NSF SES 0938099

Nanoscale Science and Engineering Center

at University of California, Santa Barbara

Year 5 (10) Annual Report

March 16, 2014 – March 15, 2015

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

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: Nanotech Risk Perception and Social Response** conducts social research on formative nanotech risk and benefit perceptions in the US and abroad by multiple stakeholders in the nano-enterprise 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 UC Davis & UCLA, Arizona State Univ., Chemical Heritage Fdn., Decision Research, Duke Univ., Lehigh Univ., and Rice Univ., and internationally from Cardiff Univ.(UK), Seoul National Univ.(S. Korea), 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 nano and society. CNS-UCSB provides 3-5 postdoctoral researcher positions each 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 8 times over the course of the CNS 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 2014-15 CNS-UCSB continued substantial progress in research on pathways and impediments to socially and environmentally sustainable futures for nanotechnologies, producing 42 new publications in the past year, bringing total publications since our renewal 4.5 years ago to 294, with another 58 in the publication stream, and making 59 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 74 presentations to key audiences in government, industry, NSE, and the public.

4. PARTICIPANTS

4A. CENTER PARTICIPANTS

Bold indicates Active in Year 10 (March 16, 2014 - March 15, 2015)

University of California, Santa Barbara (*co-funded)			
Senior Personnel			
Name	Title	Department	Organization
*Peter Alagona	Assistant 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	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 Institue**	**UC Santa Barbara**

Name	Title	Department	Organization
Patricia Holden	**Professor**	**BREN School of Environmental Science & Management**	**UC Santa Barbara**
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**

Name	Title	Department	Organization
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**
Nicholas Pidgeon	**Professor**	**Applied Psychology**	**Cardiff University, United Kingdom**
Terre Satterfield	**Professor**	**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

Name	Title	Department	Organization
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**
Karl Bryant	Assistant Professor	Sociology, Women's Studies	SUNY New Paltz
Angelina Callahan	Postdoctoral Scholar	History, Sociology of Technology & Science	Georgia Institute of Technology
Luis Campos	Assistant Professor	History	University of New Mexico
Cong Cao	**Associate Professor**	**Sociology**	**University of Nottingham, United Kingdom**
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	Postdoctoral Scholar	Environmental Studies	University of Maryland
Meredith Conroy	Assistant Professor	Politics	Occidental College
Jonathan Coopersmith	Associate Professor	History	Texas A& M
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

Name	Title	Department	Organization
James Elkins	**Professor**	**Art History, Theory & Criticism**	**Chicago Art Institute**
Guillermo Foladori	**Professor**	**Sociology**	**Universidad Autonoma de Zacatecas, Mexico**
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**
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	Quinnipac University
Matthew Harsh	**Assistant Professor**	**Engineering & Computer Science**	**Concordia University, Canada**
Jennifer Hawken	**Independent Consultant**	**Transcriber**	**Irving, Texas**
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

Name	Title	Department	Organization
Richard John	Professor	Graduate School of Journalism	Columbia University
Ann Johnson	Associate Professor	History of Science & Technology, Modern Europe	University of South Carolina
Matthew Jones	Associate Professor & Chair	Contemporary Civilization	Columbia University
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**

Name	Title	Department	Organization
Anna Lamprou	PhD Candidate	Science & Technology Studies	Rensselaer Polytechnic Institute
Matthew Lavine	Assistant Professor	History	Mississippi State University
Edgar Zayago Lau	Senior Researcher	Development Studies	Universidad Autonoma de Zacatecas, Mexico
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**
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**
Lina Nilsson	**Innovation Director**	**Blum Center for Developing Economies**	**UC Berkeley**

Name	Title	Department	Organization
Joseph November	Associate Professor	History	University of South Carolina
Ari Olmos	**Vice President of Operations**	**Global Operations & Worker Saftey**	**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	**Senior Research Associate**	**Sociology**	**Science & Technology Policy Institute**
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 &**	**Virginia Tech**
Mark Robinson	**Assistant Professor**	**Anthropology, Science & Technology Studies/Ethics**	**DePaul University**
Jennifer Rogers-Brown	Assistant Professor	Sociology	Long Island University
Trust Saidi	PhD Candidate	Traveling Nanotechnologies	Maastricht University, Zimbabwe

Name	Title	Department	Organization
Andrew Schroeder	**Director of Research and Analysis**	**Geographic Information Systems**	**Direct Relief Foundation**
Maya Schweizer	**Independent Consultant**	**Videographer**	**Berlin, Germany**
Jill Scott	**Professor, Director of Studies**	**Art and Science Research**	**Institute for Cultural Studies in the Arts / Swiss artists-in-lab**
Pankaj Sekhsaria	PhD Candidate	Nanotechnology Research	Maastricht University, India
Bhavna Shamasunder	**Assistant Professor**	**Urban & Environmental Policy**	**Occidental College**
Philip Shapira	**Professor**	**Public Policy**	**Georgia Institute of Technology / University of Manchester**
Linsey Shariq	**PhD Candiate**	**Civil & Environmental Engineering**	**UC Davis / Environmental Health Hazard Assessment at the California Environmental Protection Agency**
Asif Siddiqi	Associate Professor	History	Fordham University
Lawrence Siegel	**Executive Director**	**Environmental - Water Safety**	**Safe Water International**
Denis Simon	**Vice Provost**	**Political Science**	**Arizona State 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**
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

Name	Title	Department	Organization
Tarun Wadhwa	**Writer, Researcher & Entrepreneur**	**Technology, international development, and public policy**	**Journalist**
Vivek Wadhwa	**Fellow, Arthur & Toni Rembe Rock Center for Corporate Governance**	**Emerging Technologies**	**Stanford University**
John Weber	**Director**	**Institute of the Arts and Science**	**UC Santa Cruz**
Amy K. Wolfe	**Group Leader**	**Environmental Science**	**Oak Ridge National Laboratory**
Jeffrey Womack	Masters Student	History	University of Houston
Thomas Woodson	**Assitant Professor**	**Public Policy**	**Stony Brook University**
Xinyue Ye	Assistant Professor	Geography	Kent State University
Jan Youtie	**Manager, Policy Services**	**Political Science**	**Georgia Institute of Technology**
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

Name	Title	Department	Organization
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**
*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
***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

Name	Title	Department	Organization
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**
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**	**Communications**	**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**

Name	Title	Department	Organization
*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**
Chloe Diamond-Lenow	**Grad Student Researcher**	**Feminist Studies**	**UC Santa Barbara**
Karin Donhowe	**Grad Student Researcher**	**Economics**	**UC Santa Barbara**
*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

Name	Title	Department	Organization
Kristen Nation	Grad Student Researcher	UCSC	UC Santa Barbara
Lumari Pardo-Rodriguez	**Grad Student Researcher**	**Global & International Studies**	**UC Santa Barbara**
Shadi Roshandel	Grad Student Researcher	Education	UC Santa Barbara
Elizabeth Sciaky	Grad Student Researcher	Education	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
Aaron McGuire	Grad Student Researcher	Jenkins Collaboratory	Duke University
Miguel Ruiz	Grad Student Researcher	Sociology	UC Davis
Matthew Thomas	**Grad Student Researcher**	**Jenkins Collaboratory**	**Duke University**

Name	Title	Department	Organization
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	Undrgrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara
Angela Burger	Undrgrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Sergio Cardenas	Undrgrad Student Researcher	CNS-UCSB / IRG1	College of the Canyons
Cecilia Choi	Undrgrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara
Hannah Cruz	Undrgrad Student Researcher	CNS-UCSB / IRG3	Dos Pueblos High School
Andi Docktor	Undrgrad Student Researcher	CNS-UCSB / IRG2	UC Santa Barbara
Andi Diaz	Undrgrad Student Researcher	CNS-UCSB / IRG2	UC Santa Barbara
Catherine Enders	**Undrgrad Student Researcher**	**CNS-UCSB / IRG3**	**UC Santa Barbara**
Gianna Haro	Undrgrad Student Researcher	CNS-UCSB / IRG1	Santa Barbara City College
Katherine He	Undrgrad Student Researcher	CNS-UCSB / XIRG	UC Santa Barbara
Simone Jackson	Undrgrad Student Researcher	CNS-UCSB / IRG3	Allan Hancock College
Paul Kovacs	Undrgrad Student Researcher	CNS-UCSB / IRG1	Santa Barbara City College
Megan Kelley	Undrgrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Kelly Landers	Undrgrad Student Researcher	CNS-UCSB / IRG2	Santa Barbara City College
Alexander Lyte	Undrgrad Student Researcher	CNS-UCSB / IRG3	Santa Barbara City College
Kristen Nation	Undrgrad Student Researcher	CNS-UCSB / IRG3	UC Santa Cruz

Name	Title	Department	Organization
Emily Nightingale	**Undrgrad Student Researcher**	**CNS-UCSB / IRG2**	**UC Santa Barbara**
Bryan Phillips	Undrgrad Student Researcher	CNS-UCSB / XIRG	Santa Barbara City College
Kelli Pribble	Undrgrad Student Researcher	CNS-UCSB / IRG3	Victor Valley College
Srijay Rajan	Undrgrad Student Researcher	CNS-UCSB / IRG2	Moorpark College
William Reynolds	Undrgrad Student Researcher	CNS-UCSB / IRG3	Ventura College
Nicholas Santos	Undrgrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Andreea Larisa Sandu	Undrgrad Student Researcher	CNS-UCSB / Education	UC Santa Barbara
Merisa Stacy	Undrgrad Student Researcher	CNS-UCSB / IRG2	Santa Barbara City College
Eddie Triste	Undrgrad Student Researcher	CNS-UCSB / IRG3	Allan Hancock College
Julie Whirlow	Undrgrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara
Sabrina Wuu	Undrgrad Student Researcher	CNS-UCSB / IRG1	UC Santa Barbara
Maria Yepez	Undrgrad Student Researcher	CNS-UCSB / IRG3	UC Santa Barbara

Non-UCSB Undergraduate Researchers			
Name	Title	Department	Organization
Sean Becker	Undrgrad Student Researcher	CNS-UCSB / IRG3	University of Wisconsin,
Rachel Bowley	Undrgrad Student Researcher	CNS-UCSB / IRG3	Duke University
Kevin He	**Undrgrad Student Researcher**	**CNS-UCSB / IRG2**	**Duke University**
Christine McLaren	Undrgrad Student Researcher	CNS-UCSB / IRG3	Lehigh University
Amber Schrum	Undrgrad Student Researcher	CNS-UCSB / IRG3	Lehigh University

Name	Title	Department	Organization
Ryan White	Undrgrad Student Researcher	CNS-UCSB / IRG3	Lehigh University
Yilun Zhou	**Undrgrad Student Researcher**	**CNS-UCSB / IRG2**	**Duke University**
Alexander Zook	Undrgrad 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
Amy Jacobs	**Payroll Support**	**ISBER / 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
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**

Name	Title	Department	Organization
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
Maria Yepez	**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
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
Ben Weiss	Reseach Assistant	CNS-UCSB / IRG2	Duke University

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	**Postdoctoral Candidate**	**Department of Communication**	**UC Santa Barbara**
Andrew Flanagin	Professor	Communication	UC Santa Barbara
Nelson Lichtenstein	**Professor**	**History**	**UC Santa Barbara**

Name	Title	Department	Organization
Joseph November	**Associate Professor**	**History**	**University of South Carolina**
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
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**	**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
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**
Mary Collins	**Postdoctoral Scholar**	**Environmental Studies**	**University of Maryland**
Meredith Conroy	Assistant Professor	Politics	Occidental College

Name	Title	Department	Organization
Katie Davis	**Co-Founder**	**Environmental Advocate**	**Santa Barbara County Water Guardians**
Brian Davison	Associate Professor	Computer Science &	Lehigh University
Magali Delmas	Associate Professor	Corporate Environmental Management	UC Los Angeles
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**
Sarah Kaplan	Associate Professor	Business	University of Toronto, Canada
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**
Matthew Keller	Assistant Professor	Sociology	Southern Methodist
Mikael Johansson	**Faculty Program Director**	**Global Studies**	**University of Gothenburg, Sweden**
Sharon Ku	**Assistant Research Professor**	**History & Politics**	**Drexel University**
Jens-Uwe Kuhn	Assistant Professor	Global & International Studies	Santa Barbara City College
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 &	New York University

Name	Title	Department	Organization
André Nel	Professor, Director, Physician	UC Los Aangeles Medical School, UC Los Angeles CEIN	UC Los Angeles
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
Brittany Shields	**Doctoral Candidate**	**Humanities & Social Thought**	**University of Pennsylvani**
Rachel Siegel	**International Operations Manager**	**Nonprofit Organization**	**Surgical Eye Expeditions (SEE) International**
Joseph Summers	Test Development Engineer	Electrical Engineering	Infinera

Name	Title	Department	Organization
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
Stephen Zehr	**Professor**	**Sociology**	**University of Southern**

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**
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

Name	Title	Department	Organization
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**

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, 2014 - March 15, 2014

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	Provost, 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 10 (March 16, 2014 - March 15, 2015)

Allan Hancock Community College
Arizona State University
Australian National University, Australia
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, India
Maastricht University, Zimbabwe
Mississippi State University
Moorpark College
New York University
Northeastern University
Occidental College
Oxnard Community College
Quinnipac University
Rensselaer Polytechnic Institute
Rice University
Santa Barbara City College
Seoul National University, South Korea
Singularity University
Southeastern Louisiana University
Southern Methodist University
State University of New York (SUNY), New Paltz
State University of New York, Levin Institute
Texas A&M University

Universidad Autonoma de Zacatecas, Mexico
Université de Lyon 2, France
Université de Lyon 3, France
University of Arizona
University of British Columbia, Canada
University of Califoirnia, 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, United Kingdom
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 10 (March 16, 2014 - March 15, 2015)

American Bar Foundation
American Institute of Physics
Ashoka: Innovators for the Public
Boudreaux & Associates
Brazilian Ministry of Science, Brazil
Center for International Environmental Law
Chad Relief Foundation
Chemical Heritage Foundation
Chicago Art Institute
Compass Resource Management, Canada
Conservation Biology Institute
Decision Research Corporation
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
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
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 -4 2011**	**Reporting Year -3 2012**	**Reporting Year -2 2013**	**Reporting Year -1 2014**	**Reporting Year 2015**	**Total**
Publications that acknowledge NSF NSEC Support						
In Peer-Reviewed Technical Journals: Primary	24	17	13	18	8	80
In Peer-Reviewed Technical Journals: Leverage	0	7	13	9	14	43
Books / Chapters or sections in books: Primary	61	36	22	10	10	139
Books / Chapters or sections in books: Leverage	0	6	4	3	10	23
Other: Primary	9	0	0	0	0	9
Other: Leverage	0	0	0	0	0	0
Total Publications	***94***	***66***	***52***	***40***	***42***	***294***
With Multiple Authors	36	54	30	24	26	170
Multiple Authors: Co-Authored with NSEC Faculty	33	50	26	22	18	149
Publications that do not acknowledge NSF NSEC Support						0
In Peer-Reviewed Technical Journals	0	0	1	0	0	1
NSEC Technology Transfer						0
Inventions Disclosed	0	0	0	0	0	0
Patents Filed	0	0	0	0	0	0
Patents Awarded	0	0	0	0	0	0
Patents Licensed	0	0	0	0	0	0
Software Licensed	0	0	0	0	0	0
Spin-off Companies Started (if applicable)	0	0	0	0	0	0
Degrees to NSEC Students						0
Bachelor's Degrees Granted	0	3	1	2	2	8
Master's Degrees Granted	5	0	1	1	1	8
Doctoral Degrees Granted	8	2	3	5	4	22
NSEC Graduates Hired by						0
Industry	0	1	0	0	0	1
NSEC Participating Firms	0	0	0	0	0	0
Other U.S. Firms	0	1	0	0	1	2
Government	1	0	0	2	1	4
Academic Institutions	5	1	6	7	3	22
Other	1	0	0	0	4	5
Unknown	0	3	0	0	0	3
NSEC Influence on Curriculum (if applicable)						0
New Courses Based on NSEC Research	8	9	0	6	7	30
Courses Modified to Include NSEC Research	10	13	14	23	16	76
New Textbooks Based on NSEC Research	2	16	11	13	13	55
Free-Standing Course Modules or Instructional CDs	0	0	0	1	0	1
New Full Degree Programs	0	0	0	0	0	0
New Degree Minors or Minor Emphases	0	0	0	1	0	1
New Certificate	0	0	0	0	0	0
Information Dissemination/Educational Outreach						0
Workshops, Short Courses to Industry	6	6	5	9	2	28
Workshops, Short Courses to Others	15	21	16	21	17	90
Seminars, Colloquia, etc.	137	165	131	125	93	651
World Wide Web courses	1	1	1	9	1	13

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 Impact

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 (9 in the past year, 7 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 (15 in the current year, 13 UCSB and 2 w/ external collaborators); undergraduate summer research internships to regional community college students (11 in the current award) and undergrads at UCSB and partner institutions (4 in 2014-2015, 17 total in the current award) who are mentored at UCSB by graduate students (28 mentorships to date in this award), and 3-5 interdisciplinary social science/humanities postdocs per year (13 at UCSB in this award, 10 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 March 2014 we held an annual 2-day NanoDays in the Santa Barbara community with over 1300 adults and children participating. In addition, CNS also participates 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 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 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 Newfield in prominent blogs such as *The Huffington Post*). 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 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 (e.g., the *New Haven Independent*).

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 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, Appelbaum, Engeman and Han plan to develop a collected volume out of the *Democratizing Technologies* conference (Nov 2014) that will integrate scholarly and practitioner perspectives. CNS-UCSB also has initiated as a summative activity development of a series of *policy briefs* and *synthesis reports* to extend the implications of the maturing research mission.

CNS-UCSB
Center for Nanotechnology in Society

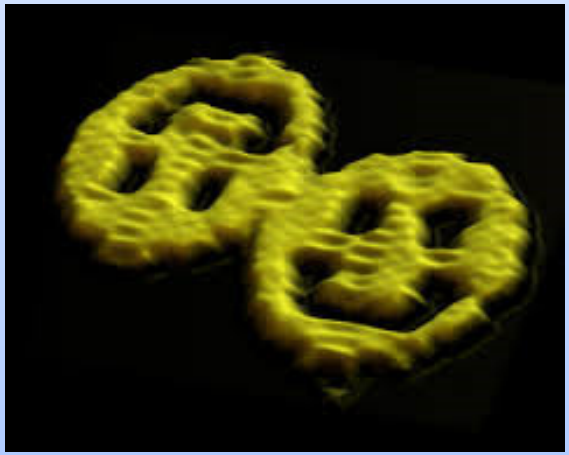
SES 0938099

From Blueprints to Bricks: The Origins of DNA Nanotechnology

Structural DNA Nanotechnology

Our research has made two key findings:

- Structural DNA nanotechnology represents a new chapter in the history of thinking about DNA
- DNA origami is an engineering technique that owes its emergence to the biological research of the Human Genome Project



An electron microscope image of Paul Rothemund's DNA origami technique. These smiley faces are nanometer-sized structures made entirely of DNA (Rothemund, 2006).

A New Way of Thinking about DNA

Since the publication of Watson and Crick's landmark article in 1953, scientists have emphasized the information-carrying capacity of DNA over its structure. The Human Genome Project signaled the pinnacle of scientists' efforts to crack the "code of life". Structural DNA nanotechnologists, however, conceive of DNA as a molecule whose structure follows simple rules. Consideration of the structural properties of DNA allowed for the creation of a new multi-disciplinary research field.

The Human Genome Project and Nanotechnology

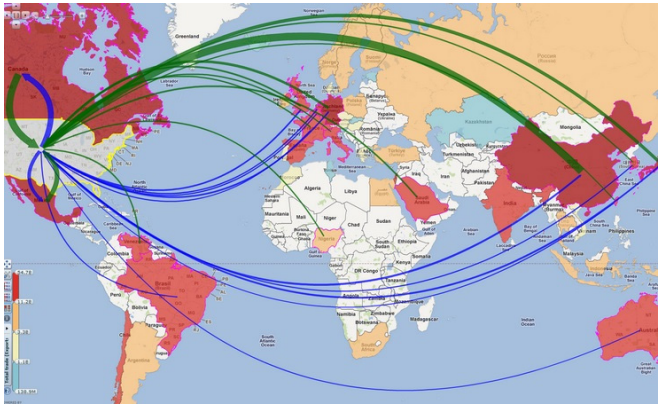
Both scientists and historians of science recognize the importance of technological advances to the success of the Human Genome Project. One of the technologies to emerge from that project was the DNA synthesizer. This machine allowed for the creation of custom-made strands of DNA. The structural DNA nanotechnology research community use this machine for its structures. This suggests that DNA nanotechnology is both an outgrowth of the Human Genome Project and a research field bolstered by the National Nanotechnology Initiative.

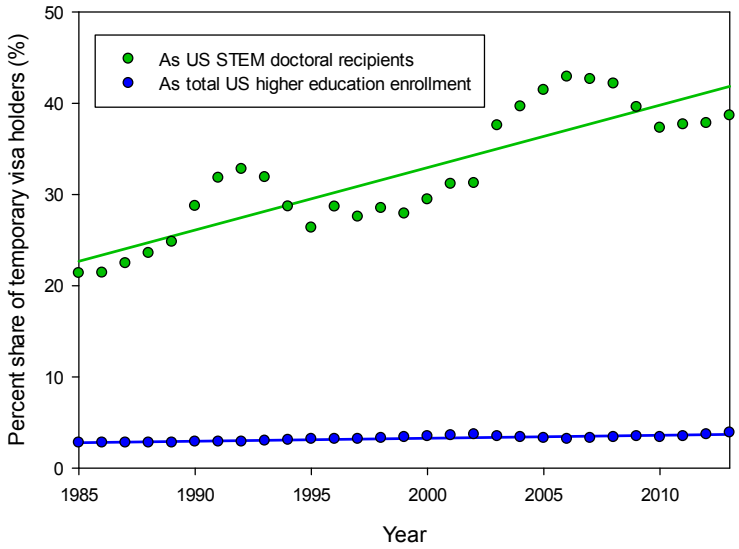
Brian Tyrrell, "Blueprints and Bricks: DNA and the Origins of the DNA Nanotechnology Community" (presentation, History of Science Society Annual Meeting, Chicago, IL, November 6-9, 2014); Patrick McCray and Brian Tyrrell, "Artifice or Application? Unfolding a History of DNA Nanotechnology" (presentation, Society for Social Studies of Science Annual Meeting, Buenos Aires, Argentina, August 20-23).

SES 0938099

National STEM Graduate Student Survey: Will They Stay or Go?

- 2,752 respondents (65% domestic, 35% international)
- 49% of international students wish to remain in the US upon graduation, 40% are uncertain, and only 11% wish to leave the US
- Job opportunities: #1 reason why students want to stay
- International students are significantly more likely to seek employment with a company than domestic students
- Domestic and international students equally likely to start a company





- International students, as a percent of total US higher education enrollment has been steady at ~3%
- International students, as a percent share of US STEM doctoral recipients, has approximately doubled over the past 3 decades
- Large implications for the future of US competitiveness

Han, Xueying, Stocking, Galen, Gebbie, Matthew A., & Appelbaum, Richard P. (2015). Will they stay or will they go? International graduate students and their decisions to stay or leave the U.S. upon graduation. *PLoS ONE, 10*(3), e0118183. doi: 10.1371/journal.pone.0118183

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

Globalization and Commercialization of Nanotechnology

Can China Become a Nano-Innovator?[1,2]

13 interviews were conducted with small business owners, low-level government officials, and researchers in Shanghai and Suzhou, China in April of 2012 to investigate the various factors that either help or hinder the development of nanotechnology communities in China.

Key findings:

- Nearly half of interviewees were returnees
- Several believed China lacks true innovation
- China's innovation model emphasizes government's role to simulate market mechanisms and shield companies from risk, yet tends to favor products over basic research
- Academics stated that funding for basic research is discouraged in favor of applied research, yet still felt intense pressure to publish in top-ranked scientific journals to secure funding
- National and regional governments publish annual lists of products and commissions companies to create these goods – several interviewees believe companies receiving government funding are neither innovative nor "hungry" for success

The results from this work will be utilized to aid in the development of a comparative framework to analyze the role of nanotechnology in emerging economies, including: Brazil, China, and Mexico.

"People would rather stay in the United States if given the choice, but with current economic conditions and decreased funding opportunities, increased numbers of Chinese nationals are deciding to go back to China"

--April 2012, small business owner/entrepreneur

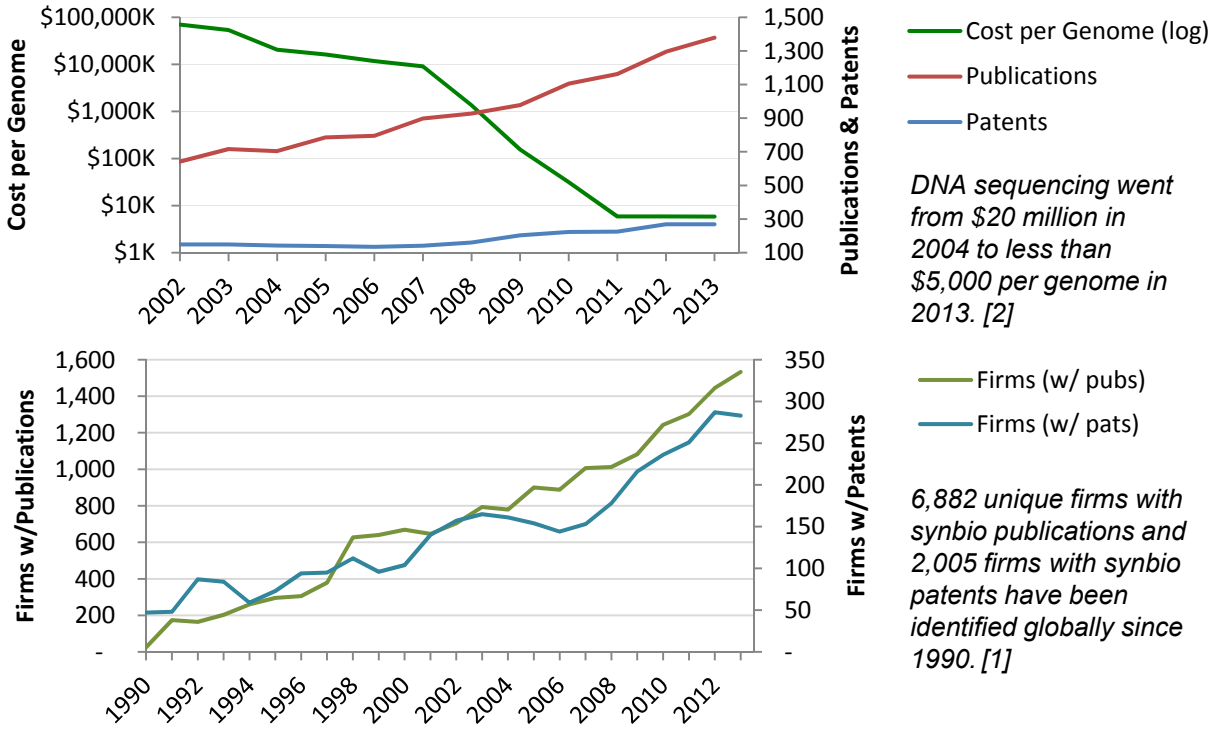
[1]Appelbaum R.P., Han, S., Gebbie, M., Stocking G. 2015 "Will China's Quest for Indigenous Innovation Succeed?" (In Preparation.)

[2]Xueying Han; Richard P Appelbaum; Matthew A Gebbie; Galen Stocking. 2015. Will China's Quest For Indigenous Innovation Succeed? Some Lessons From Nanotechnology. *China Economic Review*. (under review)

SES 0938099

Corporate activities in synthetic biology

Synthetic biology (synbio) corporate research and development activities (measured through scientific publications and patents) have grown 7.3% and 6% annually in the last decade. [1] This was fueled in part by decreasing costs. Global synbio-related markets – which include including specialty chemicals, enzymes, synthetic genes and other DNA parts, pharmaceuticals, biofuels, and chassis microorganisms – totaled nearly $2.7 billion in 2013 and are expected to grow 34% annually up to $11.8 billion in 2018. [3] The U.S. is the leading country in synbio corporate activity with 43% of publication outputs (7,024 journal articles) and 20% of patent submissions (642 patent families) since 1990.



Scientific publication data from Thomson Reuters' Web of Science and the Center for Nanotechnology in Society at University of California, Santa Barbara (CNS-UCSB)'s Global Patents database based on EPO's PATSTAT. We draw on a definition of synbio adapted from van Doren et al (2013).

[1] Kay, Luciano (CNS-UCSB) & Woolley, Jennifer (Santa Clara University). Corporate research and development activities in synthetic biology. Working paper presented at the S.NET 6th Annual Meeting, Karlsruhe, Germany, September 21-24, 2014.
[2] Wetterstrand KA. DNA Sequencing Costs: Data from the NHGRI Genome Sequencing Program (GSP). Available at: www.genome.gov/sequencingcosts. Accessed Oct. 25, 2014.
[3] BCC Research (2014). Report Overview. Synthetic Biology: Global Markets.

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

Twitter as a tool for public engagement with emergent technologies?

Project Overview

Twitter and other social media offer the potential to engage science enthusiasts and connect interested publics. In this study, our two main research questions ask: Is Twitter being used as a tool of interactive engagement between the public and nanotechnology experts? And what proportion of tweets about nanoscience are attempting to explain nanotechnology or engage interested publics?

We look at discussion of nanotechnology and found that, In recent years, there has been an increase in Tweets that describe nanoscience and nanoproducts. However, there is less content that attempts to explain nanoscience in language suited to general audience. Tweets that do attempt to explain nanoscience, tend to focus on nano-based products. We also found a significant Grangers' causality interaction between volume of Research Description Tweets and Research Explanation Tweets, meaning that at times, increase in Description Tweets leads to an increase in Explanation Tweets, while at other times, the opposite occurs.

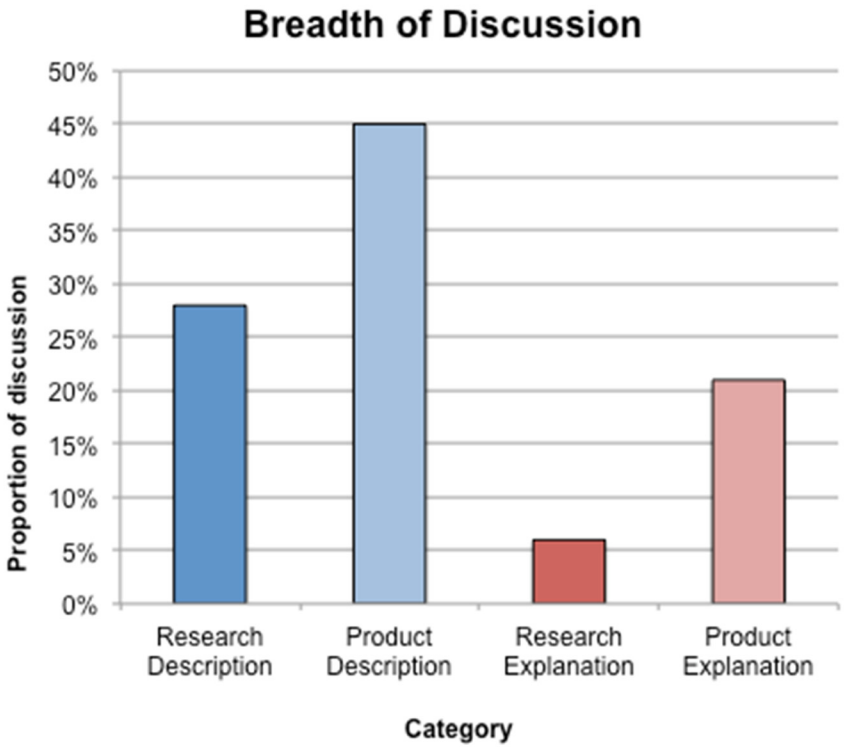
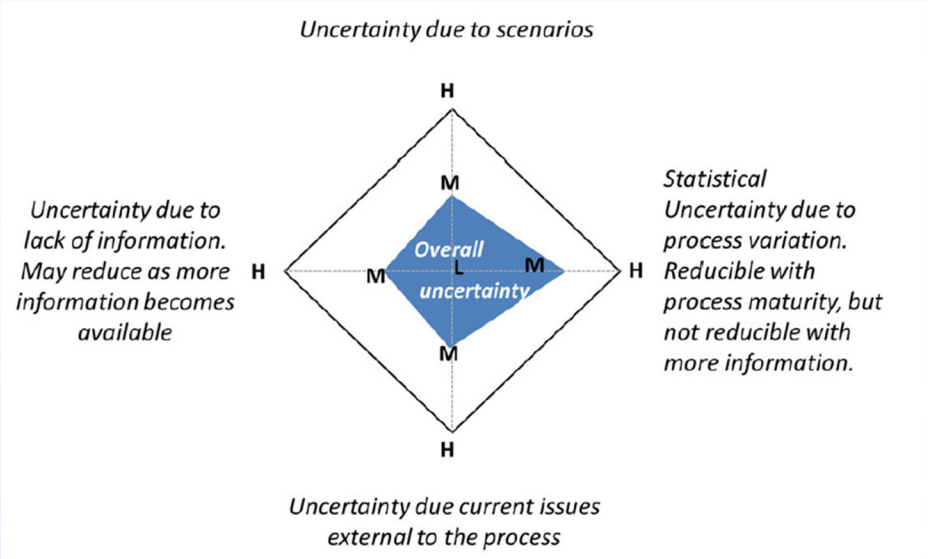


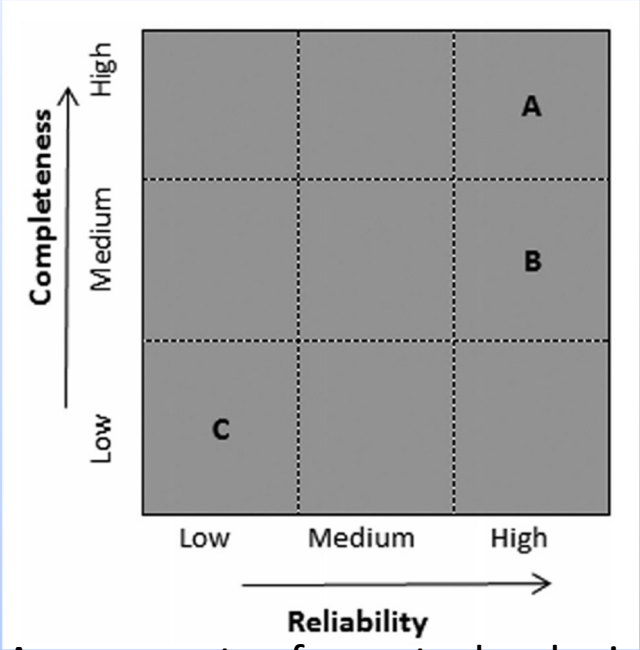
Figure 1. More Description than Explanation; larger focus on Products

Hasell, A., Stocking, *G.* , Appelbaum, R., & Harthorn, B. H., Twitter as a tool for public engagement with emergent technologies? Presented at conference *on Democratizing Technologies: Assessing the Roles of NGOs in shaping technological futures,* UCSB, Nov 13-15, 2014.

SES 0938099

Recommendations for Improving Reporting of Uncertainty in Environmental Assessments





Key Finding: Communication of uncertainty in Life Cycle Assessments of nanotechnologies falls short on key aspects of good communication. Authors recommend new means of communicating syntheses of uncertainty.

Sheetal Gavankar, Sarah Anderson, and Arturo A. Keller. Critical components of uncertainty communication in life cycle assessments of emerging technologies: Nanotechnology as a case study. (2014). *Journal of Industrial Ecology,* DOI: 10.1111/jiec.12183

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

Nanomaterial Risk Screening: A Structured Approach to Aid Decision Making under Uncertainty[1]

Nanomaterial Risk Screening Tool (NRST)

Two-day workshop conducted in May 2012 that engaged experts from the nanotoxicology, human exposure, and environmental fate and transport domains

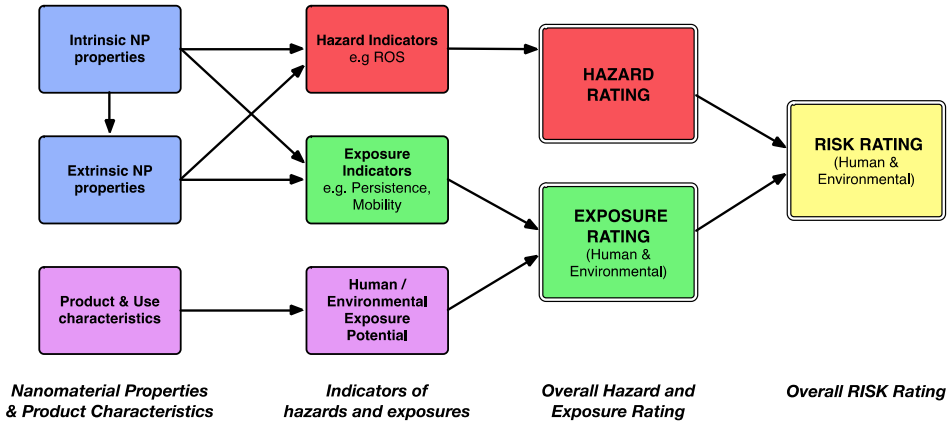
Utilized a Structured Decision Making (SDM) approach to create a conceptual framework (see inset) and decision support tool concept (NRST) to aid in the collection, organization, and contextualization of risk information

Identified key pathways of effects linking intrinsic and extrinsic nanomaterial physicochemical properties with hazard and exposure indicators

Developed a qualitative risk scoring scheme to aid in evaluation of risks to human health and environment from engineered nanomaterials (ENMs) across their life cycle.

Results

The NRST decision tool is designed to enable decision makers to make inferences about the health and environmental implications of ENMs and ENM enabled products under uncertainty.

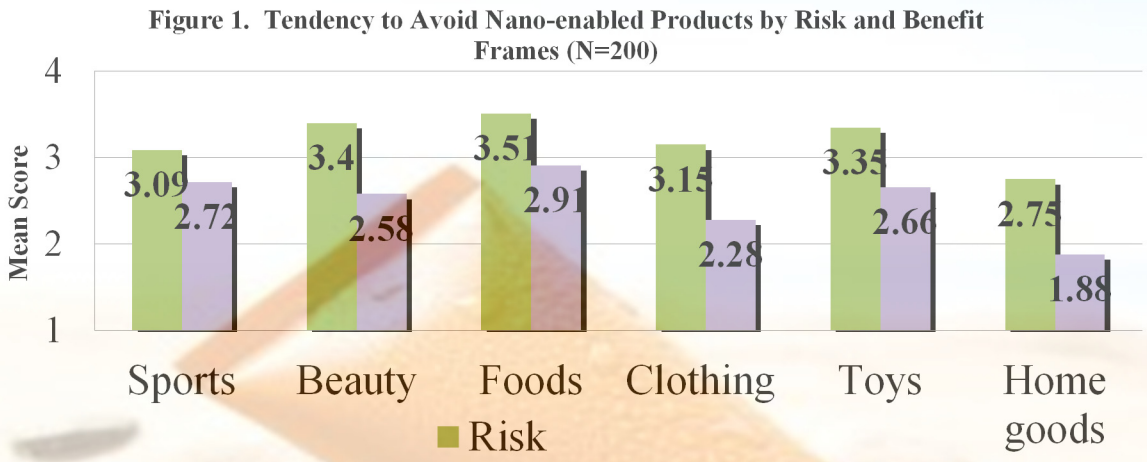


Beaudrie, C. E., Kandlikar, M., Gregory, R., Long, G., & Wilson, T. (2014). Nanomaterial risk screening: a structured approach to aid decision making under uncertainty. *Environment Systems and Decisions*, 1-22.

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

Framing Effects on People's Willingness to Purchase Nanotechnology Applications in the U.S.



Results

- People were significantly less likely to express a willingness to purchase nano-enabled consumer products if they were:
  - Exposed to the risk frame ($p < .01$)
  - Unfamiliar with nanotechnologies ($p < .01$)
  - Women ($p < .01$), younger ($p < .01$), poorer ($p < .01$), liberal ($p < .05$), less trusting of other people ($p < .05$), and concerned about the environment ($p < .01$)
  - Did not use social media for news ($p < .01$)

Surprising Findings

- Most people did not distinguish among different types of nano-enabled consumer products; there was little variation across the six product categories
- But people with children living at home were more likely to purchase sporting goods and equipment, as well as toys, with nanotechnology applications
- Little relationship between news media use and attitudes towards nanotechnology applications

Copeland, L. & Hasell, A. (2014). Framing Effects on People's Willingness to Purchase Nanotechnology Applications in the U.S. In C. Coenen, A. Dijkstra, C. Fautz, J. Guivant, K. Konrad, C. Milburn & H. Van Lente (Eds.), *Studies of New and Emerging Technologies*. Berlin: IOS Press, p. 87-106.

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

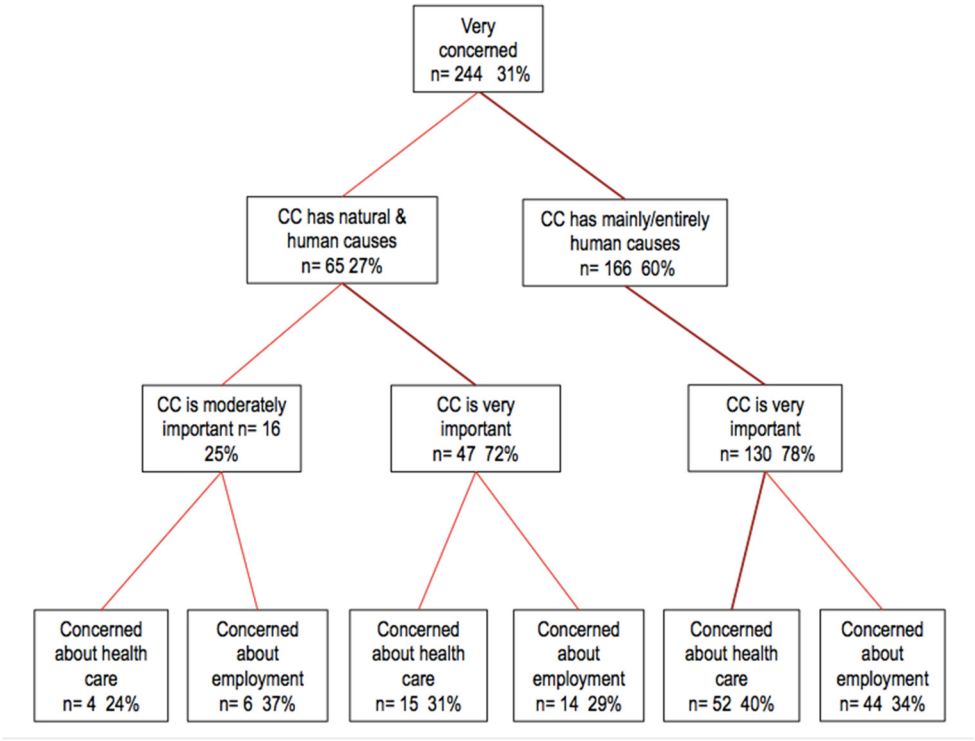
Using Decision Pathway Surveys to Inform Climate Engineering Policy Choices

Project Overview

Leading climate mitigation policies pose complex value tradeoffs across different geographic and temporal scales, especially when considering large-scale geo-engineering technologies that raise complicated moral questions.

This study uses a novel decision pathway survey that is designed to capture many of the benefits of small-group deliberative conversations, while providing a large enough sample (n=800) to reflect a broader scale of stakeholder engagement.

Pathway surveys also aid our understanding of complex decision processes behind novel (aka "upstream") policy choices. Question-answer paths link people's values and political positions to their reflections on competing policy investments and factual information. Results allows decision makers to better understand the full constellation of decision logics, including how strong value commitments affect subsequent questions about competing government priorities, which in turn underpin people's acceptance and rejection of engineering large-scale environmental change.



Gregory, R., Satterfield, T., & Hasell, A. (*in preparation*). Using Decision Pathway Surveys to Inform Climate Engineering Policy Choices.

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

Evaluating the Influence of Antinuclear Protest Movements in Public Assessments of Risk in post-3.11 Japan

Objectives:

Study of the perception of risk and responsibility around the use of nuclear power in contemporary Japan, as articulated by the emerging antinuclear protest movement, specifically the role of music and performance in generating social discourse around energy policy. This research addresses science and society interactions through a specific regional case study of collective social movements in the global crisis around safe and sustainable energy production

Methodology:

- Ethnographic fieldwork conducted in Fukushima City and Tokyo, Japan in Summer 2013 at public protests and antinuclear festivals
- Gathered online and print resources for qualitative analysis of public reactions to nuclear policy

Novak 2013a “Performing Antinuclear Movements in Post 3-11 Japan” STS Forum on Fukushima/Disaster Studies; Novak 2013b “The Sounds of Japan’s Antinuclear Movement” MoMA post website

CNS-UCSB
Center for Nanotechnology in Society

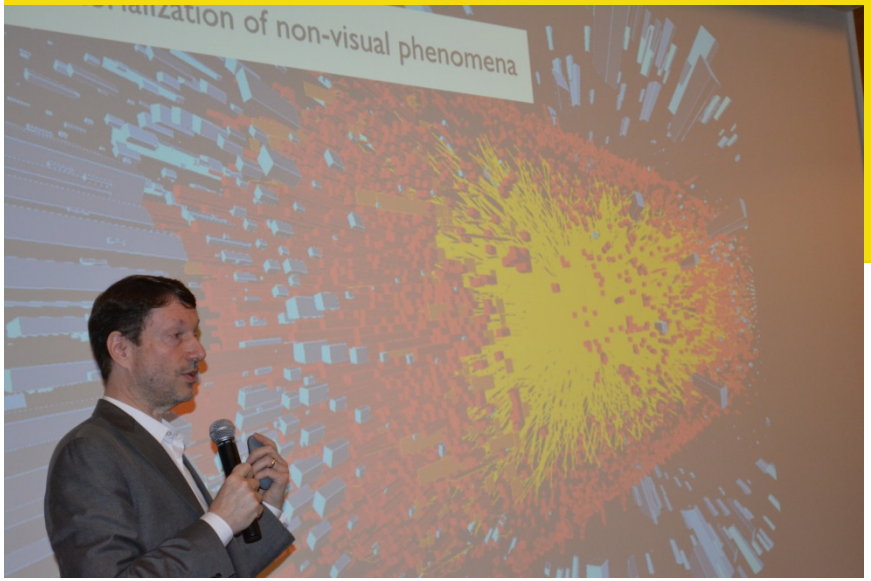
SES 0938099

Interrogating Methodologies

Exploring Boundaries in Art & Science

April 18-19, 2014

McCune Conference Room, 6020 HSSB
University of California, Santa Barbara



- Day and a half symposium to initiate conversation among specialists from the sciences, social sciences, humanities and arts about how those communities intersect, with a focus on method
- Future output will include 2016 exhibit at UCSB Museum of Art called “Vision and Wave
- Partially funded through CNS-UCSB seed grant for conference organizer and Director of UCSB’s Experimental Visualization Lab
- Videos of all talks available at: www.interrogatin-methodologies.org

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

Clockwise: David Lewis (Professor of Social Policy and Development, LSE) and Andrew Stirling (Professor of S&T Policy, U of Sussex) deliver plenary on Social Responsibility; Smart Water Solutions display at NGO outreach event; *New York Times* columnist Nicholas Kristof engages in Q&A with conference attendees

CNS hosted an international conference that brought together 40 speakers from 8 different countries, spanning the realms of academia (including the social sciences, science and engineering, and humanities), NGOs, journalism, and government. Proceedings included plenary addresses, a poster session, breakout panels, and an outreach event at which 22 NGOs shared their work with conference attendees, who numbered 120 in total

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 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, 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). New **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 pursues 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 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 renowned interdisciplinarity, its position on the Pacific Rim, its achieved Hispanic Serving Institution status, 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 1-9.5 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 9+ 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. Newfield's innovation X-IRG group hosted a workshop on global nano solar innovation in April 2010 in France that convened over a dozen leading innovation system analysts from North America, Europe, Asia and Africa, from which they have developed an edited volume focused on the pressing economic development issue of *Can Rich Countries Still Invent?* (Newfield & Boudreaux, under review). 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 anticipated to result in a series of publications. 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* 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.

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 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. This was a main topic for discussion at our Jan 31-Feb 1 2014 all-CNS Research Summit, and it is a part of ongoing conversations with our sister center at ASU and other societal researchers in the nanotech research community. 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 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
David Brock	History	Chemical Heritage Foundation
Cyrus Mody	History	Rice University
Hyungsub Choi	History	Seoul National University
Joseph November	History	Univ. of South Carolina
Amy Slaton	History	Drexel University

Affiliates

Sharon Ku	History	Drexel University

Graduate Students (3), Undergraduate Students (0)

Graduate Students:

Roger Eardley-Pryor	Research Fellow	UC Santa Barbara
Brian Tyrrell	Research Fellow	UC Santa Barbara
*Brittany Shields	History	Univ of Pennsylvania

***** Co-funded or fully funded from a non-CNS source

1. Introduction

IRG 1, with its focus on Origins, Institutions, and Communities, establishes the historical contexts for the emergence of nanotechnology as a research field, a component of US science policy, and as a site for the formation of new research communities. Together with funded colleagues at Rice University, the University of South Carolina, the Chemical Heritage Foundation, and Seoul National University, in Year 10 IRG-1 explored a variety of topics related to nanotech's history. These included research policies for micro/nanoelectronics, what is the historical context for interdisciplinary research in American nanotech labs, how federal research policies have helped foster new areas of research that bridge the physical and life sciences, the training of a nanotech-oriented workforce, and the emergence of a research community centered around DNA nanotechnology

2. Goals

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

3. Rationale, Approach, and Organization of IRG 1

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

Our group this past year continued its 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.

History is a science in a broad, qualified sense, though not an exact science. Its empirical method makes history a social science, and its critical narrative aligns history with the humanities. Academics view history as a dynamic process and interpret history as a story of the past that remains in constant dialogue with the present. IRG1's methods combine qualitative and quantitative research. These include exhaustive searches for sources of information, especially primary sources typically found through archival research; the study of the information in those sources; the critical evaluation of the information, an active process to comprehend motives and judge actions; the final synthesizing of material and recasting it according to personal judgment in a narrative.

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

4. Major IRG 1 Research Accomplishments

IRG 1-1: Nanotechnology and the Pacific Rim; Hyungsub Choi

Choi's research in this component has focused on the policies and practices that led to the development of semiconducctor technology and nanotechnology in East Asia sicne the 1960s. Focusing primarily on developments within South Korea and Japan, Choi's research seeks to place Asian technological development within the broader context of the global development of technology and industry. The in-depth case studies that Choi uses to inform his argument expand current understanding of technological development and knowledge circulation. By looking at individual researchers, as opposed to say national policies, Choi can understand the specific dynamics among policies, institutions, and individual scientists and engineers in Asian societies.

Previous work supported by CNS has been accepted for publication by *History and Technology*. Titled "Emerging Opportunities: Nanoelectronics and University Research in South Korea," Choi's work is a case study of the little-known and short-lived Seoul National University Nanoelectronics Institute (SNI), which operated between 1996 and 1998. The rationale for focusing on the SNI was 1) that it was one of the earliest efforts in South Korean universities to pursue an "emerging technology"; 2) that it consciously adopted an interdisciplinary approach,

which was rare in the Korean academic context of the time; and 3) that the research community formed around the SNI served as the core of what later became the South Korean nanotechnology community. Thus, the SNI represents a transformative moment in the history of science and technology in Korea. It is an exemplar of how SNU made the transition from a third-rate teaching university as late as the 1970s to a vibrant research community operating at the global cutting-edge. Thus, the case requires some careful explanation

In Choi's view, the case of SNI allows one to understand the Korean nanotechnology phenomenon from broader perspective. Our understanding of the phenomena, especially in Asia, has focused almost singularly on government policies. The SNI story shows that the formation of a research community was critical for the success of government policies. Especially for emerging technologies like nano, the existence of a critical mass of experienced researchers ambitious enough to pursue cutting-edge research is indispensable.

During this reporting period, Choi has made progress on his book manuscript, tentatively entitled *Manufacturing Knowledge in Transit: Transistor Technologies in the U.S. and Japan*. Choi has completed four out of six chapters, and he anticipates completing the remaining two chapters by March 2015.

IRG 1-2: Technoscientific Re-Emergence and Electronics Uncertainty; David Brock

Brock's research during this reporting period has focused on technoscientific emergence at the research frontier of present-day nanoelectronics and microelectronics communities. Brock applies an actor-network theory approach to understanding technoscientific emergence. Based on his research of nano- and microelectronics, Brock has proposed a definition of emergence. Emergence is viewed as the growth in the number and diversity of nodes in the network, as well as the density and intensity of the traffic connecting these nodes. With such an articulation of technoscientific emergence, one would expect to observe a wide diversity in patterns of emergence. Some developments may quickly emerge and then just as quickly decline. Emergence may be followed by disappearance. Other developments may emerge rapidly, appear to have matured at some level for some time, and then experience a rise or a decline in robustness thereafter. Some developments may experience steady emergence over a long period. Still other developments will strongly emerge only to decline, lay dormant, and then eventually grow again in robustness.

Brock's case studies of the silicon electronics technologies that have predominated in digital and nanotechnologies for several decades show that these research communities have entered into an age of increased uncertainty. The highly regular pace of change in the ability to reduce the scale of silicon transistors, and to fit more of these transistors onto silicon microchips thereby lowering the cost of digital electronics, is now widely anticipated to end within a decade. Some believe that this regularity has already ended. In response, researchers across university, industrial, and government laboratory settings have initiated investigations into possible nano-scale electronic devices that may be able to supplant the silicon transistor, and microchips of them, and continue to increase the capabilities of electronic systems and lower their cost.

In response to these predictions Brock has selected superconducting electronics as his focus of study. For sixty years, US, Japanese, European, and Soviet/Russian technical communities have pursued the construction of microelectronic devices based on superconductivity. In the 1950s, they were arguably more advanced, in terms of miniaturization and integration, than silicon devices. Currently, they represent electronics of much lower power than silicon electronics, and a viable route to exascale supercomputing.

Brock's CNS-funded research contributes to a work-in-progress on the sixty-year pursuit of the superconducting supercomputer, especially by the National Security Agency.

IRG 1-3: Institutions of Interdisciplinarity; Cyrus Mody, Hyungsub Choi, Brittany Shields

This research stream of IRG-1 examines how US institutional forms from the distant past shaped current nano policies. Their starting point is the sociological observation that new institutions copy from older institutions rather than inventing structures and protocols from scratch. Research will focus on institutions promoting interdisciplinary collaboration.

Mody's aim for this year was to complete a book manuscript from the totality of his involvement with CNS. In the reporting period, he completed a draft of a monograph titled, *The Long Arm of Moore's Law: Microelectronics and American Science.* Mody submitted the manuscript to MIT Press and it is currently under review. In addition to the completion of his book manuscript Mody has submitted and published several articles and made contributions to several edited volumes.

As part of his interest in the enduring legacy of Moore's Law, Mody has revised his submission for *Intellectual and Organizational Innovation in Science: Historical and Sociological Perspectives*. Two more contributions to edited volumes were published during this reporting period: first, "University in a Garage: Instrumentation and Innovation from UC Santa Barbara" was published in Martin Kenney and David C. Mowery, eds., *Public Universities and Regional Growth: Insights from the University of California*; and "Essential Tensions and Representational Strategies" in Michael Lynch, et al. eds., *Representation in Scientific Practice Revisited*.

Additionally, Mody has four submissions to edited volumes under review. They are (1) "Moore's Law" in Ashley Shew and Joseph C. Pitt, eds., *Routledge Companion to the Philosophy of Technology*; (2) "An Electro-Historical Focus with Real Interdisciplinary Appeal" in Scott Frickel, Barbara Prainsack, and Matthieu Albert, eds., *Critical Studies of Interdisciplinary Research*; (3) "Fabricating an Organizational Field for Research: US Academic Mirofabrication Facilities in the 1970s and 1980s," in Thomas Heinze and Richard Münch, eds., *Intellectual and Organizational Innovation in Science: Historical and Sociological Perspectives*; and (4) "Santa Barbara Physicists in the Vietnam Era," for David Kaiser and W. Patrick McCray, eds., *Groovy Science: The Counter-Cultures and Scientific Life, 1955-1975*.

Choi's aims have been to publish the results of his extensive archival research on the history of materials science. Since publishing the case study on Cornell University (co-authored with Cyrus Mody) in *Historical Studies in the Natural Sciences*, Choi has been collaborating with Brittany Shields (U. of Penn) on a case study of the University of Pennsylvania. This paper has been published online in *Minerva*, and is scheduled to appear in print in coming months.

In order to expand upon this work, Choi has submitted an application for a year-long fellowship at the Chemical Heritage Foundation, under the title "Interdisciplinarity as History in American Science." Using the previous work supported by CNS, this project intends to examine the evolution of interdisciplinary research in the history of American science and technology from World War II (or slightly prior) to the present.

IRG 1-4: Innovation and Research at the Nanotechnology-Biology Interface; Joseph November

This project, which aims to elucidate the roots of federal agencies' recent efforts to foster innovation and research at the bio-nano interface, will comparative 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 has visited archives at the National Institutes of Health and the National Archives. He completed his archival research at the National Archives and he made a final trip to the NIH to conduct archival work in March 2014.

Drawing from archival material gathered during the past two years, November is preparing an article “Engineering a Better Medicine” for publication. November has incorporated a portion of his archival findings into "Revolutions@home" a manuscript he is developing on the subject of the history of distributed computing; the focus of his new study is protein folding, an area in which there is considerable overlap with nanotechnology. He has presented drafts of the manuscript to colloquia at Johns Hopkins University and New York University in February 2015 and April 2015, respectively.

IRG 1-5: Divided Labor and Stratified Opportunity in American Nanomanufacturing: The Paradox of the Middle Skilled; Amy E. Slaton

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. In this reporting period Slaton attended meetings and conferences centered on technical education, including the annual meeting of the American Society for Engineering Education (ASEE), and the 2014 High Impact Technology Exchange (Hi-Tec) conference which centers on community college and vocational programming. She also attended a meeting of the organization, Science for the People (SftP). This event, which included scientists, educators and social scientists, focused on critical assessment of historical efforts within science and technology fields to enact economic and societal reform (including around STEM education and high tech innovation). Slaton also collected instructional materials from a number of post-secondary, undergraduate and graduate programs directed at training students of different levels in Atomic Force Microscopy.

As Slaton’s previous research has shown, outsourcing notwithstanding, American industrial leaders and economic planners project a growing domestic nanosector and excitedly promise many such jobs in production and quality control. The segmented nature of this new nano-related workforce is confirmed by vocal demands by employers and economic policy makers for more “middle skilled” nanoworkers, a stratum seen to possess competencies “above” routine fabrication tasks and “below” expert design or management. Such nanotechnicians are said accordingly to require “more than high school” but “less than college,” giving rise to dozens of two-year nanotech degree programs. Thus, employers and educators, often with government

support, have together delineated a recipe for workers equipped with cutting-edge, esoteric knowledge. Crucially, however, that knowledge is to be deployed within a system of constrained occupational opportunity.

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?

Through attendance at the 2014 ASEE and Hi-Tec meetings Slaton observed over 40 presentations offered by educators, policy makers and commercial producers of nanotechnology-related educational materials. She observed demonstrations of nanotech-focused educational instruments and software; keynote speeches by government and university figures; and a wide array of promotional efforts on the part of non-profit and for-profit actors involved with high-tech post-baccalaureate education. A picture emerged through this research of two-year schools, manufacturers, and federal funding agencies vigorously promoting nano-scale processes. As has now been the case for about a decade, the inculcation of nano-related skills (microscopy, micro-assembly, clean-room conduct, etc.) was routinely depicted in these meetings as assuring U.S. citizens' economic uplift (limited evidence of such employment notwithstanding). The variable role for and conceptions of "basic science" in two- and four-year nanotech curricula also became evident, as did a wide variety of pedagogical priorities across the community college sector (on the part of both schools and workforce policy makers). An important finding during this research period centered on pedagogy at Fairfield University, in which low-cost mock-ups of Atomic Force Microscopes (made of inexpensive materials such as plastic rulers, laser pointers, and graph paper) and similar innovative classroom materials are used in introductory Nanotechnology courses. This led to research on still simpler classroom versions of AFMs, revealing a universe of "nanotech" education using such materials as shoeboxes, Play-Doh and wooden skewers. The epistemic overlaps and divergences between the simplified and expert AFMs have become central to Slaton's analysis of nanotech workforce preparation, and she is now comparing instructional techniques at Fairfield and other 2- and 4-year programs with graduate-level AFM training at Worcester Polytechnic. Moving towards an analysis based on ontologically informed Science and Technology Studies (in which meaningful scientific data and operator identity are understood to develop relationally), Slaton considers these instruments and the accompanying pedagogy now to be central to her book project.

At the SftP conference, scientists and social scientists made explicit the political implications of such educational priorities. Activist scientists and the social scientists and historians interested in their work articulated emergent concerns about neo-liberal STEM-educational ideologies; this revealed a small but persistent critical response to prevailing high-tech enthusiasms in the U.S. All of the above research also allowed Slaton to formulate a list of potential interview subjects whom she will contact following Drexel IRB approval of that aspect of the project

IRG 1-8: DNS 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. Given the bio-nano focus of this project, there are strong resonances with November's work in IRG 1-4.

During the reporting year, Tyrrell has identified the DNA synthesizer as one of the technological lynchpins of the DNA nanotechnology community. This line of research connects the DNA nanotechnology community with the massive government funding associated with the Human Genome Project.

The ultimate aim of this project is to produce a peer-reviewed article in a historical journal. The research conducted to date has been building towards this end. Research presentations delivered at conferences are intended to provide a framework for future publications. The primary sources for this project consist mostly of oral history interviews, scientific publications, and general audience publications. Additionally, Tyrrell has identified archival sources held at Caltech and in corporate archives. Tyrrell has been in contact with Life Technologies to request permission to access materials.

In addition to facilitating oral history interviews (with Paul Rothemund, George Church, and William Shih), Tyrrell has travelled to New York University to collect referee reports from previous oral history informant, Nadrian Seeman. These documents relate to the foundational publications in DNA nanotechnology. To further pursue the basic science and technological aspects of the DNA synthesizer, Tyrrell has identified archival collections to visit at Caltech.

5. Broader Impacts and Implications of IRG 1 Research: Understanding nanotech's societal implications is predicated on possessing a clear and comprehensive understanding of its historical context. IRG 1's contributes to the larger social history of nanotechnology and its ancillary institutional, instrumental, and intellectual adjuncts. Work done in Year 10 contributes to a more comprehensive and holistic narrative of nanotech's trajectory.

All of the IRG-1 members who teach graduate or undergraduate courses incorporate their CNS-based research in various ways. Slaton, Mody, November, and Choi all offered instruction in the past year on the history/sociology of technology which included nano-themed topics.

In addition to her research on the nano workforce, Slaton succeeded in securing a grant in support of "Standards and Society: A Critical Curricular Platform" (grant runs from June 2014-December 2015; the PIs on it are Slaton, Scott Knowles, Tiago Saraiva and Sharon Ku, all of Drexel University). Funds will be used for the creation of a summer institute focused on social origins and impacts of industrial standards. A case-focused, two-week institute for graduate students in the sciences and social sciences, this event will focus on nanotechnology instrumentation and standardization as one of three historical cases. CNS member Brian Tyrrell will attend the first installment of meetings in summer 2015.

Another means of engagement is the blog *Leaping Robot* maintained by McCray. Although the views expressed here are solely his own and not those of the NSF, the topics McCray writes about frequently address issues related to emerging technologies. In several cases, McCray's blog posts have been picked up by *Physics Today* and rebroadcast, substantially raising their

readership. In a similar vein, Amy Slaton also maintains a blog devoted to STEM and education related issues.

IRG 1 members have remained active in their engagement with policy makers. Both McCray and Mody were recruited by Jonathan Moreno (Penn) to contribute essays and participate in a 2015 workshop sponsored by the Center for Equitable Development in Washington DC around the theme of innovation and equitable development.

Finally, *The Visioneers* (authored by IRG 1 leader McCray) received the 2014 Watson and Helen Miles Davis Award for best history of science book for a general audience from the History of Science Society.

IRG 1 Publications 2014-2015

Primary Publications: Journals

Primary Publications: Books, Chapters, Reports and other Publications

Leveraged Publications: Journals

1. Choi, Hyungsub. (2015). Emerging opportunities: Nanoelectronics and engineering research in a South Korean university. *History and Technology*, 1-20. doi: 10.1080/07341512.2015.1008961

2. Choi, Hyungsub, & Shields, Brittany. (2015). A place for materials science: Laboratory buildings and interdisciplinary research at the University of Pennsylvania. *Minerva, 53*(1), 21-42. doi: 10.1007/s11024-015-9265-6

Leveraged Publications: Books, Chapters, Reports and other Publications

3. Shah, Sonali K., & Mody, Cyrus. (2014). Creating a context for entrepreneurship: Examining how users' technological and organizational innovations set the stage for entrepreneurial activity. In Brett Frischmann, Michael Madison & Katherine Strandburg (Eds.), *Commons in the Cultural Environment* (pp. 313-339). New York: Oxford University Press.

4. Mody, Cyrus. (under review). An electro-historical focus with real interdisciplinary Aappeal: Interdisciplinarity at Vietnam-era Stanford. In Scott Frickel, Barbara Prainsack & Mathieu Albert (Eds.), *Critical Studies of Interdisciplinary Research*. New Brunswick: Rutgers University Press.

5. Mody, Cyrus. (under review). The Long Arm of Moore's Law: Microelectronics and American Science.

6. Mody, Cyrus. (under review). Santa Barbara physicists in the Vietnam era. In David Kasier & W. Patrick McCray (Eds.), *Groovy Science: The Counter-Cultures and Scientific Life, 1955-1975*.
7. Mody, Cyrus. (under review). Fabricating an organizational field for research: US academic microfabrication facilities in the 1970s and 1980s. In Thomas Heinze & Richard Münch (Eds.), *Intellectual and Organizational Innovation in Science: Historical and Sociological Perspectives*. New York: Palgrave Macmillan.

Submitted or in preparation publications: primary

Submitted or in preparation publications: leverage

8. Mody, Cyrus. (under review). Moore's Law. In Ashley Shew & Joseph C. Pitt (Eds.), *Routledge Companion to the Philosophy of Technology*. London: Routledge.

9. Shah, Sonali K., & Mody, Cyrus. (under review). How do users develop and diffuse their innovations? Resources, new Social Structures, and Scaffolding. *Organization Science*.

IRG 1 Research Presentations 2014-2015

1. Slaton, Amy. Science Education: Past and Present Virginia Commonwealth University Program in Science, Technology and Society Colloquium, Richmond, VA, March 19, 2014.
2. Mody, Cyrus. The Tangible and the Esoteric: US Physics in the 1970s, University of Notre Dame Cushing Prize Lecture, South Bend, IN, April 3, 2014.
3. McCray, Patrick. Between Art and Algorithm: Histories of the Engineer-Artist Nexus. Interrogating Methodologies: Exploring Boundaries in Art & Science, Santa Barbara, April 18-19, 2014.
4. Tyrrell, Brian, & McCray, Patrick. From Blueprints to Bricks: The Origins of DNA Nanotechnology ESOCITE / 4S (Society for Social Studies of Science), Buenos Aires, Argentina, August 21, 2014.
5. Tyrrell, Brian. DNA: It's Not Just for Biology Anymore. Center for Nanotechnology in Society Seminar, Santa Barbara, CA, October 30, 2014.
6. Tyrrell, Brian, & McCray, Patrick. Blueprints and Bricks: DNA and the Origins of DNA Nanotechnology. History of Science Society (HSS) Annual Meeting, Chicago, IL, November 7, 2014.
7. Mody, Cyrus. Burnt by the Sun: Jack Kilby and the '70s Solar Boom. Rice University Department Lunchtime Talk, Houston, TX, November 24, 2014.
8. McCray, Patrick. Many are Cold, Few Are Frozen. Histories of the Future Workshop, Princeton University, February 7, 2015.
9. Mody, Cyrus. Academic Centers and/as Industrial Consortia Academic Entrepreneurship in History: An International Survey of Current Research, Ghent, March 12-13, 2015.

IRG 1 Outreach Activities 2014-2015

10. November, Joseph. Revolutions@Home. Stevens Institute of Technology Colloquia, Hoboken, New Jersey, Mar-May 2014.
11. November, Joseph. Revolutions@Home, Johns Hopkins University Colloquia, New York, NY, Mar-May, 2014.
12. Mody, Cyrus. Whose Vision, Who's Sharing TEDx? Rice, Houston, TX, April 12, 2014.
13. Choi, Hyungsub. How did Seoul National University become a research University Colloquium Talk at Department of Chemical & Biological Engineering, Seoul National University, Seoul, Korea, April 22, 2014.
14. Mody, Cyrus. Universities and Regional Growth: Insights from the University of California Forums on the Public University and the Social Good, Davis, CA, April 22, 2014.
15. Mody, Cyrus. Jack Kilby's Failed Revolution. CENHS Cultures of Energy Spring Symposium, Houston, TX, April 24, 2014.

16. Mody, Cyrus. Probe Microscopy: A Transatlantic and Transdisciplinary Instrumental Community. Paul Bunge Prize Lecture, Hamburg, Germany, May 31, 2014.
17. Tyrrell, Brian. Blueprints to Bricks: The Origins of DNA Nanotechnology UCSB Workshop in the History of Technology and Science, Santa Barbara, CA, October 27, 2014.
18. Tyrrell, Brian. Report-Back Plenary Address CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.
19. McCray, Patrick. The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future Stevens Institute of Technology Science and Technologies Studies Book Discussion, Hoboken, November 12, 2014.
20. McCray, Patrick. Visioneering From Space colonies to Nanotechnologies HPOL Colloquium Drexel University, December 2, 2014.
21. Slaton, Amy. Meritocracy, Technocracy, Democracy: Understandings of Racial and Gender Equity in American Engineering Education Illinois Institute of Technology, Amour College of Engineering, NMAE Seminar, Chicago, IL, December 3, 2014.
22. Mody, Cyrus. Burnt By the Sun: Jack Kilby and the '70s Solar Boom American Physical Society March Meeting, San Antonio, March 4, 2015.
23. Mody, Cyrus. Mel Chin and the Sciences of the '70s Contemporary Art Museum, Houston, March 19, 2015.

IRG 2: Globalization and Nanotechnology
March 15, 2014 - March 15, 2015

Faculty and Senior Participants

R. Appelbaum, Leader	Sociology, Global & Int'l Studies	UC Santa Barbara
T. Lenoir	History	Duke University
A. Mehta	Global & Int'l Studies	UC Santa Barbara
F. Block	Sociology	UC Davis
C. Cao	Contemporary Chinese Studies	Univ. of Nottingham
H. Choi [also IRG 1]	History	Seoul Nat'l U.
D. Simon	Political Science	Arizona State University
Z. Ye	Geography	Bowling Green State Univ.

Affiliates

R. Parker	Research Staff Member	Science & Tech. Policy Inst.
G. Foladori	Sociology	Univ Autónoma de Zacatecas
P. Herron	Computer Sci	Duke University
N. Invernizzi	Anthropology	Federal Univ of Parana Brazil
Y. Motoyama	Regional Planning	Kauffman Foundation
P. Shapira	Public Policy	Georgia Tech & Univ of Manchester
J. Wooley	Business	Santa Clara University
J. Youtie	Enterprise Research Inst	Georgia Tech
E. Záyago Lau	Development Studies	Latin Amer Nanotech & Society Network (ReLans)

Postdocs (3), Graduate Students (3), Undergraduate Students (2), and Technical Staff (2)

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
Matthew Thomas	Jenkins Collaboratory	Duke University

Undergraduate Students:

Emily Nightingale	Global Studies	UC Santa Barbara
Kevin He	Computer Sci	Duke University
Yilun Zhou	Computer Sci	Duke University

Technical Staff:

Evan Donahue	Research Asst	Duke University

***** 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) nearly $21 billion (NNI 2015). 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 is 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 will draw 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 supporting grant 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 meets weekly or biweekly with his graduate fellows (Stocking and Gebbie; 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 meetings also include UCSB's development economist in Global & International Studies (Mehta) and IRG2 postdoc Kay, as well as undergraduate researcher Nightingale prior to her

graduation from UCSB in June. Integration is facilitated through regular meetings, reading and writing assignments, publications, and conference participation. A number of the core IRG 2 participants are not in Santa Barbara. Parker (on loan from STPI to the U.S. Agency for International Development in D.C.), Simon (at Arizona State University) and Cao (at the University of Nottingham, U.K.) were kept in touch via email or phone calls as necessary.

Luciano Kay, who joined IRG-2 as a postdoc on June 1, 2012, has 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) are finishing 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, and is now working with Parker on an examination of labor issues in the global nanotechnology value chain. These efforts are coordinated through telephone conversations.

Our partnership with Foladori and Zayago Lau in Mexico, initially supported in part by a separate grant from UC-MEXUS/CONACyT, has been completed. A new grant from UC-MEXUS/CONACyT was awarded during the past year, which will enable us to continued our work in Mexico and Latin America. We are planning visits later this year. Our work with ReLANS (the Latin American Nanotechnology Network, headed up by Zayago) continues.

Finally, we continue to work with other affiliated faculty members: Rachel Parker, former CNS Fellow (where she focused on nanotechnology in China), currently on leave from STPI to work with USAID for a year on technology issues in developing countries; and Denis Simon, Senior Advisor to the President of Arizona State University, and one of the world's leading experts on science, technology and innovation in China.

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 participates 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

This research stream aims 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.

Our China research concludes that China's substantial investment in nanotechnology – one of four "science megaprojects" under the Medium and Long-Term Plan (for high technology) – 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, and widespread corruption.

During this review period one article is being revised, one article was written for the UK China Policy Institute Blog, and a book contract was signed:

- Richard P. Appelbaum, Matthew A. Gebbie, Xueying Han, and Galen Stocking, "Will China's Quest For Indigenous Innovation Succeed? Some Lessons From Nanotechnology" is being revised for resubmission (*Research Policy*).
- Richard P Appelbaum, "China - Innovator or Follower?" UK China Policy Institute Blog (http://blogs.nottingham.ac.uk/chinapolicyinstitute/2014/12/05/china-innovator-or-follower/)
- *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 fall 2015.

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, is conducting 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 this 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.

Pulling together the materials we have gathered for different countries, developing a comparative framework, and writing up the results will be the major task of the remainder of year 10, and will be continued by Appelbaum throughout year 11.

IRG 2-3: Drivers of Nanotechnology Commercialization in China – Suzhou Industrial Park: Parker, Appelbaum, Cao, Han, Gebbie, Stocking, Nightingale

We are currently focusing on Suzhou Industrial Park (SIP), "China's Silicon Valley," as a case study. Based on interviews and research conducted at the 2012 Chinano Conference and Exposition held at SIP, we have papers in preparation and under submission. This research poses two key questions: "Does SIP function as a Marshallian Industrial District, with regional developmental spillover effects?" "Does SIP result in innovative products with commercial value?"

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. Some preliminary conclusions: China is poised to achieve some success in its efforts at "indigenous innovation," but is challenged by a research culture that stifles innovative thinking while over-emphasizing quantity over quality; a business culture that is risk-averse and partly hamstrung by excessive government interference; and a lack of venture capital for SMEs. At the same time, there have been enormous investments in infrastructure, so facilities are excellent.

- Richard Appelbaum, Rachel Parker, and Cong Cao, "Nanopolis and Suzhou Industrial Park: China's Silicon Valley?" (under submission)
- Richard Appelbaum, Matt Gebbie, Shirley Han, and Galen Stocking, "Can China Become a Nanotech Innovator?" (under preparation)

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 was not supported by CNS for this final period, March 16-September 15, 2014. Lenoir leveraged other funds to support student work on the project which will continue through the summer of 2015. Since February 2014 Herron has been training a CS student, Yilun Zhou. During the summer of 2014 Zhou worked with Herron to update the data gathering and data processing code. With the new code and algorithms Herron developed all nanotechnology research publication metadata records for all countries covering 01 January 1959 to 15 May 2014 were downloaded into Globonano. The code to parse and prepare these data for database load was written as well during Summer 2014, resulting in 2.7 million unique publications ready to be added to the database as of 29 September 2014, pending completion of a full quality review currently underway. 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. At the end of December 2013, excluding USPTO records, the system identified 5722 unique firms and/or research institutes. Starting in May, Herron also trained a second CS student, Kevin He, in developing web analytics and data visualization interfaces in d3.js for Globonano. Herron and He have produced web-based data visualizations for the nanotechnology research literature set, and have created several data visualizations of trends in several fields of nanotechnology, examining the roles of national funding organizations, corporations, and research institutes in these fields. 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 are also using 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:

- Motoyama, Cao, & Appelbaum. (2014). Observing Regional Divergence of Chinese Nanotechnology Centers. *Technological Forecasting and Social Change, 81*(0), 11-21. doi: http://dx.doi.org/10.1016/j.techfore.2013.02.013
- Mehta, Herron, Cao, and Lenoir, "The impact of National Nanoscience Diversification Strategies," under submission to *Research Policy*

- Lenoir, Mehta, Cao, Han and Herron are completing a paper as a follow-on to their previously-mentioned joint paper, which will address the theme of international collaboration: “The relationship between international collaboration on nanotechnology publication impact.”
- Lenoir and Herron submitted "The NCI and the Takeoff of Nanomedine" to *Scientometrics*. After a lengthy review period in which it appeared that the fit with *Scienotmetrics* was not a good one, a number of revisions were made; the paper will be submitted to *Research-Technology Management*.
- Lenoir and Herron's paper on "Star Scientists, Federal Funding and the Takeoff of Bionanotechnology and Nanomedicine" is still in preparation. They plan to revise and submit this paper based on the completion of their paper on the National Cancer Institute and the Takeoff of Nanomedicine.

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

This was a joint project, now completed, between the Doctoral Program on Development Studies at the University of Zacatecas (Mexico) and UCSB's Center for Nanotechnology in Society (CNS). It provided seed funding to determine key topics capable of being researched in future joint activities between the two research teams. 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 NSF, since the research summits were followed by NSF site visits as part of its evaluation of CNS. Three of the 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 Socioeconomics (SASE) in Madrid, Spain, the workshop was moved to Madrid (June 23-24, 2011).

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 resulted in a nine publications and many presentations (a complete listing is available on request).

A new project has been funded by UCMEXUS / CONACYT, “Nanotechnology in the Mexican industrial policy. A comparative methodological framework;” we begin work on this project later this year. The project aims to elaborate a methodological framework capable of analyzing nanotechnologies public policies in specific countries. It will rely on the case of Mexico, where the UED-UAZ group has done extensive research on related nanotechnology topics. Nevertheless, the approach of the research will be comparative, including U.S., China and Brazil. The 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. Once we elaborate the framework *vis-à-vis* the Mexican data, we will have a strong instrument to apply to other cases in future research projects. 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 will give 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 two lines of research started in previous reporting periods, a) work in the area of scientometrics/patent analysis (aimed at developing methods for scientific and patent literature analysis and topic discovery), b) corporate strategies in synthetic biology.

2-Database development: The "IRG 2 Bibliometric and patent analysis, mapping" project also seeks to develop its own databases of scientific publication and patents in the fields of nanotechnology and synthetic biology. This ongoing work started on June 2012 and has evolved to adopt the most effective data development strategy by partnering with colleagues of the Georgia Institute of Technology to have access to high quality data in the short term and develop own databases in the longer term. Most recent actions aimed at developing own databases have included, chronologically: (a) Acquisition of European Patent Office's PATSTAT database version Spring 2014 with data on patent applications and grants from all patent offices until 2014 (partial year); (b) Database uploading to own server and modification of interface to produce patent record outputs that include new, useful database fields; and (c) Development of new synthetic biology scientific publication and patent datasets.

3-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. For example, part of the work developed for this project has drawn on scientific publication and patent databases created by colleagues from Georgia Institute of Technology who collaborate with IRG 2 team on a number of projects. This has allowed access to reliable data and time to further develop own data sources in-house.

Progress has been made on the following:

1- Exploitation of scientific publication and patent databases: research efforts based on the exploitation of scientific publication and patent databases in this period include:

a) Scientometrics and patent analysis

- Started new research on new iteration of patent mapping in collaboration with colleagues from Georgia Tech, Search Technology and Ingenio Spain. Specific work in this area includes the creation of automation scripts to produce patent map visualizations using VantagePoint and Gephi
- Finalized analysis for project "Mapping the Global Race for National Security Technologies" in collaboration with Dr. Aashish Mehta. This project investigates the global development of national security technologies and their implications for U.S. security policy, drawing on the method and technique for patent mapping developed by Luciano Kay and colleagues from Georgia Tech and other institutions (see this report). This project has been awarded a $11,000 research grant from the UC Institute on Global Conflict and Cooperation.
- The "IRG 2 Bibliometric and Patent Analysis, Mapping" team updated/created a number of automation scripts that allow exporting data from text mining software into MS Excel and visualization software. These scripts are used in ongoing work and shared with colleagues and more broadly disseminated to the policy and research community.
- Submitted final version of the map visualization "Mapping Graphene Science and Development" to the 10th Iteration of Places and Spaces: Mapping Science Exhibit on “The Future of Science Mapping” (2014) in collaboration with colleagues from Georgia Tech, Search Technology and Ingenio Spain. In relation with this, the "IRG 2 Bibliometric and Patent Analysis, Mapping" team is preparing a research article for the special issue of the bulletin ASIST on how to develop patent maps in collaboration with colleagues from Georgia Tech.
- Prepared and presented the poster "Mapping Science & Patents to Track Emergence: Graphene and Nano-Enabled Drug Delivery" with Alan Porter (Georgia Tech), Jan Youtie (Georgia Tech), Ismael Rafols (CSIC-Ingenio), Nils Newman (Search Technology), and Jing Ma (Beijing Institute of Technology.

b) Corporate strategies in synthetic biology

- The "IRG 2 Bibliometric and Patent Analysis, Mapping" team created a dataset of scientific publications and patents in synthetic biology to analyze corporate R&D activities in this emerging field.
- In collaboration with Prof. Jennifer Woolley, Leavey School of Business, Santa Clara University, Luciano Kay wrote the working paper "Corporate research and development

activities in synthetic biology" and presented at the S.NET 6th Annual Meeting in Karlsruhe, Germany on that topic.
- In collaboration with Prof. Jennifer Woolley, Luciano Kay prepared the paper "Corporate research and development activities in synthetic biology" for journal publication and submitted for consideration (journal TBD).

2-Database development: the IRG 2 group purchased the EPO's PATSTAT Spring 2014 database to set up its own patent database. The group set up the new database and also modified its server's interface to facilitate database search and produce database outputs that include new database fields.

3-The "IRG 2 Bibliometric and Patent Analysis, Mapping" team continued collaborations and interactions (via email, Skype) with colleagues from Georgia Institute of Technology for database development and research collaborations. Specific topics include, for example, the creation of global maps/patent map overlays, the nanotechnology domain definition applied to patents, and the domain definition for synthetic biology. The team also shared methods and data on synthetic biology patent database creation with colleagues from Georgia Tech to further develop collaborations and new outputs.

Publications include:

- "Inter-industry knowledge flows and sectoral networks in the economy of Malaysia" by Luciano Kay, Jan Youtie (Georgia Tech) and Philip Shapira (Georgia Tech & University of Manchester).
- "Mapping Graphene Science and Development: Focused Research with Multiple Application Areas" by Luciano Kay, Alan Porter, Jan Youtie, Ismael Rafols, and Nils Newman, prepared for special issue of ASIST Bulletin.
- "Patent Overlay Mapping: Visualizing Technological Distance" by Luciano Kay, Jan Youtie (Georgia Tech), Alan Porter (Georgia Tech), Nils Newman (Search Technology), and Ismael Rafols (CSIC-Ingenio)

Additionally, "Visual analysis of patent data through global maps and overlays" by Luciano Kay, Jan Youtie (Georgia Tech), Alan Porter (Georgia Tech), Nils Newman (Search Technology), and Ismael Rafols (CSIC-Ingenio) is under review, and "Corporate research and development activities in synthetic biology," by Luciano Kay and Jennifer Woolley (Santa Clara University) is in preparation.

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

This project seeks to understand why international students pursuing STEM degrees in American universities decided to leave their home countries to come to an American university. This involves several related research questions: How does the American research and education culture compares to the cultures that international students experienced in their home countries. What aspects of the American academic culture are perceived as strengths and weaknesses with regard to fostering a collaborative and creative environment? What influences the decision of international students to either stay in America or leave the United States following the completion of their degrees?

Our initial survey was conducted in UCSB STEM departments. he survey included questions on their demographics, views on the US education system, factors that influenced their decisions to study in the US, their plans after graduation, and whether they plan to stay or leave the US (if given the choice) once they graduate. We found that if a student wishes to work in industry (i.e., work for a business or open up his/her own company), there was a 90% probability that the student wanted to stay in the US. On the other hand, if a student was hoping to stay in research (through academia or other research institutions), many other factors, such as their perception of how they will be treated by colleages in their home country, came into play. Follow-up interviews with 12 of the survey participants revealed that the intricacies of the US immigration policy was viewed as a major hindrance in staying in the US. We have extended our human subjects protocol to expand our survey to the national level to clarify results from this preliminary study. Our article from the UCSB study was accepted by PlosONE.

We have since expanded 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 (listed below) 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. We gathered 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 from 13 January to 28 January 2015 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 students approximately 10 minutes to complete and was administered in English. The survey was administered through Qualtrics. The survey ran for a total of four weeks and reminder emails were sent two weeks after the survey commenced. Students were not offered any incentives to complete the survey.

The following universities were included in the survey: New York University, UCLA, University of Washington, Arizona State University, USC, Purdue University, Northweatern University, Michigan State University, University of Illinois VChampaign-Urbana, and Columbia University.

We processed the data using the statistical program R. To analyze which factors were influential in influencing whether a student will stay or depart the US upon graduation, we used a random forest design for variable selection. We are currently analyzing the results.

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; Shapira, Youtie.

The purpose of this research project is to investigate the innovation pathways of developing countries in emerging technologies, with focus on nanotehcnology 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 emdedded 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:

1) Develop the theoretical framework and corresponding resign design to address the issue of innovation pathways in emerging technologies in developing countries. For this specific project, two country case studies have been selected: Argentina and Brazil. The research design also involves the investigation of companies as embedded case studies. The theoretical framework and research design are complete, but further revisions will be done during next reporting period. A set of meetings with scholars and policy-makers in Argentina (helped to develop main dimensions of theoretical framework (thanks to the identification of potential factors influencing the trajectories of companies in emerging technologies in the country case studies) and re-design the data gathering plan to account for company activities that may not be reflected in scientific publication and patent database

2) Develop research protocols, now completed.

3) Gather data, identifying nanotechnology firms and conducting bibliometric and patent analysis for case studies. This has been largely achieved. First, nanotechnology firms from Argentina and Brazil have been identified. Specific firm case studies have been selected based on data sources deemed reliable (databases of publications and patents, government lists of firms receiving funding for nanotechnology R&D, key informants --scholars and government officials). The firm selection criteria sought to have variation in case studies in the following dimensions: industry, geographic location, size (within the SMEs group). The case selection process has been also affected by managers' willingness to participate in the study and project budget. Data gathered to date include bibliometric and patent analysis: publication and patent data for Latin American companies based on Georgia Tech databases (IRG 2 group is taking advantage of its collaborations with Georgia Tech to source data until own data sources are developed); company case study analysis: company and interview data from companies in Argentina and Brazil, which includes interview transcriptions and observation notes; and documentary analysis: company website data and relevant nanotechnology and broader S&T policy documents for Argentina and Brazil.

4) Company case study analysis is now largely completed.

One paper is currently in preparation: "Innovation pathways of developing countries in emerging technologies: The case of nanotechnology in Argentina and Brazil" with Richard Appelbaum, Jan Youtie (Georgia Tech), Philip Shapira (Georgia Tech and University of Manchester).

IRG 2-10: Survey of China Nanotechnology Scholars in Leading Chinese Universities: Appelbaum, Han, Stocking, Gebbie, Simon; new project in this period.

Stemming from our previous field work, we are assessing the Science, Technology, Engineering, and Mathematics (STEM) research cultures and environments at leading Chinese institutions. We have developed a database consisting of ~16,000 Chinese STEM scholars from the top 25 universities in China for our full study. A separate database consisting of ~1,300 Chinese academic researchers made up our pilot study sample population. Individuals from our pilot sample were contacted via email through Qualtrics to take a survey regarding the research

culture at their university, their perceptions of the STEM research culture in China, and their patterns of collaboration with international and domestic researchers. We anticipate that results from this study will provide a much more concrete understanding of the opportunities and challenges faced by Chinese researchers as well as a more comprehensive outlook on the Chinese STEM research culture. The survey is being launched in March.

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

This project examines the current and likely future impact of nanotechnology on the workforce, globally by examining such issues as job creation and destruction, brain drain and brain circulation, the types and quality of jobs that are likely to result, training and retraining programs that will be required, and workplace health and safety issues. It examines these issues throughout the nanotechnology global value chain, from the production of raw nanomaterials such as carbon nanotubes (typically the most potentially toxic stage, and one that is most likely to occur in emerging economies) to the incorporation of nanomaterials into final products.

Nanotechnology also has the potential of becoming a transformative technology, much in the way that IT has proven transformative. Breakthroughs are anticipated in such diverse fields as low-cost hybrid (carbon, silicon) solar cells, targeted drug delivery, “labs-on-a-chip,” ultra high-speed computing, and nanoporous filtration. While the U.S. National Science Foundation anticipates a commercial revolution worth trillions of dollars within the next decade, with millions workers engaged directly in nanotechnology-related enterprises by 2015, along with many additional millions in supporting jobs, none of these studies have examined how many jobs will be lost as a result of productivity gains in these industries, from the circulation of knowledge workers back to their home countries, or from enterprises that cannot compete with nano-enabled products. This project seeks to examine the nanotechnology workforce and the many challenges faced not only by brain circulation in a knowledge-based economy, but also, challenges to workers producing nano-enabled products in a global economy.

We have not done further work on this area to date.

IRG2-12: Risks to human health and the environment within nanotechnologies research in Mexico; Zayago Lau, Edgar; Foladori, Guillermo; Frederick, Stacey

The aim of this project is to evaluate, using available direct and secondary data, the risks to human health and the environment within nanotechnologies research in Mexico. It required the implementation of three protocols. The first protocol used a database containing all articles on nanotechnologies published by Mexican authors (using tracking terms identified by Kostoff et al. 2006) for the 2000 to 2012 period. There were 4,471 articles published with at least one author with an institutional affiliation in Mexico at the moment the article was published. Then, key terms were identified that are associated with toxicity and risk analysis of nano- materials in key literature on the topic. The terms were toxic, dysfunction, impair, oxidative stress, inflammation, exposure.

The research objective required the implementation of three protocols. The first protocol used a database containing all articles on nanotechnologies published by Mexican authors (using tracking terms identified by Kostoff et al. 2006) for the 2000 to 2012 period. There were 4,471 articles published with at least one author with an institutional affiliation in Mexico at the moment the article was published. Then, key terms were idenified that are associated with toxicity and risk analysis of nano- materials in key literature on the topic. The terms were toxic, dysfunction,

impair, oxidative stress, inflammation, exposure, risk, harmful, hazard, oral uptake, ingestion, skin penetration, inhalation, transdermal/trans-dermal. Next, those terms were tested by doing a search within all articles. The manual revision identified— and discarded—those articles that did not have a direct relation to the topic such as the ones related to how nanotechnologies could be used to repair the environment and/or use it as medicine, pharmacological vehicle, or implant; thus leaving only those articles that dealt with the potential risks of nanomaterials or nanoparticles to human health and/or the environment. Finally, a search was performed for the following four key terms: toxic, dysfunction, impair, and oxidative stress, which directly identified articles related to risks of nanomaterials to health or the environment.

The second protocol focused on the identification, within all the institutions that are doing nanotechnologies related research in Mexico, of research groups, laboratories, or individual scientists researching risks of nanomaterials. To this end, the academic clus-ters (AC; Cuerpos Académicos in Spanish) database of the Ministry of Public Education (SEP) that is part of the Program for Professor- ship Development (PROMEP) were used first. In November 2012, the Mexican Secretary of Economy released a set of guidelines for the regulation of nanotechnologies. This was the first formal step towards the regulation of nanotechnologies in the country. The guidelines are important for all companies doing business in Mexico, but particularly important for U.S. businesses, as they are a part of a bilateral agreement between Mexico and the U.S.

The third protocol required the analysis of the policy context surrounding the development of these guidelines and the substantive content within the guidelines. 1) We found that the Mexican principles to regulate nanotechnologies align themselves with the content of the U.S. guidelines for the regulation of nanotechnology and nanomaterials, which reflect an interest towards advancing a lighter or less restrictive regulation platform and a pro-trade stance. The topic of risks to health and the environment are subordinated or downgraded to facilitate the movement of nano products across the border of both countries; 2) We also found that the topic of risks to health and/or the environment from manufactured nanomaterials has been absent from the vast majority of re- search efforts in Mexico, as the bibliometric analysis shows. Only 25 scientific articles dealt with this issue out of the more than 4,000 articles on nanotechnologies published in the past 12 years. This represents only 0.6% of the total. Also, a manual search by a re- search center did not offer many results. There are very few projects led by interested individuals on this subject.

Five publications resulted from this research project:

- Zayago Lau, Edgar; Foladori, Guillermo; Frederick, Stacey & Arteaga, Edgar (2014). Researching Risks of Nanomaterials in Mexico. *J. Hazard. Toxic Radioact. Waste* (http://dx.doi.org/10.1061/(ASCE)HZ.2153-5515.0000247)

- Foladori, Guillermo & Záyago Lau, Edgar (2014). The regulation of nanotechnologies in Mexico. *Nanotechnology, Law and Business Journal*, 11(2), pp. 164-171.

- Zayago Lau, Edgar; Stacey, Frederick & Foladori, Guillermo (2014). Twelve years of nanoscience and nanotechnology publications in Mexico. *Journal of Nanoparticle Research* 16:2123, pp. 1-10.

- Foladori, Guillermo & Zayago Lau, Edgar (2015-Forthcoming) La regulación de Foladori, Guillermo & Zayago Lau, Edgar (2015-Forthcoming) La regulación de las nanotecnologías en México. *Revista Legislativa*.

IRG 2-13: Framing Nanotechnology in the Media (X-IRG): Stocking, Hasell (IRG 3)

In this project, we 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.

Our previous research in this area has been on nanotechnology agendas. We chose to put this portion of the project on hold in favor of research into the type of language, because we felt that this was a more fruitful line of inquiry. We 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, we use statistical time series methods to describe the results. We have completed an initial draft of one such study and presented it at two conferences. We 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.

We have one paper in progress ("Twitter as a Tool for Public Engagement"), and one under submission ("A Pipeline of Tweets: Environmentalist Movements' Use of Twitter in Response to the Keystone XL Pipeline").

IRG2-14: Global Value Chain Analysis (X-IRG): Frederick, Appelbaum, Harthorn, Herman

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 included collecting data on degree and certification programs in the U.S. related to nanotechnology to add a "bottoms-up" approach to identify the potential scope of the U.S. nano-related workforce; completing and updating the California in the Nanotechnology Global Economy website (see http://californiananoeconomy.org/); the submission of a California Research Bureau Short Subject, "Nanotechnology in California" (currently under review); and preparion of a paper entitled "Quantifying the Nanotechnology Workforce in the US: Methods, Barriers & Estimates."

The value chain research is also being extended to Mexico and Latin America. The work on Mexico is reported under IRG2-12 (Risks to human health and the environment within nanotechnologies research in Mexico). Additionally, a meeting with Fredrick, Foladori, and Invernizzi in Brazil was held to look into the process of mapping Argentina, Brazil, and Mexico in a fashion similar to the California website. Finally, a proposal and work plan was developed for Mehta's seed grant project.

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- and upper-division undergraduate courses (e.g., Global 2, Global 130) as well as his graduate seminars.

- Lenoir has directed two independent studies by undergraduates on recent developments of nanotechnology in China and the effectiveness of new innovation policies in stimulating indigenous innovation in China.

- Lenoir has directed two independent studies by undergraduates on recent developments of nanotechnology in China and the effectiveness of new innovation policies in stimulating indigenous innovation in China.

- Lenoir directed a senior honors thesis by Hannah Sieber at Duke on the history of "sea turtles" and attitudes of overseas Chinese students and business people in the North Carolina Research Triangle to their economic prospects upon returning to China. The thesis was completed in March 2013 and won the prize for the best honors thesis at graduation in International Comparative Studies.

Leverage

- Appelbaum was selected by the Institute for International Education (IIE) to be a member of a five-person team that reviewed IIE "Global Innovation Initiative" proposals for international STEM-related projects that involve a U.S. university, a U.K university, and a university from

at least one of four emerging economies (China, India, Brazil, and/or Indonesia). The review panel met in January 2015 at IIE's international headquarters in NYC. He also spent a month-long residency (September 2014) at the Rockefeller Center in Bellagio, Italy, writing a book on *Achieving Workers' Rights in the Global Economy*. One of the chapters he completed focuses on the issue of corporate social responsibility, a theme that was taken up at the "Democratizing Technologies" conference. He completed work on the 10th edition of his co-authored introductory sociology textbook, published by WW Norton, which draws heavily on his CNS-related research. Appelbaum's conference in Curitiba resulted in discussions with Flavio Orlando Plentz Filho, Coordinator of the Micro and Nanotechnology Department at MCTI (Brazil's Ministry of Science and Technology), who subsequently participated in the "Democratizing Technologies" conference.

- Frederick submitted an NSF proposal in February 2014 with Youtie and Shapira at Georgia Tech to conduct a collaborative project on value chain mapping a subset of the global nanotechnology economy using the data she has collected on firms, in conjunction with the data they have on patents and publications. Although the proposal was not funded by the NSF, we plan to seek other sources of funding.

- Mehta is consulting with the Asian Development Bank (an intergovernmental organization) on education and export diversification, using across-country and across-industry data to examine how education and industrial policy complement each other in countries seeking market share in technologically sophisticated products.

- Luciano Kay was been interviewed by Julie Cohen, Public Affairs & Communications, UCSB, to further disseminate the work "Patent Overlay Mapping: Visualizing Technological Distance" in UCSB's news bulletins. Luciano was invited by *Wired UK*'s editor to feature his work on "Patent Overlay Mapping: Visualizing Technological Distance" in a section of the magazine related to data and visualization. His work on "Patent Overlay Mapping: Visualizing Technological Distance" has been also featured in an online section of the magazine *MIT Technology Review*, which led to further dissemination by many other media outlets related with technology.

IRG 2 Publications 2014-2015

Primary Publications: Journals

1. Han, Xueying, Stocking, Galen, Gebbie, Matthew A., & Appelbaum, Richard P. (2015). Will they stay or will they go? International graduate students and their decisions to stay or leave the U.S. upon graduation. *PLoS ONE, 10*(3), e0118183. doi: 10.1371/journal.pone.0118183

2. Motoyama, Yasuyuki, Cao, Cong, & Appelbaum, Richard. (2014). Observing regional divergence of Chinese nanotechnology centers. *Technological Forecasting and Social Change, 81*(0), 11-21. doi: http://dx.doi.org/10.1016/j.techfore.2013.02.013

Primary Publications: Books, Chapters, Reports and other Publications

3. Appelbaum, Richard. (2014). China: Innovator or Follower. *China Policy Institute Blog.* from http://blogs.nottingham.ac.uk/chinapolicyinstitute/2014/12/05/china-innovator-or-follower/

Leveraged Publications: Journals

4. Foladori, Guillermo, Appelbaum, Richard, Invernizzi, Noela, & Záyago Lau, Edgar. (2014). Nanotecnologia y trabajadores: Declaracion de Curitiba. *Observatorio del Desarrollo, 3*(9), 73-75.

5. Foladori, Guillermo, & Lau, Edgar Záyago. (2014). The Regulation of Nanotechnologies in Mexico. *Nanotechnology Law & Business, 11*, 164-171.

6. Foladori, Guillermo, & Lau, Edgar Záyago. (2015). La Regulacion de las Nanotecnologias en Mexico. *Revista Legislativa de Estudios Sociales y de Opinion Publica, 7*(14), 123-146.

7. Kay, Luciano, Newman, Nils, Porter, Alan, Rafols, Ismael, & Youtie, Jan. (2015). Mapping Graphene Science and Development. *Bulletin of the Association for Information and Technology, 41*(2), 22-25.

8. Kay, Luciano, Newman, Nils, Youtie, Jan, Porter, Alan L., & Rafols, Ismael. (2014). Patent overlay mapping: Visualizing technological distance. *Journal of the Association for Information Science and Technology, 65*(12), 2432-2443. doi: 10.1002/asi.23146

9. Záyago Lau, Edgar, Foladori, Guillermo, Frederick, Stacey, & Arteaga Figueroa, Edgar. (2014). Researching Risks of Nanomaterials in Mexico. *Journal of Hazardous, Toxic, and Radioactive Waste, 0*(0), B4014001. doi: doi:10.1061/(ASCE)HZ.2153-5515.0000247

10. Arteaga Figueroa, Edgar, Foladori, Guillermo, Záyago Lau, Edgar, & Robles Belmont, E. (forthcoming). Las nanotecnologías aplicadas al sector energético. *Observatorio del Desarrollo, 11*.

11. Foladori, Guillermo. (forthcoming). Criterios sobre la regulación de las nanotecnologías. *Observatorio del Desarrollo, 3*(11).

12. García Guerrero, Miguel, & Foladori, Guillermo. (forthcoming). Divulgación de nanotecnologías en España, Estados Unidos y México: la visión del papel de la sociedad en la nueva ola científico-tecnológica. *Observatorio del Desarrollo, 3*(11).

13. Záyago Lau, Edgar. (forthcoming). Nanotecnologías en América Latina, Asia-Pacífico y África. *Observatorio del Desarrollo, 3*(11).

Leveraged Publications: Books, Chapters, Reports and other Publications

14. Invernizzi, Noela, & Foladori, Guillermo. (forthcoming). Nanotechnology Implications for Labor. In Raj Bawa, Gerald F. Audette & Israel Rubinstein (Eds.), *Handbook of Clinical Nanomedicine*. Singapore: Pan Stanford Publishing.

15. Záyago Lau, Edgar. (forthcoming). La regulación de las nanotecnologías en México y la investigación sobre riesgos de los nanomateriales manufacturados. In Guillermo Foladori, Edgar Záyago Lau, N. Invernizzi & Miguel Ángel Porrúa (Eds.), *Trabajo, riesgos y la regulación de las nanotecnologías en América Latina*. Mexico.

Submitted or in preparation publications: primary

16. Appelbaum, Richard, Gebbie, Matt, Han, Shirley, & Stocking, Galen. (under review). Will China's Quest for Indigenous Innovation Succeed? Some Lessons From Nanotechnology. *Research Policy*.

17. Lenoir, Timothy, Herron, Patrick, Wiess, Ben, McGuire, Aaron, Pachon, Jan, & Dsousa, Lanceton. (under review). The National Cancer Institute and the Takeoff of Nanomedicine. *Scientometrics*.

18. Lenoir, Tim, Mehta, Aashish, He, Kevin, Herron, Patrick, & Zhou, Yilun. (under review). The Impact of National Nanoscience Diversification Strategies

19. Parker, Rachel, Appelbaum, Richard, & Cao, Cong. (under review). Nanopolis and Suzhou Industrial Park: China's Silicon Valley? *Technology in Society*.

20. Appelbaum, Richard, Gebbie, Matt, Han, Shirley, Nightingale, Emily, & Stocking, Galen. (in preparation). A Twitter Education: How Scientists Use Twitter to Educate the Public About Nanotechnology.

21. Kay, Luciano, Appelbaum, Richard, Shapira, Philip, & Youtie, Jan. (in preparation). Innovation Pathways of Developing Countries in Emerging Technologies: The Case of Nanotechnology in Argentina and Brazil.

22. Kay, Luciano, & Woolley, Jennifer. (in preparation). Corporate Research and Development Activities in Synthetic Biology.

23. Lenoir, Tim, Harthorn, Barbara Herr, He, Kevin, & Zhou, Yilun. (in preparation). The Relationship Between International Collaboration on Nanotechnology and Publication Impact.

24. Lenoir, Timothy, Herron, Patrick, Wiess, Ben, McGuire, Aaron, Pachon, Jan, & Dsousa, Lanceton. (in preparation). Star Scientists, Federal Funding and the Takeoff of Bionanotechnology and Nanomedicine.

Submitted or in preparation publications: leverage

25. Kay, Luciano, Youtie, Jan, & Shapira, Philip. (under review). Inter-industry knowledge flows and sectoral networks in the economy of Malaysia. *Knowledge Management Resource & Practice*.

26. Lenoir, Tim, Herron, Patrick, He, Kevin, & Zhou, Yilun. (in preparation). An Evaluation of Lexical Queries for Identifying Nanotechnology Publications.

IRG 2 Research Presentations 2014-2015

1. Appelbaum, Richard. China and Global Nano/New Materials Revolution. The Role of Science & Technology in China's International Relations, Arizona State University, Tempe, AZ, April 4, 2014.

2. Han, Xueying (Shirley). Overview of Chinese Nano-Scientists: Impact of Educational Background and Mobility on Scientific Success from CV Analysis Gordon Research Seminar & Gordon Research Conference on Science & Technology Policy, Waterville, NH, August 8-15, 2014.
3. Zayago Lau, Edgar, Foladori, Guillermo, & Appelbaum, Rich. Workers' demands for precaution and transparency in nanotechnology development. ESOCITE / 4S, Buenos Aires, Argentina, August 22, 2014.
4. Herron, Patrick, He, Kevin, & Zhou, Yilun. Functionality of Globonano. Duke University Media Arts + Sciences, Durham, NC, September 2, 2014.
5. Mehta, Aashish. Skill gaps, human capital and industrial development in India Indian Council for Research on International Economic Relations, New Delhi, India, September 7, 2014.
6. Kay, Luciano, & Woolley, Jennifer. Corporate research and development activities in synthetic biology. S.NET 6th Annual Meeting, Karlshruhe, Germany, September 21-24, 2014.
7. Zayago Lau, Edgar. Nanotechnology and Health: New Challenges. Universidad Autonoma de Zacatecas Seminar, Zacatecas, Mexico, September 2014.
8. Zayago Lau, Edgar, & Guillermo, Foladori. Seminar Talk Graduate Faculty of Public Policy, Universidad Federal do Parana Seminar, Curitiba, Brazil, September 2014.
9. Zayago Lau, Edgar. Nanotechnology Dialogues First Iberoamerican Seminar, Autonomous University of Zacatecas, Mexico, December 2014.
10. 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 Socio-Economics, London, July 2015.

IRG 2 Outreach Activities 2014-2015

11. Gebbie, Matt. Nanodays Volunteer, Nanodays, Santa Barbara Museum of Natural History, April 4-5, 2014.
12. Han, Xueying (Shirley). Nanodays Volunteer, Nanodays, Santa Barbara Museum of Natural History, April 4-5, 2014.
13. Stocking, Galen Nanodays Volunteer, Nanodays, Santa Barbara Museum of Natural History, April 4-5, 2014.
14. Kay, Luciano, Porter, Alan L., Rafols, Ismael, Newman, Nils, Search Technologues, Spain, Ingenio, & Youtie, Jan. Poster: The Future of Science Mapping. 10th Iteration of the Places & Spaces: Mapping Science Exhibit, Various, 2014.
15. Appelbaum, Richard. Making Blue the Next Green: Achieving Workers' Rights in the Global Economy Rockefeller Foundation, Bellagio Center, Bellagio, Italy, September 1, 2014.
16. Mehta, Aashish. Education, Skills and International Competitiveness in an Era of Soft Labor Demand World Bank, Washington, DC, October 15, 2014
17. Appelbaum, Richard. Co-Lead organizer, host. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 13-15, 2014.
18. Stocking, Galen. Report-Back Plenary Address, CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.
19. Gebbie, Matt. Report-Back Plenary Address, CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

20. Han, Xueying (Shirley). Report-Back Plenary Address, CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.
21. Kay, Luciano. Report-Back Plenary Address, CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.
22. Appelbaum, Richard. Making Blue the Next Green: Achieving Workers' Rights in the Global Economy, CNS-UCSB Democratizing Technologies: Assessing the Role of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 15, 2014.
23. Kay, Luciano. What is Nanotechnology? Anacapa School 7-12 grade students, Santa Barbara, CA, December 5, 2014.
24. Appelbaum, Richard. Making Blue the Next Green. Bangladesh Garment Manufacturer and Exporter Association Apparel Summit, Dhaka, Bangladesh, December 18, 2014

IRG 3 Progress Report: Risk Perception and Social Response
March 2014-March 2015

Faculty and Senior Participants

B. Herr Harthorn, Leader	Med anthropology	UC Santa Barbara
N. Pidgeon, Co-leader	Applied Psychology	Cardiff University, UK
T. Satterfield, Co-Leader	Env anthropology	University of British Columbia, CA
S. Anderson [seed grant]	Env Politics, Bren	UC Santa Barbara
E. Barvosa [seed grant]	Feminist Studies	UC Santa Barbara
B. Bimber	Political Science	UC Santa Barbara
K. Bryant	Sociology	SUNY New Paltz
J. Earl	Sociology	Univ of Arizona
S. Friedman [X-IRG]	Science Journalism	Lehigh Univ, Bethlehem, PA
R. Gregory	Env Risk	Decision Research, OR
M. Kandlikar	Science policy	University of British Columbia, CA
G. Long	Engineering	Compass Resource Management
D. Novak [seed grant]	Music	UC Santa Barbara
J. Rogers-Brown	Sociology	Long Island University, NY
P. Slovic	Risk Psychology	Decision Research, OR

Affiliates

C. Beaudrie	Env Risk	Compass Resource Management
M. Collins	Env Sociology	Univ of Maryland (SESYNC)
B. Egolf	Sci Journalism	Lehigh Univ
K. Henwood	Sociology	Cardiff Univ
P. Holden	Microbiology, Eng	UC Santa Barbara
C. Shearer	Ecology & Society	UC Irvine

Postdocs (2+2), Graduate Students (5), Undergraduate Students (1), Technical (1)

Postdoctoral researchers:

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

International Postdoctoral researchers:

*Anton Pitts	Env Risk	Univ of British Columbia, CA
Merryn Thomas	Geography	Cardiff UK

Graduate students:

*Cassandra Engeman[E&O]	Sociology	UC Santa Barbara
Bridget Harr	Sociology	UC Santa Barbara
Ariel Hasell	Communication	UC Santa Barbara
*Louise Stevenson	Ecology	UC Santa Barbara
*Megan Callahan	Env Risk	Univ of British Columbia, CA

Undergraduate students:

Catherine Enders	Psychology	UC Santa Barbara

**partially or fully funded from another source*

Technical and Research Staff:

Maria Yepez	Biochemistry	UC Santa Barbara

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 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.

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 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 are 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 the everyday public, 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, ethnographic interviews, and deliberative public engagement workshops and focus groups regarding the risks and benefits of specific applications of nanotechnologies, 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.
- 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.
- 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. Work with XIRG researcher Stocking and 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 stakeholder engagement, and risk communication.
- Seed new projects that can extend the aims, personnel, and scope of the group and respond to emerging conditions and challenges.
- Map out new syntheses of the nanotech risk perception field, based on the larger body of our work.
- Plan future fund seeking initiatives to extend the group's work beyond sunset.

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).

IRG 3 is 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

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

IRG 3-4: Nanomaterials Industry Risk Perception and Practices – UCSB, UBC

IRG 3-5 Framing of Nano in the Media– Lehigh Univ [see X-IRG report on Friedman project]; UCSB: new project on twitter framing [see X-IRG report on Stocking project]

IRG 3-6: Priming Effects in Judgments about Nano - UCSB

IRG 3-7: The Politics of Consumer Choice - UCSB

IRG 3-8: NonGovernmental Organizations and Tomorrow's Nanotechnologies – UCSB, Univ of AZ, Long Island Univ, UC Irvine

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 a 2-day IRG 3 meeting in Cardiff, UK (June 23-24) including Harthorn, Pidgeon, Satterfield, Gregory, Henwood, Barvosa, Partridge, Thomas, and Hasell before conducting a pilot deliberation at Cardiff Univ on June 25, 2014; and meetings of Partridge with Pidgeon and Thomas in Nov 2014 in Cardiff, Pidgeon with Harthorn in Santa Barbara in Dec 2014 and Pidgeon with Partridge in Dec 2014 at the SRA meetings in Denver. Partridge will meet with the Cardiff team in the UK in June 2015, and a meeting of Satterfield, Pidgeon, Harthorn, Gregory and Beaudrie is planned for July 2015 in Vancouver for advancing synthesis of the full body of the group's work on upstream risk and benefit perceptions of nanotech and comparative other technologies.

In the reporting year, IRG 3 researchers organized sessions of CNS-related research at the Society for Applied Anthropology (Pittsburgh, Mar 2015), took a leadership role in workshops and stakeholder meetings on nanotechnologies with the Society for Risk Analysis, actively participated in disciplinary and interdisciplinary conferences and meetings in the US, Canada, and Europe, making a total of 22 actual and planned presentations directly disseminating CNS work.

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. 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, recognizes Pidgeon's deep commitment to educating the public about climate change and energy security policy.

Harthorn gave invited testimony to the US President's Commission on Bioethics in Feb 2014 in relation to the societal aspects of the new BRAIN Initiative and is cited in both reports generated by the Commission (June 2014, Mar 2015). She also served on the executive committee for the NSF Workshop on Societal Implications of Synthetic Biology, Tempe AZ, Nov 2014 and participated in discussions there and in Arlington. She also presented in the NSF STS Data Management Workshop at the NSF in Jan 2015. Pidgeon

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 affiliative differences in views on risk and regulation 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. In 2013, the UBC team completed a paper (Beaudrie, Kandlikar and Satterfield, 2013, *ES&T*) based on Beaudrie's Chemical Heritage Foundation commissioned study of regulatory gaps across the life cycle of nanomaterials (2010). 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 aligns well with rising interests in the nano eco-toxicology world in the UC CEIN and elsewhere. This paper was recently (Mar 2014) awarded First Runner-Up Best Policy Analysis 2013 in *Environmental Science & Technology,* a notable honor and accomplishment. Beaudrie presented a poster on this at SETAC North America 35th Annual Meeting in Vancouver in Nov 2014 and a paper extending this at the SRA meetings in Denver, CO December 2014. He has also taken a leadership role in the SRA, co-organizing an experts workshop on Alternative Testing Strategies (ATS) in Sept 2014, and leading a sustainable management program at SRA 2014.

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 new publication in *Environment Systems and Decisions* (Dec 2014). The team is pursuing additional funding and possible means to extend the project; in the past year they circulated the NRST proposal.

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

UBC researchers Satterfield, Kandlikar & 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 now complete and the final key publication was completed in the reporting year (Beaudrie, Satterfield**,** Kandlikar & Harthorn, *PLoS One* 2013, and Beaudrie, Satterfield, Kandlikar & Harthorn, *PLoS One* 2014). Presentations on aspects of the work continue as appropriate.

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

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. See Pidgeon et al 2014 PNAS. In addition, Pidgeon made invited presentations to the Oxford Univ Geoengineering Research Governance Network Conference, the US NAS, Sept 2013; the Sackler Science of Science Communication conf, Sept 2013; Corner convened a symposium at the Science in Public conference (Nottingham, UK July 2013).

IRG 3 plans in this area for the next 1.5 years include conclusion of the decision pathway analysis in collaboration with Decision Research, and development by Harthorn and Pidgeon of a new cross-national survey of public perceptions of risks and benefits from unconventional oil and gas (UOG) technologies in the US and UK if fund raising is successful. Harthorn and former postdoc Collins are also piloting work on the spatial aspects of nano and UOG risk perception for survey research development. The first paper on this work is being presented at the Society for Applied Anthropology meetings in Pittsburgh, Mar 2015. Harthorn and Satterfield 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 and virtually 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. A final publication on affect and ambivalence response is readying for resubmission (Satterfield, Corner et al., 2015).

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

Leverage: The CNS IRG 3 collaboration with researchers in the UC CEIN offers an unprecedented opportunity for co-production of risk knowledge by scientists and societal researchers. Initially primarily funded through the UC CEIN Theme 7, and now 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, Hanna, and Harthorn, readying for resubmission, 2015).
- Consumer products safety judgments are linked to judgments about nanomaterial safety (Copeland, Collins, Satterfield, and Harthorn, 2015 in prep).
- Public's views on nanoethics indicate 4 robust factors that show responsible development ideals are well distributed in the US public (Harthorn, Collins, Satterfield, and Hanna, 2015 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), and a series of papers is planned for completion and submission in 2015.
Main findings include:

- Hypothesis from pilot data on the importance of resilience as a basis for predicting perceived risks and ENMs confirmed. Also found statistically significant 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 explaining 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. Data analysis has been underway by CNS Fellow Hasell at UCSB under direction of Satterfield, Gregory and Pidgeon. Main findings:

- Clear differences between US and UK on ideological positions regarding climate change and geo-engineering; clear decision pathways emerge on opinions about geo-engineering for those who regard climate change as primarily human made versus primarily natural. One paper full drafted and near review, another underway. Further UK papers are ongoing.

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

The aim of this project has been to conduct a meta-analysis of the use and misuse of 'the white male effect' in risk research and its implications for new research on emerging technologies using nanotechnologies as the case in point. The meta-analysis is now complete, and 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 (non white males, white and nonwhite females). A paper is in preparation for submission.

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

IRG 3-3a. The work in the past year has continued 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 IRG 3 graduate fellows Harr, Hasell, & Stevenson, in the past year initiated a new set of US-UK deliberations that builds on the team's 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. Data analysis is in progress, and the first paper is expected to address the most salient cross-national comparisons in risk judgments about unconventional oil and gas. This 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 based on his extensive experience there. Harthorn and US project postdoc Partridge have prepared and submitted a proposal to NSF (Feb 2015) for 14 months of proposed additional research on the effects of 'urgency' appeals on public risk and benefit judgments.

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. These efforts were given the signal honor in July 2014 with the award from the Queen of the prestigious MBE (Member of the Order of the British Empire) for "services to UK climate change and energy security policy."

IRG 3-3b: In a closely related project UCSB feminist political and social theorist Barvosa, initiated a project to apply new theoretical analysis to previously collected IRG 3 public deliberation research data, and 2) 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." See Seed Grants report Project XIRG 6-6 for the update on this.

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, and the team has made numerous presentations outside of social science venues. In the reporting year, Harthorn provided a webinar on the industry survey research to the nanotoxicology specialty group of the Society of Toxicology, March 2014, and continued service on the Executive Committee and Theme 7 of the UC CEIN where this work has continued applicability.

IRG 3-5 Framing of Nano in the Media (X-IRG Friedman); Friedman, Egolf; for Stocking, Bimber, Hasell component, see X-IRG Stocking

The study of 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 3 papers in preparation on these results. Friedman continued her work on the Council of the AAAS, and was honored by being named a McCormick Fellow in June 2014.

In addition, reported under the X-IRG Stocking project, IRG 3 Fellow Hasell has been working through the past year with IRG 2 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) and the new anticipated comparative US-UK survey research by Harthorn and Pidgeon.

IRG 3-6: Priming Effects in Judgments about Public Policy; Bimber, Conroy--Project completed in prior year.

IRG 3-7: The Politics of Consumer Choice; Copeland, Bimber, Hasell

To increase understanding of political consumerism, 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 incorporates 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. Copeland theorized and found key differences between boycotting and buycotting that are important to understanding how scholars should conceptualize political consumerism as a form of political behavior. She also found that boycotters are significantly more likely than non-political consumers to engage in electoral, individualized, and civic participation. In contrast, buycotters are only somewhat more likely than non-political consumers to engage in individualized and civic participation. These findings demonstrate that boycotting represents an expansion of conventional participation repertoires. The implications for buycotting, however, are less clear, but the difference between the two acts is apparent.

Finally, 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 finds 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 and filed her dissertation in 2014 and has published 4 articles from this study and has another 5 in preparation. In addition, Copeland has extensively disseminated results to political science conferences in the US and Europe and to 4S and SNET conferences. She is currently contributing her expertise as a part-time post-doctoral researcher in collaboration with IRG 3-2b (Environmental Risk Perception survey project).

IRG 3-8: NonGovernmental Organizations and Tomorrow's Nanotechnologies; Engeman, Harthorn, Earl**,** Appelbaum, Rogers-Brown, Shearer

IRG 3-8a: **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 has 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 was awarded a grant from the UCLA Institute for Research on Labor and Employment for Winter 2015, a UCSB Broom Center for Demography Graduate Associate Fellowship for 2014-15, and a visiting research position at the Social Science Research Center in Berlin (WZB) for 2014-15; she furthermore is serving as an external expert with the European Trade Union Institute on a "Scenario Project" that considers potential occupational safety and health issues in the future workplace. Such scenarios will consider the impacts of new technologies on the organization of work. These projects and awards leverage her CNS-based experience on the nanotech industry (see project IRG 3-4 above) and NGOs with her interests in labor studies.

In the reporting year this project's larger role has been its main contribution to CNS's major public engagement via a large international conference/workshop with NGO leaders Nov 15-17 2014. Then-Senior Grad Fellow Engeman was the lead project coordinator for the conference, working closely with leaders Harthorn and Appelbaum and a large group of interested campus scholars who participated in shaping the conference (see sections 11 and 12 for more information on this event).

IRG 3-8b: **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 IRG 3 postdoc, now a tenure track faculty member) 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 8 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 in 2013, and have 2 manuscripts in progress.

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 the past year, working with policymakers in the state of California, and Rogers-Brown has given outreach talks on nanotechnology in society.

IRG 3 Co-funding:

Leverage in Yr 10:

1) Harthorn & Partridge. (pending, NSF STS), $119,765, Postdoctoral Fellowship: Energy, Risk and Urgency - Emergent Public Perceptions of Unconventional Oil and Gas Extraction, submitted Feb 2, 2015.
2) Nel, Andre et al. (NSF DBI 1266377), $24,000,000. UC Center for Environmental Implications of Nanotechnology renewal, yrs 6-10, 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 have had a significant impact on this now $48M Center.
2) 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.
3) Nel, Andre et al. (NSF DBI-0830117), UCSB subk $8.7M (1.3M in CNS direct leverage funds in Theme 7, through Aug 2014) UC Center for Environmental Implications of Nanotechnology, Harthorn was Theme 7 ("Environmental Risk Perception, Regulation and Outreach") co-leader, is Co-PI of the UCSB subcontracts, and a member of the UC CEIN Executive Committee, 2008-present; Satterfield and Kandlikar were Theme 7 senior personnel in the 1st 5 years. The Theme 7 UC CEIN funding allowed CNS IRG 3 to extend its research on expert views and public perceptions to more specifically environmental issues and to enhance participatory collaboration with NSE and ecotoxicology researchers. UC CEIN provided funds for a two-stage public survey on nano environmental risk perception (Satterfield et al., 2015, in prep), the 2009-2010 international industry survey (Engeman et al. 2012, Engeman et al. 2013, both under Harthorn's and Holden's leadership); partial support of the expert survey (Beaudrie et al., PLoS One 2013; PLoS One 2014); and lead support of the expert decision making under uncertainty workshop (Beaudrie et al., report; and 2015). This support drew to a close in August 2014 at the conclusion of the no cost extension of the 1st 5 years of funding of the UC CEIN.
4) Friedman, $120,000, Lehigh University seed grants, 2013-15, on risk perception and earthquakes and hydraulic fracturing in Pennsylvania.
5) Pidgeon, $525,000 UK Engineering and Physical Sciences Research Council. Integrated assessment of geoengineering proposals. October 2010 – September 2014 (EP/I014721/1). This work has used protocols developed in the CNS deliberative work to extend to public engagement regarding another new technology with very low public awareness and potential high impacts, geoengineering.

5. Broader Impacts of IRG 3

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

IRG 3 has contributed to CNS broader impacts through integrated research on and education and outreach to key stakeholders in the nanoenterprise, sharing nano and related emerging technologies ELSI research and implications with: NSE (through partners in the CNS at UCSB, through numerous publication and professional presentation venues, and by incorporating NSE scientists-in-training into our ongoing societal research, education and outreach programs); with nano ecotoxicologists (through our research about their views on risk and regulation, and through a deep and mutually impactful collaboration with the NSF- and EPA-funded UC CEIN); with regulators (through qualitative and quantitative research, and analysis and synthesis of regulatory gaps; through leading the ELSI component of the UC CEIN in its work on safe development of engineered nanomaterials-ENMs; through engagement with California state, national and international regulators and policymakers on responsible development; through dissemination to NPEC, NNCO, PCAST, NAS and other key regulatory actors); with industry (through our novel survey research on the international ENM industry; through outreach and engagement with industry personnel in ours and UC CEIN's national advisory boards; through travel and dissemination of the research to industry audiences in the US, Japan, and Europe); through work with NIOSH on worker safety issues; and to lay audiences through an array of formal and informal events and activities (CNS seminars and visiting lectures; integration in formal coursework; 2 years of participation in UCSB Critical Issues programs--Speculative Futures, 2011-2012 and Figuring Sea Level Rise, 2012-2013; IRG 3 deliberative forums, including 7 in the reporting year; social media use; website development), notably leading the large public engagement effort in 2014-2015 that was the NGO conference (Nov 2014).

IRG 3, along with the rest of CNS, has had highly successful educational outcomes as measured by achieved employment of former fellows (both 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. IRG 1 work on nano medicine (November) also contributes to IRG 3 focus on nano health applications, one of the main threads that connect our survey and deliberative work. 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 the work this year by Harthorn, Appelbaum & Engeman et al. on a large scale NGO conference held at UCSB in Nov 2014. 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. IRG 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 in promising new directions .

IRG 3 researchers have been active contributors to CNS education and outreach efforts in the past year. See below for the full list of activities, also cited in Sections 11 & 12.

IRG 3 Publications 2014-2015

Primary Publications: Journals

1. Beaudrie, Christian E. H., Satterfield, Terre, Kandlikar, Milind, & Harthorn, Barbara H. (2014). Scientists versus Regulators: Precaution, Novelty & Regulatory Oversight as Predictors of Perceived Risks of Engineered Nanomaterials. *PLoS ONE, 9*(9), e106365. doi: 10.1371/journal.pone.0106365

2. Beaudrie, Christian E H., Kandlikar, Milind, Gregory, Robin, Long, Graham, & Wilson, Tim. (2014). Nanomaterial risk screening: a structured approach to aid decision making under uncertainty. *Environment Systems and Decisions*, 1-22. doi: 10.1007/s10669-014-9529y

3. Pidgeon, Nick, Demski, Christina, Butler, Catherine, Parkhill, Karen, & Spence, Alexa. (2014). Creating a national citizen engagement process for energy policy. *Proceedings of the National Academy of Sciences of the United States of America, 111*(Suppl 4), 13606-13613. doi: 10.1073/pnas.1317512111

Primary Publications: Books, Chapters, Reports and other Publications

4. Copeland, Lauren, & Hasell, Ariel. (2014). Framing Effects on People's Expressed Willingness to Purchase Nanotechnology Applications in the U.S. In Christopher Coenen, Anne Dijkstra, Camilo Fautz, Julia Guivant, Kornelia Konrad, Colin Milburn & Harro van Lente (Eds.), *Innovation and Responsibility: Engaging With New and Emerging Technologies* (Vol. 5, pp. 87-106). Berlin: IOS Press.

5. Copeland, Lauren, & Smith, Eric RAN. (2014). Consumer Political Action on Climate Change. In Yael Wolinsky-Nahmias (Ed.), *Changing Climate Politics: US Policies and Civic Action* (pp. 197-217). Thousand Oaks, CA: CQ Press.

6. Copeland, Lauren, & Atkinson, L. (forthcoming). Political and Ethical Considerations in the Evolution of Consumer Activism as a Form of Political Participation and Civic Engagement. . In T Newholm, M Chatzidakis, M Carrington & D Shaw (Eds.), *Ethics and Morality in Consumption: Interdisciplinary Perspectives*. New York: Routledge.

7. Fadel, Tarek, Morita, Shelah, & Mayfield, Michael. (2015). Stakeholder Perspectives on Perception, Assessment, and Management of the Potential Risks of Nanotechnology. In Michaela Panter, Pat Johnson & Geoff Holdridge (Eds.), (pp. 74). Arlington: National Nanotechnology Coordination Office.

8. Harthorn, Barbara Herr. (forthcoming). Envisioning Our Nano-Medical Futures: Techno-Benefits and Social Risks? In Lenore Manderson, Elizabeth Cartwright & Anita Hardon (Eds.), *Vital Signs: Medical Anthropology for the 21st Century*. London: Routledge.

9. Harthorn, Barbara Herr. (forthcoming). Societal Science for Converging and Emerging Technologies. In William Bainbridge & Mihail C. Roco (Eds.), *Handbook of Science and Technology Convergence*. Springer.

Leveraged Publications: Journals

10. Charles, Maria, Harr, Bridget, Cech, Erin, & Hendley, Alexandra. (2014). Who likes math where? Gender differences in eighth-graders' attitudes around the world. *International Studies in Sociology of Education, 24*(1), 85-112. doi: 10.1080/09620214.2014.895140

11. Engeman, Cassandra. (2014). Social movement unionism in practice: organizational dimensions of union mobilization in the Los Angeles immigrant rights marches. *Work, Employment & Society*. doi: 10.1177/0950017014552027

12. Powers, Christina M, Grieger, Khara D, Beaudrie, Christian, Hendren, Christine, Ogilvie, Michael Davis, J., Wang, Amy, . . . Gift, Jeffrey S. (2015). Data dialogues: critical connections for designing and implementing future nanomaterial research. *Environment Systems and Decisions, 35*(1), 76-87. doi: 10.1007/s10669-014-9518-1

13. Cleveland, D. A., Copeland, Lauren, Glasgow, G, McGinnis, M. V., & Smith, E. R. A. N. (forthcoming). The Influence of Environmentalism on Attitudes Towards Local Agriculture and Urban Expansion. *Society and Natural Resources*.

Leveraged Publications: Books, Chapters, Reports and other Publications

Submitted or in preparation publications: primary

14. Barvosa, Edwina. (under review). Ambivalence as Asset: Mapping Meaning & Epistemic Diversity in Public Engagement with Nanotechnology. *Journal of Environmental Science and Studies*.

15. Satterfield, Terre, Corner, Adam, Pidgeon, Nick, Conti, Joseph, & Harthorn, Barbara Herr. (under review). Affective Ambivalence and Nanotechnologies. *Journal of Risk Research*

16. Barvosa, Edwina. (in preparation). Deliberative Remedies to Unconscious Bias in Institutional Settings and Policymaking.

17. Barvosa, Edwina. (in preparation). Public Deliberation… *Constructing Deliberative Democracy*.

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

19. Collins, Mary, Copeland, Lauren, Harthorn, Barbara Herr, & Satterfield, Terre. (in preparation). NEP vs. Resilience: Developing a New Approach to Predicting the Acceptability of Hazards.

20. Collins, Mary, Copeland, Lauren, Harthorn, Barbara Herr, & Satterfield, Terre. (in preparation). Rating the Risks: the Non-White Female Effect.

21. Collins, Mary, Hanna, Shannon, Harthorn, Barbara, & Satterfield, Terre. (in preparation). US Public Views on Nanotechnology and Product Safety: So Far So Good?

22. Cranfill, Rachel, Bryant, Karl, Shearer, Christine, & Harthorn, Barbara Herr. (in preparation). Indexing Expertise in a Deliberative Setting: A Comparison.

23. Friedman, Sharon. (in preparation). Coverage of Nanotechnology Environmental and Health Risks by the New Haven Independent and Google Alerts.

24. Friedman, Sharon. (in preparation). Media coverage of nanotechnology regulation.

25. Friedman, Sharon. (in preparation). Nanotechnology Source Use by Journalists.

26. Gregory, Robin, & Satterfield, Terre. (in preparation). Using Decision Pathway Surveys to Address Large-Scale Climate Engineering Policy Choices.

27. Gregory, Robin, Satterfield, Terre, & Hasell, Ariel. (in preparation). Using Decision Pathway Surveys to Inform Climate Energy Policy Choice.

28. Harthorn, Barbara Herr, Collins, Mary, Hanna, Shannon, & Satterfield, Terre. (in preparation). Ethical Positions and Nanotechnology Acceptance: A Social Component of Environmental Sustainability. *Journal of Responsible Innovation*.

29. Harthorn, Barbara Herr, Copeland, Lauren, Satterfield, Terre, & Collins, Mary. (in preparation). Factors Underpinning the Perceived Acceptability of Hazards.

30. Hasell, Ariel, & Copeland, Lauren. (in preparation). The Role of Digital Media Consultants in the 2012 Elections.

31. Partridge, T. & Harthorn, B. H. (in preparation). Energy, environment and technology timeframes: on 'urgency' as a factor in risk/benefit perception.

32. Partridge, T. & Harthorn, B. H. (in preparation). Deliberating unconventional oil and gas extraction: perspectives from California.

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

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

35. Satterfield, Terre, Copeland, Lauren, & Harthorn, Barbara Herr. (in preparation). Tangibility and Resilience Across Ecotypes.

36. Satterfield, Terre, DeVries, Laura, Pitts, Anton, & Harthorn, Barbara Herr. (in preparation). Perilous Ideas: Essentialisms in Health Risk Research and the Invisibility of the White Male Effect.

37. Satterfield, Terre, Harthorn, Barbara Herr, Collins, Mary, & Pitts, Anton. (in preparation). Resilience and Tangibility as Factors Underpinning the Perceived Environmental Impact of New Technologies.

38. Thomas, Merryn, & Pidgeon, Nick. (in preparation). Deliberating Shale Gas Extraction by Hydraulic Fracturing: Urban and Rural Perspectives.

39. Thomas, Merryn, & Pidgeon, Nick. (in preparation). Public Perceptions of Shale Gas Extraction by Hydraulic Fracturing: Cross-National Comparisons Between the United States and Great Britain.

Submitted or in preparation publications: leverage

40. Copeland, Lauren, & Feezell, Jessica T. (under review). Citizenship Norms and Political Participation: The Mediating Role fo Digital Media Use.

41. Copeland, Lauren, Bimber, Bruce, & Earl, Jennifer. (in preparation). Contentious Consumers: Political Consumerism, Movement Societies and Self-Directed Political Action. *Sociological Perspective*.

42. Copeland, Lauren, & Feezell, Jessica T. (in preparation). Crowding In or Crowding Out: The Relationship Between Political Consumerism and Other Forms of Civic and Political Behavior.

43. Copeland, Lauren. (in preparation). Postmaterialism vs. Engaged Citizenship as Predictors of Non-Electoral Forms of Political Participation.

44. Copeland, Lauren. (in preparation). Putting the Political in Political Consumerism: Towards a Theory of Motivations.

45. Copeland, Lauren. (in preparation). Political Consumerism and the Expansion of Political Participation in the US.

46. Earl, Jennifer, Copeland, Lauren, & Bimber, Bruce. (in preparation). Contentious Consumers: Political Consumerism, Movement Societies and Self-Directed Political Action.

47. Gregory, Robin, & Dieckmann, Ulf. (in preparation). Thinking Outside the Box: Plotting a Response to Climate Change Uncertainty.

48. Hasell, Ariel, & Weeks, B. E. (in preparation). Angry Hordes: The Influence of Emotion and Partisan News Media in Political Information Sharing.

49. Kandlikar, Milind, & Jani, C. Dowlatabadi, H. (in preparation) Emerging Technologies and Life Cycle Management: Closing the Loop on Lithium Ion Batteries Used in Electric Vehicles.

50. Shatkin, Jo Anne, et al. (in preparation). Advancing Risk Analysis for Nanoscale Materials: Report From an International Workshop on the Role of Alternative Testing Strategies for Advancement. *Risk Analysis*.

IRG 3 Research Presentations 2014-2015

1. Harr, Bridget. Re/Situating Race and Science: Constructing and Contesting Racial Knowledge Within and Beyond the Academy. 2014 Fields of Inquiry Conference hosted by UC Berkeley's Center for Science, Technology, Medicine, & Society, Berkeley, CA, Mar 7-8, 2014.
2. Copeland, Lauren. Putting the "Political" in Political Consumerism: Towards a Theory of Motivations. Midwest Political Science Association Annual Meeting, Chicago, IL, April 3-5, 2014.
3. Copeland, Lauren, & Lekakis, E. The Changing Citizen: Creative Participation and Contentious Politics from a Comparative Perspective. Midwest Political Association Annual Meeting, Chicago, IL April 3-5, 2014.

4. Harr, Bridget. Participant Science for the People Conference hosted by UMass Amherst's Social Thought & Political Economy Program, Amherst, MA, April 11-13, 2014.
5. Harthorn, Barbara, Appelbaum, Rich, McCray, Patrick, & Metzger, Miriam. CNS-UCSB NSF Reverse Site Visit (with CNS-ASU), Arlington, VA, May 5, 2014.
6. Satterfield, Terre, Gregory, Robin, Pidgeon, Nick & Hasell, Ariel. Decision Pathway Survey. Lead discussion at multi-day research meeting at Understanding Risk Centre, Cardiff, Wales, UK, June 24, 2014.
7. Harthorn, Barbara, Satterfield, Terre, Henwood, Karen. Gender and Risk Perception. Lead discussion at multi-day research meeting at Understanding Risk Centre Cardiff, Wales, UK, June 24, 2014.
8. Satterfield, Terre, Harthorn, Barbara, Copeland, Lauren, & Collins, Mary. Intuition, Resilience and Politics in Emerging Risk Debates. Interdisciplinary Conference--Transfusion and Transformation: The Creative Potential of Interdisciplinary Knowledge Exchange, Durham University, UK, July 15-17, 2014.
9. Harthorn, Barbara. Participant and Executive Committee member, NSF Workshop on Societal Implications of Synthetic Biology, Tempe, AZ, November 4-6, 2014.
10. Beaudrie, Christian, Kandlikar, Milind, & Satterfield, Terre. From Cradle-to-Grave at the Nanoscle: Gap in U.S. Regulatory Oversight along the Nanomaterial Life Cycle SETAC North America 35th Annual Meeting, Vancouver, BC, Canada, November 9-13, 2014.
11. Harthorn, Barbara. Risk and responsible innovation & governance: Lessons from societal research on nanotechnologies. Invited plenary talk, Nanoscale Science and Engineering Conference, NSF, Arlington, VA, December 10, 2014.
12. Beaudrie, Christian, ABA, Boxall, N, Bruce, D, Carlander, LJ, Carter, Q, Chaudhry, S, Diamond, K, Doudrick, A, Dudkiewicz, S, Foss Hansen, S, Ghosal, S, Hodson, S, Lambert, A, Lazareva, I, Lynch, A, Mathuru, J, Nathaniel, M, Rudd, D, Spurgeon, M, Tellenbach, & K, Tiede. Sustainable Management of Nanomaterial Containing Wastes. Society of Risk Analysis (SRA) Annual Meeting, Denver, CO, December 2014.
13. Harthorn, Barbara. What do we mean by data? Invited workshop presentation, NSF STS Data Management Workshop, Arlington, VA, January 29-30, 2015.
14. Partridge, Tristan. Exclusion, Extraction and Containment. Invited seminar presentation in Department of Anthropology, UCSB, Santa Barbara, CA, January 30, 2015.
15. Partridge, Tristan. The Shale Boom. Invited presentation in UCSB Interdisciplinary Humanities Center workshop: "Energy Challenges in the Developing World," UCSB, Santa Barbara, CA, February 20, 2015.
16. Harthorn, Barbara, & Partridge, Tristan. Co-Chairs, Co-Organizers, Panel: Risk and Resilience: Hazards, Imagined Futures, and Emergent Responses to Fracking in the US. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.
17. Brooks, James. Community-Based Resistance to Fracking in the Chama River Basin, New Mexico. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.
18. Collins, Mary, Harthorn, Barbara Herr, Copeland, Lauren, & Satterfield, Terre. Fracking and Other Hazards: Towards Understanding the Spatial Aspects of Hazard Risk Acceptability Among US Publics. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.
19. Copeland, Lauren, Harthorn, Barbara Herr, Collins, Mary, & Satterfield, Terre. Risk, Resilience, and Cultural Politics in Emerging Debates about Fracking in the US. 75th

Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.

20. Hasell, Ariel, & Hodges, Heather. Fracking in the US and UK: a comparison of public discussion of fracking on Twitter in the US and UK. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.
21. Partridge, Tristan, Recovery and The Deep Underground: Responses to Unconventional Resource Extraction in California. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.
22. 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.

IRG 3 Outreach Activities 2014-2015

23. Harthorn, Barbara. Surveying the Nanomaterial Industry: Lessons Learned and Challenges. Invited sole webinar presenter to over 50 members of the (US) Society of Toxicology, Nanotoxicology Specialty Section, March 10, 2014.
24. Stevenson, Louise. Mentored 2 undergraduates on independent projects and 1 on joint project--Worster Award, UCSB, Santa Barbara, CA,
25. Foss, Amy. NanoDays Volunteer, NanoDays, Santa Barbara Museum of Natural History, CA, April 4-5, 2014.
26. Harr, Bridget. NanoDays Volunteer, NanoDays, Santa Barbara Museum of Natural History, CA, April 4-5, 2014.
27. Hasell, Ariel. NanoDays Volunteer, NanoDays, Santa Barbara Museum of Natural History, CA, April 4-5, 2014.
28. Stevenson, Louise. NanoDays Volunteer, NanoDays, Santa Barbara Museum of Natural History, CA, April 4-5, 2014.
29. Pidgeon, Nick. Shale Gas and Public Acceptability. Institute of Marine Engineering, Wales and South West Branch, Cardiff, Wales, UK, April 7, 2014.
30. Pidgeon, Nick. Risk and Policy Lecture. UK Government Cabinet Office, UK, April 30, 2014.
31. Merryn, Thomas, & Pidgeon, Nick. Completed a survey for Royal Society scoping project for future hydraulic fracturing workm Cardiff, Wales, UK, April 2014.
32. Harthorn, Barbara. Understanding Societal Aspects of Emerging NanoTechnologies. Invited guest lecture, WM Keck Foundation Program on Waste Management Aspects of Nanotechnologies, School of Engineering, Cal Poly San Luis Obispo, San Luis Obispo, CA, May 9, 2014.
33. Pidgeon, Nick. Public Engagement with unconventional hydrocarbons. Geographical Society of London 1-day Meeting, London, England, UK, June 2, 2014.
34. Pidgeon, Nick. Engaging the Public with Energy. Eurelectric Annual Convention & Conference, London, England, UK, June 3, 2014.
35. Pidgeon, Nick, Thomas, Merryn, Harthorn, Barbara, Partridge, Tristan, Hasell, Ariel, & Barvosa, Edwina. Cardiff Public Engagement and Deliberation. Cardiff, Wales, UK, June 25, 2014.
36. Pidgeon, Nick. Sense of Energy Public Exhibition. The White Building, Hackney Wick, London, England, UK, June 26-28, 2014. (And film of event.)
37. Pidgeon, Nick, Thomas, Merryn, and Hasell, Ariel, Cardiff Public Engagement and Deliberation UK, July 15, 2014.
38. Beaudrie, Christian. Nanomaterial Risk Screening: A Structured Decision Making (SDM) Approach. American Chemical Society Meeting, San Francisco, CA, August 11, 2014.

39. Pidgeon, Nick, & Demski, Christina. Transforming the UK Energy System, Public Values and Acceptability. International Congress of Applied Psychology, Paris, France, July 11, 2014.
40. Pidgeon, Nick, & Corner, Adam. Framing geoengineering and moral hazard. Climate Engineering Conference 2014, Berlin, Germany, August 18-21, 2014.
41. Harthorn, Barbara. Participant as Executive Committee member, UC CEIN Retreat, Santa Monica, CA, September 5-6, 2014.
42. Beaudrie, Christian. 2-Day Expert's Workshop on Alternative Testing Strategies for Nanomaterials with Members of SRA Society for Risk Analysis (SRA), Denver, CO, September 15-16, 2014.
43. Pidgeon, Nick. Sense of Energy Public Exhibition, Welsh Assembly Senedd Building, Cardiff, Wales, UK, September 30 to October 2, 2014.
44. Harthorn, Barbara, Partridge, Tristan, Hasell, Ariel, & Stevenson, Louise. CNS Public Engagement and Deliberation. Santa Barbara, CA, October 4, 2014.
45. Harthorn, Barbara, Partridge, Tristan, Hasell, Ariel, & Stevenson, Louise. CNS Public Engagement and Deliberation. Los Angeles, CA, October 11, 2014.
46. Pidgeon, Nick, & Thomas, Merryn. UK Public Engagement and Deliberation. London, UK, Oct 3 2014.
47. Pidgeon, Nick, & Thomas, Merryn. UK Public Engagement and Deliberation. Cardiff, Wales, UK, Oct 10 2014.
48. Rogers-Brown, Jennifer. Considering Context in the Question of GMOs. Public lecture: Light Millennium's, "Celebrate Food, Knowledge, Health and the Environment" (Part of Light Millennium Issue #30: Freedom of Information in the Genetically Modified Age). New York, NY, October 25, 2014.
49. Pidgeon, Nick, Thomas, Merryn & Partridge, Tristan. UK Public Engagement and Deliberation Hirwaun, Wales, UK, November 7, 2014.
50. Pidgeon, Nick, Thomas, Merryn & Partridge, Tristan. UK Public Engagement and Deliberation Winford, UK, November 10, 2014.
51. Harthorn, Barbara. Lead organizer, host. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 13-15, 2014.
52. Engeman, Cassandra. Co-Lead Organizer & Session Chair. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 13-15, 2014.
53. Hasell, Ariel. Report-Back Plenary Address CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.
54. Partridge,Tristan. Report-Back Plenary Address. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.
55. Stevenson, Louise. Report-Back Plenary Address. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.
56. Pidgeon, Nick, & Corner, Adam. Public Engagement and the integrated assessment of geoengineering project Royal Society of London, London, England, UK, November 26, 2014.
57. Stevenson, Louise. Creation Care in a Chemical Age. Community Outreach, November 2014.
58. Pidgeon, Nick. Communicating Risk and Uncertainties--The need for a strategic approach. Calculating Risk and Communicating Uncertainty Conference, UK, January 17, 2015

CNS X-IRG and Special Projects

Faculty and Senior Participants (14)

C. Newfield, XIRG project Leader	English/American Studies	UC Santa Barbara
D. Boudreaux	Commercialisation	Boudreaux and Associates
G. Gereffi, PI subk	Sociology	Duke Univ
S. Friedman, PI subk	Science journalism	Lehigh Univ
B. Egolf	Science journalism	Lehigh Univ
M. Johansson	Anthropology	Gothenburg Univ
S. Anderson, Seed project leader	Environmental politics	UC Santa Barbara
J. Barandiaran, Seed project leader	Global studies	UC Santa Barbara
E. Baravosa, Seed project leader	Social/political theory	UC Santa Barbara
G. Legrady, Seed project leader	Media Arts & Tech	UC Santa Barbara
J. Majewski, Seed project leader	History	UC Santa Barbara
A. Mehta, Seed project leader	Economics	UC Santa Barbara
D. Novak, Seed project leader	Ethnomusicology	UC Santa Barbara
C. Walsh, Seed project leader	Anthropology	UC Santa Barbara

Affiliates

Rachel Parker (see IRG 2)

Postdocs (1), Graduate Students (4), Undergraduate Students (0), and Technical Staff (3)

Postdocs:

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

Graduate students:

Clayton Caroon	Global & Int'l Studies	UC Santa Barbara
Karin Donhowe	Economics	UC Santa Barbara
Zach Horton	English	UC Santa Barbara
Lumari Pardo-Rodriguez	Global & Int'l Studies	UC Santa Barbara
Galen Stocking, XIRG project leader	Political Science	UC Santa Barbara
Caitlin Vejby	Global & Int'l Studies	UC Santa Barbara
John V. Decemvirale	History of Art & Architecture	UCSB

Undergraduate students:

Technical and Research staff:

Deborah Pierce	History	UC Santa Barbara
Laura Saldivar-Tanaka	Anthropology	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

X-IRG 3: Global Value Chain for Nanotechnology

X-IRG 4: Nanotech in the Media

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

X-IRG 6-1 to 6-8: ***CNS Faculty Seed Grants*** on Societal Issues for New Technologies

X-IRG 7: Framing Nanotech in the Media

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

This project has focused on three principal activities:
(1) Analysis of trends in commercialization of nanoscale photovoltaic devices in the context of continuing Si dominance and sector turbulence.
(2) Nanscale solar interviews.
(3) Completion of a conference volume on the alternative innovation model (previously described as the Lyon Model) with particular emphasis on solar nanotechnological innovation.

In the reporting year, this has involved: 1) ongoing database development and maintenance; 2) editing and completion of first version of 75 minute film "What Happened to Solar Innovation" (based on both semi-structured and unstructured interviews), including preparation for filming in Germany that took place at the end of September 2014, and final film editing. A film context paper was presented in the CNS Democratizing Technologies conference in Nov 2014. Additional tasks include editing of film trailers for publicity and public circulation.

The summary findings of the project include the following: 1) the viability and promise of nano-enabled advanced solar photovoltaic technology is stronger than ever, according to participating technologists; 2) the US technology funding system depends on venture capital investment, and the VC community will not support thin-film solar PV because it judges returns on investment to be always lower than in other sectors; 3) the US lacks a culture of government-based long-term, late-stage support for emerging technologies like thin-film PV; 4) technologists and executives in the sector themselves doubt that the public sector has the capacity to correct VC-based market failure, and do not advocate for an expanded public sector role; 5) US and EU (German) thin-film PV manufacturing capability has been strategically absorbed by China's PV sector, and it will not recover in those two countries that did much of the originating R&D; 6) the absence of thin film PV manufacturing endangers PV R&D in those countries; and 7) only a social movement or other cultural disruption can shift the current renewable policy stalemate, which is entrenched in spite of moderate science policy critique.

Newfield has been an invited speaker on innovation theory and the humanities in a broad range of contexts in N Europe and N. America in the past year and gave the John P. McGovern MD

Award Lecture in the Medical Humanities at the University of Texas Medical Branch in Oct 2014. He also gave an invited plenary closing address on this solar energy project in the CNS' Democratizing Technologies conference in Nov 2015. Horton has given presentations on the project's work and its film products in a number of venues as well as his own work at SNET 2014 in Karlsruhe, Germany in Sept.

* * *

X-IRG 3: Global Value Chain for Nanotechnology: Stacey Frederick, Gary Gereffi (and IRG 2 researchers: Rich Appelbaum, Aashish Mehta, Rachel Parker, Edgar Zayago Lau, and Guillermo Foladori; see also Seed Grant X-IRG 6-8 to Mehta, below)
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 site launch in November 1, 2012 through March 15, 2015 show 16,677 total site visits, 14,660 of them unique visitors
Total pages visited: 40,376
Geography of visitors: USA: 53% (4,388 visits, of which 3,362 are California); followed by India (4.7%) and Japan (4.2%)
Usage for Current Period, March 16 2014-March 15, 2015 indicates rising interest with 9,131 site visits, 8,370 of them unique visitors, 17,843 total pages visited, in visitors increasingly from beyond California: Geography of visitors: USA: 48% (4,388 visits, of which 1,736 are California)

Work was also done (in collaboration with Edgar Zayago Lau and Guillermo Foladori) on developing a database of publications by authors with an institutional affilation in Mexico, resulting in publications; additionally, two short subject pieces for the California Research Bureau were co-authored with Christine Shearer and Jennifer Brown on nanotechnology in California (overview, potential risk, and risk perceptions). New project development has included co-authoring a NSF grant proposal with GA Tech colleagues (in revision for submission elsewhere) and new seed fund project development with IRG 2 researchers.

* * *

X-IRG 4: Nanotech in the Media; Sharon Friedman, Brenda Egolf

The study of media framing of nano in the renewal award period has been conducted primiarly 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 on several fronts, primarily to continue analysis of intercoder reliabilities for all risk variables in the study, finish analysis of very complicated information sources section of the project, and continue drafting journal articles based on research data already analyzed.

During the spring and summer, Egolf continued data analysis of various segments of the risk and media aspects of the study. Her analysis included analyzing source data by individuals, year cited in articles, and affiliations. Initial analysis shows a different type of source use by journalists over time. Within the next year, a journal article will be written on this topic.
During summer 2014, Friedman began a redraft of the media coverage of nanotechnology regulation paper, primarily updating the literature review section with new material. Work is slowly continuing on this paper but will be accelerated by Friedman's upcoming sabbatical in the spring 2015. Work also began on drafting the methods and data section for a journal article on coverage of nanotechnology health and environmental risks in the New Haven Independent and Google Alerts, based on a presentation given at last year's meeting of the Society of Risk Analysis.

Friedman was honored by being named a McCormick Fellow in June 2014, and she is extending these methods in several new research projects on earthquakes and fracking as risk communication issues.

* * *

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

This project has been on hiatus as former CNS postdoc Johansson reentered his professional administrative obligations in Sweden at the Gothenburg University. Johansson is in progress writing a book about the life worlds of nanoscientists and toxicologists studying the adverse effects of nanoscale particles. Based on his CNS research he initiated a new collaboration with anthropologist Åsa Boholm (Professor in Social Anthropology, Dept. of Global Studies at Gothenborg University, Sweden) and has in now successfully applied for and just (Mar 2015) 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 the last year Johansson has also presented on his laboratory ethnographic research methods as an invited lecturer at Aarlborg University, Denmark (Sept 2014).

* * *

X-IRG 6: 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. An additional 4 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-6-1: Characterization of uncertainties in the life cycle assessments and risk assessments of nanotechnology; Sarah Anderson, Sheetal Gavankar

In order to assess and improve uncertainty communication in Life Cycle Analyses of emerging technologies, this project aims to:
1) Derive criteria for effective communication of uncertainty to public audiences from the social science literature
2) Use existing methods to evaluate location and type of uncertainty reported in LCAs of engineered nano-materials
3) Design new measures corresponding to criteria from 1) above
4) Recommend improvements (including tools) for uncertainty communication
5) Prepare manuscript for publication to capture the above 1-4

The project completed aims 1-5 in 2013-14. They have derived criteria for communication of uncertainty, used the Walker-Harremöes framework to evaluate location and degree of uncertainty, and designed a new matrix to evaluate the location of reporting of uncertainty, whether likelihoods were associated with scenario analysis, and the use of subjective researcher evaluation of uncertainty. Findings thus far indicate that while there is much discussion of uncertainty, researchers do not provide likelihoods associated with scenarios or an overall evaluation of uncertainty. Reporting of uncertainty is most often in the text, rather than in locations more accessible to a lay audience. Also, there is no unified way of presenting non-statistical, epistemic uncertainty. Finally, discussion of uncertainty lacks the contextualization necessary to make it accessible. The project has published these findings, along with the recommendations for improving uncertainty reporting.

X-IRG-6-2: Bringing Science to Life: CNS Engagement Seed Grant; George Legrady, John V. Decemvirale

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

During this reporting period, the Spring symposium, Interrogating Methodologies: Exploring Boundaries in Art & Science, was the first public iteration and presentation of our work and ideas, gathering (for eventual publication purposes) a list of previous exhibitions both national and international where science has been exhibited within the museum, researching possible grants to approach for funding and researching exhibition techniques for increasing viewer participation with scientific material. The symposium was held April 18-19 2014 and brought over 40 scholars, artists, students and scientists together the UCSB campus for the 2-day meeting/workshop. Topics included: data visualization (how do we visualize data?), Chaos, Symmetry and Granualization, How does Science ask questions? How do we discover? the current relationship of art and science, strategies for presenting scientific research to the public.

This symposium was intended to be an important first step toward the upcoming exhibition on the same topic, as well as an opportunity for our questions and ideas to be discussed and debated in public. The group is proceeding with the proposed planning of the exhibition in the UCSB Art Museum which will consist of bringing science research into the museum to compare methodologies and approaches. There may also be artistic/architectural collaboration. The symposium is posted online at http://interrogating-methodologies.org/ with all the presentations so that anyone can visit the site and review the presentations.

In the reporting period seed grantee Legrady made numerous presentations on his work in galleries and museums around the world (Paris, Bogota, Ottawa, LA, Nantes, Dubai).

X-IRG-6-3: Public Sentiment and the Performance of Protest in Japan's Antinuclear Movement David Novak

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

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

The main project outcome planned is a book-length publication. A research article entitled "The Politics of Festival in Japan's Antinuclear Movement was submitted to *American Ethnologist* in September 2014 and is currently in revision after a first round of peer review; a short piece entitled "Disturbance" was published in the bilingual volume *To See Once More the Stars: Living in a Post-Fukushima World* (ed. D.Naito et al., New Pacific Press) in 2014. Novak also gave a presentation on the work, "The Politics of Festival in Japan's Nuclear Village" at the Center for Ethnomusicology, Columbia University in March 2015. And an Academic Senate Faculty Research Grant of $10,000 was awarded to extend work on the project.

X-IRG-6-4: Filtering out the Social: Nanotechnology and Water Treatment in Mexico: Casey Walsh, Laura Saldivar-Tanaka

This project concluded early in the reporting year. The goals of the project were to acquire a general knowledge of the nanotechnology sector in Mexico, including a) research/science, b) government, and c) business and to interview key personnel in these three sectors. In addition,

the project aimed to acquire a detailed knowledge of the application of nanotechnology to water, landfill waste, and wastewater treatment sectors, based on extensive interviews with key participants.

Through the employment of ethnographic methods the project aimed to measure the degree to which water systems managers are adopting nanotechnology, whether these systems are more public/social or more private/individual, and the overall balance and relation between nanotech filtration and purification techniques and efforts to decrease the production of contaminants and their intrusion into water commons. To move beyond the local scale of analysis and gain a general perspective on the water sector in Mexico. Research has being conducted in various sites among various social actors (Enterprise, Academics, Government, Non Governmental Organizations, General Public). A summary of activities by location follows.

1. Guadalajara, Jalisco.
    a. Interviews with academics (CIESAS, Universidad de Guadalajara),
    b. City government officials (Department of Sanitation),
    c. Water treatment private enterprises (Hasars Grupo Ecologico; Blue Gold; BioDAF),
    d. 3 landfill site visits; landfull run by Hasars. Interviews with engineer in charge, and technicians of water treatment plant,
    e. Interviews with rural dwellers in the region, downstream from the landfills,
    f. Interviews with environmental activists
2. Monterrey, Nuevo León:
    a. Interviews with academics and researchers that develop nanotechnology (Centro de Investigacion en Materiales Avanzadas - CIMAV; Universidad Autonoma de Nuevo Leon - UANL; TSSI; Instituto de Innovacion y Transferencia de Tecnologia - I2T2),
    b. Interviews with representatives of municipal and private water treatment companies
3. San Luis Potosi:
    a. Interview with academic that develops nanotechnology applications for water treatment (Instituto Potosino de Investigacion en Ciencias y Tecnologia - IPICYT),
    b. Interview with water scholars at the Colegio de San Luis - COLSAN
4. Mexico City
    a. Interviews with academics that develop nanotechnology (Universidad Nacional Autonoma de Mexico - UNAM; Universidad de la Ciudad de Mexico - UCM; Instituto Politecnico Nacional - IPN),
    b. Interview at the Instituto Nacional de Ecologia y Cambio Climatico (INECC)
    c. Interview of Eric Gutierrez, Gerente de Potabilizacion (Director of Potabilization), Comision Nacional de Agua
    d. Interview at the National Center for Metrics (Centro Nacional de Metrologia - CENAM)
5. Guanajuato:
    a. Interview at the Universidad de Guanajuato (UG), Department of Engineering and Nanotoxicology,
    b. Interview at the Centro de Inovacion en Tecnologia de Agua (CITAG), collaborating with Rice University
6. Puebla: Interview at the Benemerita Universidad Autonoma de Puebla (BUAP), Department of Research in Zeolitas.

7. Morelos: Interview at the Interview at the Instituto Mexicano de Tecnologia del Agua (IMTA)
8. Chihuahua: Interview with maria Teresa Alarcon and Jesus Gonzalez Hernandez, Centro de Investigaciones en Materiales Avanzadas
9. Completed 20 survey questionnaires from academic researchers in the field of nanotechnology, especially related to topics of water and the environment

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

In addition to these educational and networking outcomes, the project has resulted so far in 2 publications in Spanish in *Mundo Nano,* a workshop convened by Walsh in Mexico in June, 2014, a keynote address in Hidalgo, Mexico, and 3 additional conference presentations.

Round 2 CNS Faculty Seed Grant Projects (2014-15):

X-IRG-6-5: Driving Development: The Lithium Trade in Bolivia, Argentina and Chile; Javiera Barandiaran, Lumari Pardo-Rodriguez, 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 will contribute 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 aims have been to: 1) gather basic information on the lithium market and prepare research materials; 2) conduct archival research on the regulation, infrastructure and market strategies employed to extract and commericialize lithium in each country, with the aim of answering basic questions about these aspects and identifying the scope and potential of different sources of information for further research; 3) establish contacts with informants in each country who work in the lithium industry; and 4) establish contacts with scholars in each country who do research on lithium and related resources.

With the help of 2 graduate student researchers (Pardo-Rodriguez and Caroon), Barandiaran is pursuing all of these. She spent July 24 to September 29 2014 in Chile and Argentina conducting research on lithium. In Chile, she interviewed seven individuals involved with lithium regulation and production and examined archival material at the national geology and mining agency, the national production agency, and the national archive. In Argentina, she interviewed eleven individuals involved with lithium regulation and production and examined some archival material at the national geology agency and the provincial libraries of Salta and Jujuy.

She was able to obtain a lot of valuable material regarding the history of lithium extraction and interview material that is relevant to understanding current debates, and she made many valuable contacts with people who work in the lithium industry, including with one business consultant, two companies, and two geology consultants. She also has made contacts with the following researchers in Chile and Argentina, that she hopes will lead to future collaborations: in Chile, with Professor Mario Grageda of the University of Antofagasta, a chemist and director of a center on lithium and innovation; in Argentina, with Diego Bombal, geographer at the University of Cuyo, Mendoza, Federico Nacif, sociologist at the University of Quilmes, and Lizardo Gonzalez, at the National University of Jujuy. All work on different aspects of lithium research.

Based on this preliminary research, she determined the necessity of: 1) spending more time in the archives of Chile's geology agency (Sernageomin) and development agency (Corfo); 2) visiting Argentina's Atomic Energy Agency to investigate the background of military operations regarding lithium, and revisit the national geology agency (Segemar); 3) investigating the history and presence of R&D efforts regarding lithium in each country. In future trips she also plans to contact the customs office that supervises exports. In June 2015 she plans to travel to Bolivia.

In addition, Barandiaran has received 3 small grants, a Research Clusters grant from the Orfalea Center for Global Studies, an Interdisciplinary Humanities Center Research Faculty Group award, and a Letters and Science award at UCSB to organize an inter-disciplinary group of faculty around the idea of "Energy Challenges in the Developing World." The funds are supporting regular meetings among members and several events, including an Open House for graduate students (Feb. 6) and a day-long workshop on “Energy Challenges in the Developing World” held Feb 20 2015, with keynote speaker, historian Gabrielle Hecht (U. Michigan), that included a presentation by Javiera on this project, and presentations by 2 other CNS research projects (Newfield X-IRG 2; Partridge IRG 3-3).

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

This project in applied political and social theory builds on IRG3 empirical research in public engagement which demonstrates that upstream 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 knowledge of public deliberation by theorizing the underlying cognitive mechanisms operating in staged and unstaged deliberation practices; 2) to develop case studies and data-driven examples to illustrate these underlying mechanisms; 3) to theorize how, if at all, these underlying cognitive mechanisms of public deliberation can serve to disrupt 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 on public deliberation.

This one-year seed grant began July 1, 2014, and has made progress in each of the three project aims. Barvosa, with assistance from Diamond-Lenow and Bermudez, has completed research on two case studies in public deliberative systems--one on gender and the other in economic concerns and inequality--both factors that arise in the IRG3 deliberation research. These cases will form the basis for further theoretical work. She has also integrated some of the theoretical analysis developed in the revision of an article submitted to the *Journal of Environmental Studies and Sciences*. This article has been extensively revised using new research conducted under the seed grant. Finally, CNS seed grant funds have been used to

research and publish a theoretical model of how attitudinal ambivalences found in public engagement research can be analytically mapped. This mapping can in turn be used to identify areas of compromise, qualification, and conditions of public acceptance for potentially disruptive new technologies such as fracking.

Barvosa has revised and resubmitted 1 article from this project, and has an additional 3 in preparation, including a book project far in development. She made a presentation on the work in the WPSA conference in April 2014. In addition, she has become an active expert witness on aspects of unconscious bias in two local court cases.

X-IRG-6-7 Democratization of Creativity and the Growth of Inequality in 19th-Century America: Explaining the Origins of America's 21st-Century Economy; John Majewski, Karin Donhowe, 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 will contribute to CNS IRG 1 on this history of innovation.

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

The project has already generated many interesting results, which Majewski will be reporting at Yale and several other places in Spring 2015. The research team has used quantitative data and GIS mapping techniques to determine the extent of education (as measured by the number of children attending school) and economic creativity (as measured by patents). They have found the geography makes a difference--in rural areas, in particular, the number of free residents per square mile makes a big difference. Even more important than slavery, however, is the presence of slavery. Where slavery was legal--even if the actual number of slaves owned was minimal--there was a big drop off in school attendance and creative activity. Majewski’s initial hypothesis was that slavery contributed to inequality that decreased investment in education. The evidence now indicates something somewhat different: slavery created conservative gender and cultural norms that discouraged the democratization of education and creativity. Even a "little" slavery made a big difference in outcomes.

The project, which is in progress, will present preliminary findings in presentations in May and to a range of scholars and policymakers at the Washington Center of Equitable Growth in July 2015.

X-IRG-6-8 Does the US Nanotechnology Sector Suffer a Skills Gap? Aashish Mehta, Stacey Frederick, Rachel Parker, Caitlin Vejby

This project will investigate 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 the US scientific skill gap is, 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 a 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?

The team has completed their literature review on each of these questions, and have updated their list (intended to be as comprehensive as possible) of small US firms engaging in nanotechnology related research, and have attempted to set up interviews with as many of them as possible in California and North Carolina. Interviewing is planned for Spring 2015.

The team has produced one directly relevant publication (under review) on the impact of national nanoscience diversification strategies, and Mehta has lectured on the material to the World Bank (Oct 2014), Indians Council for Research on International Economic Relations, New Delhi (Sept 2014). He is also participating as an advisor/consultant to the World Bank and the Asian Development Bank, in work that will lead to extensive research programs across countries, publications, reports, and “better advice to governments.” He has also prepared five working papers on closely related topics, 2 of them under review.

X-IRG-7: Framing Nanotechnology in the Media: Galen Stocking, Ariel Hasell (new project in 2014)

In this project, 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 an initial draft of one such study 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.

XIRG and Seed Grant Publications 2014-15

Primary Publications: Journals

1. Gavankar, Sheetal, Anderson, Sarah, & Keller, Arturo A. (2014). Critical Components of Uncertainty Communication in Life Cycle Assessments of Emerging Technologies. *Journal of Industrial Ecology*, n/a-n/a. doi: 10.1111/jiec.12183

Primary Publications: Books, Chapters, Reports and other Publications

2. Frederick, Stacey, Rogers-Brown, Jennifer, & Shearer, Christine. (2015). Nanotechnology in Society: An Overview. In Tonya Lindsey (Ed.), *Short Subjects*. Sacramento: California Research Bureau.

3. Novak, David. (2014). Disturbance. In Daisuke Naito, Ryan Sayre, Heather Swanson & Satsuki Takahashi (Eds.), *To See Once More the Stars: Living in a Post-Fukushima World* (pp. 99-102). Santa Cruz: New Pacific Press.

4. Newfield, Chris, & Boudreaux, Daryl. (2014). Learning From Solyndra: Filling Gaps in the US Innovation System. In Shyama Ramani, V. (Ed.), *Nanotechnology and Development: What's In It for Emerging Countries?* (pp. 39-72). Cambridge: Cambridge University Press.

Leveraged Publications: Journals

Leveraged Publications: Books, Chapters, Reports and Other Publications

5. Newfield, Christopher. (2014, June 2014). Christensen's Disruptive Innovation after the Lepore Critique. *AAUP Academe Blog.* from http://academeblog.org/2014/06/25/christensens-disruptive-innovation-after-the-lepore-critique/

6. Newfield, Christopher. (2014, August 5, 2014). How Can Public Universities Pay for Research? *Remaking the University.* from http://utotherescue.blogspot.com/2014/08/how-can-public-research-universities.html

7. Newfield, Christopher. (2014, September 17, 2014). Some Implications of the Regents' Proposed UC Ventures. *Remaking the University.* from http://utotherescue.blogspot.com/2014/09/some-implications-of-regents-proposed.html

Submitted or in preparation publications: primary

8. Novak, David. (under review). The Politics of Festival in Japan's Antinuclear Movement. *American Ethnologist*.

9. Saldivar, Laura, & Walsh, Casey. (under review). Nanotecnología para el tratamiento de agua. Claves sobre la investigación en México. *Mundo Nano*.

10. Frederick, Stacey. (under review). Nanotechnology in California. In Tonya Lindsey (Ed.), *Short Subjects*. Sacramento: California Research Bureau.

11. Hasell, Ariel, & Stocking, Galen. (under review). A Pipeline of Tweets: Environmentalist Movements' Use of Twitter in Response to the Keystone XL Pipeline.

12. Newfield, Chris, & Boudreaux, Daryl (Eds.). (under review). *Can Rich Countries Still Innovate?*

13. Frederick, Stacey. (in preparation). Quantifying the Nanotechnology Workforce in the US: Methods, Barriers & Estimates.

14. Hasell, Ariel, & Stocking, Galen. (in preparation). Twitter as a Tool for Public Engagement.

15. Walsh, Casey, & Saldivar, Laura. (in preparation). Factores en la decision de implementar la nanotecnologia para el tratamiento de aguas. *Mundo Nano*.

Submitted or in preparation publications: leverage

X-IRG Research Presentations 2014-2015

1. Walsh, Casey. Mega to Nano: Changing Scales and Socialities of Water Infrastructure in Mexico. Dimensions of Political Ecology Conference, Lexington, KY, March 1, 2014.
2. Walsh, Casey. Filtering out the Social: Nanotechnology and Water Treatment in Mexico. Annual Meeting of the Society for Applied Anthropology, Albuquerque, March 20, 2014.
3. Barvosa, Edwina. Do Some Deliberative Democratic Systems Already Exist? A Template for Assessing the Presence and Effectiveness of Large Scale Deliberative Systems. Annual Meeting of the Western Political Science Association, Seattle, WA, April 18, 2014.
4. Walsh, Casey. La nanotechnolgia en el sector agua en Mexico: una perspectiva desde las ciencas sociales, International Multidisciplinary Joint Meeting: Nanoscience, Nanotechnology and Condensed Matter Physics, Hidalgo, Mexico, June 13, 2014.
5. Walsh, Casey. Coordinator and Participant, CIIECH-UNAM Workshop on Nanotechnology and Water, Mexico City, June 16, 2014.
6. Legrady, George. Swarm Vision: Issues in Translating Human Photographic Vision Behavior to Machine Learning. Digital Intelligence, Nantes, France, September 17-19, 2014.
7. Horton, Zach. Can We Think Nano-Ecology S.NET 6th Annual Meeting, Karlsruhe, Germany, September 21-24, 2014.
8. Horton, Zach. Film: Swerve S.NET 6th Annual Meeting Karlsruhe, Germany, September 21-24, 2014.

9. Stocking, Galen, & Hasell, Ariel. Twitter as a Tool for Public Engagement with Emergent Technologies S.NET 6th Annual Meeting, Karlsruhe, Germany, September 21-24, 2014
10. Walsh, Casey. De Mega a Nano: calidad de agua e infraestructura hidráulica en México," Invited Speaker, Seminar on "Accesso, manejo y control de recursos naturales en las sociedades mexicanas Conflictos y consensos, siglos XIX-XXI, Hermosillo, Mexico, October 17, 2014.
11. Barandiaran, Javiera. Lithium: Driving Sustainable Development? Invited lecture, Arizona State University, Tempe, AZ, October 31, 2014.
12. Legrady, George. Swarm Vision. 20th Annual International Symposium on Electronic Art, Dubai, UAE, November 2-8, 2014.
13. Stocking, Galen, & Hasell, Ariel. Twitter as a tool for public engagement with emergent technologies? Poster presentation at the Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 13-15, 2014.
14. Frederick, Stacey. Value Chain Analysis in Latin America. Presentation at Federal University of Parana, Curitiba, Brazil, November 2014.
15. Barandiaran, Javiera. Sustainable Development 2.0: Lithium Mining in Chile. Interdisciplinary Humanities Center workshop on "Energy Challenges in the Developing World," UCSB, Santa Barbara, February 20, 2015.
16. Novak, David. The Politics of Festival in Japan's Nuclear Village. Center for Ethnomusicology, Columbia University, March 23, 2015.
17. Majewski, John. Why did Southerners Fail to Invest in Education before the Civil War? Economics History Workshop, Yale University, May 4, 2015.
18. Majewski, John. Slavery and the Death of Economic Creativity Before the Civil War Slavery Then, Today and Tomorrow, Augustana College, May 7, 2015.

X-IRG Outreach Activities 2014-2015

19. Han, Xueying (Shirley), & Stevenson, Louise. Nanotechnology and Its Ecological Implications. La Cuesta Continuation High School, Santa Barbara, CA, May 19, 2014.
20. Johansson, Mikael. How to do Research among Nanoscientists. Invited lecture to a group of Master students at Aalborg University, Aalborg, Denmark, September 19, 2014.
21. Barvosa, Edwina. Called as expert witness in Jury trial providing testimony on unconscious bias Santa Barbara Superior Court Santa Barbara, CA September 8, 2014.
22. Legrady, George. Voice of Sisyphus IEEE VisWeek 2014, Paris, November 9-14.
23. Newfield, Chris. What Happened to Solar Innovation? Closing plenary address, CNS-UCSB Democratizing Technologies: Assessing the roles of NGOs in Shaping Technological Futures UCSB, Santa Barbara, CA, November 13-15, 2014.
24. Fastman, Brandon. Report-Back Plenary Address CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.
25. Legrady, George. 6018 Wilshire Edward Cella Art & Architecture, Los Angeles, September 20-December 20, 2014.
26. Legrady, George. Clocks for Seeing: Time and Motion National Gallery of Canada, Ottowa, Canada, December 20, 2014-May 3, 2015.
27. Legrady, George. Arte y Ciencia de Interfaz Planetario de Bogota, Bogota, Colombia, December 28-30, 2014.

28. Barvosa, Edwina. Called as expert witness in Jury trial providing testimony on unconscious bias Santa Barbara Superior Court, Santa Barbara, CA, February 15, 2015.
29. Majewski, John. Workshop for policy makers, Washington Center of Equitable Growth, July 2015.

10. CNS-UCSB DIVERSITY PLAN

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 introduced a new set of student researchers in Yr 9, is heading toward sunset of its research program at the end of Year 10, 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 made relatively few additions to our student participants this year. We made every effort, however, to augment diversity in other areas of Center activity, especially via the *Democratizing Technologies* conference and through partnered activities with CNS-ASU.

(i) Current status and progress this reporting year and since 2010

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. This growing pool of undergraduates is 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 5 undergraduate students participated in the Center in Year 10, 2 (40%) of whom were female, 2 (40%) of whom were Asian. The academic majors of undergraduate participants included Psychology, Global and International Studies, Environmental Science. 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 (new this year); 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, since we were already filled to capacity with continuing Fellows, 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.

Since the beginning of the current award, a total of 15 students have participated as CNS Graduate Research Fellows, 9 of whom received funding during the current reporting year 10. 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 Chicana/o Studies; Communication; Ecology, Evolution, and Marine Biology; History; Material Science; Political Science; and Sociology.

Non-Fellow Graduate Student Researchers
CNS-UCSB employs a number of graduate student researchers beyond the fellowship program, as do our partners. Fifteen graduate students from UCSB and partner institutions participated in the Center in these roles during the reporting period. Twelve (80%) were female, and 3 (20%) were male. Two chose not to disclose race or ethnicity. Five of the remaining 13 (38%) were from underrepresented categories (2 Asian, 2 Hispanic, 1 mixed Native American/Pacific Islander).

Year 6-10 graduate students researchers (non-fellows) have come from fields including 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 internal postdoctoral program 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 in the reporting year include 6 females (67%), and almost half (4 of 9 or 44%) reporting ethnic or racial minority status: 1 Asian (11%), 1 person who reports mixed race identity (11%), and two of Hispanic ethnicity (22%).

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. Five 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 in the leadership, although one of the founding PIs was Asian, and one *ex officio* member identifies as mixed race heritage. We continue to actively recruit 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, virtually half (8 or 47%) of the 17 UCSB staff members were female. Six chose not to share race and ethnicity data. Five of the remaining 11 (45%) reported ethnic or racial minority status: 1 (9%) American Indian, 2 (18%) Asian, and 2 (18%) Hispanic.

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 new 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, Provost, 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, as 8 collaborators are female, 3 are of Asian heritage, 1 identifies as Hispanic and 3 are Latin American.

Visiting Researchers

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

(ii) Plans for the next reporting period

Although approaching sunset means CNS-UCSB will not recruit any new members in the upcoming year of the no cost extension, CNS-UCSB outreach materials, publications, and presentations will continue to impact large audiences. As noted throughout this report, members of the CNS-UCSB community consider our diversity to be one of our major strengths. As such, it is a primary goal of the Center's leadership to leave a legacy of research that addresses issues of diversity, speaks to a diverse listenership, and includes diversity at all levels of participation in areas such as gender, race and ethnicity (as defined by the NSF), family educational and income background, and disciplinary training.

Democratizing Technologies

The Global South: In November, CNS-UCSB hosted an international conference called *Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures*. The conference has been described elsewhere in this report, but what might not have stressed is the focus on issues of global equity. As PI Appelbaum succinctly put it in a press release for the conference, "Democratizing Technologies will take a hard look at the impact of emerging technologies on the Global South, and the appropriate role of NGOs – and governments – in assuring they best serve the public needs." Several of the NGOs invited to participate in the conference focus on the areas in Global South – Africa, Latin American, and Asia. Some of those NGOs are: Direct Relief, Ashoka, Technology for Tomorrow, Safe Water International, Seeing Eye Expeditions, and Unite to Light.

Moreover, it was important to include voices from the Global South. One example of an invited speaker who provided such a voice is Moses Kizza Musaazi, a senior lecturer in the Department of Electronic and Computer Engineering at Makerere University in Uganda. An inventor and founder of Technology for Tomorrow, Musaazi has created environmentally friendly bricks made of inorganic soil, cheap and effective sanitary pads comprised of papyrus and recycled waste, and small incinerators that create steam for electricity and sterile water. Presentations like Musaazi's as well as panels on issues like occupational safety in India, China and Brazil helped focus attention on the tangible socioeconomic gaps that technology can both widen and shrink.

Travel Stipends: An NSF supplement allowed us to provide travel for poster presenters who may otherwise not have been able to attend the conference. These were all junior researchers and they came from India, Canada and China as well as institutions all over the United States. Not only were the participants diverse, but their presentations addressed challenges faced by underrepresented populations. A sampling of the titles includes:

- The Role of Public-Private Partnerships for Disease of Poverty Nanomedicine Research

- Designing a “Responsible” Genetically Engineered Tree? The Role of the NGO in the Advancement of Responsible Innovation in the Biotechnology Sector
- The Changing Terrains of Regulatory Science in Developing Countries: NGOs, Controversies and “Opening up” of Regulatory Governance
- Integration of Structuration Theory and Social Capital Theory: Implications for Non-Profit Organizational Management Research in Science and Technology and Underrepresented Communities
- NGOs and the Governance of Genetically Modified Crops in Kenya: Democratic Implications of a Techno-Civil Society

Cross-Pollination: One hallmark of both CNS’s is their integration of humanities and social science scholars with researchers from the life and physical sciences. When organizing *Democratizing Technologies*, we wanted to go even further in creating novel communication pathways by reaching outside of the academy. We invited representatives from over 30 NGOs along with representatives from governments (US and abroad) and journalists. We believe there are few if any NSEC events that have engaged such an expansive audience. The timely release of a report and a television program based on the conference will magnify that audience.

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 disentangling the complicated social relations that surround an increasingly technological world.

Pedagogy

The largest impact of the CNS at 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 a 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' plan for its post-graduation efforts.

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.

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 10, the CNS-UCSB Education Program maintained 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. The Program's leadership team is 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. While Year 9 saw personnel changes and the addition of five new Graduate Fellows, Year 10 was much more stable in terms of participants. On the other hand, this reporting year necessitated a greater focus on evaluation as we contemplate the successes and lessons learned from the Education Program's entire tenure. The following pages provide an overview of CNS-UCSB's Educational Program components and objectives; discuss Program leadership; report on the progress of our programs for postdoctoral scholars and graduate students, 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; and discuss organization changes over the reporting period.

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. It sponsors 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 with the Center's Interdisciplinary Research Groups (IRGs). CNS staff also collaborates with education staff from the California NanoSystems Institute (CNSI) and the Bren School of Environmental Science and Management (the institutional home for the main UCSB portion of the UC Center for Environmental Implications of Nanotechnology -- UC CEIN) to develop and implement joint education materials and activities. The diagram below summarizes the four main components of the Program and their objectives.

Program Summary

The Education Program's primary objectives during Year 10 were as follows:

Training the next generation of interdisciplinary scholars:

- Train 6-8 graduate research fellows/year
- Continue postdoctoral scholars program
- Hold CNS research seminar meetings year-round
- Host 1-2 visiting speakers per quarter (3-6 per year)
- Offer professional development in communication, research methods, and academic job practices
- Plan or execute at least one major public engagement event annually where Fellows and Postdocs take a lead role
- Provide funding and professional preparation for conference travel for Program participants
- Continue our ongoing formative and summative evaluation

Creating a diverse community of scholars within CNS:

- Continue to cultivate diversity among student participants, maintaining or increasing previous levels

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

Without any new fellows or interns, we had limited means for increasing diversity this year, but we met or exceeded all of our other objectives. Further, we made plans to evaluate the Education Program's unprecedented integration of science and engineering doctoral students into social implications research projects.

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.

In Year 10, the Program was overseen by the Director of Education, Miriam Metzger, who is a senior faculty member in the Department of Communication at UCSB. She brings expertise in interdisciplinary collaboration, new media, and in communicating social science research findings about the societal implications of science and technology in various education contexts.

The core day to day operations in the program are administered by Education and Outreach Coordinator Brandon Fastman. Fastman holds a PhD in English from UCSB and worked the three years before joining CNS in 2013? as a staff writer for a prominent local newspaper, *The Santa Barbara Independent*. His familiarity with scholarly discourse and his experience teaching paired with his experience writing for a general audience make him an ideal mediator between CNS-UCSB, our S&E colleagues, the public, and policy makers. His familiarity with the local and campus community is helpful in organizing events.

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.

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 on Nanoscience and Emerging Technologies in Society: Sharing Research and Learning Tools (NETS); and the Society for the Study of Nanoscience and Emerging Technologies annual conference (S.NET 2014 in Karlsruhe, Germany) .

CNS has sponsored 20 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 10

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; Current Campus**	**Affiliation**
Mary Collins*	Environmental Sociology; UCSB	IRG 3
Adam Corner*	Social Psychology; Cardiff U.	IRG 3* GeoEng
Stacey Frederick	Textile Mgmt.; Duke University	X-IRG, IRG 2
Anton Pitts*	Risk Science; U. of British Columbia	IRG 3*, CEIN

Christine Shearer*	Environmental Sociology; UC Irvine	IRG 3
Merryn Thomas	Geography; 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 (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 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 is in a Postdoctoral Research position at UC Irvine; Mary Collins is a Postdoctoral Fellow at the National Socio-Environmental Synthesis Center at University of Maryland; Shannon Hanna is a Postdoctoral Researcher at the National Institute of Standards and Technology). Others have pursued non-academic careers (Yasuyuki Motoyama is a senior program manager with the Kauffman Foundation). Since leaving UCSB, seven of the nine who have completed and left (Collins, Eisler, Hanna, Johansson, Motoyama, Rogers-Brown, and Shearer) have continued to work on CNS-UCSB research projects as external affiliates.

IRG 3 added a new postdoctoral researcher for a 15-month appointment beginning 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. Partridge was selected from a competitive (and global) pool of 13 applicants by a search committee consisting of Harthorn, Metzger, Molitor, and Pidgeon. Partridge was distinguished by a stellar academic record, enthusiastic recommendations, and familiarity with the tools (i.e., software) necessary to conduct and analyze deliberations along with the intellectual background to do so. 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 marginalisation and uncertainty. His work at CNC-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 hydrofracturing (fracking) processes for unconventional oil and gas extraction.

Postdoc Xueying (Shirley) Han, who was formerly a Graduate Science Fellow with IRG 2, finished her dissertation in Ecology, Evolution, and Marine Biology in December 2013. Her research investigated how sea urchin population dynamics affect local coral reef community structure in French Polynesia. With IRG 2, she is investigating the emergence of Nanotechnologies in developing countries, particularly in China where she has specific knowledge and expertise. 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. Her work draws conclusions about the research climate in both the U.S. and the cultures from which these students originate. She is also contributing to a comparative study of state nanotech policy in developing countries, and she is leading the work on report and publication preparation from the Democratizing Technologies project.

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 begun to apply patent mapping and bibliometric analysis to understand innovation and corporate strategy in the development of synthetic biology applications.

Finally, postdoctoral researcher Lauren Copeland is also funded directly through CNS. She completed her doctorate at UCSB in Political Science in 2013 with a dissertation on political consumerism, including regarding nanoenabled consumer products. Since completing her dissertation, she has worked first as a UC CEIN postdoc, and, since July 2014 a CNS postdoc, working part time with IRG 3 researchers Satterfield, Harthorn, and Collins on the data analyses from the Environmental Risk Perception survey.

Postdoctoral Researchers at Other Campuses: CNS-UCSB also supports postdoctoral researchers who work with our external collaborators, including 6 in the current period. We fund a full-time postdoctoral researcher at Duke University (Stacey Frederick) who works with sociologist Gary Gereffi and heads 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. She contributes to a new Seed Grant project on worker skills. 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 a researcher studying risk perceptions with Terre Satterfield at the University of British Columbia (Anton Pitts). Shearer is a former postdoc currently continuing work on CNS research and publications from her postdoc position at UCI. Collins is an unfunded but participant postdoc in IRG 3's environmental risk perception work, from her position as a postdoc at the national ecology center, SESYNC. We integrate off-site postdoctoral researchers with other Center personnel and activities whenever possible. We also invite all postdocs to 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 (18 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 in the 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 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. Tristan Partridge gave a talk in February 2015 titled “Deliberating Fracking: Risks, Responsibilities and Energy Futures.” Postdocs also participate in and/or co-lead Seminar meetings focusing on professional development topics such as presentation skills, the academic publishing process, job hunting and networking tips, and research methods for quantitative and qualitative studies. Postdocs based off-site are encouraged to participate in Seminar meetings via conference call or Skype. Project meetings take place as frequently as weekly by Skype video conference with postdocs reporting on work in progress and getting feedback on data analyses, publications in preparation and other collaborative work.

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.

CNS Graduate Fellows and Graduate Student Researchers

One of CNS-UCSB’s most successful features is its integration of graduate students from a range of social science, humanities, science, and engineering disciplines into every facet of our research, education, and outreach programs. Graduate students 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 24 students who were active in Year 10 and descriptions of program activities are provided below.

CNS UCSB Graduate Fellows and Graduate Student Researchers during Year 10

Graduate Fellow	**UCSB Department**	**Affiliation**
Roger Eardley-Pryor	History	IRG 1
Brian Tyrrell	History	IRG 1
Matthew Gebbie	Materials	IRG 2
Galen Stocking	Political Science	IRG 2
Cassandra Engeman	Sociology	IRG 3/E&O
Amy Foss	Chicana/o Studies	IRG 3
Ariel Hasell	Communication	IRG 3
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
Megan Callahan	Institute for Resources, Environment and Sustainability (IRES); UBC	IRG 3
Clayton Caroon	Global & International Studies; UCSB	Seed grant
John V. Decemvirale	History of Art and Arch; UCSB	Seed grant
Chloe Diamond-Lenow	Feminist Studies; UCSB	Seed grant
Karin Donhowe	Economics; UCSB	Seed grant
Lisa Han	Film & Media Studies; UCSB	X-IRG
Abigail Hinsman	Film & Media Studies; UCSB	X-IRG
Zachary Horton	English; UCSB	X-IRG
Qiao Li	Global & International Studies	IRG 2
Zong (Zach) Miao	Computer Engineering	IRG 2
Lumari Pardo-Rodriguez	Global & International Studies; UCSB	Seed grant
Mathew Thomas	Jenkins Collaboratory; Duke	IRG 2
Caitlin Vejby	Global & International Studies; UCSB	IRG 2
Rong Yang	Education; 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 are 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 are awarded for one-year terms, with possibilities for renewal of up to two additional years.

Because the center is approaching the end of its funding cycle, and we are not initiating any major new projects within the CNS, we did not recruit any new Fellows for Year 10. Nine students were funded in the Graduate Fellowship Program over the course of the reporting year.

A number of those have moved on from CNS-UCSB because of graduation, new jobs, or other opportunities. Although still a UCSB graduate student, Cassandra Engeman has taken a position as Visiting Researcher at the Social Science Research Center in Berlin (WZB) in the Inequality and Social Policy Research Group. Ariel Hasell, who is still contributing to the IRG 3 decision pathway survey and comparative fracking deliberations project, and conducting research on new media coverage on new technology issues, won a prestigious dissertation fellowship from her home department. Galen Stocking recently accepted professional employment as a Research Associate on the Journalism and Media Project at the Pew Research Center. Roger Eardley-Pryor accepted a fellowship at the Chemical Heritage Foundation upon completion of his PhD in 2014.

Currently active Fellows include Brian Tyrrell (IRG 1), Matthew Gebbie (IRG 2), Bridget Harr (IRG 3), Ariel Hasell (IRG 3) and Louise Stevenson (IRG 3), who were all renewed for the 2014-2015 academic year.

Cassandra Engeman was honored with a rare CNS Senior Fellow appointment ending in 2014 for her work coordinating the planning process for the major public outreach event, the *Democratizing Technologies* NGO conference (see Section 12). The 9 Fellows active in the reporting year represented 7 academic disciplines (two in the sciences, five in the social sciences, and one in the humanities). This cohort included one Fellow of mixed Native American race and Hispanic ethnicity, and one person with a disability; 5 of the 9 were women.

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. The Seminar meets 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 are 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 2014 S.NET Conference in Karlsruhe, Germany and several other domestic and international meetings. Examples include 4S in Buenos Aires and Society for Applied Anthropology annual meeting in Pittsburgh.

Democratizing Technologies: Senior Graduate Fellow Cassandra Engeman co-led with IRG leaders Harthorn and Appelbaum the effort to plan a large international conference that focusing the nexus of NGOs and emerging technologies. This included inviting designing the conference program conceptually, choosing topics for plenaries and panels, and then inviting 50 presenters from five different continents. More details on the conference content will be shared in Section 12, but it is important to note that CNS-UCSB took advantage of this major outreach effort to create educational and professional development opportunities for Fellows and Postdocs.

During the Fall quarter, Fastman designed the CNS Research Seminar to prepare students and faculty with the background to engage fully at *Democratizing Technologies*. Fellows, postdocs, and faculty read and discussed 10 articles focusing on social movement organizations and emerging technologies, selected in consultation with IRG 3 NGO researcher Engeman. After the introductory seminar, led by Fastman, the discussions were directed by Fellows and Postdocs.

Aside from offering an intellectual baseline to students from various disciplines, the seminar also prepared them to play a demanding role in the conference. Postdocs and Fellows served as "rapporteurs" who summarized breakout sessions for the entire conference audience in plenary addresses. This duty required them to take notes at their assigned sessions, and – with only 15 minutes to prepare – synthesize these notes into a capsulation of the presentations and discussion they observed.

In addition to this responsibility, CNS students contributed to conference activities in a variety of manners. Postdoc Han pitched in to the planning effort, and co-authored a report on the conference proceedings. She also emceed an outreach event where representatives from 22 NGOs demonstrated their organization's work to conference attendees as well as graduate and undergraduate students interested in NGO careers. Fellows Hasell and Stocking presented a poster on a project on which they are collaborating – "Twitter as a Tool For Public Engagement with Emergent Technologies." Their poster won third place in a balloted competition.

Undergraduates

Since CNS-UCSB's founding, we have taken part in the Internships in Nanosystems Science, Engineering and Technology (INSET) summer internship program during which we have provided research mentorships to 27 interns, primarily community college students and most of them from minority backgrounds or underserved communities. This reporting year, however, INSET lost its federal funding, and while some other centers on the UCSB campus continued aspects of the program, we felt that, considering the resources and attention necessary to other center-wide endeavors such as *Democratizing Technologies,* 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.

That being said, CNS-UCSB still fulfills its mandate to create enriching educational experiences for undergraduate students. In addition to undergraduates at Duke working with our collaborators there, two in particular have been deeply embedded into IRG research projects at UCSB. Emily Nightingale, an undergraduate researcher who majored in Global Studies and has now graduated, worked for IRG 2 on global competitiveness research since 2013. From June to September 2013, Nightingale, under the mentorship of Fellow Stocking, worked with IRG 2 to develop a profile of India's nanotechnology policy and how it has been implemented across the country in anticipation of further research there. From April 26-May 11, 2014, Nightingale traveled to India with IRG 2 research fellow Stocking to engage in a 2 week research trip during which they interviewed scientists, academics, and entrepreneurs in Bangalore and Delhi about the development of nanotechnology as well as their views on national policy regarding nanotechnology.

Catherine Enders, a Psychology major at UCSB, has proved crucial to the comparative US-UK fracking deliberations conducted this past fall by IRG 3. Enders was originally hired to help refine transcriptions of deliberations that were conducted in Santa Barbara and Los Angeles. She has since aided with research on current affairs, national and state policy, and academic literature vis-à-vis consumer preferences and public risk perception. Both Enders and

Nightingale have not only partaken of experiences participating in cross-disciplinary research of upstream technologies, they have become meaningful contributors.

Evaluation

In February of Year 10, we asked our current in-house Postdocs and Graduate Fellows to complete a confidential survey describing their experiences at CNS-UCSB in terms of the most valuable and most challenging aspects of participating in our research and education programs, and their perceived benefits resulting from their participation in CNS a by answering six closed- and open-ended questions. The three UCSB-based postdocs and all seven Fellows completed the survey for a response rate of 100%.

The first question asked the Post docs and Fellows, “Reflecting across your time at CNS, what would you say were the most valuable aspects of this experience for you personally and/or professionally?” Answers varied widely but centered on the many skills and opportunities opened to them via their work at CNS-UCSB. For example, several mentioned such things as participation in collaborative research (design, analysis, writing, etc.) with scholars from multiple disciplinary backgrounds, publication opportunities, and professional development.

Specific professional development activities cited include practice talks; conference presentations; building interdisciplinary introductions and connections, and “structured guidance on professional development within—and becoming familiarized with—new institutional and national career contexts.” Within that they also felt they benefitted from specific advice on strategizing for career objectives, and pursuing publication plans (suggested locations, purposes and potential impact). A few mentioned support for travel to key domestic and international conferences, and also participation in the CNS-hosted “Democratizing Technologies” conference.

Other aspects listed by the respondents were developing new research tools, methods and approaches (building on past experiences, finding ways of maximizing particular histories and research experiences in current work, facilitating collaboration with junior and senior academic colleagues), aided by specific elements of training and also by maintaining space within collaborative work for reflection and co-assessment. Being introduced to, and participating in, aspects of both research project management and institutional administration procedures (e.g., funding structures; human resources and recruitment of junior personnel/assistants), budgeting and financial justification processes, data handling and information management. Learning about IRB compliance and human subjects protocols was seen as valuable by one respondent. Finally, one fellow wrote “By working with senior researchers at CNS, I learned how to write a research paper for journal publication, and I developed a productive approach for completing projects.”

Another prominent theme across the responses was networking opportunities and contact with a broad-based research community—both at UCSB and at other universities—the ability to travel to conduct research, and being introduced to the methods and conventions of other disciplines. This sentiment is further illustrated in the following quote: “There were many, many positive and valuable aspects to being a fellow, from interacting with people from outside my discipline on research to getting the opportunity to conduct interesting research and the resources to do so—something that wasn't available within my department. I loved how supportive everyone has been here and the interaction of ideas that has resulted from that interaction.”

In Year 10 the CNS-UCSB Education program emphasized the topic of “communicating your

science to a broader audience" via a number of activities. This new emphasis was apparently perceived as a particularly valuable aspect of the program, as mentioned by two of the respondents. One wrote: "Seminars on how to talk to journalists, writing op-eds, policy briefs, etc. were most valuable to me personally. These topics are not usually covered in any courses and I think a lot of students would like to know more about how to communicate their science and research to a wider public." Another similarly said, "Learning how to become a broader contributor to the academic community by getting experience with communicating my research and disciplinary studies to a broader, nonspecialist audience and being trained in how to pose and explore broader societal questions regarding how scientific R&D is disseminated to and impacts the general public. I have also had numerous opportunities to further hone my public speaking and communication skills."

A closed-ended item asked the current Post docs and Fellows about a list of specific potential benefits they may have felt they received through their time at CNS-UCSB. The list was derived from program evaluation surveys in prior years. Many of the responses echo the open-ended responses described above. The table below summarizes the closed-ended responses:

Expanded your areas or fields of interest and expertise	100%
Gained new research skills	90%
Networked with scholars outside your discipline	80%
Received professional mentoring that you would not otherwise have had	80%
Pursued new collaborations outside your discipline	80%
Increased your competitive edge for the job market	70%
Attended conferences or joined scholarly societies you would not have otherwise	70%
Made you more confident or willing to pursue interdisciplinary collaboration in the future	70%
Gained new professional development skills (e.g., public speaking, presentation skills, mentoring, teaching, data analysis, etc.)	70%
Strengthened your CV via publications, presentations, etc.	70%
Found a new career trajectory or expanded your career options	40%

Although all or most of the Post docs and Fellows felt that their participation in CNS-UCSB offered such benefits as expanding their networks, skills, research ideas, as well as their marketability after completion, a smaller percentage felt that their experience at CNS-UCSB either expanded their career options and entirely changed career trajectory.

In addition asking about the benefits or most valuable aspects of the program, participants were also asked what aspects of their experience at CNS were the most challenging, disappointing, or frustrating. Answers to these questions included balancing their dissertation work with their work at CNS and not having enough time to follow up on the ideas encountered at CNS, for example, "doing more research on the background and work of the speakers and following up when events trigger new ideas, interests, etc." One science fellow said that learning how to

perform social scientific research and “learning how to take on appropriate tasks that will further benefit my scientific development” was a challenge, but that “Overall, these challenges were good for my professional development.” One person mentioned that taxes on their CNS income came as a surprise at the end of the year. It is notable that 5 of the 10 (50%) explicitly wrote that there was nothing challenging, disappointing, or frustrating about their experience at CNS-UCSB.

Because this is our final year of funding, we wanted to draw lessons from our participants about best practices for future interdisciplinary graduate and post-graduate education and research programs. To do so, in the Year 10 survey we included an open-ended question that asked the Fellows and Post docs to tell us what they might do the same or differently as CNS-UCSB “If you were setting up a new interdisciplinary education and research program.” Five categories or themes emerged from the responses, and because the responses were so rich, and potentially highly useful to future similar endeavors, many of the answers respondents gave as quoted here verbatim:

1. Regular communication across teams or working groups

“I would dedicate more time to discussing the current research projects. One of the things I've noticed is that the IRGs have a good sense of what is going on within their group, but aren't necessarily up-to-date with the research of the other groups.”

“I think the only thing I would add is more formalized interaction—like bi-quarterly research presentations or something. I always loved hearing what was going on in other IRGs but sometimes felt like I was out of the loop.”

2. Seminar frequency and content

The respondents felt that regular seminars are very important for community building and exposure to interdisciplinary ideas and research methods, saying that exposure to “a wide-ranging and diverse group of scholars” through the seminar series is something they were retain in a future center. One respondent suggested adding additional professional development focused seminars (job market, grant/proposal writing, etc.), and another said that the seminars should take care to be both useful and appropriate to the center and graduate students.

3. Openness and responsiveness to needs of students by center leaders

“I think CNS has done a terrific job of organizing the education program. I really enjoyed it—very interesting, relevant topics. Over the years that I've been with CNS, the directors of the education and research program have been very open and responsive to our interests, which, I think, is part of the reason they've been so beneficial.”

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

4. Career counseling

“I also believe that if a new interdisciplinary program was to happen, there needs to be major support offered to the students in terms of how they can best target themselves after

graduation. When someone doesn't fall within the traditional confines of a particular discipline, it's hard to find a job in academia (and elsewhere) because academic departments are still very traditional."

5. Maximal opportunities for interdisciplinary immersion

Interestingly both science fellows mentioned this theme in similar ways. One said, "I would have the same setup where you have either social science fellows in a science-focused center or science fellows in a social science-center—it's hugely beneficial for us (the science fellows) to experience this side of research." The other similarly said he/she would increase the representation of scientific scholars within the (social science) center. Moreover this Fellow added, "I was a science and engineering fellow. I love the interdisciplinary program that CNS has set up. I would say if there was a new program, I would also do a reversal of what CNS currently has in place. Not only should science and engineering fellows go into social science research projects and groups, it would be good to also place the social science fellows in science research labs."

Overall, the Post docs and Fellows in Year 10 reported very high levels of satisfaction with their experiences at CNS-UCSB, and offered constructive advice for similar future graduate and post-graduate training opportunities.

Science and Engineering Fellows Evaluation Study

Annual surveys have informed us of the general success of the Fellows Program. That said, we have not yet collected other systematic data on how the CNS Graduate Research Fellows Program has 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. This evaluation project will gather data on the activity of all 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 purpose of this study is to assess the impacts of embedding physical and biological scientists as well as engineers into the social science enterprise in the context of upstream technological development. In the literature of Science and Technology Studies (STS), the laboratory is often treated as an enclosed system—or "black box" according to Bruno Latour (1988)—whose connections to broader societal forces must be revealed. As such, sociologists and anthropologists may, for instance, observe laboratories in order to compose ethnographies (indeed, CNS Postdoc Mikail Johansson has done this in nanoscience and toxicology labs in Sweden and the US, cf. Johansson 2012). In fact, the ethnography of the S&T laboratory has grown into a robust domain of scholarly endeavor. As one example, CNS ASU researcher Erik Fisher has developed a framework for "embedding" a humanist into the laboratory setting in

order to add a source of critical insight and reflexivity during the process of scientific discovery. And universities continue to develop science and engineering curricula that address the ethics of the scientific disciplines. By contrast, the CNS UCSB approach is entirely novel precisely because it does not attempt to enter the black box. Instead, our approach is designed to entice scientists out of the black box of their own laboratory to understand its societal context—to look at it from the outside. By drawing young technological innovators into the social science enterprise, our goal is to go farther than previous education models to elevate the value of social science in the scientific enterprise. As such, we feel it is critical to evaluate our unprecedented program to better understand the value of our approach as an educational paradigm.

To address these questions about the CNS Fellows program, we propose a qualitative study consisting primarily of semi-structured interviews with the current and former Science and Engineering Fellows and secondarily, time permitting, with their peers, mentors and advisors. This inquiry seeks concrete information about whether studying the ELSI of nanotechnology has shifted our Fellows' attitudes and values, and whether it has tangibly altered their own understanding or practice of scientific investigation.

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 will conduct this work in close collaboration with CNS Education Director & Professor of Communication Miriam Metzger and CNS Director & Professor of Anthropology Barbara Herr Harthorn. He has already designed an interview protocol and begun piloting.

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. Since no new Fellows joined the center in 2014, we began the year with a social event where new Seed Grantees and the newly hired Postdoc Tristan Partridge were able to mingle with Fellows, Postdocs, and faculty.

CNS Research Seminar: As in past years, the CNS-UCSB Research Seminar on Emerging Technologies & Society (offered quarterly as Sociology 591 and Communication 595) was the focal point of the Education Program's internal activities during the reporting year. The quarterly seminar meetings (at least 4 per quarter) help develop an interdisciplinary community of scholars with special expertise and help participants learn to communicate effectively across disciplinary boundaries. Seminars address 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 are open to researchers from the other NSF-funded Nano research centers on campus. Many of the sessions with outside speakers are 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 this reporting year who were also part of the CNS Speaker Series included the following:

- Patricia Holden, UC CEIN & Bren School of Environmental Science & Management and Jorge Gardea-Torresday, "Dudley Chair of Environmental Chemistry at University of Texas, El Paso, "Manufacutred Nanomaterials, Agriculture, and Food: What are the Potential Interactions and Impacts?" May 9, 2014)
- Amy Wolfe, Distinguished Research and Development Staff, Oak Ridge National Laboratory, "Risk and Escape Policies, Perspectives, & Practices: Issues & Implications for Synthetic Biology R&D on Microbes, Algae and Plants" (May 20, 2014)
- Stephan Winter, Research Associate in Social Psychology – Media and Communication, University of Duisburg-Essen, "Finding Scientific Answers Online: How Laypersons Select and Process Science-Related Content in Web 2.0"
- Javiera Barandiaran, Assistant Professor of Global Studies and CNS Seed Grantee, UCSB, "Lithium: Driving Sustainable Development?" (January 15, 2014)
- Eric Conway, Historian at NASA Jet Propulsion Laboratory, "The Collapse of Western Civilization," (February 12, 2104)

Seminar professional development sessions included presentations by Miriam Metzger (Communication), Barbara Walker (Office of Research), and Barbara Herr Harthorn, who addressed the academic job application process and grant proposal writing.

CNS-UCSB students can broaden their formal education in areas related to their IRG research by participating in interdisciplinary doctoral emphases programs offered by UCSB. Three of particular relevance are those in Technology and Society, Feminist Studies, and Global Studies. The interdisciplinary doctoral emphasis program in Technology and Society is organized through the UCSB Center for Information Technology and Society (CITS). CNS-UCSB faculty Bimber, Harthorn, McCray and Metzger are affiliated with CITS. The CITS Director, Lisa Parks, is a member of the CNS-UCSB Executive Committee, and a close working relationship exists between the two Centers. 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 series.

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.)

<u>Graduate Level Courses:</u>

- LING 505, Research Methods in the Digital Humanities, University of South Carolina (November, Summer 2014)
- Sociology 591 or Communication 595, *CNS Research Seminar in Emerging Technologies and Society*, UCSB, taught 4 quarters/yr. (Harthorn/Metzger)

Undergraduate Level Courses:

- ANTH 104, *Risk & Inequality*, UCSB (Harthorn, Spring 2014)
- ANTH 157L, *Medical Anthropology*, UCSB (Harthorn, Winter 2015)
- Comm 134, *The Social Construction of News*, UCSB (Hasell, Summer 2014)
- EEMB 120, *Intro to Ecology*, UCSB (Stevenson, Summer 2014)
- EEMB 179 *Ecological Dynamics*, UCSB (Stevenson, Guest Lecture, Winter 2015)
- ENV S 120, *Toxics in the Environment*, UCSB, (Stevenson, Guest Lecture, Winter 2015)
- FemSt 260, *Feminist Research Methods*, UCSB (Harthorn, Guest Lecture, Winter 2014)
- *Global Engineering Ethics*, Seoul National University (Choi, Spring/Fall 2014)
- Global Studies 101, *Introduction to Global Studies*, SBCC (Appelbaum, Guest Lecture Fall 2014)
- Global 130, *Global Economy and Development*, UCSB (Mehta, Winter/Spring 2014)
- Global 173, *Energy in Global Societies*, UCSB (Partridge, Winter 2015)
- Global 2, *Global Economic and Political Processes*, UCSB (Appelbaum, Guest Lecture, Fall 2014)
- Hist 108, *Science and Technology in World History*, University of South Carolina (November, Fall 2014)
- Hist 152, *US Environmental History*, Linfield College (Eardley-Pryor, Fall 2014)
- Jour / STS 124, *Politics of Science*, Lehigh College (Friedman, Fall 2014)
- MAT 254, Arts & Engineering/Science Research, UCSB (Legrady, Fall 2014)
- Materials Science and Engineering 201, *Intro to Nanoengineering*, Rice University (Mody, Guest Lecture, Fall 2014)
- Public Admin 4300-02, Southern Utah University, *Special Topics in World Affairs* (Appelbaum, Guest Lecture, Winter 2015)
- Soc 144S, *Sexuality, Race, Gender and Class*, UCSB (Harr, Summer 2014)
- *Societal Nanotechnology*, University of Virginia (Slaton, Guest Lecture, Spring 2014)
- *Technology and Society*, Seoul National University (Choi, Fall 2014)

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	**32**	**11**	**21**	**0**	**0**	**0**	**19**	**8**	**2**	**0**	**3**	**3**	**0**
Undergraduate	**5**	2	3	0	0	0	3	2	0	0	0	0	0
Masters	**6**	3	3	0	0	0	2	3	0	0	1	0	0
Doctoral	**21**	6	15	0	0	0	14	3	2	0	2	3	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	**32**	**11**	**21**	**0**	**0**	**0**	**19**	**8**	**2**	**0**	**3**	**3**	**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	**29**	**9**	**20**	**0**	**0**	**0**	**19**	**5**	**2**	**0**	**3**	**3**	**0**
Undergraduate	**5**	2	3	0	0	0	3	2	0	0	0	0	0
Masters	**4**	1	3	0	0	0	2	1	0	0	1	0	0
Doctoral	**20**	6	14	0	0	0	14	2	2	0	2	3	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	**29**	**9**	**20**	**0**	**0**	**0**	**19**	**5**	**2**	**0**	**3**	**3**	**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 as well. CNS-UCSB is unique in that it addresses these challenges through both its research and its outreach activities. The core of 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, we hope, 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 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 will spend 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. Efforts during Year 10 have included a an address to the Department of Chemical and Biochemical Engineering at Seoul National University, a talk by PI Rich Appelbaum on the importance of materials technology on China's economy at an ASU conference on China, and a demonstration of the Globonano value chain database at Duke University.

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 recent 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 UCSB 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). This project represents a highly successful integration of social science and nanoscale science expertises.

Harthorn's involvement in UC CEIN has led to several grassroots collaborations between scientists and social scientists, both formal and informal. For example, Holden and UC CEIN collaborator Jorge Gardea-Torresday addressed CNS scholars in May 2014 about the toxicological implications of nanomaterials used in agriculture.

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 (7 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. The high value that many of the Fellows place on their experience with us (as detailed in Section 11) 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.

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 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 based on Susan Nieman's work (e.g., *Moral Clarity*, 2008) that Harthorn introduced 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 are also central activities 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 2 leader Appelbaum presented on workers' rights in the global economy at venues domestic and international including the Bangladesh Garment Manufacturer and Exporter Association Apparel Summit in Dhaka, Bangladesh in December. Seed grantee Aashish Mehta addressed the World Bank on international job skills competitiveness. IRG 3 collaborator Nick Pidgeon lectured on "Risk and Policy" at the UK Government Cabinet Office.

National: Past participation by Director Harthorn in national policy-setting venues led to reports this year. As reported in Year 9, CNS-UCSB Director Harthorn testified to the Presidential Commission for the Study of Bioethical Issues in Washington DC to address how the National Nanotechnology Initiative employs advisory committees to inform ethics integration into nanotechnology research and development. The purpose of the meeting was to consider ethical issues raised by Brain Research through the Advancing Innovative Neurotechnologies (BRAIN) Initiative. Harthorn's presentation addressed the structures of the main NNI advisory committees and how they inform ethics integration into nano R&D. This testimony has been integrated into two reports, the first in June 2014, and the 2nd, titled *Gray Matters: Topics at the Intersection of Neuroscience, Ethics, and Society* was issued by the Commission in March 2015.

Harthorn also co-organized and delivered one of two keynote addresses at the National Nanotechnology Initiative (NNI) workshop held on September 10-11, 2013, in Washington, DC. The purpose of this two-day workshop was to facilitate stakeholder discussion of key elements needed to assess, manage, and communicate potential risks associated with the use of nanomaterial and nanotechnology-enabled products. Lessons from her talk, "Nanotechnology Multi-Stakeholder Risk Perception: Implications for Risk Analysis Management and Communication" were integrated into the recently-released report, "Stakeholder Perspectives on Perception, Assessment, and Management of the Potential Risks of Nanotechnology," published by the National Nanotechnology Coordination Office.

Harthorn's participation at the national planning level continues as, this past December, she delivered a plenary address on risk perception and responsible innovation at the annual NSF NSEC meeting, and served on the executive committee for a 3-day workshop in Tempe, AZ funded by the NSF to explore agendas for societal implications research on synthetic biology

EHS: Harthorn has also forged a strong set of connections in the national EH&S community. As one aspect of this, she delivered a webinar on the nanomaterial industry to over 50 members of the US Society of Toxicology, Nanotoxicology Specialty Section on March 10, 2014.

State: The first "Nano Short Subject" policy brief was delivered to California lawmakers on February 17, 2015. Written by former Postdocs Shearer and Rogers-Brown, along with current Postdoc Frederick for the California Research Bureau, Short Subjects are 800-word papers that report research to the California Legislature, Governor's office, and the public about pertinent policy topics. CNS-UCSB's Short Subjects address nanotechnology's role in the California economy as well as risk perceptions. The first, a general overview, was received by the Senate committee on Business, Professions, and Economic Development; Senate Committee on Labor and Industrial Relations; Assembly Committee on Environmental Safety and Toxic Materials; and the Assembly Committee on Jobs, Economic Development, and the Economy.

Beyond Nano: As the twilight of CNS-UCSB approaches our researchers are applying the tools they've created over the past decade to look at the societal implications of other emerging technologies and the global marketplaces they inhabit. Moreover, organizations outside of the nanotechnology sector are paying attention to this work. For example, IRG 1 and 2 have both directed attention to international STEM education policy and its impacts on global collaboration and competition. Seed grantee and IRG 2 collaborator Aashish Mehta addressed the World Bank with a talk titled, "Education, Skills and International Competitiveness in an Era of Soft Labor." While IRG 3 studies the risk perceptions of hydraulic fracturing, collaborators have given lectures and created exhibitions (i.e., at The White Building in Hackney Wick, London) on energy extraction. Research across IRGs on worker safety has been applied to sectors that go

beyond nanotechnologies. For example, IRG 2 leader Rich Appelbaum was invited to address the Bangladesh Garment and Manufacturer and Exporter Association Apparel Summit in December 2014.

Maintaining CNS-UCSB's Base of International Researchers: While we did not wish to continue expanding our base of researchers in our penultimate 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 conference 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, a member of the American experts team for the U.S.-China Innovation Dialogue and one of only 12 foreign experts invited by the Chinese government to participate in the first midterm review of China's 15 Year Medium-to-Long-Term Science and Technology Plan (MLP).

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.

The *First International Nanotechnology & Labor Workshop* in Curitiba, Brazil, co-hosted by CNS-UCSB and ReLANS in 2013, generated several papers and presentations in 2014 and 2015, including a forthcoming issue of the journal *Observatorio del Desarrollo* dedicated to nanotechnology. Invernizzi also visited UCSB to present on labor unions and nano-worker protection at the *Democratizing Technologies* conference.

Seed grantee Javiera Barandiarán strengthens CNS-UCSB knowledge and relationships in Latin America with her Seed project on lithium mining and development in 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.

This year continued that trend. In December, Stephan Winter, a research associate in the department of social psychology – media and communication at the University of Duisberg-

Essen in Germany addressed CNS-UCSB researchers. His lecture discussed how laypersons select and process science articles in new media (Web 2.0) environments.

In February 2015, CNS-UCSB hosted visiting scholar Bart Walhout from the University of Twente in The Netherlands. He interviewed several CNS-UCSB leaders for his Science, Technology, and Policy Studies dissertation research on responsible innovation of nanotechnologies.

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. In the past year they have extended this project by working together on the scoping of societal research on synthetic biology, culminating in a 3-day workshop in Nov 2014.

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 was co-hosted by CNS-UCSB with CNS-ASU and 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, S.NET took place in Karlsruhe, Germany, and researchers from all three IRGs attended. IRG 1 Fellow Brian Tyrrell gave a presentation on the history of DNA nanotechnology at the 4S conference in Buenos Aires, Argentina which was also attended by IRG 2 collaborator Edgar Zayago Lue who spoke about nanotechnology workers' rights. IRG 2 researchers addressed industry and government bodies in India. IRG 3 researcher Terre Satterfield (with Barbara Harthorn, Lauren Copeland, and Mary Collins) were invited to speak on "emerging risk debates" at the Institute of Advanced Study in Durham, UK. IRG 3 Postdoc Tristan Partridge, a UK citizen, will address the British International Studies Association this summer on societal responses to extractive technologies. UK collaborators Nicholas Pidgeon, Merryn Thomas, and Adam Corner created exhibits and delivered multiple talks in the UK as well as one titled "Framing Geoengineering and Moral Hazard" at the International Conference on Geoengineering in Berlin. Former postdoc and Goethenburg, Sweden-based scholar Mikael Johansson delivered an invited lecture on nanotechnology research to students at Aalborg University in Denmark.

Conference Travel Support for US and International Attendees: In addition to its role in organizing international conferences, CNS-UCSB has supported expanded participation from the Global South and students and early career scholars in Science and Society conferences via travel support and conference coordination. This year, we provided travel grants with NSF

supplement support that enabled poster presenters from around the world to attend the CNS-hosted *Democratizing Technologies* conference.

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 77. See full listing at the end of this section. Additionally, CNS researchers, including graduate students and postdocs, organized numerous panels at scholarly conferences. They also all took part in the centerpiece of CNS-UCSB's outreach efforts in the reporting year, *Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures*, either by planning, presenting at plenary report-back sessions, moderating panels, and/or participating in the poster competition.

Democratizing Technologies Conference

The *Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures* conference (www.cns.ucsb.edu/demtech2014/welcome) convened at the University of California, Santa Barbara November 11-13, 2014. It focused on NGOs with environmental and social justice concerns regarding new technologies and 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," exploring questions such as:

- To what extent, and in what areas, are NGOs attempting to fill the governance roles traditionally provided by states – and with what results?
- What are the views and priorities of NGOs regarding diffusion of new technologies?
- When are the agendas and policies advocated by NGOs adopted by states or in international agreements? When do industries or companies comply with NGO-advocated standards?
- How do NGOs, especially those that are local- or nation-based organizations, advocate public interests with respect to technologies that have *global* implications?
- How do NGOs help shape the science and technology-related areas in which scarce public resources are invested?
- What are the challenges for NGOs in the global media environment? How do NGOs manage a media landscape where attention is unpredictable?
- Which NGOs gain access as participants in S&T governance-related issues – and how is such participation determined?
- How are new media changing the landscape for NGO engagement, participation, recruitment and dissemination?

Participants explored these questions as they related to a range of new technologies: nanotechnology, synthetic biology and biotechnology, information technology, spatial analytic technology, and robotics.

In a departure from typical academic conferences, CNS-UCSB invited a wide array of participants from several different sectors including government, the nonprofit sector, science

and engineering, the social sciences and humanities, and media. While these different constituencies often labor over similar issues, they don't always speak with one other. Democratizing Technologies offered a unique opportunity for technologists, policymakers, nonprofit leaders, and researchers to share their experiences, their knowledge, and their ideas with one another. In fact, several participants voiced how refreshing it was to address new audiences.

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 is leveraging 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 has prepared a report on the conference that will be disseminated to policymaking bodies including the NSF. We are also in the process of creating a one-hour television program based on video footage of conference talks. This program will air to a national audience on the University of California Television network (UCTV).

Publications Resulting from Conferences: All recent CNS conferences and workshops have had strong international participation and components, and have leveraged these connections into scholarly and outreach contributions.

- The CNS-UCSB NGO conference, *Democratizing Technologies,* has plans to develop a major publication on the same model at the Routledge volume edited by Parker and Appelbaum out of our 2009 *Emerging Economies, Emerging Technologies* conference on equitable development held in Washington DC. One strength of that publication that we plan to emulate in the new volume to be is the inclusion of practitioner as well as scholarly contributions.

- The June 2013 workshop held at UCSB and organized by McCray, Johnson and Mody, *Emerging Technologies Past and Present*, led to the preparation of several papers including a recently published article in *Minerva*. Co-authored by Choi, it traces the decisions faced by the architects who designed seminal structure for interdisciplinary materials research on the University of Pennsylvania campus.

- The April 2010 *States of Innovation Workshop* organized by X-IRG leader Newfield and researcher Boudreaux was located in, and partially supported by the regional government of Lyon, France (with participants from 6 countries around the globe). An edited volume of the proceedings is now well along in preparation. It is titled *Can Rich Countries Still Innovate?* and is currently under review at a prominent academic press (Newfield & Boudreaux, in preparation).

Workshops: In addition to regularly welcoming visiting scholars to Santa Barbara, CNS-UCSB puts on larger-scale events where entire communities of scholars can coalesce. There was one such happening in the past year.

Interrogating Methodologies

CNS-UCSB provided seed grant funding to George Legrady, director of UCSB's Experimental Visualization Lab and chair of the Department of Media Arts and Technology, to convene a symposium that initiated conversation between practitioners in the natural sciences, social sciences, humanities, and the arts to interrogate questions at the heart of research methods and practices. Participants came from disciplines including geography, physics, chemistry, history,

art and art history, among others. They represented departments and centers across the University of California system as well as the Art Institute of Chicago and Zurich University of the Arts.

Convened on April 18-19, 2014, the symposium included panels on visualizing big data, citizen science, the lab and the museum, and histories of art and science, with a presentation by IRG 1 PI McCray on the "artist-engineer" nexus.

This two-day event allowed CNS-UCSB to reach new audiences, explore interdisciplinary approaches to scientific challenges, and it will lead to a curated exhibit at the UCSB Museum of Art and Design, a groundbreaking space for provoking contemplation about the scientific method. Video of every panel is also available for viewing at www.interrogating-methodologies.org.

UCSB and Santa Barbara Regional Communities
CNS-UCSB and its affiliates engaged members of our local campus and Santa Barbara-area communities in multiple ways during the reporting year, as described below.

Lectures and Public Events: CNS-UCSB sponsored its own, as well as co-hosted lectures and special events that were promoted across campus to the humanities, social science, and science and engineering disciplines, and to the larger Santa Barbara community.

CNS-UCSB Speaker Series: During the reporting year, we hosted three public lectures through our speaker series in addition to the CNS seminars, which are also typically advertised to interested members of the entire UCSB campus. Because of the major conference in Fall 2014, we did not host any lectures that quarter. The public lectures were:

- Patricia Holden, UC CEIN & Bren School of Environmental Science & Management and Jorge Gardea-Torresday, Dudley Chair of Environmental Chemistry at University of Texas, El Paso, "Manufactured Nanomaterials, Agriculture, and Food: What are the Potential Interactions and Impacts?" (May 9, 2014)
- Amy Wolfe, Distinguished Research and development Staff, Oak Ridge National Laboratory, "Risk and Escape Policies, Perspectives, & Practices: Issues & Implications for Synthetic Biology R&D on Microbes, Algae and Plants" (May 20, 2014)
- Eric Conway, Historian at NASA Jet Propulsion Laboratory, "The Collapse of Western Civilization," (February 12, 2104)

NanoDays: CNS-UCSB participates in "NanoDays" events, the annual national program coordinated by the Nanoscale Informal Science Education (NISE) Network. Hands-on activities are utilized to 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 2014 was a two-day event at the Museum, held on April 5-6, 2014. CNS Education Coordinator Fastman and five CNS-UCSB Graduate Fellows (Stevenson, Hasell, Gebbie, Harr, Foss) as well as Postdoc Han were on hand to demonstrate a nano sunblock 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, nano surveillance technologies and privacy, in addition to nano sunblock. 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. There was also a second activity, "Exploring Nano & Society - Robots" which is an experience where visitors 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 2014 NanoDays two-day event at the Santa Barbara Museum of Natural History was extremely successful, attracting about 1,300 visitors of all ages and from a diversity of racial backgrounds. (We reported attendance of 85 at our first CNSI-partnered Nanodays in 2008.) Nanodays 2015 will take place on April 11-12, 2015. We have added an activity called "Exploring Products—Nano Food" that explains how nano-sized particles of food additives such as salt may offer health advantages, but also prompts visitors to consider necessary avenues of research in nano food applications in terms of health and safety.

Connecting with community groups. Members of the general public were invited via press releases and listings to attend the *Democratizing Technologies* conference. Many did attend, including about 700 community members at the Keynote talk by author and *The New York Times* columnist Nicholas Kristof, along with students from a nanotechnology ethics course at Santa Barbara City College.

Although, per instruction from the NSF at our founding, CNS-UCSB does not focus outreach efforts on K-12, researchers are regularly invited to present to local schools. In May 2014, Fellow Stevenson and IRG 2 Postdoc Han made a joint presentation to students of La Cuesta Continuation High School that included a general introduction to nanotechnology along with a discussion of its ecological implications. A slide show for their presentation is publicly available at https://prezi.com/grfs_ovxgfse/introduction-to-nanotechnology-and-its-ecological-implications/. In addition, IRG 2 Postdoc Luciano Kay gave a talk titled "What is Nanotechnology?" to 7th-12th grade students at the Anacapa School in Santa Barbara.

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).

IRG researchers also contribute to online forums. Examples include a guest post penned by Appelbaum for the China Institute Policy Blog ("China: Innovator or Follower?" December 5, 2014) and an invited guest article written by Postdoc Han for the website, The Conversation ("STEMming Reverse Brain Drain: What would Make Foreign Students Stay in the US?" March 31, 2015)

Traditional Media: Traditional media continues 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:

- Cong Cao and Denis Simon (IRG 2) were quoted as sources for an article in *Nature Jobs* on reversing brain drain in China. (March 5, 2014).
- *The Santa Barbara Independent* conducted a Q&A with Director Harthorn ("The Blessings and Curses of Nanotechnology," May 12, 2014).
- Postdoc Han composed an op-ed questioning whether political changes have accompanied economic development in China since the Tiananmen Square demonstrations ("Tiananmen Square 25 Years Later," June 4, 2014).
- Appelbaum published an interview of Democratizing Technologies keynote speaker and *The New York Times* columnist Nicholas Kristof for *The Santa Barbara Independent* (November 6, 2014). Other media outlets, including *The Santa Barbara News-Press* and *UCSB Nexus* covered Kristof's visit.
- Appelbaum served as an expert source on the global value chain in an article about garment worker safety published in *Just-Style* magazine ("Bangladesh: the business benefits of compliance," December 16, 2014.)

- IRG 1 collaborator Cyrus Mody was interviewed for and quoted in an article about graphene in *The New Yorker* ("Material Question," December 22, 2014).
- The U Penn public affairs website featured a paper on the architecture of the Krishna P. Singh Center for Nanotechnology and the Laboratory for Research on the Structure of Matter co-authored by CNS-UCSB collaborator Hyungsub Choi.
- McCray was interviewed for an article on anti-aging technology in *The Guardian* ("Live forever: scientists say they'll soon extend life 'well beyond 120,'" January 11, 2015)
- Mody penned an article for IEEE Spectrum on the semicentennial of Moore's Law ("What Kind of Thing is Moore's Law?" April 6, 2015), a topic he is currently writing a book about.

Future Plans: 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 Outreach Coordinator Fastman to compose three synthesis reports based on the entire 10-year output of each interdisciplinary research group. The primary purpose of these reports 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.

Presentations 2014-2015

A. Education and Outreach (to NSE, industry, government, media, public) (N = 74)

Stevenson, Louise. Mentored 2 undergraduates on independent projects and 1 on joint project--Worster Award, UCSB, Santa Barbara, CA,

Kay, Luciano, Porter, Alan L., Rafols, Ismael, Newman, Nils, Search Technologues, Spain, Ingenio, & Youtie, Jan. Poster: The Future of Science Mapping. 10th Iteration of the Places & Spaces: Mapping Science Exhibit, Various, 2014.

November, Joseph. Revolutions@Home. Stevens Institute of Technology Colloquia, Hoboken, New Jersey, Mar-May 2014.

November, Joseph. Revolutions@Home, Johns Hopkins University Colloquia, New York, NY, Mar-May, 2014.

Foss, Amy. NanoDays Volunteer, NanoDays, Santa Barbara Museum of Natural History, CA, April 4-5, 2014.

Harr, Bridget. NanoDays Volunteer, NanoDays, Santa Barbara Museum of Natural History, CA, April 4-5, 2014.

Hasell, Ariel. NanoDays Volunteer, NanoDays, Santa Barbara Museum of Natural History, CA, April 4-5, 2014.

Stevenson, Louise. NanoDays Volunteer, NanoDays, Santa Barbara Museum of Natural History, CA, April 4-5, 2014.

Gebbie, Matt. Nanodays Volunteer, Nanodays, Santa Barbara Museum of Natural History, April 4-5, 2014.

Han, Xueying (Shirley). Nanodays Volunteer, Nanodays, Santa Barbara Museum of Natural History, April 4-5, 2014.

Stocking, Galen Nanodays Volunteer, Nanodays, Santa Barbara Museum of Natural History, April 4-5, 2014.

Pidgeon, Nick. Shale Gas and Public Acceptability. Institute of Marine Engineering, Wales and South West Branch, Cardiff, Wales, UK, April 7, 2014.

Mody, Cyrus. Whose Vision, Who's Sharing TEDx? Rice, Houston, TX, April 12, 2014.

Choi, Hyungsub. How did Seoul National University become a research University Colloquium Talk at Department of Chemical & Biological Engineering, Seoul National University, Seoul, Korea, April 22, 2014.

Mody, Cyrus. Universities and Regional Growth: Insights from the University of California Forums on the Public University and the Social Good, Davis, CA, April 22, 2014.

Mody, Cyrus. Jack Kilby's Failed Revolution. CENHS Cultures of Energy Spring Symposium, Houston, TX, April 24, 2014.

Pidgeon, Nick. Risk and Policy Lecture. UK Government Cabinet Office, UK, April 30, 2014.

Merryn, Thomas, & Pidgeon, Nick. Completed a survey for Royal Society scoping project for future hydraulic fracturing workm Cardiff, Wales, UK, April 2014.

Harthorn, Barbara. Understanding Societal Aspects of Emerging NanoTechnologies. Invited guest lecture, WM Keck Foundation Program on Waste Management Aspects of Nanotechnologies, School of Engineering, Cal Poly San Luis Obispo, San Luis Obispo, CA, May 9, 2014.

Han, Xueying (Shirley), & Stevenson, Louise. Nanotechnology and Its Ecological Implications. La Cuesta Continuation High School, Santa Barbara, CA, May 19, 2014.

Mody, Cyrus. Probe Microscopy: A Transatlantic and Transdisciplinary Instrumental Community. Paul Bunge Prize Lecture, Hamburg, Germany, May 31, 2014.

Pidgeon, Nick. Public Engagement with unconventional hydrocarbons. Geographical Society of London 1-day Meeting, London, England, UK, June 2, 2014.

Pidgeon, Nick. Engaging the Public with Energy. Eurelectric Annual Convention & Conference, London, England, UK, June 3, 2014.

Pidgeon, Nick, Thomas, Merryn, Harthorn, Barbara, Partridge, Tristan, Hasell, Ariel, & Barvosa, Edwina. Cardiff Public Engagement and Deliberation. Cardiff, Wales, UK, June 25, 2014.

Pidgeon, Nick. Sense of Energy Public Exhibition. The White Building, Hackney Wick, London, England, UK, June 26-28, 2014. (And film of event.)

Pidgeon, Nick, & Demski, Christina. Transforming the UK Energy System, Public Values and Acceptability. International Congress of Applied Psychology, Paris, France, July 11, 2014.

Pidgeon, Nick, Thomas, Merryn, and Hasell, Ariel, Cardiff Public Engagement and Deliberation UK, July 15, 2014.

Beaudrie, Christian. Nanomaterial Risk Screening: A Structured Decision Making (SDM) Approach. American Chemical Society Meeting, San Francisco, CA, August 11, 2014.

Pidgeon, Nick, & Corner, Adam. Framing geoengineering and moral hazard. Climate Engineering Conference 2014, Berlin, Germany, August 18-21, 2014.

Appelbaum, Richard. Making Blue the Next Green: Achieving Workers' Rights in the Global Economy Rockefeller Foundation, Bellagio Center, Bellagio, Italy, September 1, 2014.

Harthorn, Barbara. Participant as Executive Committee member, UC CEIN Retreat, Santa Monica, CA, September 5-6, 2014.

Barvosa, Edwina. Called as expert witness in Jury trial providing testimony on unconscious bias Santa Barbara Superior Court Santa Barbara, CA September 8, 2014.

Beaudrie, Christian. 2-Day Expert's Workshop on Alternative Testing Strategies for Nanomaterials with Members of SRA Society for Risk Analysis (SRA), Denver, CO, September 15-16, 2014.

Johansson, Mikael. How to do Research among Nanoscientists. Invited lecture to a group of Master students at Aalborg University, Aalborg, Denmark, September 19, 2014.

Pidgeon, Nick. Sense of Energy Public Exhibition, Welsh Assembly Senedd Building, Cardiff, Wales, UK, September 30 to October 2, 2014.

Pidgeon, Nick, & Thomas, Merryn. UK Public Engagement and Deliberation. London, UK, Oct 3 2014.

Harthorn, Barbara, Partridge, Tristan, Hasell, Ariel, & Stevenson, Louise. CNS Public Engagement and Deliberation. Santa Barbara, CA, October 4, 2014.

Pidgeon, Nick, & Thomas, Merryn. UK Public Engagement and Deliberation. Cardiff, Wales, UK, Oct 10 2014.

Harthorn, Barbara, Partridge, Tristan, Hasell, Ariel, & Stevenson, Louise. CNS Public Engagement and Deliberation. Los Angeles, CA, October 11, 2014.

Mehta, Aashish. Education, Skills and International Competitiveness in an Era of Soft Labor Demand World Bank, Washington, DC, October 15, 2014

Rogers-Brown, Jennifer. Considering Context in the Question of GMOs. Public lecture: Light Millennium's, "Celebrate Food, Knowledge, Health and the Environment" (Part of Light Millennium Issue #30: Freedom of Information in the Genetically Modified Age). New York, NY, October 25, 2014.

Tyrrell, Brian. Blueprints to Bricks: The Origins of DNA Nanotechnology UCSB Workshop in the History of Technology and Science, Santa Barbara, CA, October 27, 2014.

Pidgeon, Nick, Thomas, Merryn & Partridge, Tristan. UK Public Engagement and Deliberation Hirwaun, Wales, UK, November 7, 2014.

Legrady, George. Voice of Sisyphus. IEEE VisWeek 2014, Paris, November 9-14.

Pidgeon, Nick, Thomas, Merryn & Partridge, Tristan. UK Public Engagement and Deliberation Winford, UK, November 10, 2014.

Harthorn, Barbara. Lead organizer, host. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 13-15, 2014.

Engeman, Cassandra. Co-Lead Organizer & Session Chair. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 13-15, 2014.

Hasell, Ariel. Report-Back Plenary Address CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

Partridge,Tristan. Report-Back Plenary Address. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.Tyrrell, Brian. Report-Back Plenary Address CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

Appelbaum, Richard. Co-Lead organizer, host. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 13-15, 2014.

Gebbie, Matt. Report-Back Plenary Address, CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

Han, Xueying (Shirley). Report-Back Plenary Address, CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

Kay, Luciano. Report-Back Plenary Address, CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

Stevenson, Louise. Report-Back Plenary Address. CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

Stocking, Galen. Report-Back Plenary Address, CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

Newfield, Chris. What Happened to Solar Innovation? Closing plenary address, CNS-UCSB Democratizing Technologies: Assessing the roles of NGOs in Shaping Technological Futures UCSB, Santa Barbara, CA, November 13-15, 2014.

Fastman, Brandon. Report-Back Plenary Address CNS-UCSB Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, Santa Barbara, CA, November 13-15, 2014.

McCray, Patrick. The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future Stevens Institute of Technology Science and Technologies Studies Book Discussion, Hoboken, November 12, 2014.

Appelbaum, Richard. Making Blue the Next Green: Achieving Workers' Rights in the Global Economy, CNS-UCSB Democratizing Technologies: Assessing the Role of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 15, 2014.

Pidgeon, Nick, & Corner, Adam. Public Engagement and the integrated assessment of geoengineering project Royal Society of London, London, England, UK, November 26, 2014.

Stevenson, Louise. Creation Care in a Chemical Age. Community Outreach, November 2014.

McCray, Patrick. Visioneering From Space colonies to Nanotechnologies HPOL Colloquium Drexel University, December 2, 2014.

Slaton, Amy. Meritocracy, Technocracy, Democracy: Understandings of Racial and Gender Equity in American Engineering Education Illinois Institute of Technology, Amour College of Engineering, NMAE Seminar, Chicago, IL, December 3, 2014.

Kay, Luciano. What is Nanotechnology? Anacapa School 7-12 grade students, Santa Barbara, CA, December 5, 2014.

Appelbaum, Richard. Making Blue the Next Green. Bangladesh Garment Manufacturer and Exporter Association Apparel Summit, Dhaka, Bangladesh, December 18, 2014.

Legrady, George. 6018 Wilshire Edward Cella Art & Architecture, Los Angeles, September 20-December 20, 2014.

Legrady, George. Clocks for Seeing: Time and Motion National Gallery of Canada, Ottowa, Canada, December 20, 2014-May 3, 2015.

Legrady, George. Arte y Ciencia de Interfaz Planetario de Bogota, Bogota, Colombia, December 28-30, 2014.

Pidgeon, Nick. Communicating Risk and Uncertainties--The need for a strategic approach. Calculating Risk and Communicating Uncertainty Conference, UK, January 17, 2015.

Barvosa, Edwina. Called as expert witness in Jury trial providing testimony on unconscious bias Santa Barbara Superior Court, Santa Barbara, CA, February 15, 2015.

Mody, Cyrus. Burnt By the Sun: Jack Kilby and the '70s Solar Boom American Physical Society March Meeting, San Antonio, March 4, 2015.

Harthorn, Barbara. Surveying the Nanomaterial Industry: Lessons Learned and Challenges. Invited sole webinar presenter to over 50 members of the (US) Society of Toxicology, Nanotoxicology Specialty Section, March 10, 2014.

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

Majewski, John. Workshop, Washington Center of Equitable Growth, July 2015.

B. Research (N = 59)

Walsh, Casey. Mega to Nano: Changing Scales and Socialities of Water Infrastructure in Mexico. Dimensions of Political Ecology Conference, Lexington, KY, March 1, 2014.

Harr, Bridget. Re/Situating Race and Science: Constructing and Contesting Racial Knowledge Within and Beyond the Academy. 2014 Fields of Inquiry Conference hosted by UC Berkeley's Center for Science, Technology, Medicine, & Society, Berkeley, CA, Mar 7-8, 2014.

Slaton, Amy. Science Education: Past and Present Virginia Commonwealth University Program in Science, Technology and Society Colloquium, Richmond, VA, March 19, 2014.

Walsh, Casey. Filtering out the Social: Nanotechnology and Water Treatment in Mexico. Annual Meeting of the Society for Applied Anthropology, Albuquerque, March 20, 2014.

Mody, Cyrus. The Tangible and the Esoteric: US Physics in the 1970s, University of Notre Dame Cushing Prize Lecture, South Bend, IN, April 3, 2014.

Copeland, Lauren. Putting the "Political" in Political Consumerism: Towards a Theory of Motivations. Midwest Political Science Association Annual Meeting, Chicago, IL, April 3-5, 2014.

Copeland, Lauren, & Lekakis, E. The Changing Citizen: Creative Participation and Contentious Politics from a Comparative Perspective. Midwest Political Association Annual Meeting, Chicago, IL April 3-5, 2014.

Appelbaum, Richard. China and Global Nano/New Materials Revolution. The Role of Science & Technology in China's International Relations, Arizona State University, Tempe, AZ, April 4, 2014.

Harr, Bridget. Participant Science for the People Conference hosted by UMass Amherst's Social Thought & Political Economy Program, Amherst, MA, April 11-13, 2014.

Barvosa, Edwina. Do Some Deliberative Democratic Systems Already Exist? A Template for Assessing the Presence and Effectiveness of Large Scale Deliberative Systems. Annual Meeting of the Western Political Science Association, Seattle, WA, April 18, 2014.

McCray, Patrick. Between Art and Algorithm: Histories of the Engineer-Artist Nexus. Interrogating Methodologies: Exploring Boundaries in Art & Science, Santa Barbara, April 18-19, 2014.

Harthorn, Barbara, Appelbaum, Rich, McCray, Patrick, & Metzger, Miriam. CNS-UCSB NSF Reverse Site Visit (with CNS-ASU), Arlington, VA, May 5, 2014.

Walsh, Casey. La nanotechnolgia en el sector agua en Mexico: una perspectiva desde las ciencas sociales, International Multidisciplinary Joint Meeting: Nanoscience, Nanotechnology and Condensed Matter Physics, Hidalgo, Mexico, June 13, 2014.

Walsh, Casey. Coordinator and Participant, CIIECH-UNAM Workshop on Nanotechnology and Water, Mexico City, June 16, 2014.

Satterfield, Terre, Robin Gregory, Nick Pidgeon & Ariel Hasell. Decision Pathway Survey. Lead discussion at multi-day research meeting at Understanding Risk Centre, Cardiff, Wales, UK, June 24, 2014.

Harthorn, Barbara, Terre Satterfield, Karen Henwood. Gender and Risk Perception. Lead discussion at multi-day research meeting at Understanding Risk Centre Cardiff, Wales, UK, June 24, 2014.

Satterfield, Terre, Harthorn, Barbara, Copeland, Lauren, & Collins, Mary. Intuition, Resilience and Politics in Emerging Risk Debates. Interdisciplinary Conference--Transfusion and Transformation: The Creative Potential of Interdisciplinary Knowledge Exchange, Durham University, UK, July 15-17, 2014.

Han, Xueying (Shirley). Overview of Chinese Nano-Scientists: Impact of Educational Background and Mobility on Scientific Success from CV Analysis Gordon Research

Seminar & Gordon Research Conference on Science & Technology Policy, Waterville, Aug 10-15, 2014.

Tyrrell, Brian, & McCray, Patrick. From Blueprints to Bricks: The Origins of DNA Nanotechnology ESOCITE / 4S (Society for Social Studies of Science), Buenos Aires, Argentina, August 21, 2014.

Zayago Lau, Edgar, Foladori, Guillermo, & Appelbaum, Rich. Workers' demands for precaution and transparency in nanotechnology development. ESOCITE / 4S, Buenos Aires, Argentina, August 22, 2014.

Herron, Patrick, He, Kevin, & Zhou, Yilun. Functionality of Globonano. Duke University Media Arts + Sciences, Durham, NC, September 2, 2014.

Mehta, Aashish. Skill gaps, human capital and industrial development in India Indian Council for Research on International Economic Relations, New Delhi, India, September 7, 2014.

Legrady, George. Swarm Vision: Issues in Translating Human Photographic Vision Behavior to Machine Learning. Digital Intelligence, Nantes, France, September 17-19, 2014.

Horton, Zach. Can We Think Nano-Ecology? S.NET 6th Annual Meeting, Karlsruhe, Germany, September 21-24, 2014.

Horton, Zach. Film: Swerve. S.NET 6th Annual Meeting Karlsruhe, Germany, September 21-24, 2014.

Stocking, Galen, & Hasell, Ariel. Twitter as a Tool for Public Engagement with Emergent Technologies S.NET 6th Annual Meeting, Karlsruhe, Germany, September 21-24, 2014

Kay, Luciano, & Woolley, Jennifer. Corporate research and development activities in synthetic biology. S.NET 6th Annual Meeting, Karlshruhe, Germany, September 21-24, 2014.

Zayago Lau, Edgar. Nanotechnology and Health: New Challenges. Universidad Autonoma de Zacatecas Seminar, Zacatecas, Mexico, September 2014.

Zayago Lau, Edgar, & Guillermo, Foladori. Seminar Talk Graduate Faculty of Public Policy, Universidad Federal do Parana Seminar, Curitiba, Brazil, September 2014.

Walsh, Casey. De Mega a Nano: calidad de agua e infraestructura hidráulica en México," Invited Speaker, Seminar on "Accesso, manejo y control de recursos naturales en las sociedades mexicanas Conflictos y consensos, siglos XIX-XXI, Hermosillo, Mexico, October 17, 2014.

Tyrrell, Brian. DNA: It's Not Just for Biology Anymore. Center for Nanotechnology in Society Seminar, Santa Barbara, CA, October 30, 2014.

Barandiaran, Javiera. Lithium: Driving Sustainable Development? Invited lecture, Arizona State University, Tempe, AZ, October 31, 2014.

Frederick, Stacey. Value Chain Analysis in Latin America. Presentation at Federal University of Parana, Curitiba, Brazil, November 2014.

Legrady, George. Swarm Vision. 20th Annual International Symposium on Electronic Art, Dubai, UAE, November 2-8, 2014.

Harthorn, Barbara. Participant and Executive Committee member, NSF Workshop on Societal Implications of Synthetic Biology, Tempe, AZ, November 4-6, 2014.

Tyrrell, Brian, & McCray, Patrick. Blueprints and Bricks: DNA and the Origins of DNA Nanotechnology. History of Science Society (HSS) Annual Meeting, Chicago, IL, November 7, 2014.

Beaudrie, Christian, Kandlikar, Milind, & Satterfield, Terre. From Cradle-to-Grave at the Nanoscle: Gap in U.S. Regulatory Oversight along the Nanomaterial Life Cycle SETAC North America 35th Annual Meeting, Vancouver, BC, Canada, November 9-13, 2014.

Stocking, Galen, & Hasell, Ariel.Twitter as a tool for public engagement with emergent technologies? Poster presentation at the Democratizing Technologies: Assessing the Roles of NGOs in Shaping Technological Futures, UCSB, Santa Barbara, CA, November 13-15, 2014.

Mody, Cyrus. Burnt by the Sun: Jack Kilby and the '70s Solar Boom. Rice University Department Lunchtime Talk, Houston, TX, November 24, 2014.

Zayago Lau, Edgar. Nanotechnology Dialogues First Iberoamerican Seminar, Autonomous University of Zacatecas, Mexico, December 2014.

Beaudrie, Christian, ABA, Boxall, N, Bruce, D, Carlander, LJ, Carter, Q, Chaudhry, S, Diamond, K, Doudrick, A, Dudkiewicz, S, Foss Hansen, S, Ghosal, S, Hodson, S, Lambert, A, Lazareva, I, Lynch, A, Mathuru, J, Nathaniel, M, Rudd, D, Spurgeon, M, Tellenbach, & K, Tiede. Sustainable Management of Nanomaterial Containing Wastes. Society of Risk Analysis (SRA) Annual Meeting, Denver, CO, December 8-11, 2014.

Harthorn, Barbara. Risk and responsible innovation & governance: Lessons from societal research on nanotechnologies. Invited plenary talk, Nanoscale Science and Engineering Conference, NSF, Arlington, VA, December 10, 2014.

Harthorn, Barbara. What do we mean by data? Invited workshop presentation, NSF STS Data Management Workshop, Arlington, VA, January 29-30, 2015.

Partridge, Tristan. Exclusion, Extraction and Containment. Invited seminar presentation in Department of Anthropology, UCSB, Santa Barbara, CA, January 30, 2015.

McCray, Patrick. Many are Cold, Few Are Frozen. Histories of the Future Workshop, Princeton University, February 7, 2015.

Partridge, Tristan. The Shale Boom. Invited presentation in UCSB Interdisciplinary Humanities Center workshop: "Energy Challenges in the Developing World," UCSB, Santa Barbara, CA, February 20, 2015.

Barandiaran, Javiera. Sustainable Development 2.0: Lithium Mining in Chile. Interdisciplinary Humanities Center workshop on "Energy Challenges in the Developing World," UCSB, Santa Barbara, February 20, 2015

Mody, Cyrus. Academic Centers and/as Industrial Consortia Academic Entrepreneurship in History: An International Survey of Current Research, Ghent, March 12-13, 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. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.

Brooks, James. Community-Based Resistance to Fracking in the Chama River Basin, New Mexico. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.

Collins, Mary, Harthorn, Barbara Herr, Copeland, Lauren, & Satterfield, Terre. Fracking and Other Hazards: Towards Understanding the Spatial Aspects of Hazard Risk Acceptability Among US Publics. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.

Copeland, Lauren, Harthorn, Barbara Herr, Collins, Mary, & Satterfield, Terre. Risk, Resilience, and Cultural Politics in Emerging Debates about Fracking in the US. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.

Hasell, Ariel, & Hodges, Heather. Fracking in the US and UK: a comparison of public discussion of fracking on Twitter in the US and UK. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 2015.

Partridge, Tristan, Recovery and The Deep Underground: Responses to Unconventional Resource Extraction in California. 75th Annual Meeting of the Society for Applied Anthropology, Pittsburgh, PA, March 24-28, 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. 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.
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 Socio-Economics, London, July 2015.

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 (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 new partnerships with Education staff that bring CNS expertise to NNIN Societal and Ethical Issues education programs are expanding our reach to new audiences. 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 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 firm 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 anticipate even closer ties with this cutting edge resource and the tools it provides. (See spatial.ucsb.edu/; www.ncgia.ucsb.edu and www.csiss.org**)**

6) Social Science Survey Center (SSSC) (ISBER, UCSB)
The SSSC/Benton Survey Research Laboratory at UCSB enhances interdisciplinary collaboration on theoretical and methodological planes. The SSSC has been directed by sociologist John Mohr, a senior researcher in the CNS who has worked with both IRG 3 and IRG 2, and Associate Director, sociologist Paolo Gardinali. It is housed in the Humanities and Social Science Building and administered by ISBER and includes equipment and resources to conduct state-of-the art computer assisted interviewing system (CATI) telephone surveys,

sophisticated web-based surveys, and mail and multi-mode surveys on local, regional, or national populations in several languages. The SSSC works in extending traditional data collection methods with the use of online-based questionnaires for quantitative and qualitative data collection, in survey and experimental settings. The SSSC has also pioneered a cutting edge use of mixed data collection modes, using telephone, mail and web for maximum effectiveness. Extensive consulting is available on survey instrument design and development, programming, and data analysis and interpretation, and the SSSC is developing full GIS capability. Data security is a top priority, and multiple backups ensure stable system performance. SSSC provides ongoing support services for CNS deliberative workshops, web and phone surveys, and data analysis consulting. Campus research services infrastructure greatly reduce the cost of such data acquisition while providing a reliable and IRB-safe mode. CNS has used SSSC services for full survey sercies or components of projects. For more information see www.survey.ucsb.edu.

7) 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, and current director Parks joined the CNS executive committee in 2013. Longterm plans under discussion for the CNS include possible collaborative interactions with CITS. www.cits.ucsb.edu/

8) 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). CNS IRG 3 researchers have had an active, funded role in the UC CEIN, and Harthorn serves on the center’s executive committee; the UC CEIN’s renewal for 2013-2018 was awarded in

September 2013 for an additional $24M, bringing the total funding over 10 years to $48M. It is the nation's first such large-scale study of the potential ecological effects of nanomaterial forms. 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

9) 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 co-leads UC CEIN Theme 7 - Risk Perception, Regulation and Outreach with co-PI chemist Hilary Godwin, UCLA, and 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.

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 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/

10) 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 spatial postdoc Frederick is combining GVC expertise gained in work with the CGGC with spatial analytic approaches to examine nanotech in the US and California (and across the global value chain). See www.cggc.duke.edu/

11) 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 current home to collaborator Brock. CHF is 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/

12) 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. Current database development in IRG 2 is utilizing the professional expertise and infrastructure capabilities of this center to advance analysis of the nano innovation system. jenkins.duke.edu/

13) 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/

14) 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 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

15) 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/

16) Understanding Risk Research Group at Cardiff University, UK

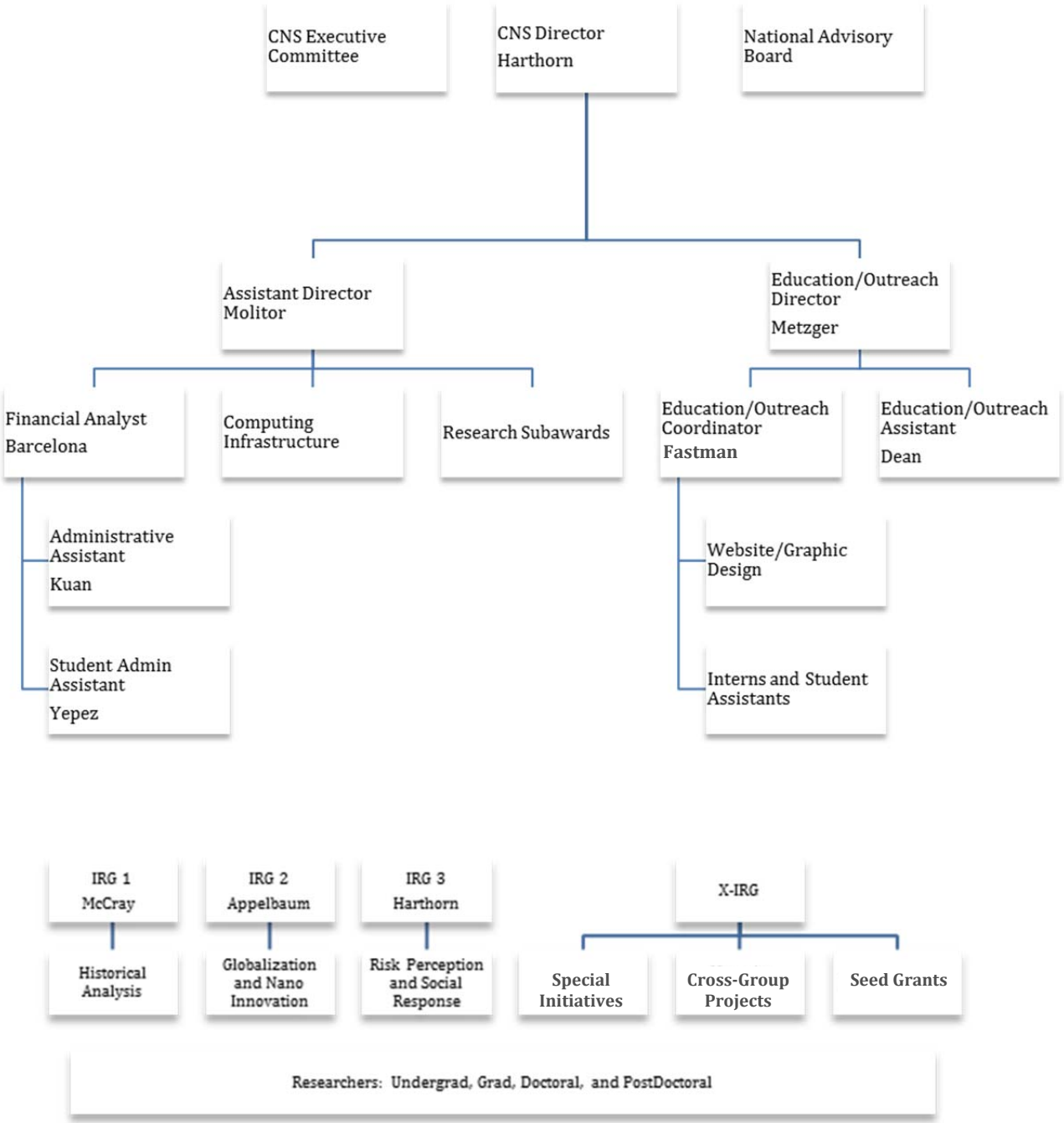
The Understanding Risk group is an interdisciplinary social sciences (psychology, sociology and technology studies, geography) research unit at Cardiff University focusing on the impacts upon individuals and communities, and acceptability to people, of environmental and technological risk within everyday life. The Group provides expertise in: the psychology of climate change; public attitudes towards and acceptability of energy supply systems; sustainable behaviour change and energy demand reduction; social conflicts and sitting 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, 3 Nobel laureates in the field), dedicated institutional commitment to diversity at all levels of leadership, and a strong team of interdisciplinary social science and humanities scholars to provide the core for CNS. 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, .75 FTE), a Financial Analyst/Events Coordinator (Barcelona, 1.0 FTE), a Travel and Purchasing Administrative Assistant (Kuan, 1.0 FTE), and a Computing Specialist (Macias, .10 FTE). 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 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, the Institute for Social, Behavioral, and Economic Research (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 meets 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.

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
We are pleased to report there have been no changes in CNS administrative staffing this reporting period. The current staffing profile provides efficient and effective administration of the Center, with expertise in such critical areas as: contracts and grants management, fiscal management, project management, travel and events coordination, and general administrative support.

CNS leverages NSF and UCSB cash contributions to achieve savings without sacrificing productivity and professionalism. UCSB cash contribution covers a significant portion of CNS staff salaries and fringe benefits. 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 shares computer technology staffing with ISBER, which gives the CNS access to 1.50 FTE IT staff, without having to commit significant salary expenditures. CNS has networked 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.

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 currently serve as Co-Chairs. Since this award began in 2010, the board plans were 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 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 to date, although some Board members have questioned the need for such regular meetings in the later years of the Center and have urged a shift to consultation. Board members are 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, the Board discussed possible reconfiguration of the Board in tandem with the CNS' evolving needs, particularly the long range development plans for beyond NSF funding horizons. The next meeting of the National Advisory Board is scheduled for April 24 2015, to discuss plans beyond the NSF NSEC funding period.

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 (S.NET), which recently completed its 6th 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 is thus benefiting 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. Harthorn and Guston correspond on a regular basis and schedule conference calls as needed to encourage a free flow of information among the Centers and their networks. This dual center relationship has developing into a collegial and supportive collaborative enterprise.

Management and Operation of Research Program

CNS has established and maintains an effective infrastructure for managing its collaborative research efforts. CNS' base on a single campus and consolidated and generous space arrangements in Girvetz Hall simplify these processes.

- Executive Committee meetings on a quasi-monthly basis allow prompt and direct reporting to and consultation with the group on both administrative and research issues.
- Research group and/or project meetings take place 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) meets approximately bi-weekly year-round and provides 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.
- 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; occasional gatherings for tea or drinks that include all CNS researchers and staff in informal exchange extend these opportunities.
- Visiting Scholar/Lecture Series brings together CNS researchers with extramural visitors for formal and informal interactions. Visitors are selected by grads, postdocs, researchers, and education program personnel.
- Research Summit meetings are held in Santa Barbara (most recently in Jan/Feb 2014) to allow the free flow of ideas among all CNS collaborators, students, and personnel from the institutions actively involved in core CNS research.
- 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.
- 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 now 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.
- 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.

- New postdoctoral researchers are required to submit a research proposal to the CNS Executive Committee within a month of their arrival and to provide milestones for assessing progress. Postdoctoral researcher evaluation by mentors takes place 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 provide significant impetus to aggregate and synthesize data within and between research groups.
- Bi-annual retreats of the Executive Committee, senior personnel, and staff to discuss NSF review results and assess other challenges and opportunities facing the Center have facilitated group assessment through SWOT analysis, collective decision making and other mechanisms, and will continue to be implemented on an as-needed basis in the future. The most recent such retreat was held in August 2013 at the Mosher House and focused on project development and long term prospects for CNS.

Clear and regular communication is essential to the management of any organization. To achieve this end, CNS-UCSB 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 on a regular basis 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. We have been successfully using secure sites on the ISBER server for sharing data and resources with collaborators around the world that cannot be hosted in the cloud. Additional resources are being pursued for long term storage, archiving and data sharing.

Seed Grants program

As it heads toward sunset, CNS has 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 is nearing completion in spring 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.

B. Evaluation plan for CNS-UCSB

The plan for the CNS-UCSB is 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 begin with efforts to 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 mechanism for this is 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. 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 is also providing periodic updates, and meeting bi-weekly with all graduate fellows and postdocs. (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 takes 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 are 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 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.

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, meets biannually in Santa Barbara if needed and may be asked to provide 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 is planned for April 24 2015 to discuss post-funding horizon futures.

NSF annual 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, is 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 are tracking changes, in the nanoscience, economic, and social worlds, and we address 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 to changing conditions by new recruitments of grads and the addition of new collaborators. The CNS postdoctoral researcher program also brings in new scholars and new ideas, and CNS is continually strengthening its network of collaborators. As detailed above, the CNS Faculty Seed Grant program is a vital step in development toward the long term future of the Center.

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	**10**	**5**	**5**	**0**	**0**	**0**	**6**	**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]	**5**	4	1	0	0	0	5	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	**103**	**51**	**52**	**1**	**0**	**0**	**59**	**17**	**3**	**1**	**22**	**10**	**0**	0%
Senior Faculty [1]	36	23	13	0	0	0	22	4	0	1	9	3	0	75%
Junior Faculty [1]	6	2	4	0	0	0	3	2	0	0	1	0	0	67%
Research Staff	17	9	8	1	0	0	8	2	0	0	6	2	0	94%
Visiting Faculty [1]	1	1	0	0	0	0	0	0	0	0	1	0	0	0%
Industry Researchers	3	3	0	0	0	0	2	0	0	0	1	0	0	67%
Post Docs [1]	9	3	6	0	0	0	6	1	1	0	1	2	0	78%
Doctoral Students [1]	20	5	15	0	0	0	13	3	2	0	2	3	0	95%
Master's Students [1]	6	3	3	0	0	0	2	3	0	0	1	0	0	100%
Undergraduate Students (non-REU) [1]	5	2	3	0	0	0	3	2	0	0	0	0	0	60%
Curriculum Development and Outreach														
Subtotal	**3**	**2**	**1**	**0**	**0**	**0**	**2**	**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	2	2	0	0	0	0	1	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]	**116**	**58**	**58**	**1**	**0**	**0**	**67**	**18**	**6**	**1**	**23**	**12**	**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."

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	**10**	**5**	**5**	**0**	**0**	**0**	**6**	**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]	5	4	1	0	0	0	5	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	**78**	**35**	**43**	**1**	**0**	**0**	**47**	**12**	**3**	**1**	**14**	**7**	**0**	**0%**
Senior Faculty [1]	27	18	9	0	0	0	18	3	0	1	5	1	0	85%
Junior Faculty [1]	3	1	2	0	0	0	1	2	0	0	0	0	0	33%
Research Staff	13	6	7	1	0	0	6	1	0	0	5	1	0	85%
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]	6	1	5	0	0	0	4	1	1	0	0	2	0	83%
Doctoral Students [1]	19	5	14	0	0	0	13	2	2	0	2	3	0	100%
Master's Students [1]	4	1	3	0	0	0	2	1	0	0	1	0	0	100%
Undergraduate Students (non-REU) [1]	5	2	3	0	0	0	3	2	0	0	0	0	0	60%
Curriculum Development and Outreach														
Subtotal	**3**	**2**	**1**	**0**	**0**	**0**	**2**	**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	2	2	0	0	0	0	1	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]	**91**	**42**	**49**	**1**	**0**	**0**	**55**	**13**	**6**	**1**	**15**	**9**	**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."

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

2014-2015
Primary Publications: 8 Journals; 10 Books, Chapters, Reports and Other Publications
Leveraged Publications: 14 Journals; 10 Books, Chapters, Reports and Other Publications
Submitted/In Preparation Publications: 43 Primary; 15 Leverage
Total: 100

Primary Publications: Journals

Beaudrie, Christian E. H., Satterfield, Terre, Kandlikar, Milind, & Harthorn, Barbara H. (2014). Scientists versus Regulators: Precaution, Novelty & Regulatory Oversight as Predictors of Perceived Risks of Engineered Nanomaterials. *PLoS ONE, 9*(9), e106365. doi: 10.1371/journal.pone.0106365

Beaudrie, Christian E H., Kandlikar, Milind, Gregory, Robin, Long, Graham, & Wilson, Tim. (2014). Nanomaterial risk screening: a structured approach to aid decision making under uncertainty. *Environment Systems and Decisions*, 1-22. doi: 10.1007/s10669-014-9529y

Choi, Hyungsub. (2015). Emerging opportunities: Nanoelectronics and engineering research in a South Korean university. *History and Technology*, 1-20. doi: 10.1080/07341512.2015.1008961

Choi, Hyungsub, & Shields, Brittany. (2015). A place for materials science: Laboratory buildings and interdisciplinary research at the University of Pennsylvania. *Minerva, 53*(1), 21-42. doi: 10.1007/s11024-015-9265-6

Gavankar, Sheetal, Anderson, Sarah, & Keller, Arturo A. (2014). Critical Components of Uncertainty Communication in Life Cycle Assessments of Emerging Technologies. *Journal of Industrial Ecology*, n/a-n/a. doi: 10.1111/jiec.12183

Han, Xueying, Stocking, Galen, Gebbie, Matthew A., & Appelbaum, Richard P. (2015). Will they stay or will they go? International graduate students and their decisions to stay or leave the U.S. upon graduation. *PLoS ONE, 10*(3), e0118183. doi: 10.1371/journal.pone.0118183

Motoyama, Yasuyuki, Cao, Cong, & Appelbaum, Richard. (2014). Observing regional divergence of Chinese nanotechnology centers. *Technological Forecasting and Social Change, 81*(0), 11-21. doi: http://dx.doi.org/10.1016/j.techfore.2013.02.013

Pidgeon, Nick, Demski, Christina, Butler, Catherine, Parkhill, Karen, & Spence, Alexa. (2014). Creating a national citizen engagement process for energy policy. *Proceedings of the National Academy of Sciences of the United States of America, 111*(Suppl 4), 13606-13613. doi: 10.1073/pnas.1317512111

Primary Publications: Books, Chapters, Reports and other Publications

Appelbaum, Richard. (2014). China: Innovator or Follower. *China Policy Institute Blog.* from http://blogs.nottingham.ac.uk/chinapolicyinstitute/2014/12/05/china-innovator-or-follower/

Copeland, Lauren, & Hasell, Ariel. (2014). Framing Effects on People's Expressed Willingness to Purchase Nanotechnology Applications in the U.S. In Christopher Coenen, Anne Dijkstra, Camilo Fautz, Julia Guivant, Kornelia Konrad, Colin Milburn & Harro van Lente (Eds.), *Innovation and Responsibility: Engaging With New and Emerging Technologies* (Vol. 5, pp. 87-106). Berlin: IOS Press.

Copeland, Lauren, & Smith, Eric RAN. (2014). Consumer Political Action on Climate Change. In Yael Wolinsky-Nahmias (Ed.), *Changing Climate Politics: US Policies and Civic Action* (pp. 197-217). Thousand Oaks, CA: CQ Press.

Copeland, Lauren, & Atkinson, L. (forthcoming). Political and Ethical Considerations in the Evolution of Consumer Activism as a Form of Political Participation and Civic Engagement. . In T Newholm, M Chatzidakis, M Carrington & D Shaw (Eds.), *Ethics and Morality in Consumption: Interdisciplinary Perspectives*. New York: Routledge.

Fadel, Tarek, Morita, Shelah, & Mayfield, Michael. (2015). Stakeholder Perspectives on Perception, Assessment, and Management of the Potential Risks of Nanotechnology. In Michaela Panter, Pat Johnson & Geoff Holdridge (Eds.), (pp. 74). Arlington: National Nanotechnology Coordination Office.

Frederick, Stacey, Rogers-Brown, Jennifer, & Shearer, Christine. (2015). Nanotechnology in Society: An Overview. In Tonya Lindsey (Ed.), *Short Subjects*. Sacramento: California Research Bureau.

Harthorn, Barbara Herr. (forthcoming). Envisioning Our Nano-Medical Futures: Techno-Benefits and Social Risks? In Lenore Manderson, Elizabeth Cartwright & Anita Hardon (Eds.), *Vital Signs: Medical Anthropology for the 21st Century*. London: Routledge.

Harthorn, Barbara Herr. (forthcoming). Societal Science for Converging and Emerging Technologies. In William Bainbridge & Mihail C. Roco (Eds.), *Handbook of Science and Technology Convergence*. Springer.

Novak, David. (2014). Disturbance. In Daisuke Naito, Ryan Sayre, Heather Swanson & Satsuki Takahashi (Eds.), *To See Once More the Stars: Living in a Post-Fukushima World* (pp. 99-102). Santa Cruz: New Pacific Press.

Newfield, Chris, & Boudreaux, Daryl. (2014). Learning From Solyndra: Filling Gaps in the US Innovation System. In Shyama Ramani, V. (Ed.), *Nanotechnology and Development: What's In It for Emerging Countries?* (pp. 39-72). Cambridge: Cambridge University Press.

Leveraged Publications: Journals

Arteaga Figueroa, Edgar, Foladori, Guillermo, Záyago Lau, Edgar, & Robles Belmont, E. (forthcoming). Las nanotecnologías aplicadas al sector energético. *Observatorio del Desarrollo, 11*.

Charles, Maria, Harr, Bridget, Cech, Erin, & Hendley, Alexandra. (2014). Who likes math where? Gender differences in eighth-graders' attitudes around the world. *International Studies in Sociology of Education, 24*(1), 85-112. doi: 10.1080/09620214.2014.895140

Cleveland, D. A., Copeland, Lauren, Glasgow, G, McGinnis, M. V., & Smith, E. R. A. N. (forthcoming). The Influence of Environmentalism on Attitudes Towards Local Agriculture and Urban Expansion. *Society and Natural Resources*.

Engeman, Cassandra. (2014). Social movement unionism in practice: organizational dimensions of union mobilization in the Los Angeles immigrant rights marches. *Work, Employment & Society*. doi: 10.1177/0950017014552027

Foladori, Guillermo, Appelbaum, Richard, Invernizzi, Noela, & Záyago Lau, Edgar. (2014). Nanotecnologia y trabajadores: Declaracion de Curitiba. *Observatorio del Desarrollo, 3*(9), 73-75.

Foladori, Guillermo, & Lau, Edgar Záyago. (2014). The Regulation of Nanotechnologies in Mexico. *Nanotechnology Law & Business, 11*, 164-171.

Foladori, Guillermo, & Lau, Edgar Záyago. (2015). La Regulacion de las Nanotecnologias en Mexico. *Revista Legislativa de Estudios Sociales y de Opinion Publica, 7*(14), 123-146.

Foladori, Guillermo. (forthcoming). Criterios sobre la regulación de las nanotecnologías. *Observatorio del Desarrollo, 3*(11).

García Guerrero, Miguel, & Foladori, Guillermo. (forthcoming). Divulgación de nanotecnologías en España, Estados Unidos y México: la visión del papel de la sociedad en la nueva ola científico-tecnológica. *Observatorio del Desarrollo, 3*(11).

Kay, Luciano, Newman, Nils, Porter, Alan, Rafols, Ismael, & Youtie, Jan. (2015). Mapping Graphene Science and Development. *Bulletin of the Association for Information and Technology, 41*(2), 22-25.

Kay, Luciano, Newman, Nils, Youtie, Jan, Porter, Alan L., & Rafols, Ismael. (2014). Patent overlay mapping: Visualizing technological distance. *Journal of the Association for Information Science and Technology, 65*(12), 2432-2443. doi: 10.1002/asi.23146

Powers, Christina M, Grieger, Khara D, Beaudrie, Christian, Hendren, Christine, Ogilvie, Michael Davis, J., Wang, Amy, . . . Gift, Jeffrey S. (2015). Data dialogues: critical connections for designing and implementing future nanomaterial research. *Environment Systems and Decisions, 35*(1), 76-87. doi: 10.1007/s10669-014-9518-1

Záyago Lau, Edgar, Foladori, Guillermo, Frederick, Stacey, & Arteaga Figueroa, Edgar. (2014). Researching Risks of Nanomaterials in Mexico. *Journal of Hazardous, Toxic, and Radioactive Waste, 0*(0), B4014001. doi: doi:10.1061/(ASCE)HZ.2153-5515.0000247

Záyago Lau, Edgar. (forthcoming). Nanotecnologías en América Latina, Asia-Pacífico y África. *Observatorio del Desarrollo, 3*(11).

Leveraged Publications: Books, Chapters, Reports and other Publications

Invernizzi, Noela, & Foladori, Guillermo. (forthcoming). Nanotechnology Implications for Labor. In Raj Bawa, Gerald F. Audette & Israel Rubinstein (Eds.), *Handbook of Clinical Nanomedicine*. Singapore: Pan Stanford Publishing.

Mody, Cyrus. (under review). An electro-historical focus with real interdisciplinary Aappeal: Interdisciplinarity at Vietnam-era Stanford. In Scott Frickel, Barbara Prainsack & Mathieu Albert (Eds.), *Critical Studies of Interdisciplinary Research*. New Brunswick: Rutgers University Press.

Mody, Cyrus. (under review). The Long Arm of Moore's Law: Microelectronics and American Science.

Mody, Cyrus. (under review). Santa Barbara physicists in the Vietnam era. In David Kasier & W. Patrick McCray (Eds.), *Groovy Science: The Counter-Cultures and Scientific Life, 1955-1975*.

Mody, Cyrus. (under review). Fabricating an organizational field for research: US academic microfabrication facilities in the 1970s and 1980s. In Thomas Heinze & Richard Münch (Eds.), *Intellectual and Organizational Innovation in Science: Historical and Sociological Perspectives*. New York: Palgrave Macmillan.

Newfield, Christopher. (2014, June 2014). Christensen's Disruptive Innovation after the Lepore Critique. *AAUP Academe Blog.* from http://academeblog.org/2014/06/25/christensens-disruptive-innovation-after-the-lepore-critique/

Newfield, Christopher. (2014, August 5, 2014). How Can Public Universities Pay for Research? *Remaking the University.* from http://utotherescue.blogspot.com/2014/08/how-can-public-research-universities.html

Newfield, Christopher. (2014, September 17, 2014). Some Implications of the Regents' Proposed UC Ventures. *Remaking the University.* from http://utotherescue.blogspot.com/2014/09/some-implications-of-regents-proposed.html

Shah, Sonali K., & Mody, Cyrus. (2014). Creating a context for entrepreneurship: Examining how users' technological and organizational innovations set the stage for entrepreneurial activity. In Brett Frischmann, Michael Madison & Katherine Strandburg (Eds.), *Commons in the Cultural Environment* (pp. 313-339). New York: Oxford University Press.

Záyago Lau, Edgar. (forthcoming). La regulación de las nanotecnologías en México y la investigación sobre riesgos de los nanomateriales manufacturados. In Guillermo Foladori, Edgar Záyago Lau, N. Invernizzi & Miguel Ángel Porrúa (Eds.), *Trabajo, riesgos y la regulación de las nanotecnologías en América Latina*. Mexico.

Submitted or in preparation publications: Primary

Appelbaum, Richard, Gebbie, Matt, Han, Shirley, & Stocking, Galen. (under review). Will China's Quest for Indigenous Innovation Succeed? Some Lessons From Nanotechnology. *Research Policy*.

Appelbaum, Richard, Gebbie, Matt, Han, Shirley, Nightingale, Emily, & Stocking, Galen. (in preparation). A Twitter Education: How Scientists Use Twitter to Educate the Public About Nanotechnology.

Barvosa, Edwina. (under review). Ambivalence as Asset: Mapping Meaning & Epistemic Diversity in Public Engagement with Nanotechnology. *Journal of Environmental Science and Studies*.

Barvosa, Edwina. (in preparation). Deliberative Remedies to Unconscious Bias in Institutional Settings and Policymaking.

Barvosa, Edwina. (in preparation). Public Deliberation… *Constructing Deliberative Democracy*.

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

Collins, Mary, Copeland, Lauren, Harthorn, Barbara Herr, & Satterfield, Terre. (in preparation). NEP vs. Resilience: Developing a New Approach to Predicting the Acceptability of Hazards.

Collins, Mary, Copeland, Lauren, Harthorn, Barbara Herr, & Satterfield, Terre. (in preparation). Rating the Risks: the Non-White Female Effect.

Collins, Mary, Hanna, Shannon, Harthorn, Barbara, & Satterfield, Terre. (in preparation). US Public Views on Nanotechnology and Product Safety: So Far So Good?

Cranfill, Rachel, Bryant, Karl, Shearer, Christine, & Harthorn, Barbara Herr. (in preparation). Indexing Expertise in a Deliberative Setting: A Comparison.

Frederick, Stacey. (in preparation). Quantifying the Nanotechnology Workforce in the US: Methods, Barriers & Estimates.

Frederick, Stacey. (under review). Nanotechnology in California. In Tonya Lindsey (Ed.), *Short Subjects*. Sacramento: California Research Bureau.

Friedman, Sharon. (in preparation). Coverage of Nanotechnology Environmental and Health Risks by the New Haven Independent and Google Alerts.

Friedman, Sharon. (in preparation). Media coverage of nanotechnology regulation.

Friedman, Sharon. (in preparation). Nanotechnology Source Use by Journalists.

Gregory, Robin, & Satterfield, Terre. (in preparation). Using Decision Pathway Surveys to Address Large-Scale Climate Engineering Policy Choices.

Gregory, Robin, Satterfield, Terre, & Hasell, Ariel. (in preparation). Using Decision Pathway Surveys to Inform Climate Energy Policy Choice.

Harthorn, Barbara Herr, Collins, Mary, Hanna, Shannon, & Satterfield, Terre. (in preparation). Ethical Positions and Nanotechnology Acceptance: A Social Component of Environmental Sustainability. *Journal of Responsible Innovation*.

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

Hasell, Ariel, & Stocking, Galen. (under review). A Pipeline of Tweets: Environmentalist Movements' Use of Twitter in Response to the Keystone XL Pipeline.

Hasell, Ariel, & Stocking, Galen. (in preparation). Twitter as a Tool for Public Engagement.

Hasell, Ariel, & Copeland, Lauren. (in preparation). The Role of Digital Media Consultants in the 2012 Elections.

Kay, Luciano, Appelbaum, Richard, Shapira, Philip, & Youtie, Jan. (in preparation). Innovation Pathways of Developing Countries in Emerging Technologies: The Case of Nanotechnology in Argentina and Brazil.

Kay, Luciano, & Woolley, Jennifer. (in preparation). Corporate Research and Development Activities in Synthetic Biology.

Lenoir, Timothy, Herron, Patrick, Wiess, Ben, McGuire, Aaron, Pachon, Jan, & Dsousa, Lanceton. (under review). The National Cancer Institute and the Takeoff of Nanomedicine. *Scientometrics*.

Lenoir, Tim, Mehta, Aashish, He, Kevin, Herron, Patrick, & Zhou, Yilun. (under review). The Impact of National Nanoscience Diversification Strategies

Lenoir, Tim, Harthorn, Barbara Herr, He, Kevin, & Zhou, Yilun. (in preparation). The Relationship Between International Collaboration on Nanotechnology and Publication Impact.

Lenoir, Timothy, Herron, Patrick, Wiess, Ben, McGuire, Aaron, Pachon, Jan, & Dsousa, Lanceton. (in preparation). Star Scientists, Federal Funding and the Takeoff of Bionanotechnology and Nanomedicine.

Newfield, Christopher, & Boudreaux, Daryl (Eds.). (under review). *Can Rich Countries Still Innovate?*

Novak, David. (under review). The Politics of Festival in Japan's Antinuclear Movement. *American Ethnologist*.

Parker, Rachel, Appelbaum, Richard, & Cao, Cong. (under review). Nanopolis and Suzhou Industrial Park: China's Silicon Valley? *Technology in Society*.

Partridge, T. & Harthorn, B. H. (in preparation). Energy, environment and technology timeframes: on 'urgency' as a factor in risk/benefit perception.

Partridge, T. & Harthorn, B. H. (in preparation). Deliberating unconventional oil and gas extraction: perspectives from California.

Saldivar, Laura, & Walsh, Casey. (under review). Nanotecnología para el tratamiento de agua. Claves sobre la investigación en México. *Mundo Nano*.

Satterfield, Terre, Corner, Adam, Pidgeon, Nick, Conti, Joseph, & Harthorn, Barbara Herr. (under review). Affective Ambivalence and Nanotechnologies. *Journal of Risk Research*

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

Risk, Reslience, and Cultural Politics in Emerging Debates About Fracking in the U.S.

Satterfield, Terre, Copeland, Lauren, & Harthorn, Barbara Herr. (in preparation). Tangibility and Resilience Across Ecotypes.

Satterfield, Terre, DeVries, Laura, Pitts, Anton, & Harthorn, Barbara Herr. (in preparation). Perilous Ideas: Essentialisms in Health Risk Research and the Invisibility of the White Male Effect.

Satterfield, Terre, Harthorn, Barbara Herr, Collins, Mary, & Pitts, Anton. (in preparation). Resilience and Tangibility as Factors Underpinning the Perceived Environmental Impact of New Technologies.

Thomas, Merryn, & Pidgeon, Nick. (in preparation). Deliberating Shale Gas Extraction by Hydraulic Fracturing: Urban and Rural Perspectives.

Thomas, Merryn, & Pidgeon, Nick. (in preparation). Public Perceptions of Shale Gas Extraction by Hydraulic Fracturing: Cross-National Comparisons Between the United States and Great Britain.

Walsh, Casey, & Saldivar, Laura. (in preparation). Factores en la decision de implementar la nanotecnologia para el tratamiento de aguas. *Mundo Nano*.

Submitted or in preparation publications: Leverage

Copeland, Lauren, & Feezell, Jessica T. (under review). Citizenship Norms and Political Participation: The Mediating Role fo Digital Media Use.

Copeland, Lauren, Bimber, Bruce, & Earl, Jennifer. (in preparation). Contentious Consumers: Political Consumerism, Movement Societies and Self-Directed Political Action. *Sociological Perspective*.

Copeland, Lauren, & Feezell, Jessica T. (in preparation). Crowding In or Crowding Out: The Relationship Between Political Consumerism and Other Forms of Civic and Political Behavior.

Copeland, Lauren. (in preparation). Postmaterialism vs. Engaged Citizenship as Predictors of Non-Electoral Forms of Political Participation.

Copeland, Lauren. (in preparation). Putting the Political in Political Consumerism: Towards a Theory of Motivations.

Copeland, Lauren. (in preparation). Political Consumerism and the Expansion of Political Participation in the US.

Earl, Jennifer, Copeland, Lauren, & Bimber, Bruce. (in preparation). Contentious Consumers: Political Consumerism, Movement Societies and Self-Directed Political Action.

Gregory, Robin, & Dieckmann, Ulf. (in preparation). Thinking Outside the Box: Plotting a Response to Climate Change Uncertainty.

Hasell, Ariel, & Weeks, B. E.. (in preparation). Angry Hordes: The Influence of Emotion and Partisan News Media in Political Information Sharing.

Kandlikar, Milind, & Jani, C. Dowlatabadi, H. (in preparation) Emerging Technologies and Life Cycle Management: Closing the Loop on Lithium Ion Batteries Used in Electric Vehicles.

Kay, Luciano, Youtie, Jan, & Shapira, Philip. (under review). Inter-industry knowledge flows and sectoral networks in the economy of Malaysia. *Knowledge Management Resource & Practice.*

Lenoir, Timothy, Herron, Patrick, He, Kevin, & Zhou, Yilun. (in preparation). An Evaluation of Lexical Queries for Identifying Nanotechnology Publications.

Mody, Cyrus. (under review). Moore's Law. In Ashley Shew & Joseph C. Pitt (Eds.), *Routledge Companion to the Philosophy of Technology*. London: Routledge.

Shah, Sonali K., & Mody, Cyrus. (under review). How do users develop and diffuse their innovations? Resources, new Social Structures, and Scaffolding. *Organization Science*.

Shatkin, Jo Anne, et al.. (in preparation). Advancing Risk Analysis for Nanoscale Materials: Report From an International Workshop on the Role of Alternative Testing Strategies for Advancement. *Risk Analysis*.

16. BIOGRAPHICAL INFORMATION

NSF-format Biographical Sketches follow for CNS-UCSB Investigators newly added this reporting year: Barandiaran, Barvosa, Majewski, and Mehta

Javiera Barandiaran

a. Professional Preparation.

University of Edinburgh	Politics	B.A.	2000
University of California, Berkeley	Public Policy	Masters	2008
University of California, Berkeley	Environment & Politics	Ph.D.	2013

b. Appointments.

2013-Present Assistant Professor, Global Studies, University of California, Santa Barbara

c. Products.

PRODUCTS MOST CLOSELY RELATED

1. Tironi, Manuel, and Javiera Barandiaran (2014). "Neoliberalism as Political Technology: Expertise, Energy and Democracy in Chile" in *Beyond Imported Magic: Studying Science and Technology in Latin America*. eds. Eden Medina, Christina Holmes, and Ivan da Costa Marques. Cambridge, MA: MIT Press.

OTHER SIGNIFICANT PRODUCTS

1. Barandiaran, Javiera (2015). Chile's Environmental Assessments: Contested Knowledge in an Emerging Democracy. *Science as Culture*. Published online 14 January 2015. Doi: 10.1080/09505431.2014.992332
2. Barandiaran, Javiera (2014). Review of the book *The Politics of Academic Autonomy in Latin America* by Fernanda Beigel, ed. (2013) Ashgate Press. *Critical Reviews on Latin American Research (CROLAR).*
3. Barandiaran, Javiera (2012). Researching Race in Chile. *Latin America Research Review*. Vol. 47, No. 1., pp. 161-176.
4. Barandiaran, Javiera (2012). Threats and opportunities of proprietary science at the University Andres Bello in Chile. *Higher Education*. Vol. 63, Issue 2, pp. 205-218
5. Philbrick, M. and Barandiaran, Javiera (2009). The National Citizens' Technology Forum: lessons for the future. *Science and Public Policy.* Vol. 36, No. 5., pp. 335-347.

d. Synergistic activities.

1. Teaches and designed a new undergraduate upper division elective called "Energy in Global Societies" that explores the political, economic, social, cultural and environmental causes and consequences of energy choices.
2. Organized a faculty research cluster on "Energy Challenges in the Developing World", with faculty and PhD students from departments in History, Geography, Film and Media, English, and Global Studies. We hold two meetings per quarter to share work in progress.
3. In February 2015 organized a day-long workshop on "Energy Challenges in the Developing World" with guest speakers from several universities across the country. The event drew over 20 participants and 60 who attended.
4. Manuscript reviewer for GeoForum, Economic Anthropology, Journal of Environment and Development, and Global Environmental Politics.

e. Collaborators & other affiliations.

1. **Collaborators**.

P. Amar (UCSB), A. French (UC Berkeley), A. H. Kimura (U. Hawaii-Manoa), W. Kuhn (UCSB), S. Miescher (UCSB), G. Ottinger (Drexel), L. Parks (UCSB), C. Rampini (UCSC), M. Tironi (PUC – Chile).

2. **Graduate advisor**.

David Winickoff (UC Berkeley), Kate O'Neill (UC Berkeley), Alastair Iles (UC Berkeley), Todd LaPorte (UC Berkeley)

Total graduate students advised: 1

3. **Thesis advising.**

Olivia Hustleby (UCSB)

Total postdoctoral scholars sponsored: 0

Edwina Barvosa

a. Professional Preparation.

Pomona College	Political Science	BA	1990
Cambridge University (Jesus College)	Social & Political Sci	BA/MA	1993
Harvard University	Government Major	PhD	1998

b. Appointments.

2011-Present	Associate Professor, Feminist Studies, UC Santa Barbara, Santa Barbara, CA
2004-Present	Affiliate Faculty, Department of Political Science, UCSB, Santa Barbara, CA
2014-Present	Affiliated Faculty, Department Chicana/o Studies, UCSB, Santa Barbara, CA
2006-2014	Associate Professor of Social and Political Theory, Department of Chicana/o Studies, UCSB, Santa Barbara, CA
1998-2006	Associate Professor of Social and Political Theory, Department of Chicana/o Studies, UCSB, Santa Barbara, CA
1992-1993	Adjunct Lecturer in Macroeconomics, Cambridge Business College, Cambridge UK

c. Products.

PRODUCTS MOST CLOSELY RELATED

1. "Mapping Public Ambivalence in Public Engagement with Science: Implications for Democratizing the Governance of US Fracking Technologies" under review, *Environmental Studies and Sciences*.
2. "Constructing Deliberative Democracy: Emerging Deliberative Systems in Science and Society" manuscript in progress.

OTHER SIGNIFICANT PRODUCTS

1. *Wealth of Selves: Multiple Identities, Mestiza Consciousness and the Subject of Politics*, Texas A&M Press 2008.
2. "Unconcsious Bias in the Suppressive Policing of Black and Latino Men and Boys: Neuroscience, Borderlands Theory, and the Policymaking Quest for Just Policing," Politics, Groups, and Identities, 2.2 (2014): 260-
3. "Mestiza Consciousness in Relation to Sustained Political Solidarity: A Chicana Feminist Interpretation of the Farmworker Movement." *Aztlán*, 36, no. 2 (2011): 121-154.
4. "Living in a World Between: Multiple Identities and the Challenges Faced by First Generations Immigrants." In *The Changing Face of America*, edited by Valerie Martinez-Ebers and Manochehr Dorraj. New York: Oxford University Press. 2007.
5. "Mestiza Autonomy as Relational Autonomy: Ambivalence and the Social Character of Free Will." *Journal of Political Philosophy* 15, no. 1 (2007): 1-21.

d. Synergistic activities.

1. Service as expert witness *People of the State of California and City of Santa Barbara* (Plaintiff and Real Party of Interest) vs. *Eastside and Westside et al*. Case No. 1379826, May 2014, for the Defendants.
2. Service as expert witness *People of the State of California v. Christian Botello*, September 2014; for the Defendant.
3. Service as expert witness *People of the State of California v. Felipe Alejandro Flores, Alejandro Peralta, and Gabriel Carbajal*, Case No. 1403516 pending trial, April 2015; for Defendant A. Peralta.
4. Service in filed Amicus Curiae brief in *People of the State of California v. Jane Laut*, Case No. 2010005507, February 2015, for the Defendant.

5. Service as expert witness *Rodriguez v. City of Los Angeles*, Case No. CV 11-01135, March 2015, for the Plaintiff.

e. Collaborators & other affiliations.

1. **Collaborators**.

There are no co-authors, collaborators, or co-editors to report.

2. **Graduate advisor**.

Seyla Benhabib, Yale University (PhD)
Richard Tuck, Harvard University (PhD & Cambridge MA)
Jill Frank, University of South Carolina
John B. Thompson, Cambridge University (MA)
Total graduate students advised: 6

3. **Thesis advising.**

Kathleen Cole, PhD, Metropolitan State University, St. Paul, MN
Amanda Zeddy, UC Santa Barbara
Amy Foss, UC Santa Barbara
Rosie Bermudez, UC Santa Barbara
Delores Mondragon, UC Santa Barbara
Ana Barba, UC Santa Barbara
Total postdoctoral scholars sponsored: 0

John Majewski

A. Professional Preparation.

University of Texas, Austin	Economics &History	B.A.	1988
London School of Economics	Economic History	M.Sc.	1989
UC Los Angeles	U.S. History	Ph.D.	1994

B. Appointments.

2014-Present	Interim Dean, Humanities and Fine Arts, UC Santa Barbara
2009-Present	Professor, Department of History, UC Santa Barbara
2000-2009	Associate Professor, Department of History, UC Santa Barbara
1995-2000	Assistant Professor, Department of History, UC Santa Barbara

A. Products.

PRODUCTS MOST CLOSELY RELATED

1. Modernizing a Slave Economy: The Economic Vision of the Confederate Nation (Chapel Hill: University of North Carolina Press, 2009).

2. "Imagined Economies: Economic Nationalism in the American and Confederate Independence Movements" in Peter Onuf and Peter Thompson, (eds.), State and Citizen in Early America (Charlottesville, University of Virginia Press, 2013).

3**. "**Geography as Power: The Political Economy of Matthew Fontaine Maury," Virginia Magazine of History and Biography (2013). Co-authored with Todd Wahlstrom

4. "Two Roads to the Transportation Revolution: Early Corporations in the U.K. and the United States," in Understanding Long-Run Economic Growth: Essays in Honor of Kenneth Sokoloff (University of Chicago Press, forthcoming 2011). Co-authored with Dan Bogart.

5. "Shifting Cultivation, Slavery, and Southern Development," Agricultural History 81 (Fall 2007), 522-548. Co-authored with Viken Tchakerian.

OTHER SIGNIFICANT PRODUCTS

1. A House Dividing: Economic Development in Pennsylvania and Virginia before the Civil War (New York: Cambridge University Press, 2000). Paperback Edition 2006.

d. Synergistic activities.

1. Teaches and lectures on technological change in the nineteenth-century U.S. and the role of creativity in the U.S. economy.
2. Several public lectures on Abraham Lincoln, Slavery, and Economic Creativity.
3. Manuscript reviewer for *Journal of Early Republic*, *Journal of American History*, *Journal of Economic History*, *Journal of Southern History, Enterprise and Society.*

e. Collaborators & other affiliations.

1. **Collaborators**.

Todd Wahlstrom, Department of History, Pepperdine University
Daniel Bogart, Department of Economics, UC Irvine.

2. **Graduate advisor**.

Masha Federova, Department of History, UC Santa Barbara
Paul Warden, Department of History, UC Santa Barbara
Jason Zeledon, Department of History, UC Santa Barbara

3. **Thesis advising.**

Jason Zeledon, Department of History, UC Santa Barbara

Aashish Mehta

a. Professional Preparation.

Oberlin College	Economics	B.A. (high honors)	1997
University of Wisconsin-Madison	Economics	M.Sc.	2000
University of Wisconsin-Madison	Energy Anal. & Policy	Certificate	2003
University of Wisconsin-Madison	Ag & Applied Econ	PhD	2004

b. Appointments.

2014-Present	Associate Professor, Global Studies, University of California, Santa Barbara
2007-2014	Assistant Professor, Global Studies, University of California, Santa Barbara
2006-2007	Economist, Economics & Research Dept, Asian Development Bank, Philippines
2004-2005	Economist, East & Central Asia Dept, Asian Development Bank, Philippines

c. Products.

PRODUCTS MOST CLOSELY RELATED

1. Aashish Mehta and Wei Sun. 2013. “Does industry affiliation influence wages? Evidence from Indonesia and the Asian Financial Crisis”, *World Development*, 51: 47-91.
2. Aashish Mehta, Jesus Felipe, Pilipinas Quising and Shiela Camingue. 2013. “Where have all the educated workers gone? Services and wage inequality in three Asian Economies”, *Metroeconomica*, 64(3): 466-497.
3. Aashish Mehta, Patrick Herron, Cong Cao and Tim Lenoir. 2012. “Globalization and De-Globalization in Nanotechnology Research: The role of China”, *Scientometrics*, 93: 439-458.
4. Aashish Mehta and Belinda Acuna-Mohr, 2012. “Economic Liberalization and Rising College Premiums in Mexico: A Reinterpretation”, *World Development*, 40(9): 1908-1920.
5. Aashish Mehta, Jesus Felipe, Pilipinas Quising and Shiela Camingue. 2011. “Overeducation in developing economies: How can we test for it, and what does it mean?”, *Economics of Education Review*, 30:1334-1347.

OTHER SIGNIFICANT PRODUCTS

1. Aashish Mehta and Shikha Jha. 2014. “Pilferage from opaque food subsidy programs: Theory and Evidence”, *Food Policy*, 45:69-79.
2. Aashish Mehta, Shikha Jha and Pilipinas Quising. 2013. “Self-Targeted food subsidies and voice: Evidence from the Philippines”, *Food Policy*, 41:204-217.
3. Michael T. Bennett, Aashish Mehta and Jintao Xu. 2011. “Incomplete property rights, exposure to markets and the provision of environmental services in China”, *China Economic Review*, 22: 485-98.
4. Aashish Mehta and Jean-Paul Chavas. 2008. “Responding to the Coffee Crisis: What can we learn from price dynamics?”, *Journal of Development Economics*, 85: 282-311.
5. Aashish Mehta and Hector J. Villarreal. 2008. “Why do diplomas pay? An expanded Mincerian specification applied to Mexico”, *Applied Economics,* 40: 3127-3144.

d. Synergistic activities.

1. Lead investigator on a World Bank funded interdisciplinary project to understand skill gaps in the Indian manufacturing sector.
2. Advisor to the Asian Development Bank’s Economics and Research Department on a large study of skill gaps, employment and skill development programs in Asia.
3. Co-author on a study prepared for the Government of India on impediments to the creation of good jobs in the garment sector.
4. Manuscript reviewer for *Applied Economics, Asia Pacific Education Review, Asia Pacific World, China Economic Review, Economics of Education Review, Education Economics, Environment and*

Development, European Review of Agricultural Economics, International Review of Economics and Finance, Journal of Public Economics, Metroeconomica, South African Journal of Economics, World Development.

e. Collaborators & other affiliations.

1. **Collaborators**.
Alison Brysk (UCSB), Cong Cao (U. of Nottingham), Liming Chen (UCSB), Jesus Felipe (Asian Development Bank - ADB), Deboshree Ghosh (U. of Aberdeen), Rana Hasan (ADB), Patrick Herron (Duke U.), Shikha Jha (ADB), Nidhi Kapoor (ADB), Luciano Kay (UCSB), Vedant Koppera (UCSB), Timothy Lenoir (Duke U.), Arpita Patnaik (Indian Council for Research on International Economic Relations), Changyong Rhee (IMF), Priyam Saraf (World Bank), Bart Verspagen (Maastricht U.)

2. **Graduate advisor**.

Jean-Paul Chavas (UW-Madison), Michael Carter (UC-Davis), Ian Coxhead (UW-Madison)

3. **Thesis advising.**

NB: We have not had PhD students in Global Studies until this year. I therefore advise MA students in Global Studies, and work closely with PhD students in other departments (not as chair).

Global Studies MAs: Thomas Oliver (Intelligent Mobility), Aisa Villanueva (Private business), Jayne Lee (Santa Barbara Public Library), Vedavati Patwardhan (Springer Publishing), Koudai Nakagawa (US State Department), Hagop Jerejian (Private business), Caroline Le (Chapman Law School), Haley Wrinkle (As You Sow).

PhD students: Belinda Acuna-Mohr (Economics, US Food & Drug Administration), Wei Sun (Economics, Govt. of Singapore), Vedant Koppera (Economics, on market), Galen Stocking (Political Science, Pew Research).

17. HONORS AND AWARDS

Anderson, Sarah, Promoted to Associate Professor with tenure, Environmental Politics, UCSB, 2014.

Appelbaum, Richard, month-long residency at Rockefeller Center in Bellagio, Italy (Aug-Sep, 2014).

Beaudrie, Christian, Kandlikar, Milind, & Satterfield, Theresa, paper received Certificate of Merit, from the American Chemical Society, Division of Environmental Chemistry. "Nanomaterial risk screening: A structured decision making (SDM) approach" at the 248th National Meeting in San Francisco, Aug 10-14, 2014.

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

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

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

Eardley-Pryor, Roger, Awarded PhD in History from UCSB, 2014.

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

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

Engeman, Cassandra, Senior Social Science Senior Graduate Research Fellow at the Center for Nanotechnology in Society at UCSB Apr – Dec 2014.

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

Friedman, Sharon, named McCormick Fellow in Jun, 2014.

Gebbie, Matthew, Science & Engineering Graduate Research Fellow at the Center for Nanotechnology in Society at UCSB, 2014-15.

Gebbie, Matthew. One of four UCSB Ph.D. students chosen to attend 65th Lindau Nobel Laureate Meeting in Germany, Jun - Jul, 2015.

Harr, Bridget, Social Science Graduate Research Fellow at the Center for Nanotechnology in Society at UCSB, 2014-15.

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

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

Hasell, Ariel, Social Science Graduate Research Fellow at the Center for Nanotechnology in Society at UCSB, 2014 -15.

Kay, Luciano, Integrated (by invitation) the Scientific Advisory Panel of the 4th Global Tech Mining Conference held in Leiden, Netherlands on Sep 2, 2014.

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

McCray, W. Patrick, Named the 2015-2016 Charles A. Lindbergh Chair in Aerospace History at the Smithsonian National Air and Space Museum for *The Visioneers: How A Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (published 2012 Princeton University Press), 2014.

Mehta, Aashish, Promoted to Associate Professor with tenure, Global and International Studies, UCSB, 2014.

Mehta, Aashish. Invited by The World Bank and the Asian Development Bank to participate in several research/writing projects involving human capital, “skill gaps” and industrial diversification and development. Researchers will be hired in various countries, to be supervised by Prof Mehta. The project will lead to peer-reviewed publications, publicly disseminated reports, and better advice to governments, 2015.

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

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

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

Novak, David, won Honorable Mention for the David Plath Media Award from the Society for East Asian Anthropology in the American Anthropological Association, for his podcast, “The Sounds of Japan’s Antinuclear Movement,” 2014

Parks, Lisa, Awarded Best Essay Award, Society for Cinema and Media Studies, for “Mapping Orbit: Toward a Vertical Public Space,” Mar 2014

Pidgeon, Nicholas, Awarded an MBE in the Queen's Birthday honors list for his services to UK climate change awareness and energy security policy, Jul 2014.

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

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

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

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

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

Stevenson, Louise, Science & Engineering Graduate Research Fellow at the Center for Nanotechnology in Society at UCSB, 2014-15.

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

Stocking, Galen, Social Science Graduate Research Fellow at the Center for Nanotechnology in Society at UCSB, 2014-15.

Stocking, Galen, Awarded PhD in Political Science from UCSB, 2014.

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

Tyrrell, Brian, Social Science Graduate Research Fellow at the Center for Nanotechnology in Society at UCSB, 2014-15.

Záyago Lau, Edgar, Accepted as a regular member to the Mexican Academy of Sciences (AMC), 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
	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, Netherlands								Y
	Moorpark College							Y	
	Natl Academy of Agricultural Research Management, India	Y							Y
	New York University	Y							
	Northeastern University	Y							
	Occidental College	Y		Y					
	Oxnard Community College			Y					
	Quinnipiac University								
	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 New Paltz								
	Universidad Autónoma de Zacatecas, Mexico	Y							Y
	Université de Lyon 3, France		Y						Y
	University of Arizona								

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**
	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, United Kingdom	Y							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	**27**	**11**	**5**	**0**	**0**	**0**	**0**	**2**	**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
	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 Research	Y	Y						
	DIYbio.org								
	Direct Relief		Y					Y	
	Engineers without Borders (UCSB Chapter)								
	Energy & Resource Institute, The, India								Y
	Environmental Defense Fund								
	European Trade Union Institute, Belgium								
	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

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
	Nanoscale Informal Science Education (NISE) network							Y	
	National Nanotech Coordinating Office (NNCO)					Y			
	National Institute of Occupational Safety & Health (NIOSH)					Y			
	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 (IDA)					Y			
	Silicon Valley Toxics Coalition								
	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	**40**	**7**	**5**	**0**	**0**	**3**	**4**	**4**	**6**

21. CURRENT AND PENDING SUPPORT

Investigator: Richard P Appelbaum

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future

Project/Proposal Title:
NSEC: Center for Nanotechnology in Society at University of California Santa Barbara

Source of Support: National Science Foundation

Total Award Amount: $6,827,759 (5-yr Award & 4 Supplements)

Total Award Period Covered: 9/15/10 – 8/31/2016

Location of Project: UC-Santa Barbara

Person-Months Per Year Committed to the Project: Cal: 0.0 Acad: 0.90 (costshare) Sumr: 1.30 (grant)

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future

Project/Proposal Title: Nanotechnology in the Mexican Industrial Policy, A Comparative Methodological Framework

Source of Support: UC MEXUS

Total Award Amount: $12,239

Total Award Period Covered: 7/1/14 – 12/31/15

Location of Project: UC-Santa Barbara

Person-Months Per Year Committed to the Project: Cal: 0.0 Acad: 0.90 Sumr: 0.00

Investigator: Barbara Herr Harthorn

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title:
NSEC: Center for Nanotechnology in Society at University of California Santa Barbara

Source of Support: National Science Foundation
Total Award Amount: $6,827,759 (5-yr Award & 4 Supplements)
Total Award Period Covered: 9/15/10 – 8/31/16

Location of Project: UC-Santa Barbara

Person-Months Per Year Committed to the Project: Cal: 0.0 Acad: 4.95 (costshare) Sumr: 2.00 (grant)

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title:
CEIN-Predictive Toxicological Assessment and Safe Implementation of Nanotechnology in the Environment

Source of Support: NSF and EPA, Subaward from UC-Los Angeles
Total Award Amount: 5,954,530
Total Award Period Covered: 9/1/13 – 8/31/2018

Location of Project: UC-Santa Barbara

Person-Months Per Year Committed to the Project Cal: 0.0 Acad: 0.18 Sumr: 0.50

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future
Project/Proposal Title:
Postdoctoral Fellowship: Energy, Risk and Urgency – Emergent Public Perceptions of Unconventional Oil and Gas Extraction

Source of Support: National Science Foundation
Total Award Amount: $119,765
Total Award Period Covered: 7/1/15 – 8/31/16

Location of Project: UC-Santa Barbara

Person-Months Per Year Committed to the Project Cal: 0.0 Acad: 0.18 Sumr: 0.50

Investigator: W. Patrick McCray

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future

Project/Proposal Title:
NSEC: Center for Nanotechnology in Society at University of California Santa Barbara

Source of Support: National Science Foundation

Total Award Amount: $6,827,759 (5-yr Award & 4 Supplements)

Total Award Period Covered: 9/15/10 – 8/31/2016

Location of Project: UC-Santa Barbara

Person-Months Per Year Committed to the Project: Cal: 0.0 Acad: 1.80 (costshare) Sumr: 1.32 (grant)

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future

Project/Proposal Title:
Building Collaborative Machines: Artists, Engineers, and Scientists during the Apollo Era

Source of Support: Smithsonian

Total Award Amount: $88,009

Total Award Period Covered: 7/1/15 – 6/30/16

Location of Project: Off-Campus

Person-Months Per Year Committed to the Project: Cal: 0.0 Acad: 9.0 Sumr: 0.0

22. BUSINESS PLAN

Overview

The plans for continuing the CNS at UCSB include a number of components, and at this point they are 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 work and mutual understanding; 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 five years) award of $7,775,078 or 112.3% of the NSF funds provided of $6,925,780). Thus CNS leaders and senior personnel definitely have the capability to successfully fund raise for future initiatives.

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 5 years alone $2,189,005 or 31.6% in reported matching support ($6,925,780 in NSF support over the same period), with an additional $93,900 committed in direct (cash) 'ramp down' funds for Yr 11. It is clear the campus would step up to provide substantial support for 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 discussion about potential larger interdisciplinary efforts on science in society.

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 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," but there have been a number of such ideas. But, lack of funding opportunities and the lack of institutional commitment of resources (particularly senior FTE) were universally seen 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 replace.

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 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 Engineer, Susanna Scott); enhance ties with the UCSB Technology Management Program, newly reinvigorated and expanding faculty and students; reinforce NNIN-societal connections, if renewed); 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.

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 prestigious Smithsonian fellowship for 2015-16 is a possible springboard for this, as well as Washington activities with policy maker outreach that it will enable.

IRG 2 intends to continue its focus on transformative technologies with UN and Regional Approaches to collaboration/monitoring of potentially controversial new technologies like synbio, 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, synbio, robotics, 3-D printing, etc.), examining the ways that politics and economics around these technologies influence the 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 will extend beyond the CNS award and 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 is 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 has a pending proposal for a Postdoctoral Scholar, to extend the work on her current deliberation project, and she and Pidgeon have begun preparation for summer 2015 submission of a new US-UK comparative survey on dhydraulic fracturing (fracking). She's also preparing a risk perception/spatial analysis proposal with former postdoc Collins for summer 2015 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.