History and Philosophy of Science Section. January 2012.

Pidgeon, Nicholas. Awarded Honorary Fellowship of the British Science Association (UK equivalent of AAAS), September 2012.

Shearer, Christine. Rachel Carson Environment Book Award (Honorable Mention). October 2012.

Shearer, Christine. Received Lannan Foundation Writing Residency Fellowship. November 2012.

Shearer, Christine. Awarded "Best book of 2011: one of the most timely and important books to be published in 2011- and in the past decade." by The Huffington Post, for *Kivalina*. Awarded 2012.

Shearer, Christine. Invited Facilitator (travel award), "Hazardous Chemicals: Agents of Risk and Change," Rachel Carson Center for Environment and Society, Munich, Germany. April 27, 2012.

Shearer, Christine. Runner-up for The Eric Wolf Prize of Political Ecology, Political Ecology Society. 2012.

Triste, Eddie. Poster presentation accepted: "Nano Regulatory Policy and NGOs: A Global View," Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference, Seattle, WA. October 11-14, 2012.

Zayago Lau, Edgar. Received a Postdoctoral Fellowship from Mexico's National Council of Science and Technology (CONACYT). August 2012 – June 2013.

## **2013**

Appelbaum, Richard. Keynote address at Global Studies Association Annual Meeting, Palo Alto, CA. June 7, 2013.

Barvosa, Edwina. Excellence in Education Award, Student Life, UCSB, Spring 2013.

Collins, Mary, Awarded Postdoctoral Fellowship, National Socio-Environmental Synthesis Center (SESYNC). 2013-2015.

Copeland, Lauren. Awarded a Conference Travel Grant, Department of Political Science, UCSB. 2013.

Copeland, Lauren. Received a Prestage-Cook Travel Award, Southern Political Science Association. 2013.

Copeland, Lauren. Awarded a Doctoral Fee Fellowship, Department of Political Science, UCSB. 2013.

Copeland, Lauren. Received National Science Foundation Workshop Support Grant, (SES1343126). September 2013.

Copeland, Lauren. Received German Academic Exchange Service Grant. September 2013.

Copeland, Lauren. Received Graduate Division Dissertation Fellowship, UCSB. Summer 2013.

Copeland, Lauren. Received Colin Reed – Robert G. Wesson Award for Best Paper Presented at a Professional Meeting, Department of Political Science, UCSB. June 2013.

Copeland, Lauren. Received Doctoral Student Travel Grant, Academic Senate, UCSB. April 2013.

Engeman, Cassandra. Awarded Graduate Associate Fellowship, UCSB Broom Center for Demography. 2013-2014.

Engeman, Cassandra. Received a Doctoral Student Travel Grant, UCSB Academic Senate. 2013.

Engeman, Cassandra. Received a Humanities and Social Sciences Research Grant for dissertation research, UCSB Graduate Division. 2013.

Engeman, Cassandra. Received honors by Project Lead on dissertation research: invited presentation: "Unions, Policy, and Family Values: How Unions Influence State-level Leave Policy in the United States." UCSB Department of Sociology Colloquium, Santa Barbara, CA. February 13, 2013.

Engeman, Cassandra. Awarded Graduate Associate affiliation with the Broom Center for Demography, UCSB (for dissertation research). 2013.

Harthorn, Barbara Herr. Keynote address, NGO and federal stakeholder meeting and webcast of the National Institute of Occupational Safety and Health (NIOSH), Cincinnati, OH. July 31, 2013.

Harthorn, Barbara Herr. Keynote address, NNI R3 Risk Stakeholder Workshop, Washington DC. September 11, 2013

Hawker, Craig. Received American Chemistry Society's national award for professional advancement. 2013.

Hawker, Craig. Appointed Scientific Director of the California Nanosystems Institute. 2013.



Hawker, Craig. ACS Award in Polymer Chemistry, American Chemical Society. 2013.

Hawker, Craig. Otto Warburg Lecturer, University of Bayreuth, Germany. 2013.

Hawker, Craig. Gassman Lecturer, University of Minnesota. 2013.

Hawker, Craig. MacLean Lecturer, McMaster University. 2013.

Kaplan, Sarah, Received Best Paper Award, UC Davis Conference on Qualitative Research (for "Interdisciplinarity in Practice") (with Jonathan Milde and Ruth Schwartz Cowan). 2013.

McCray, W. Patrick. Received Eugene M. Emme Astronautical Literature Award for *The Visioneers: How A Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (published 2012 Princeton University Press). Awarded 2013.

McLaren, Christine. Named a Presidential Scholar and awarded fee fellowship, Lehigh University. 2013.

Mody, Cyrus. Awarded Cushing Memorial Prize, University of Notre Dame Program in History and Philosophy of Science. 2013.

Mody, Cyrus (with Sonali Shah). Received Industry Studies Association "Rising Stars" Best Paper Award, "Do Users Develop and Diffuse Their Innovations Independent of Firms? Resources, New Social Structures, and Scaffolding". 2013.

November, Joseph. Received Computer History Museum Book Prize for *Biomedical Computing: Digitizing Life in the United States* (published 2012). Awarded by Special Interest Group for Computers, Information and Society (SIGCIS) and funded by the estate of computing pioneer Paul Baran. Bestowed at the Society for History of Technology (SHOT) Annual Meeting, October 2013.

November, Joseph. Received an Association for Computing Machinery History Fellowship. 2013.

November, Joseph. Awarded the Arthur L. Norberg Travel Grant Award, Charles Babbage Institute. 2013.

Pribble, Kelli. Poster presentation accepted at the Society for Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference. "Mobilizing Around Nanotechnology: The Role Of Non-Governmental Organizations," San Antonio, Texas. October 2013.

Rogers-Brown, Jennifer. Elected to a 3-year term as a representative for Sociologists for Women in Society to the United Nations Dept of Public Information. 2013-16.

Shearer, Christine. Awarded a Postdoctoral Scholar position in the Department of Earth System Science at UC Irvine on "Innovative Solutions to the Energy-Carbon-Climate Problem" in collaboration with Carnegie/Stanford and Harvard Universities. Beginning Feb 2013.

Sieber, Hannah. Awarded the prize for the best honors thesis in International Comparative Studies, Duke University. Thesis was on the history of “sea turtles” and attitudes of overseas Chinese students and business people in the North Carolina Research Triangle to their economic prospects upon returning to China. May 2013.

Walsh, Casey. Received Public Anthropology’s Paul Farmer Global Citizenship Award. 2013.

Ye, Xinyue. Received Bowling Green State University research funds for pursuing Big Data-based Spatiotemporally Integrated Social Sciences over Cyberinfrastructure, Building Strength project. 2013.

## **2014**

Appelbaum, Richard. Received a month-long residency at the Rockefeller Center in Bellagio, Italy. August - September 2014.

Beaudrie, Christian, Kandlikar, Milind, & Satterfield, Theresa. Paper received Certificate of Merit from the American Chemical Society, Division of Environmental Chemistry: “Nanomaterial risk screening: A structured decision making (SDM) approach” at the 248<sup>th</sup> National Meeting, San Francisco, CA. August 10-14, 2014.

Barvosa, Edwina. Named Section Chair, Western Political Science Association, Section on “Intersectionality”. 2014-2015.

Barvosa, Edwina. Awarded UC Regent’s Faculty Humanities Fellowship. Summer, 2014.

Barvosa, Edwina. Accepted to attend the UC Team Science Retreat. July, 2014.

Beaudrie, Christian, Kandlikar, Milind, & Satterfield, Theresa. Paper awarded First Runner-Up for Best Policy Analysis 2013 in *Environmental Science & Technology*, “From Cradle-to-Grave at the Nanoscale: Gaps in US Regulatory Oversight along the Nanomaterial Life Cycle.” March, 2014.

Eardley-Pryor, Roger. Awarded Research Fellowship at Chemical Heritage Foundation. 2014.

Engeman, Cassandra. Appointed to Visiting Scholar Research position at the Social Science Research Center, Berlin (WZB). 2014-2015.

Engeman, Cassandra. Awarded a Senior Social Science Graduate Research Fellowship at the Center for Nanotechnology in Society, UCSB. 2014.

Engeman, Cassandra. Serving as external expert with the European Trade Union Institute on a “Scenario Project” that considers potential occupational safety and health issues in the future workplace. Such scenarios will consider the impacts of new technologies on the organization of work. Begins 2014.

Friedman, Sharon. Named McCormick Fellow. June, 2014.

Engeman, Cassandra. Awarded Graduate Research and Training Grant, UCSB Broom Center for Demography. 2014.

Foladori, Guillermo. Granted Membership to the National System of Researchers-Tier II, The National Council of Science and Technology (CONACYT, Mexico). 2014.

Friedman, Sharon. Elected to three-year term on the Council of the American Association for the Advancement of Science. January 2014.

Harthorn, Barbara Herr. Invited testimony, UC Presidential Commission on Bioethics, Washington D.C. February 10-11, 2014.

Hasell, Ariel. Invited to attend the International Communication Association's Summer School on (New) Media Effects on Electoral Behavior, Milan, Italy. July 7-11, 2014.

Hasell, Ariel. Received the George McCune Dissertation Fellowship, Department of Communication, UCSB. 2014-15.

Hawker, Craig. McGavock Lectureship, Trinity University. 2014.

Hawker, Craig. Peter Timms Lecturer, University of Bristol, UK. 2014.

Kay, Luciano, Integrated (by invitation) the Scientific Advisory Panel of the 4<sup>th</sup> Global TechMining Conference, Leiden, Netherlands. September 2, 2014.

McCray, W. Patrick. Received Watson Davis and Helen Miles Davis Prize for *The Visioneers: How A Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (published 2012 Princeton University Press). Awarded 2014.

McCray, W. Patrick. Named the 2015-2016 Charles A. Lindbergh Chair in Aerospace History at the Smithsonian National Air and Space Museum. Announced 2014.

Mody, Cyrus (with Andrew J. Nelson). Received Award for Distinguished Contribution to Electrotechnical History, IEEE / Society for the History of Technology for "A Towering Virtue of Necessity: Computer Music at Vietnam-Era Stanford," (Osiris 2013). Awarded 2014.

Mody, Cyrus. Awarded Paul Bunge Prize, Hans-R.-Jenemann-Stiftung. 2014.

Newfield, Christopher. Presented "Metrics Mania in Higher Education: Strengths, Weaknesses, and Treatments," as recipient of the John P. McGovern MD Award Lecture in the Medical Humanities, University of Texas Medical Branch. October, 2014.

Novak, David, awarded the 2014 British Forum for Ethnomusicology Book Prize for his book *Japanoise*. 2014.

Novak, David. Won Honorable Mention for the David Plath Media Award from the Society for East Asian Anthropology in the American Anthropological Association, for his podcast, "The Sounds of Japan's Antinuclear Movement". 2014.

Parks, Lisa. Awarded FlowNet grant: "Internet freedom and free flow information through socially informed, censor-resistant online social networks." U.S. Department of State, Bureau of Democracy Human Rights and Labor (DRL). Awarded 2014.

Parks, Lisa. Awarded Best Essay Award, Society for Cinema and Media Studies, for "Mapping Orbit: Toward a Vertical Public Space." March 2014.

Pidgeon, Nicholas. Awarded a MBE (Member of the British Empire) in the Queen's Birthday honours list for his services to UK climate change awareness and energy security policy. July 2014.

Stevenson, Louise (and Krattenmaker, Katie). Received the Worster Award to an undergraduate-graduate student pair to conduct summer research for the project, "The effect of silver nanoparticles on *Daphnia pulicaria* at low food levels," Department of Ecology, Evolution and Marine Biology. UCSB, 2014.

Stocking, Galen and Hasell, Ariel. Awarded Top Three Poster Award at Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures Conference, UCSB. Nov 2014.

## **2015**

Appelbaum, Richard. Review panelist and lead author on the final report for the University of Oregon's International Studies Department review. November 2015.

Collins, Mary. Accepted a tenure track Assistant Professor position in Environmental Health at SUNY-ESF. August 2015.

Collins, Mary (Co-PI; PI Simone Pulver). Awarded NSF Grant (1534976), Egregious Polluters: A socially-structured explanation of disproportionality in the production of pollution. The National Science Foundation, Division of Social and Economic Sciences, Science of Organizations. Awarded August 2015.

Collins, Mary (PI, with Paul Mohai and Michael Ash). Awarded SESYNC Grant, Examining the Causes and Consequences of Environmental Inequality Over Time: A Data-Driven Computational Approach. The National Socio-Environmental Synthesis Center: Computational Working Group. Awarded 2015.

Copeland, Lauren. Accepted a faculty position at Baldwin Wallace University as Assistant Professor of Political Science and Associate Director of the Community Research Institute. August 2015.

Copeland, Lauren. Awarded an Annual Meeting Travel Grant from the American Political Science Association. September 2015.

Enders, Catherine. Accepted into CNS-ASU's Program to Increase Diversity in Science & Technology Studies and Science Policy Fields (POSTS). 2015-2016.

Engeman, Cassandra. Received the Southern California UC Research Grant, UCLA Institute for Research on Labor & Employment. 2014-2015.

Engeman, Cassandra. Received Honorable Mention for the 2015 Harry Braverman Award from the Labor Studies Section of the Society for the Study of Social Problems. 2015.

Engeman, Cassandra. Awarded a Visiting Scholar Research position at the Social Science Research Center in Berlin (WZB). For 2015-2016.

Gebbie, Matthew. One of four UCSB Ph.D. students chosen to attend the 65<sup>th</sup> Lindau Nobel Laureate Meeting in Germany. June-July, 2015.

Harr, Bridget. Awarded a UC President's Dissertation Year Fellowship at University of California at Santa Barbara, 2015-16.

Harthorn, Barbara Herr & Tristan Partridge. NSF SES STS Postdoctoral Fellowship: Energy, Risk and Urgency. 2015-2017.

Harthorn, Barbara Herr. Invited speaker in Congressional Briefing on "Nanotechnology Policy: Evolving and Maturing," American Chemical Society, Science and the Congress Project, Washington DC. October 9, 2015.

Harthorn, Barbara. Nominee, AAAS Committee on Nominations. Fall 2015.

Hawker, Craig. Elected as Member of the National Academy of Inventors. 2015.

Hawker, Craig. Elected to Fellowship in the American Association for the Advancement of Science (AAAS). 2015.

Kay, Luciano. Scientific Advisory Panel, the 5th Global Tech Mining Conference, Atlanta, GA. September 15-16, 2015.

Mehta, Aashish. Invited by The World Bank and the Asian Development Bank to participate in several research/writing projects involving human capital, "skill gaps" and industrial diversification and development. Researchers will be hired in various countries, to be supervised by Prof Mehta. 2015.

Novak, David. Japan Foundation Short-Term Research Fellowship for "The Politics of Festival: The Role of Music in Japan's Antinuclear Movement". Summer 2015.

Pidgeon, Nick. Member of the final commissioning panel of the Norwegian Research Council joint call in ELSA for nano and biotechnologies. May 15, 2015.

Pidgeon, Nick. Member of the Synthetic Biology Governance Council, responsible innovation sub-group, UK. 2015.

Rogers-Brown, Jennifer. Awarded LIU Post Sustainable Pioneer Award. "In recognition of your effort and contributions in bringing forth a more sustainable LIU Post." LIU Post Sustainability Committee. 2015

Slaton, Amy. Invited to participate in the formation of a new Chemical Heritage Foundation initiative focused on the history of industrial materials. 2015.

Stevenson, Louise. Student Board Member, Board of Directors, Southern California Society for Environmental Toxicology and Chemistry (SETAC). 2015.

Stocking, Galen, Accepted a research position at the Pew Research Center. 2015.

Walsh, James. Accepted Assistant Professor position, Social Science and Humanities at the University of Ontario Institute of Technology. 2015.

Záyago Lau, Edgar. Accepted as a regular member to the Mexican Academy of Sciences (AMC). 2015.

## **2016**

Copeland, Lauren, Elected to the Executive Committee, Information Technology and Politics Section, American Political Science Association.

Copeland, Lauren, Received a travel grant from Baldwin Wallace University. April 2016.

Copeland, Lauren, Received a grant from Baldwin Wallace University Field Trip Fund. 2016.

Copeland, Lauren, Received a summer research grant from Baldwin Wallace University. 2016.

Gebbie, Matthew, Awarded a Postdoctoral Research Fellowship at Stanford University, Material Science and Engineering, 2016.

Hasell, Ariel, Awarded a Postdoctoral Research Fellowship at University of Pennsylvania, Annenberg School for Communication, beginning July, 2016.

Legrady, George, Awarded a John Simon Guggenheim Foundation Fellowship. 2016

McCray, Patrick, Invited Speaker and Discussion Leader at the World Economic Forum in Davos, Switzerland, February, 2016.

Rogers-Brown, Jennifer, Awarded by the editorial team of *Advances in Gender Research* as an Outstanding Author Contributions in the 2016 Emerald Literati Network Awards for Excellence for chapter, "More than a war story: A feminist analysis of doing dangerous fieldwork."

Stevenson, Louise, Awarded a Postdoctoral Research Fellowship at UCSB, EEMB, beginning July, 2016.

## Nanotechnology in the Global Economy

### Conferences

- CNS researchers weighed in on China's efforts to move up the value chain at a conference hosted by Duke Kunshan University (DKU). Called "China's Role in the Global Innovation System," the conference was organized by CNS collaborator and DKU Executive Vice Chancellor Denis Simon. He and CNS collaborator, Cong Cao, addressed China's talent in science, engineering and management. CNS co-PI and IRG 2 leader Richard Appelbaum assessed China's progress towards innovation in the nanotechnology sector.
- Simon and Appelbaum will address U.S. and Canadian officials on China STI policy at a panel discussion hosted by the International Development Research Centre in Ottawa, Ontario on November 29, 2016.



### Media

"We've done surveys that show that industry is very concerned about engineered nanomaterials from a safety standpoint, but they are still averse to regulation."

--Barbara Herr Harthorn in *CQ Researcher*

PI Harthorn and co-PI Appelbaum were both consulted for a CQ researcher report on the impacts of nanotechnology on the global economy, *Nanotechnology: Will the Science of Atom-Size Objects Reshape the Economy?*





## IRG Synthesis Reports--Origins, Innovation & Risk

### Lessons Learned

Each of the three main IRGs published a synthesis report that included important lessons learned from 11 years of research on the societal implications of nanotechnologies. These reports were distributed to scholars, policymakers, media, and funders, including the NSF. They are available for free download at: <http://www.cns.ucsb.edu/irg-synthesis-reports>



### Sample Policy Recommendations

- Public acceptability of nanotechnologies is driven by: benefit perception, the type of application, and the risk messages transmitted from trusted sources and their stability over time; therefore transparent and responsible risk communication is a critical aspect of acceptability.
- Policies aimed at fostering S&T development should continue to emphasize basic research, but not to the exclusion of supporting promising innovative payoffs. The NNI, with its emphasis on basic research, would likely achieve greater success in spawning commercialization by investing more in capital programs such as the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs.
- The complex nature of technological ecosystems translates into a variety of actors essential for successful innovation. One species is the visionary, a person who blends engineering experience with a transformative vision of the technological future and a willingness to promote this vision to the public and policy makers.

Appelbaum, Richard P. (2016). *CNS Synthesis Report on IRG 2: Globalization and Nanotechnology: The Role of State Policy and International Collaboration*. (CNS-UCSB, Santa Barbara, CA), July, 2016.

Harthorn, Barbara Herr, Nick Pidgeon and Terre Satterfield. (2016) *CNS Synthesis Report on IRG 3: Understanding*

*Nanotechnologies' Risks and Benefits: Emergence, Expertise & Upstream Participation*, (CNS-UCSB, Santa Barbara, CA), August, 2016.

McCray, W. Patrick, Cyrus Mody, Amy Slaton, and Brian Tyrrell. 2016. *CNS Synthesis Report on IRG 1: Exploring*

*Nanotechnology's Origins, Institutions, and Community: A Ten Year Experiment in Large Scale Collaborative STS Research*. (CNS-UCSB, Santa Barbara, CA), July, 2016.



## 14. PUBLICATIONS 2010-2016

### PRIMARY

#### JOURNALS

- Appelbaum, Richard. (2011). Will China Eat Our Lunch? Review of Denis Fred Simon and Cong Cao, *China's Emerging Technological Edge*. *Asia Policy* (11), 160-164.
- Appelbaum, Richard, Parker, Rachel, & Cao, Cong. (2011). Developmental state and innovation: Nanotechnology in China. *Global Networks*, 11(3), 298–314. doi: 10.1111/j.1471-0374.2011.00327.x
- Appelbaum, Richard, Gebbie, Matt, Han, Shirley, & Stocking, Galen. (2016). Will China's Quest for Indigenous Innovation Succeed? Some Lessons From Nanotechnology. *Technology in Society* 46 (August): 149-163.
- Appelbaum, Richard, Zayago Lau, Edgar, Foladori, Guillermo, Parker, Rachel, Vazquez, Laura Liliana Villa, Belmont, Eduardo Robles, & Figueroa, Edgar Ramón Arteaga. (2016). Inventory of nanotechnology companies in Mexico. *Journal of Nanoparticle Research*, 18(2): 42-53. doi: 10.1007/s11051-016-3344-y
- Arteaga Figueroa, Edgar, Foladori, Guillermo, Robles Belmont, E, Záyago Lau, Edgar, Appelbaum, Richard, & Parker, Rachel. (forthcoming). Patentes e innovación de nanotecnología en México. *Revista Investigación Y Ciencia UAA*.
- Barvosa, Edwina. (2015). Mapping public ambivalence in public engagement with science: implications for democratizing the governance of fracking technologies in the USA. *Journal of Environmental Studies and Sciences*, 5(4), 497-507. doi: 10.1007/s13412-015-0340-y
- Beaudrie, Christian, & Kandlikar, Milind. (2011). Horses for Courses: Risk Information and Decision Making in the Regulation of Nanomaterials. *Journal of Nanoparticle Research Special Focus: Governance of Nanobiotechnology* 13(4):1477-1488. (DOI 10.1007/s11051-011-0234-1), 1-12.
- Beaudrie, Christian, Kandlikar, Milind, & Satterfield, Terre. (2013). From Cradle-to-Grave at the Nanoscale: Gaps in US Regulatory Oversight along the Nanomaterial Life Cycle. *Environmental Science & Technology*, 47(11), 5524-5534. doi: 10.1021/es303591x
- Beaudrie, Christian, Satterfield, Terre, Kandlikar, Milind, & Harthorn, Barbara Herr. (2013). Expert Views on regulatory preparedness for managing the risks of nanotechnologies. *PLOS One*. doi: 10.1371/journal.pone.0080250
- Beaudrie, Christian, Satterfield, Terre, Kandlikar, Milind, & Harthorn, Barbara Herr. (2014). Scientists versus Regulators: Precaution, Novelty & Regulatory Oversight as Predictors of Perceived Risks of Engineered Nanomaterials. *PLoS ONE*, 9(9), e106365. doi: 10.1371/journal.pone.0106365
- Beaudrie, Christian, Kandlikar, Milind, Gregory, Robin, Long, Graham, & Wilson, Tim. (2014). Nanomaterial risk screening: a structured approach to aid decision making under uncertainty. *Environment Systems and Decisions* 35(1) 88-109. doi: 10.1007/s10669-014-9529-y

- Becker, Sean. (2013). Nanotechnology in the marketplace: how the nanotechnology industry views risk. *Journal of Nanoparticle Research*, 15(1426), 1-13. doi: 10.1007/s11051-013-1426-7
- Cao, Cong, Appelbaum, Richard, & Parker, Rachel. (2013). Research is High and the Market is Far Away - Commercialization of Nanotechnology in China. *Technology in Society*, 35, 55-64.
- Choi, Hyungsub, & Otani, Takushi. (2012). Failure to Launch: Tarui Yasuo, the Quadrupole Transistor, and the Meanings of the IC in Postwar Japan. *IEEE Annals of the History of Computing*, 34(1), 48-59. doi: 10.1109/MAHC.2011.86
- Collins, Mary, & Freudenburg, William. (2013). Temporal Mypoa: A Case of Promising New Technologies, the Federal Government, and Inherent Conflicts of Interest. In S. Maret (Ed., special issue) *William R. Freudenburg, A Life in Social Research (Research in Social Problems and Public Policy, Volume 21)* (pp.259 – 276).
- Conti, Joseph, Satterfield, Terre, & Harthorn, Barbara Herr. (2011). Vulnerability and Social Justice as Factors in Emergent US Nanotechnology Risk Perceptions *Risk Analysis* 31(11), 1734–1748. doi: 10.1111/j.1539-6924.2011.01608.x
- Copeland, Lauren. (2013). Value Change and Political Action: Postmaterialism, Environmentalism, and Political Consumerism. *American Politics Research* 42(2):257-282. doi: 10.1177/153267X13494235
- Copeland, Lauren. (2014). Conceptualizing Political Consumerism: How Citizenship Norms Differentiate Boycotting from Buycotting. *Political Studies*, 62, 172-186. doi: 10.1111/1467-9248.12067
- Dillemuth, Julie, Frederick, Stacey, Parker, Rachel, Gereffi, Gerry, & Appelbaum, Richard. (2011). Traveling Technologies: Societal Implications of Nanotechnology through the Global Value Chain. *Journal of Nano Education*, 3(1-2), 36-44.
- Eisler, Matthew N. (2011). Energy Innovation at Nanoscale: Case Study of an Emergent Industry. *Science Progress*, 1-6.
- Eisler, Matthew N. (2013). "The Ennobling Unity of Science and Technology: Materials Sciences and Engineering, the Department of Energy, and the Nanotechnology Enigma." *Minerva*, 51(2): 225-251. doi: 10.1007/s11024-013-9224-z
- Engeman, Cassandra, Baumgartner, Lynn, Carr, Benjamin, Fish, Allison, Meyerhofer, John, Satterfield, Terre, Holden, Patricia, & \*Harthorn, Barbara Herr. (2012). Governance implications of nanomaterials companies' inconsistent risk perceptions and safety practices. *Journal of Nanoparticle Research*, 14(749), 1-12. doi: 10.1007/s11051-012-0749-0
- Engeman, Cassandra, Baumgartner, Lynn, Carr, Benjamin, Fish, Allison, Meyerhofer, John, Satterfield, Terre, Holden, Patricia, & \*Harthorn, Barbara Herr. (2013). The hierarchy of environmental, health, and safety practices, in the US nanotechnology workplace. *Journal of Occupational and Environmental Hygiene*, 10(9), 487-495. doi: 10.1080/15459624.2013.818231
- Foladori, Guillermo, Figueroa, Santiago, Záyago Lau, Edgar, & Invernizzi, Noela. (2012). Características distintivas del desarrollo de las nanotecnologías en América Latina. *Sociológicas*, 14(30), 330-363.

- Foladori, Guillermo, Figueroa, Santiago, Záyago Lau, Edgar, & Invernizzi, Noela. (2012). Nanotechnology: Distinctive Features in Latin America. *Nanotechnology Law & Business*, 9(1), 88-103.
- Foladori, Guillermo, Záyago Lau, Edgar, Appelbaum, Richard, & Parker, Rachel. (2012). Mexico-U.S. scientific collaboration in nanotechnology. *Revista Frontera Norte (english edition)* 24(48), 145-164.
- Foladori, Guillermo, Arteaga Figueroa, Záyago Lau, Edgar, Appelbaum, Richard, Robles Belmont, Eduardo, Villa, Liliana, & Parker, Rachel. (2015). Relevancia y apoyo público de la Investigación en Nanotecnología en México. *Revisita Anduli*(14), 195-222. doi: <http://dx.doi.org/10.12795/anduli.2015.i14.11>
- Foladori, Guillermo, Arteaga Figueroa, Záyago Lau, Edgar, Appelbaum, Richard, Robles-Belmont, Eduardo, Villa, Liliana, Parker, Rachel, & Leos, Vanessa. (2015). Nanotechnology in Mexico: Key Findings Based on OECD Criteria. *Minerva*, 53(3), 279-301. doi: 10.1007/s11024-015-9281-6
- Foladori, Guillermo, Arteaga Figueroa, Záyago Lau, Edgar, Robles Belmont, E, Appelbaum, Richard, & Parker, Rachel. (forthcoming). Patentes nanotecnológicas en México según sector económico de potencial aplicación. *Ciencia Ergo Sum*.
- Foladori, Guillermo, Arteaga Figueroa, Ramon, Záyago Lau, Edgar, Robles Belmont, Eduardo, Appelbaum, Richard, & Parker, Rachel. (forthcoming). Sectores económicos de potencial aplicación de las patentes de nanotecnologías en México. *Ciencia Ergo-Sum*.
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- Lécuyer, Christophe, & Choi, Hyungsub. (forthcoming). How Did Semiconductor Firms Manage Technological Uncertainty? *La Revue d'Histoire Moderne et Contemporaine*.
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