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Nanoscale Science and Engineering Center

at University of California, Santa Barbara

Year 6 (11) Annual Report

March 16, 2015 – March 15, 2016

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3. PROJECT SUMMARY

The Center at UC Santa Barbara addresses questions of nanotech-related societal change through research and education that encompasses three main areas: **IRG-1: Origins, Institutions, and Communities** produces and integrates a diverse range of historical sources and research tools in order to understand specific facets of the nano-enterprise's history; **IRG-2: Globalization and Nanotechnology** addresses global industrial policy and development of nanotechnology, with a particular focus on China, Japan & India as well as Latin America and pathways to the use of nanotechnologies to spur equitable development; and **IRG-3: Risk Perception and Social Response** conducts social research on formative nanotech and other emerging technologies risk and benefit perceptions in the US and abroad by multiple stakeholders and modes of enhancing public participation. Strategic topic projects (solar energy, California and global industry, media coverage of nano) and Seed Grant projects extend and integrate the three IRGs' work. In combination, these efforts address a linked set of issues regarding the domestic US and global creation, development, commercialization, production, consumption, and control of specific kinds of nanoscale technologies. Important features of CNS' approach are commitment to issues of *socially and environmentally sustainable innovation*; participatory research with nanoscientists; a focus on specific nanotechnologies and comprehensive consideration of their applications in industries like electronics, energy, food, environmental, and health; and employment of a comparative global framework for analysis with attention to responsible and equitable development. **IRG 3** studies cross-national modes of enhancing public participation. The Center's three IRGs combine expertise in many fields: technology, innovation, culture, cognition and perception, health, energy, global industrial development, gender and race, environment, space/location, and science and engineering. Core collaborators are drawn in the US from UCLA, Chemical Heritage Fdn., Decision Research, Duke Univ, Lehigh Univ, and SUNY EST and New Paltz, and internationally from Cardiff Univ (UK), Maastricht Univ (the Netherlands), Univ of British Columbia (Canada), Univ of Nottingham (UK) and Universidad Autónoma de Zacatecas (Mexico). CNS-UCSB has served as a leader in the NSF Network for Nanotechnology in Society and is co-founder of the international scholarly organization S.NET, which is successfully forging an international community of nano and emerging technology scholars from nations around the globe. CNS-UCSB is a research partner in the NSF/EPA-funded UC Center for Environmental Implications of Nanotechnology at UCLA/UCSB.

Education and Outreach programs at CNS-UCSB aim 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 provides 3-5 postdoctoral researcher positions per year. Graduate Fellowships and researcher postions for social science and NSE grads enable them to participate jointly in CNS IRG research and education. A hallmark of CNS-UCSB education is the introduction of scientists- and engineers-in-training into the methods and practices of societal research and their use to address responsible development. A CNS 8-week intensive summer undergraduate internship program run for 9 times over the duration of the CNS awards integrates diverse California community college students 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 accelerating outreach to key sectors of government, industry, and NGOs, the CNS maintains a solid following of campus, local, and national and international media, and interest by government, industry, NGOs, and the general public.

In 2015-16 CNS-UCSB continued substantial progress in research on pathways and impediments to socially and environmentally sustainable futures for nanotechnologies, producing 71 new publications, bringing total publications since our renewal 5.5 years ago to 365, with another 46 in the publication stream, and making 61 presentations this year at academic venues. Appelbaum, Harthorn, Pidgeon, and Simon each provided critical input to national policymaking bodies in the US and UK, and CNS researchers made over 40 presentations to key audiences in government, industry, NSE, and the public.

4. PARTICIPANTS

4A. CENTER PARTICIPANTS

Bold indicates Active in Year 11 (March 16, 2015 - March 15, 2016)

*University of California, Santa Barbara (*co-funded)*			
Senior Personnel			
Name	Title	Department	Organization
***Peter Alagona**	**Associate Professor**	**History & Environmental Studies**	**UC Santa Barbara**
Sarah Anderson	**Associate Professor**	**BREN School of Environmental Science & Management**	**UC Santa Barbara**
Richard Appelbaum	**Research Professor**	**Sociology, Global & International Studies**	**UC Santa Barbara**
David Awschalom	Professor Director	Physics California NanoSystems Institute	UC Santa Barbara
Javiera Barandiaran	**Assistant Professor**	**Global & International Studies**	**UC Santa Barbara**
Edwina Barvosa	**Associate Professor**	**Feminist Studies**	**UC Santa Barbara**
Bruce Bimber	**Professor**	**Political Science, Communication**	**UC Santa Barbara**
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
Barbara Herr Harthorn	**Professor** **Director**	**Anthropology** **CNS-UCSB**	**UC Santa Barbara**
Craig Hawker	**Professor** **Director** **Director**	**Chemical Engineering** **Materials Research Laboratory, MRSEC** **California Nano Systems Institute**	**UC Santa Barbara**
Patricia Holden	**Professor**	**BREN School of Environmental Science & Management**	**UC Santa Barbara**

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

Sub-Award PIs			
Name	Title	Department	Organization
Frederick Block	Professor Emeritus	Sociology	UC Davis
Joseph Conti	Assistant Professor	Sociology & Law	University of Wisconsin
Sharon Friedman	**Professor**	**Science Journalism, Communication**	**Lehigh University**
Gary Gereffi	**Professor**	**Sociology,** **Center for Globalization, Governance & Competitievness (CGGC)**	**Duke University**
Robin Gregory	**Senior Researcher**	**Psychology**	**Decision Research**
Timothy Lenoir	**Professor** **Chair**	**New Technologies in Society, Literature & Computer Science** **Kimberly J. Jenkins for New Technologies in Society**	**Duke University**
Cyrus Mody	**Associate Professor**	**History & Technology Studies**	**Rice University**
David Mowery	Professor	Economics, Business School	UC Berkeley

Name	Title	Department	Organization
Nicholas Pidgeon	**Professor**	**Social Psychology**	**Cardiff University, United Kingdom**
Terre Satterfield	**Professor / Director**	**Institute for Resources, Environment & Sustainability (IRES)**	**University of British Columbia, Canada**
Paul Slovic	**President**	**Psychology**	**Decision Research**

COLLABORATORS & Other Funded Participants			
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
Javiera Barandiaran	Assistant Professor	Global & International Studies	UC Santa Barbara
Gerald Barnett	Director	University Tech. Transfer	University of Washington
Indrani Barpujari	Researcher	Science & Technology	The Energy & Resource Institute, India
Christian Beaudrie	**Associate**	**Resouce Management & Environmental Studies**	**Compass Resource Management, Canada**
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
David Brock	Senior Research Fellow	Center for Contemporary History & Policy	Chemical Heritage Foundation
Jennifer Brown	**Assistant Professor**	**Sociology**	**Long Island University**
Karl Bryant	Assistant Professor	Sociology, Women's Studies	SUNY New Paltz

Name	Title	Department	Organization
Angelina Callahan	Postdoctoral Scholar	History, Sociology of Technology & Science	Georgia Institute of Technology
Luis Campos	Assistant Professor	History	University of New Mexico
Cong Cao	**Professor, Head of SCCS**	**Sociology**	**University of Nottingham, Ningbo China**
Jenny Chan	Departmental Lecturer	Chinese Studies	Students & Scholars Against Corporate Misbehavior (SACOM)
Hyungsub Choi	Assistant Professor	History of Science	Seoul National University, South Korea
Martin Collins	Curator	History	Smithsonian National Air & Space Museum
Mary Collins	**Assistant Professor**	**Environmental Studies**	**SUNY-ESF**
Meredith Conroy	Assistant Professor	Politics	Occidental College
Jonathan Coopersmith	Associate Professor	History	Texas A& M
Lauren Copeland	**Assistant Professor / Associate Director**	**Political Science Community Research Institute**	**Baldwin Wallace University**
Rodrigo Cortes-Lobos	PhD Candidate	Public Policy	Georgia Tech
Sheila Davis	Executive Director	Environmetal Policy	Silicon Valley Toxics
Dave Deamer	Research Professor	Chemistry & Biochemistry	UC Santa Cruz
Christina Demski	Lecturer	Psychology	Cardiff University, United Kingdom
Lucy Diep	Master Student	Community Health Service	University of Calgary, Canada
Jennifer Earl	Professor	Sociology	University of Arizona
Brenda Egolf	Research Scientist	Journalism	Lehigh University
Matthew Eisler	Lecturer	Engineering & Society	University of Virginia
James Elkins	Professor	Art History, Theory & Criticism	Chicago Art Institute
Guillermo Foladori	**Professor**	**Sociology**	**Universidad Autonoma de Zacatecas, Mexico**

Name	Title	Department	Organization
Rider Foley	PhD Candidate	School of Sustainability	Arizona State University
John Gallo	Senior Scientist	Environmental Reserch & Policy	Conservation Biology Institute
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	Assiciate Professor	Anthropology	Quinnipiac University
Matthew Harsh	Assistant Professor	Engineering & Computer Science	Concordia University, Canada
Jennifer Hawken	**Consultant**	**Transcription**	**Independent Consultant**
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

Name	Title	Department	Organization
Ann Johnson	Associate Professor	History of Science & Technology, Modern Europe	University of South Carolina
Matthew Jones	Associate Professor / Chair	Contemporary Civilization	Columbia University
Dan Kahan	Elizabeth K. Dollard Professor of Law & Professor	Law & Psychology	Yale Law School
Milind Kandlikar	**Professor**	**Science Policy & Regulation**	**University of British Columbia, Canada**
Sarah Kaplan	Associate Professor	Strategic Management	University of Toronto, Canada
Gul Karagoz-Kizilca	Assistant Professor	History	Ankara University, Turkey
Arturo Keller	Professor	BREN School of Environmental Science & Management	UC Santa Barbara
Matthew Keller	Assistant Professor	Sociology	Southern Methodist University
Sheron King	Phd Candidate	Public Administration	North Carolina State University
David Kirby	Senior Lecturer	Science Communiction Studies	University of Manchester
Thanate Kitisriworaphan	Lecturer	Demography	Bangkok Thonburi University, Thailand
Ronald Kline	Professor	Science & Technology Studies	Cornell University
Lotte Krabbenborg	Postdoctoral Researcher	Humanities & Political Philosophy	Radboud University, Netherlands
Nicholas Kristoff	Columnist / Writer	Law & Global Affairs	New York Times
Todd Kuiken	Senior Program Associate	Science and Technology Innovation Program	Woodrow Wilson International Center for Scholars
Kristen Kulinowski	Research Staff Member	Environmental, Health & Saftey	Science and Technology Policy Institute (STPI)
Jennifer Kuzma	Professor	Genetic Engineering & Society	North Carolina State University
Anna Lamprou	PhD Candidate	Science & Technology Studies	Rensselaer Polytechnic Institute

Name	Title	Department	Organization
Matthew Lavine	Assistant Professor	History	Mississippi State University
Lubi Lenaburg	Evaluation Coordinator	Center for Science & Engineering Partnerships (CNSI)	UC Santa Barbara
Stuart Leslie	Professor	History of Science	John Hopkins University
David Lewis	Professor	Anthropology, Social Policy & Development	London School of Economics, United Kingdom
Nelson Lichtenstein	Professor	History	UC Santa Barbara
Graham Long	Partner	Environmental Technology	Compass Resource Management, Canada
Sarah Lowengard	Adjunct Associate Professor	Humanities & Social Sciences	Cooper Union
Michael Lynch	Professor	Science & Technololgy Studies	Cornell University
Nathalie Marechal	PhD Candidate	Media, Media History & International Relations	University of Southern California
Cyrus Mody	**Chair / Professor**	**Department of History / MUSTS Research Cluster**	**Maastricht University**
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 Scicience	UC Santa Cruz
Emily Nightingale	**Science Policy Fellow**	**Global & International Studies**	**IDA Science & Technology Policy Institute**
Lina Nilsson	Innovation Director	Blum Center for Developing Economies	UC Berkeley
Joseph November	Associate Professor	History	University of South Carolina

Name	Title	Department	Organization
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
Howard Park	Independent Consultant	Music	Santa Barbara, California
Rachel Parker	**Director of Research Programs**	**Sociology**	**Canadian Institute For Advance Research**
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

Name	Title	Department	Organization
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
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
Denis Simon	**Executive Vice Chancellor**	**Political Science**	**Duke Kunshan University**
Darius Sivin	Industrial Hygienist	Occupational & Environmental Health	United Auto Workers
Amy Slaton	**Professor**	**History & Politics**	**Drexel University**
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
Galen Stocking	**Research Associate**	**Political Science**	**PEW Research Center**
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

Name	Title	Department	Organization
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
Xinyue Ye	Assistant Professor	Geography	Kent State University
Jan Youtie	Manager, Policy Services	Political Science	Georgia Institute of Technology
Edgar Zayago Lau	**Senior Researcher**	**Development Studies**	**Universidad Autonoma de Zacatecas, Mexico**
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

UCSB Postdoctoral Researchers (*co-funded)			
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
***Lauren Copeland**	**Postdoctoral Researcher**	**Political Science**	**UC Santa Barbara / UC CEIN**
*Gwen D'Arcangelis	Postdoctoral Researcher	Women's Studies	UC Santa Barbara / UC CEIN
Matthew Eisler	Postdoctoral Researcher	History	UC Santa Barbara
Xueying (Shirley) Han	**Postdoctoral Researcher**	**Ecology, Evolution, & Marine Biology**	**UC Santa Barbara**
Shannon Hanna	Postdoctoral Researcher	Environmental Science & Management	UC Santa Barbara
Mikael Johansson	Postdoctoral Researcher	Social Anthropology	UC Santa Barbara
Luciano Kay	**Postdoctoral Researcher**	**Public Policy**	**UC Santa Barbara**
Yasuyuki Motoyama	Postdoctoral Researcher	City & Regional Planning	UC Santa Barbara
Tristan Partridge	**Postdoctoral Researcher**	**Social Anthropology**	**UC Santa Barbara**

Name	Title	Department	Organization
*Christine Shearer	Postdoctoral Researcher	Sociology	UC Santa Barbara / Harthorn-Deliberation
James Walsh	Postdoctoral Researcher	Sociology	UC Santa Barbara

Non-UCSB Postdoctoral Researchers (*co-funded)			
Name	Title	Department	Organization
***Mary Collins**	**Postdoctoral Scholar**	**Environmental Studies**	**University of Maryland**
Adam Corner	Postdoctoral Researcher	Social Psychology	Cardiff University, United Kingdom
Christina Demski	Postdoctoral Researcher	Psychology	Cardiff University, United Kingdom
***Darrick Evensen**	**Postdoctoral Researcher**	**Psychology**	**Cardiff University, United Kingdom**
***Stacey Frederick**	**Postdoctoral Researcher**	**Textile Management**	**Duke University**
Matthew Keller	Postdoctoral Researcher	Sociology	UC Davis
Marian Negoita	Postdoctoral Researcher	Sociology	UC Davis
***Anton Pitts**	**Postdoctoral Researcher**	**Risk Science**	**University of British Columbia**
*Christine Shearer	Postdoctoral Researcher	Earth Science & Sociology	UC Irvine
***Merryn Thomas**	**Postdoctoral Researcher**	**Psychology**	**Cardiff University, United Kingdom**
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
Amy Foss	Research Fellow, Social Science	Chicano/a Studies	UC Santa Barbara

Name	Title	Department	Organization
Matthew Gebbie	**Research Fellow, Science & Engineering**	**Materials Department**	**UC Santa Barbara**
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
Bridget Harr	**Research Fellow, Social Science**	**Sociology**	**UC Santa Barbara**
Ariel Hasell	**Research Fellow, Social Science**	**Communication**	**UC Santa Barbara**
Zachary Horton	Research Fellow, Social	English	UC Santa Barbara
Tyronne Martin	Research Fellow, Science & Engineering	Chemistry	UC Santa Barbara
Louise Stevenson	**Research Fellow, Science & Engineering**	**Ecology, Evolution & Marine Biology**	**UC Santa Barbara**
Galen Stocking	**Research Fellow, Social Science**	**Political Science**	**UC Santa Barbara**
Brian Tyrrell	**Research Fellow, Social Science**	**History (Environmental History)**	**UC Santa Barbara**

UCSB Graduate Student Researchers & Research Assistants (*co-funded)			
Name	Title	Department	Organization
*Lynn Baumgartner	Grad Student Researcher	Environmental Science & Management	UC Santa Barbara
Rosie Bermudez	**Grad Student Researcher**	**Chicano/a Studies**	**UC Santa Barbara**
*Erin Calkins	Grad Student Researcher	Chemistry, Biochemistry	UC Santa Barbara
Clayton Caroon	**Grad Student Researcher**	**Global & International Studies**	**UC Santa Barbara**
*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
John V. Decemvirale	Grad Student Researcher	History of Art & Architecture	UC Santa Barbara

Name	Title	Department	Organization
Chloe Diamond-Lenow	**Grad Student Researcher**	**Feminist Studies**	**UC Santa Barbara**
Jacqueline Dodd	**Grad Student Researcher**	**Economics**	**UC Santa Barbara**
Karin Donhowe	Grad Student Researcher	Economics	UC Santa Barbara
Rachel Drew	**Grad Student Researcher**	**Global & International Studies**	**UC Santa Barbara**
Yuan-Yi Fan	Grad Student Researcher	Media Arts & Technology	UC Santa Barbara
***Kieran Findlater**	**Postdoctoral Researcher**	**Institute for Resources, Environment & Sustainability (IRES)**	**University of British Columbia**
*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
Lisa Han	**Grad Student Researcher**	**Film & Media Studies**	**UC Santa Barbara**
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
Isabel Ochoa	**Grad Student Researcher**	**Global & International Studies**	**UC Santa Barbara**

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
Alexander Scarlett	**Grad Student Assistant**	**Latin American & Iberian Studies**	**UC Santa Barbara**
Elizabeth Sciaky	Grad Student Researcher	Education	UC Santa Barbara
Marissa Taggart	**Grad Student Researcher**	**Global & International Studies**	**UC Santa Barbara**
Caitlin Vejby	**Grad Student Researcher**	**Global & International Studies**	**UC Santa Barbara**
Adélaîde 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

Non-UCSB Graduate Student Researchers			
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
Matthew Keller	Grad Student Researcher	Sociology	UC Davis
Chaerean Kim	**Grad Student Researcher**	**Institute for Resources, Environment & Sustainability (IRES)**	**University of British Columbia, Canada**
Aaron McGuire	Grad Student Researcher	Jenkins Collaboratory	Duke University

Name	Title	Department	Organization
Miguel Ruiz	Grad Student Researcher	Sociology	UC Davis
Laura Saldivar-Tanaka	**Grad Student Researcher**	**Anthropology**	**Colegio de Mexico**
Matthew Thomas	Grad Student Researcher	Jenkins Collaboratory	Duke University
Brittany Shields	Grad Student Researcher	History & Sociology	University of Pennsylvania

Undergraduate, High School Interns & Researchers (UCSB, Community Colleges & High Schools)			
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
Jesus Diera	**Undergrad Student Researcher**	**CNS-UCSB / IRG2**	**UC Santa Barbara**
Catherine Enders	**Undergrad Student Researcher**	**CNS-UCSB / IRG3**	**UC Santa Barbara**
Katrina Fernandez	**Undergrad Student Researcher**	**CNS-UCSB**	**UC Santa Barbara**
Gianna Haro	Undergrad Student Researcher	CNS-UCSB / IRG1	Santa Barbara City College
Katherine He	Undergrad Student Researcher	CNS-UCSB / XIRG	UC Santa Barbara
Simone Jackson	Undergrad Student Researcher	CNS-UCSB / IRG3	Allan Hancock College
Paul Kovacs	Undergrad Student Researcher	CNS-UCSB / IRG1	Santa Barbara City College

Name	Title	Department	Organization
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 Wuu	Undergrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Joy Yang	Undergrad Student Researcher	CNS-UCSB / IRG2	UC Santa Barbara
Maria Yepez	Undergrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara

Name	Title	Department	Organization

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
Shawn Barcelona	**Center Administrator**	**CNS-UCSB / Admin**	**UC Santa Barbara**
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 Dillemuth	Education Director	CNS-UCSB	UC Santa Barbara
Brandon Fastman	**Education Coordinator**	**CNS-UCSB / Ed & Outreach**	**UC Santa Barbara**
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
Valerie Kuan	**Purchasing/Travel Coordinator**	**CNS-UCSB / Admin**	**UC Santa Barbara**
Diane Laflamme-McCauley	Artist	CNS-UCSB / Admin	UC Santa Barbara

Name	Title	Department	Organization
Brendy Lim	**IT Support**	**ISBER / CNS-UCSB / Tech**	**UC Santa Barbara**
Enrique Macias (Rick)	**IT Support**	**ISBER / CNS-UCSB / Tech**	**UC Santa Barbara**
Bonnie (Lanthier) Molitor	**Assistant Director**	**CNS-UCSB / Admin**	**UC Santa Barbara**
Emily Nightingale	Staff Reseach Assistant	CNS-UCSB / IRG2	UC Santa Barbara
Kiyomitsu Odai	Staff Reseach Assistant	CNS-UCSB / Seed Grant DN	UC Santa Barbara
Deborah Pierce	**Staff Reseach Assistant**	**CNS-UCSB / Seed Grant JM**	**UC Santa Barbara**
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
Edgar Arteaga	**Reseach Assistant**	**CNS-UCSB / IRG2**	**Universidad Autonoma de Zacatecas, Mexico**
*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

Affiliated Participants (Not receiving Center support) *UCSB*			
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
Heather Hodges	**PhD Candidate**	**Political Science**	**UC Santa Barbara**
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	Enviromental 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
Barbara Walker	**Director, Research & Development, Social Science, Humanities**	**Office of Research**	**UC Santa Barbara**
Janet Walker	Professor & Chair	Film and Media Studies	UC Santa Barbara

Affiliated Participants (Not receiving Center support) *Other Institutions (Unfunded Collaborators & Other Participants)*			
Name	Title	Department	Organization
David Azoulay	**Managing Attorney**	**Environmental Law**	**The Center for International Environmental Law**

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**
Jenny Chan	**Senior Lecturer**	**Chinese Studies**	**Oxford University**
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
Katie Davis	**Co-Founder**	**Environmental Advocate**	**Santa Barbara County Water Guardians**
Brian Davison	Associate Professor	Computer Science & Engineering	Lehigh University
Magali Delmas	Associate Professor	Corporate Environmental Management	UC Los Angeles
Christina Demski	**Lecturer**	**Psychology**	**Cardiff University, United Kingdom**
Jennifer Earl	**Professor**	**Sociology**	**University of Arizona**
Brenda Egolf	**Research Scientist**	**Journalism**	**Lehigh University**
Cassandra Engeman	**Visiting Researcher**	**Sociology**	**Social Science Research Center, Berlin (WZB)**
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
Elizabeth Grossman	**Journalist, Author**	**Environmental and Science Issues**	**Independent Consultant**
Sarah Kaplan	Associate Professor	Business	University of Toronto, Canada

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

Name	Title	Department	Organization
André Nel	Professor, Director, Physician	UC Los Angeles CEIN UC Los Angeles Medical School	UC Los Angeles
Graham Long	**Partner**	**Environmental Technology**	**Compass Resource Management, Canada**
Joseph November	**Associate Professor**	**History**	**University of South Carolina**
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 (H40)
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
Andrew Schroeder	**Director of Research and Analysis**	**Geographic Information Systems**	**Direct Relief**
Bhavna Shamasunder	**Assistant Professor**	**Urban & Environmental Policy**	**Occidental College**
Philip Shapira	**Professor**	**Public Policy**	**Georgia Institute of Technology / University of Manchester**
Christine Shearer	**Research Fellow**	**Earth Science & Sociology**	**CoalSwarm**

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
Darius Sivin	**Industrial Hygienist**	**Occupational & Environmental Health**	**United Auto Workers**
Joseph Summers	Test Development Engineer	Electrical Engineering	Infinera
Thomas Tighe	Preisdent / CEO	Nonprofit Organization	Direct Relief
Jennifer Woolley	**Associate Professor**	**Management**	**Santa Clara University**
Tim Wilson	Associate	Geospatial Analysis	Compass Resource Management, Canada
Jan Youtie	**Manager, Policy Services**	**Political Science**	**Georgia Institute of Technology**
Tarun Wadhwa	**Writer, Researcher & Entrepreneur**	**Technology, international development, and public policy**	**Independent Journalist**
Stephen Zehr	Professor	Sociology	University of Southern Indiana

Visiting Scholars & Seminar Speakers			
Name	Title	Department	Organization
Ivan Amato	Science & Technology Writer/ Journalist-in-Residence	Kavli Institute for Theoretical Physicis	Dalian Institite of Chemical Physicis, China
Xinhe Bao	Professor	Engineering	Dalian Institite of Chemical Physicis, China
Francesca Bray	Professor	Gender & Technology	Edinburgh University, United Kingdom
Karl Bryant	Associate Professor	Sociology & Women's Studies	SUNY New Paltz
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
Jorge Gardea-Torresdey	Dudley Chair	Environmental Chemistry	Utrecht University, Netherlands

Name	Title	Department	Organization
Karen Henwood	**Professor**	**Social Sciences**	**Cardiff University, United Kingdom**
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 & Philosphy 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

Nanotechnology in Society Network Lead Partners			
Name	Title	Department	Organization
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

Reporting Period: March 16, 2015 - March 15, 2016

Name	*Title*
Ann Bostrom (Board Co-Chair)	Weyerhaeuser Professor of Environmental Policy, Daniel J. Evans School of Public Affairs, University of Washington
John Seely Brown (Board Co-Chair)	Independent Co-Chairman, Deloitte's Center for the Edge; Visiting Scholar and Advisor to the Provost, University of Southern California
Craig Calhoun	Director, London School of Economics, London, United Kingdom
Vicki Colvin	Brown University, Kenneth S. Pitzer-Schlumberger Professor of Chemistry, Chemical & Biomolecular Engineering, and Materials Science & Nanomaterials Engineering
Ruth Schwartz Cowan	Professor Emerita, Department of History and Sociology of Science, University of Pennsylvania
Susan Hackwood	Professor of Electrical & Computer Engineering; Executive Director of the California Council on Science and Technology (CCST), University of California Riverside
Willie Pearson, Jr.	Professor of Sociology, School of History Technology and Society, Georgia Institute of Technology; Chair; Committee on Equal Opportunities in Science and Engineering (CEOSE)
Robert Westervelt	Mallinckrodt Professor of Applied Physics & Physics, Harvard University; Director, Harvard Center for Nanoscale Systems
Former Members:	
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

Bold indicates active in Year 11 (March 16, 2015 - March 15, 2016)

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
Radboud University
Rensselaer Polytechnic Institute
Rice University
Santa Barbara City College
Seoul National University, South Korea
Singularity University
Southeastern Louisiana University
Southern Methodist University
SUNY College of Environmental Science and Forestry (SUNY-ESF)

SUNY, New Paltz
SUNY, 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 China
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 NON-ACADEMIC INSTITUTIONS

Bold indicates active in Year 11 (March 16, 2015 - March 15, 2016)

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)
Nt'l 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.

5. QUANTIFIABLE OUTPUTS

Table 1: Quantifiable Outputs							
Outputs	**Reporting Year -5 2011**	**Reporting Year -4 2012**	**Reporting Year -3 2013**	**Reporting Year -2 2014**	**Reporting Year -1 2015**	**Reporting Year 2016**	**Total**
Publications that acknowledge NSF NSEC Support							
In Peer-Reviewed Technical Journals: Primary	24	17	13	18	8	20	**100**
In Peer-Reviewed Technical Journals: Leverage	0	7	13	9	14	25	**68**
Books / Chapters or sections in books: Primary	61	36	22	10	10	11	**150**
Books / Chapters or sections in books: Leverage	0	6	4	3	10	15	**38**
Other: Primary	9	0	0	0	0	0	**9**
Other: Leverage	0	0	0	0	0	0	**0**
Total Publications	***94***	***66***	***52***	***40***	***42***	***71***	***365***
With Multiple Authors	36	54	30	24	26	46	**216**
Multiple Authors: Co-Authored with NSEC Faculty	33	50	26	22	18	34	**183**
Publications that do not acknowledge NSF NSEC Support							**0**
In Peer-Reviewed Technical Journals	0	0	1	0	0	0	**1**
NSEC Technology Transfer							**0**
Inventions Disclosed	0	0	0	0	0	0	**0**
Patents Filed	0	0	0	0	0	0	**0**
Patents Awarded	0	0	0	0	0	0	**0**
Patents Licensed	0	0	0	0	0	0	**0**
Software Licensed	0	0	0	0	0	0	**0**
Spin-off Companies Started (if applicable)	0	0	0	0	0	0	**0**
Degrees to NSEC Students							**0**
Bachelor's Degrees Granted	0	3	1	2	2	0	**8**
Master's Degrees Granted	5	0	1	1	1	0	**8**
Doctoral Degrees Granted	8	2	3	5	4	3	**25**
NSEC Graduates Hired by							**0**
Industry	0	1	0	0	0	0	**1**
NSEC Participating Firms	0	0	0	0	0	0	**0**
Other U.S. Firms	0	1	0	0	1	0	**2**
Government	1	0	0	2	1	1	**5**
Academic Institutions	5	1	6	7	3	4	**26**
Other	1	0	0	0	4	2	**7**
Unknown	0	3	0	0	0	0	**3**
NSEC Influence on Curriculum (if applicable)							**0**
New Courses Based on NSEC Research	8	9	0	6	7	12	**42**
Courses Modified to Include NSEC Research	10	13	14	23	16	8	**84**
New Textbooks Based on NSEC Research	2	16	11	13	13	5	**60**
Free-Standing Course Modules or Instructional CDs	0	0	0	1	0	0	**1**
New Full Degree Programs	0	0	0	0	0	0	**0**
New Degree Minors or Minor Emphases	0	0	0	1	0	1	**2**
New Certificate	0	0	0	0	0	0	**0**
Information Dissemination/Educational Outreach							**0**
Workshops, Short Courses to Industry	6	6	5	9	2	1	**29**
Workshops, Short Courses to Others	15	21	16	21	17	18	**108**
Seminars, Colloquia, etc.	137	165	131	125	93	47	**698**
World Wide Web courses	1	1	1	9	1	1	**14**

6. MISSION AND IMPACTS

Nanotechnology Origins, Innovations, and Perceptions in a Global Society

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 pursues 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 incorporates education for a new generation of social science and nanoscience professionals as it fosters 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.

Broader Impacts

CNS-UCSB's education and outreach programs, which are central to its mission, include a diverse range of students and participants. The Center provides novel interdisciplinary educational opportunities for a new generation of social science, humanities and nanoscience professionals via graduate fellowships (6 in the past year, 4 social science/humanities and 2 science and engineering, for a total of 8 social science/humanities fellows and 7 NSE fellows to date in the current award; graduate research assistantships (13 in the current year, 10 UCSB and 2 w/ external collaborators); undergraduate summer research internships to regional community college students (15 in the current award) and undergrads at UCSB and partner institutions (3 in 2015-2016, 18 total in the current award) who are mentored at UCSB by graduate students (15 mentorships to date in this award), and 3-5 interdisciplinary social science/humanities postdocs per year (13 at UCSB in this award, 11 at other institutions, 6 of them co-funded). CNS shows its commitment to educating a new generation of socially attuned researchers by convening a year-round graduate research seminar for credit that includes 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. CNS integrates content based on Center research into courses for undergraduate and graduate students in science and technology studies, 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. CNS is conducting 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.

CNS aims 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. In April 2015 we held an annual 2-day NanoDays in the Santa Barbara community with 1475 adults and children participating. In addition, CNS also has participated in NanoDays at the Science Center of LA. CNS-UCSB commits significant resources to conferences and workshops for diverse audiences, alternating smaller, more specialized meetings for researchers (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 takes place via electronic forms such as the CNS-UCSB webpage 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 engages and informs policymakers and governmental agencies (e.g., Appelbaum with OECD on global economic development, Block to Congress on similar issues, Harthorn to 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 contribute 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 are being 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.

Synthesis of CNS-UCSB research has culminated in 6 volumes now in print or in progress. First is 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. Seely Brown describes the volume as: **"**An encompassing collection of scholarly works touching nearly every aspect of the social currents underlying the launching of this field, its radically cross-disciplinary nature, and the crucial issue of how to engage the public in a meaningful dialogue about the risks and opportunities that this promising field might produce." 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. X-IRG project leader Newfield and his collaborator Boudreaux have developed a volume, *Can Rich Countries Still Invent?,* currently under review, from their *States of Innovation* conference in Lyon, France in April 2010 which explores the critical dimensions of a post-linear model of innovation. IRG 1 researchers are producing a series of papers from their June 2013 specialist meeting on Emerging Technologies. Appelbaum and fellow IRG 2 researchers have signed a book contract for 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 out of the *Democratizing Technologies* conference (Nov 2014) that integrates scholarly and practitioner perspectives. CNS-UCSB is also in progress with a summative activity development of a series of *research synthesis reports* to extend the implications of this mature research mission.

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

Magical Thinking Behind the 4th Industrial Revolution

- Co-PI Patrick McCray delivered an address on the 4th Industrial Revolution -- the convergence of technologies among the biological, physical, and digital spheres – at the World Economic Forum
- Technical standards allows users to create a consensus
- Technology is built on top of each other and therefore, much of history gets hidden.
- Innovation does not occur suddenly, it is based on what scientists do daily.
- Innovation is almost always championed and very little emphasis is given to whether if it *should* happen.

Patrick McCray speaking at the World Economic Forum in Davos, Jan 2016

- Innovation is *not* always beneficial:
  - It destroys jobs: automation displaced tens of thousands of workers from the 1920s-1950s
  - Technology occurs at the cost of heavy environmental impacts: ~30 nuclear power plants are needed to keep up with the world's uploading and tweeting.
  - There is a lack of prominent tech individuals who deeply question technology.
- What is needed: a more rigorous academic discourse on the history and social implications of technological advancements.

McCray, Patrick. 2016. A Brief History of Industrial Revolutions. World Economic Forum. Davos, Switzerland. Available at: https://www.youtube.com/watch?v=jl06RtB-_q4&feature=youtu.beA.
McCray, Patrick. 2014. The Technologists' Siren Song. *The Chronicle of Higher Education*, March 10. Available at: http://chronicle.com/article/The-Technologists-Siren-Song/145107/.

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SES 0938099

China's Science, Technology, Engineering, and Mathematics (STEM) Research Environment

Chinese Faculty Survey

- 18,821 STEM faculty researchers from China's top 25 institutions of higher education (Figure 1) were contacted to participate in our study.

Figure 1. University logos and locations of the top 25 institutions used in this study.

Results

- Of the 731 completed responses, 16.7% of respondents hold their terminal degree from abroad, while 83.3% received domestic degrees from China.
- The US was the number one destination country, accounting for 37.7% of respondents.
- Of those who studied abroad, *higher quality of research (77.7%)* and *higher quality of education (68.6%)* were the primary reasons why individuals decided to study abroad.
- *More job opportunities for one's self* (46.3%) and *family* (44.6%) were the primary reasons why individuals chose to return to China.
- Higher percentages of homegrown scholars believed that foreign degrees provided *better recognition from colleagues* (X^2_1=3.9, P=0.047), *better job opportunities* (X^2_1=4.8, P=0.03), *better professional networks* (X^2_1=9.5, P<0.01), and *better pay* (X^2_1=16.2, P<0.001) than those who received degrees from abroad.
- Respondents are satisfied with their current positions and the overall research culture in their respective fields (Figure 2). However, they are largely unsatisfied with the overall research culture in China.
- A large percentage of individuals (40.3%) believe the government should have less involvement in China's research environment than it does currently.

Figure 2. Percent of respondents who were very unsatisfied, unsatisfied, neither satisfied nor unsatisfied, satisfied, or very satisfied with their current position (N=723), the research culture in their department (N=718), the overall research culture in their field (N=717), and the overall research culture in China (N=721).

Han, X. and Appelbaum, R. 2016. China's STEM Research Environment. American Association for the Advancement of Science (AAAS) annual meeting. Washington, D.C.

CNS-UCSB
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SES 0938099

Inventory of Nanotechnology Companies in Mexico

This study provides the first dataset that permits an estimate of Mexico's total investment in nanotechnology.

Methodology

1. developing a comprehensive inventory
2. allocating each company to an economic sector
3. Locating each company's products in a nanotech value chain
4. determining whether products were destined to be intermediates in industrial production or final consumer goods.

Figure 1: Geographic distribution of nanotechnology companies in Mexico

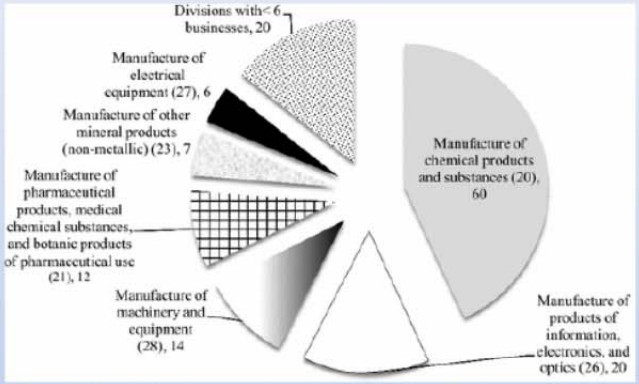

Figure 2: Nanotechnology manufacturing companies in Mexico according to United Nations International Standard Industrial Classification of All Economic Activities

Key Findings

- 139 nanotechnology companies were identified
- 40% of nanotech-related products corresponded to the manufacturing of chemical products and substances
- 14% were for the manufacturing of electronic, optic, and information products
- Approximately half of the nanotechnology products on the market are final products and half are primary nano-materials, intermediary materials and instruments
- Almost 80% of the products ended up as consumer goods

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). doi: 10.1007/s11051-016-3344-y

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SES 0938099

Using decision pathway surveys to inform climate engineering policy choices

Over coming decades citizens living in North American and European countries will be asked about a variety of new technological and behavioral initiatives intended to mitigate the worst impacts of climate change. A common approach to understanding public responses has been to conduct surveys; however, concerns that conventional survey methods are not up to the task prevail. Decision pathway surveys, we argue, can help better inform both respondents and policy makers by capturing many of the benefits of small-group deliberative conversations while meeting the needs of both publics and governments for large-sample stakeholder engagement

Methods (*n*=800)

- 6-step decision-making approach based on PrOACT framework
- Pathway structure groups into 4 main types of questions: value positions, geoengineering design, policy tradeoffs, and tutorials

Results

- Of three CO2 removal technologies, over 80% of participants favored planting new forests or adding biotic infrastructure (algae/plankton) to sequester carbon. The third option was storing carbon in industrial machines.
- Of four sunlight reflection technologies, respondents favored technologies that increase reflectivity of buildings or road surfaces followed by using large mirrors to reflect light and heat away from the earth. The other two options were brightening clouds and injecting reflective particles into the atmosphere.
- Those most concerned about climate change generally favor implementing climate engineering policies and investment in renewable resources (55-65%). This support is offered even though these participants regard the risks of climate engineering as more likely than its benefits.

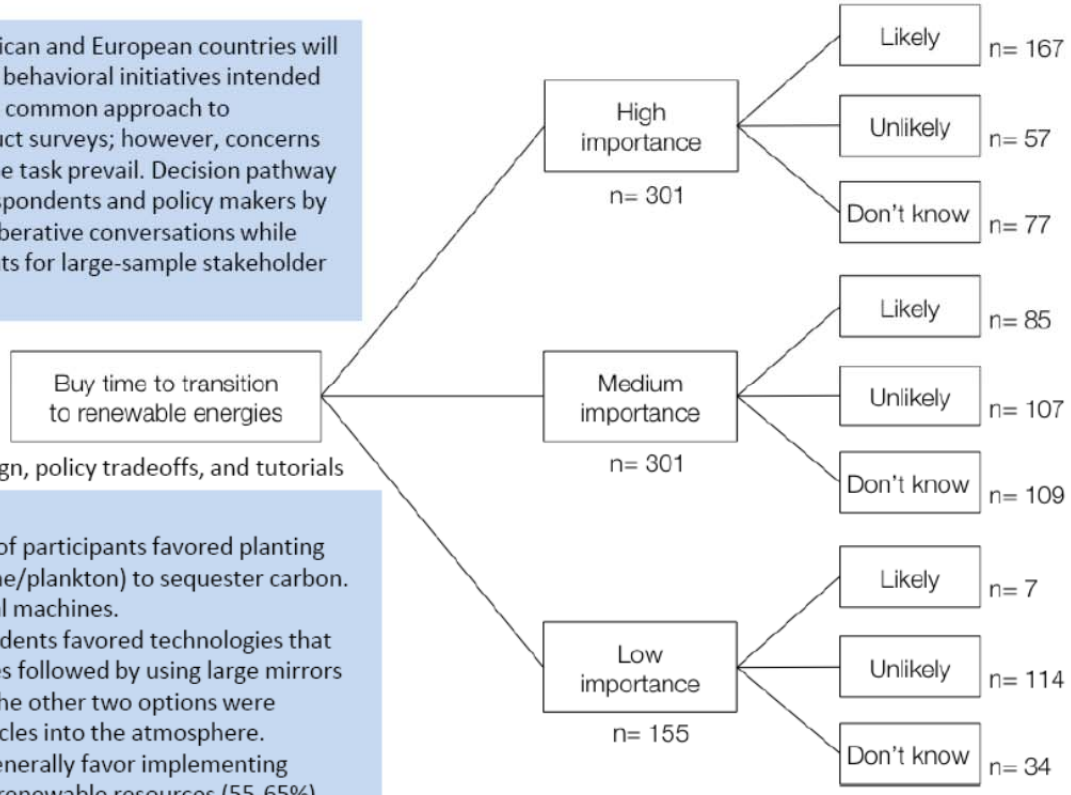

Figure: One branch of decision pathway survey

Gregory, R., Satterfield, T., & Hasell, A. (2016). Using decision pathway surveys to inform climate engineering policy choices. *Proceedings of the National Academy of Science, 2016 113 (3) 560-565; doi:10.1073/pnas.1508896113*

CNS-UCSB
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SES 0938099

Review of public perceptions of hydraulic fracturing for shale gas and oil in the United States and Canada

CNS-UCSB's expertise in risk perception research on emerging energy technologies has led to this new study of risk perceptions regarding new technologies for Oil and Gas extraction in the US and Canada. These countries are at the forefront of shale oil and gas development using new hydraulic fracturing techniques. In this study we systematically reviewed 58 articles on public perceptions of these developments, published between 2009 and 2015. We found:

- mixed levels of familiarity with shale operations, with higher awareness in areas with existing development
- negative associations with the term 'fracking', and mixed views on whether benefits outweigh risks or vice versa
- perceived benefits primarily economic (e.g., job creation)
- perceived risks environmental and/or social (e.g., water contamination)
- distrust of government and industry--perceived unfairness, heavy-handed corporate tactics, and a lack of transparency

WIREs CLIMATE CHANGE

Our results are now under review with the journal ***WIREs Climate Change***.

This work contributes to The European Union's Horizon 2020 Research and Innovation Programme, ***M4ShaleGas: Measuring, monitoring, mitigating and managing the environmental impact of shale gas***.

Collaborating authors are based at:

- Center for Nanotechnology in Society, University of California Santa Barbara (USA)
- Understanding Risk Group and Tyndall Centre for Climate Change Research, Cardiff University (UK)
- Warwick Business School. University of Warwick (UK)

M4ShaleGas
Measuring, Monitoring, Mitigating, Managing the Environmental Impact of Shale Gas

Thomas, M., N. Pidgeon, D. Evensen, T. Partridge, A. Hasell, C. Enders, B. Harthorn & M. Bradshaw (under review) "Public perceptions of hydraulic fracturing for shale gas and oil in the United States and Canada." *WIREs Climate Change*.

Thomas, M., N. Pidgeon, D. Evensen, T. Partridge, A. Hasell, C. Enders & B. Harthorn (2015) "Public perceptions of shale gas operations in the USA and Canada: a review of evidence." Report for *M4ShaleGas Consortium*. Available at: http://m4shalegas.eu/reportsp4.html

CNS-UCSB
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SES 0938099

What's at Risk?
Public discussion of fracking risks in Twitter in the US & UK

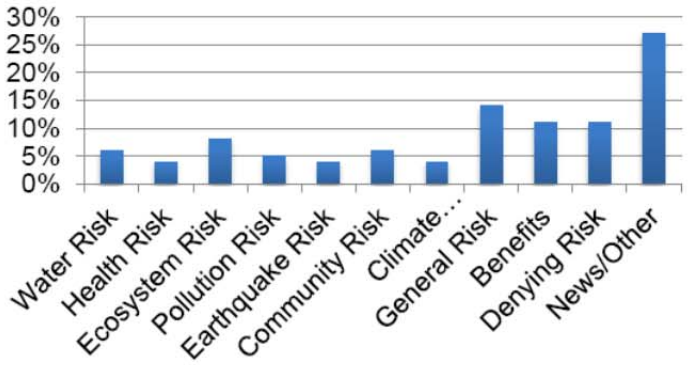
Methodology

Using Crimson Hexagon's ForSight, an online software platform with access to the complete universe of publicly shared messages on Twitter, developed at Harvard University's Institute for Quantitative Social Science, we searched for Tweets about fracking from July 2010 to March 2016. The software was trained to sort individual tweets into different categories of type of risk people were concerned about.

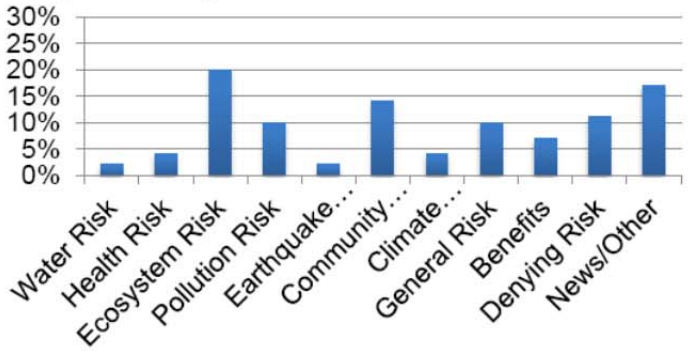
Results

- Results in 11.6 million public tweets total in English, of these 6.3 million are identifiable as from the US, and 1.8 million from the UK
- Less than 4% of the conversation was related to climate change
- In the US, about half of the discussion of fracking is related to risk but the majority is general risk, and does not identify specific concerns
- In the UK, risk makes up about two-thirds of the discussion, with the majority of the discussion about risks to communities and ecosystems.
- Overall, discussion of risk has significantly increased over time, while denial of risk has decreased

Total percentages of risk discussion in the US



Total percentages of risk discussion in the US



Hasell, A; Hodges, H. Fracking in US and UK: A comparison of public framing of fracking in Twitter in the US and UK. Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.

CNS-UCSB
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SES 0938099

Evaluating The Science & Engineering Fellowship Program

Over the past 10 years, CNS-UCSB has embedded science and engineering doctoral students into social science research projects. In Year 11, we have undertaken a formal evaluation of the program including interviews. N=10

"[The] communication skillset that you develop having to take technical science and then digest it and then communicate it in a context that's understandable by a general audience was a skill I got to refine a lot at CNS. ... So that I do think played a role indirectly in finding myself in this kind of position."

--former Fellow now in private industry

Being an environmental scientist, most of my work...avoided any thinking of human exposure. It was more about buildup in the environment, potential exposure to organisms. Working with CNS, I probably added in more on potential human health impacts, effects on economy, some of the dollar values that I heard a lot in CNS—you know, how nano is becoming this X-dollar industry.

--former Fellow who works in a government lab

Former Social Science Fellow Karl Bryant (left) with former Science & Engineering Fellow Joe Summers

What I learned from social scientists ...is this idea that perceptions can have power, and the reason they can have power is because they can be so very deeply embedded that it's difficult to educate people against [them] especially if it goes against their own value system , and that if you do want to educate them on the facts, you have to know what their perception is ."

--former Fellow who is a professor at a research university

Fastman, Brandon, Metzger, Miriam, & Harthorn, Barbara Herr. (Forthcoming). Forging new connections between nanoscience and society in the UCSB Center for Nanotechnology in Society Science & Engineering Fellows Program. In Kurt Winkelmann & Bharat Bhushan, eds., *Global Perspectives of Nanoscience and Engineering Education*. Springer.

CNS-UCSB
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SES 0938099

The Global Dissemination of Nanotechnology Knowledge

In an effort to illustrate the diverse contributions of CNS-UCSB to the broader U.S. National Nanotechnology Initiative (NNI), 3 dimensions of impact are addressed.

Research Outputs

- Outputs include ~500 publications including books, reports, datasets, and surveys-- all of which focus on diverse topics including
  - Science and Technology (19.8%)
  - Environmental Science & Ecology (11.6%)
  - Materials Science (11.6%)
  - Business & Economics (9.1%)

Mission Related Impact

- CNS has made diverse and notable contributions to NNI i.e. talks to non-academic audiences, workforce training
- To ensure public participation in nanotechnology after operations, CNS has provided educational opportunities
  - Graduate Fellows Program
  - Average of 3-5 postdocs/ year
  - 8 week intensive summer undergraduate internship program
  - Online course materials for the UC CEIN network and NSF NACK center at Penn State

Center-Related Impact

- Publication co-authorships demonstrated formal interdisciplinary collaboration between CNS researchers and involved over 140 external collaborators
- In a sample of 121 publications produced by CNS members, more than 1,100 citations were linked to the publications. The citations originated in many countries--including Germany, Netherlands, Australia, Italy, and China.

Kay, Luciano. Center for Nanotechnology in Society, University of California Santa Barbara CNS-UCSB. Preliminary findings of an impact study. Society for the Study of Nanoscience and Emerging Technologies (S.NET), Montreal, Québec, Canada, October 18-21, 2015.

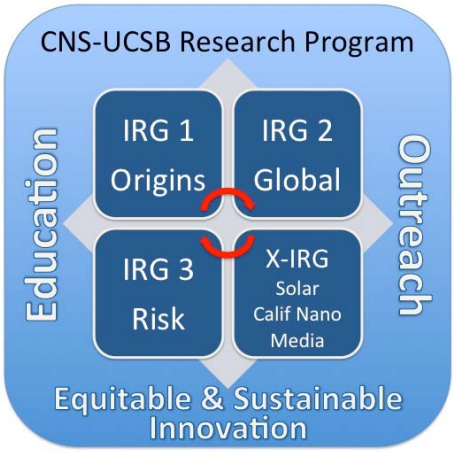
8. STRATEGIC RESEARCH PLAN

The Center's research program is 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* seeks to develop a rich understanding of the historical underpinnings of the current landscape of the nano-enterprise; **IRG 2** – *Globalization and Nanotechnology* examines nanotechnology development under differing governmental approaches in China, Japan, and Korea, the United States, and now robustly 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*--focuses 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** address 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** bring two new sets of societal researchers into dialogue with CNS as the Center's maturing research portfolio expands to include comparative analysis of other emerging technologies for energy, water, food, and health development.

Together this integrated research program provides a comprehensive understanding of current processes and societal interactions for economically successful and socially responsible development, commercialization, and global distribution of nanotechnologies. CNS-UCSB uses 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 emerging and 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.

CNS-UCSB views our linked set of foci on the scientific invention and economic development aspects of new nanotechnologies (IRGs 1 & 2), the meanings for risks and benefits that accrue on the societal side through media, expert & public processes (IRG 3, X-IRG), and the historical grounding of these in social, institutional, and policy contexts (IRG 1) as a highly productive, intersectional yet distinct mode of organizing a center's collaborative interdisciplinary research and education. The 3 IRGs that form the core of our research are connected by numerous

threads of common interests and some shared personnel, as well as the processes for integration that CNS-UCSB, as a centralized, single campus center, provides and continues to refine and develop. IRG 1 & 2 combine expertise in examining industrial policies and their effects on nano development in East Asia; IRG 2 & 3 work together on the nanotech workforce, agricultural nano in the developing world, and global NGO actions; and IRG 1 & 3 share interests in nano EH&S policy, public imaginaries of technological futures, and NGO activities. IRG 1, for example, has studied the policy history of both energy and EH&S issues with regard to nanotech. IRG 2 is engaged in the comparative study of national policies aimed at promoting nanotechnology research, development and commercialization in the previously mentioned countries. It is also centrally concerned with workplace health and safety issues, an area it has pursued in connection with IRG 2 leader Appelbaum's MacArthur Chair, which is focused on labor conditions. IRG 3's research has moved further into experimental design modes to conduct multifactorial analysis of the drivers of emerging technological risk perceptions, looking specifically at the construction of (and reversals of) judgments of benefits *and* risks, counterintuitive findings, and behavioral patterns that are of particular import to policy makers, as well as new research methods such as pathway survey. New deliberative work by Harthorn's group in collaboration with Pidgeon in the UK extends the group's consideration of social location as a factor in risk perception and interactions in small group deliberative settings by looking comparatively at new policy-relevant energy applications. The MacArthur Chair awarded in 2010 to IRG 2 leader Appelbaum enhances CNS focus for 5 years on jobs, job creation, and workplace safety issues that are also a focus of IRG 3 research. Funding to Harthorn, Satterfield & Kandlikar from the UC Center for Environmental Implications of Nanotechnology, 2008-2014, and to Harthorn 2013-2018, has produced an award-winning portfolio of work on industry, scientist, regulatory, and public views of environmental risks of nano. Altogether, CNS-UCSB's work encompasses issues of globalization, innovation, and risk, with central themes of inequality, vulnerability, product stigma, environment, and the production of policy-relevant results. Our research teams use a variety of comparative case analyses across specific nations and regions (US, EU, E and S Asia, Latin America), across applications for energy, environment, health, food, and water, and varying institutional practices (e.g., IP regimes) to highlight US nanotech R&D and public views, and situate them in their comparative global context.



CNS-UCSB's extensive collaborations with the UCSB Materials Research Laboratory (MRSEC), the College of Engineering and the Institute for Energy Efficiency, the California NanoSystems Institute, the Bren School of Environmental Science and Management, NSE participation on our National Advisory Board and Executive Committee, our unique interdisciplinary graduate fellows

program that co-educates NSE and social science grads, and the funded collaboration of the CNS-UCSB with the UC CEIN and its large global network of nanoscientists and ecotoxicologists provide us with a strong and resilient web of connections to the NSE, nanotoxicology and materials research communities. These ties have been further developed and strengthened through joint activities such as collaborative summer internship programs; public, community and campus events and programming; community college and on-line course development; and, most vital, joint program and funding development. These connections, and the highly interdisciplinary exchanges that result from them are a quintessential part of the CNS-UCSB research and education missions. Science and society work of the sort that is expected of the CNS-UCSB requires the development of mutual regard and understanding across very wide disciplinary divides, a process we as social scientists and humanists know needs to grow and develop organically to produce lasting institutional change. UCSB provides a particularly opportune context for this experiment with its AAU rank, renowned interdisciplinarity, its strategic position on the Pacific Rim, its achieved Hispanic Serving Institution status (2015), and its rising Carnegie ranking in the Research University/Very High research activity scale.

The integration, aggregation and synthesis of research results in the CNS-UCSB take a number of forms. Years 1-10.5 have culminated with the production of numerous publications, reports, and other materials contributing to cutting edge theoretical and substantive issues in disciplinary research, alongside the interdisciplinary space constructed by a highly multi-disciplinary national center such as CNS-UCSB. Center funding, with its longer horizons and IRG collaborative enterprise, have enabled a focused synthesis of research that is not possible at the individual project level. At the IRG level, this includes state of the art analyses based on cumulative knowledge developed over 10+ years of research. For example, IRG 2 (Appelbaum & Parker), with IRG 3, took the lead in organizing a large scale CNS-UCSB wide international conference in Nov 2009 in Washington DC focused on impediments to using nanotechnologies for water, energy, health and food to help the world's poor, and developed the results into an edited volume, *Can Emerging Technologies Make a Difference in Development?*, published by Routledge (Parker & Appelbaum 2012), intended to respond to CNS-UCSB members' deep commitment to ensuring that equity issues are addressed as a key aspect of responsible development of nanotechnologies. IRG 3 produced a special issue of the leading risk analysis journal, *Risk Analysis*, on nanotechnology risk perception (Pidgeon, Harthorn & Satterfield, Nov 2011), based on its Jan 2010 specialist meeting in Santa Barbara that convened an international group of leading scholars to assess the state of knowledge about nanotech risk perception. IRG 3 has also produced a synthesis piece on nanotechnology upstream and midstream deliberation (Corner & Pidgeon, 2012), based on what they have learned from conceptual work by Pidgeon in the UK, from two sets of deliberative workshops in 2007 and 2009 by the full team (Harthorn, Pidgeon, et al.), and from meta-analysis of the published literatures (Satterfield et al. 2009), as well as pioneering new work on another upstream environmental/energy technology, geoengineering. IRG 1 in June 2013 convened a specialist meeting in Santa Barbara in that engaged in critical reflection on emerging technologies and their societal characteristics and footprints, past and present, that is resulting in a series of publications. Appelbaum and fellow IRG 2 researchers are completing a book contract for a new volume on *Technology and Innovation in China: China's Evolving Role in the Global Science and Technology System* that will synthesize results from their numerous projects on China. CNS-UCSB also has initiated as a summative activity development of a series of *synthesis reports* from the IRGs to extend the implications of the maturing research mission for the federal government and policy makers.

In addition to the prolific production and dissemination of research results from individual IRGs and projects via peer-reviewed journals, book chapters and pieces to many different kinds of

audiences, CNS-UCSB also has produced an edited volume entitled *The Social Life of Nanotechnologies*, edited by Harthorn and sociologist Mohr, published by Routledge in July 2012. The volume brings together original work from all three IRGs and XIRG projects, probing the interactions and tensions between the modernist nanotechnology development enterprise with its focus on economic progress for the US and a postmodern social world concerned with issues of social progress and equitable development around the globe. CNS-UCSB Board Co-Chair John Seely Brown (author of *The Social Life of Information*, Harvard, 2000) authored a foreword to the book, which like his earlier volume aims to remind scientists, technologists, business and government that the social contexts of technologies demand close and careful attention and understanding. And Harthorn, Appelbaum, Engeman & Han (IRGs 2 & 3) have already prepared a detailed report (2015) and also plan to develop a collected volume out of the Democratizing Technologies conference (Nov 2014) that will integrate scholarly and NGO practitioner perspectives as an integrated product of CNS research and engagement foci (under review, Routledge).

As CNS-UCSB actively develops a robust set of empirical data, we have stepped up plans for interaction with and dissemination to diverse audiences, including from NSE researchers and students, policy makers, nanotech industries, and the diverse publics we study in our research. In the changing media environment, it is a challenge to create a thoughtful and effective approach to reaching key government, industry, labor, environmental, social group, and public audiences with the implications of our research. CNS-UCSB research has had much to offer such audiences. For example, IRG 2's comparative work suggests US government investment in private sector early stage development may be necessary to effectively launch nano-enabled commercial developments in the current economy. IRG 3's survey research provides experimental evidence that it may be harmful to public acceptance to focus exclusively on the benefits of new nanotechnologies, something many in both science and industry assume to be the preferred approach. Meanwhile IRG-1's work shows a trajectory of nanotechnology over a timespan that encompasses the Cold War, post Cold War and immediate post-9/11 era. And CNS-UCSB equitable development work provides a strong basis for promoting open source development strategies for humanitarian technological development. All CNS-UCSB IRGs use center resources to develop and consolidate policy relevant results that the Center's outreach infrastructure in turn will enable us to disseminate effectively to the audiences that can benefit from them.

As the CNS at UCSB approaches the conclusion of NSF funding, we have undertaken focused discussion and planning for the best methods to capture, disseminate, and pass on to future such initiatives the full range of data, knowledge, and learned experience from our societal research program. At CNS-UCSB we have taken steps to consolidate what we have learned, for example in a focused reflexive study in progress of our S&E Fellows program, in a planned series of synthesis reports, and in an organized set of legacy preservation activities for stable data storage and data sharing practices.

9. RESEARCH PROGRAM, ACCOMPLISHMENTS, AND PLANS

IRG-1: Origins, Institutions, and Communities

Faculty and Senior Participants

W. Patrick McCray	History	UC Santa Barbara
Cyrus Mody	History	Rice University/Maastricht Univ
Joseph November	History	Univ. of South Carolina
Amy Slaton	History	Drexel University

Graduate Students (1), Undergraduate Students (0)

Graduate Students:

Brian Tyrrell	Research Fellow	UC Santa Barbara

1. Introduction

The goal of the Origins, Institutions, and Communities group (IRG-1) is to continue to establish 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. 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.

2. Goals

Since it started in 2006, IRG-1 has emerged as the largest and most active 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 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.

3. Rationale, Approach, and Organization of IRG 1

IRG 1, due to the high geographic dispersal of its members, functions in a semi-autonomous manner. During its last year of activity, 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 shared information/research resources and met as a group at least once a year, typically in conjunction with one of the annual professional society meetings. 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.

4. Major IRG 1 Research Accomplishments

As has been the case the past several years, we have maintained our focus on three interrelated themes: origins, institutions, and communities. We see 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 context such as international security threats and industrial competition.

In terms of visibility, a highlight of the past year was the attendance of IRG-1 leader McCray at the 2016 World Economic Forum meeting in Davos. McCray was invited to give three talks, including a keynote address, around themes of innovation and industrial revolution. In preparing these talks, McCray drew upon materials and knowledge gained via his last decade's worth of work on emerging technologies made possible by CNS funding.

At the same time, as the CNS is winding down, some projects have moved into hibernation. These include Hyungsub Choi's work on nanotechnology and the Pacific Rim and David Brock's work on technoscientific emergence. This move was also made, in part, because both Brock and Choi took new positions in 2015-16 and much of their time was occupied with this. Consequently, some projects noted in previous annual reports do not, for the sake of simplicity, appear here as they were not sufficiently active in the past year to warrant inclusion.

IRG-1 Project #1: The Long Arm of Moore's Law; Cyrus Mody

Cyrus Mody completed revisions on a new book manuscript. *The Long Arm of Moore's Law* looks at the development of the American microelectronics industry since the late 1960s. Focusing on several case studies, it shows how the American research enterprise changed from the 1960s to the present, with a strong focus on the 1970s and 1980s. In the process, it documents the emergence of a new way of organizing American science. These include:

- Globalization and the increasing competition in semiconductor manufacturing which encouraged new ways of doing things, new forms of partnerships and collaborations.
- Growing influence of life sciences encouraged microelectronics people to seek out more interdisciplinary collaborations;
- The perceived "market failures" which steered policy makers to redirect resources to centers and then networks.

This narrative traces the influence of microelectronics research and industry on the formulation of nanotechnology research and research centers. It is under contract with MIT press and slated to appear in 2017. Members of IRG-1 met in March 2016 to discuss Mody's draft with him as part of his revision process.

IRG-1 Project #2: Innovation and Research at the Nanotechnology-Biology Interface; Joseph November

Joseph November continued his work on computers and nanotechnology—"Innovation Research at the Bio-Nano Interface." This project, which aims to elucidate the roots of federal agencies' recent efforts to foster innovation and research at the bio-nano interface, will compare early 1960s efforts to rationalize biomedicine via digital computer techniques and 21st century attempts to harness nanotechnology in life science research. Included in this aim, the project will investigate two attempts by the NIH to implement "bioengineering," one launched around 1960 and centered on the then-emerging technology of digital computing, the other launched around 2000 and grounded in today's emerging nanotechnology. Despite such different means, both varieties of bioengineering cast living systems as artifacts and cast those working with such systems as manageable engineers rather than scientists dependent on serendipitous breakthroughs. By historicizing the relations between technology development and the study of life, this case study aims to clarify the roles individuals and institutions in process that has made nanotechnology and biomedicine increasingly important to each other. November is preparing an article based on his CNS research called "Engineering a Better Medicine." Further work on this will continue after the CNS has phased out.

IRG-1 Project #3: Divided Labor and Stratified Opportunity in American Nano-manufacturing: The Paradox of the Middle Skilled; Amy E. Slaton

In this reporting period, Slaton continued her work on the nano-workforce – "Divided Labor and Stratified Opportunity in American Nanomanufacturing: The Paradox of the Middle Skilled." Slaton gave a talk at CNS in 2013; this research is an extension of that. Her research asks how do explicit limitations on the technician's career attainment possibly co-exist with customary American pre-requisites for technical proficiency such as ingenuity and ambition. At the 2015 ASEE she observed approximately 25 presentations offered by educators, policy makers and commercial producers of nano-related educational materials and by representatives of "advanced manufacturing" industry groups.

She observed demonstrations of nanotech- and MEMS-focused educational instruments and software; keynote speeches by government and university figures; and promotional efforts on the part of non-profit and for-profit actors involved with high-tech post-baccalaureate education. Slaton also attended sessions on racial, gender, LGBTQ and First-Generation/Low SES inclusion. Touring classrooms, cleanrooms and laboratory facilities at SCME/UNM, and attending a micro-electronics instructional workshop held there for post-secondary instructors, she detected conflicting approaches and goals on the part of community-college nano/MEMS instructors. Some formulated narrowed student skills and expectations through outcome-focused pedagogy, closely mirroring industry workforce projections but not necessarily on-the-ground conditions found in advanced manufacturing work settings. Others embraced a less constrained notion of student/worker empowerment, providing what were seen to be transferrable skills (trouble-shooting, forensic analysis, etc), in sync with the instructors' direct observation of advanced manufacturing operations.

Framed more broadly, this research centers on the study of sub-baccalaureate nanotechnology education in the United States. As part of a larger study of community college and university programming for "nanotechnician" workforce preparation, it considers curricula, educational materials (including instruments, textbooks, lab kits, etc.), and pedagogical exchanges among instructors, publishers, and other stakeholders. It aims to explain economic and labor stratification in the U.S. as those conditions are reflected in two-year high-tech educational programs.

Of particular importance are exceptional cases in which instructors, local employers, and students have transgressed the strict segmentation of nanomanufacturing labor. In a very few instances, shop-floor workers have been acknowledged to possess dynamic bodies of skill and knowledge. Here, the technicians' experiences of fabrication directly inform the work of product designers and process engineers. The technicians' assigned responsibilities, and in one case even their job descriptions and wages, have expanded as a result. How does such mutability come about and why so rarely? Do these exceptions prove the rule or suggest a way forward to more equitable industrial employment conditions in high-tech manufacturing?

She is currently completing a proposal for a book based on this and all of her previous CNS-supported research, entitled: *All Good People: Diversity, Difference and Opportunity in High-Tech America.*

IRG-1 Project #4: DNA Nanotechnology and Nanotechnologists**;** Patrick McCray, Brian Tyrrell,

This research project examines the historical formation of an international interdisciplinary research community around using DNA molecules as the raw material for constructing active

and passive nano-scale structures. One of the strands of the project interrogates the transformation in thinking that allowed DNA nanotechnologists to consider the structural properties of DNA separate from its genetic information. A second focus of this project is funding. Historians have argued that biology surpassed physics as the prestige discipline in American science in the post-Cold-War period. This project examines how DNA nanotechnology emerged as physicists, chemists, and computer scientists responded to the realities of federal on funding in the sciences.

Tyrrell, mentored by McCray, is proceeding ahead with their work on the recent history of DNA nanotechnology. Starting in the late 1970s, an interdisciplinary group of chemists, crystallographers, molecular biologists and computer scientists began to reconceptualize DNA. Rather than seeing it solely as an information-containing molecule, they started to envision it as a building material. After first making relatively simple two-dimensional geometric shapes, DNA nanotechnologies now fabricate three dimensional objects capable of performing elementary mechanical functions and computations. In the process of transforming DNA from "blueprints to bricks," a new hybridized research also emerged. This project aims to chart the establishment of this materials-based research community. By "community," we mean a transdisciplinary group of people that has coalesced around a shared set of research goals, lab practices, student pedagogy, instrumental techniques, conferences, and materials. Created largely in an *ad hoc* manner, the DNA nanotechnology community was united in the shared sense that one could *do* useful engineering things with the iconic biomolecule. This project will not only provide an understanding of this community's dynamic expansion over the last four decades but that it will also contribute to an expanded sense of DNA as a material. Tyrrell has been preparing an article for submission on the historical formation of the DNA nanotechnology community. Tyrrell began work on a second article on DNA synthesizers, machines that created customized DNA strands. In March 2016, members of IRG-1 met with Tyrrell to discuss progress on his research and offer suggestions as to future directions.

5. Broader Impacts and Implications of IRG 1 Research: All of the IRG 1 members who teach graduate or undergraduate courses incorporate their CNS-based research in various ways. McCray, November, and Slaton all offered instruction in the past year on the history/sociology of technology which include some nano-themed topics. Both McCray and Slaton taught at both the undergraduate and graduate level during the reporting period. McCray began work as Lindbergh Chair at the National Air & Space Museum. Mody made presentations at the Washington, D.C. Center for Equitable Growth workshop and the MIT-Wharton NSF Conference in Philadelphia. Mody also made a presentation at the Kauffman Foundation in Kansas City during an event hosted by IRG-2 member Yas Motoyama. Slaton co-led a NIST-funded summer workshop on the history of standards in society July 12-22 at Drexel University. CNS-related research featured in workshops intended for graduate students. Graduate fellow Tyrrell attended the workshop. To fund the workshop, Slaton won a National Institute of Standards and Technology (NIST) Standards Services Curricula Development Cooperative Agreement Grant. Media outlets including Inside Higher Ed, the *Wall Street Journal*, and KYW News Radio interviewed Slaton on STEM education and related issues. November presented his research to a history workshop organized by the NHGRI (NIH) on the subject of the history of the Human Genome Project. One goal of the conference was to examine the historical connections between genomics and areas such as nanotechnology. The proceedings of that conference will be published in *Journal for the History of Biology* in 2017.

IRG 1 Publications 2014-2015

Primary Publications: Journals

Primary Publications: Books, Chapters, Reports and other Publications

Leveraged Publications: Journals

1. Howe, Cymene, Lockrem, Jessica, Appel, Hannah, Hackett, Edward, Boyer, Dominic, Hall, Randal, Schneider-Mayerson, Matthew, Pope, Albert, Gupta, Akhil, Rodwell, Elizabeth, Ballestero, Andrea, Durbin, Trevor, el-Dahdah, Fares, Long, Elizabeth, & Mody, Cyrus. (2015). Paradoxical Infrastructures: Ruins, Retrofit, and Risk. *Science, Technology & Human Values*, 41(3), 547-565. doi: 10.1177/0162243915620017
2. Kelly, K. F., & Mody, C. C. M. (2015). The booms and busts of molecular electronics. *Spectrum, IEEE,* 52(10), 52-60. doi: 10.1109/MSPEC.2015.7274196
3. McCray, Patrick. (forthcoming). Gravity and Geese. *Leonardo.*
4. McCray, Patrick. (2014). How Astronomers Digitized The Sky. *Technology and Culture*, 55(4), 908-944. doi: 10.1353/tech.2014.0102
5. Mody, Cyrus. (forthcoming). Discussion Forum on Scientific Practice. *Science Education*.
6. Mody, Cyrus C. M. (2015). Scientific Practice and Science Education. *Science Education*, 99(6), 1026-1032. doi: 10.1002/sce.21190
7. Tyrrell, Brian. 2015. Book Review: Carrie Friese, *Cloning Wild Life: Zoos, Captivity, and the Future of Endangered Animals*, in *Make Literary Magazine* (http://makemag.com/review-cloning-wild-life/)
8. Tyrrell, Brian. (2015). Bred for the Race: Thoroughbred Breeding and Racial Science, 1900-1940. *Historical Studies in the Natural Sciences* 45(4),549-576.

Leveraged Publications: Books, Chapters, Reports and other Publications

9. Kaiser, David, & McCray, Patrick (Eds.). (forthcoming, 2016). *Groovy Science: Knowledge, Innovation, and American Counterculture*. Chicago: University of Chicago Press.
10. McCray, Patrick. (forthcoming). Gravity and Geese. *Leonardo.*
11. Mody, Cyrus. (2016). *Responsible Innovation: The 1970s, Today, and the Implications for Equitable Growth.* Report for the Washington Center for Equitable Growth. Washington, DC. Available for download at: http://equitablegrowth.org/report/responsible-innovation/
12. Mody, Cyrus. (2015). What Kind of Thing Is Moore's Law? *IEEE Spectrum* (online forum). Available at: http://spectrum.ieee.org/semiconductors/devices/what-kind-of-thing-is-moores-law
13. Mody, Cyrus. (2016). Professional Science. In Bernard Lightman (Ed.), *Blackwell Companion to the History of Science,* 164-178. Malden, MA: Blackwell.

14. Mody, Cyrus. (forthcoming). *The Long Arm of Moore's Law: Microelectronics and American Science.* Cambridge, MA: MIT Press.
15. Mody, Cyrus. (forthcoming). An Electro-Historical Focus with Real Interdisciplinary Appeal: Interdisciplinarity at Vietnam-Era Stanford. In Scott Frickel, Barbara Prainsack & Mathieu Albert (Eds.), *Investigating Interdisciplinary Research: Theory and Practice across Disciplines.* New Brunswick: Rutgers University Press.
16. Slaton, Amy, Riley, Donna, & Cech, Erin. (forthcoming). Grit: Yearning, Personhood, and the Ontologies of American Engineering Education. In Steve Fifield & Will Letts (Eds.), *STEM of Desire*. Dordrecht, NL: Sense Publishers.

Submitted or in preparation publications: primary

17. McCray, Patrick. (in preparation). *Re-Wiring Art*. Cambridge, MA: MIT Press.
18. Tyrrell, Brian. (in preparation). From *Theoretical Biology* to 'Where's the Biology?': A History of DNA Nanotechnology" *Journal of the History of Biology.*

Submitted or in preparation publications: leverage

19. McCray, Patrick. (in preparation). Work, Skill and Technology. In Daniel Walkowitz (Ed.), *A Cultural History of Work in the Modern Age* (Vol. 6). London: Bloomsbury Press.
20. Mody, Cyrus. (under review). Burnt By the Sun: Jack Kilby, TI, and the '70s Solar Boom.
21. Shah, Sonali K. and Mody, Cyrus C. M. (under review). Making Sparks Fly: Understanding How Users Organize to Innovate. *Organization Science.*
22. Slaton, Amy; Ebeling, Mary F. (Under Review). Promise Her Anything: Education for Work in the U.S. 'Nanoeconomy'. *International Journal of Engineering.*

IRG 1 Research Presentations 2015-2016

1. November, Joseph. Ahead of Sequence: The Biomathematics Research Center and the Question of Early Sequencing at NIH. Capturing the History of Genomics workshop at NHGRI, Bethesda, MD, April 29, 2015.
2. November, Joseph. Gaming for the Cure: Home Computer Users and Video Gamers in Medical Research. American Association for the History of Medicine, New Haven, CT, May 1, 2015.
3. November, Joseph. History of Distributed Computing. American Association for the History of Medicine, New Haven, CT, May 2015.
4. November, Joseph and George Forsythe. The ACM, and Creating a 'Science of the Artificial'. Society for the History of Technology (SHOT), Albuquerque, NM, October 9, 2015.
5. Slaton, Amy. The Impossible Necessity of Diversity. Society for the History of Technology, Albuquerque, NM, October 10, 2015.
6. Slaton, Amy. Nano-Eyes, Nano-Hands, and the Stratification of Nano-Labor. 9th Laboratory History Meeting, Albuquerque, NM, October 11, 2015.

7. November, Joseph. The Medical Record and the 50-Year Challenge to Computing. SIGCIS History of Computing Workshop, Albuquerque, NM, October 11, 2015.
8. Mody, Cyrus. Science as Occupation and Avocation: Deflating Science without Disenchanting It. IZWT 10th Anniversary workshop, Wuppertal, Germany, November 5, 2015.
9. Slaton, Amy. Selves Measured, Measuring Nature. History of Science Society, San Francisco, CA, November 20, 2015.
10. Slaton, Amy. Diversity in the Meritocracy: Thinking about Talent and Identity in High-Tech America. Department of History, Department of History, Texas A & M University, December 2, 2015.
11. Mody, Cyrus. The Countercultural Politics of Interdisciplinarity: Stanford circa 1970. Descartes Center colloquium, Utrecht, NL, January 19, 2016.

IRG 1 Outreach Activities 2015-2016

12. Mody, Cyrus. Mel Chin and the Sciences of the '70s. Contemporary Art Museum, Houston, March 19, 2015.
13. Tyrrell, Brian. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.
14. November, Joseph. History of Distributed Computing. American Association for the History of Medicine, New Haven, CT, May 2015.
15. McCray, Patrick. Presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.
16. Mody, Cyrus. Historical Approaches to User Innovation MIT-Wharton NSF Conference, Philadelphia, PA, July 28, 2015.
17. Mody, Cyrus. The Pre-History of Responsible Innovation. Washington Center for Equitable Growth, Washington, DC, August 7, 2015.
18. McCray, Patrick. Guest speaker, Museum Plays Art and Technology Matchmaker, Science Friday on NPR, August 21, 2015.
19. McCray, Patrick. A Brief History of Industrial Revolutions. Invited talk, World Economic Forum, Davos, Switzerland, January 20, 2016.
20. McCray, Patrick. Discussion leader, 'Ideas Making History.' World Economic Forum, Davos, Switzerland, January 20, 2016.
21. McCray, Patrick. Sci-Fi Dreams. World Economic Forum, Davos, Switzerland, January 21, 2016.
22. Tyrrell, Brian. NanoDays volunteer. Santa Barbara Museum of Natural History. April 2-3, 2016.

IRG 2: Globalization and Nanotechnology
March 15, 2015 - March 15, 2016

Faculty and Senior Participants

R. Appelbaum, Leader	Sociology, Global & Int'l Studies	UC Santa Barbara
C. Cao	Contemporary Chinese Studies	Univ. of Nottingham
G. Foladori	Sociology	Univ Autónoma de Zacatecas
A. Mehta	Global & Int'l Studies	UC Santa Barbara
R. Parker	Director of Research Programs	Canadian Institute for Advanced Research
D. Simon	Political Science	Duke Kunshan Center
E. Záyago Lau	Development Studies	Latin Amer Nanotech & Society Network (ReLans)

Affiliates

N. Invernizzi	Anthropology	Federal Univ of Parana Brazil
Tim Lenoir	Technology Studies	Duke Univ
Emily Nightingale	Science Policy	Science & Tech. Policy Inst.
P. Shapira	Public Policy	Georgia Tech & Univ of Manchester
J. Wooley	Business	Santa Clara University
J. Youtie	Enterprise Research Inst	Georgia Tech

Postdocs (3), Graduate Students (3), Undergrad Students (1), Technical staff (1)

Postdoctoral scholars:

Luciano Kay	CNS	UC Santa Barbara
Stacey Frederick [XIRG]	CNS	Duke University
Shirley Han	CNS	UC Santa Barbara

Graduate students:

*Matthew Gebbie	Materials	UC Santa Barbara
Galen Stocking	Political Science	UC Santa Barbara
*Edgar Ramón Arteaga	Economics	Universidad Autonoma de Zacatecas

Undergraduate students:

Jesus Diera	Computer engineering	UCSB

Technical staff:

* Patrick Herron	Computer science	Duke Univ.

***** Co-funded or fully funded from another source

1. Introduction

The overarching goal of IRG2 is 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 end of 2000, when the U.S. officially launched its National Nanotechnology Initiative, the NNI has invested (including its 2015 request) more than $22 billion (NNI 2016). Global public spending on nanotechnology has exceeded $70 billion. If one includes corporate research and private funding more generally, the total of public and private spending was predicted to reach as much as a quarter of a trillion dollars by 2015 (Cientifica, 2011). According to one recent estimate, global spending on nanotechnology increased 40-45% annually between 2010 and 2013; revenue from nano-enabled products is now estimated to exceed $1 trillion, a third in the United States (NNI 2014). Clearly, public officials across the world have come to see nanotechnology as the next technological revolution; firms and investors – no doubt in part attracted by the availability of public funding – have followed suit. Does this nanoscale "race to the bottom" – investing significant public resources in nanotechnology research, development, and commercialization – constitute industrial policy? How successful is it likely to be?

In his classic work, *MITI and the Japanese Miracle: the Growth of Industrial Policy*, Chalmers Johnson (1982) made the now-classic distinction between "plan-rational," "market-rational," and "plan-ideological" state approaches to industrial policy. Johnson's tripartite distinction of policy making was based on two interacting dimensions: the principal type of economic governance (market-driven v. state planning), and the principal type of decision-making (ideologically driven v. what might be today called "evidence-based"). In addition to the crudeness of the resulting binary distinctions, Johnson's framework is missing a logical fourth category: "market-ideological." As Henderson and Appelbaum (1992: 19) reformulated Johnson's original typology, in "*market-ideological* political economies…public policy is oriented above all toward assuring free market operations." Ha-Joon Chang subsequently emphasized the state's engagement in "institutional adaptation and innovation to achieve goals of long-term growth and structural change" (1994), while Meredith Woo-Cumings incorporated similar notions in characterizing industrial policy as "the ability of the state sector both to accommodate itself to the changing requirements for remaining competitive in the global market place and to provide support for educational infrastructure and for research and development" (1999: 27).

Sean O'Riain (2004: 29) pointed out a facilitating role played by the states of Israel, Ireland, and Taiwan, such as fostering international networks, and establishing venture capital funding and innovation centers. In the area of technology, industrial policy can take the form of what have been termed "horizontal technology policies" (HTPs) – policies that involve a class of subsidies that employ market mechanisms and self-selection to advance particular technologies (see, e.g., Hall and Rosenberg, 2010; Teubal, 1997; Breznitz (2007). In an effort to narrow the concept and adapt it to current conditions, economist Dani Rodrik (2004: 38) proposes that a "twenty-first century industrial policy" would involve "strategic collaboration between the private sector and government with the aim of uncovering where the most likely obstacles to restructuring lie and what types of interventions are most likely to remove them." In Rodrik's formulation, the government does not pick particular sectors; rather, it provides support for activities that seem likely to enhance economic advancement – for example, promising frontier technologies. For IRG-2 collaborator Fred Block (2008: 172), this suggests that industrial policy should involve "four distinct but overlapping tasks – targeted resourcing, opening windows, brokering, and facilitation."

By the same token, bibliometric studies have been very nearly unanimous in concluding that science has globalized in two distinct ways. First, there is significant evidence that it has become more internationally interconnected. These interconnections are evident in the growth

of international conferences, cross-border funding (Shapira and Wang, 2010), and in the share of peer-reviewed scientific publications involving authors from multiple countries. Second, research activity has become more evenly spread across countries, eroding national concentrations of scientific productivity. This diffusion of scientific activity is apparent in the growing shares of emerging scientific powers in research publications, on editorial boards of journals (Braun *et al*, 2007) and in global patent filings (Dang *et al*, 2010). In fact, the diffusion model, which connotes flows from center to periphery, may not adequately capture this process. As a result of increasing rates of international collaboration and the global flow of scientific talent, significant scientific advances may begin simultaneously in center and periphery through collaborative endeavors that transcend national borders – or may begin in what is conventionally thought of as the periphery and diffuse to the center. Nanotechnology research is of significant interest in this regard because the field is nascent, has seen major growth in the last twenty years, and, as noted above, has been accorded high priority by governments around the world.

Building on these distinctions, 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? The principal goals of IRG-2 – since the beginning of CNS, and throughout this review period – have been to answer these questions.

To accomplish these overarching goals, IRG-2 has engaged in a number of interrelated projects and activities that draw on field interviews, documentary analysis, and quantitative bibliometric studies. Our specific goals and accomplishments have included:

1. Develop a comparative framework for understanding innovation policies in different countries through an extensive review of the literature on industrial policy, reflected in presentations and publications during this period. This effort drew on the various projects listed below, but particularly projects 3, 5, and 12, which focus on Mexico, Latin America, and India, as well as former IRG2 postdoc Motoyama's research on Japan (he is currently with the Kauffman Foundation) and Choi (conducting research in Korea).
2. Expand our previous work on Chinese industrial policy, 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).
3. Continue our research on the development of nanotechnology into Mexico through collaborations with Guillermo Foladori and Edgar Zayago Lau (both are faculty at the University of Zacatecas). This relation was initiated through a two supporting grants obtained through UC-MEXUS and CONACYT (now completed). We have received a second UC-MEXUS/CONACYT grant in order to develop a framework that will be used to compare the U.S., China and Brazil.
4. Extend our comparative analysis to Latin American analysis to Latin America, focusing initially on Argentina and Brazil.
5. Continue our relationship with ReLANS (the Latin American Network for Nanotechnology and Society).
6. Gauge 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.
7. Build a nano-firm and organization database incorporating a global value-chain approach, using it to populate a "California in the Nano Economy" website, and develop comparison state databases.

8. Conduct bibliometric and patent analysis, through the work of postdoc Luciano Kay, and through collaborations with scholars at Georgia Tech.
9. Conduct a survey (in China) of leading nanotech academic researchers, to assess their perceptions of the strengths and weaknesses of China's approach to innovation.

3. Organization and approach of the IRG

The activities of IRG-2 are, as indicated above, 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 are 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. These efforts are organized into a group of interrelated collaborative projects, two of which are being conducted in close collaboration with IRG-3:

IRG 2-1: China's Developmental State: Becoming a 21st Century Nanotech Leader: Appelbaum, Parker, Cao, Stocking, Gebbie, Han, Nightingale
IRG 2-2: Comparative Study of State Nanotechnology Policy: U.S., China, Japan: Appelbaum, Block, Han, Gebbie, Stocking, Nightingale, Stacy; Foladori, Zayago, Invernizzi
IRG 2-3: Drivers of Nanotechnology Commercialization in China – Suzhou Industrial Park: Parker, Appelbaum, Cao, Han, Gebbie, Stocking, Nightingale
IRG 2-4: International Collaboration in Nanotech Research and Publication: Mehta, Lenoir, Herron, Cao, Han
IRG 2-5: UCMEXUS / CONACYT Binational Collaboration (USA-Mexico) in the Development of Nanotechnology: Foladori, Záyago Lau, Parker, Appelbaum
IRG 2-6: ReLANS, Research in Mexico, Latin America: Foladori, Záyago Lau, Appelbaum, Parker, Kay
IRG 2-7: Bibliometric and Patent Analysis/Mapping: Kay
IRG 2-8: Open Doors: foreign students studying in the U.S.: Appelbaum, Han, Stocking, Gebbie
IRG 2-9: Corporate Strategies of Latin American Nanotech Companies and Their Policy and Institutional Contexts with Focus on Argentina and Brazil: Kay, Appelbaum, Parker, Invernizzi
IRG 2-10 Survey of China Nanotechnology Scholars in Leading Chinese Universities: Appelbaum, Simon, Cao, Han, Stocking, Gebbie
IRG 2-11: Will Nanotechnology Prove to be Disruptive? Effects on the Workforce of an Emerging Technology: Appelbaum, Foladori, Zayago Lau, Parker, Invernizzi
IRG2-12: Risks to human health and the environment within nanotechnologies research in Mexico: Zayago Lau, Edgar; Foladori, Guillermo; Frederick, Stacey
IRG 2-13: Global Value Chain Analysis (X-IRG): Frederick, Appelbaum, Harthorn, Herman
IRG 2-14: Framing Nanotechnology in the Media (X-IRG): Stocking

IRG2's core efforts are located at UCSB, where Appelbaum has met regularly with his graduate fellows. In the current year (11), 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 IRG2 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 IRG2 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, Chin) 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.

Luciano Kay, who joined IRG-2 as a postdoc on June 1, 2012, brought IRG2 researchers into collaborations with his former colleagues at Georgia Tech (Phil Shapira and Jan Youtie). Kay has been provided with a high-powered workstation that enables him to run patent and publication data locally, using Vantage Point (the software he used at Georgia Tech to conduct his analysis); this enables us to conduct our own bibliometric and patent analysis in house.

Our other Duke University partners (Lenoir, Herron) have finished publications based on their research, including a collaborative publication with Mehta. Frederick (also at Duke) has completed her California in the Global Nanotechnology Value Chain project. These efforts are coordinated through telephone conversations.

Our partnership with Foladori and Zayago Lau in Mexico, initially supported in part by two separate grants from UC-MEXUS/CONACyT, has been completed. Our work with ReLANS (the Latin American Nanotechnology Network, headed up by Zayago) continues.

4. Major IRG 2 accomplishments

IRG 2's focus, a comparative-historical and quantitative analysis of the development of nanotechnology, crosscuts with a number of other CNS initiatives and projects. IRG2 and IRG1 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 IRG2 researchers Motoyama, Parker, and Appelbaum examined the historical origins of the U.S. National Nanotechnology Initiative. IRGs2 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 IRG2 conference on nanotech and labor in Curitiba, Brazil, during the previous reporting period (September 5-7, 2013) also contributed to the work of IRG3.

IRG 2-1 China's Developmental State: Becoming a 21st Century Nanotech Leader: Appelbaum, Parker, Cao, Stocking, Gebbie, Han, Nightingale;
IRG 2-3 Drivers of Nanotechnology Commercialization in China – Suzhou Industrial Park: Parker, Appelbaum, Cao, Han, Gebbie, Stocking, Nightingale

These two research streams converged during the current review period. They both aim at understanding where China stands in terms of innovation, R&D, and commercialization of nanotechnology, examining the degree to which China has a more centralized approach to funding for nanotechnology along the value chain, particularly towards the commercialization end. China is convinced that manufacturing prowess alone is insufficient to becoming a leading economic power in the 21st century. China's overarching goal is to become an "innovation-oriented" society by the year 2020. Since the Third National Conference on Science and Technology in 1995 when "The Decision on Accelerating Scientific and Technological Progress" was announced, "indigenous innovation" (or *zizhu chuangxin*) has been heralded as the source

of China's future development, and science, technology and education were identified as the tools that will create national prosperity and reduce the inequality that currently threatens China's rapid development. This approach has been challenged in the literature on industrial policy – most notably in Breznitz and Murphree (2011), who argue that China's strengths lie not in leading-edge innovation, but in second-tier innovations that secure prominent placement in globally fragmented supply chains. Our research addresses these issues, seeking to better understand whether China's relatively government-centered approach toward science and technology policy can succeed in creating the bases for genuine innovation, in light of its distinctive approach to technological leapfrogging, the institutional features of its innovation system, and nanotechnology's status as an early stage emerging technology. This is an ongoing project assessing China's transition from an economy based on low-wage exports to one based on high-tech innovation and manufacturing. Thus far the principal research has been fieldwork - interviews with scientists, engineers, pubic officials, and entrepreneurs in China.

We focused initially on academic research, but in the past several years have examined entrepreneurs and firms, focusing on Suzhou Industrial Park as a case study. Suzhou Industrial Park (SIP) – one of China's showcase high-tech parks – is only fifty miles (and 30 minutes by high-speed train) west of Shanghai. SIP is jockeying to propel Jiangsu Province ahead of its neighbors to become the Silicon Valley of China. One rapidly growing sector of SIP, dubbed Nanopolis (a play on Singapore's successful Biopolis) is home to some of China's rising nanotechnology startups. Promising nanotech firms are provided support for business plan development, legal and incubation services, and significant rent subsidies, among other perks. In parallel with China's efforts to strengthen its research capacity through science parks such as SIP, the country is increasingly leveraging its large stores of overseas Chinese scientists and engineers to elevate the status of Chinese nanotechnology. China's plan is to establish itself as a knowledge economy through ties with its Diaspora community trained in the US, Europe, Australia, and elsewhere.

We did not conduct additional field research during this period, focusing instead on writing papers on SIP. Our principal conclusion is that China's substantial investment in nanotechnology has paid large dividends at the research stage, but has yet to result in significant commercial payoff. While this is true in other countries as well, China faces the additional challenges of having a risk-averse state sector, an SME sector that is growing but undeveloped, a university/academy research culture that discourages innovative thinking and lacks entrepreneurial experience, uncertain venture capital (much of it coming from the state, rather than private sources), and widespread corruption.

Publications:

- Richard P. Appelbaum, Rachel Parker, and Cong Cao, "Nanopolis and Suzhou Industrial Park: China's Silicon Valley?" under revise and resubmit to *Technology in Society*
- Richard P. Appelbaum, Matthew A. Gebbie, Xueying Han, Galen Stocking, Luciano Kay, "Will China's Quest For Indigenous Innovation Succeed? Some Lessons From Nanotechnology," accepted by *Technology in Society* with minor revisions to be completed
- *Technology and Innovation in China: China's Evolving Role in the Global Science and Technology System* - book proposal to Polity Press (solicited by Polity). Co-authors: Richard Appelbaum, Cong Cao, Rachel Parker, Denis Simon. Contract has been signed; book MS to be delivered spring 2016.

IRG 2-2: Comparative Study of State Nanotechnology Policy: U.S., China, India, Japan: Appelbaum, Block, Han, Gebbie, Stocking, Nightingale, Stacy; Foladori, Zayago, Invernizzi

As previously noted, a central theme of our research is the role of public investment as a driver for nanotechnology R&D and eventual commercialization. To what extent do government-funded national nanotechnology initiatives constitute industrial policy? What are the results of different governmental approaches, in terms of publications, patents, and commercialization? Much of our research to date has focused on China, where government efforts appear to reach further into the commercial end of the value chain than in the U.S. This research stream builds on the previous research done in China, and seeks to better understand the role of state policy as a driver of nanotechnology R&D and commercialization by looking comparatively at the U.S., China, and Japan. The first step has been to focus on the U.S. NNI in an effort to better understand funding allocations across agencies, especially programs such as SBIR and STTR, two federal programs that effectively constitute seed grant programs for promising high-tech ventures that seem likely to successfully commercialize.

The overall goal of this project is to develop an understanding of the ways in which governments attempt to manage, nurture, and cultivate nanotechnology research within their country. Understanding which processes are most fruitful will be helpful for policymakers evaluating new directions for nanotechnology policy. To do this, we are gathering information on a subset of these policies and comparing varying facets to develop a framework for analysis. This framework will include funding levels, the development of highly concentrated research regions, regulation analysis, and other relevant areas. When coupled with certain output metrics, including publication and patent information, we aim to use this tool to analyze the effectiveness of nanotechnology policy in each country. Research aims include descriptively analyzing nanotechnology policy in selected countries, developing a framework for evaluating nanotechnology policy in a subset of these countries, and applying this framework to all countries with significant nanotechnology policy.

We note that Choi, in connection with IRG 1, has conducted research into the policies and practices that led to the development of nanotechnology in East Asia since the 1990s. Focusing on South Korea and Japan, this project seeks to place the Asian development within the broader context of global nanotechnology, as well as in its historical context. Going beyond the usual discussions focused on national policies, this project aims to provide detailed case studies involving individual researchers, contributing to an understanding of the specific dynamics among policies, institutions, and individual scientists and engineers in Asian societies, while analyzing the development of national policies for promoting nanotechnology in South Korea. While this year's research has been a case study of the Seoul National University Nanoelectronics Institute, projected future work will more broadly tie in with the work of IRG2, examining the Korean National Nanotechnology Initiative.

During the previous review period, India was added to the countries that are being studied. To gain a better understanding of how India's national policies have affected the development of nanotechnology (in comparison to countries such as China and the US), Stocking and Nightingale engaged in a 2-week research trip to India from April 26 - May 11, 2014 to conduct interviews with scientists, academics, and entrepreneurs. Stocking and Nightingale visited two cities during this trip, Bangalore and Delhi, where participants were asked questions regarding the development of nanotechnology in India and their views on national policies affecting nanotechnology. Preliminary findings show that that India is an example of the successes and shortcomings of a developing state that is lacking in infrastructure, resources, and

entrepreneurial culture. Faced with a shortage of infrastructure and limited pool of skilled researchers, the federal and state governments have invested heavily in developing a research environment throughout the university system, and by so doing have created a nascent nanotechnology community. However, despite the government's efforts, this has not cultivated the nanotechnology private sector. In India's view, this is simply a consequence of starting from almost nothing in the sector: before encouraging private investment, the state had to build the necessary infrastructure on which a private sector could develop. Unlike other sectors that have revolutionized economies (such as IT), the requirements of nanotechnology, as well as other advanced technologies like biotech, require a larger upfront investment that has in turn necessitated a more active role for the state. The Indian state has been active in nanotechnology research that targets technologies to help solve the specific needs of a developing country, instead of products for the wealthy. Getting the balance right between helping solve the problems of developing peoples and aiming to compete in the global nanotechnology rush has been and will continue to be a challenge for India and similar states. A draft paper was completed by Stocking and Nightingale summarizing their findings.

A long-range task, which will continue post-CNS, will involve pulling together the materials we have gathered for different countries, developing a comparative framework, and writing up the results.

IRG 2-4: International Collaboration in Nanotech Research and Publication: Mehta, Lenoir, Herron, Cao, Han

The focus for research during this period has been on publishing the group's work in progress for the past year of the CNS project. We have also been developing the algorithms used for identifying papers in nanotechnology. There are several methods in use in the literature including a well-known and popular method developed by Kostoff, a variant of which we use, a method developed by colleagues at Georgia Tech in their commercial search tool, and several other methods. To date there has not been a comparative analysis and test of these methods to examine the strengths and weakenesses of the various approaches. Patrick Herron has undertaken an analysis of the four leading lexical queries for identifying publications in nanotechnology with a very large dataset consisting of 2.7 million nanotechnology records from the ISI web of science and international patent database. These data are used as the basis for measuring the performance of the current "gold standard" for WoS retrieval, comparing the performance of the current standard to three competing lexical queries. It is hypothesized that by using all four queries and measuring the performance of each set this study will establish a new gold standard for retrieving records from WoS. Herron is in the process of writing a research methodology and analysis specification. In order to certify the results for Herron has constructed a survey that is being distributed online to a panel of experts. This paper is in progress, awaiting the results of the panel, and should be completed in the next month or two. We feel it is a very strong paper, which we plan to submit to *Scientometrics.*

Work on Globonano at Duke has not been supported by CNS since 2014. Lenoir has leveraged other funds to support student work on the project, which continued through the summer of 2015. This database of all nanotech articles supplements a separate component of Globonano focused on identifying companies, institutes, labs and funding sources for commercial nanotechnology. The data collection system developed by Herron and research assistant Evan Donahue gathers records from Hoover, Nanotech-Now, Nanowerk, and USPTO. The Globonano database was used to support the research on the paper listed above with Mehta, Cao, Herron and Lenoir, "The Impact of National Nanoscience Diversification Strategies." We

have also used the tools of Globonano in working with the Center for Environmental Implications of Nanotechnology at Duke (CEINT) to construct a global value chain for nanocellulose.

Papers published, submitted or under preparation during this review period include:

- Lenoir, Tim and Herron, Patrick. (2015). The NCI and the Takeoff of Nanomedicine. Journal of Nanomedicine & Biotherapeutic Discovery, 05(03):135. doi: 10.4172/2155-983x.1000135
- Herron, Patrick. (in preparation). Evaluation of Lexical Queries for Identifying Nanotechnology Publications.

IRG 2-5: UCMEXUS / CONACYT Binational Collaboration (USA-Mexico) in the Development of Nanotechnology: Foladori, Záyago Lau, Parker, Appelbaum

This is a joint project between the Doctoral Program on Development Studies at the University of Zacatecas (Mexico) and UCSB's Center for Nanotechnology in Society (CNS). The first grant was completed two years ago; a second grant was secured, and will be completed during the current period. These grants have provided seed funding to determine key topics capable of being researched in future joint activities between the two research teams, as well as current research and publications. Because the Mexican principals are associated with ReLANS (the Latin American Nanotechnology and Society Network), it was also intended to enable us to expand our comparative studies to Latin America beyond Mexico.

The initial proposal called for two workshops between the UAZ and UCSB collaborators to achieve these goals. In fact, four workshops were held - two funded through the UC MEXUS/CONACYT award, and two by UCSB's Center for Nanotechnology (CNS) in conjunction with its annual research summits, which served both to integrate the UC MEXUS/CONACYT project with other CNS efforts (described below), and enable the UAZ collaborators to interact with the NS, since the research summits were followed by NSF site visits as part of its evaluation of CNS. Three of these workshops were held at UCSB: on October 28-29, 2010; at the CNS research summit on May 1-2, 2011; and at the CNS research summit on May 5-8, 2012. The fourth was initially to be held at UAZ, but since all collaborators (Appelbaum, Foladori, Parker, and Záyago were presenting on a panel (organized by Appelbaum) at the annual congress of the Society for the Advancement of Socioeonomics (SASE) in Madrid, Spain, the workshop was moved to Madrid (June 23-24, 2011). A meeting for the second grant was held in conjunction with the S.NET conference in Montreal (October 18-21, 2015).

As noted, the purpose of the workshops was to develop a joint agenda for future collaborative research between UAZ and UCSB on U.S.-Mexico nanotechnology relations. In fact, the funding enabled us to analyze the development trajectory of nanotechnology in Mexico, with special attention to scientific collaboration and productive agreements between U.S. and Mexican institutions. Our collaborative research focused on the study of bilateral nanotech collaboration between U.S. and Mexican researchers and institutions. We analyzed funded collaborative nanotech projects, work done to improve collaborative ties between the two countries in nanotech industries, as well as collaboration between individual research centers. Research strategies included crawling Mexican nanotech research center websites for funded collaborations with nanotech institutions in the U.S., surveying the policy work done by the Fundación México-Estados Unidos para la Ciencia (FUMEC) in its efforts to improve U.S.-Mexico scientific collaboration, and inventorying all international collaborations administered by Mexico's Consejo Nacional de Ciencia y Tecnología (Science and Technology National Council,

CONACYT). These efforts have resulted in numerous publications and many presentations (a complete listing is available on request).

The second UCMEXUS / CONACYT was entitled “Nanotechnology in the Mexican industrial policy. A comparative methodological framework.” This project elaborates a methodological framework capable of analyzing nanotechnologies public policies in specific countries. It relies on the case of Mexico, where the UED-UAZ group has done extensive research on related nanotechnology topics. U.S. and China nanotechnology public policies have already been studied by the CNS-UCSB group. Brazil is the leading country in Latin America in nanotechnology development, and therefore useful to take into account both because of its wide public policies instruments, and because substantial information is already available for the purpose of this research. The framework that we have elaborated for Mexico is being extended to the other countries. Several Science and Technology policies are internationally applied, but each country develops specific instruments and has unique characteristics that require an individualized research approach. Developing a comparative analysis gives us a broad methodological instrument, capable of being applied to other countries in the future. Nanotechnologies, as other advanced technologies, are spearheading innovation, and well-informed public policies are key to reaching expected outcomes.

IRG 2-6: ReLANS, Research in Mexico, Latin America: Foladori, Záyago Lau, Appelbaum, Parker, Kay, Invernizzi

This partnership continues largely through the collaborative research efforts described above (IRG2-5 and IRG2-12). We continue to distribute our research through the ReLANS network, which is maintained by Zayago Lau.

IRG 2-7: Bibliometric and Patent Analysis/Mapping: Kay

The aims of this project include:

1-Exploitation of scientific publication and patent databases:

- This involves research article development, conference presentations and international journal submissions. Most of the work developed by the "IRG 2 Bibliometric and patent analysis, mapping" project is based on the application of data mining and visualization techniques to databases of scientific publications and patents in the field of nanotechnology and synthetic biology.
- Research thrusts in current reporting period include a line of research started in previous reporting periods, corporate strategies in synthetic biology, and new work that investigates the impact of the CNS-UCSB center.

2-Data and research collaborations:

- Other activities in this reporting period have sought to maintain and further develop collaborations with colleagues from other institutions. Collaborations are sought in the form of article co-authorship, joint presentation at conferences (articles and panels,) and data/tools sharing.
- In this reporting period, Luciano Kay collaborated with Ying Huang (Beijing Institute of Technology - BIT), Yi Zhang (BIT), Donghua Zhu (BIT), Alan Porter (Georgia Tech – GT), and Jan Youtie (GT) to develop a method to map research grant funding and create overlays for specific institutions and research areas using National Science Foundation grant data (“Funding Proposal Overlay Mapping”).

- Luciano Kay also continues collaborations with Prof. Aashish Mehta in the project “Mapping the Global Race for National Security Technologies”.

3-Development of new methods and tools

- Some activities in this reporting period have been related with the development of new methods and tools for data mining and analysis. While this work generally is started to address specific issues encountered in research projects, methods and tools sometimes become important contributions to the field of bibliometric and patent analysis. New tools make possible answering more complex research questions in our projects and the projects of colleagues worldwide, as we generally share developments with them.

Progress has been made on the following:

1- Exploitation of scientific publication and patent databases:

- Luciano Kay worked on creating a database of CNS scientific publications (and citing publications) and other outputs for the “CNS impact” project. This involved hiring an assistant student, organizing database search & download work, and adapting scripts to import data into text mining software for analysis. Bibliometric and other center report analysis were conducted and a presentation was made at the 2015 S.NET conference in Montreal, Canada. Ongoing work focuses on writing a research paper based on this analysis.
- Luciano Kay also worked in the analysis of the scientific publication and patent datasets created in previous periods to investigate the evolution of the field of synthetic biology. A research paper has been prepared for submission to be consider for journal publication.

2-Data and research collaborations

- Luciano Kay worked on producing visualizations and adapting scripts to automate the process of exporting data from text mining software for the project “Funding Proposal Overlay Mapping”. This involved collaborative work through Skype meetings and in person meeting at the 5th Global Tech Mining conference held in Atlanta, GA.
- Luciano Kay continued work on project "Mapping the Global Race for National Security Technologies" in collaboration with Dr. Aashish Mehta to produce publishable outputs. This project investigates the global development of national security technologies and their implications for U.S. security policy. This project has been awarded a $11,000 research grant from the UC Institute on Global Conflict and Cooperation.

3- Development of new methods and tools

- Luciano Kay developed a VantagePoint macro script for VantagePoint that reverses the process of organization name clean up using meta-data available in scientific publication or patent datasets.

IRG 2-8: Open Doors: Chinese (and other foreign) students studying in the U.S.: Han, Appelbaum

Aims: This study is a continuation of our research on how STEM graduate students affect US international competitiveness. This research has important implications on the future of US innovativeness and competitiveness in the international arena.

This is an expansion of our original UCSB pilot study to a nation-wide level that includes both

domestic and international graduate students in STEM fields.

We contacted graduate advisers and department chairs from all Science, Technology, Engineering, and Mathematics departments in the top 10 colleges/universities with regards to international student enrollment as specified by the Open Doors 2013/14 academic year report. The STEM departments identified in each university are departments that offered at least one graduate degree (i.e., Masters or PhD) that fell under the STEM-designated degree program list as specified by the US Immigration and Customs Enforcement agency (http://www.ice.gov/sites/default/files/documents/Document/2014/stem-list.pdf). We gathered the email contact addresses for all department chairs and graduate coordinators/advisors using public information provided by each of the departmental websites.

We emailed graduate advisers/coordinators and department chairs to ask for their help and cooperation in contacting the graduate students in their department, by using their listserv, to participate in our survey. The survey consisted of questions concerning (if applicable) their reasons for studying in the USA, their academic background, their career aspirations, especially in relation to their eventual geographical destination. The survey took approximately 10 minutes to complete and was administered in English. The survey was administered through Qualtrics.

Major findings:

Differences in career plans
We found that among all career options, respondents preferred to stay in academia (39% of all individuals), followed by wanting to seek employment with a company (31%). Only a small percentage of individuals wanted to work for a governmental agency (4.6%), start their own company (2.8%), or work for a non-governmental organization (2.5%). A higher percentage of respondents (13%) were interested in 'other' career options and some did not know or were uncertain of their future career plans (6.0%).

International students were significantly more likely to seek employment with a company (χ^2 = 46.8, P<0.001) than their domestic counterparts; and they are significantly less likely to want to work for a governmental agency (χ^2 = 24.2, P<0.001), to be unsure in what they want to do upon graduation (χ^2 = 13.7, P<0.001), and to choose 'other' career plans (χ^2 = 5.51, P=0.02) than domestic students. There were no significant differences between domestic and international students who wanted to remain in academia (χ^2 = 1.15, P=0.28), start their own companies (χ^2 = 2.62, P=0.11), or work for a non-governmental agency (χ^2 = 0.266, P=0.61). For international students, there was no significant difference in the percentage of respondents who wanted to pursue an academic research (38%) and those who wanted to seek employment with a company (41%) (χ^2 = 1.15, P=0.28). Domestic students significantly preferred academic research (40%) to seeking employment with a company (27%).

International students

There were significant differences among why international students chose to conduct their graduate studies in the U.S. (Cochran's $Q_{df=7}$ = 2317, P<0.001). Pairwise comparisons showed that factors influencing international students' decisions to study in the U.S. fell into 6 significantly different groups. Higher quality of education was the most important factor (group A), accounting for 84% of all international respondents, followed by future career opportunities (74%, group B), wanted to experience living abroad (45%, group C), opportunity to work with specific faculty (37%, group D), and wanted to live in the United States (22%, group E). The remaining three factors were not significantly different from one another and fell into one group

(group F)—proximity to friends/family (5.7%), lower cost (4.7%), and other (4.6%)—and accounted for significantly lower percentages of why individuals wanted to study in the U.S. The proportion of international respondents who want to stay in the U.S. upon graduation (48%, N=376) was significantly higher than the proportion of individuals who plan to leave (12%, N=92) (χ^2 = 244, P<0.001) and those who have not decided or are unsure if they want to stay or leave (41%, N=319) (χ^2 = 8.08, P=0.004). For those who indicated wanting to stay in the U.S., there were significant differences among which factors are most important in influencing this decision (Cochran's $Q_{df=10}$ = 1274, P<0.001). Future job opportunities was significantly higher than all other factors (P<0.001 for all pairwise comparisons) and was selected by 80% of respondents as the primary factor that influenced students who would like to stay in the U.S. This was followed by overall quality of life (69%), professional network opportunities (57%), and salary (52%). Social reasons were influential for only 21% of those who wish to stay in the U.S., while opportunities for family members, geographic location, family, friends, and cultural reasons accounted for less than 20% each.

For those who plan to leave the U.S. after graduation, there were significant differences among which factors are important (Cochran's $Q_{df=10}$ =196.3, P<0.001). Family was the most significant factor for those who plan to leave the U.S. upon graduation (P<0.001 for all pairwise comparisons) and accounted for 79% of respondents who are planning to leave. All other factors accounted for less than 40% of respondents each.

Publications:

- Xueying Han and Richard P. Appelbaum, "Will They Stay or Will They Go? International STEM Students Are Up for Grabs," under review after revision, Kaufman Foundation (revision sent in February 2016)

IRG 2-9: Corporate Strategies of Latin American Nanotech Companies and Their Policy and Institutional Contexts with Focus on Argentina and Brazil: Kay, Appelbaum, Shapira, Youtie.

The purpose of this research project is to investigate the innovation pathways of developing countries in emerging technologies, with focus on nanotechnology and Latin America (in particular, Argentina and Brazil), in collaboration with colleagues from other institutions. This includes a main project that looks at Argentina and Brazil as country case studies and companies from both countries as embedded cases, in collaboration with colleagues from Georgia Tech (Jan Youtie and Philip Shapira), and a subproject that looks at the trajectories of the Brazilian companies at the firm-level and from the value chain perspective, in collaboration with IRG 2 members at other institutions (Stacey Frederick, Duke University) and other colleagues (Noela Invernizzi, Federal University of Parana).

The aims and accomplishments for this reporting period have been:

- The purpose of this research project has been to investigate the innovation pathways of developing countries in emerging technologies, with focus on nanotechnology and Latin America (in particular, Argentina and Brazil), in collaboration with colleagues from other institutions. This includes a study of Argentina and Brazil as country case studies and companies from both countries as emdedded cases, in collaboration with colleagues from Georgia Tech (Jan Youtie and Philip Shapira). The aims and timeline for this

project have been: 1) Develop the theoretical framework and corresponding resign design to address the issue of innovation pathways in emerging technologies in developing countries; 2) Develop the research protocols that this kind of research require for data gathering through multiple data sources; 3) Conduct data gathering; 4) Analyze data and write findings; 5) Prepare conference presentations; 6) Produce publishable outputs.

Describe research progress for each aim (include methods and findings):

Publication:

- Kay, L., Appelbaum, R., Youtie, J. and Shapira, P. In press. "Nanotechnology in Argentina and Brazil: Innovation Pathways of developing countries in emerging technologies." *Technology Forecasting and Social Change*.

IRG 2-10: Survey of China Nanotechnology Scholars in Leading Chinese Universities: Appelbaum, Han, Stocking, Gebbie, Simon

Aim: To have a comprehensive understanding of the research environment/culture occurring at Chinese institutions of higher education and how scientists view the role of the central government in research. Participants are Chinese Science, Technology, Engineering, and Mathematics professors and/or associate professors from the top 25 ranked institutions of higher education in China. An invitation letter with a link to access the on-line survey was emailed to each subject individually using the contact information gathered from each individual's profile page. We identified a total of 18,310 individuals who fit our parameters. These individuals were contacted via Qualtrics to participate in our anonymous on-line survey. The survey included questions in the following areas: basic demographic information (e.g., gender, age, field of study, etc.), education background (e.g., highest degree attained, institutions attended by an individual, year of terminal degree conferral, etc.), research environment/culture (e.g., required number of publications on an annual basis, how research topics are selected, incentives for publishing or patenting, etc.), and individual perceptions regarding the research environment in China. The survey was active for 8 weeks total. Individuals were contacted with an initial email and then two reminder emails at one week intervals. No incentives were offered.

For an unknown reason, a large quantity of emails was bounced back via Qualtrics and did not reach its intended recipients. It is likely that the Chinese firewall has blocked our emails and we are currently in the process of contacting these individuals through individual emails as it is less likely to be picked up by the firewall to be blocked.

Xueying Han and Cong Cao conducted seventeen follow-up interviews in late-June. Interviewees were from Tsinghua University, Peking University, Renmin University of China, Beijing Normal University, Shanghai Jiaotong University, and Fudan University.
To determine if we have nonresponse bias, the survey was re-implemented in early-September and again in early-November.

Describe research progress for each aim (include methods and findings):

We received a total of 731 completed surveys.

Findings (summary statistics) of the 731 completed surveys:

- We received a total of 731 completed surveys. The ratio of female to male respondents was 1:4. By academic rank, 46.8% of respondents were *associate professors*, 50.1% were *full professors*, and 3.1% were *other*. 95.8% of respondents hold PhDs as their terminal degree, with Master's and Bachelor degrees accounting for 3.1% and 0.7% of respondents, respectively.
- 16.7% of respondents hold their terminal degree from abroad, while 83.3% received domestic degrees from China. Of those who studied abroad (i.e., returnees), the US was the number one destination country, accounting for 37.7% of respondents. Japan was the number two destination country (accounting for 19.7%), followed by Germany (7.4%), and England (6.6%).
- Of those who studied abroad, *higher quality of research* and *higher quality of education* were the primary reasons why individuals decided to study abroad (77.7% and 68.6%, respectively; Figure 2). *More job opportunities for one's self* and *family* were the primary reasons why individuals chose to return to China (46.3% and 44.6%, respectively).
- Of those who received a foreign PhD, 81.8% stayed abroad after receiving their degree to work, and 18.2% returned immediately to China. 60.4% of individuals stayed abroad for less than 5 years before returning to China, 29% of individuals stayed between 5-10 years, and only 10.4% stayed for more than 10 years.
- Individuals who studied abroad believed that the biggest advantage to a foreign degree was a *better education/knowledge of their field* (70.6% of respondents), while individuals who were trained domestically in China (i.e., homegrown scholars) felt that the biggest advantage to a foreign degree is that it provided *better recognition from colleagues* (68.7% of respondents).
- A significantly higher percentage of returnees believed that foreign degrees provided *better advisors/mentorship* than those who received domestic degrees (X^2_1=18.2, P<0.001).
- Significantly higher percentages of homegrown scholars believed that foreign degrees provided *better recognition from colleagues* (X^2_1=3.9, P=0.047)*, better job opportunities* (X^2_1=4.8, P=0.03)*, better professional networks* (X^2_1=9.5, P<0.01)*,* and *better pay* (X^2_1=16.2, P<0.001) than those who received degrees from abroad.
- A significant higher percentage (χ^2_1 = 283.4, P<0.001) of individuals were *satisfied* or *very satisfied* (54.9%) than those who were *unsatisfied* or *very unsatisfied* (12.9%) at their current position (Figure 5).
- There is no significant difference (χ^2_1 = 2.2, P=0.14) between the percentage who were *satisfied* or *very satisfied* (33.7%) than those who were *unsatisfied* or *very unsatisfied* (29.9%) with the research culture in their department.
- A significant higher percentage (χ^2_1 = 6.7, P<0.01) of individuals were *satisfied* or *very satisfied* (32.5%) than those who were *unsatisfied* or *very unsatisfied* (27.0%) with the overall research culture in their field.

- A significant higher percentage ($\chi^2_1 = 84.8$, P<0.001) of individuals were *unsatisfied* or *very unsatisfied* (27.0%) than those who were *satisfied* or *very satisfied* (32.5%) with the overall research culture in China.
- A significant higher percentage of individuals believe the government should have *much less involvement* or *less involvement* (40.3%) than those who think the government should have the *same* level of involvement as it does currently (34.2%, P=0.02).
- This percentage is also significantly higher than those who think the government should have *more involvement* or *much more involvement* (25.5%, P<0.01).
- Respondents indicated that *national funding lists* and *self-selection* are the primary ways in which they select research topics (71.0% and 67.8%, respectively) .
- The *National Natural Science Foundation of China* is the primary source of funding among respondents, followed by *private company or companies, provincial or local governments,* and the *Ministry of Science and Technology*.
- 11.6% of respondents indicated that they have 0-250,000RMB in research funding; 16.0% have 250,001-500,000RMB in funding; 13.5% have 500,001-750,000RMB in funding; 15.8% have 750,001-1,000,000RMB in funding, and 43.1% have over 1 million RMB in research funding
- Only 2.1% indicated that less than 25% of their funding goes toward research. 15.5% indicated that 25-50% goes towards research. 50.5% of respondents indicated that 50-75% of their research funding goes towards research. 32.0% indicated that 75-100% of their funding goes towards research
- 49.1% of respondents indicated that they have international collaborators; 85.5% of respondents have a collaborator within China.
- The majority of Individuals met their international collaborators during their time as a *visiting professor/scholar*.
- Individuals met domestic collaborators predominantly through *professional conferences in China, through departmental colleagues,* and *through colleagues.*

We are in the process of writing up these results.

IRG 2-11: Will Nanotechnology Prove to be Disruptive? Effects on the Workforce of an Emerging Technology: Appelbaum, Foladori, Zayago Lau, Frederick, Ramón Arteaga Figueroa

During this period we have worked on two projects:

1) *Nanotoxicology research in Mexico:* The aim of this project is to explore the extent to which the health and environmental risks of nanomaterials are researched in Mexico. The first stage illustrates the implications of the risks that nanoparticles and nanomaterials pose to workers, consumers and the environment. Next, the state of the development of nanotechnologies in Mexico is reviewed. This is followed by a description of the methodology employed, which is based on two techniques: the first involved the creation of a data base that contains every

scientific article on nanotechnology published by Mexican authors over a period of 12 years. From this data base, key words were used to identify those associated with research on nanomaterial risk. The second technique involved a web-based internet search to identify all the researchers who work in this field in various laboratories, research centers and universities within the country. We conclude that the topic of nanotechnology risk is generally absent from research in Mexico.

2) Nanotechnology Value Chain in Mexico: This study will present an inventory of 139 nanotechnology companies in Mexico, identifying their geographic distribution, economic sector classification, and position in the nanotechnology value chain. We will show that the principal economic sector of nanotechnology-engaged firms involves the manufacture of chemical products, which largely serve as means of production (primary or intermediate materials; instruments and equipment) for industrial processes. The methodology used in this analysis could be replicated in other countries without major modifications.

Publications:

- Záyago Lau, Edgar; Foladori, Guillermo; Frederick, Stacey & Arteaga Figueroa, Ramón (2015). ¿Se estudian los riesgos de los nanomateriales en México? *Temas de Ciencia y Tecnología, Num.56 Vol.19, Pp.*17-27 d

- Appelbaum, Richard; Záyago Lau, Edgar; Foladori, Guillermo; Parker, Rachel; Villa Vazquez, Liliana Robles-Belmont, Eduardo; Arteaga Figueroa, Ramón (2016). Inventory of Nanotechnology Companies in Mexico. *Journal of Nanoparticle Research,* Vol. 18. Num. 43 DOI 10.1007/s11051-016-3344-y (ISSN: 1388-0764).

- Foladori, Guillermo; Arteaga, Edgar; 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), pp. 279-301, DOI: 10.1007/s11024-015-9281-6 (ISSN: 0026-4695).

IRG2-12: This has been folded into IRG2-11 (above) Risks to human health and the environment within nanotechnologies research in Mexico; Zayago Lau, Edgar; Foladori, Guillermo; Frederick, Stacey

IRG 2-13: Framing Nanotechnology in Social Media (X-IRG): Stocking, Hasell (IRG 3) [see X-IRG 6]

IRG2-14: Global Value Chain Analysis (X-IRG): Frederick, Appelbaum, Harthorn [see X-IRG 3]

5. Broader Impacts of IRG-2: As detailed throughout this report, IRG2 has addressed two of the 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. Indeed, one of the emerging conclusions from this research is that national ambitions and global collaborations do not necessarily coincide. Another

overarching concern of IRG2 (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.

A further conclusion – which we draw in a preliminary way, since our comparative research is not yet complete – is that international collaboration notwithstanding, 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. By way of comparison, Mexico – which lacks a central nanotechnology policy – is highly dependent on the research interests of its foreign collaborators, which may or may not coincide with Mexico's desire to advance its economic growth through high-tech development.

Courses/teaching/mentoring that draws on CNS Research

- Appelbaum uses his China research in large lower-division undergraduate courses that reach 100's of students (e.g., Global 2).

IRG 2 Publications 2015-2016

Primary Publications: Journals

1. Appelbaum, Richard, Gebbie, Matthew, Han, Zueying, Stocking, Galen, and Kay, Luciano. (forthcoming). Will China's Quest for Indigenous Innovation Succeed? Some Lessons From Nanotechnology. *Technology in Society.*
2. 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). doi: 10.1007/s11051-016-3344-y (ISSN: 1388-0764)
3. 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*.
4. Foladori, Guillermo, Arteaga Figueroa, Edgar, 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
5. Foladori, Guillermo, Arteaga Figueroa, Edgar, Záyago Lau, Edgar, Robles Belmont, E, Appelbaum, Richard, & Parker, Rachel. (forthcoming). Patentes nanotecnológicas en México según sector económico de potencial aplicación. *Ciencia Ergo Sum*.
6. Foladori, Guillermo; Arteaga Figueroa, Ramón; Záyago Lau, Edgar; Appelbaum, Richard; Robles-Belmont, Eduardo; Villa, Liliana & Parker, Rachel (2015). Relevancia y

apoyo público de la Investigación en Nanotecnología en México. *Revista Anduli,* DOI: Nº DOI: http://dx.doi.org/10.12795/anduli.2015.i14.11 (ISSN: 1696-0270).

7. 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.*
8. Foladori, Guillermo, Arteaga Figueroa, Edgar, Záyago Lau, Edgar, Appelbaum, Richard, Robles Belmont, E, Villa, Liliana, & Leos, Vanessa. (forthcoming). La política pública de nanotecnología en México. *Revista Iberoamericana de Ciencia, Tecnología y Sociedad*.
9. Kay, L., Appelbaum, R., Youtie, J. and Shapira, P. (forthcoming). Nanotechnology in Argentina and Brazil: Innovation Pathways of developing countries in emerging technologies. *Technology Forecasting and Social Change.*
10. Lenoir, Tim and Herron, Patrick. (2015). The NCI and the Takeoff of Nanomedicine. *Journal of Nanomedicine & Biotherapeutic Discovery*, 05(03):135. doi: 10.4172/2155-983x.1000135
11. Záyago Lau, Edgar, Foladori, Guillermo, Carrozza, T. J., Appelbaum, Richard, Villa, Liliana, Parker, Rachel, & Robles Belmont, Eduardo. (forthcoming). Sectoral analysis of nanotechnology companies in Argentina. *Nanotechnology Law & Business Journal*.
12. Záyago Lau, Edgar, Foladori, Guillermo, Carrozza, T. J., Appelbaum, Richard, Villa, Liliana, & Robles Belmont, E. (2015). Empresas nanotecnológicas en Argentina. *Realidad Económica* (79), 34-54.
13. Záyago Lau, Edgar, Foladori, Guillermo, Frederick, Stacey, & Arteaga Figueroa, Ramon. (2015). ¿Se estudian los riesgos de los nanomateriales en México? *Temas de Ciencia y Tecnología*, 19(56), 17-27. (ISSN: 2007-0977).
14. Záyago Lau, Edgar, Foladori, Guillermo, Vazquez, Liliana Villa, Figueroa, Edgar, & Arteaga Figueroa, Ramon. (2015). Análisis Económico Sectorial de las Empresas de Nanotecnología en México. *Documentos de Trabajo IELAT*, 79, 1-25.

Primary Publications: Books, chapters, reports and other publications

15. Kay, Luciano; Porter, Alan L.; Youtie, Jan; Newman, Nils, & Rafols, Ismael. (forthcoming). Visual analysis of patent data through global maps and overlays. In Lupu, M., Kando, N., Trippe, T. and Mayer, K. (Eds.), *Current Challenges in Patent Information Retrieval*. Springer.

Leveraged Publications: Journals

Leveraged Publications: Books, Chapters, Reports and other Publications

16. Foladori, Guillermo; Invernizzi, Noela; Appelbaum, Richard; Hasmy, Anwar & Záyago Lau, Edgar (2015). Trabajo, riesgos y regulación en América Latina. En Foladori, Guillermo; Hasmy, Anwar; Invernizzi, Noela & Záyago Lau, Edgar (Eds.), *Trabajo, riesgos y regulación de las nanotecnologías en América Latina*, 5-10. México, D.F.: Miguel Ángel Porrúa.

17. Záyago Lau, Edgar; Foladori, Guillermo; Frederick, Stacey; Arteaga, Ramón & García Guerrero, Miguel (2015). Investigación sobre los riesgos de los nanomateriales en México. En Foladori, Guillermo; Hasmy, Anwar; Invernizzi, Noela & Záyago Lau, Edgar (Eds.), *Trabajo, riesgos y regulación de las nanotecnologías en América Latina*,155-170. México, D.F.: Miguel Ángel Porrúa.

Submitted or in preparation publications: primary

18. Appelbaum, Richard, Cao, Cong, Parker, Rachel, & Simon, Denis. (in preparation). *Technology and Innovation in China: China's Evolving Role in the Global Science and Technology System*. Polity Press.
19. Appelbaum, Richard P., Rachel Parker, and Cong Cao. (Under Review). Nanopolis and Suzhou Industrial Park: China's Silicon Valley? *Technology in Society.*
20. Foladori, Guillermo, Arteaga Figueroa, Edgar, Záyago Lau, Edgar, Appelbaum, Richard, Villa, Liliana, & Robles Belmont, E. (Under review). Nanotecnologías, políticas públicas y comercialización en México. *Cuadernos de Trabajo Hegoa.*
21. Han, Xueying, and Richard P. Appelbaum. (Under review). Will They Stay or Will They Go? International STEM Students Are Up for Grabs. Kaufman Foundation.
22. Herron, Patrick. (in preparation). Evaluation of Lexical Queries for Identifying Nanotechnology Publications.
23. Kay, Luciano and Jennifer Woolley. (In preparation). "Corporate research and development activities in synthetic biology."
24. Kay, Luciano. (In preparation). Center for Nanotechnology in Society, University of California Santa Barbara CNS-UCSB.
25. Záyago Lau, Edgar. (in preparation). Nanomedicine Development in Mexico: Hopes and Challenges.

Submitted or in preparation publications: leverage

26. Kay, Luciano and Mehta, Aashish. (In preparation). Mapping the Global Race for National Security Technologies.
27. Ying Huang, Yi Zhang, Luciano Kay, Alan Porter, Jan Youtie, and Donghua Zhu. (In Preparation). Funding Proposal Overlap Mapping: A Tool for Science and Technology Management.

IRG 2 Research Presentations 2015-2016

1. Appelbaum, Richard, Parker, Rachel, & Cao, Cong. Technology and Innovation in China -- China's Evolving Role in the Global Science and Technology System. Society for the Advancement of Socioeconomics, London, July 2, 2015.
2. Simon, Denis. China's International Science and Technology Relations: From Passive to pro-Active Player. SASE (Society for the Advancement of Socioeconomics), London School of Economics, July 2, 2015.

3. Parker, Rachel. Is China Becoming a Hi-Tech Superpower? Measuring Success – and Failure. SASE (Society for the Advancement of Socioeconomics), London School of Economics, July 2, 2015.
4. Cao, Cong. China's Science and Technology Enterprise: Can Government-Lead Efforts Successfully Spur Innovation? SASE (Society for the Advancement of Socioeconomics), London School of Economics, July 2, 2015.
5. Kay, Luciano, Huang, Ying, Porter, Alan, Youtie, Jan, & Zhu, Donghua. Funding Proposal Overlap Mapping: A Tool for Science and Technology Management. 5th Global Tech Mining Conference, Atlanta, GA, September 15-16, 2015.
6. Han, X; Appelbaum, R; Cao, C. China's Science, Technology, Engineering, and Mathematics (STEM) Research Environment. Society for the Study of Nanoscience and Emerging Technologies (S.NET), Montreal, October 18-21, 2015.
7. Kay, Luciano. Center for Nanotechnology in Society, University of California Santa Barbara CNS-UCSB. Preliminary findings of an impact study. Society for the Study of Nanoscience and Emerging Technologies (S.NET), Montreal, Québec, Canada, October 18-21, 2015.
8. Appelbaum, Richard. Invited plenary address, The Role of the State in Regulation and Public Policies About Nanotechnologies S.NET, Montreal, CA, October 19, 2015.
9. Han, X; Appelbaum, R. China's STEM Research Environment. AAAS Annual Meeting Washington D.C., February 11-15, 2016.
10. Zayago, Edgar. Hacia un análisis de la cadena de valor de las empresas nanotecnológicas en México CINVESTAV, Zacatenco. Seminario de Programas Transdisciplinarios, May 2016.
11. Zayago, Edgar. Creating a database of Mexican Nanotech-companies. UdeG CULAGOS, June 2016.

IRG 2 Outreach Activities 2015-2016

12. Zayago, Edgar. Festival Cultural Zacatecas. Comentarista del libro "América Latina frente a la crisis y la financiarización" autores: Dr. Roberto Soto Esquivel y Dr. Aderak Quintana, Universidad Autónoma de Zacatecas, April 2015.
13. Gebbie, Matthew. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.
14. Han, Xueying. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.
15. Appelbaum, Richard. Presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.
16. Appelbaum, Richard. China's Science and Innovation Policy: Will It Succeed? CNS-ASU, Tempe, AZ, October 6, 2015.
17. Kay, Luciano. Network Analysis. 5th Global Tech Mining Conference, Atlanta, GA, September 15-16, 2015.
18. Appelbaum, Richard. China's Science and Innovation Policy: Will It Succeed? Atlanta Conference on Science and Innovation Policy, Atlanta, GA, September 17, 2015.

IRG 3 Progress Report: Risk Perception and Social Response

Faculty and Senior Participants

B.H. Harthorn, Leader	Med anthropology	UC Santa Barbara
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C. Beaudrie	Env Risk	Compass Resource Management
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M. Collins	Env Sociology	SUNY Environmental Health & Safety
L. Copeland	Political Science	Baldwin Wallace Univ
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K. Henwood	Sociology	Cardiff Univ
P. Holden	Microbiology, Ecol	UC Santa Barbara
G. Long	Engineering	Compass Resource Management
D. Novak [seed grant]	Music	UC Santa Barbara
C. Shearer	Env Sociology	CoalSwarm

Postdocs (2+4), Graduate Students (6), Undergraduate Students (1)

Postdoctoral researchers:

Lauren Copeland	Poli Sci	UC Santa Barbara
Tristan Partridge	Anthropology	UC Santa Barbara

International Postdoctoral researchers:

Merryn Thomas	Risk & Geog	Cardiff UK
*Anton Pitts	IRES	Univ British Columbia
*Christina Demski	Risk and Climate	Cardiff UK
*Darrick Evensen	Science Studies	Cardiff UK

Graduate students:

*Cassandra Engeman	Sociology	UC Santa Barbara
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Bridget Harr	Sociology	UC Santa Barbara
Ariel Hasell	Communication	UC Santa Barbara
*Chaerean Kim	IRES	Univ British Columbia
*Louise Stevenson	Ecology	UC Santa Barbara

Undergraduate students:

Catherine Enders	Psychology	UC Santa Barbara

**partially or fully co-funded from another source*

1. Introduction:
The overarching goals of IRG 3 are 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, to develop and document methods for public engagement with new technologies in the US and comparative other sites, and to contribute to work in the CNS 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 also focuses 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 are 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, such as 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.

Quantitative methods used in IRG 3 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 the past year, researchers in IRG-3 performed work in the main areas detailed below.

Our major goals and accomplishments to date 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).
- 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 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.*
- 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.

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 2015-16 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 EHS
- 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; Project completed 2013; Harthorn**,** Holden**,** Satterfield**,** Engeman
- 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
- IRG 3-seed project(s): [see X-IRG Seed project program reports on Anderson, Barvosa, and Novak projects]

Integration and synthesis of effort. IRG 3 effort takes place within a large, complex, multi-sited group, and integration is accomplished through frequent interactions, phone conferences, and meetings among the lead researchers and their teams. Individual project meetings occur on an approximately weekly basis; Harthorn, Pidgeon and Satterfield hold teleconferences on a roughly monthly basis. In spite of this frequent interchange, the team has found that face-to-face meetings by IRG 3 leaders at least 1-2 times per year are essential to harmonize goals, assess progress across the different research projects, and advance intellectual and strategic planning for new projects. In the past year, this has included full or partial IRG 3 meetings in: Santa Barbara (May 2015, in conjunction with the CNS external site review by the NSF—Harthorn, Satterfield, et al.); SRA-E in Maastricht, Netherlands (June 2015, Partridge with Pidgeon and Thomas); Vancouver at UBC (July 2015; Harthorn, Pidgeon, Satterfield, Gregory—synthesis report preparation); Washington DC at the SRA meetings (Dec 2015, Harthorn, Pidgeon, Partridge, Evanson, Demski), and Santa Barbara in conjunction with CNS Sunset events (Mar 2016, Harthorn, Pidgeon, Satterfield, Barvosa, Beaudrie, Collins, Gregory, Kandlikar; Enders, Hasell, and Stevenson); and in Vancouver at the SfAA meetings (Mar/Apr 2016, Harthorn, Satterfield, Kandlikar, Beaudrie, Hasell, and Partridge); and a final meeting is planned prior to the SRA-E meetings in Bath, UK in Jun 2016 (Harthorn, Gregory, Pidgeon, Satterfield, Hasell and Partridge).

In the reporting year, IRG 3 researchers organized full sessions of CNS-related research at the Society for Applied Anthropology (Pittsburgh, Mar 2015); Society for Risk Analysis-Europe (Maastricht, Jun 2015); Society for Risk Analyst (Arlington VA, Dec 2015); Society for Applied Anthropology (Vancouver, Mar/Apr 2016); and Society for Risk Analysis-Europe (Bath, UK, Jun 2016). Satterfield was the conference co-chair for the entire 2016 SfAA meeting. Harthorn gave

invited testimony in a Congressional Briefing on nanotechnology environmental health and safety issues held by the American Chemical Society in Washington DC in Nov 2016.

4. Major IRG3 research 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 MBE in the Queen's Birthday honors list, July 2014, for services to UK climate change and energy security policy. This honor, rarely bestowed on academics, reflects Pidgeon's deep commitment to educating the public about climate change and energy security policy.

IRG 3-1: Expert Judgments about Nanotechnologies' Benefits and Risks Kandlikar, Satterfield, Harthorn, (leaders), Beaudrie, Gregory, Long

This work has strong synergies with IRG 3's public perception work and with our partners in the UC CEIN. In general this work has contributed to better understanding of disciplinary and other contextual differences among the emergent risk assessment community and their counterparts in basic and applied NSE, as well as anticipating points of disjuncture with other stakeholders' views. This work builds on the foundational work of CNS collaborator, Paul Slovic, on the comparative toxicological assumptions of experts and lay persons.

IRG 3-1a*: Expert Studies-Regulatory Challenges*

UBC team's analytic work on ***regulation across the life cycle*** concluded its work in 2013 and completed an award-winning paper (Beaudrie, Kandlikar and Satterfield, 2013, *ES&T*) based on Beaudrie's). This work identifies critical gaps in US regulatory coverage across the life cycle of emerging nanotechnologies. They argue that these gaps create a regulatory "no-man's land" and make it difficult for regulatory agencies to collect risk relevant data, and conduct risk analyses for emerging nanomaterials at each stage of their life cycle. The focus on LCA (life cycle analysis) in this work anticipated rising interests in the nano eco-toxicology world in the UC CEIN and elsewhere. Beaudrie has taken a leadership role in the SRA, co-organizing the nanomaterials special interest group and a series of expert workshops, including one on Alternative Testing Strategies (ATS) in Sept 2014, leading a sustainable management program at SRA 2014, and several ATS presentations in the reporting year.

Closely connected to this study, the UBC team (Kandlikar, Satterfield & Beaudrie) completed work with Decision Research structured decision making expert, Robin Gregory, and collaborator Graham Long, in developing and implementing in a 2-day expert workshop for expert elicitation of ranking nanomaterial risks, held in Vancouver in 2012. The goal of the workshop was to understand the process of expert judgment formation in the context of high uncertainty about risks. This work was the culmination of several years' work, in which they have argued that decision-analytic tools (such as risk-ranking, multi-criteria decision analysis, and control banding) can be adapted to help make decisions about emerging nanotechnologies and nanomaterials in the current condition of gaps in hard risk assessment data. In the past year, Beaudrie received a Certificate of Merit for his presentation on this at the Am Chemical

Society Aug 2014, and the work has yielded a recent publication in *Environment Systems and Decisions* (Dec 2014).

IRG 3-1b*: Expert Judgments about Nanotech Benefits/Risks—NSE, Nanotox, NanoReg;* Satterfield, Kandlikar, Beaudrie, Harthorn

UBC researchers Satterfield, Kandlikar, and Beaudrie, with Harthorn, developed a systematic web-based survey of 3 samples of nano experts in 2010. The survey was delivered to 2130 nano-experts with 424 responses from nanoscientists and engineers (NSE), nano-EHS researchers (NanoTox), and nanotechnology regulators (NanoReg). The study explores experts' views on physical or technological risks, societal risks and benefits, laboratory practices (where appropriate), and regulatory challenges for engineered nanomaterials (ENMs) and nanoenabled products. Data analysis is complete and the final key publications were completed in 2014 (Beaudrie, Satterfield**,** Kandlikar & Harthorn, *PLoS One* 2013, and Beaudrie, Satterfield, Kandlikar & Harthorn, *PLoS One* 2014).

IRG 3-2: Emergent Public Perceptions of Benefits and Risks (survey research); Satterfield, Pidgeon, Harthorn, Gregory, Collins, Copeland, Corner, Hasell, Pitts, Kim, Findlater

In addition to the others listed above, the UK team led by Pidgeon has been vital to every step of this research, from conception to fielding to data analysis and write up and dissemination, as well as contributing key effort to other projects (see below) and vital research planning for IRG 3. IRG 3 work in this area has included completion of the first decision pathway analysis in collaboration with Decision Research (Gregory, Satterfield & Hasell 2015 in PNAS), with a 2nd comparative US-UK paper in development.

Plans for future research in the group include Harthorn and former postdoc Collins who have piloted work on the spatial aspects of nanotech and risk perception for survey research development. Harthorn and Satterfield and others in the group are additionally exploring possibilities for piloting new research on upstream public views on synthetic biology.

IRG 3-2a: Public perceptions, emergent preferences

Since 2009, the team has completed analysis all write up of data from the 2008 US national survey, focusing on key contextual, experiential, affective, and demographic factors that seem to be driving nanotech perceived risk, perceived benefit, reversals of judgments about risk vs. benefit, and construction of preference.

IRG 3-2b: Environmental Risk Perception Surveys; Satterfield, Harthorn, Collins, Copeland, Pitts, Hasell

Leverage: The CNS IRG 3 collaboration with researchers in the UC CEIN has offered an unprecedented opportunity for co-production of risk knowledge by scientists and societal researchers. Initially primarily funded through the UC CEIN Theme 7, and then fully funded by CNS IRG 3, the team has conducted research on environmental risk perception in a dually novel area (specific engineered nanomaterials—ENMs--as nested in distinct perceptions of different environmental media). In order to accomplish this, the group has completed 2 public perception surveys: an initial study of public perceptions of air, water, and soil alone and in interaction with ENMs based on a series of mental models interviews in 2010. One paper on these findings is in revise and resubmit, and a number of others are in final preparation for

submission. Selective findings from this pilot survey on environmental risk perceptions of ENMs of US public (n=750) include:

- Respondents who rated the environmental media of air, water, and soil as more resilient (i.e., recovering easily from human impacts, self-cleaning over time, mostly pure, easy to control) also tended to see the benefits of various technologies as outweighing the risks, to accept specific nanotechnologies, and to agree with reassuring statements about environmental toxicology (Satterfield, Collins, Copeland, and Harthorn, readying for resubmission, 2016).
- Consumer products safety judgments are linked to judgments about nanomaterial safety (Collins, Copeland, Satterfield, and Harthorn, 2016 in prep). High correlation between perceptions of the quality of product testing and regulation and belief that the risks of ENM outweigh its benefits. Higher knowledge scores among men were predictive of benefits outweighing risks. Consumer preferences were also strongly driven by level of: confidence in scientific testing, degree of concern for the environment and level of skepticism about product testing and labels.
- Public's views on nanoethics indicate 4 robust factors that show responsible development ideals are well distributed in the US public even in this upstream context (Harthorn, Collins, and Satterfield, 2016 in prep).

The 2nd web survey (ERP2) of a larger and more representative sample (n=2500, with oversamples of 250 Latina/os and 250 African Americans) was completed late in 2012. Data analysis is far along (Satterfield, Harthorn, Collins, Copeland & Hasell), and a series of papers is planned for completion and submission in 2016.
Main findings include:

- Initial data analysis of ERP 2 survey (n=2500) completed with significant insights for the comparative meaning of different ecotypes for perceived environmental risks. Hypothesis from pilot data on the importance of resilience as a basis for predicting perceived risks and ENMs confirmed. Also found statistically signficant differences and high variability in perceived resilience across ecotypes with forest environments seen as most resilient and riparian and city ecozones as comparatively least resilient. Additonal new results explain the relationships between NEP's (New Environmental Paradigm) performance as an independent variable versus Resilience factor. New results on theories of intuitive toxicology, which uphold and add "bodily resilience" to existing factors. Multiple papers in various stages of drafting and review, see publications below

- High correlation between perceptions of the quality of product testing and regulation and belief that the risks of ENM outweigh its benefits. Higher knowledge scores among men were predictive of benefits outweighing risks. Consumer preferences were also strongly driven by level of: confidence in scientific testing, degree of concern for the environment and level of skepticism about product testing and labels.

- Comparative risk objects in this survey included 'fracking' and a paper is currently in preparation, and 2 presentations completed (the first an invited talk by Satterfield at a major UK environmental conference). The study reports on factor analysis showing that fracking is conceptualized very distinctly from nanotechnologies and other new technologies and appears more closely linked with more troublesome technologies such as guns.

This survey also provides a springboard for possible pilot research on synthetic biology under discussion in the group.

IRG 3-2c: Decision Pathway Survey; Satterfield, Gregory, Pidgeon, Demski, Hasell, Pitts

In 2013, the UBC-Decision Research-Cardiff team put in the field a novel comparative US-UK decision pathway survey to gain an understanding about public views on environmental technologies including nanotechnologies and geoengineering. The survey was run in parallel web survey modes by YouGov in the UK and US and produced a dataset w/ n=800 for each country in Fall, 2013. Pathway design and data collection and weighting of dataset is completed, along with analysis and test of 4 initial hypotheses. Team skype meetings to discuss results ongoing between Decision Research, UBC, and UCSB and clear differences between the US and UK on ideological positions regarding climate change and geo-engineering are now being analyzed.

IRG 3-2d: **Meta-analysis of 'the white-male effect';** Satterfield, Harthorn, DeVries, Pitt

Meta-analysis complete, results indicate pervasive citation errors that over-report differences in risk perception as a problem of 'gender' thereby reproducing the misleading conclusion that females are risk averse and failing to mention the overwhelming variance explained by sociopolitical variables and the fact that 'males' are the unique group as concerns risk perceptions and as compared to all other groups (nonwhite males, white and nonwhite females). This paper has been presented at conferences, some updating data analysis will be completed and paper will be completed in coming three months.

IRG 3-3: Public Participation in Nanotechnology and other Emergent Technologies R&D: Upstream Engagement and Deliberation Research; Harthorn, Pidgeon, Barvosa, Bryant, Rogers-Brown, Enders, Harr, Hasell, Partridge, Shearer, Stevenson, Thomas

IRG 3-3a. Work continued in the past year on analyses of the 2009 gender focused deliberations, with 1 paper in revise and resubmit, and 2 more in preparation based on new analyses. The Pidgeon Cardiff team's current work draws explicitly on CNS funded deliberative work and protocols (Pidgeon**,** Harthorn et al., 2009: *Nature Nanotechnology* publication) and the field of upstream engagement in nanotechnology more broadly. Harthorn continues work with Harr on medical anthropological analysis of nanomedicine/nano health/nano enhancement deliberations from 2007 and 2009 and is in discussion with several presses about a potential book on this topic.

Building on the 2007 and 2009 nano deliberations, and closely connected UK geoengineering and energy deliberations, the team led by Pidgeon and Harthorn with postdocs Partridge (US) and Thomas (UK), and project personnel Hasell and Stevenson (US) in 2014 initiated a new set of US-UK deliberations that build on the nano energy futures work to explore unconventional oil and gas (UOG) technologies, another upstream technology involving nanoscale chemicals, among other new technologies, in a context of significantly greater amplification of risk. The team conducted 3 day-long pilot workshops in the US and UK in Jun and Jul 2014, and ran 4 comparative US/UK workshops and 2 additional UK workshops in Oct & Nov 2014. Qualitative data analysis is in progress, and the first paper, just submitted for review, addresses the most salient cross-national comparisons in risk judgments about unconventional oil and gas. An additional series of publications is currently in preparation. In addition, the group published a report in Nov 2015 (Thomas et al., M4Shale 2015) that provides a depth review of the extant literature on public attitudes in the US and Canada. A journal article version of this report is also under review currently.

This new deliberative work provides further proof of concept for the deliberative workshop approach to new technologies developed in the CNS, with strong conceptual design leadership by Pidgeon from the UK. Pidgeon's leadership in this vital area of technology development is evident in the array of high profile presentations, testimony, and expert consultations he provides to the UK Government, leading international professional societies, and diverse publics.

Further extending this work, Harthorn and US project postdoc Partridge secured an additional award from NSF for 12 more months of proposed research in 2016-2017 after the conclusion of the CNS on the effects of 'urgency' appeals on public risk and benefit judgments.

IRG 3-3b: In a closely related project UCSB feminist political and social theorist Barvosa, continued a project to apply new theoretical analysis to IRG3 public deliberation research data, and to generate new theory building that relates CNS public deliberation research findings to related scholarly and policy debates on the growing the role of public deliberation in American democracy as part of large scale "deliberative systems." She has completed a book manuscript on this, currently under review and has published one journal article (Barvosa 2015). See X-IRG 7 Seed Grants for more information.

IRG 3-4: Industry risk perception study (International survey)—Project completed 2013; Harthorn**,** Holden**,** Satterfield**,** Engeman

This project, funded primarily through the UC CEIN IRG 7 (led by Harthorn), aimed to assess changes in industry EH&S views and practices and also add a new dimension of focused risk perception data on industry leaders in order to investigate links between perceived risk and behaviors such as company attention to and following of guidance documents for safe handling of nanomaterials, compliance with voluntary regulatory programs, attention to worker and environmental safety, waste management practices, and consumer safety. The first publication (Engeman et al. 2012) demonstrated that industry leaders combine moderate to high risk perception or risk uncertainty about the nanomaterials they handle while holding a number of views inconsistent with risk and uncertainty that we interpret as indicating the need for regulatory oversight, such as a 'go it alone' attitude about risk management, the view that workers are responsible for their own safety, and lack of adherence to now widely available guidance document recommendations for safe handling. The second and final publication out of the project (Engeman et al. 2013) focuses on the implications for worker safety of these findings for a US subsample (n=45) and is published in a leading industrial hygiene journal.

Although the active research on this project is concluded, the industry survey project has been of ongoing significant interest to NSE, industry, industrial hygienists, and regulators, as well as NGOs and publics, Harthorn continued service in Yr 11 on the Executive Committee and Theme 7 of the UC CEIN where this work has continued applicability.

IRG 3-5 Framing of Nano in Print and Social Media (see X-IRG-4 Friedman; and X-IRG-6 Stocking); Friedman, Egolf; Stocking, Bimber, Hasell

The study of print media framing of nano in the renewal award period has been conducted through 2014 by collaborator Friedman at Lehigh University and her team, reported below under X-IRG initiatives. Friedman and Egolf have completed 2 papers with a 3rd under review on these results.

In addition, reported under the X-IRG-6 Stocking project, IRG 3 Fellow Hasell has been working through the past year and a half with IRG 2 now former Fellow Stocking and faculty researcher Bimber on a robust new media dataset of Twitter data, extracting and analyzing comparative framing in the Twitter coverage of nano and fracking in the US and UK, for use in conjunction with IRG 3-3a (above). This work has resulted thus far in 1 publication and several other papers are in preparation or under review.

IRG 3-6: The Politics of Consumer Choice; Copeland, Bimber, Hasell

To increase understanding of political consumerism in relation to new technologies, this project addresses three main research questions. First, how should political consumerism be conceptualized as a form of political behavior? Second, does political consumerism represent an alternative form of participation or a broadening of the conventional participation repertoire? Finally, what motivates people to engage in political consumerism? The work incorporated nano products in its design. For her dissertation in Political Science at UCSB, Copeland designed and implemented a survey instrument to a nationally-representative sample of 2200 U.S. adults. She theorized key differences between boycotting and buycotting that are important to understanding how scholars should conceptualize political consumerism as a form of political behavior. Most of the literature attributes the expansion of political consumerism to the rise of postmaterialist values, but has offered limited empirical evidence to support this supposition. This research found that people with postmaterialist values are significantly more likely to engage in both boycotting and buycotting. However, people with pro-environmental beliefs are only significantly more likely to engage in buycotting. These findings demonstrate that the rise in postmaterialism and political consumerism in the U.S. is indeed linked. They also demonstrate the need to differentiate among postmaterialist values in future research.

Copeland completed her dissertation at UCSB in 2014 and has published a series of articles and chapters from this study with yet more in preparation. In addition, she has disseminated results of the study to political science, STS and other social science conferences in the US and Europe. In Sept 2015 she began a tenure track faculty position at Baldwin Wallace Univ.

IRG 3-7: NonGovernmental Organizations and Tomorrow's Nanotechnologies; Engeman, Harthorn, Earl**,** Appelbaum, Han, Rogers-Brown, Shearer

IRG 3-7a: **NonGovernmental Organizations and Tomorrow's Nanotechnologies**; Engeman, Harthorn, Earl

This project focuses on an important and often ignored type of public – the non-governmental, self-identified representatives of and advocates for the public. Examples of such organizations in the nanotech context include: Greenpeace, Environmental Defense Fund, and Friends of the Earth Australia. This research began in summer 2011 and continued through 2014 by mapping the NGO *field* by developing an exhaustive, global matrix of more than 182 NGOs engaging in nano-specific environmental, workplace, and consumer safety issues or their allied partners. The work asks why have some NGOs coalesced concern with nanotechnology as opposed other issues? Work on the nano-focused organization database and further developed a database and systematic summaries of comparative NGOs primarily concerned with other, non-nano environmental and human health issues, following the protocol developed and refined in other projects by collaborator Earl. Harthorn's interview for the August 2012 publication in *Nature* of an article on NGO possible roles in spurring eco-terrorist action against nanotech labs in Mexico stimulated examination of the full range of NGOs. One paper is in preparation on the results of this project. Engeman completed her doctorate in Sociology at UCSB in Dec 2015,

and she was been invited to continue in a visiting research position at the Social Science Research Center in Berlin (WZB) for 2015-16; she also continues is serving as an external expert with the European Trade Union Institute on “Occupational Safety and Health 2040," a 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. This honor and service is a direct outgrowth of her prior work on the IRG 3-4 Industry EHS Survey project.

In the reporting year this project’s larger role has been its continued contribution to the outcomes of CNS’s major public engagement via a large international conference/workshop convened at UCSB with NGO leaders Nov 15-17 2014. In 2015-16, Han, Appelbaum, Harthorn and Engeman co-authored the report CNS produced out of this project (Han et al. 2015, CNS), and with Harthorn, Engeman, Appelbaum and Han are co-editing the edited volume in preparation out of that conference, currently under review with Routledge.

IRG 3-7b: **Civil Society Responses to Emerging Technologies in Mexican and Brazilian Agriculture and Food;** Rogers-Brown, Shearer

This project began in 2012 and provides a strong link between IRG 3 work on NGOs, risk perception and action and IRG 2’s Latin America focus. Sociologist Rogers-Brown (a former CNS postdoc) interviewed 32 farmers activists, and biotech and nano-experts in Mexico in summer 2012 about their perceptions of biotechnology and nanotechnology in food and agriculture, and then, with sociologist CNS postdoc Shearer, conducted interviews with an additional sample of farmers, activists, and biotech nano-experts in Brazil on a similar range of issues and views. They have conducted data analysis and presented preliminary results at conferences, including at the S.NET conference in Montreal in Oct 2015, and are currently preparing 2 manuscripts for submission for review.

Rogers-Brown’s continued service as a representative for Sociologists for Women in Society to the UN Dept of Public Information provides CNS an excellent link to UN DPI meetings and resources. Rogers-Brown and Shearer also have co-authored 2 policy pieces on nanotech risk perception in 2014, working with policymakers in the state of California.

IRG 3 Co-funding:

Leverage in Yr 11:

1) Harthorn & Partridge. (NSF STS #1535193), $107,788, Postdoctoral Fellowship: Energy, Risk and Urgency - Emergent Public Perceptions of Unconventional Oil and Gas Extraction, Sept 2015-Aug 2017.
2) Pidgeon, et al. £10,000,000 Leverhulme Centre for Climate Change Mitigation (LC3M). June 2016-May 2025. This project will build upon the Cardiff CNS work on deliberating climate geoengineering and responsible innovation, to apply these methods and theories to the issue of advanced weathering for carbon sequestration (so-called ‘soft’ geoengineering) in a 10 year program of research coordinated by Sheffield University. The project will work with partners at University of Illinois Carl Woese Institute for Genomic Biology, as well as build links with CNS IRG3 partners at UCSB as the project develops.
3) Nel, Andre et al. (NSF DBI 1266377), $24,000,000. UC Center for Environmental Implications of Nanotechnology, UCLA, renewal, Sept 2013-Aug 2018. Harthorn is Theme 7 senior personnel and a member of the UC CEIN Executive Committee, 2013-2018. We are reporting only a portion of the UCSB subk of this award as leverage, but CNS through Harthorn,

Satterfield, and Kandlikar (and Freudenburg) have had a significant impact on this now $48M Center.
4) Pidgeon, 75,000 EURO. M4Shale: Measuring, monitoring, mitigating & managing the environmental impact of shale gas. WP4.3 - Translation of North American experience and 'lessons learned' about public acceptance of shale gas to Europe. From October 2015.
5) Friedman, $120,000, Lehigh University seed grants, 2013-15, on risk perception and earthquakes and hydraulic fracturing in Pennsylvania.

5. Broader Impacts of IRG 3
Key impacts on overall goals of the CNS. Include integration with other IRGs, value added, contributions to education and outreach efforts, media impact of work, etc.

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 (CNS seminars and visiting lectures; 2 years of participation in UCSB Critical Issues programs--Speculative Futures, 2011-2012 and Figuring Sea Level Rise, 2012-2013; IRG 3 deliberative forums; social media use; Weekly Clips service; website development).

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 work also intersects with that in IRGs 1 & 2 and X-IRG projects in ways that both draw on and contribute to those efforts. IRG 1 leader McCray's book length work on US public imaginaries and early nano development published in 2012 provides temporal and cultural depth to the public deliberation work in IRG 3 as well. IRG 1 work on nano medicine (November) also contributes to IRG 3 focus on nano health applications. IRGs 2 & 3 have multiple shared interests in issues of equitable development and science policy that have brought them together in a number of research lines, a past large scale conference (2009), and another large scale NGO conference held at UCSB in Nov 2014 with efforts by Harthorn & Engeman (IRG 3), Appelbaum & Han (IRG 2, et al. IRG 3 researchers Rogers-Brown and Shearer are pursuing CNS research in Mexico and Brazil in collaboration with IRG 2 collaborators Folodari, Invernizzi, and Lau. IRGs 2 and 3 also collaborate in development of the X-IRG work by Fredericks at Duke on the US and global nano industry, and the new media studies work on Twitter (X-IRG Stocking) involves direct collaboration of IRG 2 and 3 researchers at all stages. Seed grantees from both rounds of seed grant awards (Anderson, Novak—round 1; Barvosa—round 2) have worked closely with IRG 3, and their efforts expand the work of the team.

IRG 3 researchers have been active contributors to CNS education and outreach efforts in the past year. CNS IRG 3 research has been integrated into 5 graduate and 7 undergraduate courses in the past year, including Harthorn's ANTH 104 Risk and Inequality course (F15), ANTH 219 Anthropology of Risk (S15), and ANTH 240B Research Design and Writing (W 16), as well as workshop and courses on environmental risk and health offered by Collins at SUNY-ESF and on Qualitative Research Methods by Thomas at Cardiff. IRG 3 project personnel also gave 4 guest lectures in grad and undergrad courses in Anthropology, Global Studies, and Environmental Biology. See below and in Sections 11 & 12 for the full list of activities.

IRG 3 Publications 2015-2016

Primary publications: Journals

1. Gregory, Robin, Satterfield, Terre, & Hasell, Ariel. (2016). Using decision pathway surveys to inform climate engineering policy choices. *Proceedings of the National Academy of Sciences*, 113(3), 560-565. doi: 10.1073/pnas.1508896113

Primary publications: Books, Chapters, Reports and Other Publications

2. Copeland, L. & Atkinson, L. (forthcoming). Political Consumption: Ethics, Participation and Civic Engagement. In T. Newholm, A. Chatzidakis, M. Carrington, & D. Shaw (Eds.), *Ethics and Morality in Consumption: Interdisciplinary Perspectives*. New York: Routledge.
3. Harthorn, Barbara Herr. (2016). Unifying ethical concepts. In William Bainbridge & Mihail Roco (Eds.), *Handbook of Science and Technology Convergence*, ch. 54. Switzerland: Springer International. Switzerland: Springer International Publishing. ISBN-13: 978-3319070513 ISBN-10: 3319070517 (March 2016). Online publication 2015 DOI 10.1007/978-3-319-04133-2_54-1
4. Harthorn, Barbara Herr. (forthcoming). Nanotechnology. In Bryan S. Turner (Ed.), *The Encyclopedia of Social Theory*. NY: Wiley-Blackwell.

5. Harthorn, Barbara Herr. (forthcoming). Techno-benefits and social risks. In Lenore Manderson, Anita Hardon & Elizabeth Cartwright (Eds.), *The Routledge Handbook of Medical Anthropology*. London: Routledge.

6. Pidgeon, Nicholas F., Thomas, Merryn, Partridge, Tristan, Evensen, Darrick, Harthorn, Barbara Herr, & Kasperson, R.K. (forthcoming). Hydraulic fracturing: environment, energy security and affordability? In Roger E. Kasperson (Ed.), *Risk Conundrums*. Palgrave.

7. Pidgeon, Nicholas.F., Harthorn, Barbara Herr, & Satterfield, Terre. (forthcoming). Cross-national comparative communication and deliberation about the risks of nanotechnologies. In Dietram Scheufele, Dan Kahan and Kathleen Hall Jameson, K. (Eds.), *Oxford Handbook of Science Communication*. OUP.

8. Thomas, Merryn, Pidgeon, Nick, Evensen, Darrick, Partridge, Tristan, Hasell, Ariel, Enders, Catherine, & Harthorn, Barbara Herr. (2015). Public Perceptions of Shale Gas Operations in the USA and Canada: A Review of Evidence M4ShaleGas: Measuring, monitoring, mitigating and managing the environmental impact of shale gas. Netherlands: TNO-Netherlands Organization for Applied Scientific Research: The European Union's Horizon 2020 Research and Innovation Programme. Published online Jan 19 2016 at: http://m4shalegas.eu/reportsp4.html

Leveraged publications: Journal articles

9. Becker, A.B. & Copeland, L. (2015). Networked Publics: How Connective Social Media Use Facilitates Political Consumerism among LGBT Americans. *Journal of Information Technology & Politics* . Advance online publication.

10. Bimber, B., Cantijoch, M., Copeland, L. & Gibson, R. (2015). Digital Media and Political Participation: The Moderating Role of Political Interest Across Acts and Over Time. *Social Science Computer Review*, 33(1): 21-42.

11. Bimber, B. & Copeland L. (2013). Digital Media and Political Participation over Time in the U.S. *Journal of Information Technology & Politics*, 10(2): 125-137.

12. Cleveland, D.A., Copeland, L., Glasgow, G., McGinnis, M.V., & Smith, Eric R.A.N. (2016). The Influence of Environmentalism on Attitudes towards Local Agriculture and Urban Expansion. *Society and Natural Resources*, 29(1): 88-103.

13. Collins, Mary, Munoz, Ian, & JaJa Joseph. (2016). Linking 'Toxic Outliers' to Environmental Justice Communities Across the United States. *Environmental Research Letters*. 11(1), 1-9.

14. Collins, Mary B. (forthcoming). Double Disproportionality: a Framework for Integrating Environmental Privileges and Problems. *Social Science Quarterly.*

15. Copeland, L. & Roemmele, A. (2014). Beyond the Base? Political Parties, Citizen Activists, and Digital Media Use in the 2009 German Federal Election Campaign. *Journal of Information Technology & Politics*, 11(2): 169-185.

16. Copeland, L. & Bimber, B. (2015). Research Note on Variation in the Relationship between Digital Media Use and Political Participation in U.S. Elections over Time, 1996-2012: Does Obama's Re-election Change the Picture? *Journal of Information Technology & Politics*, 12(1): 74-87.

17. Copeland, L. & Roemmele, A. (2014). Beyond the Base? Political Parties, Citizen Activists, and Digital Media Use in the 2009 German Federal Election Campaign. *Journal of Information Technology & Politics*, 11(2): 169-185.
18. Corner, Adam, Markowitz, Ezra, & Pidgeon, Nick. (2014). Public engagement with climate change: the role of human values. *Wiley Interdisciplinary Reviews: Climate Change*, 5(3), 411-422. doi: 10.1002/wcc.269
19. Demski, Christina, Butler, Catherine, Parkhill, Karen A., Spence, Alexa, & Pidgeon, Nick F. (2015). Public values for energy system change. *Global Environmental Change*, 34, 59-69. doi: 10.1016/j.gloenvcha.2015.06.014
20. Engeman, Cassandra. (2015). Social Movement Unionism in Practice: Organizational Dimensions of Union Mobilization in the Los Angeles Immigrant Rights Marches. *Work, Employment & Society* 29(3), 444□461.
21. Partridge, Tristan. (2015). The Páramo, Where Water is Born. *Farming Matters*, 31, 8-9.
22. Partridge, Tristan. (2015). Recoupling Groups Who Resist: Dimensions of Difference, Opposition and Affirmation. *Journal of Resistance Studies*, 1(2), 12-50.
23. Partridge, Tristan. (forthcoming). Rural intersections: Resource marginalisation and the "non-Indian problem" in highland Ecuador. *Journal of Rural Studies*. doi: http://dx.doi.org/10.1016/j.jrurstud.2015.12.001
24. Thomas, Merryn, Pidgeon, Nick, Whitmarsh, Lorraine, & Ballinger, Rhoda. (2015). Expert judgements of sea-level rise at the local scale. *Journal of Risk Research*, 1-22. doi: 10.1080/13669877.2015.1043568
25. Thomas, Merryn, Pidgeon, Nick, Whitmarsh, Lorraine, & Ballinger, Rhoda. (2015). Mental models of sea-level change: A mixed methods analysis on the Severn Estuary, UK. *Global Environmental Change*, 33, 71-82. doi: 10.1016/j.gloenvcha.2015.04.009

Leveraged Publications: Books, Chapters, Reports and Other Publications

26. Engeman, Cassandra. (2015). How Social Movement Unionism Helped Shape the 2006 Immigrant Rights Marches in L.A. *USAPP American Politics and Policy blog*, London School of Economics.
27. Engeman, Cassandra. (2015). Family and Medical Leave in the U.S.: Incremental Policy and State Legislative Action, *UCLA Institute for Research and Employment*.
28. Henwood, Karen L. & Pidgeon, Nichoas F. (2015). Gender, ethical voices and UK nuclear energy policy in the post-Fukushima era. In Benham Taebi and Sabine Roeser (Eds.), *The Ethics of Nuclear Energy: Risk, Justice and Democracy in the post-Fukushima era*. Cambridge: Cambridge University Press.
29. Henwood, Karen L. & Pidgeon, Nicholas F. (2016). Interpretive environmental risk research: Affect, discourses and change. In J. Crichton, C. N. Candlin and A. S. Firkins (Eds.) *Communicating Risk*. Basingstoke: Palgrave MacMillan, 155-170.

30. Partridge, Tristan. (2016). Unconventional Action and Community Control: Rerouting Dependencies Despite the Hydrocarbon Economy. *ExtrACTION: Impacts, Engagements and Alternative Futures*. Walnut Creek, CA: Left Coast Press.

Submitted or in preparation publications: primary

31. Collins, Mary; Copeland, Lauren; Hanna, Shannon; Harthorn, B.H.; Satterfield, Terre. (In preparation). Nanotechnology Risk Judgment Analysis: Consumer Product Safety and Environmental Attitudes.

32. Collins, Mary; Copeland, Lauren; Harthorn, B.H.; Satterfield, Terre. (In preparation). NEP vs. Resilience: Developing a New Approach to Predicting the Acceptability of Hazards. .

33. Collins, Mary; Copeland, Lauren; Harthorn, B.H.; Satterfield, Terre. (In preparation). Rating the Risks: the Non-White Female Effect.

34. Cranfill, Rachel; Bryant, Karl; Shearer, Christine; Harthorn, Barbara Herr. (In preparation). What Kinds of Lay Expertise Matter? Public Science Deliberation and the Linguistic Construction of Traditional and Novel Expertise.

35. Harthorn, Barbara Herr; Bryant, Karl. (In preparation). Deliberating Socio-Techno Presents and Futures: Making Sense of New Technology Through the Lens of Inequality, Risk, and Difference.

36. Harthorn, Barbara Herr; Bryant, Karl; Rogers-Brown, Jennifer; Shearer, Christine. (In preparation). Gender and risk perception in deliberation of new technologies: Differences that matter. *Risk Analysis.*

37. Harthorn, Barbara Herr, Collins, Mary, and Satterfield, Terre. (in preparation) Upstream Ethics and Nanotechnologies in the US.

38. Harthorn, Barbara Herr, Copeland, Lauren; Satterfield, Terre; Collins, Mary. (In preparation). Factors Underpinning the Perceived Acceptability of Hazards.

39. Harthorn, Barbara Herr, Pidgeon, Nick; Satterfield, Terre (In Preparation). *Risk Perception and Nanotechnologies: A Synthesis of a Decade of Research*. CNS-UCSB Research Synthesis Report. Santa Barbara: University of California, Santa Barbara.

40. Partridge, Tristan, & Harthorn, Barbara Herr. (in preparation). Energy, environment and technology timeframes: On 'urgency' as a factor in risk/benefit perception.

41. Partridge, Tristan, Harthorn, Barbara Herr, Thomas, Merryn & Pidgeon, Nick. (in preparation). Deliberating unconventional oil and gas extraction: perspectives from California.

42. Partridge, Tristan; Harthorn, Barbara; Thomas, Merryn; Pidgeon, Nick; Hasell, Ariel, Stevenson, Louise, and Enders, Catherine. (In preparation). Deliberating ‘Fracking’ in the US and UK: Emergent views on shale development, energy futures and climate change. *Global Environmental Change.*

43. Rogers-Brown, Jennifer and Christine Shearer. (under review). Civil Society Responses to Emerging Technologies in Agriculture Case Studies in Mexico and Brazil. *Rural Sociology*.

44. Rogers-Brown, Jennifer and Christine Shearer. (under review). The Organics Question in the Mexican Context of Anti-GMO Activism. *The Journal of Peasant Studies*.

45. Satterfield, Terre, Collins, Mary, Copeland, Lauren, & Harthorn, Barbara. (In preparation). Risk, Resilience, and Cultural Politics in Emerging Debates About Fracking in the U.S.

46. Satterfield, Terre, Collins, Mary, Copeland, Lauren, & Harthorn, Barbara Herr. (in preparation). Bodily Resilience as a new Measure of Intuitive Toxicology.

47. Satterfield, Terre, Harthorn, Barbara Herr, DeVries, Laura, & Pitts, Anton. (in preparation). "Crude Proxies," Racializing Narrative: Reporting biases and citation errors attributed to the white male effect.

48. Thomas, Merryn, Pidgeon, Nick,Partridge, Evensen, Darrick, Partridge,Tristan, Hasell, Ariel, Enders, Catherine, Harthorn, Barbara Herr, and Bradshaw, Michael. (under review). Public perceptions of hydraulic fracturing for shale gas and oil in the United States and Canada. *WIREs Climate Change.*

49. Thomas, Merryn. (In preparation). The Town Council Game: a novel method for eliciting energy preferences in the US and UK.

50. Thomas, Merryn, Partridge, Tristan, Pidgeon, Nick*, and Harthorn, Barbara Herr. (under review). Deliberating upstream shale gas and oil extraction by hydraulic fracturing in the US and UK. Proceedings of the National Academy of Sciences.

Submitted or in preparation publications: leverage

51. Collins, Mary B. (under review) Considering Empirical Disproportionalities in Pollution Production the *Norm* Rather than the Exception. *Journal of Environmental Studies and Sciences*.
52. Hodges, Heather & Collins, Mary B. (In preparation). Using Distance to Account for Attitude Formation in the Case of U.S. Energy Policy. *Environmental Communication*.
53. Holden, Patricia, Gardea-Torresdey, Jorge, Klaessig, Fred, Turco, Ronald, Mortimer, Monika, Hund-Rinke, Kerstin, Cohen, Hubal, A, Elaine, Avery, David, Barcelo, Damia, Behra, Renata, Cohen, Yoram, Deydier-Stephan, Laurence, Ferguson, P.Lee, Fernandes, Teresa, Harthorn, Barbara Herr, Henderson, W. Matthew, Hoke, Robert, Hristozov, Danail, Johnston, John, Kane, Agnes, Kapustka, Larry, Keller, Arturo A., Lenihan, Hunter S., Lovell, Wess, Murphy, Catherine, Nisbet, Roger, Petersen, Elijah, Salinas, Edward, Scheringer, Martin, Sharma, Monita, Speed, David, Sultan, Yasir, Westerhoff, Paul, White, Jason, Wiesner, Mark, Wong, Eva, Xing, Baoshan, Steele Horan, Meghan, Godwin, Hilary A., & Nel, Andre E. (under review). Considerations of Environmentally Relevant Test Conditions for Improved Evaluation of Ecological Hazards of Engineered Nanomaterials. *Environmental Science & Technology*.

54. Partridge, Tristan. (under review). Reading Diagrams in Anthropology: Lines, Relations, Interactions. *HAU: Journal of Ethnographic Theory*, Special section (A Joyful History of Anthropology).

IRG 3 Presentations 2015-2016

1. Pidgeon, Nick. Communicating Risk and Uncertainties-the need for a strategic approach. Calculating Risk and Communicating Uncertainty Conference, UK, January 17, 2015.
2. Becker, Amy B., & Copeland, Lauren. Networked Publics: How Connective Social Media Use Facilitates Political Consumerism Among LGBT Americans. Workshop on Social Media and the Prospects for Expanded Democratic Participation in National Policy-Setting, Boston, MA, April 9, 2015.
3. Harthorn, Barbara, & Partridge, Tristan. Co-Chairs, Co-Organizers, Panel: Risk and Resilience: Hazards, Imagined Futures, and Emergent Responses to Fracking in the US. Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.
4. Copeland, Lauren, Harthorn, Barbara Herr, Collins, Mary, & Satterfield. Risk, Resilience, and Cultural Politics in Emerging Debates about Fracking in the U.S. Society for Applied Anthropology, Pittsburgh, March 24-28, 2015.
5. Collins, Mary, Harthorn, Barbara Herr, Copeland, Lauren & Satterfield, Terre. Fracking and Other Hazards: Towards Understanding the Spatial Aspects of Hazard Risk Acceptability Among U.S. Publics. Society for Applied Anthropology, Pittsburgh, March 24-28, 2015.
6. Partridge, Tristan, Harthorn, Barbara Herr, Thomas, Merryn, & Pidgeon, Nick. Recovery and the Deep Underground: Responses to Unconventional Resource Extraction in California. Society for Applied Anthropology, Pittsburgh, March 26, 2015.
7. Hasell, A; Hodges, H. Fracking in US and UK: A comparison of public framing of fracking in Twitter in the US and UK. Society for Applied Anthropology, Pittsburgh, PA, March 2015.
8. Partridge, Tristan. At the Mercy of the Future: Energy, Excess and Responsibility Amid Anthropocenic Climate Change. Conference on Approaching the Anthropocene: Perspectives from the Humanities and Fine Arts, UCSB, May 7-8, 2015.
9. Partridge, Tristan. Societal Responses to the Transforming and Reinforcing Roles of Extractive Technologies. The Place of Technology in Environmental Politics. British International Studies Association, London, June 2015.
10. Thomas, Merryn, Nick Pidgeon, Barbara Herr Harthorn & Tristan Partridge. Public perceptions of 'fracking': US/UK comparisons. Society for Risk Analysis-European meeting. Maastricht, Netherlands, June 15-17, 2015.
11. Collins, Mary. Challenges to Consider When Conducting Socio-Environmental Synthesis? Annual Meeting of the Association of Environmental Studies and Sciences, San Diego, June, 2015.
12. Collins, Mary & Galli, Anya. Power Disproportionalities: Linking Emissions Extremes to Social Forces. Meeting of the American Sociological Society ES&T Regular Paper Session, Chicago, August, 2015.

13. Bimber, Bruce, Copeland, Lauren, & Hasell, Ariel. Collective Action Frames, Organizations, and Same-Sex Marriage in the Context of Social Media. American Political Science Association, San Francisco, CA, September 3-6, 2015.
14. Beaudrie, C.E.H. Towards the acceptance of Alternative Test Strategies in nanomaterial risk assessment and regulatory decision making: A shifting paradigm. Society for the Study of Nanoscience and Emerging Technologies (S.NET), Montreal, Quebec, October 18-21, 2015.
15. Beaudrie, C.E.H. Fostering a sustainable future: Risk governance and the role of society in the development of nanotechnologies. Fourth Sustainable Nanotechnology Organization (SNO) Conference, Portland, OR, November 8-10, 2015.
16. Partridge, Tristan. Invited round-table participant, Extraction: Impacts, Engagements and Alternative Futures. American Anthropological Association, Denver, CO, November 11-14, 2015.
17. Partridge, Tristan. Energy and Urgency: Temporality in Views on Unconventional Fossil Fuels. Society for the Social Studies of Science, Denver, November 18-22, 2015.
18. Partridge, Tristan, Harthorn, Barbara Herr, Pidgeon, Nick, & Thomas, Merryn. Public Deliberation of Hydraulic Fracturing in the US. Society for Risk Analysis, Arlington, VA, December 6-9, 2015.
19. Harthorn, Barbara Herr, & Pidgeon, Nick. Co-Chairs/co-organizers, Public Perceptions of Fracking Risks: US and UK Perspectives Society for Risk Analysis, Arlington, VA December 6-9, 2015.
20. Pidgeon, Nick, Thomas, Merryn, Partridge, Tristan, & Harthorn, Barbara Herr. Public Deliberation of 'Fracking' for Shale Gas and Oil in Britain. Society for Risk Analysis, Arlington, VA December 6-9, 2015.
21. Barbara Herr Harthorn, Terre Satterfield, Mary Collins, Lauren Copeland, "Public Understanding of Fracking as an Environmental Hazard in the US." Paper presented at the Society for Risk Analysis, Arlington, VA Dec 6-9, 2015.
22. Gregory, Robin. Emergent Public Perceptions of Benefits of Nanotechnology. Society for Risk Analysis. Washington, D.C., December 6-10, 2015.
23. Hasell, Ariel and Galen Stocking. What's at Risk? A comparison of public discussion of fracking risks in Twitter in the US & UK. Society for Risk Analysis, Arlington, VA, December 2015.
24. Partridge, Tristan, and Harthorn, Barbara Herr. Co-Chairs, Panel on Intersections of Science and Society: Framing, Debating and Governing New Technologies. Society for Applied Anthropology, Vancouver, CA, March 29-April 2, 2016.
25. Satterfield, Terre, Discussant. Panel on Intersections of Science and Society: Framing, Debating and Governing New Technologies. Society for Applied Anthropology, Vancouver, CA, March 29-April 2, 2016.
26. Hasell, A; Hodges, H. Risk in Social Media: public perceptions of shale gas and oil extraction by hydraulic fracturing in the US and UK. Society for Applied Anthropology, Vancouver, BC, March 29 -April 2, 2016.
27. Partridge, Tristan, Harthorn, Barbara Herr, Pidgeon, Nick, & Thomas, Merryn. Deliberating Fracking: Emergent Views on Energy, Risk and Engagement. Society for Applied Anthropology, Vancouver, March 29-April 2, 2016.

28. Beaudrie, C.E.H. Towards the acceptance of Alternative Test Strategies in nanomaterial risk assessment and regulatory decision making: A shifting paradigm. Society for Applied Anthropology, Vancouver, March 29-April 2, 2016.
29. Partridge, Tristan, Extraction Roundtable Participant, Society for Applied Anthropology, Vancouver, March 29-April 2, 2016.

IRG 3 Outreach Activities 2015-2016

30. Harthorn, Barbara Herr. Environmental Exposure Workshop participant, UC CEIN, UCLA, March 18-19, 2015.
31. Hasell, Ariel. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.
32. Partridge, Tristan. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.
33. Stevenson, Louise. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015
34. Partridge, Tristan. Discussant, Political Economy and Development Working Paper Seminar Series, Orfalea Center for Global & International Studies, UCSB, May 1, 2015.
35. Harthorn, Barbara Herr. Chair/organizer/presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.
36. Stevenson, Louise, Enders, Catherine et al. Upstream Deliberations on Fracking Technologies: Protocol Design. Poster presentation, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.
37. Harthorn, Barbara Herr. Invited speaker, Congressional Briefing on 'Nanotechnology Policy: Evolving and Maturing', American Chemical Society, Washington, DC, October 9, 2015.
38. Harthorn, Barbara Herr. Participant, Office of Research NCURA Focus Group, UCSB, November 18, 2015.
39. Harthorn, Barbara Herr. Contributions and Legacy of a Decade of Societal Work on Nanotechnology. Invited plenary talk, NSF Nanoscale Science and Engineering annual meeting, Arlington, VA, December 6-9, 2015.
40. Harthorn, Barbara Herr. Poster Presentations of IRG 3 Research. World Anthropology Day, UCSB, February 28, 2016.
41. Hasell, Ariel. Presenter, Upstream Deliberation of Fracking. World Anthropology Day, UCSB, February 28, 2016.
42. Partridge, Tristan. Presenter, Upstream Deliberation of Fracking. World Anthropology Day, UCSB, February 28, 2016.
43. Beaudrie, Christian, Technological Status, and Risk Perceptions. Invited presentation at the Association for Environmental Health and Science in a special session “Environmental Impact of Nanotechnology.” March 23, 2016 San Diego, CA.

CNS X-IRG and Special Projects

Faculty and Senior Participants

J. Barandiaran, Seed project leader	Global studies	UC Santa Barbara
E. Barvosa, Seed project leader	Social/political theory	UC Santa Barbara
G. Gereffi, PI subk	Sociology	Duke Univ
J. Majewski, Seed project leader	History	UC Santa Barbara
A. Mehta, Seed project leader	Economics	UC Santa Barbara
R. Parker [IRG 2]		
C. Walsh, Seed project leader	Anthropology	UC Santa Barbara

Affiliates

S. Anderson, Seed project leader	Environmental politics	UC Santa Barbara
B. Egolf	Science journalism	Lehigh Univ
S. Friedman, PI subk	Science journalism	Lehigh Univ
M. Johansson	Anthropology	Gothenburg Univ
G. Legrady, Seed project leader	Media Arts & Tech	UC Santa Barbara
D. Novak, Seed project leader	Ethnomusicology	UC Santa Barbara

Postdocs (1), Graduate Students (12), and Technical Staff (1)

Postdocs:

Stacey Frederick, XIRG project	Business, GVC, GIS	Duke Univ

Graduate students:

Rosie Bermudez	Chicana/o Studies	UC Santa Barbara
Clayton Caroon	Global & Int'l Studies	UC Santa Barbara
Chloe Diamond-Lenow	Feminist Studies	UC Santa Barbara
Jacqueline Dodd	Economics	UC Santa Barbara
Rachel Drew	Global & Int'l Studies	UC Santa Barbara
Lisa Han	Film & Media Studies	UC Santa Barbara
Ariel Hasell [IRG 3]	Communication	UC Santa Barbara
Isabel Ochoa	Global & Int'l Studies	UC Santa Barbara
Laura Saldivar-Tanaka	Anthropology	Colegio de Mexico
Galen Stocking, XIRG project leader	Political Science	UC Santa Barbara
Marissa Taggart	Global & Int'l Studies	UC Santa Barbara
Caitlin Vejby	Global & Int'l Studies	UC Santa Barbara

Technical and Research staff:

Deborah Pierce	History	UC Santa Barbara

CNS X-IRG and Special Project areas

In addition to the main body of research work in the CNS conducted within the IRGs, a number of strategic 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

These projects include:

X-IRG 1: The Social Life of Nanotechnology (completed in prior year)

X-IRG 2: Solar Futures: Science and Business Life in the Race against Climate Change (completed in prior year)

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

X-IRG 1: *The Social Life of Nanotechnology:* Barbara Harthorn, John Mohr; project completed in prior year. Book published by Routledge July 2012.

* * *

X-IRG 2: Solar Futures: Science and Business Life in the Race against Climate Change; Christopher Newfield, Daryl Boudreaux, Zach Horton; project completed in prior year.

* * *

X-IRG 3: Global Value Chain for Nanotechnology; Stacey Frederick, Gary Gereffi

This project entails 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.

Data collection encompasses firms in all states (~1,500 locations), including for more than 100 products for California companies. 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.).

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 of them 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 primiarily 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 the reporting year, work has proceeded at Lehigh with one paper in press and the 2nd under review.

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

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

Based on his CNS research anthropologist Johansson initiated a new collaboration with anthropologist Åsa Boholm (Professor in Social Anthropology, Dept. of Global Studies at Gothenborg 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, while also returning to active fulltime researcher status. In Sept 2015 he began new ethnographic research among nanoscientists specialized in graphene. He has one journal article under review from his research in CNS, and gave research presentations at 4S (2015) and at Aalborg University, Denmark.

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X-IRG-6: Framing Nanotechnology in Social Media: Galen Stocking [IRG 2], Ariel Hasell [IRG 3]

In this project, graduate students Stocking and Hasell are attempting 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.

The team's previous research in this area has been on nanotechnology agendas. The have chosen to put this portion of the project on hold in favor of research into the type of language, because they felt that this was a more frutiful line of inquiry.

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 have completed one publication (Hodges and Stocking 2015), and presented it at two conferences. They are also conducting broader research on social media and emerging technologies. With an outside academic, we are also investigating Twitter activity around the oil industry. This project intersects 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, PI Harthorn has applied to the NSF for two supplements, in 2012 and 2013, to fund 2 waves of a new 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 2nd round in Spring 2014, for a total of $224,087.

Round 1 CNS Faculty Seed Grant Projects:

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

X-IRG-7-2: Bringing Science to Life: CNS Engagement Seed Grant; George Legrady, John V. Decemvirale; project completed in prior period.

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

This project's main research data collection is complete, and the PI is currently engaged in disseminating results via presentations (3 in the reporting period at Columbia University, in a keynote address at Indiana University, and at University of Virginia). 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. Novak also received an Academic Senate Faculty Research Grant of $10,000 to extend work on the project.

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

This project concluded in the prior reporting year, but project researcher Saldivar made a presentation on it at SNO in Nov, 2014, and Walsh has continued to conduct research on water quality and filtration systems in Mexico, and Saldivar has entered a PhD program that builds on this work. An anthropology graduate student at UCSB, Lindsay Vogt, is also developing a section of her doctoral thesis on water management that will deal with water quality and treatment. Walsh 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 an additional publication in Spanish in *Mundo Nano.*

Round 2 CNS Faculty Seed Grant Projects

X-IRG-7-5: Driving Development: The Lithium Trade in Bolivia, Argentina and Chile; Javiera Barandiaran, Clayton 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 IRG2 research on Latin American development and new technologies and builds on STS scholar Barandiaran's dissertation research on environmental policies and development in Chile.

In the reporting year, the project aims have been to: 1) travel to Bolivia for initial research into lithium extraction and processing policies there; 2) continue to keep abreast of news and scholarship related to the lithium economy. This has been well met, as Barandiaran travelled to Bolivia where she conducted interviews with experts in government, universities, industry, and NGOs working on lithium development, visited the Bolivian state corporation's lithium extraction plant at Llipi Llipi, collected relevant government documents, made initial contacts, and learned about lithium policies. She continues to keep abreast of lithium related news.

Barandiaran gave 3 presentations on this work: at the Latin American Studies Association Conf in May 2015 in San Juan, PR; at the Universidad Austral, Valdivia, Chilian in July 2015; and at the University of Santiago, Chile also in July 2015. She incorporated material on my 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.

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 IRG3 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 follow-up project has three aims: 1) to extend our 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. This research has been produced through a seed grant extending from July 1, 2014 - August 30, 2015

Progress has been made in each of the three project aims as follows:

1. Under aims 1 and 2 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 IRG3 collaborator Nick Pidgeon). All three are factors that arise in the IRG3 deliberation research. These form the basis of theoretical work outlined in aims 1 and 3 above. Chloe Diamond-Lenow and Rosie Bermudez have assisted me 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.

2. Under aims 1 and 3 Barvosa has integrated theoretical analysis developed in aim 1 into the heavy revision of an article submitted to the *Journal of Environmental Studies and Sciences*. This article was first and primarily funded by IRG3 research in public deliberation and major revision funded by this seed grant. 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. The essay was published in the *Journal of Environmental Studies and Sciences* (Barvosa 2015).

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

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.

For this reporting period, the key goal was analyzing a database of some 3,000 patents issued from 1848 to 1852 and then analyzing another database of patents from 1860. We then wanted to map each database using GIS techniques on a county by county level. We 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.

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. We 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).

XIRG and Seed Grant Publications 2015-16

Primary Publications: Journals

1. 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

2. Friedman, Sharon M, and Egolf, Brenda P. (2015) Nanotechnology Health Risks: Is the Public Getting the Whole Story? *JSM Nanotechnology & Nanomedicine* 3(1) 1036. Open Access.

3. Hodges, Heather E., & Stocking, Galen. (2016). A pipeline of tweets: environmental movements' use of Twitter in response to the Keystone XL pipeline. *Environmental Politics*, 25(2), 223-247. doi: 10.1080/09644016.2015.1105177

4. Mehta, Aashish, Herron, Patrick James, Cao, Cong, & Lenoir, Timothy. (2015). Research Diversification and Impact: The Case of National Nanoscientific Development. *SSRN Electronic Journal*. doi: http://dx.doi.org/10.2139/ssrn.2359278

5. Saldivar, Laura and Casey Walsh. 2015. "Nanotecnología para el tratamiento de agua. Claves sobre la investigaciónen México" *Mundo Nano* 8 (14), enero□junio. www.mundonano.unam.mx

Primary Publications: Books, Chapters, Reports and other Publications

6. Fastman, Brandon, Metzger, Miriam, & Harthorn, Barbara Herr. (Forthcoming). Forging new connections between nanoscience and society in the UCSB Center for Nanotechnology in Society Science & Engineering Fellows Program. In Kurt Winkelmann & Bharat Bhushan, eds., *Global Perspectives of Nanoscience and Engineering Education.* Springer.

7. Han, Xueying, Engeman, Cassandra, Appelbaum, Richard, & Harthorn, Barbara Herr. (2015). *Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures.* Santa Barbara, CA: University of California, Santa Barbara. Available for download at: http://www.cns.ucsb.edu/sites/www.cns.ucsb.edu/files/demtech/Democratizing%20Technologies%20Conference%20Report.pdf

8. Majewski, John. (2015). Not All Inequality is the Same. Paper presented at the History of Technology series, Washington, DC. http://equitablegrowth.org/report/not-all-inequality-is-the-same/

Leveraged Publications: Journals

Leveraged Publications: Books, Chapters, Reports and Other Publications

9. Stocking, Galen. (2015). *The Dynamics of Attention: Agenda Setting in the Modern Media Environment.* (PhD), Department of Political Science. University of California, Santa Barbara.

Submitted or in preparation publications: primary

10. Barvosa, Edwina. (Under Review). *Deliberative Democracy Now: Realizing Deliberative Systems on LGBT Civil Rights, Economic Inequality, and Climate Change*. Cambridge Univ Press.

11. Barvosa, Edwina. (In preparation). Theorizing Public Deliberation in Contexts of Political Polarization: Considerations on US Fracking and Democratic Science Governance.

12. Barvosa, Edwina. (In preparation). Theorizing Unconscious Bias in Institutional Settings and Policymaking.

13. Friedman, Sharon; Egolf, Brenda. (Under Review). Regulating Nanotechnology Risks: Traditional and Online Media Coverage in the US and UK.

14. Harthorn, Barbara Herr, Engeman, Cassandra, Appelbaum, Richard, & Han, Xueying. (in preparation). *Democratizing Technologies: Assessing the roles of NGOs in Shaping Technological Futures.* London: Routledge.

15. Johansson, Mikael. (Under Review). Risk perceptions and practice among nanoresearchers and toxicologists working with nanomaterials.

Submitted or in preparation publications: leverage

X-IRG Research Presentations 2015-2016

1. Novak, David. The Politics of Festival in Japan's Nuclear Village Center for Ethnomusicology, Columbia University, March 23, 2015.
2. Majewski, John. Why did Southerners Fail to Invest in Education before the Civil War? Economics History Workshop, Yale University, May 4, 2015.
3. Majewski, John. Slavery and the Death of Economic Creativity Before the Civil War Slavery Then, Today and Tomorrow, Augustana College, May 7, 2015.
4. Barandiaran, Javiera. Lithium Mining in the Andes Latin American Studies Association Conference, San Juan, PR, May 27-30, 2015.
5. Majewski, John. Slavery and Schumpeterian Capitalism Slavery Then, Today and Tomorrow. Augustanna College, May 2015.
6. Majewski, John. Slavery and Schumpeterian Capitalism. Yale University Economic History Workshop, New Haven, CT, May 2015.
7. Barandiaran, Javiera. Credibilidad científica y conflictos ambientales en Chile: algunas reflexiones. Universidad Austral, Valdivia, Chile, July 2, 2015.
8. Barandiaran, Javiera. ¿Qué rol juega la ciencia en decisiones colectivas en un estado que “raya la cancha”? University of Santiago Colloquium on Science, Citizenship, and Experts in Environmental Impact Evaluations, Santiago, Chile, July 13, 2015.
9. Fastman, Brandon. Educating Globally Conscious Nano Researchers: A Case Study From the Center for Nanotechnology in Society at UCSB Society for the Study of New and Emerging Technologies, Montreal, CA, October 18-21, 2015.
10. Stocking, G.; Hasell, Ariel; Han, S. Science on social media: How people discuss risks related to emergent technologies on social media Annual meeting of the Society for the Study of Nanosciences and Emerging Technologies, Montreal, CA, October 2015.
11. Johansson, Mikael. Research methods -- how to do participatory observation among nanoscientists. Aalborg University, Denmark, 2015.
12. Johansson, Mikael. Perception of risk among scientists working with nanomaterials. 4S Annual Meeting, Denver, CO, November, 2015.
13. Barandiaran, Javiera. "Strategic Resources for Development: the State and Contested Energy projects in South America”, at the Colorado School of Mines, February 16, 2016.

X-IRG Outreach Activities 2015-2016

1. Fastman, Brandon. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.

2. Metzger, Miriam. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.
3. Barandiaran, Javiera. Seed Grantee Presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.
4. Mehta, Aashish. Seed Grantee Presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.
5. Fastman, Brandon. Presenter, Outreach and Knowledge Transfer, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.
6. Metzger, Miriam. Presenter, Education, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.
7. Majewski, John. Slavery, Inequality, and Economic Creativity. Workshop for policymakers, Washington Center for Equitable Growth, Washington, DC, May 2015.
8. Fastman, Brandon. Societal and Ethical Implications of Nanotechnology World Anthropology Day, UCSB, February 28, 2016.

10. CENTER DIVERSITY - PROGESS AND PLANS

The CNS-UCSB community recognizes from experience that diversity strengthens the quality of research and the capacity to disseminate results to a wide range of audiences. Our diversity mission is 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 not accepted any new Graduate Fellows since Yr 9, is heading toward sunset of its research program, and concluded in Yr 8 the 3rd and final funding award for the institutional REU summer internship program that we had annually partnered on since Year 1, we have added relatively few participants. In fact, our focus has been on tapering activity. We made every effort, however, to sustain diversity in our center and to embed it as a value in our work.

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 11 CNS interns, 9 (82%) were minority (including African American, Asian, Latino/a, Mixed, Native American, and Pacific Islander). Three (27%) 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. 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 3 undergraduate students participated in the Center in Year 11, 2 (67%) of whom were female, 2 (67%) of whom reported Hispanic ethnicity. The academic majors of undergraduate participants included Psychology, Computer and Electrical Engineering, and Accounting. Past undergraduates have come from the fields of Biochemistry, Chemistry, Chinese, Environmental Studies, Geography, Global Studies, History, Linguistics, Psychology, and Women's Studies.

Graduate Students

The CNS-UCSB Graduate Research Fellowship program recruits 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 15 students have participated as CNS Graduate Research Fellows, 6 of whom received funding during the current reporting year 11. Two of the 9 (22%) were from the Sciences/Engineering, and 7 (77%) from the Social Sciences/Humanities. Five (56%) are female and 4 (44%) are male. One reported being of mixed Native American race and Hispanic ethnicity, and 1 of the 9 reported a disability. Two chose not to report race or ethnicity data. Their areas of study are: Communication; Ecology, Evolution, and Marine Biology; History; Material Science; Political Science; Sociology and Black Studies.

Non-Fellow Graduate Student Researchers
CNS-UCSB employs a number of graduate student researchers beyond the fellowship program, as do our partners. Thirteen graduate students from UCSB and partner institutions participated in the Center in these roles during the reporting period. Ten (77%) were female, and 3 (23%) were male. Five chose not to disclose race or ethnicity. Of the remaining, 1 was Asian.

Year 6-11 graduate students researchers (non-fellows) have come from fields including Anthropology; Biochemistry; Chemistry; Chicana/o Studies; Communication; Computer Science; Economics; Education; English; Environmental Science & Management; Feminist Studies; Film & Media Studies; Geography/GIS; Global & International Studies; History; History of Art & Architecture; Linguistics; Materials/Risk Science; Political Science; Risk 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 9 CNS-UCSB affiliated and active postdocs at all institutions in the reporting year include 5 females (56%). Two postdocs did not report race or ethnicity data. One was of Hispanic ethnicity, and 1 reported minority status (Asian).

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 current members 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 reporting year, 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 is a hallmark of CNS-UCSB, as shown above by the backgrounds of our student and postdoctoral participants. Our participants represent 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 (see e.g., Pidgeon 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 directly addresses the interactions of an increasingly diverse and global workforce. CNS-UCSB maintains 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 is 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 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. Total enrollment includes undergraduate and graduate students, both full- and part-time. 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 will have an international reach.

POSTS: UCSB is a partner institution and Harthorn a partner faculty member to CNS-ASU's Policy, Science, Technology & Society (POSTS) Scholars Program, 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 receives 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 is a participant in the POSTS program in the reporting year, and Harthorn is her mentor.

Evaluation

Section 11 described an evaluation of the Science and Engineering Fellows Program that has been undertaken by Coordinator Fastman in collaboration with Center leaders Metzger and Harthorn. 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. Questions on this matter 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.

11. EDUCATION

In Year 11, the CNS-UCSB Education Program continued its core mission of bringing together researchers and students in the social sciences, humanities, engineering, and sciences to foster critically needed and truly interdisciplinary collaborations. At the same time, CNS-UCSB scaled back activity and focused its resources on evaluation in anticipation of the Center's sunset. The Program's leadership team remained the same in Year 11. It was headed by Professor Miriam Metzger, a senior Communication scholar with expertise in new media, interdisciplinary collaborations between social researchers and scientists, and mediated education and outreach, with the assistance of Education Coordinator, Dr. Brandon Fastman, who joined the team in September 2013 after working in print media and teaching at UCSB. The following pages provide an overview of CNS-UCSB's Educational Program components and objectives; report on the progress of our programs for postdoctoral scholars and graduate students, and highlight some of our curricular contributions to teaching the ethical, legal, and societal implications (ELSI) of nanotechnologies and other emerging technologies in multiple educational environments during this reporting period. As this is primarily a year of no cost extension of the Center, some activities have necessarily been curtailed.

CNS-UCSB Education Program Objectives & Key Programs

CNS-UCSB brings together researchers and students in the social sciences, humanities, engineering, and sciences to create collaborative education programs. Throughout its history it has sponsored graduate fellowships, graduate student researchers, undergraduate and community college internships, and new curricula. The Education Program provides mentorship and educational opportunities to postdoctoral scholars working within and between the Center's Interdisciplinary Research Groups (IRGs). CNS staff also collaborates with education staff from the UCSB 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.

Program Summary

The Education Program's primary objectives were scaled down considerably during Year 11. With diminished resources and the impending conclusion of the center's funding, CNS-UCSB efforts pivoted from planning to reflection.

Training the next generation of interdisciplinary scholars:

- Continue postdoctoral scholars program.
- Host 3-6 speakers per year.
- Offer professional development in communication, research methods, and academic job practices.
- Provide funding and professional preparation for conference travel for Program participants
- Continue our ongoing formative and summative evaluation

Curricula Development and Dissemination:

- Annually increase the number of new or modified courses incorporating CNS-UCSB research

Creating a community across the disciplines (SS, Hum, NSE):

- Invite researchers representing multiple disciplines to speak in the CNS Research Seminar
- Invite participants from departments across campus to attend CNS public lectures and events across campus
- Track the home departments of participants attending the CNS Seminars
- Track the continuing participation of graduate students and postdocs after their funding ends
- Track CNS-UCSB participants' presentations both on and off the UCSB campus and at professional meetings and conferences

Evaluation

- Conduct a qualitative evaluation study of the Science & Engineering Fellowship program in which doctoral students from science and engineering departments were integrated into social science projects over a period of 10-plus years

Program Leadership

Education is a core goal of all Center activities, including research and outreach efforts. As measured by formal and informal feedback from participating students and postdocs, some of which will be reported in the following pages, CNS-UCSB has been very successful in training the next generation of scholars to conduct and understand high quality interdisciplinary research on the societal implications of science and technology.

Education Programs Overview

CNS-UCSB's Education programs are 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 research training received in the IRGs and at partner institutions, 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 are cross-disciplinary and provide 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 serve postdocs, graduate students, and undergraduates, as well as serving to integrate the full CNS community of scholars.

CNS-UCSB Postdoctoral Scholars and Researchers Program
CNS-UCSB provides research and training opportunities for postdoctoral scholars based at UCSB and in our collaborating institutions. During the past year, postdoctoral scholars and researchers have made important contributions to the success of CNS-UCSB programs and activities, including the NanoDays informal science education program at the Santa Barbara Museum of Natural History; the CNS Research Seminar in Emerging Technologies & Society; the national workshop; and the Society for the Study of Nanoscience and Emerging Technologies annual conference.

CNS has sponsored 22 postdoctoral researchers since the beginning of the current award (2010). Those active in the current reporting period are listed in the following table. Their work, CNS-UCSB's postdoctoral mentorship program, and program evaluation findings are described below.

CNS Postdoctoral Scholars and Researchers Active in Year 11

Postdoctoral Scholars	**PhD Field; Granting Institution**	**Affiliation**
Lauren Copeland	Political Science, UCSB	IRG 3
Luciano Kay	Public Policy, Georgia Institute of Technology	IRG 2
Xueying (Shirley) Han	Ecology, Evolution and Marine Biology, UCSB	IRG 2
Tristan Partridge	Anthropology, Edinburgh University	IRG 3
Non-UCSB Based Postdoctoral Researchers	**PhD Field; Granting Institution**	**Affiliation**
*Mary Collins	Environmental Sociology; UCSB	IRG 3
*Christina Demski	Risk and climate; Cardiff Univ	IRG 3
*Darrick Evensen	Technology Studies; Cornell Univ	IRG 3
*Stacey Frederick	Textile Mgmt.; Duke University	X-IRG, IRG 2
*Anton Pitts	Risk Science; U. of British Columbia	IRG 3
Merryn Thomas	Psychology; Cardiff Univ	IRG 3

* indicates postdocs funded partially or in full through other awards

Postdoctoral Researcher Program: Since 2010, the UCSB-based Postdoctoral Researchers Program has recruited 13 outstanding postdoctoral scholars from the U.S. and around the globe 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, Argentina, Canada, and UK in disciplines including City & Regional Planning, Ecology, Ecotoxicology, Geography, History, Political Science, Public Policy, Science & Technology Studies, Sociology, Social Anthropology, and Women's Studies. Several former postdoctoral scholars have gone on to faculty positions (Mary Collins at SUNY-ESF; Lauren Copeland at Baldwin Wallace College; Gwen D'Arcangelis at Scripps College and Cal State Pomona; Mikael Johansson at Sweden's University of Gothenburg; Philip McCarty at UCSB; Jennifer Rogers-Brown at Long Island University; Mary Collins at SUNY; Lauren Copeland at Baldwin Wallace College; and James Walsh at University of Ontario Institute of Technology). Matt Eisler is a visiting faculty member at the University of

Virginia. Others have continued on to new postdoctoral positions (Christine Shearer was at a Postdoctoral Research position at UC Irvine; Mary Collins was a Postdoctoral Fellow at the National Socio-Environmental Synthesis Center at University of Maryland; Shannon Hanna was a Postdoctoral Researcher at the National Institute of Standards and Technology and is now on staff as a Research Scientist). Others have pursued non-academic careers (Yasuyuki Motoyama is a senior program manager with the Kauffman Foundation; Shearer is Program Director for the NGO, Coalswarm). Since leaving UCSB, eight of the nine who have completed and left (Collins, Copeland, Eisler, Hanna, Johansson, Motoyama, Rogers-Brown, and Shearer) have continued to work on CNS-UCSB research projects as external affiliates.

IRG 3 continued postdoctoral researcher Tristan Partridge, who was hired in Summer 2014. Tristan Partridge, who received his PhD in Social Anthropology from the University of Edinburgh in June 2014, was hired as a full time researcher and US project coordinator on a project led by Harthorn, and UK collaborator Nick Pidgeon. At Edinburgh, Partridge worked as Research Fellow on the interdisciplinary project “Off The Grid, looking at relationships between people, technology and the environment in rural Scotland. This followed the completion of his doctoral research on value, precarity and political action conducted in highland Ecuador. His work examines links between resource relations, environmental justice and collaborative action in conditions of marginalization and uncertainty. His work at CNS-UCSB builds on a series of prior public deliberations conducted by IRG 3 on nanotechnologies’ environmental and health risks, on energy futures, and on gender and race in public participation. Partridge and Cardiff postdoc Thomas coordinated and co-facilitated with Harthorn and Pidgeon a series of four US-UK workshops, 3 pilots and two additional UK workshops in October and November 2014 on new technologies for hydrofracturing (fracking) processes for unconventional oil and gas extraction. Since then, they have been analyzing data, presenting their research and preparing and submitting publications.

CNS-UCSB also continued postdoc Xueying (Shirley) Han, who was formerly a Graduate Science Fellow with IRG 2. With IRG 2, she is investigating the emergence of Nanotechnologies in developing countries, particularly in China where she has specific knowledge and expertise. *Technology in Society* just accepted a paper on indigenous innovation in China that Han co-authored. In March 2014, Shirley published a paper based on surveys and interviews of international graduate students in STEM fields that are studying in the United States. She continues to lead a research stream that draws conclusions about the research climate in both the U.S. and the cultures from which these students originate. In addition, she is coordinating and co-editing a book manuscript based on our 2014 Democratizing Technologies conference.

A third postdoctoral researcher currently housed at CNS-UCSB is Luciano Kay. He joined IRG 2 in residence at UCSB in June 2012. Kay is an Argentine citizen who received his PhD from Georgia Tech in Public Policy, where he worked with CNS-ASU collaborators Philip Shapira and Jan Youtie. The pioneering work of Kay, Youtie, and Shapira on patent-mapping has received widespread attention. It was featured on the NSF homepage as well as the *MIT Technology Review* website and in *Wired UK* magazine. This reporting year, Kay has applied patent mapping and bibliometric analysis to understand innovation and corporate strategy in the development of synthetic biology applications as well as to study CNS-UCSB outcomes.

Former postdoctoral researcher Lauren Copeland continued working part time with IRG 3 researchers Satterfield, Harthorn, and Collins on the data analyses from the Environmental Risk Perception survey. She has since taken a tenure track position at Baldwin Wallace where she is also Associate Director of the Community Research Institute.

Former postdoctoral researcher Mary Collins continues close collaboration with IRG 3 researchers following her recent move from a post-CNS postdoc at SESYNC, the national ecology center, to a tenure track faculty position in Environmental Health at the College of Environmental Science and Forestry in the SUNY system, based in Syracuse.

Postdoctoral Researchers at Other Campuses: CNS-UCSB also supports postdoctoral researchers who work with our external collaborators, including 6 in the current period. We have funded in the past a full-time postdoctoral researcher at Duke University (Stacey Frederick) who works with sociologist Gary Gereffi and headed a Cross-Interdisciplinary Research Group (X-IRG) research project examining the impact of California nanotechnology in the global economy, working with both IRG 2 and IRG 3. In the reporting year, she has contributed effort to a Seed Grant project on worker skills (see X-IRG 7 Mehta project). In the past year we have fully supported the work of one postdoctoral researcher conducting public deliberation research with Nick Pidgeon at Cardiff University (Merryn Thomas); CNS also partially supported 2 researchers studying risk perceptions with Terre Satterfield at the University of British Columbia (Kieran Findlater and Anton Pitts). We integrate off-site postdoctoral researchers with other Center personnel and activities whenever possible. In the past we have invited all extramural postdocs to participate in CNS Research Summits and other conferences and to face-to-face IRG meetings that take place 2-3 times per year.

Postdoctoral Mentoring: CNS-UCSB postdoctoral scholars based at UCSB and other campuses participate in a variety of mentoring and professional development opportunities through our research, education, and outreach programs. The faculty leaders of the Interdisciplinary Research Groups (IRGs) are the primary research mentors for the postdocs who work with them. In addition to communicating with their postdocs by email and phone, the PIs meet regularly with their UCSB-based postdocs, both individually and at meetings of their IRGs. Off-campus-based postdocs participate in IRG team meetings via phone or Skype. In addition to funding their research, CNS-UCSB provides postdocs with financial and mentoring support to submit and present papers and research posters at professional conferences, workshops, and meetings (21 this year). Postdocs also participate in all CNS-UCSB research and advisory board meetings, where they are encouraged to discuss their research with CNS-UCSB's external collaborators and board members to expand their professional networks with leading nanotechnology researchers and science policy experts. They take an active role as research presenters Mary Collins at SUNY-ESF; Lauren Copeland at Baldwin Wallace College; in annual NSF site visits as well.

The Education Program supports postdocs by providing them with professional and personal development opportunities. Postdocs, including alumni/ae and those based at other campuses, are invited to give repeated public presentations about their research at CNS-UCSB Seminar meetings attended by CNS-UCSB faculty, postdocs and graduate fellows, along with other members of the campus and Santa Barbara communities. Although we ended the seminar this academic year, postdocs were active in the university research community. Tristan Partridge, for instance, gave several talks and guest lectures to students and faculty in Global Studies, Geography, and Anthropology, and all postdocs are encouraged to give practice presentations with CNS audiences prior to professional presentations or job talks.

In addition, the Education Program provides postdoctoral researchers and their mentors with the Individual Development Plan for Postdoctoral Fellows (IDP) developed by the Federation of American Societies for Experimental Biology (FASEB), a document utilized in many universities to identify and meet professional development needs and career objectives. Campus programs available to CNS-UCSB postdocs include the California Nanosystems Institute's Professional

Development Program for Postdocs and Graduate Students, as well as the UCSB Society of Postdoctoral Scholars, which provides training and other development opportunities for campus postdocs. 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). Indeed, former CNS postdoc Mikael Johansson, a labor scholar, served as president of the then-fledgling UCSB Society of Postdoctoral Scholars during his tenure in Years 5 & 6 of the CNS.

CNS-UCSB postdocs are kept informed about conference, publication, and professional opportunities sponsored by NSF, the NNI, and other entities addressing the societal implications of nanotech and science policy through daily CNS-UCSB listserv announcements. The listservs also include frequent announcements about CNS-UCSB activities, and those for lectures, events, and visitors to UCSB from NSE departments, the Bren School of Environmental Science and Management, the UCSB UC CEIN, the Center for Information Technology and Society (CITS), the Interdisciplinary Humanities Center, and social science and humanities departments. Postdocs are provided with $5,000/year for their own research travel and other relevant research expenses, in addition to IRG support funds.

CNS Graduate Fellows and Graduate Student Researchers

One of CNS-UCSB's most successful features is its integration of graduate students from a wide range of social science, humanities, science, and engineering disciplines into every facet of our research, education, and outreach programs. Graduate students participate in IRG research through our Graduate Fellowship Program and in Graduate Student Researcher positions. The Education Program provides these students with a variety of interdisciplinary professional and personal development opportunities to supplement their research training. A list of the 12 students who were active in Year 11 and descriptions of program activities are provided below.

CNS UCSB Graduate Fellows and Graduate Student Researchers during Year 11

Graduate Fellow	**UCSB Department**	**Affiliation**
Brian Tyrrell	History	IRG 1
Matthew Gebbie	Materials	IRG 2
Galen Stocking	Political Science	IRG 2/X IRG
Ariel Hasell	Communication	IRG 3/X IRG
Louise Stevenson	Ecology, Evolution & Marine Biology	IRG 3
Bridget Harr	Sociology	IRG 3
Grad Student Researcher	**Department/Campus**	**Affiliation**
Rosie Bermudez	Chicana/o Studies; UCSB	X-IRG
Clayton Caroon	Global & International Studies; UCSB	Seed grant
Chloe Diamond-Lenow	Feminist Studies; UCSB	Seed grant
Jacqueline Dodd	Economics; UCSB	Seed grant
Rachel Drew	Global & International Studies; UCSB	Seed grant
Cassandra Engeman	Sociology; UCSB	IRG 3/X-IRG
*Kieran Findlater	Env Sci; U. of British Columbia	IRG 3

Lisa Han	Film & Media Studies; UCSB	X-IRG
*Chaerean Kim	Institute for Resources, Environment & Sustainability; UBC	IRG 3
Isabel Ochoa	Global & International Studies; UCSB	Seed grant
*Laura Saldivar-Tanaka	Anthropology; Colegio de Mexico	Seed grant
Marissa Taggart	Global & Int'l Studies; UCSB	Seed Grant
Caitlin Vejby	Global & International Studies; UCSB	IRG 2

*Indicates partial or full co-funding

Research Fellowships in Social Science and Humanities and Science and Engineering: The Graduate Research Fellows Program is a 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. Graduate Fellows take lead roles in the Center's research, education, and outreach initiatives, and are trained within the IRGs in a unique joint context of social science and nanoscale science and engineering research and training.

Fellows, in residence at UCSB, work directly with their IRG PI mentors. Outstanding students were selected for the program through a campus-wide open recruitment. Social Science and Humanities Fellows are funded at a 20-hour per week time commitment, comparable to that required of UCSB teaching assistants. Science and Engineering Fellows are funded for a 10-hour per week commitment, allowing them to continue to participate fully in their laboratory-based research opportunities available through their home departments. Both Social Science and Humanities Fellowships and Science and Engineering Fellowships were awarded for one-year terms, with possibilities for renewal of up to two additional years. Because the center is at the end of its funding cycle, we did not recruit any new Fellows for Year 10 or 11. Therefore, we did extend those who wished to continue for a third year.

Six students were funded in the Graduate Fellowship Program over the course of the reporting year. Of those six, four have already secured new postgraduate positions. Matthew Gebbie, Louise Stevenson and Ariel Hasell accepted postdoctoral fellowships at Stanford University, UCSB, and the University of Pennsylvania respectively. At the very beginning of the reporting period, Galen Stocking became a Research Associate on the Journalism and Media Project at the Pew Research Center. Bridget Harr is teaching sociology at Bates College as she completes her PhD in Sociology. The other active Fellow, Brian Tyrrell continues his graduate work in UCSB's History Department and Environment and Society doctoral emphasis. Former Fellow Zach Horton was not active this year but he did graduate during the reporting period, and he has accepted a tenure track position in the English Department at the University of Pittsburgh.

Consistent with the noteworthy intellectual diversity in the CNS, the 6 Fellows active in the reporting year represented 6 academic disciplines (2 in the sciences, 3 in the social sciences, and 1 in the humanities).

In addition to their IRG research activities, the Education Program provides CNS-UCSB Graduate Fellows with many additional professional and personal development activities during the year. A number of these activities are organized under the auspices of the CNS Research Seminar on Emerging Technologies & Society (Sociology 591 or Communication 595), which includes 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. No longer in operation in this no cost extension year, in prior years 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 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.

During the reporting year, Graduate Fellows received funding and encouragement to attend professional meetings and conferences, including the 2015 S.NET Conference in Montreal, Canada, the 2015 4S meeting in Denver, the 2015 Society for Risk Analysis in Arlington, VA and 2015 Society for Risk Analysis-Europe meeting in Maastricht, Netherlands and a number of other domestic and international disciplinary and interdisciplinary meetings. CNS support enables their full participation as authors and presenters in such meetings and provides extensive networking opportunities.

Undergraduates

During years 1-8 of our funding, we took part in the *Internships in Nanosystems Science, Engineering and Technology* (INSET) summer internship program during which we provided research mentorships to 35 interns, primarily community college students and most of them from minority backgrounds or underserved communities. After year 8, INSET lost its NSF Institutional REU funding. Other centers on the UCSB campus have continued aspects of the program, although we felt that it was not within our budget to fund a revamped version of the program on our own, especially so close to the CNS-UCSB's sunset date.

In spite of this shift, CNS-UCSB still fulfills its mandate to create enriching educational experiences for undergraduate students. We still embed exceptional undergraduate students into our research teams, both at Duke University and here at CNS. Last year, we reported on Emily Nightingale who is now a Fellow at the Science and Technology Policy Institute, and Catherine Enders, who is still working with IRG 3. Enders, a Psychology major at UCSB, has contributed indispensable effort to the study of comparative US-UK fracking deliberations conducted by IRG 3. Her primary assignments have been to help with mixed methods data analysis and bibliographic research. Postdoc Tristan Partridge trained her in NVivo qualitative data analysis software and subsequently, she has used that skill to develop and implement a coding scheme for the narrative data from day-long deliberative workshops. More recently, she conducted exploratory data analysis in SPSS and Excel on the pre-/post-workshop survey data.

Under the mentorship of Director Harthorn, Enders has earned co-authorship on a number of publications, and she has won a number of honors, including funding through the UCSB Sustainability Research Program, inclusion in the CNS-ASU Program to Increase Diversity in Science and Technology Studies and Science Policy (POSTS), and an invitation to the same STPI fellowship that Nightingale was awarded. Enders has instead chosen to attend graduate school. After being accepted to several top programs, she plans to study health/biostatistics at either Harvard or UC Berkeley.

Also this year, IRG2 postdoctoral scholar Luciano Kay has mentored Jesus Diera, an undergraduate electrical and computer engineering student. Kay has trained him in cross-disciplinary bibliographic research methodologies that require programming expertise. With this training, Diera is currently aiding Kay in conducting an impact analysis of CNS-UCSB's ten-plus years of activity.

Science and Engineering Fellows Evaluation Study

Annual surveys have kept us informed on the general success of the Fellows Program. However, until this year we had not yet collected systematic detailed data on how the CNS Graduate Research Fellows Program influenced the work of young scientists and technologists once they graduate and enter professional life. To address this gap in evidence, we were granted a supplemental award from the NSF to conduct an evaluation of the Education Program that will offer a more robust and fine-grained understanding of the CNS Fellows Program's long-term successes and challenges. This study will serve as a model to help shape the design of future federally funded R&D Centers as well as interdisciplinary educational programs, no matter the funding source. More specifically, we would like to better understand one unique and specific element of the education program. That is the processes for and effects of integration of Science and Engineering Fellows into the Center's diverse portfolio of social and behavioral science research projects. So far, this evaluation project has gathered data on the activity on 11 of the 16 current and former CNS Science Fellows to answer two basic questions: 1) Has the Science Fellows 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 – made a difference in their practice of scientific inquiry or had any other beneficial effects, and 2) How so? Answering these deceptively simple questions will help future centers to duplicate and build upon the successes of CNS UCSB's Education Program.

The lead researcher on this project is Brandon Fastman, the Academic Coordinator at CNS who overseas the Education Program. Fastman has the advantage of familiarity with the CNS UCSB Fellows Program and with many of the Fellows. With a background in both academia and journalism, Fastman is practiced at conducting interviews and with interview methodology. A PhD in English, Fastman's intellectual background includes research in STS and coursework in cognitive science. Fastman is conducting this work in close collaboration with CNS Education Director & Professor of Communication Miriam Metzger and CNS Director & Professor of Anthropology Barbara Herr Harthorn.

Fastman presented this project at the 2015 S.NET conference in Montreal. He has also, along with Metzger and Harthorn, co-authored a book chapter for a forthcoming volume titled, "Global Perspectives of Nanoscience and Engineering Education." In this chapter, the authors elucidated three salient impacts of the Science & Engineering Fellows Program. Fellows reported: 1) greater facility for community with both scholars in other disciplines and the general public; 2) willingness to examine their own cognitive biases; and 3) a more sophisticated understanding of data and data analysis. Fastman continues to analyze these outcome data, and the team plans on publishing the final study findings in a science education journal.

Curriculum

Graduate Fellows Orientation Meeting: Typically, the academic year begins with an orientation that provides a primer on nanotechnology, an introduction to the center's leadership, and an overview of CNS-UCSB's mission, activities, and policies and procedures as well as specific background on each IRG's research programs. With no new Fellows admitted over the past two years, such an orientation was unnecessary in Year 11.

CNS Research Seminar: The CNS-UCSB Research Seminar on Emerging Technologies & Society (offered quarterly as Sociology 591 and Communication 595) was concluded at the end of the 2014-2015 academic year. It was the focal point of the Education Program's internal activities in past years. The quarterly seminar meetings (at least 4 per quarter) helped develop

an interdisciplinary community of scholars with special expertise and helped 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 and strategic projects.

Most of our seminars were open to researchers from the other NSF-funded Nano research centers on campus. Many of the sessions with outside speakers were advertised to the campus community, generating interest in CNS-UCSB research among departments such as Anthropology, Communication, East Asian Languages and Cultural Studies, Economics, Environmental Studies, Feminist Studies, Global & International Studies, History, Political Science & Sociology.

Seminar speakers during this reporting year who were also part of the CNS Speaker Series included the following:

- John Majewski, Professor of History and acting Dean of Humanities and Fine Arts, UCSB, “Slavery, Inequality and Economic Creativity in Nineteenth Century United States.”
- Greg Siegel, Associate Professor of Film and Media Studies, UCSB, “Accidents and the Origins of Forensic Reason.”

We also hosted one speaker after the seminar series ended. Karen Henwood, Professor of Social Sciences at Cardiff University gave a talk titled “Energy biographies, psychosocial research, and sustainable living.”

CNS-UCSB students have been able to broaden their formal education in areas related to their IRG research by participating in interdisciplinary doctoral emphases programs offered by UCSB. Four of particular relevance are those in Technology and Society, Feminist Studies, Global Studies, and Environment and Society. The interdisciplinary doctoral emphasis program in Technology and Society is organized through the UCSB Center for Information Technology and Society (CITS). CNS-UCSB faculty members Bimber, Harthorn, McCray and Metzger are all affiliated with CITS. The CITS former Director, Lisa Parks, is a member of the CNS-UCSB Executive Committee, and the current Director, Cynthia Stohl has a long history of close working relationships with CNS. The doctoral emphasis requires coursework in the areas of culture and history and society and behavior, and a dissertation on a topic concerning technology and society. All CNS faculty and students are kept informed about upcoming events and speakers in the CITS seminar and speakers series.

Classroom Curriculum: CNS-UCSB faculty, external collaborators and former Graduate Fellows incorporated Center research into 23 unique university courses during this reporting period, listed below. (Note that some courses were taught more than once per year, which is not reflected in the overall count of unique courses above.)

Graduate Level Courses:

- ANTH 219, Anthropology of Risk, UCSB, (Harthorn, Spring 2015)
- ANTH 240B, Research Design and Writing, UCSB, (Harthorn, Winter 2016)
- ANTH 240B, Research Design and Writing, UCSB (Partridge, guest lecture, Winter 2016)

- ANTH 277 Proseminar, UCSB (Harthorn, Guest Lecture, Fall 2015)
- *Bayesian Statistics for Ecologists and Social Scientists*, University of Maryland National Socio-Environmental Synthesis Center (Collins, 10-day Course co-taught with H. Thompson Hobbs \& Christian Che-Castaldo, January / August 2015)
- Environmental Studies 696, *Race, Class, & Environmental Justice*, SUNY-ESF (Collins, 2016)
- Soc 591, *Human / Human-made*, Drexel (Slaton, Spring 2014-2015)
- Sociology 591 or Communication 595, *CNS Research Seminar in Emerging Technologies and Society*, UCSB, taught 4 quarters / yr (Harthorn / Metzger)
- Summer Institute, *Standards in Society: A Critical Curricular Platform*, Drexel (Slaton, Summer 2015)

Undergraduate Level Courses:

- ANTH 104, *Risk and Inequality*, UCSB (Harthorn, Fall 2015)
- Geog 200b, *Place as Project*, UCSB (Partridge, Guest Lecture, Spring 2016)
- Global 2, *Global Economic and Political Processes*, UCSB (Appelbaum, Winter 2016)
- Global 173, *Energy in Global Societies*, UCSB (Barandiaran, Winter 2015)
- Global 173, *Energy in Global Societies*, UCSB (Partridge, Guest Lecture, Winter 2015)
- HIST 20, *Science, Technology, and Medicine in Modern Society*, UCSB (McCray, Spring 2015)
- HIST 451, *History of American Medicine*, University of South Carolina (November)
- HIST 108, *Science and Technology in World History*, University of South Carolina (November, Spring 2016)
- HIST 314, *Video Games and History*, University of South Carolina (November)
- Earth Sciences, *Introduction to Qualitative Research Methods*, Cardiff University (Thomas)
- *Environmental Effects of nanomaterials in lakes and Streams*, UCSB (Stevenson, Guest Lecture, Spring 2015)
- Environmental Health Science 350, *Environmental Health Management,* SUNY-ESF (Collins, Spring 2016)
- Environmental Health Science 250, *Foundations of Environmental Health*, SUNY-ESF (Collins, Fall 2015)
- Environmental Studies 496, *Race, Class, & Environmental Justice*, SUNY-ESF (Collins 2016)

Evaluation Databases

CNS-UCSB maintains databases containing diversity information about all undergraduates, graduate students, and postdoctoral researchers and scholars who participate in the education program. We keep anonymous responses from the annual surveys of postdoctoral researchers and graduate student fellows, and plan to develop future surveys addressing all levels of active participants. We also collect email addresses and department/interests information from attendees who provide this on sign-in sheets at our events. We use this information to identify the nature of the population that is interested in our activities, and it shapes our planning for future education, research, and outreach activities.

Website

The CNS-UCSB website provides 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 address nano and society issues at least in part. Resources for educators include course materials for the *Nanoscience in Society* community college course and the *Traveling Technologies* internship project. Both the community college course and the internship project were developed by CNS-UCSB beginning in 2011. 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 below in Section 12: Outreach and Knowledge Transfer.

Table 3a: Education Program Participants - All, irrespective of citizenship													
Student Type	Total	Gender		Race Data								Ethnicity: Hispanic	Disabled
		Male	Female	AI/AN	NH/PI	B/AA	W	A	More than one race reported, AI/AN, B/AA, NH/PI	More than one race reported, W/A	Not Provided		
Enrolled in Full Degree Programs													
Subtotal	**22**	**7**	**15**	**0**	**0**	**0**	**14**	**1**	**1**	**0**	**6**	**4**	**0**
Undergraduate	**3**	**1**	**2**	0	0	0	1	0	1	0	1	2	0
Masters	**6**	**1**	**5**	0	0	0	4	0	0	0	2	1	0
Doctoral	**13**	**5**	**8**	0	0	0	9	1	0	0	3	1	0
Enrolled in NSEC Degree Minors													
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Undergraduate	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Masters	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Doctoral	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Enrolled in NSEC Certificate Programs													
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Undergraduate	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Masters	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Doctoral	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Practitioners taking courses	**0**	0	0	0	0	0	0	0	0	0	0	0	0
K-12 (Precollege) Education													
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Teachers	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Students	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Total	**22**	**7**	**15**	**0**	**0**	**0**	**14**	**1**	**1**	**0**	**6**	**4**	**0**

LEGEND:	
AI/AN -	**American Indian or Alaska Native**
NH/PI -	**Native Hawaiian or Other Pacific Islander**
B/AA -	**Black/African American**
W -	**White**
A -	**Asian, e.g., Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, Other Asian**
More than one race reported, AI/AN, B/AA, NH/PI -	**Personnel reporting a) two or more race categories and b) one or more of the reported categories includes American Indian or Alaska Native, Black or African American, or Native Hawaiian or Other Pacific Islander**
More than one race reported, W/A -	**Personnel reporting a) both White and Asian and b) no other categories in addition to White and Asian**
US/Perm -	**U.S. citizens and legal permanent residents**
Non-US -	**Non-U.S. citizens/Non-legal permanent residents**

Table 3b: Education Program Participants - US Citizens and Permanent Residents													
Student Type	Total	Gender		Race Data								Ethnicity: Hispanic	Disabled
		Male	Female	AI/AN	NH/PI	B/AA	W	A	More than one race reported, AI/AN, B/AA, NH/PI	More than one race reported, W/A	Not Provided		
Enrolled in Full Degree Programs													
Subtotal	**18**	**6**	**12**	**0**	**0**	**0**	**12**	**1**	**1**	**0**	**4**	**4**	**0**
Undergraduate	**3**	**1**	**2**	0	0	0	1	0	1	0	1	2	0
Masters	**4**	**1**	**3**	0	0	0	3	0	0	0	1	1	0
Doctoral	**11**	**4**	**7**	0	0	0	8	1	0	0	2	1	0
Enrolled in NSEC Degree Minors													
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Undergraduate	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Masters	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Doctoral	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Enrolled in NSEC Certificate Programs													
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Undergraduate	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Masters	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Doctoral	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Practitioners taking courses	**0**	0	0	0	0	0	0	0	0	0	0	0	0
Total	**18**	**6**	**12**	**0**	**0**	**0**	**12**	**1**	**1**	**0**	**4**	**4**	**0**

LEGEND:	
AI/AN -	**American Indian or Alaska Native**
NH/PI -	**Native Hawaiian or Other Pacific Islander**
B/AA -	**Black/African American**
W -	**White**
A -	**Asian, e.g., Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, Other Asian**
More than one race reported, AI/AN, B/AA, NH/PI -	**Personnel reporting a) two or more race categories and b) one or more of the reported categories includes American Indian or Alaska Native, Black or African American, or Native Hawaiian or Other Pacific Islander**
More than one race reported, W/A -	**Personnel reporting a) both White and Asian and b) no other categories in addition to White and Asian**
US/Perm -	**U.S. citizens and legal permanent residents**
Non-US -	**Non-U.S. citizens/Non-legal permanent residents**

12. OUTREACH AND KNOWLEDGE TRANSFER

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 is a critical aspect of the NSEC and NNI mandates for responsible technology development. It is also vital to the economic success of the nano-enterprise. CNS-UCSB addresses these challenges through both its research and its outreach activities. The core CNS-UCSB societal implications research focuses on understanding and conducting comparative analysis of the views of the multiple stakeholders in emerging technology contexts, in order to engage them in mutual analysis, discussion, and, ultimately, decision making. To that end, CNS-UCSB pursues a multi-layered outreach and knowledge transfer program designed to integrate our research with our efforts to reach and interact with the multiple stakeholders in the growing nano-enterprise. Although the term "knowledge transfer" implies a one-way and top-down process of knowledge deposition, we strive to facilitate two- or even multi-way interaction between the scientific, scholarly, and social communities.

CNS-UCSB Outreach Activities to Nano Stakeholder Groups

NSE Community

Engagement through participatory research and activities 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. There are many reasons for this. We seek 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.

One important aspect of CNS-UCSB's engagement with the NSE community is in our commitment to the involvement of the NSE community at the very top of our organization. Five of the eight members of our National Advisory Board come from science backgrounds, including Co-Chair and Former Xerox PARC chief John Seely Brown**;** former CBEN (Rice Univ) leader chemist Vicki Colvin; Harvard nanoscientist and former NSEC director Robert Westervelt; and engineer Susan Hackwood, Director of the California Council on Science and Technology Policy. The Center's ten-member Executive Committee includes two physical and life scientists: materials scientist and MRSEC director Craig Hawker and microbiologist and environmental engineer Patricia Holden**.**

Research: Since our beginnings in 2006, members of all CNS-UCSB research groups have actively engaged 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 conducting ethnographic laboratory studies. CNS-UCSB researchers are engaged in studies across many domains of the nanoscience community.

IRG 1 historians conduct research and engage with the scientific community on a regular basis in their work. In collaboration with the Chemical Heritage Foundation (CHF), they have

conducted structured interviews with important nanoscale scientists and engineers with the goal of capturing their recollections of key meetings, events, discoveries and people. These oral histories are archived at the CHF and readily made available for others to use. Experts interviewed for this project come from many diverse nano fields, including nanoelectronics, nano solar, nanobio, nanomedicine, nanoecotoxicology, and include individuals from the US and abroad. Upon winning the Charles A. Lindbergh Chair in Aerospace and History for 2015-16, IRG 1 Leader Patrick McCray is spending a year in residence at the Smithsonian Air and Space Museum.

IRG 2 researchers have worked closely with NSE researchers in developing and understanding the contexts for international collaboration in their work. This year, Appelbaum was invited to address three interdisciplinary meetings about state policy regarding nanotechnologies—at Arizona State University, at the Atlanta Conference on Science and Innovation Policy and at the S.NET 2015.

IRG 3 has developed deep and lasting ties with both NSE and nanotoxicologists. CNS-UCSB is a funded partner in the UC Center for Environmental Implications of Nanotechnology at UCLA, in which Director Harthorn led the sole social science research group in its first 5 years and has served continuously on the leadership team, the UC CEIN Executive Committee. This involves extensive participation in all aspects of a 'Big Science' center, including conceptual planning of UC CEIN direction, the challenges of ENM risk assessment, serving as a voice for embedding societal implications issues within the structures and practices of the Center. Harthorn has collaborated with the UC Center for Lab Safety as they have sought to develop a risk perception survey of all UC laboratory researchers, based in part on the awareness of the value of risk perception research generating within the UC CEIN community at UCLA. This collaboration has led to joint education and outreach activities between UC CEIN and CNS-UCSB, the fostering of new projects with the wider societal implications community (e.g., Harthorn's participation as the sole social scientist in the March 2015 UC CEIN multi-stakeholder workshop on risk assessment led by Holden at UCLA), and the co-production of knowledge through collaborative research with UCSB engineer and microbiologist Patricia Holden, a professor in the Bren school of Environmental Science and Management and also a principal in the UC CEIN. IRG 3 has collaborated on the 2nd international survey of industry risk perceptions and safe handling practices for nano materials (see Engeman et al., 2012 and 2013; also Conti et al. 2008 on the 1st such survey). This project represents a highly successful integration of social science and nanoscale science expertises.

Publications: In publishing our results, CNS researchers have chosen 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*, and *Nature Climate Change*, and *Chemical Engineering*. Our researchers have been invited to attend and make presentations to meetings and conferences for the semiconductor industry, the software industry, the aerospace 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.

Education: One of the most successful and novel methods by which CNS-UCSB engages scientists and engineers has been to directly involve S&E graduate students in our work through our innovative interdisciplinary Graduate Fellowship program where they are embedded into the social science enterprise. Alongside their peers from the social sciences and humanities (4 in

the reporting year), Nanoscale Science and Engineering Graduate Fellows (2 in the reporting year) participate fully in the CNS-UCSB IRGs of which they are members, by attending IRG meetings, helping to design studies, and collecting and analyzing data, and co-authoring publications. The high value that many of the Fellows place on their experience with us is demonstrated by the ongoing commitment of past NSE Fellows to CNS-UCSB (including former Science Fellows Burks, Ferguson, Macala, Martin, Rowe, and Hanna), as shown by their continuing participation in our events and other activities even beyond the time they leave campus. We continue to keep alumni/ae Fellows informed of happenings through our listserv announcements and informal contacts by IRG leaders. To assess the program's enduring impacts, Education and Outreach Coordinator Fastman has conducted research interviews with a number of former Fellows as part of an evaluation study (See Section 11).

We also regularly partner on educational and outreach activities, such as NanoDays, with the faculty and staff of other NSF-funded nano organizations based at UCSB, including the NNIN, the MRSEC housed in the Materials Research Laboratory (MRL), and the UC CEIN, among others, and the California state funded UCSB California NanoSystems Institute (CNSI). We frequently invite scholars from these organizations to our talks and seminars, and they often attend. The appointment of CNS Executive Committee member Craig Hawker—who was named a AAAS Fellow in November—to the Directorship of the CNSI has enhanced this set of connections.

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), a term Harthorn based on Susan Nieman's work, *Moral Clarity* (2008) when she introduced it into the societal discussions at the Nano2 meetings in Evanston, IL, in March 2010. Participation in ongoing discussions of EU- and other frameworks for responsible innovation is also a central activity of senior CNS researchers (e.g., Pidgeon et al., 2013-15). In the past year, CNS researchers have continued to interact with policymakers at the state, federal, and international levels to share their research and its societal implications. IRG 3 researchers have published on media frames and nano consumer attitudes, climate change policy, EHS policy, Nano and public participation, and the impact of public perception on nano policy dialogues.

Policy Presentations: As the research agenda from the CNS has developed a consolidated set of research results on the *global innovation system* for nanotechnologies (IRGs 1 and 2) and issues regarding the *responsible development* of nanotechnologies (IRGs 2 and 3), CNS is increasingly being called upon and initiating opportunities to disseminate findings to key national (NNI, NNCO, NIOSH, EPA, NSF, US Congressional organizations), international (UK, EU, and Canadian governmental organizations) and state level organizations (CCST, DTSC). Some of these presentations during the reporting year are described below.

International: IRG 1 leader McCray was invited to participate in the World Economic Forum held in Davos, Switzerland. He delivered two presentations, and led a forum called "Ideas Making History." One of his talks, "A Brief History of Industrial Revolutions," is archived on the World Economic Forum Youtube channel at https://www.youtube.com/watch?v=jI06RtB-_q4&nohtml5=False. His talk was also covered by the *Financial Times* blog, Alphaville.

National: Director Harthorn has participated in several national policy-setting venues. In October, she was invited to speak in a Congressional briefing on "Nanotechnology Policy: Evolving and Maturing." The event, organized by the American Chemical Society, was live-

streamed, and a video recording is available to the public on Youtube at https://www.youtube.com/watch?v=JwHOILd39ms. The second volume of a report that drew from Harthorn's testimony at the Presidential Commission for the Study of Bioethical Issues, *Gray Matters: Topics at the Intersection of Neuroscience, Ethics, and Society*, was issued by the Commission in March 2015.

Harthorn's participation at the national planning level continued this past December when she delivered a plenary address, titled "Contributions and Legacy of a Decade of Societal Work on Nanotechnology," at the NSF NSEC annual meeting.

Last spring, IRG 1 researchers Mody and McCray as well as Seed Grantee John Majewski all participated in a policymaker workshop at the Washington Center for Equitable Growth. Workshop proceedings, which focused on the relationship between the history of technology and historical inequality, are published on the Center's website.

Maintaining CNS-UCSB's Base of International Researchers: While CNS-UCSB could not continue expanding our base of researchers in our ultimate reporting year, we did maintain a robust program of international collaboration, some of which (Pidgeon, Satterfield) we support with international subawards. These collaborations strengthen our ability to access and share data, policy analysis, and research efforts in other countries. The subawards support students and other researchers as well, further expanding the international reach of CNS. Our international presence is evinced by our presence at numerous international conferences and meetings in the reporting year.

Specific areas in which we have continued our international research include:

Asia: IRG2 has two partnerships that bring strong research ties into Chinese and Korean research networks (Xinyue Ye in China; Hyungsub Choi in Korea). We continue to work with Cong Cao, whose strong networks among academicians in China have enabled him to emerge as one of the leading experts on China's S&T reforms (see for example *Science* 2, August 2013: 460-462); and Denis Simon who was appointed Vice Chancellor of Duke Kunshan University during the reporting year.

Latin America: Appelbaum is Co-PI on a UC MEXUS/CONACYT grant (with collaborators Foladori and Invernizzi) to develop new research collaborations with Mexican scholars and, by extension, with other Latin America scholars through ReLANS, the Latin American Nanotechnology & Society Network. This project led to the year-long appointment of postdoctoral visiting scholar Edgar Zayago Lau at CNS-UCSB. A full professor in the Development Studies Academic Unit at Universidad Autonoma de Zacatecas, Lau serves as the technical secretary for the Latin American Network on Nanotechnology & Society (ReLANS/ www.relans.org) headquartered in Zacatecas, Mexico with one coordination office in Curitiba, Brazil.

Seed grantee Javiera Barandiarán, a native of Chile, strengthens CNS-UCSB knowledge and relationships in Latin America with her Seed project on lithium mining and development in Bolivia, Chile and Argentina. UCSB Postdoc Luciano Kay, a citizen of Argentina, studies development in Latin America, and continues to bolster CNS-UCSB's knowledge-base in this area.

Hosting International Research Visitors: CNS-UCSB has in the past hosted visiting international scholars from Brazil, Canada, China, Denmark, France, Germany, India, Mexico, The Netherlands, Spain, Sweden, Switzerland, and the UK, among others.

During this final Year 11, CNS-UCSB could not host any international scholars, although we did host a talk by psychologist Karen Henwood of Cardiff University in the UK.

Participation in Developing International Research Networks and Conferences: CNS-UCSB researchers have been active in strengthening existing, and developing new, networks among international researchers studying the societal implications of emerging technologies.

Nanotechnology in Society Network (NSN): Along with CNS-ASU's director Guston, Harthorn has 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 began as part of a community-wide workshop on societal implications of synthetic biology in Nov 2014 have continued throughout this reporting year.

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 for 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.

Presentations Abroad: This year, the S.NET 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. A cohort of IRG 2 researchers presented at the Society for the Advancement of Socioeconomics in London. Seed Grantee Javiera Barandiaran delivered two presentations at universities in Chile. This June, a number of IRG 3 researchers will present in a panel organized by Pidgeon and Harthorn at the Society for Risk Analysis Europe conference at the University of Bath.

Conference Presentations: CNS-UCSB researchers, including postdocs and graduate students, also make numerous public presentations to campus, local, regional, and wider audiences about the work of the CNS-UCSB. In the reporting year these presentations totaled at 40. See full listing at the end of this section. Additionally, CNS researchers, including graduate students and postdocs, organized numerous panels at scholarly conferences (e.g. Society for Applied Anthropology, Society for the Advancement of Socioeconomics).

Democratizing Technologies Conference

Results of the Year 10 conference, *Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures* (www.cns.ucsb.edu/demtech2014/welcome), endured into the current reporting year. Convened at the University of California, Santa Barbara November 11-13, 2014, the conference focused on NGOs with environmental and social justice concerns

regarding new technologies 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." The conference itself constituted an outreach and engagement activity as over thirty NGOs and 120 participants, from the local to the international, were represented. The conference's primary goal was to facilitate conversation between scholars who study NGOs, technologists who are inventing new tools, and the actual NGOs who are working to improve global health and wealth. In addition to that goal, CNS-UCSB continues to leverage the 3-day conference to reach an even wider audience.

With NSF supplement support to fund postdoc Han's dedicated effort on this project, CNS-UCSB prepared a final report on the conference that was disseminated to scholars, NGOs, and policymaking bodies including the NSF. She is also one of the co-editors, along with former Graduate Fellow and co-conference organizer Cassandra Engeman and IRG leaders Appelbaum and Harthorn, on a book volume derived from conference talks. The format will follow the Routledge volume edited by Parker and Appelbaum based on our 2009 *Emerging Economies, Emerging Technologies* conference on equitable development held in Washington DC. One strength of that publication that we plan to emulate is the inclusion of practitioner as well as scholarly contributions. Routledge is currently reviewing a book proposal that includes 16 chapters written by 18 contributors.

The conference also received media attention when, in January 2016, conference participant Tarun Wadhwa reported on a panel about workers' rights in the global economy for *Forbes*. The panel, focusing on workers' rights in the global economy, featured talks by Appelbaum; Executive Director of the Worker Rights Consortium, Scott Nova; and Vice President of Operations at Labor Voices, Ari Olmos. They are all quoted in the article which discusses the role that technology can play in helping multinational businesses to achieve the stated goals of their corporate social responsibility programs and avoid tragedies like the 2013 collapse of Rana Plaza in Bangladesh that killed 1,129 garment workers.

Workshops: In addition to regularly welcoming visiting scholars to Santa Barbara, CNS-UCSB has put on larger-scale events where entire communities of scholars can coalesce. In this concluding year we were unable to host any workshops this year, but we did bring national and international collaborators together for a series of final group meetings in Santa Barbara in March 2016. We took advantage of their presence by hosting a reception to celebrate the Center's collective accomplishments.

CNS researchers also regularly organize and participate in interdisciplinary workshops nationally and internationally. In addition to the aforementioned workshop at the Washington Center for Equitable growth, CNS researchers participated in a workshop on environmental exposure at UCLA (Harthorn) and an STS workshop at the Wuppertal Interdisciplinary Centre for Science and Technology Studies in Germany (Mody). IRG 1 collaborator November presented his research to a history workshop organized by the National Human Genome Research Institute (NIH) on the subject of the history of the Human Genome Project. One goal of the conference was to examine the historical connections between genomics and areas such as nanotechnology. The proceedings of that conference will be published in *Journal for the History of Biology* in 2017. Another IRG 1 collaborator, Amy Slaton leveraged her work with

CNS to win a grant from NIST for a summer workshop on the history of standards, July 12-22. CNS Graduate Fellow Brian Tyrrell attended the workshop.

Nanodays: CNS-UCSB participates in “NanoDays” events, the annual national program coordinated by the Nanoscale Informal Science Education (NISE) Network. Hands-on activities engage and promote understanding of nanoscale science and technology among children and members of the general public. These events are led by CNS-UCSB Graduate Fellows, Postdoctoral Scholars, and additional student volunteers. After hosting the event at both campus and community venues, CNS-UCSB began a continuing partnership with CNSI to co-host NanoDays starting in 2008. Additional partners joined the activity in 2010 and 2011, when we co-sponsored a NanoDays event at the Santa Barbara Museum of Natural History in collaboration with the museum, UCSB’s National Nanotechnology Infrastructure Network (NNIN) and UC CEIN, in addition to CNSI. Those events drew audiences of nearly 500 visitors per day, including families and children.

Nanodays 2015 took place on April 11-12, 2015. CNS Education Director Miriam Metzger, Coordinator Fastman, four CNS-UCSB Graduate Fellows (Stevenson, Hasell, Gebbie, Tyrrell) and Postdocs Han and Partridge were on hand to demonstrate a nano-sunblock experiment, a nano-food experiment, and to explain societal and ethical implications of nano to interested museum goers using posters supplied by NISE Net covering topics including nano and energy, nano toxicity, nano and safe drinking water, nanosilver in toys, and nano surveillance technologies and privacy. CNS-UCSB personnel also administered a game titled "Exploring Nano & Society - You Decide!" which is a hands-on activity where visitors sort and prioritize cards with new nanotechnologies according to their own values and the values of others. Visitors explore how technologies and society influence each other and how people’s values shape how nanotechnologies are developed and adopted. Another activity, "Exploring Nano & Society - Robots" asked visitors to imagine and draw what a nanoscale robot might look like, what support systems would surround it, and what other technologies it might enable, as well as what benefits it may bring and what dangers it may pose. Conversation around the nanobots leads even the youngest visitors to explore how technologies and society influence each other and how people’s values shape the ways nanotechnologies are developed and adopted.

The two-day 2015 NanoDays event was the most successful to date. It attracted 1,475 visitors of all ages and from a diversity of backgrounds to the Santa Barbara Museum of Natural History. (We reported attendance of 85 at our first CNSI-partnered Nanodays in 2008 which was held on campus at UCSB.) Although outside of the reporting period, Nanodays 2016 was held at the Santa Barbara Museum of Natural History on April 2-3. CNS-UCSB sponsored the event once again, providing funding, publicity, and volunteers. Attendance was 1,154.

World Anthropology Day: This past February, CNS-UCSB also used the Nanodays kits at a community outreach event hosted by the UCSB Anthropology Department. Coordinator Fastman ran the demonstrations while Director Harthorn, Postdoc Partridge, Fellow Hasell, and Undergrad Researcher Enders all presented on research related to IRG 3 upstream deliberations of hydraulic fracturing. The event attracted students from grade-school to graduate school as well as university faculty and staff.

Virtual and Media Outreach to Multiple Stakeholder Communities

The increasingly central role of the Internet in every form of social interaction means that CNS-UCSB must develop sophisticated online resources if we are to participate in the conversations

among stakeholders that are influencing the development of nanoscience and technology. Below are some of the tools we are using to reach these stakeholder audiences.

CNS-UCSB Website: The website is an important clearinghouse of information about CNS-UCSB. An upgrade to the Drupal platform in Year 8 along with continual reformatting have made it much easier for site viewers to find information about papers that were published by CNS-UCSB participants and, where possible, to read them.

In addition to news, event information, and podcasts of selected lectures by CNS-UCSB faculty and invited speakers, the website provides visitors with a broad overview of our activities: 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 searchable list of CNS-UCSB publications dating back to 2006; a list of presentations from the current and former reporting years, among other materials; and a news and media section containing a news item archive, as well as links to our videos.

Social Media: CNS-UCSB maintains a Facebook account and Twitter feed to help disseminate information about CNS-UCSB research as well as more general information about nanotechnology. As with disseminating news clips in the past, however, finding the time for robust ongoing maintenance without dedicated staff for this purpose has been challenging. Our affiliated scholars also maintain their own social media profiles as well as professional blogs that are not focused on but do sometimes incorporate CNS-UCSB research. Examples include utotherescue.blogspot.com co-written by X-IRG researcher Christopher Newfield; STEMequity.com, maintained by IRG 1 collaborator Amy Slaton; and McCray's Leaping Robot Blog (www.patrickmccray.com/blog). Other researchers actively participate in online forums. Seed grantee and longtime IRG 3 collaborator Aashish Mehta, for example, contributes to the World Bank Blog. Appelbaum and Han have started an Open Science Notebook for a new project studying Chinese undergraduate students in U.S. universities. In order to increase transparency and share knowledge, Open Science Notebooks document the primary research process, allowing members of the public to follow along.

Traditional Media: Traditional print media continue to be an important tool for reaching CNS-UCSB's nano stakeholder audiences. For this purpose, we continue to put out press releases in conjunction with UCSB's public affairs office, as well as online and through our listservs, and we make our researchers available for interviews with reporters from the local, national, and international press. Some examples from this reporting year include:

- Research on "superpolluters" by former postdoc Mary Collins was covered by *The Washington Post* ("It's not just Flint: Poor communities across the country live with 'extreme' polluters," January 27, 2016).
- Phys.org covered an IRG 3 publication about a decision pathway survey on geoengineering ("Researchers explore the use of decision pathway surveys to inform climate engineering policies," January 13, 2016).
- The website *Science Daily* also picked up the decision pathway story ("New tool for gauging public opinion reveals skepticism of climate engineering," February 1, 2016).
- *Forbes* online contributor Tarun Wadhwa reported on a panel that was held at our Democratizing Technologies conference ("Using Technology to Create Safe and Ethical Supply Chains," January 8, 2016). This article was also republished on the *Huffington Post*.

- IRG 2 collaborator Denis Simon was quoted as an expert source in a *Raleigh News & Observer* article about research infrastructure in China ("An Innovative China: A threat to Research Triangle Park?" January 8, 2016).
- Simon also appeared on the NPR program, *Here and Now*, to explain the significance of Chinese medical researcher Dr. Tu Youyou winning the Nobel Prize in natural science ("What Chinese Scientist's Nobel Win Says About Science in China," October 9, 2015).
- The *Financial Times* Alphaville blog covered one of Patrick McCray's talks at the World Economic Forum ("Davos: Historians dream of fourth industrial revolutions," January 20, 2016).
- McCray was a guest on NPR program *Science Friday* to discuss his research on science and aesthetics ("Museum Plays Art and Technology Matchmaker," August 21, 2015).
- IRG 1 collaborator Amy Slaton was interviewed by KYW News radio (CBS) in Philadelphia about diversity in STEM education ("Software Company's Effort to Recruit Women, Minorities Sparks Unexpected Reaction on Social Media," August 11, 2015).
- IRG 2 leader Rich Appelbaum was quoted in an *Outdoor Magazine* story about labor practices in textile supply chains ("The Dirty Secret Hiding in Our Outerwear," July 22, 2015).
- Slaton co-authored an op-ed (with Donna M. Riley of Virginia Tech) for *Inside Higher Ed* about engineering accreditation ("The Wrong Solution for STEM Education," July 8, 2015). She was also interviewed by the same outlet for a news article on the topic ("Measuring Competency," November 25, 2015).
- Postdoc Han wrote a post for the website, *The Conversation* ("STEMming Reverse Brain Drain: What would Make Foreign Students Stay in the US?" March 31, 2015)

Synthesis Reports: As CNS-UCSB approaches the end of its award cycle, it is important for us to both synthesize and share our work. To complete this task, NSF supplement support will enable IRG leaders to compose three synthesis reports based on the entire 10-year output of each interdisciplinary research group. Outreach Coordinator Fastman will play an editorial role in the production of these reports. Their goal is to explain to a policy audience the pivotal research findings of CNS-UCSB researchers as they pertain to the nano-enterprise as well as larger societal issues including responsible development, responsible innovation, public risk perception, sustainability, and equity. The reports will also be written with an eye toward the following secondary goals: illustrating the impact of the first federally funded societal implications center, accounting for the worthwhile investment in CNS-UCSB's research, providing a template for any future such endeavors, and providing a document that can be enlisted in support of proposals to support research that was begun under the auspices of the center but will hopefully continue after we close our figurative doors. IRG leaders have agreed on a format for these reports, and they dedicated a significant portion of the March meetings to drafting these documents with the input of their collaborators. Production and dissemination is planned for Summer 2016.

Presentations 2015-2016

A. Education and Outreach (to NSE, industry, government, media, public) N=40

Harthorn, Barbara Herr. Environmental Exposure Workshop participant, UC CEIN, UCLA, March 18-19, 2015.

Mody, Cyrus. Mel Chin and the Sciences of the '70s. Contemporary Art Museum, Houston, March 19, 2015.

Fastman, Brandon. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.

Gebbie, Matthew. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.

Han, Xueying. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.

Hasell, Ariel. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.

Metzger, Miriam. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.

Partridge, Tristan. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.

Stevenson, Louise. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015

Tyrrell, Brian. NanoDays volunteer. Santa Barbara Museum of Natural History. April 11-12, 2015.

Zayago, Edgar. Festival Cultural Zacatecas. Comentarista del libro “América Latina frente a la crisis y la financiarización” autores: Dr. Roberto Soto Esquivel y Dr. Aderak Quintana, Universidad Autónoma de Zacatecas, April 2015.

Majewski, John. Slavery, Inequality, and Economic Creativity. Workshop for policymakers, Washington Center for Equitable Growth, Washington, DC, May 2015.

Partridge, Tristan. Discussant, Political Economy and Development Working Paper Seminar Series, Orfalea Center for Global & International Studies, UCSB, May 1, 2015.

Appelbaum, Richard. Presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.

Barandiaran, Javiera. Seed Grantee Presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.

Fastman, Brandon. Presenter, Outreach and Knowledge Transfer, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.

Harthorn, Barbara Herr. Chair/organizer/presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.

McCray, Patrick. Presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.

Mehta, Aashish. Seed Grantee Presenter, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.

Metzger, Miriam. Presenter, Education, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.

Stevenson, Louise, Enders, Catherine et al. Upstream Deliberations on Fracking Technologies: Protocol Design. Poster presentation, National Science Foundation External Site Visit Review, CNS-UCSB, May 4-5, 2015.

November, Joseph. History of Distributed Computing. American Association for the History of Medicine, New Haven, CT, May 2015.

Mody, Cyrus. Historical Approaches to User Innovation MIT-Wharton NSF Conference, Philadelphia, PA, July 28, 2015.

Mody, Cyrus. The Pre-History of Responsible Innovation. Washington Center for Equitable Growth, Washington, DC, August 7, 2015.

McCray, Patrick. Guest speaker, Museum Plays Art and Technology Matchmaker, Science Friday on NPR, August 21, 2015.

Kay, Luciano. Network Analysis. 5th Global Tech Mining Conference, Atlanta, GA, September 15-16, 2015.

Appelbaum, Richard. China's Science and Innovation Policy: Will It Succeed? Atlanta Conference on Science and Innovation Policy, Atlanta, GA, September 17, 2015.

Appelbaum, Richard. China's Science and Innovation Policy: Will It Succeed? CNS-ASU, Tempe, AZ, October 6, 2015.
Harthorn, Barbara Herr. Invited speaker, Congressional Briefing on 'Nanotechnology Policy: Evolving and Maturing', American Chemical Society, Washington, DC, October 9, 2015.
Harthorn, Barbara Herr. Participant, Office of Research NCURA Focus Group, UCSB, November 18, 2015.
Harthorn, Barbara Herr. Contributions and Legacy of a Decade of Societal Work on Nanotechnology. Invited plenary talk, NSF Nanoscale Science and Engineering annual meeting, Arlington, VA, December 6-9, 2015.
McCray, Patrick. A Brief History of Industrial Revolutions. Invited talk, World Economic Forum, Davos, Switzerland, January 20, 2016.
McCray, Patrick. Discussion leader, 'Ideas Making History.' World Economic Forum, Davos, Switzerland, January 20, 2016.
McCray, Patrick. Sci-Fi Dreams. World Economic Forum, Davos, Switzerland, January 21, 2016.
Fastman, Brandon. Societal and Ethical Implications of Nanotechnology World Anthropology Day, UCSB, February 28, 2016.
Harthorn, Barbara Herr. Poster Presentations of IRG 3 Research. World Anthropology Day, UCSB, February 28, 2016.
Hasell, Ariel. Presenter, Upstream Deliberation of Fracking. World Anthropology Day, UCSB, February 28, 2016.
Partridge, Tristan. Presenter, Upstream Deliberation of Fracking. World Anthropology Day, UCSB, February 28, 2016.
Beaudrie, Christian, Technological Status, and Risk Perceptions. Invited presentation at the Association for Environmental Health and Science in a special session “Environmental Impact of Nanotechnology.” San Diego, CA, March 23, 2016
Tyrrell, Brian. NanoDays volunteer. Santa Barbara Museum of Natural History. April 2-3, 2016.

B. Research (N=61)

Pidgeon, Nick. Communicating Risk and Uncertainties-the need for a strategic approach. Calculating Risk and Communicating Uncertainty Conference, UK, January 17, 2015.
Novak, David. The Politics of Festival in Japan's Nuclear Village Center for Ethnomusicology, Columbia University, March 23, 2015.
Harthorn, Barbara, & Partridge, Tristan. Co-Chairs, Co-Organizers, Panel: Risk and Resilience: Hazards, Imagined Futures, and Emergent Responses to Fracking in the US. Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.
Brooks, James. Community-Based Resistance to Fracking in the Chama River Basin. Society for Applied Anthropology, Pittsburgh, March 24-28, 2015.
Copeland, Lauren, Harthorn, Barbara Herr, Collins, Mary, & Satterfield. Risk, Resilience, and Cultural Politics in Emerging Debates about Fracking in the U.S. Society for Applied Anthropology, Pittsburgh, March 24-28, 2015.
Collins, Mary, Lauren, Harthorn, Barbara Herr, Copeland, Lauren & Satterfield, Terre. Fracking and Other Hazards: Towards Understanding the Spatial Aspects of Hazard Risk Acceptability Among U.S. Publics. Society for Applied Anthropology, Pittsburgh, March 24-28, 2015.
Hasell, A; Hodges, H. Fracking in US and UK: A comparison of public framing of fracking in Twitter in the US and UK. Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.

Partridge, Tristan, Harthorn, Barbara Herr, Thomas, Merryn, & Pidgeon, Nick. Recovery and the Deep Underground: Responses to Unconventional Resource Extraction in California. Society for Applied Anthropology, Pittsburgh, March 26, 2015.

Becker, Amy B., & Copeland, Lauren. Networked Publics: How Connective Social Media Use Facilitates Political Consumerism Among LGBT Americans. Workshop on Social Media and the Prospects for Expanded Democratic Participation in National Policy-Setting, Boston, MA, April 9, 2015.

November, Joseph. Ahead of Sequence: The Biomathematics Research Center and the Question of Early Sequencing at NIH. Capturing the History of Genomics workshop at NHGRI, Bethesda, MD, April 29, 2015.

November, Joseph. Gaming for the Cure: Home Computer Users and Video Gamers in Medical Research. American Association for the History of Medicine, New Haven, CT, May 1, 2015.

November, Joseph. History of Distributed Computing. American Association for the History of Medicine, New Haven, CT, May 2015.

Majewski, John. Why did Southerners Fail to Invest in Education before the Civil War? Economics History Workshop, Yale University, May 4, 2015.

Majewski, John. Slavery and the Death of Economic Creativity Before the Civil War Slavery Then, Today and Tomorrow, Augustana College, May 7, 2015.

Partridge, Tristan. At the Mercy of the Future: Energy, Excess and Responsibility Amid Anthropocenic Climate Change. Conference on Approaching the Anthropocene: Perspectives from the Humanities and Fine Arts, UCSB, May 7-8, 2015.

Barandiaran, Javiera. Lithium Mining in the Andes Latin American Studies Association Conference, San Juan, PR, May 27-30, 2015.

Thomas, Merryn, Nick Pidgeon, Barbara Herr Harthorn & Tristan Partridge. Public perceptions of ‘fracking’: US/UK comparisons. Society for Risk Analysis-European meeting. Maastricht, Netherlands, June 15-17, 2015.

Collins, Mary. Challenges to Consider When Conducting Socio-Environmental Synthesis? Annual Meeting of the Association of Environmental Studies and Sciences, San Diego, June, 2015.

Appelbaum, Richard, Parker, Rachel, & Cao, Cong. Technology and Innovation in China -- China's Evolving Role in the Global Science and Technology System. Society for the Advancement of Socioeconomics, London, July 2, 2015.

Simon, Denis. China's International Science and Technology Relations: From Passive to pro-Active Player. SASE (Society for the Advancement of Socioeconomics), London School of Economics, July 2, 2015.

Parker, Rachel. Is China Becoming a Hi-Tech Superpower? Measuring Success – and Failure. SASE (Society for the Advancement of Socioeconomics), London School of Economics, July 2, 2015.

Cao, Cong. China’s Science and Technology Enterprise: Can Government-Lead Efforts Successfully Spur Innovation? SASE (Society for the Advancement of Socioeconomics), London School of Economics, July 2, 2015.

Barandiaran, Javiera. Credibilidad científica y conflictos ambientales en Chile: algunas reflexiones. Universidad Austral, Valdivia, Chile, July 2, 2015.

Barandiaran, Javiera. ¿Qué rol juega la ciencia en decisiones colectivas en un estado que “raya la cancha”? University of Santiago Colloquium on Science, Citizenship, and Experts in Environmental Impact Evaluations, Santiago, Chile, July 13, 2015.

Collins, Mary & Galli, Anya. Power Disproportionalities: Linking Emissions Extremes to Social Forces. Meeting of the American Sociological Society ES&T Regular Paper Session, Chicago, August, 2015.

Bimber, Bruce, Copeland, Lauren, & Hasell, Ariel. Collective Action Frames, Organizations, and Same-Sex Marriage in the Context of Social Media. American Political Science Association, San Francisco, CA, September 3-6, 2015.

Kay, Luciano, Huang, Ying, Porter, Alan, Youtie, Jan, & Zhu, Donghua. Funding Proposal Overlap Mapping: A Tool for Science and Technology Management. 5th Global Tech Mining Conference, Atlanta, GA, September 15-16, 2015.

November, Joseph and George Forsythe. The ACM, and Creating a 'Science of the Artificial'. Society for the History of Technology (SHOT), Albuquerque, NM, October 9, 2015.

Slaton, Amy. The Impossible Necessity of Diversity. Society for the History of Technology, Albuquerque, NM, October 10, 2015.

Slaton, Amy. Nano-Eyes, Nano-Hands, and the Stratification of Nano-Labor. 9th Laboratory History Meeting, Albuquerque, NM, October 11, 2015.

November, Joseph. The Medical Record and the 50-Year Challenge to Computing. SIGCIS History of Computing Workshop, Albuquerque, NM, October 11, 2015.

Han, X; Appelbaum, R; Cao, C. China's Science, Technology, Engineering, and Mathematics (STEM) Research Environment. Society for the Study of Nanoscience and Emerging Technologies (S.NET), Montreal, October 18-21, 2015.

Kay, Luciano. Center for Nanotechnology in Society, University of California Santa Barbara CNS-UCSB. Preliminary findings of an impact study. Society for the Study of Nanoscience and Emerging Technologies (S.NET), Montreal, Québec, Canada, October 18-21, 2015.

Appelbaum, Richard. Invited plenary address, The Role of the State in Regulation and Public Policies About Nanotechnologies S.NET, Montreal, CA, October 19, 2015.

Mody, Cyrus. Science as Occupation and Avocation: Deflating Science without Disenchanting It. IZWT 10th Anniversary workshop, Wuppertal, Germany, November 5, 2015.

Slaton, Amy. Selves Measured, Measuring Nature. History of Science Society, San Francisco, CA, November 20, 2015.

Slaton, Amy. Diversity in the Meritocracy: Thinking about Talent and Identity in High-Tech America. Department of History, Department of History, Texas A & M University, December 2, 2015.

Mody, Cyrus. The Countercultural Politics of Interdisciplinarity: Stanford circa 1970. Descartes Center colloquium, Utrecht, NL, January 19, 2016.

Han, X; Appelbaum, R. China's STEM Research Environment. AAAS Annual Meeting Washington D.C., February 11-15, 2016.

Zayago, Edgar. Hacia un análisis de la cadena de valor de las empresas nanotecnológicas en México CINVESTAV, Zacatenco. Seminario de Programas Transdisciplinarios, May 2016.

Zayago, Edgar. Creating a database of Mexican Nanotech-companies. UdeG CULAGOS, June 2016.

Beaudrie, C.E.H. Towards the acceptance of Alternative Test Strategies in nanomaterial risk assessment and regulatory decision making: A shifting paradigm. Society for the Study of Nanoscience and Emerging Technologies (S.NET), Montreal, Quebec, October 18-21, 2015.

Fastman, Brandon. Educating Globally Conscious Nano Researchers: A Case Study From the Center for Nanotechnology in Society at UCSB. Society for the Study of New and Emerging Technologies, Montreal, CA, October 18-21, 2015.

Stocking, G.; Hasell, Ariel; Han, S. Science on social media: How people discuss risks related to emergent technologies on social media. Annual meeting of the Society for the Study of Nanosciences and Emerging Technologies, Montreal, CA, October18-21, 2015.

Beaudrie, C.E.H. Fostering a sustainable future: Risk governance and the role of society in the development of nanotechnologies. Fourth Sustainable Nanotechnology Organization (SNO) Conference, Portland, OR, November 8-10, 2015.

Partridge, Tristan. Invited round-table participant, Extraction: Impacts, Engagements and Alternative Futures. American Anthropological Association, Denver, CO, November 11-14, 2015.

Johansson, Mikael. Perception of risk among scientists working with nanomaterials. 4S Annual Meeting, Denver, CO, November 18-22, 2015.

Partridge, Tristan. Energy and Urgency: Temporality in Views on Unconventional Fossil Fuels. Society for the Social Studies of Science, Denver, November 18-22, 2015.

Johansson, Mikael. Research methods- how to do participatory observation among nanoscientists. Aalborg University, Denmark, 2015.

Harthorn, Barbara Herr, & Pidgeon, Nick. Co-Chairs/co-organizers, Public Perceptions of Fracking Risks: US and UK Perspectives Society for Risk Analysis, Arlington, VA December 6-9, 2015.

Partridge, Tristan, Harthorn, Barbara Herr, Pidgeon, Nick, & Thomas, Merryn. Public Deliberation of Hydraulic Fracturing in the US. Society for Risk Analysis, Arlington, VA, December 6-9, 2015.

Pidgeon, Nick, Thomas, Merryn, Partridge, Tristan, & Harthorn, Barbara Herr. Public Deliberation of 'Fracking' for Shale Gas and Oil in Britain. Society for Risk Analysis, Arlington, VA December 6-9, 2015.

Barbara Herr Harthorn, Terre Satterfield, Mary Collins, Lauren Copeland, Public Understanding of Fracking as an Environmental Hazard in the US. Paper presented at the Society for Risk Analysis, Arlington, VA Dec 6-9, 2015.

Hasell, Ariel and Galen Stocking. What's at Risk? A comparison of public discussion of fracking risks in Twitter in the US & UK. Society for Risk Analysis, Arlington, VA, December 6-9, 2015.

Barandiaran, Javiera. Strategic Resources for Development: the State and Contested Energy projects in South America, Colorado School of Mines, February 16, 2016.

Partridge, Tristan, and Harthorn, Barbara Herr. Co-Chairs, Panel on Intersections of Science and Society: Framing, Debating and Governing New Technologies. Society for Applied Anthropology, Vancouver, CA, March 29-April 2, 2016.

Satterfield, Terre, Discussant. Panel on Intersections of Science and Society: Framing, Debating and Governing New Technologies. Society for Applied Anthropology, Vancouver, CA, March 29-April 2, 2016.

Hasell, A; Hodges, H. Risk in Social Media: public perceptions of shale gas and oil extraction by hydraulic fracturing in the US and UK. Society for Applied Anthropology, Vancouver, BC, March 29-April 2, 2016.

Partridge, Tristan, Harthorn, Barbara Herr, Pidgeon, Nick, & Thomas, Merryn. Deliberating Fracking: Emergent Views on Energy, Risk and Engagement. Society for Applied Anthropology, Vancouver, March 29-April 2, 2016.

Beaudrie, C.E.H. Towards the acceptance of Alternative Test Strategies in nanomaterial risk assessment and regulatory decision making: A shifting paradigm. Society for Applied Anthropology, Vancouver, March 29-April 2, 2016.

Partridge, Tristan, Extraction Roundtable Participant, Society for Applied Anthropology, Vancouver, March 29-April 2, 2016.

13. SHARED AND OTHER RESEARCH FACILITIES

CNS-UCSB's infrastructure needs for the societal implications research are well met through UCSB and partner organizations.

1) CNS-UCSB
CNS is housed in a centrally located building on campus that allows effective coordination and communication among all participants. The main facilities for CNS are a suite of contiguous offices in Girvetz Hall, providing space for all CNS personnel in proximity among researchers, staff, and infrastructure, with ample conference and meeting space. The commitment of this space (by the Executive Vice Chancellor, College of Letters and Science, and Dean of Social Sciences) to the CNS on a continually space-constrained campus is a strong mark of support for our interdisciplinary research and education efforts. Since 2011, the College of Letters and Science has generously provided an additional contiguous office to accommodate the needs of CNS' numerous visiting scholars and researchers. We continue to have access as needed to additional space for larger meetings, conferences, seminars, and other gatherings in the **Institute for Social, Behavioral & Economic Research** (ISBER) in North Hall, Global and International Studies, and other campus locations. ISBER additionally provides the organized research infrastructure for CNS through 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 UCSB CNSI offers a unique set of resources that contribute to the collaborative, interdisciplinary nature of the Center. Completed early in the first award period, CNSI is a dedicated Institute building that serves as a state-of-the-art laboratory facility and hub for many of the nanoscientists and engineers working on campus. It includes a consolidated 10,000 square foot Materials Characterization Laboratory, equipped with NMR, electron microscopes, scanning probe tools, optical and electrical characterization and surface analysis capability, and trio of shared Nanostructures Laboratories—a 1600 square foot Biological NanoStructures Laboratory for biological synthesis and analysis; a 1200 square foot Chemical NanoStructure Lab for chemical synthesis, and a 8,500 square foot NanoStructures Cleanroom Facility of Class 100/Class 1000 level space. The CNSI building also houses the Allosphere, a 360 degree, 3-story data-visualization space, and extensive exhibition space that accomodates travelling nano science education exhibitions and public engagement events. These spaces are important sites for CNS's partnered education programs with CNSI. Although CNS no longer occupies office space in the CNSI building, the foundation created by our partnerships with CNSI education personnel and co-residence with them for several years endures, and we continue to use CNSI conference and meeting spaces for seminars, lectures, and other events to increase our visibility and engagement with the NSE community. CNS Executive Committee member and MRL Director, Craig Hawker, was appointed Director of the CNSI in April 2013, and this has reaffirmed our ties with the institute. More information on CNSI, the MRL, and UCSB nanoscale shared research facilities can be found at www.cnsi.ucsb.edu and www.cnsi.ucsb.edu/facilities/.

3) Materials Research Laboratory (MRL) (UCSB)
The MRL was established in September 1992 with funding from the National Science Foundation (NSF), and became an NSF Materials Research Science & Engineering Center (MRSEC) in 1996. The research, scientific and engineering activities of the Materials Research Laboratory focus on educational outreach and four major interdisciplinary research groups (IRGs), as well as six laboratories. MRL also runs the IGERT program ConvEne — Conversion

of Energy Through Molecular Platforms, an interdisciplinary approach to graduate education aimed at providing a new generation of Chemical Scientists and Engineers with the technical skills, environmental awareness, business expertise, and teamwork approaches that will be required to address fundamental and applied issues in the generation and conversion of energy in efficient and environmentally-sustainable ways. The Director of MRL, Craig Hawker, is a co-PI of the Center's NSEC award and a member of the CNS 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

4) Nanotech: The UCSB Nanofabrication Facility, National Nanotechnology Infrastructure Network (formerly NNIN) (UCSB)
UCSB has extensive facilities and research in nanotechnology. Specific UCSB strengths include leading expertise in compound semiconductors, photonics, quantum structures, and expertise with non-standard materials and fabrication processes. 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 currently consists of 12,700 sq ft of clean space. Both on-site and remote support of users (including equipment training, process consultation, and remote job processing) is provided by a staff of six engineers supporting facilities and three Ph.D.-trained engineers supporting process. 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)
The Center for Spatial Studies, NCGIA, and CSISS (housed within NCGIA) 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, and CNS' close connection to them constitute significant resources. CNS PIs Harthorn and Appelbaum are former executive committee members of CSISS (a former NSF-funded social science infrastructure center), and the spatial center's former director, Michael Goodchild, has been a key advisor and resource for the CNS. He retired from campus in June 2012, but director Don Janelle has continued as a key resource for CNS. Spatial@ucsb provides free consulting services on GIS, cartographic and other spatial research. CNS has drawn GSRs (Glennon, Hurt) and a fellow (Hurt) from CSS, and CNS has a commitment to incorporating cartographic and spatial analysis in the data analysis and data visualization phases of our research. In our current award, as CNS generates more databases adequate for spatial statistics we draw on this cutting edge resource and the tools it provides. (See spatial.ucsb.edu/; www.ncgia.ucsb.edu and www.csiss.org**)**

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, particularly in the highly dynamic environments that seem so pervasive in organizations and societies today. They also work to improve engineering through infusing social insights into the innovative process. CITS was founded at UC Santa Barbara in 1999, on the thirtieth anniversary of the birth of the Internet, through the efforts of founding director Bruce Bimber, also a senior researcher and executive committee member in

the CNS. CITS research initiatives range from ground-breaking research on social computing, to the role and effectiveness of technology in the classroom, to the role of technology in organizing community events. In addition to research, CITS also supports an optional Technology and Society Ph.D. emphasis, which is available to students in participating doctoral programs at UCSB from the College of Engineering, the Social Sciences, and the Humanities and of interest to CNS grads. The emphasis provides interdisciplinary training on the relationships between new media and society with intensive faculty involvement. CITS serves as a close partner on graduate recruiting, shared programming, and other interests in common. CNS PIs Harthorn and McCray as well as Executive Committee member Bimber are all affiliated faculty in CITS, CNS Education Director Metzger is also the advisor of the CITS graduate emphasis program, collaborator Earl is a former director, former director Parks is a CNS executive committee member, and newly appointed director Stohl is a longtime CNS affiliate. www.cits.ucsb.edu/

7) Bren School of Environmental Science and Management (UCSB)
The Bren School is among a handful of schools in the United States and the only one in the West that integrates science, management, law, economics, and policy as part of an interdisciplinary approach to environmental problem-solving. The school is housed in what was the "greenest" laboratory facility in the United States when it was completed in 2002, and in 2009 it became the first building to receive a second LEED Platinum certification, this time in recognition of maintenance and operations of an existing building. Bren Hall is home to a collection of superbly equipped laboratories, computer centers, lecture halls, and other teaching and meeting places that support instruction, research, interaction, and the development of tomorrow's most capable scientists and environmental managers. Bren School faculty and colleagues at UCSB (including CNS researchers), UCLA, and other universities have completed the 1st 5-year, $24 million nanotechnology risk-assessment project funded by the National Science Foundation (NSF) and the U.S. Environmental Protection Agency (EPA), the UC Center for the Environmental Implications of Nanotechnology (UC CEIN). Bren School microbiologist Holden has been a collaborator with CNS IRG 3 and IRG 2 since 2006 and joined the Executive Committee in Fall, 2011. Seed Grant recipient Anderson is an Environmental Politics professor in Bren. www.bren.ucsb.edu

8) 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 National Science Foundation and the U.S. Environmental Protection Agency to explore the impact of engineered nanomaterials on a range of cellular lifeforms, organisms and plants in terrestrial, fresh water and sea water environments. The UC CEIN integrates the expertise of engineers, chemists, colloid and material scientists, ecologists, marine biologists, cell biologists, bacteriologists, toxicologists, computer scientists, and social scientists to create the predictive scientific platform that will inform us about the possible risks and safe design of nanomaterials (NMs) that may come into contact with the environment. Led by Andre Nel, UCLA, CNS-UCSB Director Barbara Harthorn has served as a grouop leader, Theme co-leader, and now serves on the Executive Committee for the Center. The UC CEIN's renewal proposal for an additional 5 years of NSF and EPA funding 2013-2018 was awarded in September 2013. It is the nation's first such large-scale study of the potential ecological effects of nanomaterial forms.

The UC CEIN is housed within the California NanoSystems Institute (CNSI) at UCLA, with a second major hub at the University of California, Santa Barbara, led by Bren professor Arturo Keller. The Santa Barbara facilities include office, lab, meeting, and classroom space in the UCSB Bren School of Environmental Science and Management, research offices in CNS, and

administrative and computing facilities within the Earth Research Institute (ERI) at UCSB. UCSB CEIN provides meetings, seminars, education program activities, and outreach events in which CNS researchers and students collaborate. www.cein.ucla.edu/

9) Center on Globalization, Governance, and Competitiveness (CGGC) (Duke University) This Center, led by CNS IRG 2 collaborator, Gary Gereffi, was created to address one of the key challenges of the contemporary era: to harness the potential advantages of globalization to benefit firms, countries, and organizations of all kinds that are trying to maintain or improve their position in the international arena. It does so by creating a comprehensive research framework that links the global, national, and local levels of analysis, translating research into appropriate organizational strategies and government policies. Its goal is to draw on a widespread, interdisciplinary network of scholars to formulate creative solutions for firms, countries, and organizations that want to improve their competitiveness or forge better development policies. It draws on the experience and expertise of the Rockefeller Foundation's Global Value Chains Initiative, assembling interdisciplinary, international groups of researchers with deep expertise on a broad range of industries affected by globalization. The Center's first three priority areas are China, India, and Mexico. The Center provides essential intellectual contributions to IRG 2's work on nanotechnology, globalization and E. Asia, as well as to the CNS undergraduate education program's project of the Global Value Chain. CNS former postdoc Frederick combines 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). She has served as a collaborator with Seed Grantee and IRG 2 faculty Mehta. See www.cggc.duke.edu/

10) Chemical Heritage Foundation (CHF), Philadelphia
The Chemical Heritage Foundation is a library, museum, and center for scholars. Located in Philadelphia, CHF maintains world-class collections, including instruments and apparatus, rare books, fine art, and the personal papers of prominent scientists, all related to the chemical and molecular sciences. CHF also hosts conferences and lectures, supports research, offers fellowships, and produces educational materials. Their programs and publications provide insight on subjects ranging from the social impact of nanotechnology to alchemy's influence on modern science. CHF is the former base of CNS IRG 1 collaborators, Cyrus Mody, Hyungsub Choi, Matt Eisler, and David Brock; and current base of former CNS Fellow Roger Eardley-Prior. CHF was a partner in CNS's production of *oral histories* of leading nanoscientists, hosts key nano in society workshops and conferences, in which CNS has been a welcome participant; CNS has also partnered with CHF in the publication of a series of commissioned research briefs, including some involving CNS researchers (Beaudrie, 2010; Mody, 2010; Parker, 2010). www.chemheritage.org/

11) 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. Their work focuses particularly on the current fusion of biotechnology, nanotechnology, and information technologies, and the transformative possibilities of this fusion for biomedicine, human-machine engineering, cultural production, and civic engagement. The Jenkins Collaboratory has several computer lab spaces and offices/workspaces as well as dedicated server space on the Duke campus. IRG 2 has utilized the professional expertise and infrastructure capabilities of this center to advance analysis of the nano innovation system. jenkins.duke.edu/

12) 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/

13) Decision Research, Eugene, Oregon, is a non-profit research organization investigating human judgment, decision-making, and risk. They conduct both basic and applied research in a variety of areas including aging, aviation, environmental risk, finance, health policy, medicine, and law. Founded in 1976 by the leading international risk perception researcher, Dr. Paul Slovic, Decision Research is dedicated to helping individuals and organizations understand and cope with the complex and often risky decisions of modern life. Their research 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, Dr. Robin Gregory, an expert on stakeholder participation in environmental decision making. DR provides unique expertise on psychometric risk perception and decision risk research. www.decisionresearch.org/

International Facilities

14) The Institute for Resources, Environment and Sustainability (IRES) at the University of British Columbia (UBC), Canada
The Institute for Resources, Environment and Sustainability (IRES) is an issue-driven interdisciplinary research institute with interest and expertise in a wide range of environment and sustainability issues. IRG 3 researchers Terre Satterfield and Milind Kandlikar serve as core faculty in the Institute, and Satterfield currently as its head. 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. IRES is home to a major interdisciplinary graduate education program (RMES) with 80 doctoral and 40 master students. Located within the Aquatic Ecosystems Research Laboratory (AERL) on the Main Mall of UBC's Vancouver campus, IRES facilities include office space, meeting facilities, classroom space, study space, and computing. ires.ubc.ca/

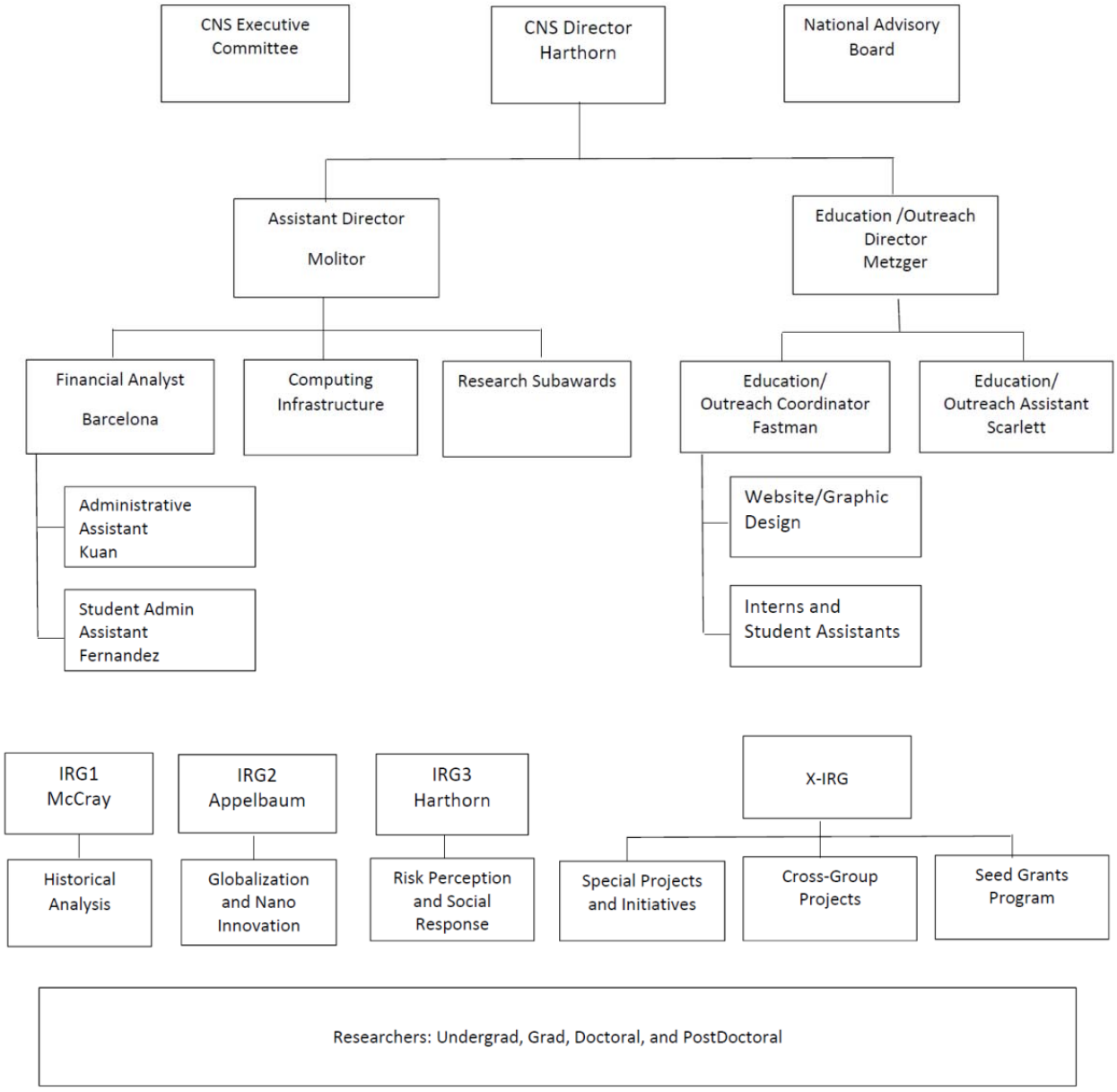
15) Understanding Risk Research Group at Cardiff University, UK
The Understanding Risk group is an interdisciplinary social sciences (psychology, sociology and technology studies, geography) research unit at Cardiff University focusing on the impacts upon individuals and communities, and acceptability to people, of environmental and technological risk within everyday life. The Group provides expertise in: the psychology of climate change; public attitudes towards and acceptability of energy supply systems; sustainable behavior change and energy demand reduction; social conflicts and siting of large scale energy technologies; risk perception, communication and public engagement. IRG 3 collaborator Nick 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/

14. PERSONNEL

CNS-UCSB is 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 and Materials Department #1 in public institutions in the world, California NanoSystems Institute, NNIN site until recently, 4 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. CNS-UCSB Director and lead PI Barbara Herr Harthorn is assisted by an Assistant Director (Molitor, 1.0 FTE), a faculty Director of Education (Metzger), a PhD'd education program Academic Coordinator (Fastman, 1.0 FTE), and a Travel and Purchasing Administrative Assistant (Kuan, 1.0 FTE). In September of 2015, as CNS entered its NCE year (11), two previously CNS-funded positions were absorbed by CNS control-point, the Institute for Social, Behavioral, and Economic Research (ISBER): Financial Analyst/Events Coordinator (Barcelona) reduced CNS-funded effort from 1.0 FTE to 10%, and a Computing Specialist position (Macias) is no longer funded by CNS. PI Harthorn works collaboratively with 3 co-PIs (Appelbaum, McCray, and MRL/MRSEC/CNSI Director Hawker) and an active, engaged CNS Executive Committee, which includes the 4 PI/co-PIs and former co-PI Bimber, Director of Education Metzger, CEIN collaborator Holden, and former CITS Director Parks; CNS Assistant Director Molitor and Academic Coordinator Fastman serve *ex officio.* The 3 IRG leaders (Appelbaum, Harthorn, and McCray) are all based on the UCSB campus, share research space in the CNS, and meet frequently face to face with their on campus IRG research teams, and remotely with collaborators. Thus, IRG leaders integrate their research issues and needs through the Executive Committee and senior researcher meetings and seminars.

Director Harthorn is responsible for all official agency contact with the CNS-UCSB, for CNS adherence to campus and agency policies regarding fiscal controls, IRB, and the oversight of all CNS business. She is the primary contact for the CNS to the UCSB upper administration and the CNS' immediate administrative unit, ISBER. In these capacities, she is responsible for oversight of fiscal management, including both cooperative agreement and campus matching funds, CNS subawardees, space allocation, and compliance with UC and UCSB campus policies. As lead PI, Dr. Harthorn also represents the CNS in NSF Nanotechnology in Society Network and NSEC network interaction. The CNS Executive Committee used to meet quasi-monthly on a face-to-face basis, conferencing in those who may be off site, and electronic and face-to-face communication takes place more frequently on matters both practical and intellectual. In the current reporting year, with reduced activity and decision making, the Committee is meeting quarterly, and expects to hold its final meeting later this spring.

CNS Organizational Chart



Personnel changes in the current reporting period

Executive Committee
The CNS-UCSB Executive Committee membership has remained unchanged this reporting year.

Staffing
As mentioned above, as the CNS-UCSB moved into its no-cost extension year in September 2016, two CNS positions were reduced: Financial Analyst/Events Coordinator (Barcelona) reduced CNS-funded effort from 1.0 FTE to 10%, and the Computing Specialist position (Macias) is no longer funded by CNS. The current staffing profile provides efficient and effective administration of the Center in this final year of NSF funding, with expertise in such critical areas as: contracts and grants management, fiscal management, project management, data archiving and sharing, travel and events coordination, evaluation and synthesis report preparation, and general administrative support.

In Years 1-10, CNS leveraged NSF and UCSB cash contributions to achieve savings without sacrificing productivity and professionalism. UCSB cash contribution has covered a significant portion of CNS staff salaries and fringe benefits, and without that support in the NCE more staffing costs have shifted onto the award. CNS staff draws regularly on the expertise of the staff of CNS' immediate control point, ISBER, for assistance in many aspects of extramural award pre-award submissions and post-award administration, human resources/personnel actions, and computer network administration. ISBER's support has enabled CNS to achieve efficiencies in a number of areas, providing backup to CNS' smaller, more specialized staff. In addition, CNS has shared computer technology staffing with ISBER, which has given the CNS access to 1.50 FTE IT staff, without having to commit significant salary expenditures. In the current year, ISBER is fully providing for all of CNS' limited computing needs. CNS networks and further draws from expertise on the UCSB campus by contracting specific tasks (e.g., web design and updates, disseminating press releases, print design) to on-campus specialists, and that continues in this final year of operation.

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 John Seely Brown and Ann Bostrom have served throughout the current award as Co-Chairs. Since this award began in 2010, the board plans have been to meet remotely or face-to-face 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 provides informal consultation on an as needed basis to Director Harthorn, and board meetings serve as an informal evaluation mechanism, as a sounding board for brainstorming new ideas and new directions, as a means to elicit elite views from a range of stakeholders in nanotechnology's societal impacts. This has been highly successful, and as we have moved closer to the funding horizon, CNS has followed Board member instructions to shift to an emphasis on consultation over regular meetings. Board members have been willing and available for such consultation by phone and e-mail throughout the year, with serendipitous individual face-to-face meetings as travel schedules allow. In its most recent meeting on April 24 2015, the Board met with Center leaders via video conference to discuss the Center's successes and plans beyond the NSF NSEC funding period. No further meetings of the NAB are planned.

Center as Infrastructure for Societal Implications Researchers
The Center has taken a leadership role, with CNS-ASU, in development of the Society for the Study of Nanoscience and Emerging Technologies (the S.NET), which recently completed its 7th year. In addition to co-organizing and co-hosting the 2011 S.NET meeting in Tempe, CNS-UCSB has taken a lead role in seeking, obtaining and administering NSF supplement funds to support junior and developing world researchers traveling S.NET meetings (e.g., 2010, 2011, and 2012), and has helped other organizers with such proposals (e.g., 2013 in Boston). Harthorn served on the program committee for the 2012 meeting as well, and provided consultation for the Boston hosts in 2013. The infrastructure investment by NSF in the CNS at UCSB has thus benefitted a much wider community of scholars and researchers, and the multi-agency NNI as well. In collaboration with CNS-ASU and the NISEnet, CNS-UCSB has taken a leading role in many structured interactions between NSE and societal dimensions researchers over the duration of its operation. Harthorn and Guston have maintained regular correspondence and have conferred as needed to encourage a free flow of information among the Centers and their networks. This dual center relationship has developed into an enduring collegial and supportive collaborative enterprise.

Management and Operation of Research Program
CNS has established and maintained an effective infrastructure for managing its collaborative research efforts throughout its operation. CNS' base on a single campus and consolidated space assignments in Girvetz Hall simplify these processes. In the reporting year, many of these have been scaled back commensurate with the reduction in activity.

- Executive Committee meetings have continued on a quarterly basis to allow direct reporting to and consultation with the group on both administrative and research issues.
- Research group and/or project meetings have continued for most projects on a roughly weekly basis at UCSB, often dialing/skyping in off-site collaborators for teleconference participation.
- The CNS Graduate Seminar (Soc 591 or Comm 595) met approximately bi-weekly through the 2014-15 academic year 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, as well as informal interaction. This has been discontinued in the current academic year to allow focus on culminating and legacy activities.
- Grad Fellows and Graduate Student Researchers work together in common space, which facilitates information sharing across the groups.
- Postdoctoral researchers work in shared and adjacent space, which also serves to promote interactions..
- Research Summit meetings are held in Santa Barbara to allow the free flow of ideas among all CNS collaborators, students, and personnel from the institutions actively involved in core CNS research. In March 2016 all groups met over a 3-day period in conjunction with the CNS Sunset celebration event on March 3.
- Management of projects - CNS requires semi-annual reporting and invoicing from all subawardees, and similar reporting from all IRG researchers, X-IRG projects and the education program. This permits ongoing formative evaluation by the director and assistant director of progress toward goals, personnel changes on projects at all sites, and outputs, and has continued unabated during the NCE.
- IRB - CNS operates under a blanket human subjects protocol in PI Harthorn's name; individual project approvals for all projects involving human subjects, at UCSB and other campuses, are required in addition. Assistant Director Molitor maintains a centralized database to ensure full compliance and to monitor upcoming expirations of existing

protocols; the UCSB campus utilizes an online system to provided notification of approaching deadlines and simplify renewal processes. PI Harthorn provides annual training on research ethics and individual consultation on specific projects, and Harthorn and Molitor provide extensive consultation on individual projects as needed. Project reporting includes required IRB status reporting. All non-exempt projects renew their IRB approval annually, including the blanket protocol, and approvals are shared with the NSF.

- Annual process for IRG budget review and allocation - CNS Director Harthorn solicits annual budget proposals from IRG leaders, allocates funds based on performance, unexpended funds carried forward, and competing needs. Budgets are gauged to different research methods and needs, as well as progress toward goals.
- Postdoctoral researchers are evaluated by mentors on an annual basis in conjunction with university and agency protocols and in compliance with the requirements of the union now in place for those appointed as UC postdoctoral scholars.
- Funder-required annual reporting and site visits have provided significant impetus to aggregate and synthesize data within and between research groups.

Clear and regular communication is essential to the management of any organization. To achieve this end, CNS-UCSB PIs, researchers and staff are in regular communication with one another, and this process is greatly facilitated by shared space. Members of the executive committee meet regularly and those not physically present join via conference call. Email provides another forum for the exchange of ideas and information. Finally, the CNS website is continuing development to increase the means for more complex databases to be created, stored, and shared internally with adequate security maintenance and externally when desired and appropriate. In this final year of operation, additional resources are being pursued for long term storage, archiving and data sharing of the diverse data resources produced by this multi-disciplinary effort.

Seed Grants program

In its final 3 years, CNS developed an institutional means to broaden participation by UCSB faculty. The center pursued and received two supplements (in 2012 and 2013) from the NSF for the 1st and 2nd rounds of a UCSB Faculty Seed Grant program. The first call for proposals was initiated in Fall 2012, and 4 of 14 proposals were selected for funding. This first call brought into the CNS 4 new faculty, from all 3 Divisions of the College of Letters and Science and the Bren School and Engineering; 2 of them were assistant professors, 1 was associate, with projects concluding in Spring/Summer 2013. In Fall 2013 a second call for proposals was issued; 4 new seed grants (out of 7 proposals) were awarded in response to this call; 1 to an Assistant Prof. (Global & International Studies), 2 to recently promoted Associate Professors (Social Theory, and Global & International Studies), and 1 to a Professor (History of Science). This second round of seed grant projects was completed in spring/summer 2015. Seed grant researchers have been invited to join in numerous CNS events and activities, and have presented their research in progress to the CNS seminar, in addition to joining in discussions about and proposals for developing longer term science in society research, education and outreach at UCSB. Seed Grantees, by and large, continued this involvement with CNS researchers, events, and activities although seed funding ended in summer 2015. Seed Grantees are a part of various spinoff activities and have brought significant intellectual capital to those efforts (see Section 22. Business plan).

B. Evaluation plan for CNS-UCSB

The plan for the CNS-UCSB has been to evaluate performance against our goals in the main functional areas - research, education and public outreach and engagement, networks with other nanotechnology in society programs, international collaboration, and the website. We evaluate work using formative and summative processes at several levels of aggregation: within each working group on a regular, semi-annual basis, at the Executive Committee level also on a regular basis, and at the level of the National Advisory Board on a biannual or intermittent basis, depending on need. Annual reporting on established metrics provides an important set of data on the accomplishments of the CNS and highlights any problematic areas. Processes are in place to evaluate and defund projects that are unable to meet goals, as well as to be responsive to newly arising opportunities, and the seed grants program has particularly enabled the latter.

Seek continuous feedback

We solicit and incorporate continuous feedback. This type of formative evaluation involves a continual quest for information about all areas of our functioning. In the research groups, the main mechanism for this is the standardized 6-month progress reports by the working group project leaders and each specific project within the IRGs. These reports are reviewed by CNS director and assistant director, and are available for review by the full CNS executive committee. All subawardees are required to submit such reports as well. Until the current NCE year, monthly face-to-face meetings of the Executive Committee have proven invaluable for appraising progress toward goals and identifying areas of concern. Additional meetings among working group personnel are also ongoing, both to coordinate research within groups and to integrate efforts between groups. The education and outreach program also provides periodic updates, and met bi-weekly with all graduate fellows and postdocs through Aug 2015. (See Education section 11 for specific education program evaluation methods, goals, and metrics.)

The CNS Executive Committee is the main formal mechanism through which such formative evaluation has taken place, with on-going discussion of possible problems, necessary adjustments to plans or activities, and communication. The Director maintains oversight of this process. National Advisory Board (NAB) members have been available for consultation on an as needed basis as well, and we confer with them when additional advice is needed. There is a high level of intercommunication among the principals of the CNS, and a very significant circulation of scholarly and practical advice, references, articles, and other knowledge sources among the Executive Committee members, senior personnel, staff, postdocs, and students, primarily by electronic media. We are using online methods to facilitate this process, and we conduct ongoing analysis of their effectiveness.

The CNS Assistant Director, Director of Education, and Education Coordinator are involved in the monthly (now quarterly) Executive Committee meetings and report to the Director. CNS staff members have recourse for advice and assistance to the experienced and knowledgeable professional staff of the Institute for Social, Behavioral, and Economic Research (ISBER). Regular work performance evaluation is mandated for all UCSB employees.

Budgetary controls within the University of California are very rigorous, and budget oversight of the CNS is maintained by ISBER and the Office of Research. The CNS Assistant Director and Director are in near daily consultation about budget matters, and, as needed, with all personnel, subawardees, and service providers.

Semi-annual reporting is required from all CNS research teams, UCSB and extramural subcontractors. This is a requirement in conjunction with invoicing for subawardee payments. The Education program also reports semi-annually on accomplishments and any issues of

concern. These written records provide systematic detail that our face-to-face meetings cannot cover, and serve to inform everyone about ongoing work of the CNS. Work on the final cumulative report will begin upon submission of this annual report.

Achieve aims
This kind of summative evaluation takes place primarily on an annual basis. The main mechanisms for achieving this are: annual reporting (for the CNS and for the NSF) and meetings with the NAB if needed. Annual reporting is required for all components of the CNS, and such cumulative records are the subject of focused meeting and discussion. The NAB, in addition, has met biannually in Santa Barbara if needed and provides detailed commentary, advice, and criticism both in person and, in some cases, in a written report. In the past a key aspect of the NAB process has been an executive session without CNS leadership, aimed at producing candid discussion and appraisal by this distinguished body of people outside CNS but familiar with us, although the Board has not seen the need for this in recent years. A NAB teleconference meeting with the CNS Executive Committee was held April 24 2015 to report center successes and discuss post-funding horizon futures.

The final NSF annual review was completed in May 2015. Such NSF and external site visit reviews provide the main opportunity for summative evaluation. Preparation for the site visits involves extensive discussion and reflexive analysis by the PI and Co-PIs, CNS Executive Committee and staff.

Additional summative measures are drawn at any natural junctures, for example, the completion of a particular research program, or the completion of an iteration of the summer intern program. Entry and exit interviews are conducted with all summer interns and graduate mentors at the start and end of the program, respectively. The annual survey to graduate fellows, both current and past, has been conducted in conjunction with the annual report cycle. More details about these measures are available in the Education section (Section 11) of this report.

Prepare to meet changing conditions, emerging issues
This challenge of meeting changing conditions is particularly great in the context of studying nanotechnology in society, as the issues are far ranging and many of them still in development. Uncertainty about the economic forecast, technical risks and public reception to these emerging technologies complicates this picture. We have taken seriously the task of tracking changes, in the nanoscience, economic, and social worlds, and we have addressed these issues as they emerge. In particular, IRG 3 is tracking social response and participation in a number of ways (public perception studies, NGO study, social media studies). Taken together, these data do provide empirical data about the changing economic, political and social worlds in which nanotechnologies and other emerging technologies of comparative interest are unfolding. CNS has responded in the past to changing conditions by new recruitments of grads and the addition of new collaborators. The CNS postdoctoral researcher program also has brought in new scholars and new ideas, and CNS’s network of collaborators is robust and ever expanding.

Table 4a: NSEC Personnel - All, irrespective of Citizenship

Personnel Type	Total	Gender		Race Data								Ethnicity: Hispanic	Disabled	% NSEC Dollars
		Male	Female	AI/AN	NH/PI	B/AA	W	A	More than one race reported, AI/AN, B/AA, NH/PI	More than one race reported, W/A	Not Provided			
Leadership, Administration/Management														
Subtotal	**8**	**3**	**5**	**0**	**0**	**0**	**4**	**1**	**3**	**0**	**0**	**2**	**0**	0%
Director(s) [1]	**1**	0	1	0	0	0	1	0	0	0	0	0	0	100%
Thrust Leaders [1]	**3**	2	1	0	0	0	3	0	0	0	0	0	0	100%
Administrative Director and Support Staff	**4**	1	3	0	0	0	0	1	3	0	0	2	0	100%
Research														
Subtotal	**69**	**33**	**36**	**0**	**0**	**0**	**46**	**5**	**1**	**1**	**16**	**9**	**0**	0%
Senior Faculty [1]	25	17	8	0	0	0	16	3	0	1	5	3	0	88%
Junior Faculty [1]	6	1	5	0	0	0	5	0	0	0	1	0	0	50%
Research Staff	7	2	5	0	0	0	6	0	0	0	1	0	0	57%
Visiting Faculty [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Industry Researchers	2	2	0	0	0	0	1	0	0	0	1	0	0	100%
Post Docs [1]	7	4	3	0	0	0	4	1	0	0	2	1	0	71%
Doctoral Students [1]	13	5	8	0	0	0	9	1	0	0	3	2	0	100%
Master's Students [1]	6	1	5	0	0	0	4	0	0	0	2	1	0	100%
Undergraduate Students (non-REU) [1]	3	1	2	0	0	0	1	0	1	0	1	2	0	100%
Curriculum Development and Outreach														
Subtotal	**2**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	0%
Senior Faculty [1]	1	0	1	0	0	0	1	0	0	0	0	0	0	100%
Junior Faculty [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Research Staff	1	1	0	0	0	0	0	0	0	0	1	0	0	100%
Visiting Faculty [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Industry Researchers	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Post Docs [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Doctoral Students [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Master's Students [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Undergraduate Students (non-REU) [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
High School Students	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
REU Students														
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0%
REU students participating in NSEC Research [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
NSEC Funded REU Students	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Precollege (K-12)														
Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0%
Students	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Teachers—RET	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Teachers—Non-RET	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Total[1]	**79**	**37**	**42**	**0**	**0**	**0**	**51**	**6**	**4**	**1**	**17**	**11**	**0**	**0**

1 The percentage of people in the personnel category receiving at least some salary or stipend support from NSF NSEC Program must be provided in the far right column, "% NSEC Dollars." Details are described in the Instructions section for this table.

LEGEND:	
AI/AN -	**American Indian or Alaska Native**
NH/PI -	**Native Hawaiian or Other Pacific Islander**
B/AA -	**Black/African American**
W -	**White**
A -	**Asian, e.g., Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, Other Asian**
More than one race reported, AI/AN, B/AA, NH/PI -	**Personnel reporting a) two or more race categories and b) one or more of the reported categories includes American Indian or Alaska Native, Black or African American, or Native Hawaiian or Other Pacific Islander**
More than one race reported, W/A -	**Personnel reporting a) both White and Asian and b) no other categories in addition to White and Asian**
US/Perm -	**U.S. citizens and legal permanent residents**
Non-US -	**Non-U.S. citizens/Non-legal permanent residents**

Table 4b: NSEC Personnel - US Citizens and Permanent Residents														
Personnel Type	Total	Gender		Race Data								Ethnicity: Hispanic	Disabled	% NSEC Dollars
		Male	Female	AI/AN	NH/PI	B/AA	W	A	More than one race reported, AI/AN, B/AA, NH/PI	More than one race reported, W/A	Not Provided			
Leadership, Administration/Management														
Subtotal	**8**	**3**	**5**	**0**	**0**	**0**	**4**	**1**	**3**	**0**	**0**	**2**	**0**	**0%**
Director(s) [1]	1	0	1	0	0	0	1	0	0	0	0	0	0	100%
Thrust Leaders [1]	3	2	1	0	0	0	3	0	0	0	0	0	0	100%
Administrative Director and Support Staff	4	1	3	0	0	0	0	1	3	0	0	2	0	100%
Research														
Subtotal	**54**	**25**	**29**	**0**	**0**	**0**	**37**	**5**	**1**	**1**	**10**	**6**	**0**	**0%**
Senior Faculty [1]	20	14	6	0	0	0	14	3	0	1	2	1	0	85%
Junior Faculty [1]	4	0	4	0	0	0	3	0	0	0	1	0	0	100%
Research Staff	6	1	5	0	0	0	5	0	0	0	1	0	0	50%
Visiting Faculty [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Industry Researchers	1	1	0	0	0	0	0	0	0	0	1	0	0	100%
Post Docs [1]	5	3	2	0	0	0	3	1	0	0	1	1	0	60%
Doctoral Students [1]	11	4	7	0	0	0	8	1	0	0	2	1	0	100%
Master's Students [1]	4	1	3	0	0	0	3	0	0	0	1	1	0	100%
Undergraduate Students (non-REU) [1]	3	1	2	0	0	0	1	0	1	0	1	2	0	100%
Curriculum Development and Outreach														
Subtotal	**2**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0%**
Senior Faculty [1]	1	0	1	0	0	0	1	0	0	0	0	0	0	100%
Junior Faculty [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Research Staff	1	1	0	0	0	0	0	0	0	0	1	0	0	100%
Visiting Faculty [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Industry Researchers	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Post Docs [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Doctoral Students [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Master's Students [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Undergraduate Students (non-REU) [1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Total[1]	**64**	**29**	**35**	**0**	**0**	**0**	**42**	**6**	**4**	**1**	**11**	**8**	**0**	**0%**

1 The percentage of people in the personnel category receiving at least some salary or stipend support from NSF NSEC Program must be provided in the far right column, "% NSEC Dollars." Details are described in the Instructions section for this table.

LEGEND:	
AI/AN -	**American Indian or Alaska Native**
NH/PI -	**Native Hawaiian or Other Pacific Islander**
B/AA -	**Black/African American**
W -	**White**
A -	**Asian, e.g., Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, Other Asian**
More than one race reported, AI/AN, B/AA, NH/PI -	**Personnel reporting a) two or more race categories and b) one or more of the reported categories includes American Indian or Alaska Native, Black or African American, or Native Hawaiian or Other Pacific Islander**
More than one race reported, W/A -	**Personnel reporting a) both White and Asian and b) no other categories in addition to White and Asian**
US/Perm -	**U.S. citizens and legal permanent residents**
Non-US -	**Non-U.S. citizens/Non-legal permanent residents**

15. PUBLICATIONS AND PATENTS

2015-2016
Primary Publications: 20 Journals; 11 Books, Chapters, Reports and Other Publications
Leveraged Publications: 25 Journals; 15 Books, Chapters, Reports and Other Publications
Submitted/In Preparation Publications: 40 Primary; 6 Leverage
Total: 117

Primary Publications: Journals

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Satterfield, Terre, Harthorn, Barbara Herr, DeVries, Laura, & Pitts, Anton. (in preparation). "Crude Proxies," Racializing Narrative: Reporting biases and citation errors attributed to the white male effect.

Shah, Sonali K. and Mody, Cyrus C. M. (under review). Making Sparks Fly: Understanding How Users Organize to Innovate. *Organization Science.*

Slaton, Amy; Ebeling, Mary F. (Under Review). Promise Her Anything: Education for Work in the U.S. ‘Nanoeconomy’. *International Journal of Engineering.*

Thomas, Merryn, Pidgeon, Nick,Partridge, Evensen, Darrick, Partridge,Tristan, Hasell, Ariel, Enders, Catherine, Harthorn, Barbara Herr, and Bradshaw, Michael. (under review). Public perceptions of hydraulic fracturing for shale gas and oil in the United States and Canada. *WIREs Climate Change.*

Thomas, Merryn, Partridge, Tristan, Pidgeon, Nick*, and Harthorn, Barbara Herr. (In preparation). The Town Council Game: a novel method for eliciting energy preferences in the US and UK.

Thomas, Merryn, Partridge, Tristan, Pidgeon, Nick*, and Harthorn, Barbara Herr. (under review). Deliberating upstream shale gas and oil extraction by hydraulic fracturing in the US and UK. Proceedings of the National Academy of Sciences.

Tyrrell, Brian. (in preparation). From *Theoretical Biology* to 'Where's the Biology?': A History of DNA Nanotechnology" *Journal of the History of Biology.*

Záyago Lau, Edgar. (in preparation). Nanomedicine Development in Mexico: Hopes and Challenges.

Submitted or in preparation publications: Leverage

Collins, Mary B. (under review) Considering Empirical Disproportionalities in Pollution Production the *Norm* Rather than the Exception. *Journal of Environmental Studies and Sciences*.

Hodges, Heather & Collins, Mary B. (In preparation). Using Distance to Account for Attitude Formation in the Case of U.S. Energy Policy. *Environmental Communication*.

Holden, Patricia, Gardea-Torresdey, Jorge, Klaessig, Fred, Turco, Ronald, Mortimer, Monika, Hund-Rinke, Kerstin, Cohen, Hubal, A, Elaine, Avery, David, Barcelo, Damia, Behra, Renata, Cohen, Yoram, Deydier-Stephan, Laurence, Ferguson, P.Lee, Fernandes, Teresa, Harthorn, Barbara Herr, Henderson, W. Matthew, Hoke, Robert, Hristozov, Danail, Johnston, John, Kane, Agnes, Kapustka, Larry, Keller, Arturo A., Lenihan, Hunter S., Lovell, Wess, Murphy, Catherine, Nisbet, Roger, Petersen, Elijah, Salinas, Edward, Scheringer, Martin, Sharma, Monita, Speed, David, Sultan, Yasir, Westerhoff, Paul, White, Jason, Wiesner, Mark, Wong, Eva, Xing, Baoshan, Steele Horan, Meghan, Godwin, Hilary A., & Nel, Andre E. (under review). Considerations of Environmentally Relevant Test Conditions for Improved Evaluation of Ecological Hazards of Engineered Nanomaterials. *Environmental Science & Technology*.

Partridge, Tristan. (under review). Reading Diagrams in Anthropology: Lines, Relations, Interactions. *HAU: Journal of Ethnographic Theory*, Special section (A Joyful History of Anthropology).
Kay, Luciano and Mehta, Aashish. (In preparation). Mapping the Global Race for National Security Technologies.

Ying Huang, Yi Zhang, Luciano Kay, Alan Porter, Jan Youtie, and Donghua Zhu. (In preparation). Funding Proposal Overlap Mapping: A Tool for Science and Technology Management.

16. BIOGRAPHICAL INFORMATION

CNS-UCSB did not add any new Investigators this reporting year.

17. HONORS AND AWARDS

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

Choi, Hyungsub, Appointed Assistant Professor in the School of Liberal Arts, Seoul National University of Science and Technology, September, 2015.

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

Collins, Mary B. (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 ($375,000), Awarded August, 2015.

Collins, Mary B. (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 ($200,000), 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 ($250) by the American Political Science Association, September, 2015.

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

Copeland, Lauren, Received a grant ($300) from Baldwin Wallace University Field Trip Fund.

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, Awarded PhD in Sociology from UCSB, December, 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, Awarded PhD in Materials from UCSB, 2016.

Gebbie, Matthew, Selected to attend the Lindau Nobel Laureate Meeting in Lindau, Germany, Summer, 2015.

Gebbie, Matthew, Awarded a CNS Science & Engineering Graduate Research Fellowship at University of California Santa Barbara, 2015-16.

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

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

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

Harthorn, Barbara, nominee, AAAS Committee on Nominations, Fall 2015

Hasell, Ariel, Awarded a CNS Social Science & Humanities Graduate Research Fellowship at University of California at Santa Barbara, 2015-16.

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

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

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

Horton, Zachary, Awarded the PhD in English from UCSB, June, 2015.

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

McCray, Patrick, Lindbergh Chair, National Air and Space Museum, Smithsonian Institution, 2015-16.

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

Mody, Cyrus, Appointed Full Professor at Maastricht University, the Netherlands, Aug, 2015.

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

Parker, Rachel, Accepted the Director of Research Programs position at the Canadian Institute for Advanced Research (CIFAR), September, 2015.

Stevenson, Louise, Awarded a CNS Science & Engineering Graduate Research Fellowship at University of California Santa Barbara, 2015-16.

Tyrrell, Brian, Awarded a CNS Social Science & Humanities Graduate Research Fellowship at University of California Santa Barbara, 2015-16.

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

Table 6: Partnering Institutions									
Institution Type	**Name of Institution**	**Receives Financial Support From Center**	**Contributes Financial Support To Center**	**Minority Serving Institution Partner**	**Female Serving Institution Partner**	**National Lab/ Other Govt. Partner**	**Industry Partner**	**Educ / Museum Partner**	**International Partner**
I. Academic Partnering Institution(s)	Allan Hancock Community College			Y				Y	
	Arizona State University	Y							
	Australian National University, Australia								Y
	Baldwin Wallace University								
	Bangkok Thonburi University, Thailand								Y
	Beijing Institute of Technology, China	Y							Y
	Bowling Green State University								
	California Polytechnic State University, San Luis Obispo							Y	
	Cardiff University, United Kingdom	Y	Y						Y
	Centre National de la Recherche Scientifique (CNRS), France								
	Clark University								
	College of the Canyons			Y				Y	
	Cornell University								
	Cuesta Community College			Y				Y	
	Dalian Institute of Chemical Physics, China								Y
	Dalian University of Technology, China								Y
	Darmstadt University, Germany								Y
	Drexel University	Y							
	Duke University	Y	Y						
	Ecole Polytechnique, France								Y
	Federal University of Parana, Brazil								Y
	Federal University of Santa Catarina, Brazil								Y
	Georgia Institute of Technology								
	IRD-IFRIS, France								Y
	Jackson State University			Y				Y	
	Kent State University								
	Kibi International University, Japan								Y
	Lehigh University	Y	Y						
	Long Island University								
	Maastricht University, The Netherlands	Y							Y
	Moorpark College							Y	
	Natl Academy of Agricultural Research Management, India	Y							Y
	New York University	Y							
	Northeastern University	Y							
	North Carolina State University								
	Occidental College			Y					
	Oxford University								
	Oxnard Community College			Y					
	Quinnipiac University								
	Radboud University								Y
	Rensselaer Polytechnic Institute								
	Rice University	Y	Y						
	Santa Barbara City College	Y						Y	
	Seoul National University, South Korea								Y
	Singularity University								
	Southeastern Louisiana University			Y					
	Southern Methodist University								
	SUNY Levin Institute	Y							
	SUNY College of Environmental Science and Forestry (SUNY-ESF)								
	SUNY New Paltz								
	Universidad Autónoma de Zacatecas, Mexico	Y							Y
	Université de Lyon 3, France		Y						Y

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	University of Arizona								
	University of British Columbia, Vancouver, Canada	Y	Y						Y
	University of California, Berkeley	Y							
	University of California, Davis	Y							
	University of California, Irvine							Y	
	University of California, Los Angeles		Y						
	University of California, Santa Cruz							Y	
	University of Copenhagen, Denmark								Y
	University of Edinburgh, United Kingdom								Y
	University of Exeter, United Kingdom								Y
	University of Gothenburg, Sweden								Y
	University of Manchester, United Kingdom								Y
	University of Maryland								
	University of Minnesota-Twin Cities		Y						
	University of Nottingham, Ningbo China								Y
	University of Pennsylvania								
	University of South Carolina	Y							
	University of Southern Indiana								
	University of Sussex, United Kingdom								Y
	University of Toronto, Canada		Y						Y
	University of Twente, Netherlands								Y
	University of Utrecht, Netherlands								Y
	University of Virginia								
	University of Washington	Y							
	University of Wisconsin-Madison	Y							
	Ventura College			Y				Y	
	Victorville Community College			Y					
	York University, Canada								Y
Total Number of Academic Partners	**25**	**11**	**6**	**1**	**0**	**0**	**0**	**0**	**9**

Institution Type	Name of Institution	Receives Financial Support From Center	Contributes Financial Support To Center	Minority Serving Institution Partner	Female Serving Institution Partner	National Lab/ Other Govt. Partner	Industry Partner	Educ / Museum Partner	International Partner
II. Non-academic Partnering Institution(s)	American Bar Foundation								
	American Institute of Physics Incorporated								
	Ashoka: Innovators for the Public								
	Boudreaux and Associates	Y					Y		
	Brazilian Ministry of Science, Brazil								Y
	Canadian Institute For Advanced Research								Y
	Center for International Environmental Law								
	Chad Relief Foundation								
	Chemical Heritage Foundation	Y	Y				Y		
	Chicago Art Institute								
	Compass Resource Management, Canada	Y					Y		Y
	Conservation Biology Institute								
	Decision Science Research Institute, Inc., d.b.a. Decision Research	Y	Y						
	DIYbio.org								
	Direct Relief		Y					Y	
	Engineers without Borders (UCSB Chapter)								
	Energy & Resource Institute, India								Y
	Environmental Defense Fund								
	European Trade Union Institute, Belgium								Y
	Facts 'N Figures	Y							
	FracTracker Alliance								
	Hands 4 Others (H4O)								
	International Committee for Robot Arms Control & Campaign to Stop Killer Robots								
	International Council on Nanotechnology (ICON), Rice University		Y						Y
	International Risk Governance Council, Switzerland								Y
	Kauffman Foundation						Y		
	Knowledge Networks	Y							
	LaborVoices								
	Latin American Network of Nanotechnology and Society (ReLANS), Mexico	Y							Y
	Los Angeles County Museum of Art							Y	
	Meridian Institute	Y							Y
	Nanoscale Informal Science Education (NISE) network							Y	
	National Nanotech Coordinating Office (NNCO)					Y			

Institution Type	Name of Institution	Receives Financial Support From Center	Contributes Financial Support To Center	Minority Serving Institution Partner	Female Serving Institution Partner	National Lab/ Other Govt. Partner	Industry Partner	Educ / Museum Partner	International Partner
	National Institute of Occupational Safety & Health (NIOSH)					Y			
	PEW Research Center								
	Safe Water International								
	Santa Barbara Bicycle Coaliton								
	Santa Barbara Channelkeeper								
	Santa Barbara County Water Guardians								
	Santa Barbara Museum of Natural History	Y						Y	
	Santa Monica Public Library							Y	
	Science and Technology Policy Institute (STPI)					Y			
	Silicon Valley Toxics Coalition								
	Smithsonian National Air & Space Museum							Y	
	Social Science Research Center (WZB)								Y
	Students & Scholars Against Corporate Misbehavior, Hong Kong, China								
	Surgical Eye Expeditions International								
	Technology for Tomorrow Ltd, Africa								Y
	The Fund for Santa Barbara		Y					Y	
	The TOR Project								
	United Auto Workers								
	Unite to Light								
	U.S. Agency for International Development								
	U.S. Environment Protection Agency					Y			
	Vitamin Angels								
	Woodrow Wilson International Center for Scholars	Y	Y						
	You Gov America Inc.	Y					Y		Y
Total Number of Non-academic Partners	**20**	**6**	**4**	**0**	**0**	**1**	**2**	**5**	**6**

22. BUSINESS PLAN

Overview

The plans for continuing the CNS at UCSB include a number of components, best described as spin off and sequel activities rather than direct continuation of the national Center in its current form.

In considering the possibilities for institutionalizing some or all of the CNS, center leaders and faculty participants have identified a key set of opportunities and challenges. Opportunities on the research side include: continuing an unprecedented long term 'upstream' study of an emerging technology; and the ability to use this platform to develop new research on other emerging technologies as a broader, comparative focus. Additional opportunities include: unprecedented foundations for full partnerships with S&E, established through years of collaborative research and education programs and the mutual understanding that has accompanied them; unrivaled opportunities for engagement with policymakers regarding public participation in S&T; a thriving global community of societal implications researchers that is well networked and organized; and the knowledge gained from organizing and managing a successful collaborative, interdisciplinary social science center.

In addition, the CNS at UCSB has demonstrated a strong record of success in using the CNS funding base to generate additional support (conservative figures of direct leverage reported in the current (last six years) award of $26,080,802 or 368% of the NSF funds awarded of $7,077,759). Thus CNS leaders and collaborating senior personnel definitely have the capability to successfully fund raise for future initiatives. In the most recent example, collaborator Pidgeon has recently secured a £10,000,000 10-year award from the Leverhulme Foundation for energy systems research that builds directly on CNS IRG 3 energy technologies research.

However, significant challenges confront institutionalization as a full center upon sunset of NSF support. The most serious impediment at CNS-UCSB is the lack of suitable potential funding sources for social science (and humanities) Center-scale research and education. The campus has been very supportive of the CNS at UCSB, providing in the last 6 years alone $2,138,437 or 30.2% in committed match funds ($7,077,759 in NSF support over the same period), with an additional $93,900 in direct non-match campus cash 'ramp down' funds (reported in Leverage) for the current Yr 11. It is clear the campus would step up to provide substantial support in conjunction with a new initiative with a federal or other funder, but they are not willing or able to carry forward center scale infrastructure and funding alone after the sunset of NSF support. Existing campus infrastructure support to Organized Research Units, including the Institute of Social, Behavioral & Economic Research (ISBER), is in place and assumed to provide the necessary core support and space for Research projects and activities. Support to carry on Education and Outreach components would not, of course, be included in conventional pre- and post-award administrative services provided by the ORUs. It is important to point out that a societal center such as CNS-UCSB has little prospect of developing industry partners on the model of S&T NSEC sustainability, so that potential source of ongoing NSEC support is not available.

In addition, a large part of the CNS' lifespan has coincided with a serious economic downturn in California (and the nation) accompanied by a number of years of faculty hiring freeze in the UC and at UCSB. Supplemental funding from the NSF has enabled CNS-UCSB seed grant support of a rising group of talented early and early mid-career faculty, but the relative scarcity of senior

faculty in the science and technology studies area with suitable funding and administrative track records and availability to assume leadership of a new large-scale effort is a significant impediment. We anticipate such coalesced effort will be possible in the future, and in the interim, our plans, outlined below, have focused on continuing key aspects of the research portfolio of the CNS via development of spin off projects that build on aspects of the research agenda of the CNS and providing support to the group of rising scholars in the field, while continuing program development activities directed toward potential larger interdisciplinary efforts on science in society here and with our collaborators.

Steps taken

1) Assess Community Interests, Ideas, Resources

This has taken place first through intensive CNS daylong leadership retreats in January 2012 and August 2013. Both retreats were closed door but involved broad inclusive participation of all faculty on campus we were able to identify with potential interests in science and technology studies (STS) and the broader issues of responsible, sustainable technology development and management for societal benefit. In the latter meeting, we invited participants to arrive with white papers and/or proposals, and in the meetings, we extensively workshopped a wide range of ideas for extending, expanding large-, medium- and small-scale research, education and outreach components of the Center. These discussions were carried forward in the IRGs and Center-wide in the CNS-wide Research Summit convened in January 31-February 1 2014. A follow up survey that included questions about future initiatives and support avenues was conducted with all participants.

We have also had recurrent discussions with diverse Executive Committee members, National Advisory Board members, cognate unit leaders, Vice Chancellors, Deans, S&E partners and Research Development. Center leaders have diligently pursued discussion with senior campus officials about possibilities for full-Center scale reinvention beginning almost as soon as the renewal award was announced. As indicated above, these discussions have centered on the need for faculty FTE in key areas, particularly at a senior enough level to offer leadership potential, and about the need for adequate outside opportunities for such support.

In and outside of these retreats we have engaged in proposal drafting and community engagement on various forms center development could and should take. New relationships have been developed in the process, along with a new understanding of the community's interests and expertise. These iterations of collaborative projects/center ideas have also increased preparedness for rapid response to rising center level funding opportunities in the future.

Main pathways discussed

The forms of possible new initiatives have taken several forms:

1) Reinvention as a Full Science in Society Center
Such a center would be focused not just on nanotechnologies but on a range of Science, Technology & Society issues. One proposed title from the 2013 retreat was for a "Center for the Realignment of Science with Society," and others have advocated a more general focus on Emerging Technologies in Society. But, lack of funding opportunities and the lack of institutional commitment of resources (particularly senior FTE to provide essential leadership) have been identified consistently as key impediments.

2) Education & Outreach
Like the other graduated NSECs, CNS-UCSB has been particularly concerned about the loss of infrastructure support to perpetuate key Education and Outreach initiatives. As indicated above, the specialized personnel for these programs are not available in campus ORUs, and the organized research initiatives enabled by center integration provide unique infrastructure for interdisciplinary training that will be difficult to reproduce.

Ideas under discuss within the group include seeking NSF funding from the post-IGERT program for research training on converging issues of risk, politics, and spatial analysis; and on social sustainability & responsible development. We are in discussion on paths to refund the INSET program that has provided such excellent diversity education (INSET was a NSF Institutional REU, but discontinued after three highly successful rounds of funding). We also have noted a number of nascent, pending, or possible new partnerships that some CNS team members could work with: continue collaborative programs for informal physical science *and* social science education, such as science cafes in wine tasting rooms; strengthen ties with the Materials Department in their new Mellichamp Sustainability program (led by collaborator engineer Susanna Scott); enhance ties with the UCSB Technology Management Program, newly reinvigorated and expanding faculty and students; reinforce NNIN-based societal connections disrupted by the funding hiatus there); continue discussions in Engineering regarding ethics education program development with societal implications content; explore ways to continue our flagship program of S&E Graduate Fellows; continue discussions of a new Science Studies minor in discussion; extend ties with the Carsey-Wolf center to pursue ideas discussed on potential public deliberations on Environmental Risk & Climate Change; and consider possibilities for expanding a new CITS joint postdoctoral training program. Additional discussions include program development on public deliberations across a range of potential science policy issues.

3) Spinoffs
A number of ideas and plans have already been launched at the level of the IRGs. For example, IRG 1 plans a series of conference panels with IRG 1 members to consider the past decade of work, its place in larger STS community, and ways to think about how this might engage/inform STEM education, thus taking IRG-1 work into the realm of technical practice/training. IRG 1 Leader McCray's current prestigious Smithsonian fellowship for 2015-16 is a possible springboard for this, as well as Washington activities with policy maker outreach that it enables.

IRG 2 intends to continue its focus on transformative technologies with UN and Regional Approaches to collaboration/monitoring of potentially controversial new technologies like synthetic biology, sharing basic research, and, more generally, negotiations around reports and resolutions that focus on the use of transformative technologies. The group is also interested in NGO implementation of transformative technologies to solve social, economic, and development issues, leveraging ideas from the NGO conference, Nov 2014. Also in discussion is a rolling multi-year panel study to investigate the innovation cycle (from basic research to commercialization) of transformative technologies (e.g., nano (graphene), synbio, robotics, 3-D printing, etc.), examining the ways that politics and economics around these technologies influence societal and commercial outcomes. As a rolling panel study, they would be able to add a new subset of respondents each time the survey is conducted. Work funded by the UC MEXUS/CONACYT program has extended beyond the CNS award and brings focus on Mexico and Latin America in the global value chain for new products, with a continuing interest on workforce implications of technology development. Closely related and separately funded has been Appelbaum's MacArthur Chair project on Corporate Social Responsibility. Appelbaum's

team also includes a member who plans to use his NSEC gained research expertise to launch a start up business.

IRG 3 is in active fund seeking to extend its work on collaborative, interdisciplinary risk perception research. Harthorn in 2015 secured a NSF STS award for a Postdoctoral Scholar, to extend the work on her current deliberation project, and she and other collaborators have begun preparation for summer 2016 submission(s) of new comparative surveys on emerging technologies. She's also preparing a risk perception/spatial analysis proposal with former postdoc Collins for summer 2016 submission. In response to encouragement from NSF BIO, the team is also assessing possible new risk perception work on synthetic biology. New opportunities at UCSB for IRG 3 include participation in a new Center for Resilience Studies, focused on neuroscience, possible small center development on public deliberation/public participation, the Bren school's Environmental Politics initiative, a New Health, Medicine and Care Research Focus Group. Harthorn has also initiated discussion on campus of a possible institutional ADVANCE proposal that will build on collaborations developed in the CNS

In sum, there is a vibrant community of students and scholars at UCSB and our CNS partner institutions that has come together and forged ties through shared CNS work, and has engaged in active discussion of or actual launching of next step plans. The years ahead will further develop and strengthen these ties, through joint activities such as collaborative joint program and funding development.