



NSF SES 0938099

Nanoscale Science and Engineering Center

at University of California, Santa Barbara

Year 2 ~~Final~~ Annual Report

March 16, 2011 – March 15, 2012

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3. PROJECT SUMMARY

The Center 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 aimed at studying perceptions of emerging nanotechnologies by multiple stakeholders in the nano-enterprise. Strategic topic projects (solar energy, California industry, media coverage of nano) 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 global framework for analysis with attention to 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, health, energy, global industrial development, gender and race, environment, space/location, and science and engineering. Collaborators are drawn in the US from UC Davis and UCLA, the Chemical Heritage Foundation, Decision Research, Duke Univ., Lehigh Univ., Long Island Univ., Rice Univ., SUNY New Paltz, and Univ. of Wisconsin, and internationally from Beijing Institute of Technology (China), Cardiff Univ. (UK), Seoul National University, Univ. of British Columbia (Canada), and University of Nottingham (UK). CNS has served as a leader in the NSF Network for Nanotechnology in Society and is co-founder of the international scholarly organization S.NET; co-hosted with CNS-ASU the 3rd annual meeting in AZ in Nov 2011, forging an international community of nano and emerging technology scholars from 20 nations. CNS-UCSB is also a research partner in the NSF/EPA-funded UC Center for Environmental Implications of Nanotechnology at UCLA.

Education and Outreach programs at CNS-UCSB aim to nurture an interdisciplinary community of nano scientists, social scientists, 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 4-5 postdoctoral research scholar positions each year. Graduate Fellowships and researcher positions for social science and NSE 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 through them to key issues of responsible development. A CNS 8-week intensive summer undergraduate internship program integrates diverse California community college students into CNS activities. Through a year-round bi-weekly seminar program, a speakers series, conferences, visiting scholars, informal science education events for the public, electronic dissemination of a popular nano and society-related News Clips service to about 500, over a dozen public events with local community members, and accelerating outreach to key sectors of government and industry, the CNS maintains a solid following of campus, local, and national and international media, as well as interest by government, industry, NGOs, and the general public.

In 2011-12 CNS-UCSB continued substantial progress in research on pathways and impediments to socially and environmentally sustainable futures for nanotechnologies, producing 66 new publications in the past year, bringing total publications since our renewal of 1.5 yrs ago to 160, with another 62 in the publication stream, and making 100 presentations this year at academic venues. Applebaum, Block, Harthorn, and Pidgeon each provided critical input to national policymaking bodies in the US and UK, and CNS researchers made over 40 presentations to key audiences in government, industry, NSE, and the public.

4. PARTICIPANTS

4A. CENTER PARTICIPANTS

Bold indicates active in Year 7

UCSB (*CO-FUNDED)		
*Peter Alagona	Assistant Professor	History & Environmental Studies
Richard Appelbaum	Professor McArthur Chair	Sociology, Global & International Studies
David Awschalom	Professor Director	Physics California NanoSystems Institute
Edwina Barvosa	Associate Professor	Chicana/o Studies, Feminist Studies
Bruce Bimber	Professor	Political Science, Communication
Cathy Boggs	Director of Education Programs & Comm.	CNS-UCSB
Tim Cheng	Professor	Electrical and Computer Engineering
Brad Chmelka	Professor	Chemical Engineering
Julie Dilleuth	Education Director	CNS-UCSB
Jennifer Earl	Professor	Sociology
William Freudenburg	Professor (deceased)	Environmental Studies
Fiona Goodchild	Education Director	California NanoSystems Institute
Michael Goodchild	Professor	Geography
Barbara Herr Harthorn	Associate Professor Director	Feminist Studies, Anthropology, Sociology CNS-UCSB
Craig Hawker	Professor Director	Chemical Engineering Materials Research Laboratory, MRSEC
Patricia Holden	Professor	Microbiology, Environmental Studies
W. Patrick McCray	Professor	History of Science
Aashish Mehta	Assistant Professor	Global & International Studies
Miriam Metzger	Associate Professor	Communication
John Mohr	Professor	Sociology
Meredith Murr	Director	Research Development
Christopher Newfield	Professor	English

SUB-AWARD PIs			
Frederick Block	Professor Emeritus	Sociology	U. of California, Davis
Joseph Conti	Assistant Professor	Sociology, Law	University of Wisconsin
Sharon Friedman	Professor	Science Journalism, Communication	Lehigh University
Gary Gereffi	Professor Director	Sociology, CGGC	Duke University
Robin Gregory	Senior Researcher	Psychology	Decision Research
Timothy Lenoir	Professor	History, Data Visualization, Visual Studies	Duke University

Cyrus Mody	Assistant Professor	History, Technology Studies	Rice University
David Mowery	Professor	Economics, Business School	University of California, Berkeley
Nicholas Pidgeon	Professor	Social Psychology, Environmental Risk	Cardiff University
Terre Satterfield	Professor	Culture, Risk & Env.	U. of British Columbia

COLLABORATORS			
Gerald Barnett	Director	University Tech. Transfer	University of Washington
Daryl Boudreaux	President	Commercialization	Boudreaux and Associates
David Brock	Senior Research Fellow	History	Chemical Heritage Foundation
Karl Bryant	Assistant Professor	Sociology, Women's Studies	SUNY New Paltz
Eric Bullock	Professor	Chemistry	Santa Barbara City College
Cong Cao	Associate Professor	Sociology	University of Nottingham
Hyungsub Choi	Assistant Professor	History of Science	Seoul National University
Meredith Conroy	Assistant Professor	Politics	Occidental College
Zhu Donghua	Vice Dean	Management and Economics	Beijing Institute of Technology
Brenda Egolf	Research Scientist	Journalism	Lehigh University
Guillermo Foladori	Professor	Sociology	U. Autonoma de Zacatecas
Robin Gregory	Senior Researcher	Psychology	Decision Research
Hillary Haldane	Assistant Professor	Anthropology	Quinnipac University
Patrick Herron	Researcher	Data Mapping and Visualization	Duke University
Noela Invernizzi	Adjunct Professor	Science & Technology Policy	Federal University of Parana
Jacqueline Isaacs	Professor	Mechanical & Industrial Eng.	Northeastern University
Mikael Johansson	Lecturer	Chemistry	U. of Gothenburg
Milind Kandlikar	Associate Professor	Science Policy & Regulation	U. of British Columbia
Graham Long	Partner	Environmental Technology	Compass Resource Management
Rachel Parker	Senior Research Associate	Sociology	Science & Technology Policy Institute
Jennifer Rogers-Brown	Assistant Professor	Sociology	Long Island University
Marilynn Spaventa	Acting Executive VP	ESL	Santa Barbara City College
Paul Slovic	President	Psychology	Decision Research
Edgar Zayago Lau	Researcher	Development St.	U. Autonoma de Zacatecas

UCSB POSTDOCTORAL SCHOLARS AND RESEARCHERS (*CO-FUNDED)	
Meredith Conroy	Political Science
*Gwen D'Arcangelis	Women's Studies
Matthew Eisler	History
Mikael Johansson	Social Anthropology
Yasuyuki Motoyama	City and Regional Planning
*Christine Shearer	Sociology
James Walsh	Sociology

NON-UCSB POSTDOCTORAL RESEARCHERS		
Adam Corner	Cardiff University	Social Psychology
Christina Demski	Cardiff University	Psychology
Stacey Frederick	Duke University	Textile Management
Marian Negoita	U. of California, Davis	Sociology
Anton Pitts	U. of British Columbia	Risk Science

CNS GRADUATE FELLOWS	
Peter Burks	Chemistry, Biochemistry
Yiping Cao	Environmental Science and Management
Meredith Conroy	Political Science
Amanda Denes	Communication
Roger Eardley-Pryor	History
Cassandra Engeman	Sociology
Matthew Gebbie	Materials
Summer Gray	Sociology
Shirley Han	Ecology, Evolution and Marine Biology
Shannon Hanna	Environmental Science and Management
Zachary Horton	English
Erica Lively	Electrical Engineering
Tyronne Martin	Chemistry
Rachel Parker	Sociology
Claron Ridge	Chemistry
Christine Shearer	Sociology
Galen Stocking	Political Science
James Walsh	Sociology

UCSB GRADUATE STUDENT RESEARCHERS & RESEARCH ASSISTANTS (*COFUNDED)	
*Lynn Baumgartner	Environmental Science and Management
*Erin Calkins	Chemistry, Biochemistry
*Benjamin Carr	Environmental Science and Management
*Mary Collins	Environmental Science and Management
Lauren Copeland	Political Science

Rachel Cranfill	Linguistics
*Allison Fish	Environmental Science and Management
Angus Forbes	Media Arts & Technology
Sarah Hartigan	Global Studies
Zachary Horton	English
Pejr Hovey	Media Arts & Technology
Indy Hurt	Geography, Geographic Information Science
*John Meyerhofer	Environmental Science and Management
Margaret Moody	Education
Shadi Roshandel	Education
Elizabeth Sciaky	Education
Ad��la��de Veyre	Political Science
David Weaver	Political Science
*Lily Anne Welty	Asian American History, Mixed Race Studies
Silke Werth	East Asian Languages and Cultures
Qian Yang	East Asian Languages and Cultures
Yuan-Yi Fan	Media Arts and Technology
Anna Walsh	Global Studies & International Studies

NON-UCSB GRADUATE STUDENT RESEARCHERS	
Jennifer Bayzick	Lehigh University
Christian Beaudrie	University of British Columbia
Laura DeVries	University of British Columbia
Aaron McGuire	Duke University
Brittany Shields	U. of Pennsylvania

UCSB Undergraduate Interns & Researchers		
Brent Boone	Katherine He	Nicholas Santos
Sergio Cardenas	Simone Jackson	Julie Whirlow
Cecilia Choi	Alexander Lyte	Sabrina Wu
Andi Diaz	Srijay Rajan	Joy Yang
Andi Docktor	William Reynolds	

NON-UCSB UNDERGRADUATE RESEARCHERS	
Sean Becker	University of Wisconsin, Madison
Rachel Bowley	Duke University
Christine McLaren	Lehigh University
Ryan White	Lehigh University
Alexander Zook	Lehigh University

CNS STAFF	
Shawn Barcelona Cory Jones Valerie Kuan Diane Laflamme-McCauley Brendy Lim	Bonnie Molitor Kristen Nation Stacy Rebich Hespanha Andrey Soloviev Maria Yepez

NON-CNS STAFF	
Lesley Strabel	Ben Weiss

Affiliated Participants affiliated (Not receiving Center support)			
<u>UCSB:</u>			
Kevin Almeroth	Professor	Computer Science	
Andrew Flanagan	Professor	Communication	
Arturo Keller	Professor	Biogeochemistry, Mechanical & Enviro. Eng.	
Lubi Lenaburg	Evaluation Coordinator	CNSI Center for Science and Eng. Partnerships	
Miriam Metzger	Associate Professor	Communication	
Mark Rodwell	Professor, Director	Electrical and Computer Engineering, NNIN	
Ram Seshadri	Professor	Materials, Chemistry and Biochemistry	
Sangwon Suh	Associate Professor	Environmental Science and Management	
<u>OTHER INSTITUTIONS:</u>			
Francesca Bray	Professor	Gender and Technology	Edinburgh University
Brian Davison	Associate Professor	Computer Science and Engineering	Lehigh University
Magali Delmas	Associate Professor	Corporate Environmental Mgmt.	U. of California, Los Angeles
Jennifer Earl	Professor	Sociology	University of Arizona
Matthew Eisler	Postdoctoral Research Fellow	History	Chemical Heritage Fdn
Mikael Johansson	Lecturer	Anthropology	U. of Gothenburg
Ann Johnson	Associate Professor	History of Science and Technology, Mod. Europe	U. of South Carolina
Sarah Kaplan	Associate Professor	Business	University of Toronto

Matthew Keller	Assistant Professor	Sociology	Southern Methodist U.
Sharon Ku	Postdoc. Researcher	History & Phil. of Science	U. of Southern Indiana
Jens-Uwe Kuhn	Assistant Professor	Global and International Studies	SB City College
Ephraim Massawe	Assistant Professor	Computer Science, Industrial Technology	Southeastern Louisiana U
Mara Mills	Assistant Professor	Media, Culture & Communication	New York University
Yasuyuki Motoyama	Senior Scholar	City & Regional Planning	Kauffman Fdn
André Nel	Professor, Director, Physician	UCLA Medical School, UCLA CEIN	U. of California, Los Angeles
Joseph November	Assistant Professor	History	U. of South Carolina
Takushi Otani	Associate Professor	History and Philosophy of Technology	Kibi International U.
Ismael Rafols	Researcher	Science Policy	Sussex U.
Gurumurthy Ramachandran	Professor	Environmental Science and Engineering	U. of Minnesota
Shyama Ramani	Researcher	Dev. Economics	Ecole Polytech, INRA
Alain Rieu	Professor	Philosophy	Université Lyon 3
Kalpana Sastry	Principal Scientist	Agriculture	Nat'l Academy of Ag Research
Philip Shapira	Professor	Public Policy	Georgia Institute of Technology
Joseph Summers	Test Dev. Engineer	Electrical Engineering	Infinera
Jan Youtie	Manager, Policy Services	Political Science	Georgia Institute of Technology
Stephen Zehr	Professor	Sociology	U. of Southern Indiana
<u>VISITING SCHOLARS</u>			
Jacqueline Isaacs	Professor	Mech. & Industrial Eng.	Northeastern University
Sharon Ku	Postdoctoral Scholar	History & Phil. of Science	U. of Southern Indiana
Kalpana Sastry	Principal Scientist	Agriculture	Nat'l Academy of Ag Research
<u>NANOTECHNOLOGY IN SOCIETY NETWORK COLLABORATORS</u>			
Davis Baird	U. of South Carolina		
David Guston	CNS-ASU		

4B. EXTERNAL ADVISORY BOARD

John Seely Brown, Visiting Professor at University of Southern California and former Chief Scientist of Xerox Corporation and the director of its Palo Alto Research Center (PARC), [Board Co-Chair](#)

Ann Bostrom, Professor and Dean in School of Public Policy at University of Washington, Seattle, [Board Co-Chair](#)

Craig Calhoun, Incoming Director of the London School of Economics and Political Science, President of the Social Sciences Research Council, and University Professor of the Social Sciences at New York University

Vicki Colvin, Professor of Chemistry and Executive Director of the Center for Biological and Environmental Nanotechnology at Rice University

Ruth Schwartz Cowan, Professor in the History and Sociology of Science Department at the University of Pennsylvania

Susan Hackwood, Executive Director of the California Council on Science and Technology

Willie Pearson, Jr., Chair of History, Technology and Society at Georgia Institute of Technology

Robert Westervelt, Director of the Nanoscale Science and Engineering Center-NSEC at Harvard University

Thomas Kalil, Deputy Director of the White House Office of Science and Technology Policy; Special Assistant to the Chancellor for Science and Technology at UC Berkeley, [Board Chair Emeritus](#), 2007-2008

Julia Moore, Director of Research for the Pew Health Group, Pew Charitable Trusts; former Deputy Director of Foresight and Governance Project at the Woodrow Wilson International Center for Scholars, [Board Co-Chair Emerita](#), 2006-2009

4C. PARTICIPATING ACADEMIC INSTITUTIONS

Allan Hancock Community College

Arizona State University

Beijing Institute of Technology, China

California Polytechnic State University, San Luis Obispo

Cardiff University, Wales, UK

Centre National de la Recherche Scientifique (CNRS), France

College of the Canyons

Cornell University

Cuesta Community College

Duke University

Ecole Polytechnique, France

Edinburgh University, UK

Georgia Institute of Technology

Jackson State University

Kibi International University, Japan

Lehigh University

Long Island University

Moorpark College

National Academy of Agricultural Research Management, India

New York University

Northeastern University

Occidental College

Oxnard Community College

Quinnipiac University

Rice University (William Marsh)

Santa Barbara City College

Seoul National University, South Korea

Southeastern Louisiana University

Southern Methodist University

State University of New York, Levin Institute

State University of New York, New Paltz

Sussex University, UK

Universidad Autónoma de Zacatecas, Mexico

Université de Lyon 2, France

Université de Lyon 3, France

University of Arizona

University of British Columbia, Canada

University of California, Berkeley

University of California, Davis

University of California, Los Angeles

University of Exeter, UK

University of Gothenburg, Sweden

University of Minnesota-Twin Cities

University of Nottingham, UK

University of Pennsylvania

University of South Carolina

University of Southern Indiana

University of Toronto, Canada

University of Washington
University of Wisconsin-Madison
Ventura College

4D. PARTICIPATING NON-ACADEMIC INSTITUTIONS

American Bar Foundation
American Institute of Physics
Boudreaux and Associates
Chemical Heritage Foundation
Compass Resource Management
Decision Research Corporation
Environmental Defense Fund
International Council on Nanotechnology (ICON), Rice University
International Risk Governance Council, Switzerland
Kauffman Foundation
Knowledge Networks
Latin American Network of Nanotechnology and Society (ReLANS), Mexico
Meridian Institute
Nanoscale Informal Science Education Network (NISE)
Santa Barbara Museum of Natural History
Science and Technology Policy Institute
Woodrow Wilson International Center, Project on Emerging Nanotechnologies
YouGov America Inc.

5. QUANTIFIABLE OUTPUTS

Table 1: Quantifiable Outputs			
Outputs	Reporting Year -1	Reporting Year	Total
Publications that acknowledge NSF NSEC Support			
In Peer-Reviewed Technical Journals: Primary	24	17	41
In Peer-Reviewed Technical Journals: Leverage	0	7	7
Books / Chapters or sections in books: Primary	61	36	97
Books / Chapters or sections in books: Leverage	0	6	6
Other: Primary	9	0	9
Other: Leverage	0	0	0
Total Publications	94	66	160
With Multiple Authors	36	54	90
Multiple Authors: Co-Authored with NSEC Faculty	33	50	83
Publications that do not acknowledge NSF NSEC Support			
In Peer-Reviewed Technical Journals	0	0	0
NSEC Technology Transfer			
Inventions Disclosed	0	0	0
Patents Filed	0	0	0
Patents Awarded	0	0	0
Patents Licensed	0	0	0
Software Licensed	0	0	0
Spin-off Companies Started (if applicable)	0	0	0
Degrees to NSEC Students			
Bachelor's Degrees Granted	0	3	3
Master's Degrees Granted	5	0	5
Doctoral Degrees Granted	8	2	10
NSEC Graduates Hired by			
Industry	0	1	1
NSEC Participating Firms	0	0	0
Other U.S. Firms	0	1	1
Government	1	0	1
Academic Institutions	5	1	6
Other	1	0	1
Unknown	0	3	3
NSEC Influence on Curriculum (if applicable)			
New Courses Based on NSEC Research	8	9	17
Courses Modified to Include NSEC Research	10	13	23
New Textbooks Based on NSEC Research	2	16	18
Free-Standing Course Modules or Instructional CDs	0	0	0
New Full Degree Programs	0	0	0
New Degree Minors or Minor Emphases	0	0	0
New Certificate	0	0	0
Information Dissemination/Educational Outreach			
Workshops, Short Courses to Industry	6	6	12
Workshops, Short Courses to Others	15	21	36
Seminars, Colloquia, etc.	137	165	302
World Wide Web courses	1	1	2

6. MISSION, SIGNIFICANT ADVANCES, AND BROADER IMPACTS

Nanotechnology Origins, Innovations, and Perceptions in a Global Society

The global vision for nanotechnology to mature into a transformative technology that furthers social as well as economic aims 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 the US, 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, the nanomaterials industry, 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 (10 social science/humanities fellows and 8 NSE fellows to date in the renewal, 32 total since 2006); graduate research assistantships (32 at UCSB and 9 w/ external collaborators); undergraduate summer research internships to regional community college students (3 in the past year, 15 since inception) and UCSB undergrads (2 in 2011-2012, 12 total since 2006) who are mentored by UCSB graduate students (7 mentorships to date), and 1-3 interdisciplinary social science/humanities postdocs per year (7 in 2011-12, 4 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. 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 has developed and piloted a model curriculum for community college science and society education, a primary population for nano workforce development.

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 2012 we held 2 annual NanoDays with nearly 700 adults and children, participated in NanoDays at the Science Center of LA, and reached out to dialogue with 6 local community service organizations). CNS-UCSB commits significant resources to conferences and workshops for diverse audiences, alternating smaller, more specialized meetings for researchers (Nanotech risk perception 2010, Nanotech innovation systems 2010) with larger-scale international conferences and workshops (co-hosted/co-sponsored with CNS-ASU the 3rd annual S.NET conference in Tempe, AZ in Nov 2011 for 200 scholars, scientists, industry representatives, journalists, and NGO members from 20 countries. In addition to its co-founding role in S.NET, CNS serves as a key connection hub in the growing 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 others). Outreach to still wider publics and interested parties takes place via electronic forms such as our popular “CNS-UCSB News Clips,” contributions to leading blogs such as *Science Progress*, *2020 Science*, and *Huffington Post*, podcasts of interviews with researchers, and media briefings, and anticipated new media methods in the future such as online deliberation, currently piloted in an undergraduate course. 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 NPEC working group of the NNI and NNCO personnel as well as 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 (in which he draws on CNS nano research); Patrick McCray via op ed pieces in the influential blog, *Science Progress*; Newfield via *The Huffington Post*). CNS researchers contribute to the UC CEIN evidence-based knowledge of the public, emerging views of nanotech, and past risk controversies for use in developing risk reduction and risk management advice to regulators. 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., posts to the prominent blog, *Science Progress*, and *The Blog* (*Huffington Post*); development of online course materials; interviews with nano journalism (e.g., the *New Haven Independent*), and contributions to science journals that reach a wide array of industry, policy, and academic audiences).

Synthesis of CNS-UCSB research in the first 5 years has culminated in 4 volumes currently in print, in press, or in late stages of preparation: a book for a wider public audience developed from the 2009 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 and *which will be released* by Routledge in June 2012, draws from and integrates all three research groups’ work in a social science analysis of innovation, public perception, and governance; a special issue of the leading journal, *Risk Analysis* (Nov 2011) from the IRG 3 nanotech risk perception specialist meeting in Jan 2010 and edited by IRG 3 leaders Pidgeon, Harthorn & Satterfield; and *Can Rich Countries Still Invent?*, edited by Newfield and Boudreaux, developed from the *States of Innovation* international conference in Lyon, France in April 2010, which explores the critical dimensions of a post-linear model of innovation that will integrate with the public. CNS-UCSB also has initiated as a summative activity development of a series of *policy briefs* to extend the implications of the maturing research mission. CNS-UCSB’s distinguished National Advisory Board provides us with strategic advice from leaders of stakeholder constituencies at all phases of research and dissemination

7. HIGHLIGHTS



CNS-UCSB
Center for Nanotechnology in Society

NSF
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Book Explores Contributions of the Scanning Probe Microscopy Community to Nanotechnology



**Instrumental Community:
Probe Microscopy and the Path to Nanotechnology**

Rice University historian Cyrus Mody tells the story of the forty-year history of the probe microscopy community that played a key role in the development of nanotechnology techniques and institutions.

Main Findings:

- Healthy research communities innovate and experiment as much in the forms of their institutions as they do in their technologies.
- Commercialization of academic research takes many forms, is driven by many motivations, and has a very long history.
- There is no one best way to structure university-industry cooperation.
- Blurring of lines among academic, government, and corporate organizations causes friction, but is ubiquitous and necessary to the circulation of tools, people, and ideas within research communities.

Conclusion: New research fields (such as nanotechnology) emerge in response to the combination of external pressures on the research system and demographic, social, intellectual, and technological pressures arising within pre-existing fields.

Mody, C. C. M. (2011). *Instrumental Community: Probe Microscopy and the Path to Nanotechnology*. Cambridge, MA: The MIT Press. ISBN: 9780262134941

What Explains China's Low and Fluctuating International Collaboration Rates?

Problem

- China's nanotech research output grew exponentially between 1990-2010.
- Chinese scientists were involved in fairly few international collaborations.
- This reduced international collaboration rates in global nanotechnology research.

Theory

We suggest that China is following a two-phase process of scientific capacity building outlined by Stichweh based on European experience in the 18th and 19th centuries. Stichweh, R. (1996). Science in the system of world society. *Social Science Information*, 35, 327-340.

Nationalist Phase

Democratize Science

Build national scientific institutions

Develop comparative advantages



International Phase

Reemphasize quality over quantity

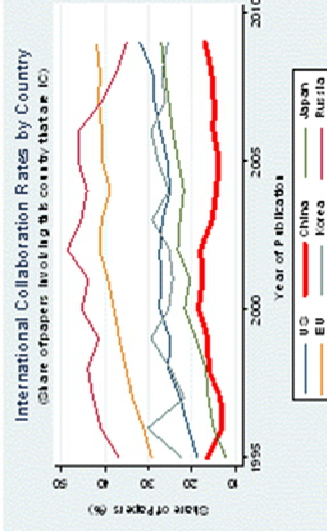
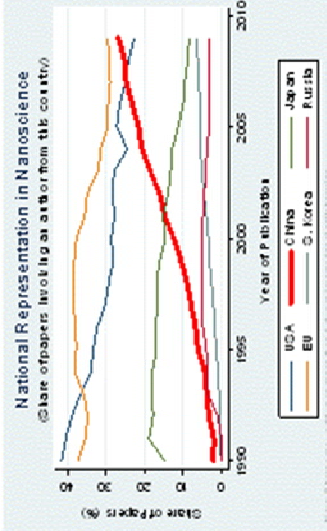
Some national institutions achieve global excellence

Exploit comparative advantages through IC.

Findings:

Seven ways that China's nationalist phase resembles Europe's

- Increased emphasis on science in mission of educational institutions.
- Growth of science around national centers of excellence.
- Development of distinctive comparative advantages.
- Temporary shift towards domestic collaboration.
- Temporary increase in bilingual journals.
- Specific geographic areas become sites for penetration of international science.
- Voluntary turn to the vernacular language.



Conclusion

Having undergone its transitional inward-looking phase in the 2000s, China's engagement with the international scientific community is now turning up again. This process seems likely to continue as its research capacity matures.

Mehta, A., Herron, P., Motoyama, Y., Appelbaum, R., and Lenoir, T. (2012, forthcoming). Globalization and deglobalization of nanotechnology research: The role of China. *Scientometrics*.

CNS-UCSB Partners with Universidad Autónoma de Zacatecas to Study U.S.-Mexico Nanotechnology Research Collaborations

Project Overview

This project seeks to uncover and explain nanotechnology collaboration projects between Mexico and the U.S through an analysis of:

- Funded nanotech projects featuring collaboration.
- Work done to improve collaborative ties between countries in the nanotech industry.
- Collaboration between individual research centers.

Methods

- Scouring Mexican nanotech research center websites for funded collaboration projects with nanotech institutions in the U.S.
- Surveying the policy work done by the Fundación México-Estados Unidos para la Ciencia (FUMEC), to improve U.S.-Mexican scientific collaboration.
- Surveying all international collaborations administered by Mexico's Consejo Nacional de Ciencia y Tecnología (Science and Technology National Council, CONACYT)

Main Findings

- The majority of the Mexican projects have only short-term funding or collaboration contracts with American counterparts.
- Most collaboration is between Mexico and projects located in border states
- Grant projects are often geared toward US interests, not Mexican interests because they are often administered by American counterparts.

Conclusion

There are few opportunities for bilateral collaboration between countries in the broad nanotech area – and those that do exist tend to involve seed funding.

Future Research

How will collaboration projects continue to develop over time? Will they shift closer to Mexican approaches? What will be the eventual results in terms of research, products, and business development?

Project Leaders

Rich Appelbaum

UCSB McArthur Chair and Professor

Global & International Studies and Sociology

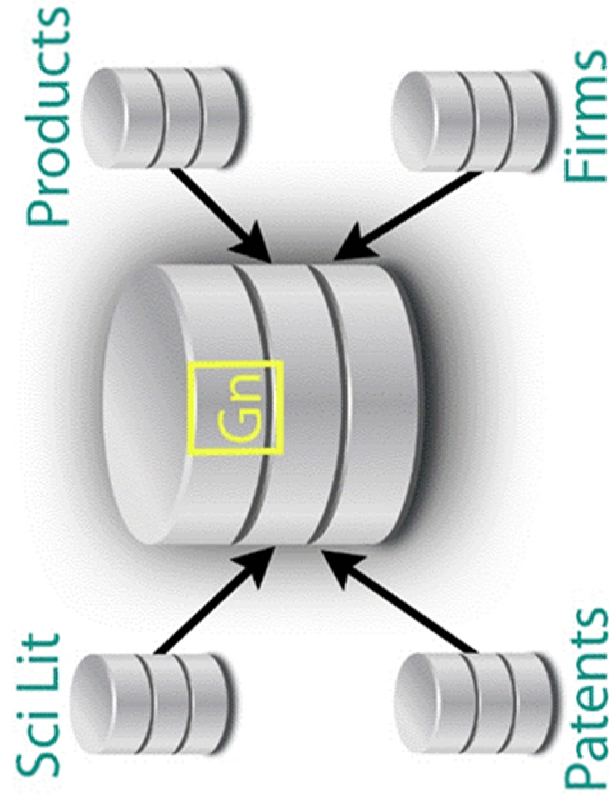
Guillermo Foladori

UAZ Professor, Development Studies

Research funded through an award from the UC Mexus-Conacyt and the U.S. National Science Foundation



Globonano (Gn) Database



- **Scientific literature**
 - ~650,000 nano articles
 - 1975-end 2011 for 40+ countries
 - update: 2000-2011 for 65+ countries
 - adding funding data
- **Patent data**
 - EPO PATSTAT
 - 83 countries
- **adding Commerce:**
 - *Products and Firms*
 - ~3000 firms
 - ~5000 products
 - VC data (Kenney)

•Research projects:

- comparative global nanoscience production
- star nanoscientists
- “Globalization and de-globalization in nanotechnology research: China” (Mehta, Herron, Motoyama, Appelbaum, Lenoir, *Scientometrics*, 2012)

CNS-UCSB International Collaboration with the UK



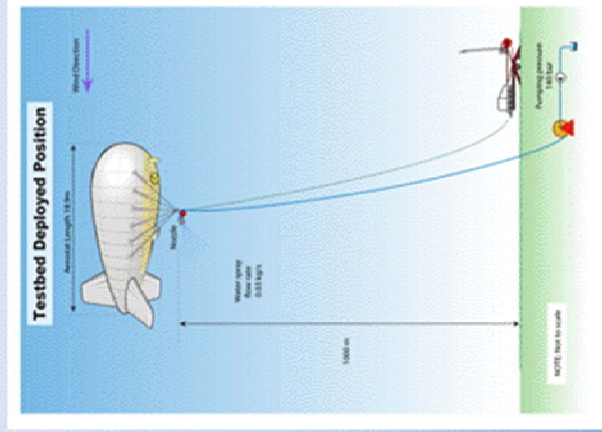
IRG 3: April 2011-March 2012

- Editing of Special Issue of *Risk Analysis* on Nanotechnology Risk Perceptions (with Harthorn & Satterfield)
- Exploring relevance of CNS work on 'upstream' risk perceptions for the issue of climate geoengineering
- Analysing new deliberative data on public perceptions of solar radiation management (the UK's SPICE project)

Deliberating Geoengineering

Aim: Explore public responses to stratospheric aerosols for solar radiation management and the SPICE deployment mechanism.

Methodology: Modified CNS-IRG3 workshops lasting 1.5 days (in Cardiff, Norwich, Nottingham). Participants were navigated through several stages which funnelled down from climate change, to specific geoengineering approaches, to an aerosol deployment mechanism (the SPICE stratospheric aerosols 'test-bed' trial see Figure).



Findings: Few participants were comfortable with the idea of solar radiation management as a response to climate change – although limited research was not ruled out if research governance concerns could be addressed.

Figure Copyright:
Hugh Hunt (used with permission)

Impacts: The public dialogue work was used by the UK's Science and Engineering Research Councils in a 'responsible innovation' process for evaluating the SPICE proposal.

Pidgeon, N, et al. (in press) Exploring early responses to geoengineering.
Philosophical Transactions of the Royal Society (A).
Pidgeon, Parkhill, Corner and Vaughan.
(under review) Deliberating stratospheric aerosols for climate geoengineering.

Nanotechnology Risk Perceptions and Communication: Emerging Technologies, Emerging Challenges

CNS Santa Barbara International Workshop, January 2010

International Contributions: US, UK, Canada, Switzerland, Germany

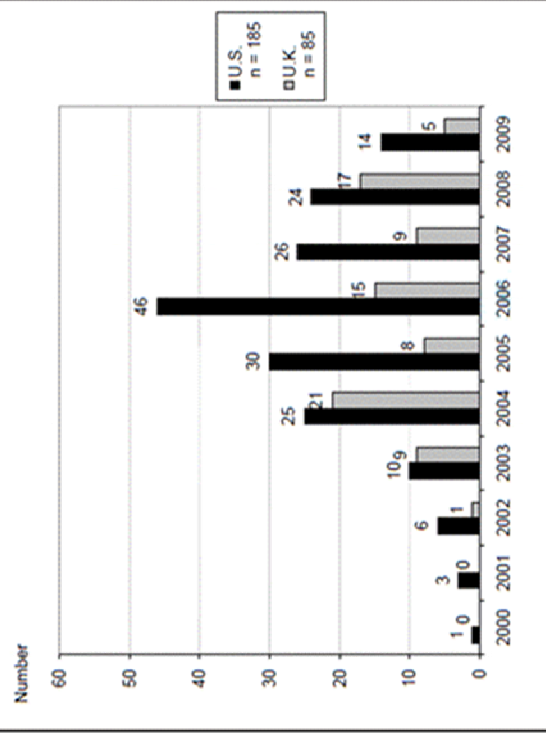
Topics: Newspaper Coverage, Emerging Perceptions, Vulnerability Justice and Fairness, Labelling Impacts, Risk Communication, Methodologies for Researching 'Upstream' Perceptions

Priest et al.

Table II. Panelist's Perceptions of the Main Risks of Nanotechnology

Perceived Risk	Panelist Responses	Percentage
Unexpected consequences, harmful side effects, nano effects unknown	28	36.8%
Weaponization, possible terrorism, end up in the wrong hands	10	13.2%
Medical and health issues, cancer agent, water contamination, health side effects	7	9.2%
Invasion of privacy	4	5.3%
Lack of control over nanotechnology	4	5.3%
No perceived risks at all	4	5.3%
Expense, cost too much to develop, government will spend too much on it	3	3.9%
Technology may not work, products may malfunction	2	2.6%
Displacement of workers	2	2.6%
Nano chemicals may be unstable	2	2.6%
Other	10	13.1%

Inter-rater reliability measured using Scott's Kappa, $k = 0.87$.



Siegrist and Keller

Experimental stimulus used: lotion shown with 'Nanoparticle' label



Pidgeon, N., Harthorn B., and Satterfield, T. 2011. "Nanotechnology Risk Perceptions and Communication: Emerging Technologies, Emerging Challenges. *Risk Analysis*. 31:1694-1784

Deliberating Nanotechnologies in the US:

Gendered Beliefs and Patterns of Speech in Public Deliberation

Gender, Risk, and Equitable Participation: Analysis of Speech and Discourse¹

Six deliberative workshops conducted Fall 2009 in Santa Barbara, CA. Focused on nanotechnology in

- 1) Energy/Environment
- 2) Health/Human enhancement



Results:

- Men spoke 28% more than women ($p = .02$)
- Men used more intrusive interruptions than women ($p = .07$), and white participants used more intrusive interruptions than others ($p = .01$)
- Women used more backchannels than men, particularly in health contexts ($p = .01$)
- Individuals who move towards a benefit stance on nano use more backchannels than those who do not change ($p = .04$)

Views on health and food nano applications

Health applications²

- High levels of hope and hesitation for nano in health.
- Ambivalence not necessarily a transitory state; complex risk/benefit views
- Ambivalent statements voiced more by people of color and women



Food applications³

- Nano for food/food packaging raised most discussion less certainty of benefits, consistent with many nano survey findings
- All-women deliberation particularly skeptical of nano for food
- Food a particularly 'sacred' cultural domain, makes people uneasy about technological modifications

¹Harthorn, B.H., Rogers, J.B., Shearer, C., Denes, A., Cranfill, R., Hanna, S., Martin, T., Hurt, I.

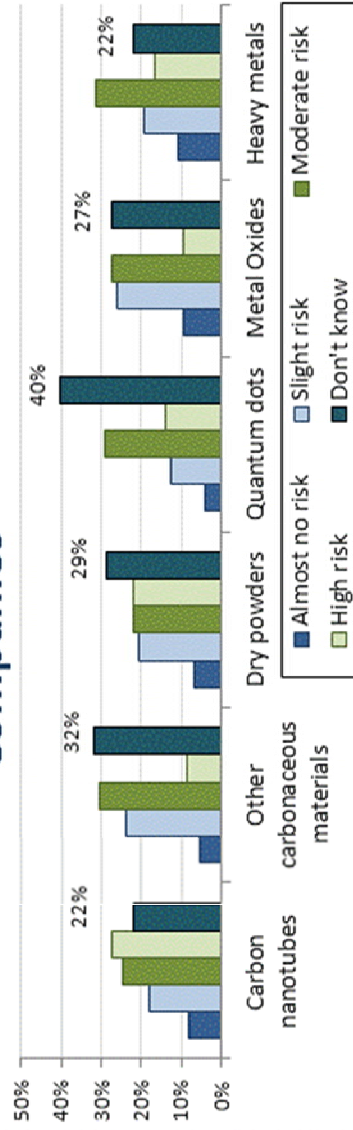
²Barbara Herr Harthorn, Christine Shearer, and Jennifer Rogers-Brown. 2012. "Exploring Ambivalence: Techno-Enthusiasm and Skepticism in US Nanotech Deliberations," *Quantum Engagements* (IOS Press).

³Jennifer Rogers-Brown, Christine Shearer, and Barbara Herr Harthorn. 2012. "From Biotech to Nanotech: Public Debates about Technological Modification of Food." *Environment and Society: Advances in Research*, Volume 2.

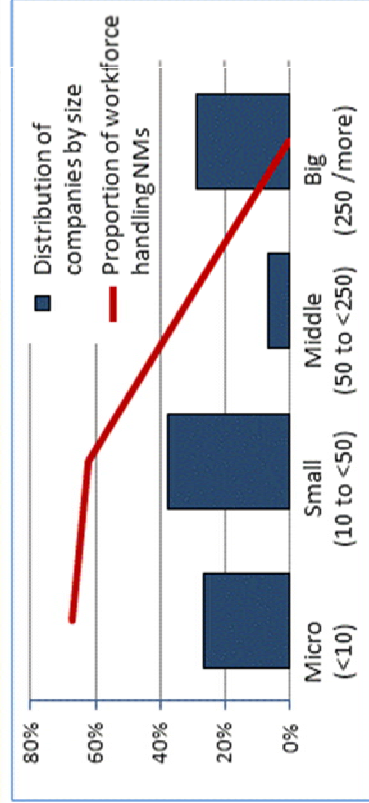
IRG 3 International Survey of Private ENM Companies

Key findings → more direct regulation needed

- Majority (61%) cited "lack of information," but their reported practices indicate inconsistent uptake of government recommended practices
- Participants reported high levels of uncertainty about ENM risks
- **Despite reported lack of information and uncertainty about ENM risk, a majority of participants expressed preference for autonomy from regulatory agencies**



Engeman, Baumgartner, Carr, Fish, Meyerhofer, Satterfield, Holden, & Harthorn. (2012). Governance implications of nanomaterials companies' inconsistent risk perceptions and safety practices. *J Nanopart Res* 14(3):749-760.



Engeman, Baumgartner, Holden, & Harthorn. (2012). Hierarchies of practice and the US Nanotechnology Workplace. In Prep.

Key findings → more direct regulation complicated

- Reported handling 26 types of nanomaterials
- Small proportion of workforce (0.2%) reported to actually handle ENMs
- Reported implementing all elements of a hierarchical approach to risk management but only to the extent that practices were general chemical hygiene practices
- Results suggest diminishing responsibility for safe handling toward product end-of-life
- **Implementing and enforcing nano-specific practices complicated by wide variety of ENMs handled and elusive character of the industry**

Affective neutrality in response to nanotechnologies

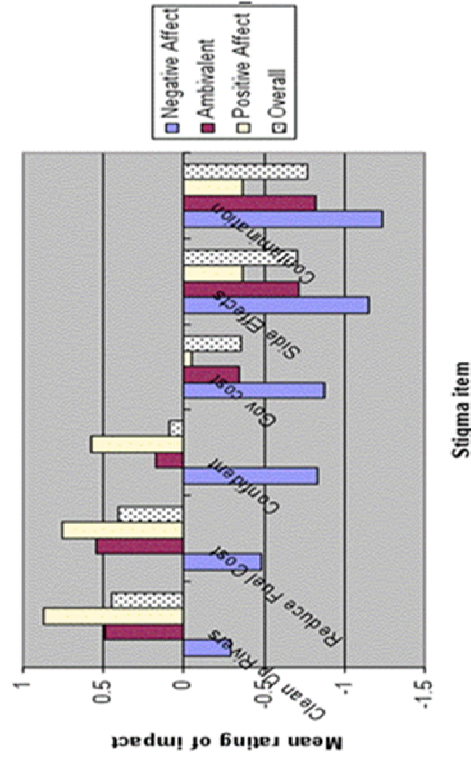
Aims :

Negative affect predicts high perceived risk, but as most are affectively neutral in response to ENMs:

- How does this 'neutral' group view nanotechnologies in response to + and – news stories as compared to negative v positive affect groups?
- How do those now affectively neutral compare across known predictors of risk perception?

	Affectively -ve group	Affectively +ve group	Affectively ambivalent group
Expert risk	0.13 (0.188)	0.146 (2.4)*	0.092 (2.22)*
Controllability	-0.40 (-0.55)	0.012 (0.197)	0.031 (0.755)
Bodily invasion	0.122 (1.72)	0.201 (3.3)**	0.243 (5.88)***
Social justice	0.244 (3.44)**	0.213 (3.49)**	0.198 (4.81)***
R ²	0.059	0.097	0.108
Adjusted R ²	0.054	0.086	0.103

t-values are shown in parentheses *p<0.05, **P<0.01, ***p<0.001
Standardized regression coefficients from a series of three linear regression analyses (affectively negative, positive and ambivalent participants).



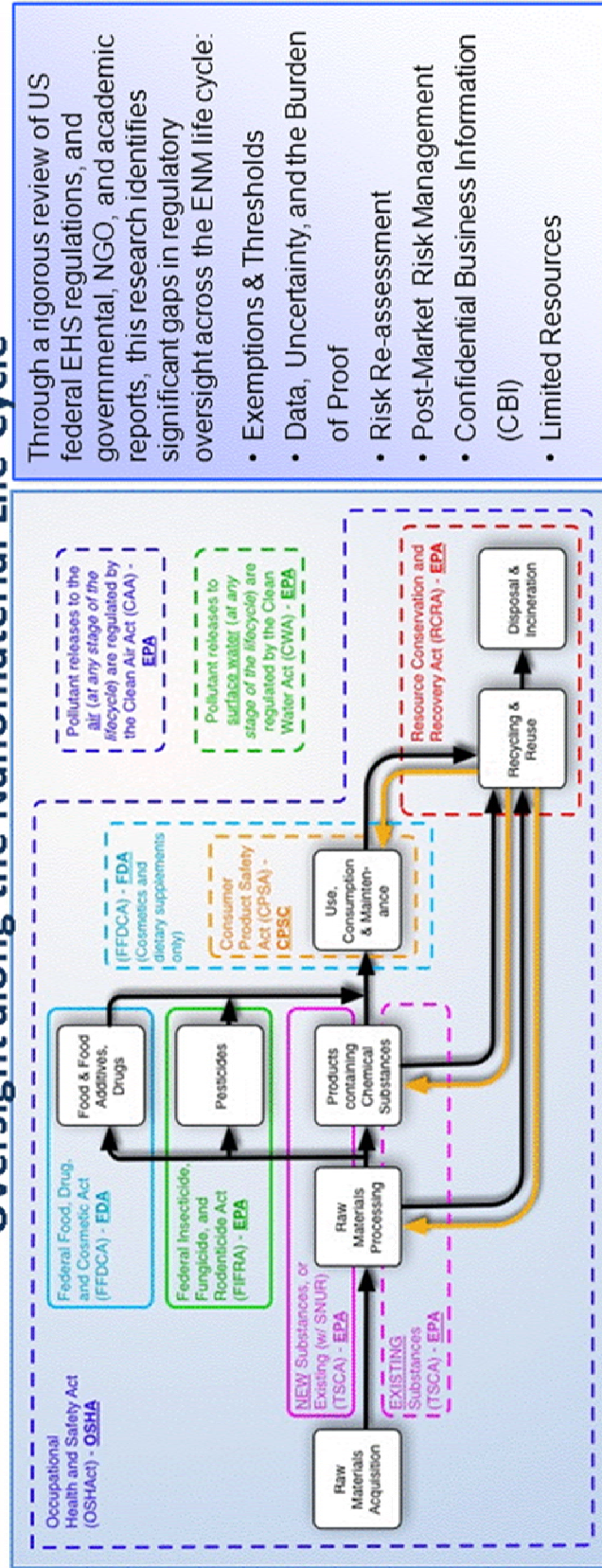
Methods

- U.S. National survey (N=1,100)

Main Findings :

- High levels of uncertainty or ambivalence about nanotechnologies.
- Those reporting negative affect would stigmatize nanotechnologies even in positive scenarios (e.g. river cleanup improving salmon health).
- Regression analyses show greater effect of risk predictors for affectively ambivalent respondents.

From Cradle-to-Grave at the Nanoscale: Gaps in US Regulatory Oversight along the Nanomaterial Life Cycle



Closing the Gaps – Changes in progress:

- Proposed TSCA reform: Limiting CBI, Manufacturer minimum testing, Improving EPA authority to require testing
- Nano-specific SNURs (CNTs, several ENM categories)
- Proposed definition for 'special substance characteristics' – to differentiate between nano and non-nano forms of materials

Additional Recommendations:

- Reduce End-Of-Life gaps – rapid development of monitoring and control technologies, proactive/preventative risk mitigation
- Enhance collaborative efforts, promote product stewardship
- Increased disclosure & sharing of product and risk information

Beaudrie, Kandlikar, Satterfield 2012. In Review, ES&T.

CNS-UCSB Joins CNS-ASU in Co-Hosting

International Conference on Emerging Technologies and Society

Third Annual Conference of the Society for the Study of Nanoscience and Emerging Technologies (S.NET)
November 7-10, 2011
Tempe, AZ



Conference Statistics

More than 200 international scholars from a broad range of academic disciplines and intellectual perspectives met to discuss innovative research approaches and findings exploring the ethical, legal, and societal implications (ELSI) of nano and other new technologies.

205 scholars
19 countries
44 panels
6 plenary sessions
24 posters

Participants included: social scientists, humanists, scientists, engineers, and industry practitioners.

<http://www.cns.ucsb.edu/SNet2011>



CNS IRG2 Faculty and Student Researchers at S.NET 2011

About S.NET

- Founded in 2008 by members of the NSF Network for Nanotechnology in Society
- An interdisciplinary society promoting intellectual exchange and critical inquiry about the societal implications of emerging science and technologies
- Fields of interest include nanoscale science and engineering, biotechnology, synthetic biology, cognitive science, and geoeengineering

Traveling Technologies: An Innovative Global Value Chain Approach to Teaching Nanotechnology's Societal Implications

Overview

- Traveling Technologies is a curriculum developed for an 8-week college summer internship program but useful in other educational contexts
- Students work in teams to critically analyze the societal impacts of a nanomaterial by tracing the journey from origins and raw state to finished product or application
- Teaches roles of firms, countries and products involved in bringing a product from concept to commercialization
- Provides tangible outcome in the form of a diagram useful for educating and communicating issues to stakeholder audiences
- Structure and approach easily adaptable to student level and numbers

Figure 1: Traveling Technologies Project Overview

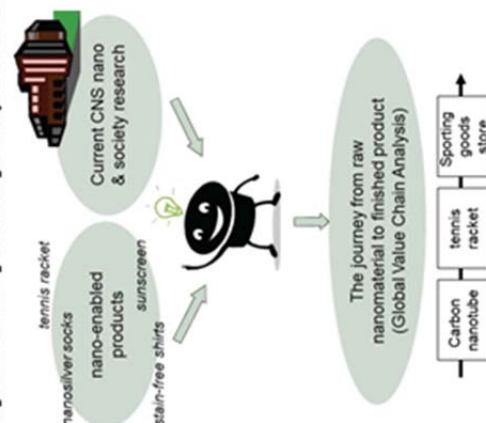


Figure 2: General nanotechnology value chain

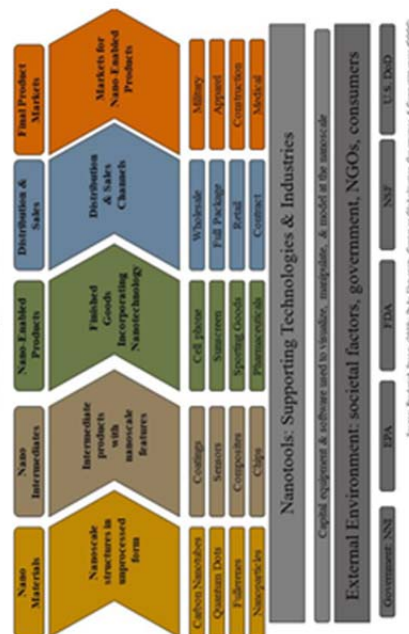


Figure 2: General nanotechnology value chain

Project Components

- Nanomaterial case study
- Research question addressing a societal, ethical, or legal impact
- The Global Value Chain Framework for investigation and analysis
- Final presentation of results

Dillemath, J., Frederick, S., Parker, R., Gereffi, G., & Appelbaum, R. (2011). Traveling Technologies: Societal Implications of Nanotechnology Through the Global Value Chain. *Journal of nano education*, 3, 36-44

Table 1. Possible Research Questions Addressing Societal Impacts of Carbon Nanotubes (CNTs)

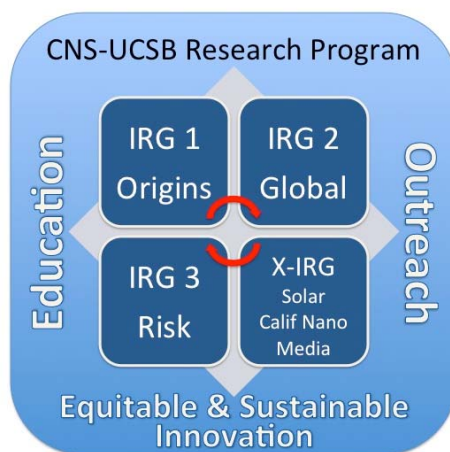
Areas of Societal Impact	Research Questions
Intellectual property & technology transfer	Are there patterns in the distribution (univ., industry, govt.) of CNT intellectual property (IP) in the US? How is IP related to innovation?
Risk & risk perception	What are the risks & regulatory frameworks for CNTs in medical applications, and what are the broader implications of these?
Media framing & the public sphere	What are the dominant frames in nano news stories, and what is the potential impact of public perception on CNT?
Globalization, nano in China	Which companies & countries dominate the CNT industry, and what are the implications for the global economy?

8. STRATEGIC RESEARCH PLAN

The Center's research program is designed as a systematic analysis of historical and contemporary aspects of nanoscale science and engineering (NSE) policy and innovation systems for successful commercialization, globalization as a key factor in comparative economic development in East and South Asia, Europe & Latin America, and emerging regulation and social perceptions of 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: **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 elsewhere in E. and S. Asia, and now in Latin America, to ask how different industrial policies, in combination with international cooperation and collaboration among researchers, shape distinctive nanoscience and industry outcomes; **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, Nano in California global value chain project on nano industry, media framing of nanotech, nano lab ethnography). Together these provide a comprehensive understanding of current processes for successful development, commercialization, and global distribution of nanotechnologies. CNS-UCSB uses a strategic mixture of social, cultural, economic, political, and historical methods to address these issues at different scales, temporal frames, and resolutions. The composite picture of the emerging and growing nano-enterprise 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 and a global framework for analysis.

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 expertises in examining industrial policies and their effects on nano development in East Asia; IRG 2 & 3 plan future 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, is looking at the policy history of both energy and EH&S issues

with regard to nanotech. IRG 2 is engaged in a comparative study of national policies aimed at promoting nanotechnology research, development and commercialization in the U.S., China, Japan, Mexico, and – in coming years – other Latin American countries. It is also centrally concerned with workplace health and safety issues, an area it plans to pursue in connection with IRG 2 leader Appelbaum's MacArthur Chair, which is focused on labor conditions in the Pacific Rim. IRG 3's research is moving further into experimental design modes to conduct multifactorial analysis of the drivers of emerging nanotech 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. New deliberative work funded by an NSF award 2008-2011 to PI Harthorn has allowed a closer focus on gender as a factor in risk perception and interactions in small group deliberative settings. The MacArthur Chair awarded in 2010 to IRG 2 leader Appelbaum enhances CNS focus on jobs, job creation, and workplace safety issues that are also a focus of IRG 3 research. IRG 1 leader McCray and collaborator Mody received a prestigious collaborative research fellowship from the American Council of Learned Societies for 2010-11. Funding to Harthorn, Satterfield & Kandlikar from the UC Center for Environmental Implications of Nanotechnology, 2008-2013, is producing new 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 (US, EU, E 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 CNSI, 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 network of nanoscientists and ecotoxicologists provide us with a strong web of connections to the NSE, nanotoxicology and materials research communities. The years ahead will serve to further develop and strengthen these ties, through joint activities such as collaborative summer internship programs; public, community and campus events and programming; community college and on-line course development; and many other means. These connections, and the highly interdisciplinary exchanges that result from them are absolutely essential to the fulfillment

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 possibly unique context for this experiment.

The integration, aggregation and synthesis of research results in the CNS-UCSB take a number of forms. Years 1-6 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, enable 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 6.5 years of research. For example, this year IRG 3 has produced a special issue of a leading journal on nanotechnology risk perception (Pidgeon, Harthorn & Satterfield, 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, forthcoming 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). Newfield's innovation X-IRG group hosted a workshop on global nano 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 are developing an edited volume focused on the pressing economic development issue of *Can Rich Countries Still Innovate?* (Newfield & Boudreaux). 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 of that into an edited volume just 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.

In addition to the increasingly prolific production and dissemination of research results from individual IRGs via peer-reviewed journals, book chapters and pieces to many different kinds of audiences, CNS-UCSB also has produced an edited volume with the title *The Social Life of Nanotechnologies*, edited by Harthorn and sociologist Mohr, now in the final stages of production by Routledge (forthcoming, June 2012). The volume brings together original work from all three IRGs, 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) has 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.

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 nanoenabled 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 as the preferred approach. Meanwhile IRG-1's work shows a trajectory of nanotechnology over a span of time which encompasses the Cold War, post Cold War and immediate post-9/11 era. And the CNS-UCSB NanoEquity 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.

9. RESEARCH PROGRAM, ACCOMPLISHMENTS, AND PLANS

IRG 1: Origins, Institutions, and Communities

W. Patrick McCray , lead	History	UC Santa Barbara
Cyrus Mody	History	Rice University
Hyungsub Choi	History	Seoul National University (beg. Sept. 2011)
Joseph November	History	Univ. of South Carolina
David Brock	History	Chemical Heritage Foundation
Sarah Kaplan	Business	University of Toronto
Mara Mills	History	New York University
Ann Johnson	History	Univ. of South Carolina
Takushi Otani	History	Seoul National University

1 Postdoc, 2 Grads, and 3 Undergrads

Postdoctoral researchers: Matthew Eisler, History

Graduate students: **Social science/humanities**
Roger Eardley-Pryor, History
Brittany Shields, History, U Penn

Undergraduate students: UCSB: Sabrina Wu
UCSB: Nick Santos
College of the Canyons (community college): Sergio Cardenas

1. Introduction

The Origins, Institutions, and Communities group (IRG 1) establishes the historical contexts for the emergence of nanotechnology as a research field, a component of US science policy, and an element in popular imaginings of future technologies. Together with funded colleagues at Rice University, the University of South Carolina, the Chemical Heritage Foundation, and Seoul National University, IRG 1 explores topics related to nanotech's history, including research policies for micro/nanoelectronics, what the historical context is 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, and the emergence of new research areas such as DNA nanotechnology.

2. Goals

Reliable knowledge about nanotechnology's contemporary social, economic, and policy implications must be based on a comprehensive and robust understanding of its historical contexts. 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 nano's potential. Those borrowings shape how nanotechnology is done, perceived, and regulated. Our work will 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. 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.

Our research group in the period March 2011-March 2012 was composed of: **W. Patrick McCray** (Professor of History, UCSB); **Cyrus Mody** (Asst. Professor of History, Rice University); **Joseph November** (Asst. Professor of History, University of South Carolina) and **Hyungsub Choi** (Seoul National University as of Sept. 2011) and David Brock (Chemical Heritage Foundation). We had the participation of CNS Graduate Research Fellow Roger Eardley-Pryor. We also had contributions from three unfunded collaborators: Sarah Kaplan, Mara Mills, and Ann Johnson. It is hoped to expand their contributions in the next funding cycle via seed grants. Finally, Postdoctoral Scholar Matthew Eisler continued into the second year of his postdoctoral position; he is mentored by **McCray** and is affiliated with IRG 1. In September 2011, Eisler left CNS to assume a new post at Chemical Heritage; we hope to appoint a new postdoc at some point in the near future. So far as growth, we feel the size of the group is near-ideal and brings together a group of researchers whose diverse research interests overlap in key ways with regard to nanotechnology.

In Year 7, IRG 1, despite its relatively small size in CNS, continued its established pattern of productivity. This included:

- 15 books, articles, or essays published or have been accepted for publication
- 11 works that have been submitted for publication or are in preparation

In addition, funded researchers from IRG 1 gave some 22 talks at conferences and other forums in the United States and abroad.

3. Rationale, Approach and Organization of IRG 1: In the last several years, IRG 1 has emerged as the largest and most active groups 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 continued research focuses 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, organizational practices in universities, corporations, and government agencies, and broader context such as international security threats and industrial competition. We seek to investigate a broad range of questions within these three themes. These include: How have the research policies for micro/nanoelectronics in the U.S. compare with those of other Pacific Rim nations? What is the historical context for interdisciplinary research in U.S. research institutions and to what degree is it manifested? How have federal research policies helped foster the growth of new areas of research that bridge the physical and life sciences?

British historian Lord Acton said, "Method makes the historian." History is a science in a broad, qualified sense, though not an exact science. Its empirical method makes history a social science, and its critical narrative aligns history with the humanities. Academics view history as a dynamic process and interpret history as a story of the past that remains in constant dialogue with the present.

IRG 1, due 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 Area 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.

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.

4. Major IRG 1 Research Accomplishments in the Center

IRG 1 produces and integrates a diverse range of historical sources and research tools in order to understand specific facets of the nano-enterprise's history. Since our last report, we have expanded our research focus on nano-bio to include a pilot study of "DNA nanotechnology," for example. Finally, research from our group was included in various ways in our classroom undergraduate teaching; **Mody**, **November**, and **Choi** all offered instruction on the history/sociology of technology which included some nano-themed topics. IRG 1 research is detailed below according to various research areas.

IRG 1-1: Nanotechnology and the Pacific Rim Hyungsub Choi, Takushi Otani

This project, within the context of IRG 1, is an investigation of the formation of the South Korean nanotechnology enterprise and the historical precedents that contributed to its rapid ascendancy. Toward this goal, **Choi** has conducted some field research at the National Nano Fabrication Center in 2011 and continued to network with South Korean practitioners and observers of nanotechnology. Follow-up on this project has been put on hold in light of **Choi's** relocation to his new position as Assistant Professor of Science & Technology Studies at Seoul National University, effective September 1, 2011.

As part of this project's focus on South Korea's recent and rapidly expanding nanotechnology infrastructure, **Choi** conducted a week-long visit to the National Nano Fabrication Center (NNFC), in Daejeon, Korea. The NNFC is the first and largest shared facility in Korea that provides silicon-based nano instrumentation and characterization services to academia, industry, and government laboratories around the country. Established in 2004 with funds from the Ministry of Science and Technology (renamed the Ministry of Knowledge Economy), the city of Daejeon, and local industrial partners, the NNFC is now slated to become fully self-supportive by 2012.

Choi has also started participating in a Korean research project on "convergence science" that aims to analyze the character and policy of interdisciplinary collaboration – ranging from cognitive science to nanotechnology. He has presented the results of the research conducted for Area 3 (Institutions of Interdisciplinarity) to the research seminar series of this project group. As part of this project, Choi has received funding to study the characteristics of the Korean nanotechnology enterprise, beginning in the spring of 2012.

Leveraging his position in the Department of Materials Science and Engineering, **Choi** is networking with key nanotechnology practitioners. One of them is Ki-Bum Kim, who has been the "Mike Roco" figure in South Korean nanotechnology policymaking. **Choi** plans to use Kim as an entry point to the Korean nanotechnology community.

Continuing the earlier IRG 1 research project on “Semiconductor Technology and the Path to Nanoelectronics” (as it was called in Phase 1, from 2006-2010) **Choi** is continuing this research on the history of Japanese semiconductor technology. The aim is to complete the book manuscript by the end of calendar year 2012 and submit it to the MIT Press. Two articles will appear in early 2012: one on the history of Japanese IC development in the IEEE Annals of the History of Computing (with Takushi Otani); and the other on the semiconductor industry’s strategies to deal with “technological uncertainty” in *Revue d’Histoire Moderne et Contemporaine* (with Christophe Lecuyer). The former has been accepted and in press (to appear March 2012); the latter has been accepted and is currently being translated into French.

IRG 1-2: Pioneers of Nanotechnology (Oral History Project)

David Brock, **Patrick McCray**

The development of nanotechnology in the late twentieth and early twenty-first centuries has left very few traces of the sort that historians have relied upon: paper manuscripts and documents. Communications have increasingly taken ephemeral electronic forms, as have reports, data, and other documentation. To help remedy this, since 2005 IRG 1 has been documenting the nano-enterprise with oral histories.

In May 2011, Brock conducted a multi-hour oral history with electron microscopy and microfabrication pioneer Thomas Everhart -- a former professor at UC Berkeley and president of Caltech. **Cyrus Mody** participated in the preparation for and conduct of the oral history. The oral history has been transcribed and ready for further processing once signed release forms are returned from Everhart.

The first two oral histories, with Thomas Everhart (former president of Caltech and a pioneer of electron microscopy) and with James Von Ehr (the software developer turned early nanotechnology entrepreneur), have moved through transcription and editing, and are now in the hands of the interviewees for review.

In this period, Nadrian Seeman was selected as a third oral history interviewee for his spearheading of the growing field of DNA nanotechnology. Brock and **McCray** developed an extensive question list for the Seeman interview, which was conducted by **McCray** in December 2011. The interview recordings are being transcribed and edited.

Brock is now considering possible oral history interview candidates in the areas of biological or medical nanotechnology, that is, the application of nanotechnology approaches to biological and medical intervention. Such an oral history would make a highly useful companion to the Seeman interview for comparison and contrast.

IRG 1-3: Institutions of Interdisciplinarity

Cyrus Mody, Hyungsub Choi, Mara Mills, Sarah Kaplan, Brittany Shields

This research stream of IRG 1 will examine how U.S. institutional forms from the distant past shaped current nano policies. Our 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. This project currently consists of two related sub-projects largely carried out by **Mody** and **Choi** with some collaboration with **Mills**; in late 2011, **Kaplan**’s project on interdisciplinarity was added as a seed project.

The first sub-project (IRG 1-3a), led by **Hyungsub Choi**, is titled “The Origins of Academic Interdisciplinarity Research: Emergence and Transformation of Materials Research Laboratories, 1960-1975.” It aims to examine the continuities and discontinuities of interdisciplinary research institutions at the University of Pennsylvania, Pennsylvania State University, and Cornell University; and it explores the interplay between materials (and nanoscale) research and laboratories on these campuses.

Choi spent the several months conducting extensive archival research at the University of Pennsylvania, Stanford, the University of Illinois, MIT, Pennsylvania State University, and the National Archives. Also, in collaboration with Penn graduate student Brittany Shields, **Choi** conducted an oral history interview with Dawn Bonnell, director of the Penn Nano/Bio Interface Center (NBIC). Additional research during summer 2012 at Stanford University and Princeton University will provide the core archival information for **Choi’s** book project on the history of interdisciplinary materials research in the United States.

Choi prepared, submitted, and succeeded in winning an NSF Scholars Award for his project “A Study of Interdisciplinary Research and Training in the United States” (SES-1127663), which developed as a spinoff of **Choi’s** CNS-supported research during the last couple of years. This project, comprised of detailed case studies of early Interdisciplinary Laboratories at Cornell University, University of Pennsylvania, and Northwestern University, will examine three themes: 1) Interdisciplinarity and the Built Environment; 2) Origin of the “Center Mode of Support”; and 3) “Training Interdisciplinary Researchers.”

The second sub-project (IRG 1-3b), led by **Cyrus Mody**, is titled “Building Interdisciplinary Institutions, 1975-2005.” It examines numerous aspects of interdisciplinarity at Stanford, UCSB, and IBM between 1965 and 1985. This includes exploration of electronic music at Stanford in the Vietnam era, research on Stanford’s Center for Integrated Systems, a study of the commercialization of scientific instrumentation research in the UCSB physics department, and a study of the superconducting supercomputer program at IBM in the ‘70s and early ‘80s.

In sub-project Area 3b, **Mody** and others continued ongoing research into interdisciplinarity at Stanford University, including drafting an article on electronic music at Stanford, as well as expanding research into the Center for Integrated Systems at Stanford. Mara Mills assembled a prodigious amount of material on the Optacon, a reading aid for the blind developed at Stanford in the ‘60s. **Mody** also conducted extensive archival research at UCSB on the physics department’s pedagogical experiments and early entrepreneurship during the Vietnam Era. He has now submitted a first draft of an article based on that research for an edited volume. He will conduct follow-up research in the UCSB archives as well as interviews with participants from that era during the May site visit. **Mody** conducted several interviews related to the history of Josephson computing, and also acquired a substantial trove of lab notebooks from IBM’s program in that area. He presented preliminary findings at the 2011 Society for the History of Technology meeting and will write a more polished chapter-length version over the summer.

Mody and **Choi** submitted a draft to *Historical Studies in the Natural Sciences* of an article on interdisciplinary institutions at Cornell spanning from the first Materials Research Laboratories in 1960 to the National Nanotechnology Infrastructure Network today. This article is *the* major expression of the aims of IRG 1-3; it also summarizes much of the argument of the larger projects that will eventually be **Mody’s** and **Choi’s** (separate) second books.

In addition to the above two areas, Kaplan is conducting research (unfunded as of now by CNS)¹ on practices of interdisciplinary research in nanotechnology. Convinced that the nature of today's scientific and technological problems demand interdisciplinary solutions, research policy makers and funders are increasingly demanding coordination among academic disciplines. This has been particularly true in the field of nanotechnology, where patrons demand interdisciplinary research, not just across different scientific or engineering areas but also including the social sciences and humanities. Yet, studies attempting to document the degree of interdisciplinarity in nanoscience and technology outcomes (such as publications) have provided mixed results. Further, research on interdisciplinarity has with few exceptions treated it monolithically as a style of research or research outcome rather than considering the coordination as it happens. It is thus difficult to identify mechanisms of coordination and the consequent policy implications.

Kaplan's project traces the day-to-day activities of researchers in the Nano/Bio Interface Center at the University of Pennsylvania (an NSF-funded university interdisciplinary research center) using ethnographic techniques such as observation, interviews and collection of a wide range of documentary evidence (such as grant applications and instrument signup sheets). Specifically, it explores how interdisciplinary coordination takes place both on the cognitive plane and in the political economy of research, being neither wholly about the generation of creative ideas across disciplines nor about the breaking down of barriers across departments. Drawing from the history and sociology of science literature on interdisciplinarity and matching it with organizational theories about coordination, we have identified the objects (instruments) and boundary spanners (primarily students) who operate at the nexus of disciplines. Kaplan intends this mapping of the research process to provide a framework for understanding tensions in interdisciplinary work and identifying the micro- mechanisms by which change in the management of scientific research occurs. A further extension of this project is examining how these changes in research practices map onto changes in publication patterns, examining the degree of interdisciplinarity in publications by NBIC researchers before and after the creation of the NBIC, and also comparing NBIC-funded projects from other projects (and publications) completed by NBIC-affiliated researchers during the time of the NSF grant.

IRG 1-4: Innovation and Research at the Nanotechnology-Biology Interface **Joseph November, Patrick McCray**

The main focus of this project aims to elucidate the roots of federal agencies' recent efforts to foster innovation and research at the bio-nano interface, will compare early 1960s efforts to rationalize biomedicine via digital computer techniques and 21st century attempts to harness nanotechnology in life science research. Included in this aim, the project will investigate two attempts by the NIH to implement "bioengineering," one launched around 1960 and centered on the then-emerging technology of digital computing, the other launched around 2000 and grounded in today's emerging nanotechnology. Despite such different means, both varieties of bioengineering cast living systems as artifacts and cast those working with such systems as manageable engineers rather than scientists dependent on serendipitous breakthroughs. This project will be grounded in extensive archival research at the NIH, the National Archives' collections, and historical materials available via the NSF and the NNI. It will also draw from data gathered in recorded interviews with personnel and grantees connected to agencies where nano-bio research is supported.

¹ This project is supported by the NBIC through the National Science Foundation NSEC DMR-04-25780 and by the Canadian Social Sciences and Humanities Research Council under grant #410-2010-0219.

Building on the project's initial research trip to Washington DC for archival work at the National Institutes of Health, **November** was, in early October 2011, provided access to NIH material pertinent to this project. This access and photocopies were provided by Richard Mandel, Ph.D., Lead Record Management Specialist, Office of the Director, NIH. Mandel also provided **November** information and contacts at the National Archives essential for finding material there. **November** also acquired from the NIH extensive materials related to attempts to develop nanotechnology for biomedical purposes. This mostly comes in the form of slides from research presentations by NIH and NIH-sponsored researchers to the FAES graduate course, Insights into Nanobiotechnology (BIOCH 319 [Nov-Dec 2007]). **November** used a digital camera to reproduce much of the information in these collections. He estimates that he has examined about half of the relevant material in that archive, and is therefore planning a return trip in the March 2012 in order to complete the work.

In 2011 **November** pursued another lead generated by the initial visit to the NIH and conducted several lengthy discussions with Daniel M. Fox in New York, NY. Fox is the former president of the Milbank Memorial Fund, an influential philanthropic organization which publishes *The Milbank Quarterly*, a major biomedical research journal; since the 1960s, he has also been directly involved efforts by federal agencies to develop/employ emerging technologies in biomedicine, and is the author of several books on this subject. Fox has agreed to be formally interviewed. **November** plans to carry out this interview in March 2012.

November is planning a separate trip to the Washington, DC to examine the archives at the National Science Foundation. **November** is also planning a trip in April or May 2012 to Philadelphia to interview John Clarke, MD, a surgeon who is a leading figure in the Society for Medical Decision Making, one of the groups responsible for promoting computer use among physicians and research. The SMDM, which was founded by Lee B. Lusted, one of my main research subjects for this project, may have records related to Lusted's work in the 1960s. Clarke, who has witnessed the NIH's efforts to harness computers as well as nanotechnology to build what the agency labels as "bioengineering," could provide otherwise inaccessible insight into the parallels between the 1960s efforts and those of today.

In addition to **November's** work on bio-nano, **McCray** started a pilot project called "From Blueprints to Bricks." The goal is to explore the establishment of a research community in the U.S. that does DNA nanotechnology. During this reporting period, **McCray** made multiple research trips to Caltech. He met regularly with people active in the field of "DNA nanotechnology" (a form of nano-engineering that treats DNA not as an information-containing molecule but as a building material). He also attended a conference on the topic in the fall of 2011 at Caltech and interviewed Nadrian Seeman, one of the field's founders in December 2011. This 5-hour oral history was done at Seeman's lab in New York City. **McCray** plans to develop a focus on DNA nanotechnology with the goal toward understanding the field's evolution over time as well as the community of researchers who are active in it.

IRG 1-5 (Nano)Technological Enthusiasm and the Public Imagination **Patrick McCray, Sabrina Wu**

This project utilizes historical case studies to explore how public perceptions of nanotechnology were influenced by its connections with earlier expressions and advocacy of technological enthusiasm in the 1970s and expressions of technological utopias, and how public imaginings of future technologies have intersected with public policy. By examining the political and social context of several exploratory or even fringe technologies—the distinction often rests with the beholder— and the communities of the scientists, technologists, and futurists who advocated

them, this project explicates a clearer understanding of how modern technological utopias emerge, which clearly carries implications for the contemporary nanotechnology regime.

The primary result of this project is production of **McCray's** book manuscript, now titled *The Visioneers*. While some people fear the depletion of natural resources and humanity's impact on the planet others see terrestrial constraints as a challenge and opportunity. The book follows the careers of two "visioneers" who from the 1970s onward imagined, designed, and advocated for a future that could be radically improved through space colonies and nanotechnologies. During this reporting period, **McCray** completed a final draft; it was sent to the press in early 2012 with publication expected late 2012. With the book finished, **McCray** will terminate this line of research, other than attending a final round of conferences to present results.

IRG 1-6 Nanotechnology Narratives and U.S. Environmental, Health, & Safety (EHS) Policies

Roger Eardley-Pryor, **Patrick McCray**, Sabrina Wu, Sergio Cardenas

This research project examines how and why concern over the environmental, health, and safety (EHS) of nanotechnologies developed historically for American policy-makers, scientists, and the public. This project builds on related IRG 1 research by integrating public and policy-maker imaginings of nanotechnology with the development of national and state EHS policies. First, it analyzes how popular utopian and dystopian narratives about nanotechnology have influenced the evolution of nanotechnology-related EHS policies in the United States. And, second, it aims to retrospect so as to prospect. It does so by analyzing historical analogies between earlier technologies and certain nanotechnologies as a guide to the anticipatory governance of nanotechnology.

During this reporting period, Eardley-Pryor conducted primary research on the historical development of nanoEHS policies in the United States; participated in on-going CNS graduate seminars; served as a graduate mentor for an undergraduate research project on the emerging attempts to regulate nanotechnology in California; presented nanoEHS research at several conferences across the United States; and began designing another summer undergraduate research project that he will mentor.

In April 2011, Eardley-Pryor completed archival research on nanoEHS issues in two collections at the Chemical Heritage Foundation (CHF) in Philadelphia, with guidance from his CNS advisor, Prof. **McCray**, and from Dr. Jody Roberts, the manager of CHF's Environmental History and Policy program. This research included analysis and recording of recently donated papers from the Environmental Protection Agency related to nanotechnology, as well as analysis of the personal papers of nanotechnology researcher and Nobel laureate, Richard E. Smalley. He is using this research for a project tentatively titled, "From Promise and Peril to Policy Formation: Toward an Environmental History of U.S. Nanotechnology Policy, 1992-2005."

During the summer, in addition to his on-going participation in the CNS Graduate Research Seminar, Eardley-Pryor served as a graduate mentor to a community college undergraduate student as part of the summer 2011 Internships in Nanosystems Science, Engineering and Technology (INSET) program. INSET brings science and engineering community college undergraduates to UCSB for a directed summer research experience. For the 2011 INSET program, Eardley-Pryor designed a research curriculum aimed at exploring the social and scientific factors shaping the state of California's nascent and evolving policy history regarding anticipatory governance of nanoEHS risks. To complete this project, Eardley-Pryor selected and oversaw the work of Sergio Cardenas, an undergraduate chemistry major from the College

of the Canyons in Valencia, California. Under Eardley-Pryor's supervision, Cardenas used historical analysis of recent scientific studies, government documentation, and public discourse to outline how and why the state of California selected carbon nanotubes instead of other nanoparticles in the state's first nano-specific chemical information call-in to nanotechnology manufacturers.

As part of the research, Eardley-Pryor guided Cardenas's recorded interview of Dr. Jeffery Wong, the chief scientist for California's Department of Toxic Substances Control. Cardenas presented his findings orally and as a poster at UCSB for faculty, graduate fellows, and INSET participants. In October 2011, Cardenas presented his poster at the 2011 SACNAS National Conference in San Jose, California, a conference hosted by a society of scientists dedicated to advancing Hispanics/Chicanos and Native Americans in science.

In September and November 2011, Eardley-Pryor prepared and presented a series of papers at science and technology conferences around the country. In September, Eardley-Pryor presented a paper titled, "Looking Backward to Look Forward: Historical Examples for Nanotechnology's Environmental Future," at the University of South Carolina's conference on The Public History of Science and Technology. The conference explored the interaction of history, science, and the public by asking, among other questions, how historians of science and technology can best interact with policy-makers. In November 2011, Eardley-Pryor presented other iterations of this research at the annual conference of the Society for the Social Studies of Science (4S) in Cleveland, Ohio, as well as in Tempe, Arizona at the third annual meeting of S.NET, the Society for the Study of Nanoscience and Emerging Technologies. At the 4S conference in Cleveland, Eardley-Pryor and IRG 1 postdoctoral researcher, Matt Eisler, co-organized a panel titled "Historical Perspectives of Nanotechnology," with commentary prepared by IRG 1 researcher **Hyungsub Choi. McCray** and Eardley-Pryor are preparing another version of this EHS research for presentation in late March at the 2012 Business History Conference in Philadelphia, Pennsylvania.

The findings in these presentations included historical analysis of spreading radiation from atmospheric nuclear testing, the potential of silent springs from toxic synthetic chemicals, the carcinogenic hazards of asbestos, and the controversies surrounding recombinant DNA research, all in light of their significance to establishing EHS policies for nanotechnology. The deployment of these various historical analogies helped concerns about nanoEHS move rapidly to the forefront of policy discussions in the early 2000s. However, regulators' and policy-makers' inability to recognize how the social construction of their analogies mirrors the social construction of nanotechnology itself has precluded American progress in regulating the safe production, application, and disposal of nanomaterials. This research reiterates the social construction of science, particularly for nanoscience, and it holds important ramifications for the politically and socially constructed realm of regulation, especially as it applies to the EHS regulation of nanotechnologies. It indicates that any attempt to define nanotechnology based only on science as an objective practice actually forestalls needed protections against potentially toxic nanotechnologies for workers, consumers, and the environment.

In 2012, Eardley-Pryor also began preliminary work toward another summer undergraduate research project that he will oversee as a graduate mentor in UCSB's summer 2012 Internships in Nanosystems Science, Engineering and Technology (INSET) program. In light of Eardley-Pryor's earlier archival research, this summer project will explore how visions of nanotechnology as an enabling techno-solution to environmental limits initially blinded policy-makers and regulators to the potential threats some nanoparticles pose to the health of nature. From the 1980s through early 2000s, utopian visions about nanotechnology's imagined environmental

benefits included predictions of nanotechnology's removal of the biological limits of natural resources, the elimination of disease, its healing of polluted ecosystems, and it helping bring *homo sapiens* to a new evolutionary stage of transhumanism. The intern's summer research project would reveal the political influences that these celebratory environmental and health visions of nanotechnology had on American policy-makers and government agencies, while also placing them in much broader and deeper historical contexts. In particular, this project will connect the eco-topian thoughts by nanotechnology promoters like K. Eric Drexler, Ray Kurzweil, and Richard E. Smalley with theories developed in the 1920s by Russian biogeochemist Vladimir Verdansky about the noosphere – an imagined third phase of Earth's evolutionary development that would emerge when humankind, through the technological mastery of atomic processes, creates resources through the transmutation of elements. The project is tentatively titled, "Planet Nano-topia: The Noosphere, Nanotechnology, and Nature."

IRG 1-7: Nanoscale Science and Engineering, Federal R&D Policy, and Energy Conversion Technology

Matthew N. Eisler, **Patrick McCray**

This research project investigates the relationship between the history of nanoscale science, engineering, and technology (NSET) and the history of United States science and technology policy, with an emphasis on energy and power source research and development. Having assembled, analyzed, and synthesized archival materials, secondary sources, and oral history interviews in a series of draft articles in the previous reporting periods, Eisler spent the current reporting period revising and refining these articles in preparation for publication.

In this period, Eisler completed final revisions of his book manuscript *Overpotential: Fuel Cells, Futurism, and the Making of a Power Panacea*, which explores the history of futurism and the materials sciences of fuel cell research and development (including nanoscale science, engineering, and technology). This book will be published by Rutgers University Press in 2012.

In April 2011, Eisler published (with first author Yasuyuki Motoyama) a refereed article reassessing national NSET productivity in *Technological Forecasting and Social Change*. In May 2011, Eisler published an article in *Science Progress* on use of nanoscale science, engineering, and technology in power source R&D, focusing on the emergence of the lithium-ion battery industry in the U.S. That May, he also completed revision of an essay on the origins of nano for an edited collection entitled *Nanotechnology and the Public: Risk Perception and Risk Communication*.

Throughout this period, Eisler revised an article exploring the history of nanotechnology in the Department of Energy for resubmission to the journal *Minerva*. Concurrently, he revised an article assessing the history of nanotechnology and U.S. science policy for an edited collection organized by the Center for Nanotechnology in Society-UCSB entitled *The Social Life of Nanotechnology*.

In late 2011, Eisler accepted a postdoctoral fellowship at the Chemical Heritage Foundation, where he has continued to investigate the history of nanoscale science, engineering, and technology and United States science and technology policy in the energy and power source sectors. Utilizing oral history interviews and archival sources, he began an investigation of the history of start-up energy and power source companies utilizing NSET, building on work conducted at the CNS-UCSB. He will continue to be affiliated with the CNS's IRG 1.

On February 16-18, 2012, Eisler conducted an oral history of Mihal E. Gross, program manager of the Nanoscale Science Research Centers and E-beam Microcharacterization Centers of the Office of Basic Energy Sciences in the Department of Energy.

5. Broader Impacts of IRG 1

Understanding nanotech's societal implications is predicated on possessing a clear and comprehensive understanding of its historical context. The research IRG 1 does contribute to the larger social history of nanotechnology and its ancillary institutional, instrumental, and intellectual adjuncts. Work done in the past 12 months contributes to a more comprehensive and holistic narrative of nanotech's trajectory. This history will ultimately trace the 50+ year arc of nanotechnology's history from its origins in the materials science community in the 1950s and 1960s. It will then follow through new instrumental developments at places like Bell Labs and IBM in the 1970s to major discoveries in the 1980s like the invention of the buckyball and the STM and, eventually, the creation of a vast transnational infrastructure for doing interdisciplinary research in the 21st century. This history will be accessible, valuable and relevant not only to our historian colleagues but also to scientists, engineers, and policy makers.

IRG 1 Publications 2011-2012

Primary Publications: Journals

1. **Choi, Hyungsub**, & Otani, Takushi. (2012). Failure to Launch: Tarui Yasuo, the Quadrupole Transistor, and the Meanings of the IC in Postwar Japan. *IEEE Annals of the History of Computing*, 34(1), 48-59.
2. **Choi, Hyungsub** and **Takushi Otani**. (2012). "The Meanings of the Integrated Circuit in Postwar Japan: Tarui Yasuo and the Quadrupole Transistor," *IEEE Annals of the History of Computing* 34(1) (January – February 2012): 48-59.
3. Lécuyer, Christophe, & **Choi, Hyungsub**. (forthcoming). How Did Semiconductor Firms Manage Technological Uncertainty? *La Revue d'Histoire Moderne et Contemporaine*
4. **Motoyama, Yasuyuki**, & Eisler, Matthew N. (2011). Bibliometry and Nanotechnology: A Meta Analysis. *Technological Forecasting and Social Change*, 78, 1174-1182. doi: doi:10.1016/j.techfore.2011.03.013

Primary Publications: Books, Chapters, Reports and Other Publications

5. Brock, David. (2011). The Uncertain Future of Moore's Law - The Rise of 3-D Transistors and What it Means for Technology in the 21st Century. *Science Progress*, 1-5.
6. Eisler, Matthew N. (2011). Energy Innovation at Nanoscale: Case Study of an Emergent Industry. *Science Progress*.
7. Eisler, Matthew N. (forthcoming). Science that Pays for Itself: Nanotechnology and the Discourse of Science Policy Reform. In Barbara Herr Harthorn & John Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.
8. Eisler, Matthew N. (forthcoming). Where Nano Came From. In Susanna Priest (Ed.), *Nanotechnology and the Public Sphere: Risk Perception, in Risk Communication, and Public Engagement*.
9. **Mody, Cyrus**. (2011). Climbing the Hill: Seeing (and Not Seeing) Epochal Breaks from Multiple Vantage Points. In Alfred Nordmann, Hans Radder & Gregor Schiemann (Eds.), *Science Transformed?: Debating Claims of an Epochal Break* (pp. 54-65). Pittsburgh: University of Pittsburgh Press.

10. **Mody, Cyrus C.M.** (2011). Review of Nanoethics: Big Ethical Issues with Small Technology by Dónal P. O'Mathúna. *Technology and Culture*, 52, 49-51. d
11. **McCray, W. Patrick.** (forthcoming). California Dreamin': Visioneering the Technological Future. In Volker Janssen (Ed.), *Minds and Matters: Technology in California and the West*. Berkeley, CA: University of California Press.
12. **McCray, W. Patrick.** (forthcoming). From L-5 to X-Prize. In Peter J. Westwick & William Deverell (Eds.), *Blue Sky Metropolis: Aerospace and Southern California*. Berkeley, CA: University of California Press.
13. **McCray, W. Patrick.** (forthcoming). When Space Travel and Nanotechnology Met at the Fountains of Paradise. In Barbara Herr Harthorn & John W. Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.
14. **Mody, Cyrus C.M.** (forthcoming). Conferences and the Emergence of Nanoscience. In Barbara Herr Harthorn & John Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.
15. **McCray, W. Patrick.** (forthcoming). *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future," Histories of Our Technological Future: How Space Colonies, Nanotechnology, and Transhumanism Challenged the Idea of Limits*. Princeton, NJ: Princeton University Press.

Leveraged publications: Journals

16. **Mody, Cyrus C.M.** (2012). Conversions: Sound and Sight, Military and Civilian. In Trevor Pinch & Karin Bijsterveld (Eds.), *Oxford Handbook of Sound Studies* (pp. 224-248). New York: Oxford University Press.

Leveraged publications: Books, Chapters & Other Publications

17. Eisler, Matthew N. (forthcoming). *Overpotential: Fuel Cells, Futurism, and the Making of a Power Panacea*. Piscataway, NJ: Rutgers University Press.
18. **Cyrus C.M. Mody**, *Instrumental Communities: Probe Microscopy and the Path to Nanotechnology* (Cambridge: MIT Press, 2011).

Submitted or in preparation publications: Primary

19. Brock, David, & Lécuyer, Christophe. (under review). Silicon gate MOS technology – the mainstay of microfabrication in the semiconductor industry since the 1970s. *Technology and Culture*.
20. Brock, David. (in preparation). "James Von Ehr." Oral History Interview.
21. Brock, David. (in preparation). "Nadrian Seeman." Oral history interview.
22. Brock, David. (in preparation). "Thomas Everhart." Oral history interview.
23. **Choi, Hyungsub.** (in preparation). Solid State Electronics. In Hugh Slotten (Ed.), *The Oxford Encyclopedia of American Scientific, Medical, and Technological History*. New York: Oxford University Press.
24. **Choi, Hyungsub**, & Otani, Takushi. (in preparation). The Japanese Integrated Circuit and the Limits of Technology Followership. *IEEE Annals of the History of Computing*, (special issue on the history of integrated circuits).
25. Eardley-Pryor, Roger. (in preparation) "Take a Little Risk? Historical Analogies and the Regulation of Nanotechnology."
26. Eisler, Matthew N. (under review). Boundaries of Science Policy Communication: Nanotechnology and the Discourse of Revolutionary Applied Science. *Minerva*.
27. **McCray, W. Patrick.** (in preparation). Timothy Leary's Transhumanist SMI²LE. In David Kaiser (Ed.), *Groovy Science: The Counter-Cultures and Scientific Life, 1955-1975*.

28. **Mody, Cyrus C.M.** (in preparation). An Electro-Historical Focus with Real Interdisciplinary Appeal: Interdisciplinarity at Vietnam-Era Stanford. In David Kaiser (Ed.), *Groovy Science: The Counter-Cultures and Scientific Life, 1955-1975*.
29. **Mody, Cyrus C.M.** (in preparation). Instrumentation and Innovation from UC Santa Barbara. In David Mowery & Martin Kenney (Eds.), *Volume on technology transfer, economic development, and scientific instrument commercialization in the UC system*.
30. **Mody, Cyrus C.M., & Choi, Hyungsub.** (in preparation). From Materials Science to Nanotechnology: Institutions, Communities, and Disciplines at Cornell University, 1960-2000. *Historical Studies in the Natural Sciences*.
31. **Mody, Cyrus C.M.** (submitted). Nanotechnology. In Hugh Sloten (Ed.), *The Oxford Encyclopedia of American Scientific, Medical, and Technological History*. New York: Oxford University Press.
32. **Mody, Cyrus C.M.** (submitted). University in a Garage: Instrumentation and Innovation from UC Santa Barbara. In Martin Kenney, David Mowery & Mary Walshok (Eds.), *Volume on Tech Transfer and Economic Development in the University of California System*. Stanford: Stanford University Press
33. **Mody, Cyrus C.M.** (under review). Essential Tensions and Representational Strategies. In Michael Lynch, Steve Woolgar, Janet Vertesi & Catelijne Coopmans (Eds.), *Representation in Scientific Practice II*. Cambridge, Mass: MIT Press.
34. Shah, Sonali K., & **Mody, Cyrus C.M.** (under review). Innovation, Social Structure, and the Creation of New Industries. *Academy of Management Journal*.

Submitted or in Preparation Publications: Leveraged

35. **Mody, Cyrus C.M.** (submitted). Review of Gravity's Ghost: Scientific Discovery in the Twenty-First Century, by Harry Collins *Contemporary Sociology*.
36. **Mody, Cyrus C.M.** (submitted). Review of Makers of the Microchip: A Documentary History of Fairchild Semiconductor by Christophe Lécuyer and David C. Brock *Isis*.
37. **Mody, Cyrus C.M.** (submitted). Review of Science-Mart: Privatizing American Science by Philip Mirowski *Journal of American History*.

IRG 1 Presentations 2011-2012

1. **McCray, Patrick.** "Vioneering," invited talk for "The Landscape of Science in Postwar California," seminar, Huntington Library, Los Angeles, CA, April 1, 2011.
2. Santos, Nicholas. "The Geohistory of Nano Policy in the United States," Poster session, Association of American Geographers, Seattle, WA, April, 12, 2011.
3. Brock, David. CNS-UCSB Research Summit, Santa Barbara, CA, May 1, 2011
4. **Mody, Cyrus.** CNS-UCSB Research Summit, Santa Barbara, CA, May 1, 2011.
5. **November, Joseph.** CNS-UCSB Research Summit, Santa Barbara, CA, May, 1, 2011.
6. Eardley-Pryor, Roger. CNS-UCSB Research Summit, Santa Barbara, CA, May 1, 2011.
7. Eisler, Matt. CNS-UCSB Research Summit, Santa Barbara, May 1, 2011.
8. Cardenas, Sergio. "Avoiding the Next Asbestos: California's Emerging Regulation for Carbon Nanotubes," INSITE Program Participants, Santa Barbara, CA, August 2, 2011.
9. Cardenas, Sergio. "Avoiding the Next Asbestos: California's Emerging Regulation for Carbon Nanotubes," UCSB Summer Undergraduate Research Colloquium, Santa Barbara, CA, August 11, 2011.
10. Eardley-Pryor, Roger. "Looking Backward to Look Forward: Historical Examples for Nanotechnology's Environmental Future," University of South Carolina's conference on "The Public History of Science and Technology," Columbia, SC, September 1, 2011.

11. **McCray, Patrick.** "How California Invented Nanotechnology?" Invited talk and workshop discussion, Institut Méditerranéen de Recherches Avancées, Marseille, France, September 1, 2011.
12. **McCray, Patrick.** "Bob Guccione's Scientific Americans," Annual Meeting of the History of Science Society, Cleveland, OH, October 1, 2011.
13. **Mody, Cyrus.** "Interdisciplinarity and Vietnam-Era Protest at Stanford" CNS seminar, CNS-UCSB, Santa Barbara, CA, October 1, 2011.
14. **Choi, Hyungsub.** "The Limits of the Followership Strategy: The Case of the Japanese Integrated Circuit Development," Department of Science Studies, Chonbuk National University, Jeonju, Korea, October 7, 2011.
15. **Mody, Cyrus.** "Interdisciplinarity and Vietnam-Era Protest at Stanford," CNS seminar, CNS-UCSB, Santa Barbara, CA, October 13, 2011.
16. **Choi, Hyungsub.** "From Materials Science to Nanotechnology: Historical Origins of Interdisciplinary Research," 4th Experimental Seminar, Knowledge Convergence and Future Social Studies of Science Research Group, November 1, 2011.
17. **Mody, Cyrus.** "The Josephson Junction at IBM, 1968-1983," Annual Meeting of the Society for the History of Technology, Cleveland, OH, November 1, 2011.
18. **Mody, Cyrus.** "Choosing Paths for Research at Vietnam-Era Stanford," Annual Meeting of the Society for Social Studies of Science, Cleveland, OH, November 1, 2011.
19. Eisler, Matthew, Eardley-Pryor, Roger, Co-Chairs, "Situating Emerging Technology: Nanotechnology in Historical Perspective," Conference of the Society for Social Studies of Science (4S), Cleveland, OH, November 1, 2011.
20. Eisler, Matthew. "Boundaries of Science Communication in the Era of Nanotechnology: The Department of Energy and the Discourse of Revolutionary Applied Science," Conference of the Society for Social Studies of Science (4S), Cleveland, OH, November 1, 2011.
21. Eardley-Pryor, Roger. "Looking Backward to Look Forward: Historical Examples for Nanotechnology's Environmental Future," Society for the Social Studies of Science Annual Conference, Cleveland, OH, November 1, 2011.
22. **Choi, Hyungsub.** "Historical Perspectives on Nanotechnology," Annual Meeting of the Society for Social Studies of Science (4S), Cleveland, OH, November 1, 2011.
23. Eisler, Matthew. "Boundaries of Science Communication in the Era of Nanotechnology: The Department of Energy and the Discourse of Revolutionary Applied Science," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 7, 2011.
24. **Mody, Cyrus.** "Emerging Technologies and the Future of Medicine," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
25. **Mody, Cyrus.** "Emerging Histories of Emerging Technologies," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
26. **Mody, Cyrus.** "What Happens When an Emerging Technology Never Quite Emerges? Josephson Computing in the '70s and '80s," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
27. Eardly-Pryor, Roger. "Regulatory Analogues? Environmental History and Nanotechnology's Potential Future," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
28. Eisler, Matthew. "Innovation and Ideology: Producing and Interpreting Facts from Lab to Policy Salon in the Energy R&D Sector," Science, Technology, and Society Program, University of Puget Sound, January 1, 2012.

29. **Mody, Cyrus.** "Emerging Technology: The Coevolution of Performances, Regulations, and Markets," Business History Conference, Philadelphia, PA, March 1, 2012.
30. Eisler, Matthew. "Boundaries of Science Policy Communication: Nanotechnologizing Materials Science in the Department of Energy," Eighth Laboratory History Conference (LH8), Georgia Institute of Technology, Atlanta, GA, March 1, 2012.
31. Eardley-Pryor, Roger, **McCray, Patrick.** "Take a Little Risk? Historical Analogies and the Regulation of Nanotechnology," Business History Annual conference, Philadelphia, PA, March 1, 2012.
32. **Mody, Cyrus.** "Emerging Technology: The Coevolution of Performances, Regulations, and Markets," Business History Conference, Philadelphia, PA, March 31, 2012.
33. **Mody, Cyrus.** "University in a Garage: Instrumentation and Innovation from UC Santa Barbara," Edited Volume Workshop, UC Berkeley, CA, March 1, 2012.
34. **McCray, Patrick.** "Did California Invent Nanotechnology?" invited talks, versions given multiple times at various venues including Georgia Institute of Technology; University of California, San Diego; Johns Hopkins University; University of Pennsylvania; UCLA; throughout 2011 and 2012.

IRG 2 Progress Report: Globalization and Nanotechnology

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Timothy Lenoir	History	Duke University
Aashish Mehta	Global & International Studies	UC Santa Barbara
Fred Block	Sociology	UC Davis
Cong Cao	Contemp. Chinese Studies	Univ. of Nottingham
Hyungsub Choi [IRG 1]	History	Seoul Nat'l University

Affiliates

Patrick Herron	Computer Science	Duke University
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Gary Gereffi	Sociology	Duke University
Noela Invernizzi	Anthropology, S&T Policy	Federal Univ of Parana, Brazil
Rachel Parker	Sociology	Science & Tech. Policy Inst., DC
E. Záyago Lau	Sociology	Latin Amer. Nanotech & Society Network (ReLans)
Matthew Keller	Sociology	Southern Methodist University

2 postdocs [+1 +1 X-IRG], 7 grads, 5 undergrads, 1 technical

Postdoctoral researchers: Yasuyuki Motoyama, Regional Planning, UCSB
 Stacey Frederick, Business and Spatial analysis (X-IRG), Duke
 James Walsh, Sociology, UCSB
 Marian Negoita, Sociology, UCD

Graduate students:

Social Science/Humanities:

Galen Stocking, Political Science, UCSB
 Anna Walsh, Global & International Studies, UCSB
 Matthew Keller, Sociology, UCD

Science and Engineering:

Claron Ridge, Chemistry/Biochemistry, UCSB
 Peter Burks, Chemistry/Biochemistry, UCSB
 Matthew Gebbie, Materials, UCSB
 Shirley Han, Ecology, Evolution, and Marine Biology, UCSB

Undergraduate Students:

Andi Doktor, UCSB
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Ben Weiss, Jenkins Collaboratory, Duke

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 2000, when the U.S. officially launched its National Nanotechnology Initiative, global public spending on nanotechnology has totaled an estimated \$67.5 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). 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 also involved training IRG 2's new Graduate Fellows, including one from the social sciences and two from the sciences)
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
3. Launch a new research project on the development of nanotechnology into Mexico, through a supporting grant obtained through UC-MEXUS and CONACYT
4. Establish relations with ReLANS (the Latin American Network for Nanotechnology and Society)
5. Complete and publish the book from our "Emerging Economies/Emerging Technologies" conference (November 4-6, 2009, Washington, D.C.): *Can Emerging Technologies Make a Difference in Development?* (Routledge, 2012)
6. Gauge the contributions of foreign-born scientists and engineers to the development of nanotechnology in the United States through a study of recent PhD's in nanotechnology
7. Gain a better understanding of how nanotechnology diffuses, both within a country (focusing on China) as well as globally
8. Build a nano-firm and organization database incorporating a global value-chain approach, using it to populate a "California in the Nano Economy" website
9. Continue development of "GLOBONANO," a large scale database including all nanotechnology-related scientific literature, patents, and eventually products, for nearly 60 countries (including the US, China, South Korea, Japan, India, Singapore, and EU countries), and – using this database – begin research on nanotechnology commercialization and international collaboration in nanotechnology research

3. Rationale, Approach and Organization: The activities of IRG 2 are, as indicated above, designed to assess the role of state policy and international collaboration on 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:

- IRG 2-1: China's Developmental State: Becoming a 21st Century Nanotech Leader: **Appelbaum, Parker, Cao**, Stocking, Gebbie, Han
- IRG 2-2: Comparative Study of State Nanotechnology Policy: U.S., China, Japan: **Appelbaum, Parker**, Motoyama, **Choi, Block**
- IRG 2-3: The Implications of China's Move to High-Tech Innovation for U.S. Policy: **Appelbaum, Parker**
- IRG 2-4: Drivers of Nanotechnology Commercialization in China: Patent Analysis: **Parker, Appelbaum, Motoyama, Lenoir**, Herron, Ridge
- IRG 2-5: Development of GLOBONANO database of publications, patents, products: **Lenoir**, Herron
- IRG 2-6: Global Value Chain Analysis: Frederick, **Appelbaum, Harthorn**
- IRG 2-7: International Collaboration in Nanotech Research and Publication: **Mehta, Lenoir**, Herron
- IRG 2-8: Contributions of Foreign-Born Scientists to Nanotechnology Innovation: Walsh, Ridge
- IRG 2-9: UCMEXUS/CONACYT Binational Collaboration (USA-Mexico) in the Development of Nanotechnology: **Folodari, Záyago Lau, Appelbaum**, Rogers [IRG 3]
- IRG 2-10 Establish connection with ReLANS: **Foladori, Záyago Lau, Appelbaum, Parker**
- IRG 2-11: Publication of *Can Emerging Technologies Make a Difference in Development?* (Routledge, 2012); **Parker, Appelbaum**

IRG 2's core efforts are located at UCSB, where **Appelbaum** meets weekly or biweekly with his new graduate fellows (Stocking, Gebbie, and Han) and UCSB's development economist **Mehta**. This year has been one of transition in this regard, involving their recruitment and training of the graduate fellows (they began in the fall of 2011). Integration was facilitated through regular meetings, reading and writing assignments, publications, and conference participation (for example, at SNET in Tempe, Arizona, November 2011, where IRG 2 organized a panel on Latin American nanotechnology). IRG 2 (**Appelbaum, Mehta**, Stocking, Gebbie, Han) also gave an integrated public presentation on "global innovation systems" (UCSB, February 2011) that provided an opportunity for the graduate fellows to synthesize their efforts and each speak publicly on our evolving research projects.

A number of the core IRG 2 participants are not in Santa Barbara. **Parker** (at STPI in D.C.) and **Cao** (at the University of Nottingham, U.K.) were looped in via conference calls during most of IRG 2's meetings. **Motoyama** completed his postdoc and relocated to the Kaufmann foundation in Kansas City, but continued his collaboration through the completion of a number of co-authored papers (some published, some under submission). IRG 2 successfully completed a search for a new post-doc, appointing Luciano Kay; he will begin June 1, 2012. Kay was previously working as a post-doc at Georgia Tech, a key collaborator in their bibliometric and field studies nanotechnology research. Kay's relocation to UCSB will foster future collaboration between CNS-UCSB and CNS-ASU via CNS-ASU's Georgia Tech partnership. Our Duke University partners (**Lenoir**, Herron) have completed their development of the GLOBONANO database, which has been used by **Mehta**, Herron, **Motoyama, Appelbaum**, and **Lenoir** for one research publication thus far; Frederick (also at Duke) will complete her California in the global nanotechnology value chain project this coming fall. These efforts are coordinated

through frequent telephone conversations. Finally, our new partnership with **Foladori** and **Zayago Lau** in Mexico has been facilitated by face-to-face meetings at two international conferences in which we organized panels on nanotechnology at SNET (on Latin America, previously mentioned) and the Society for the Study of Socioeconomics (SASE) annual meetings in Madrid, Spain (on Developmental States and Nanotech Innovation, June 2011). Our Graduate Fellows are submitting a proposal for a panel at the October 2012 SNET meetings in Twente, Netherlands, which will provide future integration of efforts.

4. Major IRG 2 accomplishments in the Center

IRG 2's focus, a comparative-historical and quantitative analysis of the development of nanotechnology, cross-cuts with a number of other CNS initiatives and projects. IRG 2 and IRG 1 share an interest in the historical development of national innovation policies focused on nanotechnology. Choi participates in the work of both IRGs, focusing on Korean nanotech innovation systems. Published research by IRG 2 researchers **Motoyama**, **Parker**, and **Appelbaum** examines the historical origins of the U.S. National Nanotechnology Initiative, and IRG 2 postdoc **Motoyama** collaborated with IRG 1 postdoc Eisler in a published meta-analysis of bibliometric studies of nanotechnology. In terms of the potential contribution of nanotechnology to equitable development in such areas as energy, water, food security, and health, IRG 3 helped out in the planning and implementation of IRG 2's equitable development conference in Washington, D.C. (November 2009), as well as contributing chapters to the resulting publication (*Can Emerging Technologies Make a Difference in Development*, Routledge 2012). By the same token, IRG 2 has contributed chapters to CNS's forthcoming book, *The Social Life of Nanotechnology*. IRG 2 leader **Appelbaum** is working with IRG 3 researchers **Harthorn**, **Holden** and Engeman to assess feasibility of extending the industry survey to IRG 2's China business contacts in 2012. IRG 2 is also working with IRG 3 on its study of NGOs in Latin America, East Asia, and Europe, along with X-IRG researchers **Friedman** and **Newfield**. IRG 2 and 3 also collaborate in development of the X-IRG work by Frederick at Duke on the US and global nano industry. This work contributes a base for future planned IRG 3 spatial analysis by **Harthorn**, **Satterfield**, and Collins of nano industrial development and risk perception in California. **Tim Lenoir** and Patrick Herron have been in discussions with X IRG project leader **Chris Newfield** regarding collaboration on **Newfield's** analysis of photovoltaics patents. Finally, **Foladori** and **Invernizzi's** publication, *Social and Environmental Implications of Nanotechnology Development in Latin America and the Caribbean* (2012), directly addressed the EHS concerns of IRG 3 (this pamphlet was initially written in Spanish; IRG 2 translated it and adapted it to the English-speaking population of the Caribbean).

IRG 2-1: China's Developmental State: Becoming a 21st Century Nanotech **Appelbaum, Parker, Cao, Stocking, Gebbie, Han**

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.

Our current research focuses on nanotechnology commercialization in China. In June 2011 **Appelbaum** conducted interviews at the Shanghai offices of Kaye-Scholer, a global law firm that provides legal services to corporations seeking to do business in the U.S., U.K., E.U., and China. He also conducted interviews at AmCham-Shanghai. During the last two weeks of April, 2012, IRG 2 researchers **Appelbaum**, Stocking, Gebbie, Han, **Parker**, and **Cao** will conduct interviews at Suzhou Industrial Park (focusing on SIP's bioBay "bionano" district), as well as the greater Shanghai area. This will build on research conducted at SIP and Shanghai in 2010.

A number of publications have resulted from this research during the past year (references are to the bibliographic entries at the end of this IRG 2 report): **Appelbaum** 2011; **Appelbaum, Parker**, and **Cao**, 2011; **Appelbaum, Parker, Cao**, and **Gereffi**, 2011; **Cao, Appelbaum**, and **Parker**, 2012 forthcoming.

IRG 2-2: Comparative Study of State Nanotechnology Policy: U.S., China, Japan Appelbaum, Parker, Motoyama, Choi, Block

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. 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, and a university and science academy-based research sector that lacks entrepreneurial experience.

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. In one publication, **Motoyama, Appelbaum** and **Parker** (2012) conclude that the NNI provides an example of a form of "hidden industrial policy," in that its ultimate goal (which has justified funding since 2000) is to foster research that will eventually find its way into a multi-trillion dollar nano-enabled commercial economy (see also Keller and **Block**, forthcoming; Negoita and **Block**, 2012). In comparison with the United States, Chinese governmental bodies – at the

central, provincial, and local levels – have invested not only in basic research, but also in providing infrastructure and financial support for nano-scale product development (**Appelbaum, Cao, Parker** and **Motoyama**, forthcoming). In a study of Japan's efforts to develop nanotechnology, **Motoyama** (under review) argues that university-industry collaborations in Japan often take a long time (6-7 years) before technologies are developed, which can impede successful commercialization.

IRG 2-3: The Implications of China's Move to High-Tech Innovation for U.S. Policy **Appelbaum, Parker**

The economies of the U.S. and China are currently deeply intertwined: innovation, product design, and marketing originate with U.S. (and other foreign) firms; contract manufacturing occurs in China; and final products are sold to U.S. (and other advanced economy) consumers. On the U.S. side, firms benefit from low-cost labor; U.S. consumers benefit from low-cost products (contributing to historically low rates of inflation that partly mitigate sluggish middle class income growth); and U.S. government debt is financed by Chinese purchase of government securities. On the Chinese side, tens of thousands of factories benefit from contract work for U.S. (and other foreign) firms; hundreds of millions of workers benefit from waged salary, if often under harsh conditions in violation of ILO minimal standards; the Chinese government has accumulated significant foreign reserves, which in turn help to finance significant investments in infrastructure; and the Chinese economy continues to grow at 10% annually as a result.

China's turn to indigenous innovation heralds a major shift in economic strategy, one that will lead to a partial uncoupling from what has thus far been a mutually advantageous relationship with the U.S. and other foreign economies. If China is successful in its efforts, in 10-15 years it may well be competing head-on with foreign firms – designing, branding, and marketing its own innovative products to hundreds of millions of Chinese consumers. In other words, one possible future for China will be to become more economically autonomous than it has been thus far. In two papers, **Appelbaum** and **Parker** (forthcoming 2012) and **Parker** and **Appelbaum** (forthcoming 2012) examine some implications of these possible trends for the U.S. as well as China's regional neighbors.

IRG 2-4: Drivers of Nanotechnology Commercialization in China: Patent Analysis **Parker, Appelbaum, Motoyama, Lenoir, Herron, Ridge**

We have begun an analysis of Chinese (SIPO) patent data, initially acquired from Beijing Institute of Technology. One key finding is that while the number of nanotechnology patent applications in China has grown markedly in recent years, most patents come from the country's research institutions such as major universities and the Chinese Academy of Science, and not the private sector. Many patents also “sleep in the safe,” most likely taken out primarily to justify funding or discourage foreign patenting. Furthermore, as many as two-thirds of all Chinese patents are design model or utility model patents, which are far more readily conferred by SIPO than invention patents, further discouraging foreign competitive patenting. In one paper (**Motoyama, Appelbaum** and **Cao**, under review), we show that despite some regional diffusion of patenting in China, overall patenting activity has become increasingly concentrated in a few key regions, particularly along China's east coast development poles. While Beijing and Shanghai have remained two dominant regions of nanotechnology, the Shanghai region together with Jiangsu and Zhejiang surpassed the traditionally productive Beijing-Tianjin region by 2007. These results support the regional divergence theory and a small scale of technology diffusion, and the possibility of enlarging inequality in China and its technology development.

IRG 2-5: Development of GLOBONANO database of publications, patents, products: Lenoir, Herron

The Duke team has made considerable advances in their development of a large-scale database to support quantitative research on the development of scientific literature, patents, and products in all fields of nanotechnology for several countries, including the US, China, South Korea, Japan, India, and Singapore, but also every country for which data is available. The goal of this project is to measure nanotech output and changes on terms of intellectual property, publications, actors, firms, states, policies, manufacturing, and trade. The dataset now includes 58 countries (up from 43). Patent data from EPO now encompasses 80 countries and 70 million records (63 million patent applications and 7 million granted patents, utility models, etc.). New updates of PATSTAT have been ordered and will be integrated into GLOBONANO during late Spring 2012. Firm data has been obtained from the Nanowerk nanoBASE database (product list, product ontology, firm lists, firm websites, firm home office addresses). Tools are being developed that will crawl financial sites (EDGAR, SEC filings) to update the company database in an automated fashion (this work is in the design phase). The company database will incorporate key features of the Zucker & Darby Nanobank and StarZD data sets, as well NIH RePORTER data (funding of NIH-supported projects, PI information, publications, and resulting patents). Finally, progress is being made on analytics software development that will permit visualization of results. A number of publications are under preparation (all listed in the bibliography below under **Lenoir** and Herron, in progress). GLOBONANO was also used to identify firms in the Shanghai-Suzhou region that will be the research site for the April 2012 visit by Appelbaum, Parker, Cao, Stocking, Gebbie, and Han. Finally, while not directly utilizing the GLOBONANO database, **Motoyama** and Eisler (2011) address an important issue in bibliometric studies – whether standardizing for the size of the scientific research community in a country affects its international productivity standing (it does: such standardization drops the U.S. to fourth place, behind Germany, the United Kingdom, and France).

IRG 2-6: Global Value Chain Analysis Frederick, Appelbaum, Harthorn [IRG 3]

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 will include a California in the Nanotechnology Global Economy website.

The database (in Microsoft Access) is complete; it is searchable by variables such as location, sectors, markets, and firm relationships. This will be a valuable resource for all the working groups and it can be used to scale up future visualization or value chain mapping projects. The “California in the Nano Economy” website has two main parts: a text/analysis content section similar to the “North Carolina in the Global Economy” website on industries (providing an overview, corporations, workforce development, public policy, and resources), and mapping and visual sections that create interactive maps of firms. We hope to include patent and publication data for California authors and inventors and inventors on the website as well, if we can resolve some data disaggregation issues. Regarding firms and products, there are currently 680 locations listed for California. This project should be largely completed by the end of this reporting period. One result is the “value chain research template,” materials originally created for the CNS summer internship and modified for other projects that have been added to the

CNS website as part of the Resources for Educators. One publication has also resulted (Dilleuth, Frederick, **Parker**, **Gereffi**, and **Appelbaum** 2011).

IRG 2-7: International Collaboration in Nanotech Research and Publication

Mehta, **Lenoir**, Herron

Most countries engaged in nanotech research encourage international research collaborations. As noted above, the role of international collaboration in affecting the diffusion and impact of nanotechnology research, particularly in emerging economies, is a central concern of IRG 2. Thus far one publication has addressed these issues. **Mehta**, Herron, **Motoyama**, **Appelbaum** and **Lenoir** (2011), in an analysis of nanotechnology publications involving at least one Chinese author, find that international collaboration (as indexed by publications involving more than one author) more than doubled in the 1990s, but then fell again until 2004, before recovering somewhat during the latter years of the decade – a trend that was largely due to patterns of Chinese international collaboration. As China came to account for an increasing share of international collaborations during the period, its growing number of qualified Chinese nanoscientists and engineers initially resulted in lowered rates of Chinese international collaboration – a nationalist phase which only in recent years has begun to reverse itself.

IRG 2-8: Contributions of Foreign-Born Scientists to Nanotechnology Innovation

Walsh, Ridge

This research employs an original dataset to examine the nativity of scientists making significant contributions to nanotechnology research and innovation. In addition to identifying individuals central in nano-innovation, the research highlights the internal globalization of the American scientific community and informs intellectual and policy debates on immigration and its impacts on the American knowledge economy. Kotoff's bibliometric methods were used to collect all journal articles on nanotechnology between 1999-2009. These were ranked by number of citations; the top 1%- or high-impact- articles were included in the study, which recorded the names of both corresponding and non-corresponding authors. Sources such as the biographical reference work *American Men and Women of Science*, department and faculty web pages, and Linked-In were used to determine the nativity of the population. Aggregate and yearly figures were benchmarked against the prevalence of the foreign-born in both the American scientific labor force and general population.

This research finds that the prevalence of the foreign-born significantly exceeds that of the general population and American Scientific community. Several trends are also apparent. First, both the number of nanotechnology related articles and the number of foreign-born contributions increased each year. While the United States contributed the largest share of corresponding authors China, India and Germany also made significant contributions. A related study of all nanotechnology-related Ph.D. dissertations at US institutions between 1999-2009 (a total of 4,616 individuals) was used to generate a random sample of all Ph.D.'s; the sample was then used to conduct a survey that provides basic demographic information, as well as information concerning place of birth, citizenship and migration history. This will permit some insights into the career trajectories of foreign-born recipients of U.S. Ph.D.'s in nanotechnology. This project has thus far resulted in one publication (Walsh and Ridge, 2012), and one paper under preparation (Walsh, in progress). The survey analysis should be completed by the end of summer 2012.

IRG 2-9: UCMEXUS/CONACYT Binational Collaboration (USA-Mexico) in the Development of Nanotechnology; Establish connection with ReLANS
Foladori, Záyago Lau, Appelbaum, Parker

This joint project, with the Doctoral Program on Development Studies at the University of Zacatecas (Mexico), analyzes the development trajectory of nanotechnology in Mexico, with special attention to scientific collaboration and productive agreements between U.S. and Mexican institutions. This is 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 will also give us the ability to expand our comparative studies to Latin America beyond Mexico. Thus far we have had several meetings (two Santa Barbara, one at the S-NET meetings in Tempe, Arizona, and one at the SASE meetings in Madrid, Spain). One principal finding of this new research stream, focusing on MEMS and NEMS, is that in less than a decade Mexico has developed significant human capital in MEMS technology, as well as technology-based networks within Mexico as well as with the U.S. and other foreign partners. Mexico has also developed a substantial infrastructure for MEMS development – an accomplishment that is all the more impressive given the fact that little more than a decade ago there was virtually no MEMS technology in Mexico at all. But the strong Mexico-U.S. ties that have been developed, with Mexico's MEMS efforts seemingly shaped either by the needs of foreign transnational corporations or U.S. military needs, calls for further examination of how effectively this vital high-tech area will develop in terms of Mexico's own high-tech and economic growth aspirations. A number of publications have already resulted, with particular focus on the relationship between U.S. universities and institutions and nanoscale R&D in Mexico. These include **Foladori**, 2011 (in Spanish and English); **Foladori** and **Invernizzi**, 2012; **Foladori, Záyago Lau, Appelbaum** and **Parker**, 2012; **Záyago Lau** and **Foladori**, 2012 (in press); and **Foladori, Figueroa, Záyago Lau**, and **Invernizzi**, 2012 (in press). **Foladori, Záyago Lau, Sandoval, Appelbaum**, and **Parker** is currently under submission.

IRG 2-10: Publication of *Can Emerging Technologies Make a Difference in Development?* (Routledge, 2012)

IRG 2 researchers believe that nanotechnology (and other emerging technologies) hold the promise of solving some of the world's most critical problems related to energy scarcity, finite clean water sources, diminished availability of sustainable food resources, and pandemic diseases. Increased international collaboration on technological innovation can help advance progress in these four areas, while also reducing inequality between the global North and South. IRG 2, in collaboration with IRG 3, hosted an international conference in Washington, D.C. November 4-6, 2009 to explore these possibilities. The conference was a collaborative effort of CNS-UCSB, which organized the conference with the Woodrow Wilson International Center for Scholars (the host organization), and Rice University's Center for Biological and Environmental Nanotechnology. The roughly 85 participants came from the US and Europe; China, India, and Brazil, the world's three largest emerging economies; and Mexico, South Africa, Uganda, and Zimbabwe, and included leading scientists and engineers, government employees and NGO activists, social scientists and new technology business entrepreneurs. Discussion and dialogue were facilitated by the Meridian Institute, an organization committed to increasing more equitable North/South dialogue. A central concern of the conference was how to best manage global science and technology development to ensure that the benefits of technological advancement contribute to equitable development.

This past year the conference book, *Can Emerging Technologies Make a Difference in Development*, was published by Routledge (**Parker and Appelbaum**, 2012). The 17 chapters (and forward) provide evidence of the opportunities for, and the challenges of, developing collaborative approaches to bringing advanced and emerging technology to poor communities in developing countries in a responsible and sustainable manner. A number of IRG 2 collaborators contributed chapters, including **Parker and Appelbaum** (2012), **Foladori** (2012), and **Invernizzi** (2012).

5. Broader Impacts of IRG 2: As detailed throughout this report. IRG 2 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.

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 expat 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.

One overarching concern of IRG 2 (indeed, of CNS in general) is the use of nanotechnology and other emerging technologies to foster more equitable and sustainable development. IRG 2's 2009 conference, and the subsequent publication this past year of the resulting book, *Can Emerging Technologies Make a Difference in Development*, addresses these broader impacts. The answer is a qualified “yes” – qualified both because the larger promise of nanotechnology in such key areas as energy, water filtration, food security and health remains in the future, and because more traditional technologies (including low-tech approaches) are often more likely to be implemented and hence appropriate. One of the chief conclusions of the conference (and the book) is that nanotechnologists must partner with, and respond to, the needs of locals if they hope to make inroads into solving key local needs with advanced technologies.

IRG 2 Publications 2011-2012

Primary Publications: Journals

1. **Appelbaum, Richard P., Parker, Rachel, & Cao, Cong.** (2011). Developmental state and innovation: Nanotechnology in China. *Global Networks*, 11(3), 298–314. doi: 10.1111/j.1471-0374.2011.00327.x
2. Dilleuth, Julie, Frederick, Stacey, **Parker, Rachel, Gereffi, Gerry, & Appelbaum, Richard.** (2011). Traveling Technologies: Societal Implications of Nanotechnology through the Global Value Chain. *Journal of Nano Education*, 3(1-2), 36-44.

3. **Foladori, Guillermo**, Lau, Edgar Záyago, **Appelbaum, Richard**, & Parker, Rachel. (forthcoming). Mexico-U.S. scientific collaboration in nanotechnology. *Revista Frontera Norte (english edition)* 27(47).
4. **Mehta, Aashish**, Herron, Patrick, **Motoyama, Yasuyuki**, **Appelbaum, Richard**, & **Lenoir, Timothy**. (forthcoming). Globalization and De-globalization in Nanotechnology Research: The Role of China. *Scientometrics*
5. Motoyama, Yasuyuki, & Eisler, Matthew N. (2011). Bibliometry and Nanotechnology: A Meta Analysis. *Technological Forecasting and Social Change*, 78, 1174-1182. doi: doi:10.1016/j.techfore.2011.03.013
6. Motoyama, Yasuyuki, **Appelbaum, Richard P.**, & Parker, Rachel. (2011). The National Nanotechnology Initiative: Federal Support for Science and Technology, or Hidden Industrial Policy? *Technology in Society*, 33(1-2), 109-118. doi: doi:10.1016/j.techsoc.2011.03.010
7. Walsh, James, & Ridge, Claron. (2012). Knowledge Production and Nanotechnology: Characterizing American Dissertation Research, 1999-2009. *Technology in Society*, 1-11.

Primary Publications: Books, Chapters, Reports and Other Publications

8. **Appelbaum, Richard**, & Parker, Rachel. (2012). Introduction: The Promise and Perils of High-Tech Approaches to Development, introductory chapter. In Rachel Parker & Richard Appelbaum (Eds.), *Can Emerging Technologies Make a Difference in Development?* (pp. 1-20). New York: Routledge
9. **Appelbaum, Richard**, Cao, Cong, Parker, Rachel, & Motoyama, Yasuyuki. (forthcoming). Nanotechnology as Industrial Policy: China and the United States. In Barbara Herr Harthorn & John W. Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.
10. **Appelbaum, Richard**, & Parker, Rachel. (forthcoming). China's Move to High Tech Innovation. In Christopher Dent & Joern Dosch (Eds.), *The Asia-Pacific, Regionalism And The Global System*. Northampton, MA: Edward Elgar
11. **Foladori, Guillermo** (2012). Achieving Equitable Outcomes Through Emerging Technologies: A Social Empowerment Approach. In Rachel Parker & Richard Appelbaum (Eds.), *Can Emerging Technologies Make a Difference in Development?* (pp. 40-46). New York: Routledge.
12. **Invernizzi, Noela** (2012). Implications of Nanotechnology for Labor and Employment: Assessing Nanotechnology Products in Brazil. In Rachel Parker & Richard Appelbaum (Eds.), *Can Emerging Technologies Make a Difference in Development?* (pp. 140-152). New York: Routledge.
13. Parker, Rachel, & **Appelbaum, Richard** (Eds.). (2012). *Can Emerging Technologies Make a Difference in Development?* New York: Routledge.
14. Parker, Rachel, & **Appelbaum, Richard**. (forthcoming). The Chinese Century? Some Implications of China's Move to High-Tech Innovation for U.S. Policy. In Barbara Herr Harthorn & John W. Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.

Leveraged publications: Journals

15. **Foladori, Guillermo**. (2011). Participación militar estadounidense en la ciencia y tecnología de México. *Revista Iberoamericana de Ciencia, Tecnología y Sociedad*, 19(7), 1-29.
16. Negoita, Marian, & **Block, Fred**. (2012). Networks and Public Policies in the Global South: The Chilean Case and the Future of the Developmental Network State. *Studies in Comparative International Development*, 1-22. doi: 10.1007/s12116-012-9097-4
17. **Foladori, Guillermo**, Figueroa, Santiago, Lau, Edgar Záyago, & **Invernizzi, Noela**. (forthcoming). Características distintivas del desarrollo de las nanotecnologías en América Latina. *Sociológicas*, 14(30).

Leveraged publications: Book Chapters & Other Publications

18. Záyago Lau, Edgar, & **Foladori, Guillermo**. (2012). La política de ciencia y tecnología en México y la incorporación de las nanotecnologías. In G. Foladori, E. Záyago & N. Invernizzi (Eds.), *Perspectivas sobre el desarrollo de las nanotecnologías en América Latina* (pp. 137-163). México D.F: Miguel Angel Porrua.
19. **Foladori, Guillermo, & Invernizzi, Noela** (2012). Implicaciones sociales y ambientales del desarrollo de las nanotecnologías en América Latina y el Caribe. Zacatecas, Mexico and Curitiba, Brazil: ReLANS.
20. **Foladori, Guillermo, & Invernizzi, Noela** (2012). Social and Environmental Implications of Nanotechnology Development in Latin America and the Caribbean. Zacatecas, Mexico and Curitiba, Brazil: ReLANS.
21. **Foladori, Guillermo**. (2011). U.S. Military Involvement in Mexican Science and Technology. *GlobalResearchCA*: Global Research.

Submitted or in preparation publications: Primary

22. **Cao, Cong, Appelbaum, Richard, & Parker, Rachel**. (submitted). Research is High and the Market is Far Away - Commercialization of Nanotechnology in China. *Technovation*.
23. **Foladori, Guillermo**, Lau, Edgar Záyago, Sandoval, Remberto, **Appelbaum, Richard, & Parker, Rachel**. (submitted). Mexico-U.S. Collaboraton in MEMS/NEMS. *NanoEthics*.
24. Motoyama, Yasuyuki. (under review). Long-Term Collaboration between Universities and Industry: A Case Study of Nanotechnology Development in Japan. *Review of Policy Research*.
25. Motoyama, Yasuyuki, & **Appelbaum, Richard**. (under review). Observing Regional Divergence in Chinese Nanotechnology Centers *Technological Forecasting and Social Change*.
26. **Lenoir, Timothy**, & Herron, Patrick. (in preparation). Comparative nanotech: China, US, India, Korea, Japan, Singapore, France, and Germany.
27. **Lenoir, Timothy**, & Herron, Patrick. (in preparation). Rising trends ion Chinese patent sets.
28. **Lenoir, Timothy**, & Herron, Patrick. (in preparation). Star Scientists in the Takeoff of Bionanotechnology: Comparisons with the Role of Federal Funding in the First Biotech Revolution.
29. Walsh, James. (in preparation). Foreign Talent and its Contribution to American Science and Innovation: the Case of Nanotechnology.

Submitted or in Preparation Publications: Leveraged

30. Keller, Matthew R., & **Block, Fred**. (under review). Explaining the Transformation in the U.S. Innovation System: The Impact of a Small Government Program. *Socio-Economic Review*.

IRG 2 Presentations 2011-2012

1. **Appelbaum, Richard**, Motoyama, Yasuyuki, and Cao, Cong. "Observing Regional Divergence of Chinese Nanotechnology Centers," Association of American Geographers, Seattle, WA, April, 1, 2011.
2. **Lenoir, Tim** and Patrick Herron. "The Takeoff of Bionanotechnology: Comparison of the US and China," Bayh-Dole at 30: Mapping the Future of University Patenting Conference, Davis, CA, April 30, 2011.
3. Frederick, Stacey, **Gereffi, Gary**. CNS Research Summit and NSF Site, Santa Barbara, CA, May 1, 2011.
4. **Appelbaum, Richard**. "China's Move to High-Tech Innovation: Some Regional Policy Implications," Worldwide Universities Network, conference on "The Asia-Pacific, Regionalism and the Global System," University of Leeds, England, May 12, 2011.

5. **Rich Appelbaum.** "Nanotechnology in China and Latin America," The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.
6. Záyago Lau, Edgar. "Nanotechnology in México: A Path Towards National Development?" The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.
7. Cong Cao, "Nanotechnology in China - How Effective is State-Led Development?" Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.
8. **Appelbaum, Richard.** "Developmental States and High-Tech Innovation: The Case of Nanotechnology. Can National Policies Make a Difference?" The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.
9. **Appelbaum, Richard,** Parker, Rachel. "The U.S. National Nanotechnology Initiative: Federal Support for Science and Technology, or Hidden Industrial Policy?" The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.
10. **Foladori, Guillermo.** "Brazilian National Nanotechnology Program: Can Public Investment Drive Innovation?" The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.
11. **Appelbaum, Richard.** "The Chinese Century," Worldwide Universities Network Conference on "The Asia-Pacific, Regionalism and the Global System," University of Leeds, England, August, 1, 2011.
12. **Appelbaum, Richard.** "Chinese Century," Annual Meetings of the American Sociological Association, Las Vegas, NV, August 22, 2011.
13. Motoyama, Yasuyuki. "When Clusters Get Loose In Global Business, Local Strategies: Lessons for Economic Development," International Economic Developers Conference, Charlotte, NC, September 1, 2011.
14. Frederick, Stacey, Gereffi, Gary. Nanotechnology Commercialization Conference, Boston, MA, September 26-27, 2011.
15. Zayago Lau, Egdar, **Foladori, Guillermo.** "The Path of Nanotechnologies in Mexico," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
16. **Appelbaum, Richard, Foladori, Guillermo,** Parker, Rachel, Zayago Lau, Edgar. "Mexico-US Bilateral Scientific Collaboration on Nanotechnology," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
17. **Appelbaum, Richard.** "The Chinese Century? Some Policy Implications of China's Move Towards 'Indigenous Innovation,'" China Rising Conference, Bristol University, Bristol, England, December 5, 2012.
18. **Appelbaum, Richard,** Parker, Rachel. "Latin American Network on Nanotechnology and Society," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
19. Frederick, Stacey, Gereffi, Gary. Nanoinformatics Conference, Arlington, VA, December 7-9, 2011.

IRG 2 related outreach activities

1. Appelbaum, Richard, "The Chinese Century?" presentation at the Santa Barbara Institute for World Affairs, Lobero Theater (February 26, 2011)
2. Appelbaum, Richard, guest lecture in ENG285F on nanotech and China, UCSB's Technology Management Program (March 2, 2011)
3. Appelbaum, Richard, "Will China Rule the World?" noon luncheon talk at Santa Barbara Rotary Club (June 3, 2011)
4. Appelbaum, Richard, "China and High-Tech Development: Is nanotechnology a Case of Industrial Policy?" Fielding Graduate University summer session seminar (July 21, 2011)

5. Appelbaum, Richard, "Will China Rule the World?" noon luncheon talk at the Santa Barbara Club (October 3, 2011)
6. Appelbaum, Richard, Organized IRG2 CNS public presentation on "global innovation systems" (presenters included Appelbaum, Mehta, Stocking, Gebbie, Han) (February 9, 2011)
7. Appelbaum, Richard hosted Denis Fred Simon, who gave a public presentation on "China – Emerging Superpower – or Laggard?" (February 23, 2012) (Simon is Vice-Provost for International Strategic Initiatives and Foundation Professor of Politics and Global Studies at Arizona State University, and a member of the American Experts Group participating in the US-China innovation Dialogue under the auspices of OSTP)
8. Appelbaum, Richard attended and participated in NNI-OECD meeting on "assessing the economic impact of nanotechnology," Washington, D.C. (March 27-28, 2012)
9. Block, Fred will be participating in a Congressional briefing on federal R&D spending sponsored by nine scientific organizations on March 16, 2012

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IRG 3: Risk Perception and Social Response

B. Herr Harthorn, Leader	Med anthropology	UC Santa Barbara
N. Pidgeon, Co-leader	Social Psychology	Cardiff University, UK
T. Satterfield, Co-Leader	Env anthropology	University of British Columbia, CA
B. Bimber	Political Science	UC Santa Barbara
J. Conti	Sociology, Law	University of Wisconsin, Madison
S. Friedman	Science Journalism	Lehigh Univ, Bethlehem, PA
R. Gregory	Env Risk	Decision Research, OR
M. Kandlikar	Science policy	University of British Columbia, CA
P. Slovic	Psychology	Decision Research, OR

Affiliates

E. Barvosa	Chicana/o Studies	UC Santa Barbara
L. Baumgartner	Env Sci & Mgt	Sierra Nevada Alliance
F. Bray	Anthropology	Edinburgh University, UK
K. Bryant	Sociology	SUNY New Paltz
J. Earl	Sociology	UC Santa Barbara
B. Egolf	Sci Journalism	Lehigh Univ
W. Freudenburg*	Env Sociology	UC Santa Barbara
H. Haldane	Anthropology	Quinnipiac University, CT
P. Holden	Microbiology, Eng	UC Santa Barbara
Graham Long	Engineering	Compass Resource Management
Miriam Metzger	Communication	UC Santa Barbara
Jennifer Rogers-Brown	Sociology	Long Island University, NY

* deceased Dec 2010

.5 [+3] Postdocs, 5 [+2] Grads, and 5 Undergrads

Postdoctoral researchers: *Christine Shearer, Sociology (0.5 CNS)
 *Gwen D'Arcangelis, Women's Studies
International: *Adam Corner, Social Psych (Cardiff UK)
International: *Anton Pitt, Environmental Risk (UBC)

Graduate students:

Social science/humanities:

Lauren Copeland, Poli Sci
 Rachel Cranfill, Linguistics
 Amanda Denes, Communication
 Cassandra Engeman, Sociology

Nanoscience/Ecotox/EnvSci:

*Mary Collins, Environmental Science
 Shannon Hanna, Environmental Science
International: *Christian Beaudrie, Environmental Risk (UBC)

Undergraduate students:

UCSB: Julie Whirlow, Psychology
 Univ of Wisc: *Sean Becker, Sociology
 Community college: William Reynold, Alexander Lyte

Other

UCSC: Kristen Nation, Women's Studies

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

1. Introduction: The overarching goals of IRG 3 are to generate new knowledge about the perceived risks and benefits of nanotechnology and related social action among multiple stakeholders in the nanoenterprise, to explore methods for public engagement in the US context, and to contribute to work in the CNS to disseminate the knowledge gained to an array of critical stakeholders, including diverse US publics, the engineered nanomaterials industry, and policy makers/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 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 anticipate primary focal points of public concern to be risk, benefit, regulation, trust, responsibility, and justice, and the degree to which experts share, anticipate, and address these concerns is a powerful predictor of the likelihood of ensuing controversy. IRG 3 thus conducts novel social research on formative nanotech risk and benefit perceptions 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 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., Kasperson, **Pidgeon**, & **Slovic**, 2003), which has been useful in understanding the evolution of risk controversies. However, thus far, as our work, among others, 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 and low risk signal amplification. Regulatory action has the potential to impact perceived risk quickly and hence is also a vital component of research. This unprecedented lengthy opportunity to study emergent attitudes, beliefs and perceptions is a particular attraction of the nano context for risk analysis, although it brings unique challenges as well. As the work progresses, 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 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, of how risk perceptions impact critical behavior, 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 research on critical stakeholder

groups – including the everyday public, organized groups, scientists, industry, environmental health and safety professionals, and regulators.

Quantitative methods used in IRG 3 include: standard, psychometric, consumer, and experimental decision pathway phone and web surveys of demographically diverse US (and other) public 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; qualitative methods 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:

- i. 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.
- ii. Examine emergent perceptions, attitudes and beliefs of the US (and comparative other) publics. 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 new survey examines environmental risk perception, looking at risk signal sensitivity in relation to application domain and particular engineered nanomaterials, and develops a novel new measure of perceived environmental resilience of air, water and soil. Midstream/downstream effects are being explored in this survey by examining nano risk perception in relation to consumer product safety attitudes. Another new survey examines political consumerism and how perceptions of nanotechnology affect consumers' decisions to avoid or purchase products with nanomaterials.
- iii. 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 more recent set of US workshops focus on gender dynamics in technological knowledge production in the deliberative setting; planning has begun for the next deliberative work that will expand the gender focus to look at race and ethnicity.
- iv. 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.
- v. 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 (carbon nanotubes, nano silver)
- vi. Study regulatory challenges across the product life cycle
- vii. Analyze how the international nanomaterials industry's perceptions of risk and regulation impact their environmental stewardship & workplace safety practices and their receptivity to the regulation of engineered nanomaterials
- viii. Gain initial 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.
- ix. Through X-IRG researcher Friedman, continue tracking of nano media coverage in the US and UK.
- x. Convene a 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*

- xi. Hands on engagement with the nano risk assessment enterprise through direct participation at the leadership level in the UC CEIN. In particular contribution to reflexive practice in the UC CEIN around issues of ethics and justice issues involved in public engagement, responsible innovation, and risk communication.

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” we draw on feminist 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 - collaborating teams, lead listed first:

IRG 3-1: Expert studies - UBC, U Wisc, UCSB, SUNY New Paltz, Decision Research, Compass Resource Management

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 (X-IRG) – Lehigh Univ

IRG 3-6: Priming Effects in Judgments about Public Policy - UCSB

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

IRG 3-8: NonGovernmental Organizations and Tomorrow’s Nanotechnologies – UCSB, Univ of AZ

Integration and synthesis of effort

IRG 3 effort takes place within a large, complex group, and integration is accomplished through frequent interactions, phone conferences, and meetings among the lead researchers and their teams. Individual project meetings occur on a weekly or even more frequent basis; **Harthorn, Pidgeon** and **Satterfield** hold regular monthly teleconferences. 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 and assess progress across the different research projects. In the past year, this has included half- or full-day IRG 3 meetings at the CNS Research Summit (May 2011), in Vancouver in Oct 2011, and at the SNET conference in Tempe in Nov 2011. Meetings are usually planned in conjunction with planned IRG 3 sessions at national or international conferences that also synthesize work across projects in the IRG. IRG 3 organized 2 full sessions at S.NET 2011 (grad Engeman and former postdoc **Rogers** were the organizers and chairs), has organized a session for the SRA-Europe in June 2012, as well as proposed sessions at 4S (Oct 2012) and S.NET 2012 (Oct 2012). If accepted, all of these sessions will provide a context for IRG meetings as well. **Pidgeon, Harthorn, & Satterfield** concluded nearly 2 years of work in concert putting together on a special edition of *Risk Analysis* (Nov 2011) that built on the white papers first presented at the Jan 2010 Nano Risk Perception specialist meeting in Santa Barbara and constitutes the first scholarly journal edition devoted to nanotech risk perception (see Priest 2012 for dedicated book volume on this topic). **Harthorn** has also, with collaborator **Mohr**, completed another lengthy editorial project on the edited volume, *The Social Life of Nanotechnology*, now in the final stages of production with Routledge and due out June, 2012. This volume integrates IRG 3 risk research (chapters by **Pidgeon’s** group, **Harthorn’s** deliberation group, **Johansson’s** lab ethnographic work, **Bimber’s** media framing group, and a theoretical contribution by **Freudenburg & Collins**) with other CNS work. **bimber**

4. Major IRG 3 research accomplishments in the Center

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, feminist studies, linguistics, materials science, political science, psychology, risk analysis, science and technology studies, and sociology), published at an accelerating rate in a number of leading journals and publications. IRG 3 also contributes to the educational and outreach accomplishments of the CNS in a number of ways.

IRG 3 work also intersects with that in IRGs 1 & 2 and X-IRG projects in a number of ways that both draws on and contributes to those efforts. In the past year that has included extensive interactions with IRG 1 graduate fellow Eardley-Pryor as his historical work on nano EH&S develops and draws on the extensive networks and knowledge of IRG 3 researchers working on EH&S risk issues, particularly in conjunction with the risk assessment efforts in the UC CEIN. IRG 1 leader McCray's book length work on US public imaginaries and early nano development provides temporal and cultural depth to the public deliberation work in IRG 3 as well. IRG 1 work on nano medicine (**November**) also contributes to IRG 3 focus on nano health applications, one of the main threads that connects our survey and deliberative work. IRGs 2 & 3 have shared interests in issues of equitable development that have brought them together in a number of research lines. IRG 3 contributed to the planning and facilitation of the CNS Equitable Development conference in 2009 and the IRG 2 publication that has emerged from it (**Parker & Appelbaum**, 2012; see also **Harthorn** et al., 2012; **Rogers & Zader**, 2012). IRG 3 researchers **Rogers** and Shearer are developing new CNS research in Mexico and Brazil in collaboration with IRG 2 collaborators **Folodari**, **Invernizzi**, and Lau. IRG 3 researchers **Harthorn**, **Holden** and Engeman are working with IRG 2 leader **Appelbaum** to assess feasibility of extending the industry survey to IRG 2's China business contacts in 2012. IRG 3's NGO study is similarly working w/ IRG 2 researchers and X-IRG researchers **Friedman** and **Newfield** to pool information on NGOs in Latin America, E. Asia, and Europe. IRG 2 and 3 also collaborate in development of the X-IRG work by Frederick at Duke on the US and global nano industry. This work contributes a base for future planned IRG 3 spatial analysis by **Harthorn**, **Satterfield**, and Collins of nano industrial development and risk perception in California.

IRG 3-1: Expert Judgments about Nanotechnologies' Benefits and Risks
Conti, Harthorn, Kandlikar, Satterfield (leaders); Beaudrie, Becker, **Bryant**, **Haldane**.

IRG 3-1a: Expert Interviews-NSE

Begun by **Harthorn** and **Bryant** in 2006-2007 in California, in 2010-11, anthropologist **Haldane**, an Asst. Prof at Quinnipiac Univ., piloted a new instrument to add a set of new respondents from the US upper northeast nano research world, developed a sample and contacted new NSE research participants in the US Midwest & Northeast to interview. Interviews focus on scientists' ideas about 'responsible development' of nanotechnologies, and on aspects of gender and scientific labor, from a cultural analytic perspective. This work provides important interpretive background for the more systematic survey work below. Key issues include gender differences among experts in risk attenuation (which has potential implications for safety practices in laboratory settings), attitudes toward the public and media (which impact the quality and extent of scientist participation in essential science and society engagement activities), direction of tech development labor toward social goals and responsible practices, and organizational aspects of laboratory practice. X-IRG former postdoc Johansson also contributes to this effort through his ethnographic interviews, now a book in progress and a chapter, Johansson (2012, forthcoming).

IRG 3-1b: Expert Studies-Regulators and Regulatory Challenges

Another component of CNS-UCSB expert study by **Conti**, an Asst Prof. of Sociology, affiliated in the Law School, at UW Madison, focuses on **nano regulators and policymakers**. His prior work with IRG 3 as a key collaborator on both the 2008 public risk perception survey and the 2006 industry EHS survey has attuned him to the protocols and risk perception issues of interest, and his unique background as an expert on international governance provides an extremely useful comparative framework. In 2010-2011 he conducted an extensive series of interviews with US nano environmental regulators in which he explored their views on issues of regulating nanomaterials and nano-enabled technologies, particularly in the context of significant risk uncertainty and jurisdictional constraints that provoke “relational regulation” (Huisin and Silbey 2011). This work connects directly to the expert web survey project (**IRG 3-1c**), and the teams have been coordinating closely. In the past year, **Conti** has directed an undergrad honors project with Becker involving additional interviews, and has completed the study of environmental regulators and is preparing a publication to better understand how regulators think about risk, the way precaution and analogical references by regulators partially overcome what Beck has called “the ultimate deadlock of modern society,” that is, the need to make decisions about oversight under conditions of uncertainty, and the way regulatory risk judgment works as an inevitable form of discretion and informs risk management.

This work also will interface well with the UBC team’s analytic work on **regulation across the life cycle** and both studies link well to our collaborative work in the UC CEIN. In 2011, the UBC team completed a paper (Beaudrie, **Kandlikar** and **Satterfield**, under review) based on Beaudrie’s Chemical Heritage Foundation commissioned study of regulatory gaps across the life cycle of nanomaterials, released in Sept. 2010 and reported in our Yr 6 Annual Report. This work identifies critical gaps with respect to 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, and Beaudrie and **Harthorn** have been participating in the nano LCA work in development in the UCSB CEIN at the Bren School.

Closely connected to this, the UBC team (**Kandlikar**, **Satterfield** & Beaudrie) is working with Decision Research structured decision making expert, **Robin Gregory**, and collaborator **Graham Long**, to develop a framework for expert elicitation for the ranking of nanomaterial risks, to be run as a workshop in spring 2012. The goal of the workshop is to understand the process of expert judgment formation in the context of high uncertainty about risks. They aim to develop generalized risk influence diagrams to track nano risk pathways (specific to carbon nanotubes & nano silver), to identify measureable attributes for key risk factors, and to test the feasibility of weighting risk concerns in light of attribute thresholds. This work is culmination of the past 2 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. Yet, they note that decision analytic research and tool development is lagging, and will require targeted funding mechanisms (Beaudrie & **Kandlikar** 2011). Also, they have pointed out that baseline information call-ins for nanomaterials have so far provided scant data to assist in risk assessment (EPA’s NMSP, DTSC’s call-in). However, they argue that both approaches have some merit, with the DTSC call-in benefiting from engagement with companies. They also note that confidentiality (CBI—Confidential Business Information) claims are likely to be a significant barrier to collecting risk-relevant data by regulatory agencies, and future information call-ins should be designed carefully with decision-objectives and potential barriers in mind. The

experimental expert workshop in spring 2012 is a highly experimental attempt to address lagging development. Collaborating CEIN leaders will be active participants.

IRG 3-1c: Expert Web Survey—NSE, Nanotox, NanoReg

On a parallel track, and incorporating knowledge gained in expert interviews (IRG 3-1a) the UBC team (Beaudrie, **Kandlikar & Satterfield**) completed data collection for a Nanoscience Expert Survey in spring/summer 2010, working with the Social Science Survey Center at UCSB in collaboration with **Harthorn**. The survey was delivered to 2130 nano-experts with 424 responses from nanoscientists and engineers (NSE), nano-EHS researchers (NanoTox), and nanotechnology regulators (NanoReg). Data analysis is far along, with presentations at UC CEIN (May 2011), Nano OEH (Aug 2011), SNET (Nov 2011) and SRA (Dec 2011), and key publications nearing readiness to submit (Beaudrie, **Satterfield, Kandlikar & Harthorn**, 2 papers in preparation). 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. Preliminary results:

- The expert survey found consistent patterns in risk ranking of nanomaterial release scenarios and product applications across the three nano expert groups, suggesting a general trend and agreement in relative ranking of potential risks. Occupational exposures and environmental releases from production facilities were deemed most risky compared to other release scenarios and specific nano-applications.
- Nonetheless, we also found significant differences in risk perceptions across nano-expert groups, and across demographics including gender and race. We argue that these small but consistent differences in risk judgment once identified, should be taken into consideration and controlled when utilizing expert judgment under conditions of high uncertainty, such as when conducting risk analysis for emerging nanomaterials.
- Experts in regulatory agencies judge risks across a range of nano-application categories to be significantly higher than corresponding judgments of NSE and nano-EHS researchers. Somewhat surprisingly, regulators in this study are also *more* likely than the other two groups to agree that US regulatory agencies are inadequately prepared for controlling risks from nanotechnologies across application categories.

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

IRG 3-2: Emergent Public Perceptions of Benefits and Risks (survey research)

Satterfield, Pidgeon, Harthorn, Kandlikar, Beaudrie, **Conti**, Collins, Corner, D'Arcangelis, Hanna, Pitts

IRG 3-2a: Public perceptions, emergent preferences

Since 2009, the team has continued analysis and write up of data from the 2008 national survey, preparing a series of papers from this work, 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. The first of these on vulnerability and inequality as factors in risk perception was published in *Risk Analysis* (**Conti et al.** 2011), 1 on judgment reversals is under review (**Satterfield, Conti et al.**, 2012),

and another on affect and ambivalence response is in final steps of revision for resubmission (**Satterfield**, Corner et al., 2012).

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 the deliberation research, other public attitude survey studies, including environmental risk perception survey research, and research planning for IRG 3 for years 8-10. **Pidgeon** also collaborated with Baruch Fischhoff (Carnegie Mellon University and the NSF funded Climate Decision Making Center) on a paper published in the March 2011 issue of *Nature Climate Change* arguing that US scientists should build future strategic capability around risk communication for environmental decision making. Climate change provides one important comparative case for nano risk perception.

In addition, **Pidgeon** (with **Harthorn** and **Satterfield** as co-editors) has been the lead editor on the special issue of *Risk Analysis*, just out in Nov 2011 and distributed at the Dec 2011 annual meeting of the Society for Risk Analysis. **Pidgeon**, **Harthorn** and **Satterfield** (2011) co-authored the introductory overview for the collection. This is the first special issue of a journal exclusively focused on risk perception research on nanotechnologies. As a whole, the pieces in this volume demonstrate that most nanotechnologies – to date – hold the characteristics, in social amplification terms, of an attenuated hazard.

IRG 3 plans for the next 3 years include additional cross-national survey in the US and UK, and experimental decision pathway analysis in collaboration with Decision Research. Additional parallel survey in the UC CEIN in 2012 led by **Satterfield** will further these efforts.

IRG 3-2b: Environmental Risk Perception Survey

Satterfield, **Harthorn**, Collins, D'Arcangelis, Hanna, Pitts

Leverage: Primarily funded through the UC CEIN IRG 7, 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 completed a study of public perceptions of air, water, and soil alone and in interaction with ENMs. This survey was based on a series of mental models interviews (which seek lay theories of cause and effect, and lay intuitions about harm and safety). A paper on the environmental values from the mental models research is in preparation (D'Arcangelis et al.). Selective preliminary findings from the pilot survey on environmental risk perceptions of ENMs by a large pilot sample (n=750) of US public include:

- Reporting that ENMs are present in air, soil, and/or water leads to respondents scoring the ENMs as more difficult to detect and/or measure in the environment (i.e., to touch, feel, see, describe, measure, sample and test). Those who see ENMs as highly intangible are more likely to have higher risk ratings for some materials.
- Respondents with higher tested nanotech knowledge were consistently slightly more accepting of specific ENMs than those with little or no knowledge of nanotechnologies, though the differences are modest.
- 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**, Pitts and **Harthorn**, in preparation 2012).

Planning and implementation of a stage 2 survey to a larger and more representative sample is planned for Spring-Summer 2012. 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.

IRG 3-3: Public Participation in Nanotechnology R&D: Upstream Engagement and Deliberation Research

Harthorn, Barvosa, Bryant, Rogers, Pidgeon, Corner, Cranfill, Denes, Hanna, Lyte, Martin, Nation, Shearer, Whirlow

2008-2011. Leverage*: To extend our earlier deliberation work (US-UK comparative deliberation; **Pidgeon** et al. 2009) and follow the very suggestive gender differences in perceived risk that emerged within all the groups in the 2007 workshops, **Harthorn** (and **Bryant**) sought and received additional funding from NSF for new research to explore gendered aspects of nanotech risk perception. This study examines gender as a between group effect in 6 deliberative workshops plus one pilot, conducted in California in summer and fall, 2009. Feminist sociologist **Rogers**, now Asst. Prof. of Sociology at Long Island Univ., was postdoctoral researcher on the project Jan 2009-Aug 2010; sociologist Shearer followed up on a year as fellow on the project by assuming the postdoc position in Sept 2010 on a parttime basis. Additional team members in the past year include grads Cranfill, Denes, & Hanna, undergrad Whirlow, community college student Lyte, and research assistant Nation.

The work in the past year has advanced the project significantly, and this project is in its final stages. The team has published extensively on the project (**Harthorn, Rogers** et al. 2012; **Harthorn**, Shearer et al. 2011; **Harthorn**, Shearer et al. 2012; **Rogers**, Shearer & **Harthorn** 2011; **Rogers**, Shearer et al, 2012 forthcoming), and 3 additional publications are currently in preparation (Cranfill et al. in prep; Denes et al. in prep; Shearer et al in prep), and a larger piece on the main gender analysis (**Bryant** et al, in prep). In general, the work supports findings from survey work on the highly gendered nature of technological risk perception but is aiming to explicate how, why and through what kinds of narratives and group dynamics such views are produced in public dialogue, as well as the kinds of responses they generate. These are important questions for participatory democracy. Looking ahead, **Harthorn** and **Bryant** have begun collaboration with UCSB feminist political theorist, Edwina **Barvosa**, to plan a future deliberative project that will incorporate a focus on racial/ethnic identity and multiple identities/intersectionality as factors in risk and benefit perception and deliberative outcomes. The team has disseminated findings extensively in the past year, with plans for additional presentations in the coming year.

In addition the Cardiff team under **Pidgeon** has worked with UK House of Commons Science & Technology Select Committee inquiry on the Regulation of Geoengineering, arguing that any investment in the physical science of geoengineering should be pre-empted by investment in social science too – so that public engagement on geoengineering can be as upstream and effective as possible. Their 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. This work demonstrates the applicability of NNI-funded upstream nano research to other emerging technologies and its potential contributions to regulatory decision making and responsible innovation. **Pidgeon** gave a keynote address on this work at the S.NET conference in Tempe in Nov, 2011.

The Cardiff team (Corner & **Pidgeon**) took on a key writing task for *The Social Life of Nano* edited volume, producing an overview/synthesis of nano public engagement entitled: “Nanotechnologies and upstream public engagement: dilemmas, debates and prospects?” For this work, they created a comprehensive and up-to-date database of all (global) public

engagement projects that were documented by either peer-reviewed publications or reports that reflected on data and methodology. The chapter argues that upstream engagement, though challenging in a number of respects, is an important aspect of responsible development. The database is included as part of the chapter and serves as an anchor for CNS discussions in the volume and other venues of the debates around upstream engagement.

IRG 3-4: Industry risk perception study (International survey)

Harthorn, Holden, Satterfield, Engeman, Baumgartner

This project, funded primarily through the UC CEIN IRG 7 (led by **Harthorn**), aims to assess changes in industry EH&S views and practices, first studied in our 2006 international survey (**Conti** et al. 2008) 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 project was run as a Bren School for Environmental Science and Management Masters Group Project, for the MSc degree, with **Holden** the Bren advisor, **Harthorn** the PI, and sociology doctoral candidate Cassandra Engeman the project coordinator and lead student researcher. The phone and web survey concluded data collection in June 2010 ($n=78$ companies in 14 countries). **Satterfield** has provided extensive consultation regarding the novel risk perception portion of the instrument and data analysis for those data. The first publication (Engeman et al. 2012) demonstrates 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. A second publication nearing readiness to submit (Engeman et al., in preparation 2012) focuses on the implications for worker safety of these findings.

The industry survey project has been of significant interest to NSE, industry and regulators, as well as NGOs and publics, and the team has made numerous presentations outside of social science venues.

IRG 3-5 Framing of Nano in the Media (X-IRG)

Friedman, Egolf

The work on media framing of nano and analysis of news trends over time in coverage of nanotechnology led by **Bimber** in the first 5 years is concluded with one publication in press (Lively et al, forthcoming, 2012). Former grad researcher in this project Weaver is continuing his work in media analysis for CNS by producing the Weekly Clips publication for the CNS-UCSB.

The study of media framing of nano, a critical issue in public opinion formation, has now shifted fully to collaborator **Friedman** at Lehigh University and her team, reported below under X-IRG initiatives. **Friedman** and **Egolf** have developed an extensive coding system for analyzing print media coverage of nano and will be exploring methods for studying on-line coverage in a valid and reliable fashion. **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 (**Friedman & Egolf** 2011; **Friedman and Egolf** 2012).

IRG 3-6: Priming Effects in Judgments about Public Policy

Bimber, Conroy, Lively

The use of analogies has been a strong recurrent theme in anticipatory discussion of public response to nanotechnologies. This project, led by political scientist **Bimber**, has examined the effects of issue framing on how the US public forms opinions about nano. The group has developed a theoretical framework combining research in psychology on cognitive biases with theories of framing in political science and communication and completed an experimental web survey with about 700 subjects in 2010, using Knowledge Networks. The results show substantial contrast effects: that is, subjects primed first to think about a technological issue or other public problems tend to view a second, target issue or problem in contrast to the priming issue. Exposure shifts opinion away from the priming issue, compared with subjects not so exposed. In the past year, they have investigated the effects on certain comparisons of an issue priming effect, in which conspicuous comparison evokes a process of mental contrast, resulting in audiences seeing the target issue as different rather than similar to the issue being compared. They hypothesized that this effect would be moderated by cognitive sophistication and opinion strength and tested these ideas using data from an experiment, and found support for most of their expectations on three of four policy issues. The results of this project are under journal review (**Bimber, Conroy** and Lively, under review 2012).

IRG 3-7: The Politics of Consumer Choice

Bimber, Copeland

Research shows an increase in recent decades in political consumption across Europe and in the US: that is, instances where consumers make choices in the marketplace that partially reflect political, ethical, or social concerns. Boycotting or “buycotting” are reported by about 30% of Americans each year. This phenomenon is not well understood, especially the circumstances under which these acts represent risk-avoidance as opposed to environmental or ethical choices involving public goods problems (Copeland and Smith, forthcoming 2012). It is entirely unclear, moreover, how the rise in political consumption might affect consumer products with nanotechnology in them. This project involves a national survey of citizens, examining the attributes and attitudes associated with political choices in the marketplace, and examines how people who engage in political consumption respond to questions about nano-related products. The survey of 2200 was fielded in summer 2011. The study (in progress) is finding significant differences between people who received the risk frame and people who received the benefits (of nano) frame regarding decisions to avoid or purchase products with nanomaterials (Copeland in preparation; Copeland & **Bimber**, in preparation; Copeland, **Bimber** and **Earl**, in preparation;).

IRG 3-8: NonGovernmental Organizations and Tomorrow’s Nanotechnologies

Harthorn, Earl, Engeman, Reynolds

New project in 2011. This project, long in planning, 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 by mapping the NGO *field* by developing an exhaustive, global matrix of more than 80 NGOs engaging in nano-specific environmental, workplace, and consumer safety issues. The work asks why have some NGOs coalesced concern with nanotechnology as opposed other issues? The next phase (summer 2012) will be to continue to build the nano-focused organization database, while developing a database and 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**. These non-nano-focused NGOs of interest will be matched with the nano-focused NGOs in our current global matrix. In Yr 8, interviews will extend understanding of key selected organizations, including eliciting risk perception data from NGO leaders. This work in turn will contribute to CNS's planned public engagement efforts in Yrs 8-10, including plans for a large international conference/workshop with NGO leaders.

***IRG 3 Co-funding:**

Leverage:

1) **Harthorn** (NSF SES-0824042), \$249,996, "Deliberating Nanotechnologies in the US: Gendered Beliefs about Benefits and Risks as Factors in Emerging Public Perception and Participation," 2008-2011. **Rogers** was a postdoc researcher for 1.5 years, now a collaborating faculty member, developing a new CNS project in Mexico; Shearer began as a fellow in IRG 3 and then moved into the postdoc role, parttime, 2010-2011, now funded through CNS in Yr 7, Martin, Hanna, and Denes were/are CNS fellows who contribute effort on this project. Cranfill and Whirlow were student researchers on this project in the past year. This project concluded in Sept 2011.

2) **Nel, Andre** et al. (NSF DBI-0830117), UCSB subk \$8.7M (1.3M in CNS direct leverage funds in Theme 7) UC Center for Environmental Implications of Nanotechnology, **Harthorn** is Theme 7 ("Environmental Risk Perception") leader, Co-PI of the UCSB subcontract, and a member of the UC CEIN Executive Committee, 2008-2013; **Satterfield** and **Kandlikar** are Theme 7 senior personnel; **Freudenburg** was senior personnel until his untimely death in Dec 2010;

Freudenburg's student Collins is now working with **Harthorn**. The IRG 7 UC CEIN funding allows 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. The IRG 7 funding in the UC CEIN has provided funds for public survey research on nano environmental risk perception (**D'Arcangelis**, in preparation; **Satterfield**, Pitts and **Harthorn**, in preparation; Collins, Hanna, **Harthorn & Satterfield**, in preparation), the 2009-2010 international industry survey (Engeman et al. 2012); partial support of the expert survey (Beaudrie et al, in preparation); partial support of the expert workshop; and the Collins nanoremediation study (Collins, **Harthorn** and **Satterfield**, in preparation).

3) **Conti** secured intramural funding at Univ. of Wisconsin that is supporting a student researcher and partially supported his research travel in 2010 on the regulator interview project (**Conti & Becker**, in preparation).

4) **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 how to engage with the general public in a way that builds trust both for academic researchers and for nanotechnology, as well as the priorities of critical stakeholders when it comes to both the regulation and deployment of nanotechnology.

IRG 3 has contributed to CNS broader impacts through research on, education, and outreach to key stakeholders in the nanoenterprise, sharing nano 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 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, 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; UCSB Speculative Futures program; IRG 3 deliberative forums; social media use; Weekly Clips service; website development).

IRG 3, along with the rest of CNS, has had highly successful educational outcomes as measured by achieved employment of former fellows (nanoscience and social science) and postdocs in academia, industry, science policy, and NGOs. This contribution to the rising societal implications workforce is substantial and growing.

IRG 3 Publications 2011-2012

Primary Publications: Journals

1. **Conti, Joseph, Satterfield, Theresa, & Harthorn, Barbara.** (2011). Vulnerability and Social Justice as Factors in Emergent US Nanotechnology Risk Perceptions *Risk Analysis* 31(11), 1734–1748. doi: 10.1111/j.1539-6924.2011.01608.x
2. Engeman, Cassandra D., Baumgartner, Lynn, Carr, Benjamin M., Fish, Allison M., Meyerhofer, John D., **Satterfield, Terre A., Patricia Holden, Harthorn, Barbara Herr.** (2012). Governance implications of nanomaterials companies' inconsistent risk perceptions and safety practices. *Journal of Nanoparticle Research*, 14(749), 1-12. doi: 10.1007/s11051-012-0749-0
3. **Friedman, Sharon M., & Egolf, Brenda P.** (2011). A Longitudinal Study of Newspaper and Wire Service Coverage of Nanotechnology Risks. *Risk Analysis*, 31(11), 1701-1717.
4. **Pidgeon, Nick, Harthorn, Barbara, & Satterfield, Theresa, Eds.** (2011). Nanotechnology Risk Perceptions and Communication: Emerging Technologies, Emerging Challenges. *Risk Analysis (special issue)*, 31(11), 1694–1700. doi: 10.1111/j.1539-6924.2011.01738.x
5. **Pidgeon, Nick, Harthorn, Barbara, & Satterfield, Theresa, Eds.** (2011). *Risk Analysis (special issue)*, 31(11): 1694-1783. doi: 10.1111/j.1539-6924.2011.01738.x
6. **Roco, Mihail C., Harthorn, Barbara, Guston, David, & Shapira, Philip.** (2011). Innovative and responsible governance of nanotechnology for societal development. *Journal of Nanoparticle Research* 13(9), 3557-3590. doi: 10.1007/s11051-011-0454-4
7. **Rogers-Brown, Jennifer B., Shearer, Christine, & Harthorn, Barbara Herr.** (2011). From Biotech to Nanotech: Public Debates about Technological Modification of Food. *Environment and Society: Advances in Research*, 2(1), 149-169. doi: doi:10.3167/ares.2011.020109

Primary Publications: Books, Chapters, Reports and Other Publications

8. Beaudrie, C.E.H., **Kandlikar, M.**, & Ramachandran, G. (2011). Using Expert Judgment for Risk Assessment. In G. Ramachandran (Ed.), *Assessing Nanoparticle Risks to Human Health* (pp. 110-138). Maryland Heights, MO: Elsevier.
9. **Friedman, Sharon M.**, & **Egolf, Brenda P.** (2012). What have the Mass Media been Reporting on Nanotechnology Risks? In Susanna Hornig Priest (Ed.), *Nanotechnology and the Public: Risk Perception and Risk Communication* (pp. 157-165). Boca Raton, FL: CRC Press.
10. **Harthorn, Barbara Herr.** (2011). Methodological Challenges Posed by Emergent Nanotechnologies and Cultural Values. In *The Handbook of Emergent Technologies and Social Research*, Ed. Sharlene Nagy Hesse-Biber, New York: Oxford University Press, 65-88.
11. **Harthorn, Barbara**, Rogers, Jennifer, Shearer, Christine, & Martin, Tyrone. (2012). Debating Nanoethics: U.S. Public Perceptions of Nanotechnology Applications for Energy and the Environment. In Dane Scott & Blake Francis (Eds.), *Debating Science: Deliberation, Values, and the Common Good* (2nd ed., pp. 227-249). New York: Prometheus Books.
12. **Harthorn, Barbara**, Shearer, Christine, & **Rogers, Jennifer.** (2012). Risk perception, public participation, and sustainable global development of nanotechnologies. In Rachel Parker & Richard Appelbaum (Eds.), *Can Emerging Technologies Make a Difference in Development?* (pp. 188-197). New York: Routledge.
13. **Harthorn, Barbara Herr**, Shearer, Christine, **Rogers, Jennifer.** 2011. Exploring ambivalence: Techno-enthusiasm and skepticism in US nanotech deliberations. In *Quantum Engagements: Social Reflections of Nanoscience and Emerging Technologies.* Ed. Torben B. Zülsdorf, Christopher Coenen, Arianna Ferrari, Ulrich Fiedeler, Colin Milburn, & Matthias Wienroth. Amsterdam: IOS Press, 75-89
14. Johansson, Mikael. (2010). Vi är dina provexemplar - om etnografiskt fältarbete i laboratoriemiljö (We are your samples - On ethnographic fieldwork in laboratory environments). In J. Bärmark (Ed.), *Att tänka genom kulturer (To think through cultures)*. Gamla Stan, Stockholm: Carlssons förlag.
15. **Roco, Mihail, Harthorn, Barbara Herr, Guston, David, & Shapira, Philip.** (2011). Innovative and Responsible Governance of Nanotechnology for Societal Development. In Mihail Roco & Mark C. Hersam (Eds.), *Nanotechnology Research Directions for Societal Needs in 2020* (pp. 561-618). Boston and Berlin: Springer.
16. Rogers, Jennifer, & Zader, Amy. (2012). Food Security: From the Green Revolution to Nanotechnology. In Rachel Parker & Richard Appelbaum (Eds.), *Can Emerging Technologies Make a Difference in Development?* (pp. 75-85). New York: Routledge.
17. Copeland, Lauren & **Smith, Eric. R.A.N.** (forthcoming, 2012). Political Consumerism: Citizen Activism in Response to Climate Change and other Environmental Problems. In Y. Wolinsky-Nahmias (Ed.), *Climate Change Policy and the Role of Society*. Washington, D.C.: CQ Press.
18. Corner, Adam, & **Pidgeon, Nick.** (forthcoming). Nanotechnologies and Upstream Public Engagement: Dilemmas, Debates and Prospects? In Barbara Herr Harthorn and John Mohr (Ed.), *The Social Life of Nanotechnology*. New York: Routledge.
19. **Freudenburg, William**, & Collins, Mary B. (forthcoming). Public Responses to Nanotechnology: Risks to the Social Fabric? In Barbara Herr Harthorn and John Mohr (Ed.), *The Social Life of Nanotechnology*. New York: Routledge.
20. **Harthorn, Barbara Herr, & Mohr, John.** (forthcoming). Introduction: The Social Scientific View of Nanotechnologies. In Barbara Herr Harthorn and John Mohr (Ed.), *The Social Life of Nanotechnology*. New York: Routledge.
21. **Harthorn, Barbara Herr, & Mohr, John W.** (Eds.). (forthcoming). *The Social Life of Nanotechnology*. New York: Routledge.

22. Johansson, Mikael. (forthcoming). Working for Next to Nothing - Labor in the Global Nanoscientific Community. In Barbara Herr Harthorn & John W. Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.
23. Lively, Erica, **Conroy, Meredith**, Weaver, David, & **Bimber, Bruce**. (forthcoming). News Media Frame Novel Technologies in a Familiar Way: Nanotechnology, Applications, and Progress. In Barbara Herr Harthorn and John Mohr (Ed.), *The Social Life of Nanotechnology*. New York: Routledge.
24. Rogers-Brown, Jennifer, Shearer, Christine, **Harthorn, Barbara Herr**, & Martin, Tyrone. (forthcoming). Different Uses, Different Responses: Exploring Emergent Cultural Values through Public Deliberation. In Barbara Herr Harthorn & John Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.

Leveraged publications: Journals

25. Beaudrie, C.E.H., **Kandlikar, M.**, (2011) Horses for Courses: Risk Information and Decision Making In the Regulation of Nanomaterials. *Journal of Nanoparticle Research*, 13(4), 1477–1488. <http://www.springerlink.com/content/k45528766006522v/>
26. **Pidgeon, Nick**, Corner, Adam, Parkhill, K, Spence, A, Butler, C, & Poortinga, W (forthcoming). Exploring early responses to geoengineering. *Philosophical Transactions of the Royal Society (A)*.

Leveraged publications: Book Chapters & Other Publications

Submitted or in preparation publications: Primary

27. Beaudrie, C.E.H, **Kandlikar, M**, & **Satterfield, T** (under review). Engineered nanomaterials and life-cycle regulation: A review of Federal Regulatory Oversight from Cradle-to-Grave. *Environmental Science & Technology*.
28. **Bimber, B**, **Conroy, M**, & Lively, E. (under review). Priming Effects and Contrast in Issue Comparisons.
29. **Satterfield, Terre**, Corner, Adam, **Pidgeon, Nick**, **Conti, Joseph** and **Harthorn, Barbara Herr**. (under review). Affective Ambivalence and Nanotechnologies.
30. **Satterfield, Terre**, **Conti, J**, Pitts, A, & **Harthorn, Barbara Herr**. (under review). Understanding Malleable Perceptions of Nanotechnologies' and their Implications for Science and Policy Dialogues about Emerging Technologies. *Science and Public Policy*.
31. Beaudrie, C.E.H, **Satterfield, T**, **Kandlikar, M**, & **Harthorn, B. H**. (in preparation). Nanotechnology and Regulation: Experts views on regulator preparedness for managing risks from engineered nanomaterials. *Nature Nanotechnology*.
32. Beaudrie, C.E.H, **Satterfield, T**, **Kandlikar, M**, & **Harthorn, B. H** (in preparation). Scientists vs Bureaucrats: Precaution, Novelty, & Politics as predictors of perceived risk of ENMs. *Risk Analysis*.
33. **Bryant, Karl**, **Barbara Herr Harthorn**, Christine Shearer and **Jennifer Rogers-Brown**. (in preparation). "Deliberating Socio-Techno Presents and Futures: Making Sense of New Technology through the Lens of Inequality, Risk, and Difference."
34. **Bryant, Karl**, **Barbara Herr Harthorn**, **Jennifer Rogers-Brown**, and Christine Shearer. (in preparation). Deliberating New Technologies and the Production of Gendered Risk Perception.
35. **Conti, Joseph**, & Becker, Sean. (in preparation). Regulatory Risk Judgment: How the EPA confronts scientific uncertainty and the challenges of Nanotechnology.
36. Copeland, Lauren. (in preparation). Conceptualizing Political Consumerism.
37. Copeland, Lauren, & **Bimber, Bruce**. (in preparation). New Technology and Political Consumerism: Predicting Aversive Behavior in the Market to Nanotechnology.

38. Copeland, Lauren, **Bimber, Bruce**, & Earl, Jennifer. (in preparation). Collective Action and Political Consumerism.
39. Cranfill, Rachel, Christine Shearer, Karl Bryant, Jennifer Rogers, Shannon Hanna, Amanda Denes, Barbara Herr Harthorn. (in preparation). Indexing Expertise in a Deliberative Setting: A Comparison
40. Denes, Amanda, Rachel Cranfill, Barbara Herr Harthorn, Christine Shearer, Julie Whirlow, and Shannon Hanna. (in preparation). Talking Nano: The Importance of Gender, Race, and Power in Deliberations on the Risks and Benefits of Nanotechnology
41. Engeman, Cassandra, Lynn, Baumgartner, **Holden, Patricia**, & **Harthorn, Barbara Herr**. (in preparation). Environmental safety practices and implications for workers in the international nanomaterials industry.
42. Shearer, Christine, Jennifer Rogers-Brown, Karl Bryant, Rachel Cranfill, and Barbara Herr Harthorn. (in preparation). Power and Vulnerability: Reexamining "Low Risk" Perceptions of Environmental and Health Hazards.

Submitted or in Preparation Publications: Leveraged

43. Corner, Adam, **Pidgeon, Nick**, & Parkhill, K. (under review). Perceptions of geoengineering: Public attitudes, stakeholder perspectives & the challenge of 'upstream' engagement. *Wiley Interdisciplinary Reviews (WIREs) Climate Change*.
44. Parkhill, K. A, **Pidgeon, N. F**, Corner, A, & Vaughan, N (under review). Geoengineering. In Owen (Ed.), *Responsible Innovation*.
45. Collins, M, & **Freudenburg, W**. (in preparation). Technological Risk Messages: Comparing Nuclear Power and Nanotechnology.
46. Collins, M, & **Freudenburg, W**. (in preparation). Temporal Myopia: A Case of Promising New Technologies, the Federal Government, and Inherent Conflicts of Interest.
47. Collins, Mary, Hanna, Shannon, **Harthorn, Barbara**, & **Satterfield, Terre**. (in preparation). Nanotechnology Risk Judgement Analysis: Consumer Product Safety and Environmental Attitudes.
48. Collins, M, **Harthorn, B.**, & **Satterfield, T**. (in preparation). Nanoremediation: Are there equity concerns?
49. D'Arcangelis, Gwen, DeVries, Laura, **Satterfield, Terre**, & **Harthorn, Barbara Herr**. (in preparation). Cultural models of environment and hazard in the US and Canada: Exploring emergent views on engineered nanomaterials. *Journal of Environmental Ecology*.
50. **Satterfield, Terre**, Pitts, Anton, & **Harthorn, Barbara Herr**. (in preparation). Resilience as a Primary Factor in the Perceived Environmental Risk. *Ecology and Society*.

IRG 3 Presentations 2011-12

1. **Bimber, B.** 2011. "Political Consumerism: Organization, Goods, Ideology & Communication." Presentation at The Politics of Consumption/The Consumption of Politics International Conference, Madison, Wisconsin, March 1, 2011
2. Copeland, L. 2011. "Political or Civic Consumerism?" Poster presentation at The Politics of Consumption/The Consumption of Politics international conference, Madison, Wisconsin, March 1, 2011.
3. **Barbara Herr Harthorn**. "Health Enhancement and Hazard Posed by New [Nano]Technologies." Keynote at Cascadia Seminar: Ethnographic Adventures in Medical Anthropology. Univ. of Washington, Seattle, Mar 4-6, 2011.
4. **Barbara Herr Harthorn, Milind Kandlikar, & Terre Satterfield**. "IRG 7- Environmental Risk Perception: Implications for the UC CEIN and Regulators," Presentation at the UC CEIN annual retreat, Lake Arrowhead, Mar 11-12, 2011.

5. Christine Shearer, Jennifer Rogers & **Barbara Herr Harthorn**. "The Importance of Application Domain in Public Deliberations of Nanotechnology." Society for Applied Anthropology Meeting, Seattle, Mar 30-Apr 2, 2011.
6. Engeman, Cassandra. "Reported Practices and Perceived Risks Related to Health, Safety and Environmental Stewardship in Nanomaterials Industries." Paper presented to the CNS National Advisory Board. April 4, 2011.
7. **Harthorn, Barbara Herr**. Risk, Uncertainty and Ambivalence in Views on New [Nano]Technologies." Cultural Anthropology Collective & Forum, Department of Anthropology, UCSB, Apr 14, 2011.
8. Cassandra Engeman. "Perception and Practices in the Nanomaterial Industry: Implications for Regulation." Poster presented at NSF site visit to CNS. UCSB, May 1, 2011.
9. D'Arcangelis, Gwen, **Satterfield, Terre**, DeVries, Laura, Hanna, Shannon, Pitts, Anton & **Harthorn, Barbara Herr**. "US Public Knowledge and Perception of Nanomaterials in Air, Water, and Soil" Poster presented at NSF site visit to CNS. UCSB, May 1, 2011.
10. Cassandra Engeman. "Perception and Practices in the Nanomaterial Industry: Implications for Regulation." Poster presented at ICEIN – International Conference on the Environmental Implications of Nanotechnology, Durham, NC, May 9-11, 2011.
11. Mary Collins, **Barbara Herr Harthorn, Terre Satterfield**. "Nanoremediation: Will equity concerns arise?" Poster presented at the 3rd Annual International Conference on Environmental Implications of Nanotechnology (ICEIN), Duke University, Durham, NC, May 9-11, 2011.
12. Beaudrie, Christian, **Satterfield, Terre, Kandlikar, Milind, Herr Harthorn, Barbara**. "Benefits, Risks, and Regulation of Nanomaterials: Results from an Expert Survey," Paper presented at ICEIN – International Conference on the Environmental Implications of Nanotechnology, Durham, NC, May 9-11, 2011.
13. **Barbara Herr Harthorn, Terre Satterfield**, Anton Pitts, **Gwen D'Arcangelis**, & Laura DeVries. "Intuitive Cognition in the Perception of Environmental Media and Nanomaterials: A Study of US Public Views." 3rd Annual International Conference on Environmental Implications of Nanotechnology (ICEIN), Duke University, Durham, NC, May 9-11.
14. Mary B. Collins, **Barbara Herr Harthorn**, and **Terre Satterfield**. 2011. "Nanoremediation Siting Under Conditions of Technological Uncertainty." Presentation at the annual meeting of the Association of Environmental Studies and Sciences. June 2011, Burlington, VT
15. **Pidgeon, Nicholas**. "The Curious Case of SPICE: Deliberating Geoengineering as Anticipatory Research Governance?" Annual Meeting of the Society for Social Studies of Science (4S), Cleveland, OH, November 1, 2011.
16. **Pidgeon, Nicholas**. "The Curious Case of SPICE: Deliberating Geoengineering as Anticipatory Research Governance?" Keynote paper, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, Arizona, November 1, 2011.
17. Engeman, Cassandra. "Regulation and the Global Nanotechnology Industrial Workplace," CNS seminar, CNS-UCSB, Santa Barbara, CA, November 2, 2011.
18. Hanna, Shannon. "Impacts of Zinc Oxide Nanoparticles on the Mussel," CNS seminar, CNS-UCSB, Santa Barbara, CA, November 2, 2011.
19. Collins, Mary. "Nanoremediation: Are There Equity Concerns?" CNS seminar, CNS-UCSB, Santa Barbara, CA, November 2, 2011.
20. Cranfill, Rachel. "Talking Nano: The Importance of Gender, Race, and Power in Deliberations on the Risks and Benefits of Nanotechnology," CNS seminar, CNS-UCSB, Santa Barbara, CA, November 2, 2011.
21. **Harthorn, Barbara Herr, Guston, Dave** "Opening Remarks," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 7, 2011.

22. **Bryant, Karl.** "Nanomaterials, Toxicology & Risk," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
23. Hanna, Shannon, **Miller, Robert,** and Lenihan, Hunter. "Impacts of Zinc Oxide Nanoparticles on the Mussel," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
24. Collins, Mary. "Nanoremediation: Are There Equity Concerns?" Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
25. Freidman, Shanon. "Nano, Media & the Public," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
26. **Invernizzi, Noela.** "Nanotechnology and Labor: Trends in Industry and Union's Perspectives," Plenary Address. Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
27. **Rogers-Brown, Jennifer,** Shearer, Christine, Co-Chairs. "Food, Nanotech Food," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
28. **Rogers-Brown, Jennifer,** Shearer, Christine, & **Harthorn, Barbara Herr.** "Public deliberation and democratic participation: The methodological and political possibilities of deliberation on nanotechnology." Presentation at the S.NET Conference, Tempe, AZ, Nov 8, 2011.
29. Engeman, Cassandra, Chair & Organizer, "Regulatory Challenges of Nanotechnology" Panel at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
30. **Rogers-Brown, Jennifer,** Chair & Organizer, "Gender and Nanotechnology: A Mixed-Method Panel of Risk Perception and Social Location." Panel at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
31. Denes, A., Cranfill, R., **Harthorn, Barbara Herr.,** Shearer, C., Whirlow, J., Hanna, S. "Talking Nano: The Importance of Gender, Race, and Power in Deliberations on the Risks and Benefits of Nanotechnology." Paper presented at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
32. **Kandlikar, Milind.** "Challenges in Regulating Nano." Presentation at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
33. **Conti, Joe,** & Becker, Sean. "Regulatory Risk Judgment: How the EPA Confronts Scientific Uncertainty and the Challenges of Nanotechnology." Presentation at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
34. Engeman, Cassandra, Baumgartner, Lynn, **Holden, Patricia,** & **Harthorn, Barbara Herr.** "Risk and the Global Nanotechnology Industrial Workplace." Presentation at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
35. Shearer, Christine, **Rogers-Brown, Jennifer.,** and **Harthorn, Barbara Herr.** "Power and vulnerability: reconsidering "low risk" views of health and environmental hazards. Paper presented at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
36. Cranfill, Rachel, Shearer, Christine, **Rogers, Jennifer & Harthorn, B.H.** "Indexing expertise in a deliberative setting: A comparison study." Poster presented at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
37. Beaudrie, Christian, **Satterfield, Terre, Kandlikar, Milind** and **Harthorn, Barbara Herr.** "Nano-Expert Perceptions and Regulatory Challenges for Emerging Nanotechnologies," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
38. **Bostrom, Ann.** "Moving Pictures: Popular Perceptions of Nanotechnology and its Risks," Plenary Address. Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.

39. Cranfill, Rachel, Shearer, Christine, Rogers-Brown, Jennifer and **Harthorn, Barbara Herr**. "Indexing Expertise in a Deliberative Setting: A Comparison Study," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
40. **Friedman, Sharon**. "What have the U.S. and U.K. Media Reported about Nanotechnology Regulation?" Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
41. **Conti, Joseph**, Fleischer, Torsten, Eggleson, Kathleen and Merchant, Gary. "Roundtable-The Science Policy and Regulatory Implications of Emerging Technologies," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 10, 2011.
42. Beaudrie, Christian, Chair. "What Do the Scientists Think?" Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 10, 2011.
43. Johansson, Mikael. "Perception of Risk among Scientists Working with Nano," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 10, 2011.
44. Reynolds, William. "Non-Governmental Organizations and Tomorrow's Nanotechnology," Student Research Conference, Sigma Xi Annual Meeting and International Research Conference, Raleigh, NC, November 11, 2011.
45. Shearer, Christine. "Climate Change Health and Environmental Risks and Perceptions in Kivalina, Alaska." American Anthropological Association annual meeting, Montreal, QC Canada, November 19, 2011.
46. **Bryant, Karl**, "NVivo: A Powerful Data Management Tool for Qualitative Research" Guest lecture to UCSB campus on methodological tools for social research, Nov 30, 2011.
47. Beaudrie, Christian. "Expert opinion and lifecycle regulation for emerging nanomaterials." Presentation at the Society for Risk Analysis, December, 2011.
48. **Harthorn, Barbara Herr**. "Public Participation in Nanotechnology Risk Governance: Best Practices for Best Outcomes." Keynote Presentation, NSEC PI meeting, Arlington, VA, Dec 5-7, 2011.
49. **Harthorn, Barbara Herr**. "Theme 7: Risk Perception, Regulation and Outreach" presentation to the External Science Advisory Board, UC CEIN, UCLA, Jan 12, 2012.
50. Beaudry, Christian. "Social context of infrastructure, climate change and energy, leadership, and project management and construction," CIVL 202, Civil Engineering II, University of British Columbia, Vancouver, BC, March 7, 2012.
51. Shearer, Christine. "The Political Economy of Risk Perception: A socio-historical look at the climate change lawsuit /Native Village of Kivalina v. ExxonMobil et al." Guest Lecture, Sociology Department Colloquium, UCSB, March 14, 2012.
52. **Harthorn, Barbara Herr, Nick Pidgeon, Terre Satterfield**. Organizers & Chairs. "Nanotechnology Risks—Intersections across the Social Sciences." Session at the Society for Risk Analysis Europe Annual Meeting 2012, Zurich, Jun 18-20.
53. Collins, Mary & Engeman, Cassandra, Organizers & Chairs, "Social Location and Nanotechnology Risk Perception" Session proposal for 4S, Nov 2012, Copenhagen.
54. Cortes-Lobo, Rodrigo (GA Tech), and Engeman, Cassandra (UCSB), Organizers & chairs, "Public Interest Groups: The Role of Organizational Participation in Nanotechnology" Development" Session proposed for SNET 2012, Oct, Twente, The Netherlands.

IRG 3 Meetings/Outreach to NSE, Nanotox, industry, policymakers, publics/Engagement

1. Whirlow, Julie, "NVivo and Endnote Tools for Research" Presentation in FemSt 280, May 17, 2011.

2. **Barbara Herr Harthorn**, "IRG 7-Environmental Risk Perception," presentation at UC CEIN site visit by NSF & EPA, UCLA, Jun 8, 2011.
3. **Harthorn, Barbara Herr**. "Ethical Issues in Social Research," CNS seminar, CNS-UCSB, Santa Barbara, CA, June 28, 2011.
4. **Barbara Herr Harthorn**. CNS Public Research. Meeting of the Nanotechnology Public Engagement & Communications Working Group of the Nanoscale Science, Engineering, and Technology Subcommittee. Washington, DC, July 8, 2011.
5. **Bimber, Bruce**. "Academic Publishing: Trends and Processes," CNS seminar, CNS-UCSB, Santa Barbara, CA, July 12, 2011.
6. **Barbara Herr Harthorn**, Grant Proposal Workshop, CNS Seminar, July 26, 2011.
7. Reynolds, William. "Non-Governmental Organizations and Tomorrow's Nanotechnology," INSITE Program Participants, Santa Barbara, CA, August 2, 2011.
8. **Harthorn, Barbara Herr**. Presenter, UC CEIN Bootcamp for Women Scientists. UCLA and UCSB, August 3-4, 2011.
9. **Barbara Herr Harthorn**, presentation on "Nanotech Risk Perception," UC CEIN Bootcamp for Women Scientists UCLA, Aug 4, 2011.
10. Beaudrie, C.E.H, **Satterfield, T., Kandlikar, M, Harthorn, B. H.** "Benefits, Risks, Bias, and Nanomaterial Regulation: Results of an Expert Survey," Paper presented at the Fifth International Symposium on Nanotechnology – Occupational and Environmental Health, Boston, MA, Aug 9-12, 2011.
11. **Harthorn, Barbara Herr**. Final Closing Plenary Panel Speaker, Nano OEH conference, Boston, August 10-12, 2011.
12. Engeman, Cassandra. "Risk and the Global Nanotechnology Industrial Workplace." Paper presented at the Fifth International Symposium on Nanotechnology – Occupational and Environmental Health, Boston, MA, Aug 11, 2011.
13. Lyte, Alexander. "Establishing Expertise in Public Deliberations on Nanotechnology," UCSB Summer Undergraduate Research Colloquium, Santa Barbara, CA, August 11, 2011.
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15. **Barbara Herr Harthorn**, CNS Overview, Lecture in New Fellows Orientation, UCSB, Sept 20, 2011.
16. **Barbara Herr Harthorn & David Guston**, co-chairs, co-hosts, 3rd annual meeting S.NET conference, Tempe, AZ, Nov, 2011.
17. Amanda Denes, Cassandra Engeman and Roger Eardley-Pryor. Societal and Ethical Implications of Nanotechnologies. NanoDays, Santa Barbara Museum of Natural History. April 9, 2011.
18. **Harthorn, Barbara Herr**. "Theme 7: Risk Perception, Regulation and Outreach" presentation to the UC CEIN Executive Committee, Camarillo, CA, Mar 10, 2012.
19. Christine Shearer. "The Political Economy of Risk Perception: A socio-historical look at the climate change lawsuit /Native Village of Kivalina v. ExxonMobil et al/." Guest lecture in FemSt 186HH, UCSB, March 13, 2012.
20. **Barbara Herr Harthorn**—continued this contact by meeting w/ NPEC chair, John Bobalek, US Dept of Treasury, Dec 7, 2011; and is part of a conf call scheduled for Apr 13 2012.
21. **Milind Kandlikar, Terre Satterfield, Robin Gregory, Graham Long**, and Christian Beaudrie. Work with elite group of nanotoxicology risk experts 2011-2012 to develop expert structured decision making workshop, to be held in Vancouver, May 2012.
22. Engeman, Cassandra and **Harthorn, Barbara**. Invited participants in a meeting of the National American Industrial Hygiene Association Nanotechnology Working Group (NTWG); presentation in conference call planned for Apr 18, 2012, based on industry survey project.

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CNS X-IRG projects and Special Projects

C. Newfield , Project leader	English/American Studies	UC Santa Barbara
D. Boudreaux	Commercialization	Boudreaux and Associates
B. Davison	Computer Science & Eng	Lehigh Univ
B. Egolf	Science journalism	Lehigh Univ
S. Friedman , Project leader	Science journalism	Lehigh Univ
G. Gereffi , Project leader		
M. Goodchild	Geography	UCSB
B. Harthorn , Project leader	Feminist Studies/Anthro	UCSB
M. Johansson , Project leader	Anthropology	Gothenburg Univ
J. Mohr	Sociology	UCSB

Affiliates

Gerald Barnett	Tech Transfer Policy	Univ of Washington
David Mowery	Economics	UC Berkeley

1 Postdoc

Stacey Frederick	Business, GVC, GIS	CNS/Duke Univ
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3 Grads, 4 Undergrads

Graduate students:

Per Hovey, Media Arts & Technology, UCSB
 Zach Horton, English, UCSB
 Jennifer Bayzick, Computer Sci & Eng, Lehigh
 Christine McLaren, Sci & Env Writing, Lehigh
 Alexander Zook, Env Eng, Lehigh
 Ryan White, Computer Sci & Business, Lehigh
 Li Chen, Computer Sci

Undergraduate students:

Technical

Ben Weiss, Duke
 Rachel Bowley, Duke

X-IRG 1: The Social Life of Nanotechnology

Barbara Harthorn, John Mohr IRGs 1, 2 & 3 & X-IRG

The Social Life of Nanotechnology is an edited volume contracted to Routledge, in press and expected mid-June, 2012. The editors are anthropologist **Harthorn** and sociologist and cultural theory expert **Mohr**, a collaborator in the CNS; CNS Board Co-Chair, John Seely Brown has authored a foreword for the volume. *The Social Life of Nanotechnology* starts from the basic premise, developed throughout the text, that nanotechnologies have an under-theorized and often invisible social life that starts with the very concept of “nanotechnology” itself which, as we show in the volume, takes on a wide range of socio-historically specific meanings around the globe, across multiple localities, institutions and collaborations, through diverse industries, research labs, and government agencies and on into a variety of discussions within the public sphere itself. The volume looks at this process through the lenses of the social and cultural sciences, revealing a surprisingly complicated social milieu where a series of traditionally modernist scientific projects have been (and are continuously being) re-assembled into new configurations that are sharply marked by their emergence within a rapidly changing, increasingly globalized, and decidedly postmodern world. As the authors in this volume explain, this results in a series of unique contradictions, tensions and unexpected developments. We highlight three dimensions of this process in the papers collected here: the early origins of

nanotechnologies, questions about the social (and political) organization of the field, and studies concerned with the cultural and subjective meanings ascribed to nanotechnologies in social settings.

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X-IRG 2: States of Innovation and the Case of Solar Energy

Christopher Newfield, Daryl Boudreaux, Zach Horton

1. Introduction

The Innovation Group has analyzed among other things the social impact of “innovation narratives” on nanoscience and technology (NST). This year our analyses were validated in the worst possible way when the Solyndra bankruptcy mushroomed into an already familiar narrative of government waste, fraud and interference in the private sector. The Solyndra story taught many people the false lesson that public agencies always undermines technology development, which should be left to the private sector.

Obituaries are now being written for the US solar industry in particular and for cleantech in particular. Likely Republican presidential candidate Mitt Romney said in a speech on April 4th that President Barack Obama “handed out tens of billions of dollars to green energy companies, including his friends and campaign contributors at companies like Solyndra that are now bankrupt.” Obama has distanced himself from the sector, and is running for reelection not on a platform of renewable energy but on an “all of the above” energy policy that foregrounds his desire to drill for new oil and gas. Federal oil subsidies continue, and official interest in a manufacturing renaissance (Sperling 2012) has not prevented cleantech investors from hanging back—and for good reason, since most investors who bought five or in some cases even a year ago have lost 70-90% of their investment. One of our venture capital interview subjects told us that their universe of active U.S. cleantech investors is down to about 20 firms.

And yet worldwide, solar photovoltaic installations increased 54% in 2011 alone, making it the sector’s best year ever. Chinese PV modules are being produced at a cost of about \$0.93 per watt, and yet China’s extraordinary expansion of solar PV market share rests on a price advantage that is now only 12%, perhaps 10% after the new small tariffs put in place in March (Gombar 2012). The decline of U.S. 2nd and 3rd generation solar manufacturing is not fated, but the U.S. seems to be positioning itself to miss an environmentally indispensable global solar boom. How can the NSF, NNI, and various technology communities rebuild broad public support for NST and for its application to climate and energy issues?

The National Nanotechnology Initiative has been bucking adverse conditions for a long time, and has been marked from its beginnings in the late 1990s by the promise to transform not just technology but also American industry through the accelerated development of nanoscale science. Some early material suggested the nanotechnology would yield marketable products at a “rate of translation . . . orders of magnitude faster than it was for computing” (Roco and Bainbridge 2001, 33). These increases were generally described as though they would take place in a semi-autonomous realm of technical development as supported by public research funding and private sector investment. The roles of policy, government, culture, and the public were generally left in the background.

Nanotechnology has not played the accelerator role for which most of us had hoped. On the “grand challenge” that our group has covered closely, climate change, progress has always depended on policymakers setting concrete environmental goals and then funding some large portion of difficult and unprofitable development processes. Investors lack an ambitious policy environment based on a concrete goal such as a “450 ppm Scenario” for CO₂ levels (IEA 2010). Our studies of energy R&D have suggested that public *and* private investments are woefully inadequate (**Newfield** and

Boudreaux in preparation). We have hypothesized a causal connection between these two facts. It thus causes us concern that NNI advocates have successfully supported NST funding but have not intervened in the larger policy environment, or sought to rethink the national innovation system (NIS) for current challenges. There is mounting evidence that nanoscale applications in renewable energy will be too little too late. In the United States, we are facing a *policy disappointment cycle* in which underfunded R&D produces unimpressive practical results which in turn discourages both private investment and increased public funding.

The Innovation Group has posited from the start that NST would not achieve the promised technical acceleration under status quo research conditions, but would require positive *deviations from norms of existing scientific and policy practice*. When we looked for these deviations, our findings were predominantly negative. We did not find evidence of new collaborative practices in our pilot survey or interviews (IRG 2-1: numbering refers to our Spring 2011 report). We did not find evidence that increases in aggregate patenting in nano-related USPTO classes and subclasses – focusing on quantum dot patents--were signaling clear product development lines (2-2). We found no evidence of nano-focused exceptions or modifications in technology transfer practice (2-3). Finally, we found no evidence that NST was producing novel “innovation narratives” that would dramatically increase public acceptance of –and public enthusiasm for–nanotechnology (2-4). One of our papers recommended that nanotechnology be officially redefined as “normal science” (**Newfield in Harthorn and Mohr** 2012). This would help policymakers and the public see that positive deviations from normal science are rare and thus in need of active, systematic support.

Given the suboptimality and even the fragility of the national innovation system in the U.S., we were not surprised by the Solyndra story’s fallout. The mainstream media is now aware of problems that we and other specialists have been discussing for years (e.g., *Newsweek* (Fareed Zakaria), *BusinessWeek* (Andy Grove), and the *New York Times* (Charles Duhigg). There is hope that our analyses will find an increasingly receptive audience.

This year’s research extends past findings into the solar sector, with special emphasis on the nano-enabled leading edge. We are identifying and describing elements that we think will improve the overall innovation environment, including some deeper cultural issues that we’ll mention at the close.

2. Goals and accomplishments for current year research

In 2011-12, we have focused on three principal activities:

- (1) Continued development of the “Lyon Model” for post-linear national innovation systems and a reform and reconstruction of the current national innovation system.
- (2) Conducted a full- spectrum review of nano-scale solar energy research and development in the context of solar R&D, policy, and production in the US and EU.
- (3) Investigated non-standard innovation practices via Interviews and related fieldwork with a range of solar energy companies (25-30 to date in four countries)

3. Organization and Approach

X-IRG 5a: “Lyon” model for post-linear innovation systems

This model took first form during a 3-day conference the IG held in Lyon, France, in April-May 2010. The book manuscript is called *Can Rich Countries Still Innovate? Towards a Post-Linear Innovation System*. As of this writing it is missing three key papers, which we expected to be submitted this spring. The editors in a technology series at a major university press remain interested in reviewing the manuscript. The Table of Contents is reproduced below the Publications and Presentations list. The book explores three major themes: the ongoing domination of the much-critiqued but still-operative “linear model” of innovation; uncertain if not declining levels of innovation in the wealthy countries, and the need to redevelop national innovation systems in open international collaboration. The linear model is marked both by a relatively fixed sequence of steps and by the relative isolation of each step from others. The book contributors consider both of these features to impair efficient

and sustainable technological development. When conducted in relative isolation, each phase of the research and development process remains driven largely by its own institutional systems and internal cultures. Laboratories operate at a great remove from social concerns, regardless of the opinions of individual scientists. Similarly, the technology transfer process remains a property-based transaction between parties acting out of public view: the result is an enormous, subterranean pool of confidential agreements in which technology pathways have disappeared from public view. Development decisions are made by executives necessarily thinking of returns to their firm rather than to society. In this model, the public generally lacks the expertise, the time, the training, and the general encouragement required to involve itself in any of the previous stages of research or development. Widespread *individual* interest among scientists and technology administrators in broader concerns such as improving public health or reversing global warming does not result in changes in collective expert behavior. Determinate decisions occur upstream in a process that, for society as a whole, remains hidden from view.

The published volume critiques this linear model and at the same time describes the essential elements of a more productive and sustainable *post-linear* model. Some chapters use case studies to describe the way that innovation is non-linear in practice, and rests on reciprocal interactions among users and designers, government funders and researchers, research managers and principal investigators, graduate students and staff technicians, among many others. But the world's most developed national innovation systems (NISs) treat these non-linear interactions as non-systemic, confining their effects to local domains or to small or outlier groups. In order to reverse the limitations on learning and collaboration that occur when interactions remain largely within their section of the innovation pipeline, many of the book's chapters describe working aspects of "broadband" interaction among different elements in the innovation system—between, for example, chemical sensor experts ("upstream") and a poor community on the outskirts of Marseille ("downstream") that needed instruments and methods for testing for radioactivity in the local water. The book points towards NISs in which societal dimensions are richly and continuously present in all "prior" stages of the R&D process, rather than represented by small-scale or artificial mechanisms like focus groups, industry or university publicity, and the circulation of specific individuals. The Lyon conference enacted this broadband interaction among scholars and practitioners from very different innovation cultures; the conference structure allowed them to communicate with unusual directness. The content of the book diverges from standard accounts of innovation issues, articulating an alternative to the standing innovation system as noted above.

This table, taken from the book's introduction, summarizes the alternative model we are proposing.

Standard Linear (Expert Driven)	Lyon Model (Bottom-up)
Curiosity-driven research goals	Expression of widespread social need
(Incremental) public funding	Targeted "moonshots" – 10x / 100x
Expert-driven research	Public / expert cogeneration of research
Precompetitive transactions (\$ <-> IP)	Open source research communities
Invention disclosure	Invention disclosure
Property transactions: patent, license	Negotiated hybrids of proprietary & open
Industry development	Industry and community development
Inter-firm competition	Continuous user inputs
Modest government bridging	Government partnerships
Market demand	Social narratives about goals of use, success
Innovative product in marketplace	Continuous dialogue-based improvement

PDFs of the book's Introduction, table of contents, and chapters by **Boudreaux** and Horton are included with the IG's publications.

The next research stream uses advanced solar energy technology as a case-study domain for an international, comparative study of nanoscale application and development. In addition to responding to the intrinsic importance of accelerating efficient solar energy adoption for environmental and economic reasons, we are using solar as a test bed for our post-linear model of the role of NST in national innovation systems.

X-IRG-5b: Nano Solar Case

i) Full spectrum review of nano-scale solar energy research and development in the context of solar R&D, policy, and production in the US and EU.

We have developed a collaborative database of technical and business literature on the worldwide solar energy industry. We use the open source Firefox plug-in database software Zotero. Our collection has 1750 articles, distributed among 40 categories. We store annotations and discussion notes with articles. The categories range from collaboration theory and analysis of open source forms of intellectual property, to solar-related nano-science, energy and environmental policy, as well as business news on the solar energy industry organized by primary countries and regions of production. The material is searchable and easily reorganized. The database contributes to our analyses and our intragroup discussions of solar and nanoscale energy trends. The materials are available to anyone (although the Zotero storage and commentary processes are accessible by invitation only).

Selected material from our innovation archive joins news, book reviews, video, and longer analyses on Newfield's CNS-linked Innovation Center website (<http://innovate.ucsb.edu>). This project is under the administration and lead authorship of Horton. The site organizes research under six principal headings: Creativity, Innovation Communities, Innovation Theory, IP and Open Source, Nanotechnology, and Solar Energy Crisis. The site displays research discussions and work in progress, offers commentary on topics related to the current status of nanotechnology, and is being developed with the idea of serving as discussion resource for a broader audience. The site also links to our first attempt at open source patent annotations, based on our archive of quantum dot patents.

The Zotero database and our website have allowed us to identify and validate major trends in solar and in NST. They have allowed us to store and ponder at length the “weak signals” that point obscurely toward the unpredictable future. Our current conclusions are based on dozens of individual items, and can be summarized as follows:

1. Prior to the Solyndra bankruptcy, policy and R&D support were not adequate to stabilize the U.S. solar manufacturing sector overall.
2. In contrast to most successful high-tech industries, solar cannot count on internal cash flow from incumbent technologies to generate elevated levels of R&D spending in emerging technologies.
3. 2nd and 3rd generation nano-enabled technology, exemplified by quantum dot PV R&D, are not on the commercial radar. Public R&D levels are not high enough to change this.
4. The U.S.'s core innovation strategy is to “outinvent” the rest of the world, forcing all other economies to play technological “catch up.” (The idea here is to stay one step ahead of the commoditization of an incumbent technology by lower-cost entrants.) Solar examples are thin-film photovoltaic modules (PV) (First Solar's CdTe products, Solyndra's CIGS tubes, Konarka's conducting polymers). But there is no evidence that the U.S. is the leading PV innovator (vs. Germany, Japan, Taiwan, South Korea, and China).
5. Although policy discourse continues to cast the U.S. as a solar leader, markets do not. Investors now price the U.S. solar sector as a laggard, with no special market advantage, both in the commoditized realm of low-cost silicon PV and in advanced 2nd and 3rd generation research. The country's leading solar company, First Solar, has lost 90% of its market capitalization since its peak in 2008 (earning it a place with Bank of America and AIG

as top-town worst performing stocks of 2011). This is unfortunately not an anomaly in the sector.

6. The decline of the US solar sector has not benefitted competing national industries. The “solar shakeout” is global, and includes Germany, Spain, and even China, where at least one executive has predicted the disappearance of half of all Chinese solar firms in 2012.
7. Post-Solyndra, the U.S. policy world has shifted from lukewarm or neutral on solar to negative. Although the negatives listed in points 1-5 might be overcome by an unwavering focus on environmental and energy goals and major public commitments to make up for current market failure, no such policy focus exists. For example, the trade complaint brought against China by US solar manufacturers (SolarWorld-America leading for the Coalition of American Solar Manufacturers) has not united the sector but divided it (solar retail installers, who are doing well, are more concerned about reducing costs of panels than about US manufacturing capability, and are happy to buy Chinese).
8. Low prices for polysilicon and continuous innovation in production and installation have brought solar energy as close to “grid parity” as it has been anytime in history. The US faces a paradoxical situation in which installations boom while manufacturers die.

Given a kind of quiet desperation in US solar manufacturing, the acute problems of the global industry, and at the same time the huge potential for low-cost p-Si installation, we have looked for innovation in every aspect of the industry from lab to rooftop. This brings us to our third research stream.

ii) Interviews and related fieldwork with a range of solar energy companies.

We have conducted approximately 30 meetings and formal interviews so far, in the US, UK, France, and Germany. Our solicitations emphasize that we are looking for *solar narratives* that will help a broad audience understand the challenges and triumphs of the sector on an everyday basis. What is daily life in the solar world like? How is working life the same or different from the kinds of jobs members of the public have? What human drama needs to be better understood, both to create wider sympathy and to help pool new ideas and problem solving? Are there conflicts, tragedies, and victories that could both teach and inspire? We have found considerable interest in this approach and will continue to refine it as we continue this year.

As part of our study of this sector, we are completing an in-depth analysis of Solyndra before its bankruptcy. We are preparing an article that argues that Solyndra in fact succeeded at most of the things that it was required to do under the standard innovation model. Although company leaders made a couple of important mistakes, the deeper problem for the company was that it was not able to use elements of a *tacit but unacknowledged* post-linear innovation model as outlined under Stream 1.

Linear – Solyndra Example	Lyon: a Solyndra that could have been
Public and private, competitive funding	Gov funding expresses social goal-decarbonization
Expert research, mindful of products	Expert research, mindful of social goal
Gronet CIGS invention disclosures	Gronet CIGS invention disclosures
Strong IPR – closed portfolio, trade secrets, in-house manuf-aims at market domination, high ROI	Weak IPR: Gronet operates in research community, open publication, shared articulation of problems and aims
Company formation--Gronet Technologies (2005) becomes Solyndra (2007)	Company formation--Gronet Technologies (2005) becomes Solyndra (2007)
Rounds of angel and VC funding attracted by high future ROI based on “closed innovation” model	Hybrid of proprietary & open IP support broad, complex research and pooled results with multiple producers
Gov bridging: DOE loan as signal of tech validity to investors	Gov procurement supports multiple industry and community development
Development and deliver process driven by investment inputs	Continuous user inputs on technology, economics, cultural value
Market demand: does not materialize, undermined by price drops	Market demand rests on gov inputs, social narratives, existing public uses
Innovative product lost to bankruptcy	Individual company rests on developed cleantech ecosystem

The highlighted terms in the right-hand column could well in our judgment have saved a good company and a valuable technology. We emphasize these as realistic measures since they were central components of our Cold War-era NIS but now play a diminished role.

Given our research on non-linear innovation elements, we are looking carefully for *divergent thinking* within existing solar-sector institutions– for people and companies we might showcase as trying to move away from average research, management, and development practices by actively modifying their scientific or business practices. By the end of the summer 2011, we had identified three such firms and a baseline company that represents a high-quality version of current norms.

Company A – UK – baseline

Company B – US – internal research process innovation, research partnerships

Company C – France – design-based system-integration

Company D – Germany – company development rooted in social processes.

We are in the process of negotiating extensive contacts with each of these firms so that we can offer in-depth analysis of where their part of the advanced solar industry is going.

4. Major accomplishments that contribute to the research mission of the CNS

*** Continued development of the “Lyon Model” for post-linear national innovation systems.**

Accomplishments: (A) published volume of essays (Newfield and Boudreaux, in preparation, nearly complete); (B) articles and chapters in preparation and presentations on key elements of post-linear innovation strategy (e.g. **Newfield’s** “innovation jobs” piece in the *Huffington Post*, **Boudreaux’s** presentation on “Transferring University Nanotechnologies To Startups/Companies And Capitalizing Their Development” at RUSNANOtech 2011, October 26-28 in Moscow; (C) innovation theory website (<http://innovate.ucsb.edu/>) which is linked to the main CNS website and part of the work of the Center.

*** Full spectrum review of nano-scale solar energy research and development in the context of solar R&D, policy, and production in the US and EU.** Accomplishments: (A) shared publications and business news library using Zotero collaboration tools; (B) articles (submitted and in process).

***Interviews and related fieldwork with a range of solar energy companies** (25-30 to date in four countries) Accomplishments: (A) identification of highly innovative solar firms for in-depth fieldwork; (B) conference papers and lectures.

Synthesis:

- * Nano-enabled solar technology is advancing slowly if at all.

- * Nano-solar stagnation was triggered by the crisis in equity markets in the fall of 2008 that endangered or destroyed funding for all of the emerging-technology operators in the sector. But stagnation in the NST-related solar sector is now being enforced by ordinary investor decisions rather than economic crisis.

- * Markets do not see nanoscale innovation (or other emerging solar technologies) as assets but as liabilities. “Nano” is irrelevant to or negative for business decisions.

- * Solar practitioners are innovating in their own organizations but do not have many ideas for modifications of the overall solar innovation system that might sustain advanced PV design in the face of market indifference or hostility.

- * 2nd and 3rd generation solar is stuck in an industry that is trapped in an “innovator’s dilemma” (Christensen): lower-cost versions of the incumbent crystalline-silicon technology have taken huge parts of existing market share before incumbent firms could find new large markets with new technologies funded by their (now rapidly shrinking) existing customer base. and find new users of PV with “good-enough” cheaper modules. In an unusual situation which standard NIS analysis does not explain, rapid market expansion is combined with widespread manufacturer / supplier contraction.

- * Neither a given U.S. solar firm, nor the national sector as a whole, can solve the innovator’s dilemma. A large-scale public intervention in solar markets is required, but this will require a post-linear NIS and significant change in US economic culture.

Taken together, these research streams combine a new and evolving innovation model with broad sector analysis of solar trends and norms, and with empirical case studies of particularly innovative organizations. Our hope is to contribute knowledge that will help 2nd and 3rd generation solar –NST-based--emerge successfully from the current, adverse situation.

5. Broader Impacts: Implications for CNS and its larger mission

For NST to obtain its full potential, the U.S. needs a paradigm shift in its innovation system. We have identified specific issues above. The single core takeaway is that NST, under the auspices of the NNI, has been struggling for over a decade to develop public-purpose technology without a developed public infrastructure. NST will reach its potential only when advocates focus unambiguously on developing public infrastructure (large R&D funding, profit partnerships, IP pools, procurement programs) at least to a Cold War level.

Our analysis supports the creation of programs that will develop a *public innovation ecosystem*, and *technocultural innovation education*, which would require cross-training in STEM and socio-cultural fields. **Newfield** piloted elements of the latter in two courses in 2011-12; English 236: Literature, Technology, Mass Creativity (graduate, Fall 2011), and English 197: Creativity, College, Corporation (senior seminar, Winter 2012). Both courses identified the current paradigm of innovation, explored cultural variables that complicate this paradigm and suggest its incompleteness, and developed ideas for using cultural study to go beyond the current national innovation system.

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X-IRG 3: Spatial Analysis and the Global Value Chain for Nanotechnology/Nano in California

Stacey Frederick (supervised by **Gereffi, Appelbaum, Harthorn & Goodchild**), Ben Weiss, Rachel Bowley

This project entails value chain mapping of California and the United States in the global nanotechnology economy. Objectives include (1) identifying firms working in each stage of the supply chain from nanomaterials through end-markets, (2) analyzing the impact of value chain dynamics in each stage such as policies, risk, perception, and competitiveness factors, and (3) evaluating how these are linked together in California and how California compares to competing geographies. Aims include developing and making available the California in the Nano Economy website and developing a global database of nano-related firms and organizations.

Two preliminary website templates have thus far been created: one for the value chain research framework, and the other designed to provide a framework for carrying out the California in the Nano Global Economy project. To accomplish these goals, Frederick has been reviewing existing data mining and mapping methodologies to determine their applicability to nanotechnology publications, patents, funding sources, and firms. The ultimate goal is to identify ways to link this information to the value chain framework, enabling users to visualize the results. Existing visual mapping programs, and their associated costs, are being examined. (For an example of what we are striving for, see the North Carolina in the Global Economy website, which Frederick developed.) Frederick has also met with organizations involved in the North Carolina nanotechnology industry, to discuss possible synergies between efforts in NC and the California project. Finally, she is also developing an inventory of nanoproducts, and is coordinating this effort with **Lenoir** and Herron to assess feasibility of using their database to include visual maps of patents granted to people/firms in California and California authors. There are currently 680 locations listed for California, and Frederick is working to place them in the value chain.

We anticipate completion of this project by the end of 2012, at which point CNS will take over maintenance throughout the life of CNS (and beyond). We are considering expanding it to all nano products (not just those associated with California).

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X-IRG 4: Nanotech in the Media

Sharon Friedman, Brenda Egolf, Brian Davison, Jennifer Bayzick, Christine McLaren, Alexander Zook, Ryan White, Li Chen IRG1, IRG 2, IRG 3, X-IRG

This research contributes substantive data on areas of news coverage relevant to all 3 IRGs and other special projects. In the reporting year, X-IRG collaborator **Friedman** and her Lehigh colleague **Egolf** et al. continued their systematic longitudinal study of nano news coverage in print media in the US and UK (begun in collaboration with Harvard and UCLA in 2005), and also began exploration of new media nano coverage by analysis of on-line articles and blogs at the *New Haven Independent*.

In 2011-12 they completed searches of a sample of 41 newspapers and 2 wire services for articles that discussed environmental, health and social risks and regulation issues. Numbers for 2010 and 2011 continue very low: a total of 25 articles (12 US, 13 UK) in 2010, and 23 for 2011 (7 US, 16 UK). Online articles and blogs trend in the opposite direction—from this one source studied in depth, 2010 produced 26 articles or blogs, and 2011 33 articles on the same topics. The move to analysis of blogosphere production has entailed extensive revision of the coding document; the incorporation of online search data in general necessitates extensive modification of the computer news collection program as both Google, Google News and Lexis Nexis have changed their protocols over the time of this project, and web crawling tools rapidly generate massive databases that in turn generate additional problems. Data analysis for this project is under way; the team will assess future directions in conjunction with IRG 3 leaders at a meeting at SRA-E in June 2012.

* * *

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

Mikael Johansson, IRG 1, IRG 3

During 2011, while reentering his professional obligations in Sweden at the Gothenburg University, **Johansson** continued analysis of the extensive ethnographic field data collected during his postdoc at CNS 2009-2010. He is in progress writing a book about the life worlds of nanoscientists and toxicologists studying the adverse effects of nano particles. During the year completed revisions on two chapters.

X-IRG: Publications 2011-2012

Primary Publications: Journals

1. **Friedman, Sharon M., & Egolf, Brenda P.** (2011). A Longitudinal Study of Newspaper and Wire Service Coverage of Nanotechnology Risks. *Risk Analysis*, 31(11), 1701-1717.

Primary Publications: Books, Chapters, Reports and Other Publications

2. **Friedman, Sharon M., & Egolf, Brenda P.** (2012). Perspective: What Have the Mass Media been Reporting on Nanotechnology Risks? In Susanna Hornig Priest (Ed.), *Nanotechnology and the Public: Risk Perception and Risk Communication* (pp. 157-165). Boca Raton, FL: CRC Press.
3. Johansson, Mikael. (2010). Vi är dina provexemplar - om etnografiskt fältarbete i laboratoriemiljö (We are your samples - On ethnographic fieldwork in laboratory environments). In J. Bärmark (Ed.), *Att tänka genom kulturer (To think through cultures)*. Gamla Stan, Stockholm: Carlssons förlag.
4. Johansson, Mikael. (forthcoming). Working for Next to Nothing - Labor in the Global Nanoscientific Community. In Barbara Herr Harthorn & John W. Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.
5. **Newfield, Chris.** (2011). Was the Innovation Economy Killed by the Debt Debate? *The Blog* http://www.huffingtonpost.com/christopher-newfield/innovation-economy-debt-debate_b_917151.html
6. **Newfield, Chris.** (forthcoming). Is Nanoscale Collaboration Meeting Nanotechnology's Social Challenge? A Call for Nano-Normalcy. In Barbara Herr Harthorn & John Mohr (Eds.), *The Social Life of Nanotechnology*. New York: Routledge.

Leveraged publications: Journals

7. **Barnett, Gerald.** (2011). Recombinant Innovation. Review of Genentech The Beginnings of Biotech by Sally Smith. *Science Progress*, 334(6062). doi: DOI: 10.1126/science.1215785

Leveraged publications: Book Chapters & Other Publications

Submitted or in preparation publications: Primary

8. Boudreaux, Daryl. (in preparation). Evolution of Innovation Pathways: Impact on Solar Energy. In Chris Newfield & Daryl Boudreaux (Eds.), *Can Rich Countries Still Innovate?*
9. Horton, Zach. (in preparation). Pursuing The Right To Maximal Innovation: Open Source, Energy Crisis, and Social Narrative.
10. **Newfield, Chris.** (in preparation). Are Strong Intellectual Property Rights Helping Nanoscale Research? Results from a Quantum Dot Case Study. *Can Rich Countries Still Innovate? (Lyon volume)*
11. **Newfield, Chris.** (in preparation). Learning From Solyndra: Filling Gaps in the US Innovation System.
12. **Newfield, Chris.** (in preparation). Solar Energy Funding After the Crisis: Has the Obama Administration Made a Difference?
13. **Newfield, Chris.** (in preparation). Solar Innovation: the Case of Germany.
14. **Newfield, Chris, & Boudreaux, Daryl** (Eds.). (in preparation). *Can Rich Countries Still Innovate? (Lyon volume)*.
15. **Newfield, Chris, & Boudreaux, Daryl.** (in preparation). Introduction. In Chris Newfield & Daryl Boudreaux (Eds.), *Can Rich Countries Still Innovate?*
16. **Newfield, Chris, & boudreaux, Daryl.** (in preparation). Learning From Solyndra: Filling Gaps in the US Innovation System.
17. **Newfield, Chris, & Boudreaux, Daryl.** (in preparation). Solyndra, the Symptom not the Disease.

Submitted or in Preparation Publications: Leveraged

X-IRG Presentations 2011-2012

1. Frederick. "A Value Chain Research Approach to Nanotechnology: a Framework for Competition and Collaboration," CNS Seminar, March 2, 2011.
2. Frederick, Stacey, **Gereffi, Gary**. CNS Research Summit and NSF Site, Santa Barbara, CA, May 1, 2011.
3. **Newfield, Chris**. "Open Source Nano for the 'Developing' World? INRA, Ivry-sur-Seine, Paris, France, May 1, 2011.
4. Boudreaux, Daryl. "Insights into Innovation Systems," CNS Annual Meeting, Santa Barbara, CA, May 2, 2011.
5. **Newfield, Christopher**. "Solar Innovation: The Case of Germany," American Anthropological Association, Montréal, Québec, November 1, 2011.
6. **Newfield, Christopher**. "Solar Innovation: The Case of Germany," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 1, 2011.
7. **Newfield, Christopher**, Chair. "Studying Emerging Innovation Located in Wind Flower," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
8. **Newfield, Christopher, Boudreaux, Daryl**. "What is Nano Doing for Solar? A Report on Notes from the Field," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
9. Johansson, Mikael. "Perception of Risk among Scientists Working with Nano," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 10, 2011.
10. Frederick, Stacey, **Gereffi, Gary**. NanoInformatics Conference, Arlington, VA, December 7-9, 2011.

10. CENTER DIVERSITY PROGRESS AND PLANS

The CNS-UCSB community recognizes from experience that diversity strengthens the quality of research and the capacity to disseminate results to a wide range of audiences. Our diversity mission is focused on creating a community comprised of outstanding researchers, staff, and advisors from different gender, racial, ethnic, disciplinary, family, and educational backgrounds that represent and reflect the communities we serve in our research mission. Additionally, the Center has broadened participation by seeking out researchers in other countries across North America, Europe, Asia and Africa, including increasing numbers in the Global South.

(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 and 7 through a partnership with UCSB's California NanoSystems Institute's (CNSI) INSET summer program, a REU program that recruits students from California community colleges with an emphasis on diversity. 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.

For the current reporting year, we hosted 3 male summer undergraduate interns, 1 of whom was Latino. The four interns hosted during summer 2010 included 3 males (including 1 Asian and 1 Mixed White and Pacific Islander) and 1 female who was both African-American and Latina. Cumulative data for interns from underrepresented groups for the two reporting years is noted in Table 10-1. Of the 7 interns, 5 were participants in the INSET program, and two were UCSB undergrads. Two of them will be the first members of their family to graduate from college. These interns also contributed to the academic diversity of CNS, with majors in Chemistry, Engineering, Economics, Math, and Geology.

Table 10-1: Diversity information, **Summer Undergraduate Interns**, Years 6 and 7 (n=7)

Female	African-American	Asian	Latino	Mixed racial origins
1		1	1	2

[Summer 2010: We received applications from 24 UCSB students for 2 intramural internship positions. Applicant pool statistics: 8 female, 10 Caucasian, 1 mixed race (including Pacific Islander), 1 Asian, 6 Latino/a. Applicants represented 15 different majors. Applicant information is not available from CNSI for the extramural INSET program applicants for Years 6 or 7.]

In addition to the summer internship program, CNS-UCSB engages UCSB 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. Although not always selected via an open recruitment, these students contributed to the Center's diversity, as indicated in Table 10-2. A total of 11 UCSB students participated in the Center in Years 6 and 7, eight of whom were active during both reporting years (Year 6 undergraduate research assistants n=8, Year 7 n=10). Of these 11 students, 82% are female, and 73% are part of other under-represented categories.

Table 10-2: Diversity Information, **undergraduate researcher assistants**, Years 6 and 7(n=11)

Female		Asian	Mixed racial origin	Native American	Latino/a Ethnicity
9		4	1	1	2

Academic Disciplines of current year UG research assistants: Biology, Chemistry, Chinese, Environmental Studies, Geography, Global Studies, Linguistics, Psychology

Graduate Students

The CNS-UCSB Graduate Research Fellowship program recruits doctoral student participants through an open, competitive application process. During the reporting year, we ran open recruitments to hire both Social Science/Humanities and Science/Engineering Graduate Fellows. The search was publicized through email announcements, including a diversity statement, sent multiple times to graduate advisors in all academic departments on campus; 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.

For Years 6 and 7, 17 students participated in the Center as Graduate Fellows, 8 of whom were active during both years. In Year 6, there were 13 Graduate Fellows: 8 in Social Sciences and Humanities and 5 in Science and Engineering. Twelve Graduate Fellows were active during the reporting Year 7: 6 each in Social Sciences/Humanities and Science/ Engineering. Table 10-3 shows diversity information for the 17 Graduate Fellows: 47% were Female, and 24% were from under-represented groups. In addition, 2 were the first in their families to graduate from college, and 4 will be the first to receive a graduate degree.

Table 10-3: Diversity information, **Graduate Research Fellows**, Years 6 and 7 (n=17)

Female	African-American	Asian	Latino/a	Mixed racial origins
8	1	1	2	

[Current reporting year: Application data for the 2011-2012 Fellows in the Social Sciences and Humanities: Eighteen graduate students submitted applications for two positions. Statistics on the applicant pool: 5 male, 13 female; 4 Latino/a; 4 are the first in his/her family to graduate from college, and 6 are the first to receive a graduate degree. Fellowships in the Sciences and Engineering had 6 applicants for 1 position (2 were hired): 1 female, 5 male; 1 Asian, and 1 who will be first in the family to receive a graduate degree.]

CNS-UCSB engages an increasing number of graduate students beyond the fellowship program. These students serve as Graduate Student Researchers, research assistants, and in a variety of other data collection and analysis functions. Seventeen students participated in the Center in these roles during years 6 and 7: 12 from doctoral and 5 from masters' degree programs across campus. As indicated in Table 10-4, 59% are females, and 24% were from underrepresented categories.

10-4: Diversity information, Other **Graduate Student Researchers**, Years 6 and 7 (n=17)

Female	African-American	Asian			
10	1	3			

Academic Disciplines of year 6 and 7 graduate student researchers (non-fellows):

Computer Science; East Asian Languages & Cultures; English; Environmental Science & Management; Geography/GIS; Global & International Studies; Linguistics; Political Science

Please note: we are not reporting on students at our partner institutions in this section.

Postdoctoral Scholars and Researchers

CNS-UCSB began its 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. Positions are broadly advertised nationally to achieve this aim; one example is sending announcements to professional society specialty groups that are geared toward diversity. During our recent search for open postdoctoral positions with the 3 IRGs in Fall, 2012, we advertised the positions at S.Net and through the on-line listservs of the American Anthropological Association's Science, Technology, and Society interest group and the National Communication Associations CRTNet. We also listed position announcements online in the Chronicle of Higher Education online, on Linked-In, and on the National Postdoctoral Association's Postdoctoral Forum and distributed them through our partner organization, CNS-ASU's listserv. We also distributed announcements at the S.NET conference and sent notices through their listserv.

The six CNS-UCSB funded postdocs in year 7 include three females, one of whom is of mixed-racial and Latina origin, and two non-US Citizens (one Asian and one Canadian). Of five additional, non-UCSB-based postdoctoral scholars in the reporting year, two are female, and three are based in Great Britain.

With the departure of three postdocs in summer and fall, 2011 to full-time professional employment, we ran an open recruitment to hire 1-2 new Postdoctoral Scholars. The resulting applicant pool of 13 candidates was internationally diverse, including applicants from Western Europe, Southern and Central Asia, and Latin America. The pool included 4 women and 3 Latinos. We hired a male Latino researcher and non-U.S. citizen who will join CNS-UCSB in June, 2012.

In addition, a female who is currently a graduate student researcher from the UC CEIN will assume a postdoctoral position there starting in summer, 2012, and will participate in CNS-UCSB research and center-wide activities. We plan to host a visiting postdoctoral scholar from Mexico for a year beginning in summer, 2012, and will begin a search in spring, 2012 for a postdoctoral scholar to participate in IRG3 public deliberation research.

Disciplinary backgrounds of CNS-UCSB's reporting year postdoctoral scholars include City & Regional Planning, History, Social Psychology, Sociology, Psychology, Textile Management, and Women's Studies. Incoming postdocs during summer 2012 were trained in Science Policy and Environment Science & Management.

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 Feminist Studies, a past longtime member of the governing boards of the UCSB Institute for Chicano Studies and the UCSB Center for Black Studies, a current member of the Advisory Committee for the new Center for Latina/o Health, Education & Research as well as 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. Three of the seven current members are women, two of whom (**Holden** and **Metzger**) were added during the past year; two other women, served on past Executive Committees. In addition, Assistant Director Molitor and Director of Education Programs and Communication **Boggs** serve as *ex officio* members, adding additional gender diversity. We have been less successful in maintaining ethnic diversity in the leadership, although one of the founding PIs was Asian. We have been and 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.

The CNS-UCSB staff also reflects a commitment to diversity. In the reporting year, eight of the thirteen staff members were female. Ethnically, two were Asian, and three were of mixed racial origin, including the current Assistant Director. Of the four senior faculty involved in curriculum development activities during the reporting year, two were women, as were the four research staff including the current Director of Education Programs and Communication.

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, English, Feminist Studies, Global and International Studies, History, Political Science, and Sociology. Senior Personnel at UCSB expand that list to include: Chicana & Chicano Studies, Engineering, Environmental Studies, Geography, Global Economics, Microbiology, and Physics. And our collaborators at other universities and settings add Asian Studies, Business, Economics, Science Journalism, Law, Risk Studies, Social Psychology, Science Policy, 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 who is professor and associate dean for research at Evans School of Public Affairs, University of Washington (**Ann Bostrom**), a Chemistry professor and the executive director of the Center for Biological and Environmental Nanotechnology at Rice University (**Vicki Colvin**), the executive director of the California Council on Science and Technology (**Susan Hackwood**), and a professor in the History and Sociology of Science department at the University of Pennsylvania (**Ruth Schwartz Cowan**) who is 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; fewer contribute to gender/ethnic/racial diversity, although 10 collaborators are female, 4 are of Asian heritage, and 4 are Latino. Increasing our diversity in these areas is a central goal as we recruit new Center participants.

Visiting Researchers

The CNS Visiting Researcher program has attracted scholars that contribute to the Center's diversity. Recent visiting scholars include 5 females, 4 junior scholars, two Asians, one E.

European, and 2 Mexicans. As noted above, we will host a Mexican postdoctoral researcher during 2012-2013.

(ii) Plans for the next reporting period

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 continue building and increasing our diversity at all levels of participation in areas such as gender, racial origins, ethnicity, family background, and disciplinary training. Below we describe some of the strategies we are using to accomplish this goal.

Undergraduate and Graduate Student Participants

One primary strategy for maintaining and improving diversity is to start with a large and diverse pool of strong applicants for our programs. 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 Research 1 campus in a beautiful coastal setting, UCSB is successful in recruiting a diverse student body and is itself projected to become a Hispanic Serving Institution (HSI) in the near future. California currently has 76 HSI schools in the community college and state university system, and CNS has been successful in drawing students from such neighboring organizations into its popular undergraduate summer intern program.

Strategies:

- Open recruitment process

A competitive, open recruitment process for our undergraduate internship, graduate fellowship, and postdoctoral programs has allowed us to attract a broad range of applicants. For internal programs (graduate and UCSB undergrad internship positions), information has been disseminated to students by sending email and fliers to all pertinent UCSB departments. These have been augmented by announcements to the UCSB Women's Center, campus organizations including Women in Science and Engineering (WISE), SACNAS (Society for the Advancement of Chicanos and Native Americans in Science), and Los Ingenieros, to ensure that students from underrepresented groups learn about our opportunities. For community college interns in the INSET program, CNS-UCSB staff work closely with campus partners in CNSI's CSEP (Center for Science and Engineering Partnerships), which recruits widely through established networks in area community colleges to recruit a diverse, talented pool of applicants.

- Collaborations with NSF diversity programs and campus organizations

CNS-UCSB has in the past, and will in the future, work with a variety of on-campus programs and organizations promoting diversity. From its inception to dissolution in 2009, CNS-UCSB collaborated with the AGEF (Alliance for Graduate Education in the Professoriate) program, including a very well received invited talk on the CNS Education program by CNS Director Harthorn at the NSF SBES AGEF meeting (May 2008) at UCSB. CNS-UCSB has had one NSE fellow who is a veteran of the AGEF program, and who continues to be involved in Center activities following the end of his fellowship.

The UC-DIGSS program (Diversity Internships for Graduate Study in the Social Sciences) supports UC recruitment of minority students in the social sciences, and this collaboration allowed us to successfully recruit a new incoming Latina sociology student who worked with us

from 2007-2010 first as an Associate Fellow and then a CNS Social Science Graduate Research Fellow.

The NSF-funded Bridges to the Doctorate program in CNSI aims to connect students to NSF funded opportunities. CNS-UCSB participates in this network of programs that seek to recruit and retain excellent scholars from underserved populations.

In addition, CNS-UCSB researchers and former Education staff have developed ties with student organizations that serve underrepresented groups, including Los Ingenieros, SACNAS, and Women in Science and Engineering (WiSE). These groups address a wide variety of interests within the student community, and CNS research that focuses on environmental and social impacts has resonated with these groups' members. Presentations to these organizations by education staff, graduate research fellows and postdocs have informed participants about nanotechnology and society issues and current research, as well as described opportunities for students in CNS-UCSSB. The new Education staff will reach out to these groups in the coming year to increase their involvement with our work as opportunities arise. We will also collaborate with new UCSB-wide diversity programs at UCSB as they are developed, by maintaining close communication with key administrators in the College of Letter and Science, Graduate Division, and the Graduate School of Education.

- Partnership with the California Nanosystems Institute's INSET REU Program

For the past 6 summers, CNS-UCSB has hosted California community college STEM students participating in CNSI's Internships in Nanosystems Science, Engineering and Technology (INSET) REU program. INSET's participants annually include high percentage of students from underrepresented racial and ethnic groups. Since 2006, more than half of all of our undergraduate summer interns (15 out of 27) have been in the INSET program. Between 2002 and 2010, the entire group of CNSI INSET interns was 45% minority, 42% female and 3% disabled (diversity data not available for individuals over this full period). Tapping into this recruitment network has been useful in increasing CNS-UCSB's diversity. We will host four interns through this program during Summer, 2012.

- Promoting Opportunities for Involvement through Reputation

We at CNS-UCSB have found that diversity reproduces itself. Diversity in our Graduate Fellowship Program helps to make CNS a welcoming context for undergraduates of diverse backgrounds as well. In a regional program such as ours, word of mouth and reputation are important factors in successful recruitment and retention, as is leadership dedicated to achieving a diverse organization that welcomes and supports a wide range of talents, experiences, and interests. We have and continue to make it a priority to create a climate of cross-cultural and cross-ethnic acceptance at all levels. Our record of multi-year participation by both graduate and undergraduate student researchers who are female and/or from underrepresented communities is evidence of success in these areas.

The institutional context for thoughtful commitment to diversity at UCSB is excellent, with an upper administration that is prepared to walk the walk, a McNair scholar's program, 3 ethnic studies programs and departments and both feminist studies and Chican@Studies departments both offering a doctorate. Additional resources that contribute to the climate on campus include the recently funded UC-wide Multi-campus Research Unit based at UCSB, The Center for New Racial Studies, directed by eminent racial formation scholar Howard Winant, and, like CNS, housed in the Institute for Social, Behavioral, & Economic Research.

Postdoctoral Researchers

All CNS-UCSB postdoctoral positions are recruited in an open, competitive process, some of which was described above. We aim our 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. In recruiting for open or new positions, we have worked with the UCSB Office of Equal Opportunity, and in addition to the traditional networks, listservs, and professional organizations (above) we have sent our advertisements to specialty groups serving women and minorities. We will use these approaches in our upcoming search for a new postdoctoral position that will open during spring, 2012, and continue to broaden our reach to expand our connections with as diverse a group of potential applicants as possible.

Leadership: Pls, Advisory Board, Senior Personnel

To enhance diversity on the faculty level, we have been mindful of our commitment to diversity, recognizing its contribution to research excellence and the broader impact a diverse group can have on the climate and culture of our Center. One of the ways we have been and continue to promote diversity in our leadership is by recruiting new senior personnel representing underserved gender, racial, and ethnic communities. As noted above, our current Senior Personnel include 10 collaborators who are female, 4 who are of Asian heritage, and 4 who are Latina/o. We also have expressly sought to include faculty earlier in their careers and during years 6 and 7 added two assistant and associate level professors at UCSB (one of whom is Chicana and the other Asian), and another junior faculty member at the University of Wisconsin. We also continue to add disciplinary diversity and expand our expertise by adding UCSB faculty from Chicana and Chicano studies, communication, economics, and environmental studies. We hope the Seed Program we aim to implement in Fall 2012 will further diversify our faculty.

The majority of Advisory Board members from the Center's first five years continue to serve on the board, except for two (**Kalil** and **Moore**) who took on new jobs that precluded them from continued service. It is not expected that the same Board will serve all ten years, and thus in replacing those roles over time we will continue to pursue diversity goals in recruitment.

Engaging Diverse Publics

Expanding public engagement is one of the core goals of CNS-UCSB's outreach plans in the coming year, which are discussed in more detail in Section 12 of this report. We continue to connect with the public by participating in informal science education activities such as NanoDays, which in 2012 is being held over two days at the Santa Barbara Museum of Natural History; the spring, 2011 one-day event drew almost 500 children, parents, and others from throughout the community. We publicize events in our Speakers Series to a listserv consisting of close to 300 individuals from on-campus and the regional community, and plan public activities with a goal of reaching members of Central California's diverse population. We hope to contribute new understandings of ways to create effective upstream public engagement with emerging technologies through our IRG 3 public deliberation research, which is conducted with panels whose participants reproduce the socio-demographic diversity of the communities in which we conduct them (Santa Barbara, Vancouver, and Cardiff, UK). Another round of research in this arena is planned for 2013.

11. EDUCATION

CNS-UCSB's Education Program continued its successful record of accomplishments in Year 7. The biggest change during the year was the restructuring of the Program's leadership team, so that it is now headed by two social scientists with expertise in new media, interdisciplinary collaborations between social researchers and scientists, and mediated education and outreach. The following pages provide an overview of CNS-UCSB's Educational Program components, objectives, and metrics; discuss the leadership changes; report on the progress of our ongoing programs for postdoctoral scholars, graduate students, and summer interns; and highlight some of our curricular contributions to teaching the ethical, legal, and societal implications (ELSI) of nanotechnologies in multiple educational environments during this 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 new, critically-needed collaborative education programs. It sponsors graduate fellowships, graduate student researchers, undergraduate 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: Metrics

The following metrics tables reflect accomplishments of the Education Program's primary objectives during Year 7.

Training the next generation of interdisciplinary scholars

Metric	Met in current reporting year?
7-8 graduate research fellowships/year	Yes (7 in 2011/12)
3-4 undergrad internships/year, with emphasis on community college students from lesser-served communities	Yes (3 in 2011, 4 expected in summer 2012)
Expand postdoctoral scholars program beyond the 6 active in years 2006-10	Yes (6 this year [3 CNS-funded], 1-2 new scholars incoming in Year 7)
Hold Research Seminar meetings year-round	Yes (14 this year)
1-2 visiting speakers per quarter (3-6 per year)	Yes and no (8 visitors total, but 0 in summer)
Professional development in communication, research methods, and academic job practices	Yes (see Postdoctoral, Graduate and Undergraduate report sections for details)
At least one major public engagement event annually where Fellows and Postdocs take the lead role	Yes (NanoDays, n=4 CNS participants)
Funding and professional preparation for conference travel for participants	Yes (travel funds for 24 conferences)
Ongoing formative and summative evaluation	Yes (annual surveys)

Diversity – creating a diverse community of scholars within CNS

Metric	Met in current reporting year?
Continue to cultivate diversity among student participants, maintaining current levels: 45% women, 25% underrepresented groups, 25% first generation grads	Women: Yes (53%) Underrepresented groups: No (16%) First-generation grads: Yes (25%)

Curricula Development and Dissemination

Metric	Met in current reporting year?
Annually increase the number of new or modified courses incorporating CNS-UCSB research	Yes (22 in year 7, 15 in year 6)

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

Metric	Met in current reporting year?
Invite researchers representing multiple disciplines to speak in the CNS Research Seminar	Yes (7 disciplines in the reporting year)
Invite participants from departments across campus to attend CNS public lectures and events across campus	Yes
Track the home departments of participants attending the CNS Seminars	Yes
Track the continuing participation of graduate students and postdocs after their funding ends	Yes
Track CNS-UCSB participants' presentations both on and off the UCSB campus and at professional meetings and conferences	Yes

Program Leadership

Education Director Dr. **Julie Dillemath's** resignation in spring, 2011 for personal reasons prompted a reassessment of the CNS-UCSB Education Program's focus and structure. 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.

To build on and extend these successes, CNS-UCSB expanded the Education Program in Year 7 by adding resources and restructuring its leadership. Whereas previously the Education Program was headed by one staff member with training in science education, the Program is now overseen by two social scientists with PhDs in Communication, who bring 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.

Dr. **Miriam Metzger**, Associate Professor in the UCSB Department of Communication, joined the CNS-UCSB Executive Committee as Education Director in October 2011. Professor **Metzger's** research focuses on emerging information and communication technologies (ICTs), centering on the social uses and impacts of technology, as well as on regulatory issues brought about by ICTs, including privacy and digital literacy education. Her work has been widely published in journals including *Human Communication Research*, *Journal of Communication*, *Journal of Computer-Mediated Communication*, *New Media & Society*, *Mass Communication & Society*, *Media Psychology*, *Journal of the American Society for Information Science & Technology*, *Computers & Education*, and *Information, Communication & Society*. She has also published several book chapters and co-edited *Digital Media, Youth, and Credibility* (MIT Press) and *Kids & Credibility: An Empirical Examination* (MIT Press). **Dr. Metzger** brings considerable experience in interdisciplinary graduate education to the CNS, as she has served as the PhPHDD Emphasis Director of UCSB's Center for Information, Technology & Society (CITS), a partner organization of the CNS, since 2010, and as former Associate Director and current faculty affiliate of the Carsey-Wolf Center, an interdisciplinary film and new media center at UCSB, since 2001.

Dr. **Cathy Boggs** (PhD, Organizational and Intergroup Communication, UCSB) joined CNS-UCSB as acting Education Director in May, 2011, and was appointed Director of Education Programs and Communication (DEPC) after a national search in February, 2012. As DEPC, she is responsible for managing the day-to-day operations of the Center's Education and Outreach Programs. **Dr. Boggs** was previously Associate Director of UCSB's Carsey-Wolf Center. Among her accomplishments there were heading a grant team awarded a \$211,000 grant from the MacArthur Foundation's Digital Media and Learning Competition to fund the development of *DigitalOcean: Sampling the Sea*, an online ocean science education program for middle and high school students from around the world. She also managed the Carsey-Wolf Center's internship programs, and handled publicity and coordination for Center events, initiatives, and projects. Prior to that, she was Research Communications Coordinator for UCSB's Center for Information Technology and Society (CITS), where she organized a major national conference, the 2006 Santa Barbara Forum on Digital Transitions and also served as staff coordinator of the initial CNS-UCSB grant proposal to the NSF, which provided extensive background in nanotechnologies and the societal issues CNS-UCSB addresses. In addition to past teaching appointments in UCSB's Department of Communication and UCLA's Anderson Graduate School of Business, her prior experience includes five years in Washington, DC as a

telecommunications policy analyst, conference organizer and public relations consultant. She has consulted on workplace communication issues for a variety of non-profit, for-profit, and government organizations. Together, she and **Prof. Metzger** provide a robust team for advancing the education, outreach, and communication agendas of CNS-UCSB.

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, 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 elsewhere in collaborating institutions. During the past year, postdoctoral scholars and researchers have made important contributions to the success of CNS-UCSB programs, including the NanoDays informal science education program at the Santa Barbara Museum of Natural History; the 2011 Research Summit; the CNS Research Seminar in Emerging Technologies & Society (research presentations by Stacey Frederick and Yasuyuki Motoyama); and the Society for the Study of Nanoscience and Emerging Technologies annual conference (S.Net 2011) in Tempe, AZ. They have also played key roles in mentoring graduate and undergraduate students in the CNS Graduate Fellows and INSET Summer Internship programs.

CNS has sponsored 13 postdoctoral scholars since 2008. Those active in Year 7 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, Year 2 (7)

Postdoctoral Scholars	PhD Field; Granting Institution	Affiliation
Meredith Conroy	Political Science; UCSB	IRG 3
Gwen D'Arcangelis*	Women's Studies, UCLA	IRG 3, UC CEIN
Matthew Eisler	History, University of Alberta	IRG 1
Yasuyuki Motoyama	City & Regional Planning, UC Berkeley	IRG 2
Christine Shearer*	Sociology; UCSB	IRG 3, NSF Delib.
James Walsh	Sociology; UCSB	IRG 2
Non-UCSB Based Postdoctoral Researchers	PhD Field; Current Campus	Affiliation
Adam Corner*	Social Psychology; Cardiff U.	IRG 3* GeoEng
Christina Demski	Psychology; Cardiff University	IRG 3
Stacey Frederick	Textile Mgmt.; Duke University	X-IRG
Marian Negoita*	Sociology; U. of California, Davis	IRG 2

Anton Pitts*	Risk Science; U. of British Columbia	IRG 3, UC CEIN
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* indicates postdocs funded partially or in full through other awards, but housed and collaborating in CNS-UCSB

Postdoctoral Scholars Program: Starting in 2008, the UCSB-based Postdoctoral Scholars Program has recruited 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, and Canada, in disciplines including City & Regional Planning, History, Political Science, 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; **Mikael Johansson** at Sweden's University of Gothenburg; **Philip McCarty** at UCSB; and **Jennifer Rogers-Brown** at Long Island University). Two other former postdocs left to take up prestigious research positions: **Yasuyuki Motoyama** as a senior program manager with the Kauffman Foundation, and **Matt Eisler** as a research fellow with the Chemical Heritage Foundation. Since leaving UCSB, four of these scholars (Eisler, Johansson, Motoyama, and Rogers-Brown) have continued to work on CNS-UCSB research projects as external affiliates.

With the departure of **D'Archangelis**, **Motoyama**, and **Eisler** in summer and fall, 2011 to full-time professional employment, we ran an open recruitment for new Postdoctoral Scholars. This resulted in our hiring Luciano Kay, who will join IRG2 in residence at UCSB in June, 2012. Luciano 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**. He possesses considerable expertise in Latin American nanotechnology policy and in bibliometric research methods. In spring, 2012, we will conduct an open recruitment to hire an additional postdoctoral scholar to work with IRG3 starting in fall, 2012. Upon completion of her PhD in the Bren School, graduate student researcher Mary Collins will assume a full-time UC CEIN-funded postdoc position (leverage) in summer 2012 to continue collaborative research with **Harthorn** and **Satterfield** on environmental risk perception and the spatial analysis of nano-remediation environmental justice. She will participate as a CNS postdoc in all CNS IRG 3 and center-wide activities.

Several former CNS-UCSB Graduate Fellows who finished their PhD studies are working with their IRGs as postdoctoral researchers to complete research projects begun as students. The three scholars who did this in year 7 work on projects dealing with anchoring effects in public perceptions of nanotechnologies (Conroy), the role of gender in public deliberations (Shearer), and migration and international collaboration in nanoscience innovation (Walsh). Shearer, a sociologist and published writer with expertise in environmental policy issues, is also contributing to the development of CNS-UCSB website materials and public policy briefs for our Outreach Program, discussed in Section 12.

Postdoctoral Researchers at Other Campuses: CNS-UCSB also supports postdoctoral researchers who work with our external collaborators. We fund a full-time postdoctoral researcher at Duke University (Stacey Frederick) who heads a Cross-Interdisciplinary Research Group (X-IRG) spatial analysis project examining the impact of California nanotechnology in the global economy. We partially support the work of two postdoctoral researchers conducting public deliberations research with **Nick Pidgeon** at Cardiff University (Adam Corner and Christina Demski), a researcher examining industrial policy and new technologies at UC Davis with **Fred Block** (Marian Nagoita), and a researcher studying risk perceptions with **Terre Satterfield** at the University of British Columbia (Anton Pitts). We integrate off-site postdoctoral researchers with other Center personnel and activities whenever possible. For instance, Stacey

Frederick served as a mentor for the INSET summer internship program in the past, and will do so again in summer 2012 for IRG2, partnering with UCSB Graduate Fellow Galen Stocking. We also invite all postdocs to CNS Research Summits and other conferences and IRG meetings.

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. Principal Investigators (PIs) 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 (24 this year). Postdocs also participate in all-CNS-UCSB Research Summits and National 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 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. In 2011, UCSB Postdoctoral Scholar Yasuyuki Motoyama and Postdoctoral Researcher Stacey Frederick from Duke University presented their research to the Research Seminar. Postdocs also participate in 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.

In addition, the Education Program provides postdocs 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. UCSB's 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 Yrs 5 & 6.

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.

Evaluation:

We evaluate the postdoctoral program through a confidential annual survey in which our current and former postdoctoral scholars are asked to assess their experience and ratings of program components. For the Year 7 survey, conducted in March, 2012, we received responses from six of the twelve current and former postdocs contacted.

Overall, responses to the survey were quite positive. Responses ranged from “good” to “excellent” (averaging 3.66 or above on a 4-point scale) to quantitative measures of the quality of their interactions with various members of the CNS-UCSB community, including their IRG leader and fellow researchers. Open-ended responses were also generally quite positive. One respondent noted that involvement as a postdoc “allowed me to undertake research that I would not have had the time or resources to otherwise complete.” All respondents appreciated the value of their interdisciplinary research experience, although noting the communication difficulties that can arise, and all but one indicated that they had benefited by expanding their professional networks to include individuals from other disciplines. One scholar was bothered by a lack of timely feedback on draft work submitted to the IRG leader. Several noted that they valued learning to view problems from new perspectives through their interdisciplinary experiences; as one said “Helps me look at things from a different point of view with a different set of priorities and values - expands my overall understanding, and makes me a better researcher and scholar.” One respondent summarized time as a CNS-UCSB Postdoctoral Scholar as “the best experience of my professional career so far.”

Postdoctoral scholars also complete quarterly surveys providing input to the Research Seminar about possible topics and suggestions for improvements. Throughout the year, postdocs are encouraged to meet with CNS-UCSB’s Education Director **Metzger** and Director of Education Programs and Communication **Boggs** to discuss their suggestions for program improvements, to seek advice about professional matters such as job hunting tips and publication processes, and to discuss confidential issues such as handling workloads and interpersonal conflicts with other researchers.

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 students active in year 7 and descriptions of program activities are provided below.

CNS Graduate Fellows and Graduate Student Researchers during Year 7

Graduate Fellow	Department	Affiliation
Peter Burks	Chemistry	IRG 2
Amanda Denes	Communication	IRG 3
Roger Eardley-Pryor	History	IRG 1
Cassandra Engeman	Sociology	IRG 2
Matthew Gebbie	Materials	IRG 2

Shirley Yueying Han	Ecology, Evolution & Marine Biology	IRG 2
Shannon Hanna	Environmental Science & Management	IRG 3
Zachary Horton	English	X-IRG
Claron Ridge	Chemistry	IRG 2
Galen Stocking	Political Science	IRG 2
James Walsh	Sociology	IRG 2
Grad Student Researcher	Department	Affiliation
Erin Calkins	Chemistry and Biochemistry	Education
Mary Collins*	Environmental Science & Management	IRG 3
Lauren Copeland	Political Science	IRG 3
Rachel Cranfill	Linguistics	IRG 3
Sarah Hartigan	Global and International Studies	IRG 2
Zachary Horton	English	X-IRG
Lily Anne Welty	History	Education

*Indicates partial or full co-funding

Research Fellowships in Social Science and Humanities and Science and Engineering:

The Graduate 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.

Eleven students participated in the Graduate Fellowship Program during the reporting year. Of the seven Graduate Fellows active during the 2010-2011 academic year, two received their PhDs in 2011 (Claron Ridge and James Walsh). Two additional students who had planned to remain active with us in 2011-2012 left the program after being awarded highly prestigious fellowships funding their dissertation research projects: Amanda Denes (recipient of a UC President's Dissertation Year Fellowship), and Peter Burks (NSF ConvEne IGERT Fellowship focused on Conversion of Energy through Molecular Platforms). Three Fellows from 2010-2011 were renewed in 2011-2012 (Roger Eardley-Pryor, Cassandra Engeman, and Shannon Hanna); they were joined by four new Fellows (Matthew Gebbie, Shirley Yueying Han, Zachary Horton, and Galen Stocking). The 11 Fellows active in the reporting year represented nine academic disciplines (four in the sciences, three in the social sciences, and two in the humanities), and include two women, one of whom is Asian. This somewhat skewed gender composition is in part the result of the graduation in the preceding year of five women Science and Social Science Fellows.

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 BH), 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 to attend professional meetings and conferences, including the 2011 S.Net Conference in Tempe, AZ. In addition, Graduate Fellows Hanna and Engeman presented their own research and received feedback on their presentation skills to the Research Seminar at a rehearsal session prior to the S.Net Conference (Nov 2011). Graduate Fellows Gebbie, Han, and Stocking from IRG 2 joined senior researchers **Rich Appelbaum** and **Aashish Mehta** in presenting IRG 2 research in a panel that was part of a widely advertised and well-attended two-part public lecture series on “China and Indigenous Innovation” in February, 2012. The IRG 2 Fellows will travel to China in April, 2012 to conduct research on the emerging Chinese bioengineering industry.

Evaluation

Among the most important indicators of the value placed by Graduate Fellows on their experience is their continued involvement with CNS-UCSB beyond their initial funding periods and following graduation, and their success in obtaining research funding from campus and national funding sources.

As part of ongoing formative and summative evaluation, we annually ask current and former Fellows to complete confidential surveys describing their expectations, their general level of satisfaction, and perceived benefits resulting from their Fellowships. Of the 32 individuals who have participated in the program since its inception, 16 (50%), completed one of the two 2012 surveys. Among current Graduate Fellows, the rate was 85% (6 out of 7): three Social Science/Humanities Fellows, and three Science/Engineering Fellows.

Current Fellows rated their experiences positively, with cited benefits including learning to view and address research questions from new perspectives through their interdisciplinary experiences, improved research skills, a better understanding of the social and policy contexts in which scientific and technology development take place, and having access to resources for research and presenting their work at conferences that would not have been available otherwise. Several Fellows specifically valued attending S.NET in November, 2011. Primary challenges mentioned include managing time commitments to fulfill both IRG research and other Center participation requirements (Seminars, outreach activities, NSF reporting), understanding different methodological approaches, and learning to communicate with researchers from other disciplines. None of the respondents reported problems communicating with their peers from other disciplines, however, which had been an issue for some Science and Engineering Fellows in past surveys, and in fact all Fellows rated communication among the Fellows as being excellent (4 on a scale of 4). Several Fellows indicated their belief that their experiences had improved their marketability for academic jobs, and several said they were

interested in exploring additional career options, although none said they had changed their career path.

Five of the six respondents rated the Research Seminar as “Good” or “Excellent”, with the other rating it as “Satisfactory.” One returning Fellow noted that “I think the quality of the CNS seminars have improved over this past year. They’ve always been good, but they’re getting better.” Suggestions for improvement included having more science and engineering speakers, and adding sessions focusing on structured discussion of shared readings.

Ten alumni Fellows responded to the March, 2012 survey. Three of these were former Science Fellows, and the remaining six were Social Science/Humanities Fellows. All respondents reported having had positive experiences at CNS-UCSB that benefited their current professional activities. Learning experiences most noted by respondents as being useful during the past year include their research (n=9), mentoring from faculty (n=8), interdisciplinary interactions (n=7), and continued collaboration with CNS (n=6). The quality of faculty mentoring was praised by all respondents, with several indicating that they still keep in regular contact with their IRG leader, and one expressing gratitude for supporting letters submitted on behalf of successful scholarship applications. Additional benefits reported by respondents were improved research capabilities, better interdisciplinary collaboration skills, and increased marketability for jobs in academia and in business. One former Fellow noted that “My experiences at CNS were invaluable. The most influential experiences were probably the interdisciplinary interactions, and the mentoring from my advisor.” Nine of the ten described their Fellowship experience as being of High or Very High Value, and the other as being of Moderate Value.

Of the ten alumni survey respondents, three hold academic positions, one runs his own consulting business, two have alumni postdoc positions with CNS-UCSB, three are still completing their graduate studies at UCSB, and one has recently received the PhD and is seeking employment.

Graduate Student Researchers (GSRs): In addition to the Graduate Fellows Program, CNS-UCSB provides graduate students with opportunities for involvement in research projects as GSRs. These students are hired by, and work closely with, IRG leaders on projects for periods of one or more quarters’ duration, usually for fewer than 20 hours per week. GSRs are invited, but not required, to participate in all CNS-UCSB activities, including the Research Seminars and graduate student information meetings, and receive regular announcements of professional development opportunities through Center listservs. Like other Education Program participants, GSRs are encouraged to discuss issues of interest and concern with the Education Director and Director of Education Programs and Communication. Several former GSRs were later awarded Graduate Fellowships through open recruitment processes, including current year 7 Fellows Eardley-Pryor, Engeman, and Horton.

Seven GSRs worked on research and educational outreach projects during the reporting year; six were women and one was mixed Caucasian and Asian-American. Three GSRs worked on IRG 3 projects, two of whom worked with CNS-UCSB Director and IRG3 PI **Barbara Herr Harthorn** on projects related to gender and public participation and risk analysis. Rachel Cranfill analyzed language usage by men and women participating in public deliberation workshops evaluating nanotechnology risks. Mary Collins, a GSR with the UC Center for the Study of the Environmental Implications of Nanotechnology (UC CEIN) at UCSB, evaluated the equity of siting decisions by the EPA of nanoremediation interventions, and studied product consumer safety attitudes in relation to views on nanotechnology risk and benefit. Lauren Copeland worked with **Bruce Bimber** and **Barbara Harthorn** in developing a survey of consumer and

political attitudes toward nanotechnology products. Zachary Horton worked with **Chris Newfield** as a GSR conducting research for a book on solar energy policy as part of the X-IRG Nano Solar Project. Sarah Hartigan assisted IRG2 leader **Rich Appelbaum** in researching the Chinese nanotechnology industry. Two students, Erin Calkins and Lily Anne Welty, assisted in revising and teaching the Santa Barbara City College course, Physical Science 107, *Nanoscience in Society*, which was developed by a team led by former CNS-UCSB Education Director **Julie Dillemuth** and which will be discussed in further detail in the curriculum section of this section.

To date, CNS-UCSB has had no formal program of tracking outcomes for current and former GSRs. **Boggs** met one-on-one in Winter 2012 with two of the three currently active GSRs to obtain feedback about the quality of their experience and ideas for improvement. They reported satisfaction with their IRG research experience and the support received from their faculty mentors in shaping their research to simultaneously address their own and the Center's goals. They also reported satisfaction with their levels of integration into the CNS-UCSB community; feeling adequately appraised of Center announcements and activities, but enjoying their freedom to opt out of participation in activities outside their areas of interest so they could devote their limited weekly hours at the Center to their research projects. In the coming year, Education Program leaders **Metzger** and **Boggs** plan to develop an annual survey that will be administered to GSRs, and will explore options for more formally structuring the GSR program while respecting the time constraints and research requirements of their work.

INSET Summer Internship Program

In 2011, CNS-UCSB provided three internships to students participating in the NSF-funded Interns in Science, Engineering and Technology (INSET) REU program at the California Nanosystems Institute (CNSI). This program recruits community college students to participate in an 8-week summer research experience on the UCSB campus. As participants in the INSET program, CNS-UCSB interns participate in weekly meetings and special seminars, and are trained in presentation skills alongside REU interns working on experimental science research projects in CNSI laboratories.

At CNS-UCSB, the interns worked on projects addressing the societal implications of nanotechnology under the mentorship of the Humanities and Social Science Graduate Fellows: the regulation of carbon nanotubes by the State of California (Sergio Cardenas for IRG1); identification of NGOs that have taken positions on regulation of nanotechnologies (William Reynolds for IRG3); and techniques for communication expertise used by participants in nanotechnology public deliberations meetings (Alexander Lyte also for IRG3). In addition to working on individual research projects, the interns participated in IRG meetings, attended CNS Graduate Fellows Seminar meetings, and met weekly with the DEPC. At the end of the program, they gave oral presentations about their research projects to the CNS-UCSB community and to a session attended by other INSET interns and mentors. They also presented their research at a campus-wide research poster colloquium with UCSB interns from the INSET and other summer research programs.

Following completion of their internships, Lyte matriculated at UCSB, while Cardenas and Reynolds entered UC San Diego. In November, 2011, Reynolds presented his summer internship project to a poster at the annual meeting of Sigma Xi conference, and Lyte has since been awarded an internship at the Santa Fe Institute for summer 2012 based in part on recommendations he received from his mentors (Denes and **Harthorn**).

2011 INSET Summer Interns

Intern	Home University/ Major	Grad Mentor	PI	IRG
Sergio Cardenas	College of the Canyons/ Chemistry	Roger Eardley- Pryor	Patrick McCray	1
Alexander Lyte	Santa Barbara City College/Economics	Amanda Denes	Barbara Harthorn	3
William Reynolds	Ventura College/ Mathematics	Cassandra Engeman	Barbara Harthorn/ Jennifer Earl	3

Evaluation

Evaluations completed by both interns and mentors point to a successful summer. Interns reported being satisfied with the research they conducted, how much they learned, participation in CNS activities, and interactions with their mentors and other members of the CNS-UCSB community. As in past years, the 2011 interns reported increased confidence in their knowledge, research skills, and communication and presentation skills as a result of participating in the program. Particular challenges reported include conducting research outside the intern's scientific academic background, finding the focus for the project, and completing the work within the project's timeframe. The most enjoyable aspects cited were participating in their research group meetings, and interacting with CNS-UCSB researchers. Overall, it appears that the interns developed a greater appreciation for the issues influencing nanotechnology's social acceptance and the role of social science research in general. As one intern summarized the learning experience, "The critical reading skills I developed with the help of everyone at the CNS really helped me realize what research in a social science is about."

Mentors generally evaluated their experience positively, consistent with previous years. Two of the three mentors reported enjoying working with their students and all three mentors noted that their objectives for the internship were met or exceeded. Mentors particularly enjoyed seeing the growth of their intern's knowledge and confidence, using their teaching skills, their intern's enthusiasm for the project, and meeting the project goals by the end of eight weeks. One mentor summarized the value of the program to mentors and interns as follows: "The INSET program provided me an opportunity to include exceptional undergraduate researchers in the workings of CNS. It allowed me to see my own research from a new perspective, and it afforded a chance for community college students in California to better understand the rigors of graduate work in the social sciences."

Curriculum

Graduate Fellows Orientation Meeting: In September 2011, CNS-UCSB started the academic year with a half-day orientation workshop and lunch for the new and returning Graduate Fellows. The orientation was built around an interactive discussion of the Center's mission, activities, and policies and procedures, as well as specific background on the IRG research programs. In addition, the orientation included an introduction to nanoscale science and engineering concepts, which included a short lecture by former Graduate Fellow Peter Burks, and hands-on exposure to nanoscale materials using some of the exercises developed by the Nanoscale Informal Science Education Network for NanoDays. The session was followed by a lunch to introduce the new Fellows to CNS-UCSB leadership, faculty, postdocs, and staff.

CNS Research Seminar: As in past years, the CNS-UCSB Research Seminar on Emerging Technologies & Society (offered quarterly as Sociology 591 BH) was the focal point of the

Educational Program's internal activities during the reporting year. The four quarterly seminar meetings 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.

Many of the sessions with outside speakers are open and are advertised to the campus community, generating interest in CNS-UCSB research among departments such as Economics, Global & International Studies, Environmental Sciences, History, and Feminist Studies.

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

- **Karl Bryant**, Assistant Professor of Sociology and Women's Studies, State University of New York, "NVivo: A Powerful Data Management Tool for Qualitative Research" (Nov 2011)
- **Luis Campos**, Assistant Professor of History, Drew University, "Next-Generation Nano? Narratives of Synthetic Biology" (Mar 2011)
- **Céline Lafontaine**, Professeur agrégée, Sociologie, Université de Montréal, "The Quebec Nanotech: The Conquest of the Infinitely Small as Seen by Researchers" (Apr 2011)
- Sharon Ku, Postdoctoral Researcher, University of Southern Indiana, "Disappearing Nanoparticles: Regulatory Gaps in U.S. Nanotechnology EHS Policy" (Oct 2011)
- **Cyrus Mody**, Assistant Professor of History and Science, Rice University, "Interdisciplinary and Vietnam-Era Protest at Stanford" (Oct 2011)
- **Chris Mooney**, Science Writer, "The Republican Brain on Science: Understanding Conservatives' Denial of Research-Based Reality" (co-sponsored with the Lawrence Badash Memorial Lecture in the Department of History) (Jan 2012)
- IRG 2 Panel presentation, "Will China Eat Our Lunch? Some Thoughts on China's State-Driven Policies to Become a Global High-Tech Leader" by **Rich Appelbaum**, Professor of Sociology, Professor and MacArthur Chair of Global and International Studies, Leader of CNS-UCSB's Globalization and Nanotechnology IRG; **Aashish Mehta**, Assistant Professor of Global and International Studies; and Doctoral Students Mathew Gebbie (Materials), Shirley Han (Ecology, Evolution, and Marine Biology), and Galen Stocking (Political Science) (Feb 2012)
- **Denis Simon**, Vice-Provost of International Strategic Initiatives, Arizona State University, "US-China Innovation Dialogue: Boom or Bust?" (Feb 2012)
- **Stephen Zehr**, Professor of Sociology, University of Southern Indiana, "Science Funding Trends and Proposal Success at NSF: A View from a Former Program Officer" (Sept 2011)

Seminar professional development sessions included presentations by **Barbara Herr Harthorn**, CNS-UCSB Director, and Associate Professor of Feminist Studies, Anthropology and Sociology, addressing "Ethical Issues in Social Research" and "Writing Successful Research Grants"; **Bruce Bimber**, Professor of Political Science, speaking on "Academic Publishing: Trends and Processes"; and **Cathy Boggs**, CNS-UCSB Director of Education Programs and Communication, discussing "Public Speaking 101: Tips for the Whole Scholar." 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, 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.

New Community College Course: In Spring, 2011, Santa Barbara City College (SBCC) offered Physical Science 107, *Nanoscience in Society*, a 4-unit general education science course with laboratory. The course built upon the 'Greenworks' course developed by the INSCITES program (Insights on Science and Technology in Society) at UCSB. It was developed under an NSF STS award, *Bringing Nanotechnology and Society Courses to California Community Colleges*, by a team led by CNS-UCSB's former Education Director **Julie Dillemath** and Co-PI **Patrick McCray** as PI and Co-PI, respectively. Other team participants included UCSB Professor of Environmental Studies & History **Peter Alagona**; Director of Research Development **Dr. Meredith Murr** from UCSB's Office of Research; the course's instructor, SBCC Chemistry Professor **Dr. Eric Bullock**, who taught the course; SBCC Acting Executive Vice-President, **Dr. Marilynn Spaventa**; and CNS-UCSB Graduate Student Teaching Scholars Erin Calkins (Chemistry and Biochemistry) and Lily Anne Welty (History), who taught the course lab sections. The Evaluation team for the course consisted of **Dr. Lubi Lenaburg**, Evaluation Coordinator for the Center for Science and Educational Partnerships (CSEP) at UCSB's California NanoSystems Institute (CNSI), and two graduate students from the Girvetz Graduate School of Education, Shadi Roshandel and Elizabeth Sciaky.

The course's objective was to introduce nanoscience and nanotechnology and their historical contexts and societal implications to first year college students majoring in science as well as nonscience fields. Like the original Greenworks course in which CNS researchers also played a key role, it was based on four pillars: science, technology, society, and history. The scientific course material was developed from elementary but rigorous basic scientific principles drawn from physics, chemistry, materials science, and biology. The course was certified as a fully transferable general education science course with lab that articulates to the UC and CSU systems.

The 16-week long course consisted of two weekly lecture sections of 1 hour, 20 minutes and one weekly 3-hour lab section. Eighteen students enrolled in the course, 17 of whom completed it. Students came from a diverse range of major fields, including the sciences (Biology and Artificial Intelligence) as well as non-science fields such as English and Media Arts. Evaluation survey results indicated that students from across the majors considered both the lecture and lab material to be accessible and interesting. Of particular note were survey findings that 79% of the students considered the integration of science and society issues to be among the course's most valuable features, 86% indicated they would definitely recommend the course to others, and 64% said the course increased their interest in taking further science and engineering classes.

Course materials, including syllabi, labs and assignments, lab notes from the graduate student teaching scholars, the instructor's report, and the report of the outside evaluation team, are posted on the CNS-UCSB website at <http://www.cns.ucsb.edu/education/nanocourse>. Plans to hold a training workshop for other community college instructors in 2012 or 2013 have been put

on hold due to a combination of lack of funding and budget cutbacks at the community colleges that prevent them from adding new courses. This will be reevaluated as conditions evolve.

Other Courses: CNS-UCSB faculty, external collaborators and former Graduate Fellows incorporated Center research into 22 university courses during this reporting period, listed below. Asterisks indicate new courses.

Graduate Level Courses:

- *Civil Engineering 202, University of British Columbia, *Civil Engineering II* (Beaudrie guest lecture)
- Engineering 285F, UCSB, *Business Skills: Asia: New Opportunities for Technology Businesses* (**Appelbaum** – guest lecture)
- *English 236, UCSB, *Studies in Literary Criticism and Theory: Literature, Technology, Mass Creativity* (**Newfield**)
- Feminist Studies 260, UCSB, *Feminist Research Methods* (**Harthorn** guest lecture)
- *Feminist Studies 280A, UCSB, *Research Seminar* (Whirlow guest lecture)
- Global & International Studies 221, UCSB, *Political Economy, Global Development, and the Environment* (**Appelbaum**)
- Health, Medicine, and Society 323, Lehigh University, *Health and Environmental Controversies* (**Friedman**)
- Materials Engineering 232, California State Polytechnic University, San Luis Obispo, *Materials, Ethics, and Society* (**Boggs** guest lecture)
- *Resource Management and Environmental Studies 507, University of British Columbia, *Human-Technological Systems* (**Satterfield** and **Kandlikar**)
- *Sociology 496, University of Wisconsin, *Globalization and Social Change: Institutions, Power and Inequality* (**Conti**)
- Sociology 210, University of Wisconsin, *Survey of Sociology* (**Conti**)
- Sociology 591BH, UCSB, *CNS Research Seminar in Emerging Technologies and Society*, taught 4 quarters/yr. (**Harthorn**)
- Summer Seminar 2011. *Globalization—The Rise of China*. Fielding Graduate University (**Appelbaum** guest lecture)

Undergraduate Level Courses:

- *English 197, UCSB, *American Literature & Business Culture/Creativity* (**Newfield**)
- *Feminist Studies 186HH, UCSB, *Gender and Society: Risk & Inequality* (**Harthorn**)
- Global & International Studies 2, UCSB, *Introduction to Global Studies: Politics and Economics* (**Appelbaum**)
- History 233, Rice University, *Science in the Modern World* (**Mody**)
- History 237/Chemistry 235/Anthropology 235, Rice University, *Nanotechnology: Content and Context* (**Mody** and **Kristin Kulinowski**)
- History 391, University of South Carolina, *Information Technology Revolutions* (**November**)
- *Interdisciplinary Program in History and Philosophy of Science 066,025, University of Seoul, *Science, Technology, and Society* (**Choi**)
- *Physical Science 107, Santa Barbara City College, *Nanoscience in Society* (**Bullock**: NSF STS Award)
- Sociology 124, University of Wisconsin, *Contemporary American Society* (**Conti**)

Traveling Technologies Internship Project: This innovative interdisciplinary collaborative research project is a prime example of how CNS-UCSB has combined the approaches of multiple IRGs to create valuable educational outcomes. In 2011, The *Journal of Nano Education* published a case study about the project written by a diverse group of CNS-UCSB participants (former Education Director **Dillemath**, postdoc Frederick, former Graduate Fellow and current Collaborator **Parker**, sub-award PI **Gereffi**, and IRG2 leader **Appelbaum**). Originally developed for the 8-week INSET summer internship program, the project can be adapted to other educational contexts. Students work in teams using a Global Value Chains (GVC) framework to critically analyze the societal impacts of a particular nanomaterial by tracing its journey from origins and raw state to finished product or application. By doing this, they learn how firms, countries, economics, regulations, and socio-cultural factors affect how a product is brought from concept to commercialization. As a tangible project outcome, students develop GVC diagrams useful for educating and communicating issues to stakeholder audiences. The project can be structured to accommodate different numbers and levels of students. A detailed description of the project and supporting materials are posted on the CNS-UCSB website (<http://www.cns.ucsb.edu/educationresources>), and in the journal article [Dillemath, J., Frederick, S., Parker, R., Gereffi, G., & Appelbaum, R. (2011). Traveling technologies: Societal implications of nanotechnology through the Global Value Chain. *Journal of Nano Education*, 3, 36-44.]

Proposed Nanoecotoxicology Undergraduate Education (NUE) Program: CNS-UCSB Director **Harthorn** is a Co-PI on a two-year, \$200,000 NUE funding proposal to NSF that will be submitted at the end of April, 2012. This undergraduate program is designed to introduce engineering and science students to many applications of nanotechnology, and to provide them with knowledge and hands-on experience that will support careful consideration of potential environmental and societal impacts when choosing nanomaterials to achieve desired design solutions. CNS-UCSB will work with participating faculty and mentors to provide information on the societal and ethical implications of nanotechnology suitable to all aspects of the program, which includes lecture and laboratory courses and internships, and is expected to involve faculty, postdoc and graduate student mentors, upper division undergraduate students, and community college interns. Lead PI on the proposal is **Dr. Arturo Keller**, Professor of Biogeochemistry at the Bren School for Environmental Science & Management, who holds a joint appointment with the Department of Mechanical and Environmental Engineering. This project builds on a UC CEIN on-line ecotoxicology course, being disseminated in the US and internationally, for which **Harthorn** provided one of 15 lectures and the only societal implications content.

Reports to the National Advisory Board

CNS-UCSB faculty and staff report evidence of progress towards completion of the objectives listed above to the National Advisory Board (NAB). At the NAB's April, 2011 meeting, discussion centered on broad questions related to the Center's future following the end of the second NSF grant period. The Board was especially concerned that CNS-UCSB identify new sources of support to maintain and build on the Education Program's successes in training interdisciplinary graduate student and postdoctoral research scholars. Aware that NSECs that have sunsetted reported difficulties in obtaining new funding for their education and outreach programs, the NAB advised the Center's leadership to make this a major priority. This issue was discussed further at an all-day Executive Committee planning retreat held in January, 2012, and **Metzger** and **Boggs** are taking the lead in working with the Executive Committee to develop a strategic plan to identify future Education Program activity foci and funding needs.

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. A “New to Nano” section provides links to resources provided by nano educational organizations such as the Nanoscale Informal Science Education Network (NISE Net), Penn State’s Nanotechnology Applications and Career Knowledge Center (NACK), and the Woodrow Wilson Center’s Project on Emerging Nanotechnologies (PEN). Education Highlights from NSF reports are also posted on the site. News and upcoming events related to the education program are promoted on the website’s front page and archived under the site’s “News” and “Events” tabs. Additional information about Education Program promotion activities can be found in Section 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	51	24	27	1	0	2	37	4	0	1	2	4	0
Undergraduate	20	11	9	0	0	0	12	3	0	0	0	4	0
Masters	6	2	4	1	0	0	6	0	0	0	0	0	0
Doctoral	25	11	14	0	0	2	19	1	0	1	2	0	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	51	24	27	1	0	2	37	4	0	1	2	4	0

Table 3b: Education Program Participants - US Citizens and Permanent Residents													
Student Type	Total	Gender		Race Data								Ethnicity: Hispanic	Disabl ed
		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	50	24	26	1	0	2	36	4	1	1	5	4	0
Undergraduate	20	11	9	1	0	0	12	3	1	0	3	4	0
Masters	6	2	4	0	0	0	6	0	0	0	0	0	0
Doctoral	24	11	13	0	0	2	18	1	0	1	2	0	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	50	24	26	1	0	2	36	4	1	1	5	4	0

12. OUTREACH AND KNOWLEDGE TRANSFER

The overall purpose of CNS-UCSB's Outreach and Knowledge Transfer activities is to create awareness and use of our research findings about the societal implications of nanotechnologies among stakeholders at the local, regional, national and international levels, in order to encouraging conversations during this “upstream” period that will lead to their responsible and sustainable development.

As personnel have changed and our research course matured over the past year, we have begun a process of evaluating the long-term direction of our outreach activities even as we continue those that have proven successful in the past. In this section, we offer an overview of our approach to public engagement, and then describe our outreach efforts during the reporting year and some of our future plans for sharing our work with various stakeholder audiences—nanoscientists and engineers, the policy community, other technology and society researchers, and members of the general public—who are affected by the nano-enterprise.

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

Addressing the challenges of devising and implementing new methods for learning about and engaging with the full range of stakeholders in the nano enterprise is a critical aspect of the NSEC and NNI mandates for responsible technology development and vital to the economic success of the nano enterprise as well. The core of CNS-UCSB societal implications research focuses on understanding and conducting comparative analysis of the views of the multiple stakeholders in the nano enterprise, in order to engage them in mutual analysis, discussion, and, 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. The term “knowledge transfer” implies a one-way and top-down process of knowledge deposition that is at odds with our views about the importance of two- or even multi-way interaction between the scientific and social communities.

CNS strives to gain the knowledge and lay the foundations necessary to pursue the more difficult mutual, interactive forms of engagement with science and society, including addressing the many interested social actors, as well as those individuals and groups who lack familiarity with nanotechnologies but are *implicated* in nanotechnologies' futures. Ongoing relatively low levels of public awareness of nanotechnologies (see our high impact meta analysis of public attitude and perception surveys, **Satterfield** et al., *Nature Nanotechnology*, 2009) particularly challenge the project of public engagement, and CNS-UCSB is discussing new approaches to helping improve this situation as we move forward. **Harthorn** is in active discussion as an informal advisor to the NNI's working group on public engagement, NPEC, so this work has the potential to impact (indeed, we're told it has already impacted) government decision making at the highest levels.

There are no easy answers as to how to create multi-stakeholder participation. At CNS-UCSB, we see our role in this process as having three dimensions. First, we conduct research that generates necessary new knowledge about the contours and beliefs of upstream perceptions about nanoscale science and technology, and responses to messages about them, held by members of the public and of stakeholder groups, which include nanoscale scientists and engineers, nanotoxicologists, regulators, industry, insurers, public interest groups, the media, and societal implications researchers. Second, we seek to disseminate this knowledge through

our outreach activities to these various stakeholders. Third, we want to use this knowledge to develop replicable models of the type of tailored public participation activities that past studies have shown to be effective.

The challenges to full engagement are many: the experts are diverse, the industry is global, nanomaterials themselves are an enormous class of technologies and their enabled products equally heterogeneous. There are also many publics—workers, members of communities located near industrial sites, consumers, the environmentally exposed—having varying concerns that may exist at the local, state, national, and even global levels. The nano-enterprise is a complex social and historical reality, and capturing it adequately requires multiple methods, along with a selective, strategic approach. A full-scale, national US deliberation effort would require investment far beyond that reflected in the budgets for the two current nano societal research centers, CNS-UCSB and CNS-ASU, even if they were exclusively devoted to public deliberation research and action (which they are not). Our awareness of this constraint on scale of effort has been particularly acute because of the extensive knowledge and advice provided to us since the Center's beginnings by our UK collaborator, **Nick Pidgeon**, a veteran and outside evaluator of numerous public deliberation and participation campaigns in the risk controversy-plagued UK.

To understand the highly distributed and complex global nature of the nano enterprise and its stakeholders requires research approaches that are collaborative, interdisciplinary, and international in scope. The multiple methods used by CNS-UCSB's researchers to meet these challenges include:

- Qualitative social science—interviews, small group dialogue, on-line forums, participant-observation—for learning about deeper, contextual, cultural domains, values, narratives, identities, and experiences
- Quantitative social science—phone, web, & mail surveys using broad, representative samples, or large-scale experimental studies
- Historical analyses—comparative, descriptive, narrative explorations of the nano-enterprise via in-depth oral histories of leading NSE scientists; content analysis of policy, media and other documents; and archival research.

CNS-UCSB Outreach Activities to Nano Stakeholder Groups

The full range of CNS-UCSB research is thus important and integral to the Center's outreach and knowledge transfer goals. Like our research, we believe that our outreach activities must be premised on the understanding that there is no universal, one size fits all approach; rather outreach much be tailored to each party, based on careful assessment and knowledge of their level of technology awareness and understanding, perceptions (positive, negative, neutral, or indifferent), and interests (environmental, economic, health, social, or political, among others).

We also view engagement with the various stakeholder groups as central not only to CNS-UCSB's Outreach Program, but as a key responsibility shared by all members of the CNS-UCSB community. Below we will describe some of the many successful outreach activities through which we have interacted with key stakeholder groups during the reporting year in the hope of encouraging their increased interest in engaging with the important societal implications shaping the developing nano-enterprise.

NSE Community

Engagement with nanoscientists and engineers is a central and distinctive aim of the CNS-UCSB, as well as one of our most fruitful areas of activity. 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.

Leadership: 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. 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**; CBEN (Rice Univ) leader **Vicki Colvin**; Harvard nanoscientist and NSEC director **Robert Westervelt**; and engineer **Susan Hackwood**, Director of the California Council on Science and Technology Policy. The Center's seven-member Executive Committee includes two scientists: materials scientist **Craig Hawker** and ecotoxicologist and engineer **Patricia Holden**.

Research: Since our beginnings in 2006, members of all CNS-UCSB research groups have actively engaged members of the science and engineering community in our work. Much of this takes the form of direct engagement – attending meetings and conferences; studying scientific research and research practices, and conducting interviews. 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 near daily 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 ephemeral recollections of key meetings, events, discoveries and people. These oral histories will be archived at the CHF and 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. IRG 1 Leader **Patrick McCray** was offered a prestigious visiting professorship at Cal Tech for 2011-2012, based on earlier interactions with scientists there, and is developing a new project based on what he has learned.

IRG 2 researchers have worked closely with NSE researchers in developing and understanding the contexts for international collaboration in their work. As part of their research on the impacts of the nano-enterprise on international social, economic, and development processes, IRG 2 leader **Rich Appelbaum** and three Graduate Fellows (Gebbie, Han, and Stocking) are traveling to Suzhou, China in April 2012 to interview managers and early-career stage scientists working on bionanotechnology in companies located in BioBay, a nanotechnology center located within Suzhou Industrial Park.

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** leads the only social science IRG and serves 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 is collaborating with the UC Center for Lab

Safety as they seek 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 collaborative education and outreach activities between UC CEIN and CNS-UCSB, the fostering of new projects-in-planning with the wider societal implications community (e.g. **Guston** and **Eggleson**'s NSF workshop proposal, pending 2012), and the co-production of knowledge, e.g. 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 conducting ecotoxicology research. IRG 3 has collaborated on our 2nd international survey of industry risk perceptions and safe handling practices for nano materials (see Engeman et al., 2012; also Conti et al. 2008). This project represents a highly successful integration of social science and nanoscale science expertises and interests and has led to further points of connection, for example, the addition of **Holden** to the CNS Executive Committee in Fall 2011. Finally, CNS postdoc Johansson, a cross-IRG appointment, conducted lab ethnography in the NINN facility on campus—the ESB clean room—and in CEIN toxicologists' labs. Director **Harthorn** has also served as a consulting expert with researchers at Oak Ridge National Laboratory to collaborate in a project involving 8 DOE national centers for nanoscience and technology research and development.

Joint Funding Proposals: CNS-UCSB researchers have collaborated with scientists and engineers on numerous joint funding proposals, a majority of them successful. One of the most important of these was the \$24 million award that established the UC Center for the Environmental Implications of Nanotechnology (UC CEIN), for whom CNS-UCSB director **Harthorn** has been an active IRG leader and researcher in addition to the range of activities noted above. Harthorn is also Co-PI with Dr. **Arturo Keller** from the Bren School of Environmental Science & Management on a proposal to fund development of a new undergraduate curriculum in nanoecotoxicology being submitted to the NSF at the end of April, 2012.

Publications: In publishing our results, our 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 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 their graduate students in our work through our innovative interdisciplinary Graduate Fellowship program. Alongside their peers from the sciences and humanities (6 in the reporting year), Nanoscale Science and Engineering Graduate Fellows (5 in the reporting year) participate fully in the CNS-UCSB IRGs of which they are members, by attending IRG meetings, helping to design studies, analyzing data and in some instances helping to collect it, as is the case with the two Science and Engineering Fellows who will accompany IRG 2 leader Rich Appelbaum to China in April, 2012. The high value that many of them place on their experience with us is demonstrated by the ongoing commitment of past NSE Fellows to CNS-UCSB (including former Science Fellows Burks, Ferguson, Macala, Martin and Rowe), as shown by their continuing participation in our events and other activities even beyond the time they leave campus. We continue to keep alumni

Fellows informed of happenings through our listserv announcements and informal contacts by IRG leaders. We also intend to celebrate their contributions to the Center by reconvening them along with all other Fellows and Postdocs in a meeting at the end of our first 10 years of existence.

CNS-UCSB collaborates with nanoscientists and engineers on other aspects of our education program. Our summer internship program is integrated with CNSI's INSET REU program, in which STEM students from California community colleges spend 8 weeks in residence developing and completing a research project on the societal implications of nanotechnology under the mentorship of our Graduate Fellows and Postdocs. In addition to the nanoeotoxicology course under preparation, we 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.

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, Mar 2010). 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.

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 and Canadian governmental organizations) and state level organizations (CCST, DTSC). Some of these presentations during the reporting year are described below.

International: IRG3 leader **Appelbaum** participated in NNI-OECD discussion on "assessing the economic impact of nanotechnology" in Washington, DC (Mar, 2012), and has made contacts with the NNI's Global Issues in Nanotechnology working group. X-IRG leader **Newfield** represented CNS-UCSB and circulated his work on the importance of a public agenda in the solar innovation system at a 'Responsible Innovation' US-UK workshop in Wash DC organized by Arizona State University's Consortium for Science, Policy, & Outcomes and CNS-ASU, which was attended by six UK and nine US researchers as well as representatives from thirteen government agencies (Jan 2012).

National: CNS-UCSB Director **Harthorn**, along with CNS-ASU Co-PI **Dietram Scheufele**, made a remote presentation to the NPEC NNI working group discussing public participation and communication in July, 2011. We have been told that this discussion, along with a follow-up conversation in April 2012 and resources we shared with the group, made a direct impact at the OSTP level. In March, 2012, IRG 2 collaborator **Fred Block** testified at a Congressional briefing on federal R&D spending sponsored by nine scientific organizations.

State: Through her participation in the UC CEIN, **Harthorn** has been involved in discussions with the State of California Department of Toxic Substance Control (DTSC) regarding their regulatory work with the state's nanotechnology industry; with officials in NIOSH, EPA, FDA and other agencies to plan a workshop for NSE, industry, and policymakers about the risks

associated with carbon nanotubes (CNTs); and with the University of California (systemwide) Center for Lab Safety, which is interested in developing a risk perception survey for the UC's entire population of laboratory researchers.

CNS-UCSB Policy Briefs Program (in development): In a new effort, Outreach Program director **Boggs** is working with postdoc Shearer, a professional writer and environmental policy researcher, and Rachel Parker, a former CNS Social Science Graduate Fellow now at the Science and Technology Policy Institute, to develop policy briefs explaining the implications of CNS-UCSB research findings to those involved in the nanotechnology policymaking process. The first examples of these briefs will be available at the 2012 site visit, and we hope to use this mechanism to provide readily accessible implications of CNS findings for those making decisions about regulation of various aspects of the nanoenterprise.

NGO Nano Policy Conference (in development): IRG 3 is in the early stages of conducting research on the role of Non-Governmental Organizations (NGOs) in the nanotechnology governance process, both domestically and internationally. We plan to share the results and implications of this research with relevant NGO leaders at a large international conference we will organize, tentatively planned for 2013-2014.

US and International Research Communities

One of CNS-UCSB's primary goals has been to help build networks of relationships among nanotechnology and society researchers from the US and worldwide. We have had a strong international focus from the beginning, and this global, international, and transnational approach is welded into the fabric of the Center. IRG 2 is deeply and theoretically oriented to comparative globalization studies, in which its leader **Appelbaum** has been a pioneering scholar, and has had a dedicated focus on nano R&D in China and E. Asia from the beginning. International collaborations with Canadian and UK researchers formed the backbone of IRG 3's work, which has been conducted with US/UK/Canada comparative analyses, and the new NGO study is global in scope. IRG 1 has also contributed extensively to the scholarship on scientific and technological advances in East Asia and Europe, as well as in North America.

Building on this robustly international orientation at the core, CNS-UCSB has worked to expand its international impact through involving additional international researchers in our work, by participation in international research networks and conferences, and in our publications.

Expanding CNS-UCSB's Base of International Researchers: During the reporting year, we continued to expand the reach of our IRG research programs through our collaborations with international researchers, some of whom (**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 increased international presence is evinced by our presence at numerous international conference and meetings in the reporting year.

Specific areas in which we have strengthened our international research base include:

Asia: IRG 1/IRG 2 historian and collaborator **Choi** has moved from the US to a faculty position in S. Korea, where he is studying developments in the Korean nanotechnology industry.

Latin America: **Appelbaum** is Co-PI on a UC MEXUS/CONACYT grant (with collaborators **Foladori & Invernizzi**) to develop new research collaborations with Mexican scholars, and by extension, with Latin America scholars, through ReLANS, the Latin American Nanotechnology & Society Network. IRG 3 researchers **Rogers-Brown** and Shearer are also collaborating with **Foladori** and **Invernizzi** to extend IRG 3 research efforts in Brazil and Mexico.

Globally: IRG 3 researchers Engeman, **Earl** and **Harthorn** have begun a new project to identify NGOs from around the world that are involved in work around nanotechnology's social implications and so far have a database with more than 80 organizations.

Hosting International Research Visitors: CNS-UCSB has in the past hosted visiting international scholars from Canada, China, India, the UK, Germany, France, Spain, Switzerland, The Netherlands, and Sweden, among others. In 2012, we expect to host a visit from Mexican scholars Edgar Zayago Lau and **Guillermo Foladori**.

Participation in Developing International Research Networks and Conferences: CNS-UCSB researchers have contributed to the strengthening of existing, and development of new networks among international researchers studying the societal implications of 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.

S.NET: **Harthorn** was a founding executive committee member of S.NET (The Society for the Study of Nanoscience and Emerging Technologies), a new international professional society for researchers studying nano societal implications. **Harthorn** also served on the planning committees for all three annual conferences to date (Seattle, 2009; Darmstadt, Germany, 2010; Tempe, AZ, 2011, the last of which was co-hosted by CNS-UCSB with CNS-ASU), and also for the upcoming 2012 conference in The Netherlands.

CNS-UCSB collaborated with CNS-ASU to jointly host the third annual meeting of S.NET, the Society for the Study of Nanoscience and Emerging Technologies. S.NET is a young international professional society created in part out of NSF's Nanotechnology in Society Network. The meeting was hosted physically in November, 2011 in Tempe, AZ by CNS-ASU and virtually by CNS-UCSB (<http://www.cns.ucsb.edu/snet2011>); ASU's **Guston** and UCSB's **Herr Harthorn** co-chaired the program committee. The meeting drew more than 200 registrants from 20 countries and presented more than forty-five panels and other activities. Keynote speakers included Steve Rayner (Oxford, UK), **Nicholas Pidgeon** (Cardiff, UK), **Noela Invernizzi** (FU Parana, Brazil), Geri Augusto (Brown, USA), **Ann Bostrom** (Washington, USA), and a plenary panel on "Immigration and Emerging Technologies" included Darren Petrucci (ASU), Ricardo Dominguez (UCSD), and Simone Brown (UT Austin). The program also featured emerging technology-themed walking tours of Tempe and Phoenix, short theatrical performances by NISE Net, a poster session with table-top demonstrations and videos, and student-organized activities. The conference provided ample evidence of a flourishing international community of scholars actively involved in describing, theorizing, and debating the societal implications of new [nano]technologies.

Canadian Nano Conference: **Harthorn** is the sole US representative on the scientific organizing committee for a major international conference to be held in Nov, 2012 in Montreal, Canada (the

Ne³LS Network International Conference 2012 on The Responsible Development of Nanotechnology: Challenges and Perspectives).

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, students and early career scholars in Science and Society conferences, via travel support and conference coordination. We provided such travel support for S.NET in 2011, and plan to continue this for the 2012 S.NET conference in The Netherlands.

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 least 144 and included 44 presentations or sessions in education and outreach and 98 in social science and humanities research contexts. See full listing at the end of this section (12). Additionally, CNS researchers, including graduate students and postdocs organized numerous panels at scholarly conferences. In 2011-2012 this has included taking a leadership role in organizing 8 panels and sessions at 6 conferences in the US, Canada, Denmark, The Netherlands, Spain and Switzerland.

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 November, 2009 *NanoEquity Conference* in Washington DC was organized by CNS-UCSB's IRG 2 in collaboration with international NGOs interested in development and drew participants from around the globe. This resulted in the publication of a book that circulates those diverse views widely (**Parker and Appelbaum**, 2012).
- The January, 2010 *Risk Perception Workshop* organized by IRG 3 was attended by participants from 5 different countries. The outcome was a special edition of the leading risk analysis journal, *Risk Analysis*, edited by **Pidgeon, Harthorn & Satterfield** (November, 2011)
- 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 April 2010 (with participants from 6 countries around the globe). An edited volume of the proceedings is now well along in preparation (**Newfield & Boudreaux**, in preparation)
- The 2010 S.NET conference in Darmstadt, Germany resulted in the publication of an edited volume published in the reporting year that includes contributions from multiple CNS-UCSB researchers (**Harthorn et al.** 2011). **Harthorn** was a lead founder of the organization, executive committee member, and program committee member.
- The 2011 S.NET conference in Tempe, AZ (co-hosted by CNS-UCSB with CNS-ASU) was attended by participants from over 20 countries, and will result in three different dedicated publications—an edited volume and two special issues of journals.

Hosting Visiting Scholars: CNS-UCSB hosts an active visiting scholars program, providing extensive opportunities for our researchers and students to interact with scholars studying a range of issues on the societal dimensions of nanotechnologies. Scholars who visited us during 2011-2012 included

- **Jackie Isaacs**, Professor in the Department of Mechanical and Industrial Engineering at Northeastern University (Feb 2011)
- Stacey Frederick and **Patrick Herron**, both of Duke University (March 2011)
- **Karl Bryant** (SUNY New Paltz, Sociology & Women's Studies), a former CNS-UCSB Graduate Fellow, was in residence from Aug-Dec 2011 to work on the IRG 3 gender and deliberation project that he helped launch
- **Jennifer Rogers-Brown** (Sociology, Long Island University), another former CNS-UCSB Graduate Social Science Fellow, was in residence during Summer, 2011, to work on extending IRG 3 deliberation research, and planning for future research IRG 3 research on NGOs and gender issues, as well as a study with IRG 2 researchers investigating nanotechnologies for food and food systems
- Sharon Ku, a visiting postdoctoral researcher and collaborator with **Stephen Zehr** from the University of Southern Indiana, spent Sept 2011-Jan 2012 engaged in the CNS-UCSB community as she studied the challenges and rewards of interdisciplinary collaboration among social scientists/humanists and scientists/engineers engaged in understanding nanotechnologies' social significance.
- Edgar Zayago-Lau from Mexico plans to be in residence as a visiting scholar for a year starting in summer, 2012.

UCSB and Santa Barbara Regional Communities

CNS-UCSB and its members engaged members of our local campus and Santa Barbara-area communities through multiple venues during the reporting year. These are described below.

Lectures and Public Events: CNS-UCSB sponsors its own, and 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 eight public lectures through our speaker series. One of the highlights was a two-part series on "China and the Global Innovation System: 'Indigenous Innovation' and Economic Competitiveness," featuring a panel discussion by the IRG 2 research team and a presentation by visiting speaker Denis Simon from ASU. These programs were:

- **Karl Bryant**, Assistant Professor of Sociology and Women's Studies, State University of New York, " NVivo: A Powerful Data Management Tool for Qualitative Research" (Nov 2011)
- **Luis Campos**, Assistant Professor of History, Drew University, "Next-Generation Nano? Narratives of Synthetic Biology" (Mar 2011)
- **Céline Lafontaine**, Professeur agrégée, Sociologie, Université de Montréal, "The Quebec Nanotech: The Conquest of the Infinitely Small as Seen by Researchers" (Apr 2011)
- Sharon Ku, Postdoctoral Researcher, University of Southern Indiana, "Disappearing Nanoparticles: Regulatory Gaps in U.S. Nanotechnology EHS Policy" (Oct 2011); Interdisciplinary Collaborations at CNS-UCSB (Jan 2012)

- **Cyrus Mody**, Assistant Professor of History and Science, Rice University, “Interdisciplinary and Vietnam-Era Protest at Stanford” (Oct 2011)
- **Chris Mooney**, Science Writer, “The Republican Brain on Science: Understanding Conservatives’ Denial of Research-Based Reality” (Jan 2012) (Badash Memorial Lecture in History)
- IRG 2 Panel presentation, “Will China Eat Our Lunch? Some Thoughts on China’s State-Driven Policies to Become a Global High-Tech Leader” by **Rich Appelbaum**, Professor of Sociology, Professor and MacArthur Chair of Global and International Studies, Leader of CNS-UCSB’s Globalization and Nanotechnology IRG; **Aashish Mehta**, Assistant Professor of Global and International Studies; and Doctoral Students Mathew Gebbie (Materials), Shirley Han (Ecology, Evolution, and Marine Biology), and Galen Stocking (Political Science) (Feb 2012)
- **Denis Simon**, Vice-Provost of International Strategic Initiatives, Arizona State University, “US-China Innovation Dialogue: Boom or Bust?” (Feb 2012)
- **Stephen Zehr**, Professor of Sociology, University of Southern Indiana, “Science Funding Trends and Proposal Success at NSF: A View from a Former Program Officer” (Sept 2011)

Collaborative Events: CNS-UCSB also co-sponsored a campus-wide, year-long program on risk in postmodern society entitled *Speculative Futures*. This included 12 separate and generally well-attended events, encompassing public lectures, films, workshops, and creative events focused on risk perspectives, nuclear risk, security and catastrophe, conservatives’ risk denial, privacy risk, biomedical surveillance, contagion control, and other topics. *Speculative Futures* was the winner of the competitively-awarded UCSB Critical Issues series for 2011-2012 year (see <http://www.criticalissues.ucsb.edu/home.html>). **McCray** and **Harthorn** were both involved in writing the proposal for this program and in planning meetings, hosting events, providing expert commentary and, along with other CNS participants, introducing societal implications issues from CNS-UCSB research into the wider discourse on campus through these events and activities.

NanoDays: For the past four years, CNS-UCSB has participated 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 nanotechnology 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 events for several years at both campus and community venues, CNS-UCSB began a continuing partnership with CNSI to co-host NanoDays starting in 2009. Additional partners joined the activity in 2010 and 2011, when we co-sponsored a NanoDay at the Santa Barbara Museum of Natural History in collaboration with the Museum and UCSB’s National Nanotechnology Infrastructure Network (NNIN) and UC CEIN, in addition to CNSI. Those events drew audiences of nearly 500 visitors, including families and children. .

NanoDays 2012 has expanded to a two-day event at the Museum and is scheduled for April 14-15. Four CNS-UCSB Graduate Fellows (Eardley-Pryor, Engeman, Hanna, and Martin) will be 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. IRG 3 Graduate Student Researcher Collins will participate in a NanoDays exhibit with volunteers from the

UCLA UC CEIN, extending our work to the LA science museum world and thereby reaching a much larger audience than is possible in Santa Barbara.

Connecting with community groups. In the past year, we decided to place less emphasis on creating special outreach events, such as science café type activities, designed to bring the public to us. Instead, we have sought out and responded to invitations from community-based organizations to participate in their events. For instance, during the reporting year, **Appelbaum** discussed China's influences on technology development with the three local organizations: the Santa Barbara Rotary Club, the Santa Barbara Club, and the Santa Barbara Institute of World Affairs. The latter group subsequently recruited him to its steering committee.

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 technologies. Below are some of the tools we are using to reach these stakeholder audiences.

CNS-UCSB Website: During the past year, we have been making ongoing changes to our website (www.cns.ucsb.edu) both in design and content. The site has been upgraded to the Drupal platform, enabling CNS-UCSB staff to enter content changes to most areas without the need to involve a web designer. During the past year, we employed undergraduate student web assistants to help with making changes and updates to the site's content, including posting links to videos of CNS-UCSB Speakers' Series events, and updating news and events information. We also have brought in an undergraduate student intern from UCSB's undergraduate professional writing minor program in Spring, 2012; she will receive training in public relations writing and promoting public events on the web from outreach director **Boggs**. The upgrade is a large undertaking that has not yet been completed, and progress will continue to be made in the coming year.

In addition to news, event information, and podcasts of selected lectures by CNS-UCS 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 archives, links to our videos, and links to current and past CNS-UCSB Clips (see below).

In the coming year, we plan to explore methods for increasing our web presence among our target audiences through social media such as Facebook and Twitter, and determine what resources will be needed to make effective use of these communication channels. One idea we are exploring is the possibility of setting up a social network for NGOs interested in nano and society issues, as part of our planning process for the upcoming conference on this topic.

CNS-UCSB Clips:

Another popular continuing outreach effort reaching a virtual international audience is the CNS-UCSB Clips. Leading breaking news stories on nanotechnology and societal issues are tracked

and circulated electronically twice monthly. Twenty-six Clips compilations were sent out during the reporting period to a national and international list of nearly 500 interested colleagues, students, government and policy people, industry contacts, NGO leaders and members of the general public. The clips are generated by former CNS-UCSB Graduate Fellow David Weaver, one of several former students who continue to be engaged with the Center following completion of their studies

Traditional Media: Although our focus for the future is on expanding the quality of our web presence, we consider it important to continue using traditional media to reach 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.

CNS-UCSB Media Plan for 2011-12: Some of our goals for using traditional and new media in the coming year include:

- Increased networking with regional and national media to secure better placement and promotion of CNS-UCSB news items.
- Continue efforts to post CNS-UCSB op eds and opinion pieces to other prominent blogs (e.g., *Science Progress*, *The Blog*, *Miller-McCune*).
- More opportunistic launching and placing of press releases with print, electronic, and online media, in a context of rapidly changing news publishing.
- Continue to improve the CNS-UCSB website for more effective interaction and information retrieval, including showcasing new CNS-UCSB research through written pieces and short video interviews, and developing a rotating series of online articles featuring student activities.
- Utilize analytical tools to track traffic patterns to specific areas of our website.
- Conduct a cost/benefit analysis of podcasting CNS-UCSB events of interest to different stakeholder groups
- Continue to assess requirements for implementing new media tools for engagement (e.g., posting short video clips on research findings of interest to different audiences).
- Develop aims consistent with the resources available and changing media contexts for dissemination and engagement.

Nano and Society Data Archive Proposal: CNS-UCSB is excited to partner with the University of Massachusetts at Amherst and CNS-ASU, on a \$48,000 IMLS planning grant proposal, *Nanoscience and Emerging Technologies in Society: Sharing Research and Learning Tools (NETS)*. The purpose of the grant is to explore the opportunities and challenges of establishing a permanent, online repository of nano and society research and data accessible by researchers, policymakers, students, and members of the public who want to learn more about the societal processes influencing nanotechnologies' development and use. If awarded, the planning grant will be used to set up a meeting of nano and society researchers to discuss these issues in conjunction with the December, 2012 NSEC meeting in Washington, DC.

Presentations 2011-2012

A. Education and Outreach (to NSE, industry, government, media, public) (n=44)

- Appelbaum, Richard**, "The Chinese Century?" presentation at the Santa Barbara Institute for World Affairs, Lobero Theater (February 26, 2011) (omitted last year)
- Appelbaum, Richard**, guest lecture in ENG285F on nanotech and China, UCSB's Technology Management Program (March 2, 2011)
- Barbara Herr Harthorn, Milind Kandlikar, & Terre Satterfield**. "IRG 7- Environmental Risk Perception: Implications for the UC CEIN and Regulators," Presentation at the UC CEIN annual retreat, Lake Arrowhead, Mar 11-12, 2011.
- McCray, Patrick**. "Vioneering," invited talk for "The Landscape of Science in Postwar California," seminar, Huntington Library, Los Angeles, CA, April 1, 2011.
- Amanda Denes, Cassandra Engeman and Roger Eardley-Pryor. Societal and Ethical Implications of Nanotechnologies. NanoDays, Santa Barbara Museum of Natural History. April 9, 2011.
- Newfield, Chris**. "Open Source Nano for the 'Developing' World? INRA, Ivry-sur-Seine, Paris, France, May 1, 2011.
- Boudreaux, Daryl. "Insights into Innovation Systems," CNS Annual Meeting, Santa Barbara, CA, May 2, 2011.
- Whirlow, Julie, "NVivo and Endnote Tools for Research" Presentation in FemSt 280A, May 17, 2011.
- Appelbaum, Richard**, "Will China Rule the World?" noon luncheon talk at Santa Barbara Rotary Club (June 3, 2011)
- Barbara Herr Harthorn**, "IRG 7-Environmental Risk Perception," presentation at UC CEIN site visit by NSF & EPA, UCLA, Jun 8, 2011.
- Harthorn, Barbara Herr**. "Ethical Issues in Social Research," CNS seminar, CNS-UCSB, Santa Barbara, CA, June 28, 2011.
- Barbara Herr Harthorn**. CNS Public Research. Presentation to a meeting of the Nanotechnology Public Engagement & Communications Working Group of the Nanoscale Science, Engineering, and Technology Subcommittee. Washington, DC, July 8, 2011.
- Bimber, Bruce**. "Academic Publishing: Trends and Processes," CNS seminar, CNS-UCSB, Santa Barbara, CA, July 12, 2011.
- Appelbaum, Richard**, "China and High-Tech Development: Is nanotechnology a Case of Industrial Policy?" Fielding Graduate University summer session seminar (July 21, 2011)
- Barbara Herr Harthorn**, Grant Proposal Workshop, CNS Seminar, July 26, 2011.
- Cardenas, Sergio. "Avoiding the Next Asbestos: California's Emerging Regulation for Carbon Nanotubes," INSITE Program Participants, Santa Barbara, CA, August 2, 2011.
- Reynolds, William. "Non-Governmental Organizations and Tomorrow's Nanotechnology," INSITE Program Participants, Santa Barbara, CA, August 2, 2011.
- Boggs, Cathy**. "Public Speaking 101: Tips for the Whole Scholar," CNS seminar, CNS-UCSB, Santa Barbara, CA, August 2, 2011.
- Barbara Herr Harthorn**, Participant, discussant, UC CEIN Bootcamp for Women Scientists. UCLA and UCSB, August 3-4, 2011.
- Barbara Herr Harthorn**, presentation on "Nanotech Risk Perception," UC CEIN Bootcamp for Women Scientists UCLA, Aug 4, 2011.
- Cardenas, Sergio. "Avoiding the Next Asbestos: California's Emerging Regulation for Carbon Nanotubes," UCSB Summer Undergraduate Research Colloquium, Santa Barbara, CA, August 11, 2011.

Lyte, Alexander. "Establishing Expertise in Public Deliberations on Nanotechnology," UCSB Summer Undergraduate Research Colloquium, Santa Barbara, CA, August 11, 2011.

Reynolds, William. "Non-Governmental Organizations and Tomorrow's Nanotechnology," UCSB Summer Undergraduate Research Colloquium, Santa Barbara, CA, August 11, 2011.

Barbara Herr Harthorn, CNS Overview, Lecture in New Fellows Orientation, UCSB, Sept 20, 2011.

Frederick, Stacey, Gereffi, Gary. Nanotechnology Commercialization Conference, Boston, MA, September 26-27, 2011.

Mody, Cyrus. "Interdisciplinarity and Vietnam-Era Protest at Stanford" CNS seminar, CNS UCSB, Santa Barbara, CA, October 1, 2011.

Appelbaum, Richard, "Will China Rule the World?" noon luncheon talk at the Santa Barbara Club (October 3, 2011)

Choi, Hyungsub. "The Limits of the Followership Strategy: The Case of the Japanese Integrated Circuit Development," Department of Science Studies, Chonbuk National University, Jeonju, Korea, October 7, 2011.

Mody, Cyrus. "Interdisciplinarity and Vietnam-Era Protest at Stanford," CNS seminar, CNS-UCSB, Santa Barbara, CA, October 13, 2011.

Harthorn, Barbara Herr & David Guston, co-chairs, co-hosts, 3rd annual meeting S.NET conference, Tempe, AZ, Nov, 2011.

Choi, Hyungsub. "From Materials Science to Nanotechnology: Historical Origins of Interdisciplinary Research," 4th Experimental Seminar, Knowledge Convergence and Future Social Studies of Science Research Group, November 1, 2011.

Choi, Hyungsub. "The Development of the Integrated Circuit in Japan and the Limits of the Followership Strategy," Korean Association for Science and Technology Studies, November 19, 2011.

Bryant, Karl, "NVivo: A Powerful Data Management Tool for Qualitative Research" Guest lecture to UCSB campus on methodological tools for social research, Nov 30, 2011.

Harthorn, Barbara Herr. "Keynote Presentation," Annual NSEC PI meeting to multiple federal agency personnel, incl. NNCO Acting Director, Sally Tinkle, Arlington, VA, Dec 7, 2011.

Harthorn, Barbara Herr. "Theme 7: Risk Perception, Regulation and Outreach" presentation to External Science Advisory Board, UC CEIN, UCLA, Jan 12, 2012.

Boggs, Cathy. "Exploring the Societal Implications of Nanotechnology at CNS-UCSB," Materials Engineering 232, Materials, Ethics, and Society, California State Polytechnic University, San Luis Obispo, CA, February 13, 2012.

Harthorn, Barbara Herr. "Feminist Research Methods: Focus Groups and Surveys." FemSt 260, Winter Q, Feb 29, 2012.

Foladori, Guillermo. "Social and Environmental Implications of Nanotechnology Development in Latin America," Press Conference. Asociación de Prensa Mexicana, México, March 1, 2012.

Beaudry, Christian. "Social context of infrastructure, climate change and energy, leadership, and project management and construction," CIVL 202, Civil Engineering II, University of British Columbia, Vancouver, BC, March 7, 2012.

Christine Shearer. "The Political Economy of Risk Perception: A socio-historical look at the climate change lawsuit /Native Village of Kivalina v. ExxonMobil et al/." Guest lecture in FemSt 186HH, UCSB, March 13, 2012.

Block, Fred participated in a Congressional briefing on federal R&D spending sponsored by nine scientific organizations on March 16, 2012

Appelbaum, Richard attended and participated in NNI-OECD meeting on "assessing the economic impact of nanotechnology," Washington, D.C. (March 27-28, 2012)

Milind Kandlikar, Terre Satterfield, Robin Gregory, Graham Long, and Christian Beaudrie. Work with elite group of nanotoxicology risk experts 2011-2012 to develop expert structured decision making workshop, to be held in Vancouver, May 2012.

Engeman, Cassandra and **Harthorn, Barbara**. Invited speakers in a meeting of the National American Industrial Hygiene Association Nanotechnology Working Group (NTWG); presentation in conference call planned for Apr 18, 2012, based on industry survey project.

B. Research Presentations (n= 98)

Bimber, B. 2011. "Political Consumerism: Organization, Goods, Ideology & Communication." Presentation at The Politics of Consumption/The Consumption of Politics International Conference, Madison, Wisconsin, March 1, 2011

Copeland, L. 2011. "Political or Civic Consumerism?" Poster presentation at The Politics of Consumption/The Consumption of Politics international conference, Madison, Wisconsin, March 1, 2011.

Barbara Herr Harthorn. "Health Enhancement and Hazard Posed by New [Nano]Technologies." Keynote at Cascadia Seminar: Ethnographic Adventures in Medical Anthropology. Univ. of Washington, Seattle, Mar 4-6, 2011.

Christine Shearer, Jennifer Rogers & **Barbara Herr Harthorn.** "The Importance of Application Domain in Public Deliberations of Nanotechnology." Society for Applied Anthropology Meeting, Seattle, Mar 30-Apr 2, 2011.

Appelbaum, Richard, Motoyama, Yasuyuki, and Cao, Cong. "Observing Regional Divergence of Chinese Nanotechnology Centers," Association of American Geographers, Seattle, WA, April, 1, 2011.

Engeman, Cassandra. "Reported Practices and Perceived Risks Related to Health, Safety and Environmental Stewardship in Nanomaterials Industries." Paper presented to the CNS National Advisory Board. April 4, 2011.

Hawker, Craig. "Keynote address," Top-down Meets Bottom-up at Foundations of Nanoscience Meeting (FNANO), International Society for Nanoscale Science, Computation, and Engineering, Snowbird, UT, April 11, 2011.

Santos, Nicholas. "The Geohistory of Nano Policy in the United States," Poster session, Association of American Geographers, Seattle, WA, April, 12, 2011.

Harthorn, Barbara Herr. Risk, Uncertainty and Ambivalence in Views on New [Nano]Technologies." Cultural Anthropology Collective & Forum, Department of Anthropology, UCSB, Apr 14, 2011.

Lenoir, Tim and Patrick Herron. "The Takeoff of Bionanotechnology: Comparison of the US and China," Bayh-Dole at 30: Mapping the Future of University Patenting Conference Davis, CA, April 30, 2011.

Frederick, Stacey, **Gereffi, Gary.** "Spatial Analysis of the Nano Industry." CNS Research Summit and NSF Site Visit, Santa Barbara, CA, May 1, 2011.

Cassandra Engeman. "Perception and Practices in the Nanomaterial Industry: Implications for Regulation." Poster presented at NSF site visit to CNS. UCSB, May 1, 2011.

D'Arcangelis, Gwen, **Satterfield, Terre**, DeVries, Laura, Hanna, Shannon, Pitts, Anton & **Harthorn, Barbara Herr.** "US Public Knowledge and Perception of Nanomaterials in Air, Water, and Soil" Poster presented at NSF site visit to CNS. UCSB, May 1, 2011.

Brock, David. CNS-UCSB Research Summit, Santa Barbara, CA, May 1, 2011.

Mody, Cyrus. CNS-UCSB Research Summit, Santa Barbara, CA, May 1, 2011.

November, Joseph. CNS-UCSB Research Summit, Santa Barbara, CA, May, 1, 2011.

Eardley-Pryor, Roger. CNS-UCSB Research Summit, Santa Barbara, CA, May 1, 2011.

Eisler, Matt. CNS-UCSB Research Summit, Santa Barbara, May 1, 2011.

Engeman, Cassandra. "Perception and Practices in the Nanomaterial Industry: Implications for Regulation." Poster presented at NSF site visit to UC CEIN. May 1, 2011.

Engeman, Cassandra. "Perception and Practices in the Nanomaterial Industry: Implications for Regulation." Poster presented at ICEIN – International Conference on the Environmental Implications of Nanotechnology, Durham, NC, May 9-11, 2011.

Mary Collins, **Barbara Herr Harthorn, Terre Satterfield**. "Nanoremediation: Will equity concerns arise?" Poster presented at the 3rd Annual International Conference on Environmental Implications of Nanotechnology (ICEIN), Duke University, Durham, NC, May 9-11, 2011.

Beaudrie, Christian, **Satterfield, Terre, Kandlikar, Milind, Herr Harthorn, Barbara**. "Benefits, Risks, and Regulation of Nanomaterials: Results from an Expert Survey," Paper presented at ICEIN – International Conference on the Environmental Implications of Nanotechnology, Durham, NC, May 9-11, 2011.

Appelbaum, Richard. "China's Move to High-Tech Innovation: Some Regional Policy Implications," Worldwide Universities Network, conference on "The Asia-Pacific, Regionalism and the Global System," University of Leeds, England, May 12, 2011.

Rich Appelbaum. "Nanotechnology in China and Latin America," The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.

Záyago Lau, Edgar. "Nanotechnology in México: A Path Towards National Development?" The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.

Cong Cao, "Nanotechnology in China - How Effective is State-Led Development?" Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.

Appelbaum, Richard, Chair. Panel on "Developmental States and High-Tech Innovation: The Case of Nanotechnology. Can National Policies Make a Difference?" The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.

Parker, Rachel & Richard Appelbaum. "The U.S. National Nanotechnology Initiative: Federal Support for Science and Technology, or Hidden Industrial Policy?" The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.

Foladori, Guillermo. "Brazilian National Nanotechnology Program: Can Public Investment Drive Innovation?" The Society for the Advancement of Socioeconomics, Madrid, Spain, June 24, 2011.

Appelbaum, Richard. "The Chinese Century," Worldwide Universities Network Conference on "The Asia-Pacific, Regionalism and the Global System," University of Leeds, England, August, 1, 2011.

Beaudrie, C.E.H, **Satterfield, T., Kandlikar, M, Harthorn, B. H.** "Benefits, Risks, Bias, and Nanomaterial Regulation: Results of an Expert Survey," Paper presented at the Fifth International Symposium on Nanotechnology – Occupational and Environmental Health, Boston, MA, Aug 9-12, 2011.

Harthorn, Barbara Herr. Final Closing Plenary Panel Speaker, Fifth International Symposium on Nanotechnology – Occupational and Environmental Health, Boston August 10-12, 2011.

Engeman, Cassandra. "Risk and the Global Nanotechnology Industrial Workplace." Paper presented at the Fifth International Symposium on Nanotechnology – Occupational and Environmental Health, Boston, MA, Aug 11, 2011.

Appelbaum, Richard. "Chinese Century," Annual Meetings of the American Sociological Association, Las Vegas, NV, August 22, 2011.

McCray, Patrick. "How California Invented Nanotechnology?" Invited talk and workshop discussion, Institut Méditerranéen de Recherches Avancées, Marseille, France, September 1, 2011.

Eardley-Pryor, Roger. "Looking Backward to Look Forward: Historical Examples for Nanotechnology's Environmental Future," University of South Carolina's conference on

- "The Public History of Science and Technology," Columbia, SC, September 1, 2011.
- Motoyama, Yasuyuki. "When Clusters Get Loose In Global Business, Local Strategies: Lessons for Economic Development," International Economic Developers Conference, Charlotte, NC, September 1, 2011.
- McCray, Patrick.** "Bob Guccione's Scientific Americans," Annual Meeting of the History of Science Society, Cleveland, OH, October 1, 2011.
- Mody, Cyrus.** "The Josephson Junction at IBM, 1968-1983," Annual Meeting of the Society for the History of Technology, Cleveland, OH, November 1, 2011.
- Mody, Cyrus.** "Choosing Paths for Research at Vietnam-Era Stanford," Annual Meeting of the Society for Social Studies of Science, Cleveland, OH, November 1, 2011.
- Eisler, Matthew, and Eardley-Pryor, Roger, Co-Organizers, Co-Chairs. Panel on "Situating Emerging Technology: Nanotechnology in Historical Perspective," Conference of the Society for Social Studies of Science (4S), Cleveland, OH, November 1, 2011.
- Eisler, Matthew. "Boundaries of Science Communication in the Era of Nanotechnology: The Department of Energy and the Discourse of Revolutionary Applied Science," Conference of the Society for Social Studies of Science (4S), Cleveland, OH, November 1, 2011.
- Eardley-Pryor, Roger. "Looking Backward to Look Forward: Historical Examples for Nanotechnology's Environmental Future," Society for the Social Studies of Science Annual Conference, Cleveland, OH, November 1, 2011.
- Choi, Hyungsub.** "Historical Perspectives on Nanotechnology," Annual Meeting of the Society for Social Studies of Science (4S), Cleveland, OH, November 1, 2011.
- Pidgeon, Nicholas.** "The Curious Case of SPICE: Deliberating Geoengineering as Anticipatory Research Governance?" Annual Meeting of the Society for Social Studies of Science (4S), Cleveland, OH, November 1, 2011.
- Engeman, Cassandra. "Regulation and the Global Nanotechnology Industrial Workplace," CNS seminar, CNS-UCSB, Santa Barbara, CA, November 2, 2011.
- Hanna, Shannon. "Impacts of Zinc Oxide Nanoparticles on the Mussel," CNS seminar, CNS-UCSB, Santa Barbara, CA, November 2, 2011.
- Collins, Mary. "Nanoremediation: Are There Equity Concerns?" CNS seminar, CNS-UCSB, Santa Barbara, CA, November 2, 2011.
- Cranfill, Rachel. "Talking Nano: The Importance of Gender, Race, and Power in Deliberations on the Risks and Benefits of Nanotechnology," CNS seminar, CNS-UCSB, Santa Barbara, CA, November 2, 2011.
- Harthorn, Barbara Herr, Guston, Dave.** "Opening Remarks," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 7, 2011.
- Pidgeon, Nicholas.** "Control Dilemmas: Great and Small, and The Curious Case of SPICE: Deliberating Geoengineering as Anticipatory Research Governance," Plenary Address. Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 7, 2011.
- Bryant, Karl.** "Nanomaterials, Toxicology & Risk," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
- Engeman, Cassandra, Chair & Organizer, "Regulatory Challenges of Nanotechnology" Panel at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
- Friedman, Sharon.** "Nano, Media & the Public," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
- Newfield, Christopher.** "Solar Innovation: The Case of Germany," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.

- Invernizzi, Noela.** "Nanotechnology and Labor: Trends in Industry and Union's Perspectives," Plenary Address. Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
- Rogers-Brown, Jennifer,** Shearer, Christine, Co-Chairs. "Food, Nanotech Food," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
- Collins, Mary. "Nanoremediation: Are There Equity Concerns?" Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 8, 2011.
- Rogers-Brown, Jennifer,** Shearer, Christine, & **Harthorn, Barbara Herr.** "Public deliberation and democratic participation: The methodological and political possibilities of deliberation on nanotechnology." Presentation at the S.NET Conference, Tempe, AZ, Nov 8, 2011.
- Rogers-Brown, Jennifer,** Chair & Organizer, "Gender and Nanotechnology: A Mixed-Method Panel of Risk Perception and Social Location." Panel at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
- Denes, A., Cranfill, R., **Harthorn, B.H.,** Shearer, C., Whirlow, J., Hanna, S. "Talking nano: The importance of gender, race, and power in deliberations on the risks and benefits of nanotechnology." Paper presented at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
- Kandlikar, Milind.** "Challenges in Regulating Nano." Presentation at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
- Conti, Joe,** & Becker, Sean. "Regulatory Risk Judgment: How the EPA Confronts Scientific Uncertainty and the Challenges of Nanotechnology." Presentation at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
- Engeman, Cassandra, Baumgartner, Lynn, **Holden, Patricia,** & **Harthorn, Barbara Herr.** "Risk and the Global Nanotechnology Industrial Workplace." Presentation at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
- Shearer, Christine, **Rogers-Brown, Jennifer,** and **Harthorn, Barbara Herr.** "Power and vulnerability: reconsidering "low risk" views of health and environmental hazards. Paper presented at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
- Cranfill, Rachel, Shearer, Christine, **Rogers, Jennifer** & **Harthorn, B.H.** "Indexing expertise in a deliberative setting: A comparison study." Poster presented at the S.NET Conference, Tempe, AZ, Nov 8-10, 2011.
- Mody, Cyrus.** "What Happens When an Emerging Technology Never Quite Emerges? Josephffson Computing in the '70s and '80s," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
- Eardly-Pryor, Roger. "Regulatory Analogues? Environmental History and Nanotechnology's Potential Future," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
- Beaudrie, Christian, **Satterfield, Terre,** **Kandlikar, Milind** and **Harthorn, Barbara Herr.** "Nano-Expert Perceptions and Regulatory Challenges for Emerging Nanotechnologies," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
- Newfield, Christopher,** Boudreaux, Daryl. "What is Nano Doing for Solar? A Report on Notes from the Field," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
- Zayago Lau, Egdar, **Foladori, Guillermo.** "The Path of Nanotechnologies in Mexico," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.

- Appelbaum, Richard, Foladori, Guillermo,** Parker, Rachel, Zayago Lau, Edgar. "Mexico-US Bilateral Scientific Collaboration on Nanotechnology," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
- Bostrom, Ann.** "Moving Pictures: Popular Perceptions of Nanotechnology and its Risks," Plenary Address. Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9 2011.
- Friedman, Sharon.** "What have the U.S. and U.K. Media Reported about Nanotechnology Regulation?" Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
- Parker, Rachel.** "Latin American Network on Nanotechnology and Society," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 9, 2011.
- Conti, Joseph,** Fleischer, Torsten, Eggleston, Kathleen and Merchant, Gary. "Roundtable-The Science Policy and Regulatory Implications of Emerging Technologies," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 10, 2011.
- Eisler, Matthew. "Boundaries of Science Communication in the Era of Nanotechnology: The Department of Energy and Discourses of Revolutionary Applied Science," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 10, 2011.
- Johansson, Mikael. "Perception of Risk among Scientists Working with Nano," Annual Meeting, Society for the Study of Nanoscience and Emerging Technologies Conference, Tempe, AZ, November 10, 2011.
- Boggs, Cathy.** "Exploring Nanotechnology SEI through Internships: The INSET Summer Program for Community College Students," Congress on Teaching the Social and Ethical Implications of Research, Tempe, AZ, November 10, 2011.
- Reynolds, William. "Non-Governmental Organizations and Tomorrow's Nanotechnology," Student Research Conference, Sigma Xi Annual Meeting and International Research Conference, Raleigh, NC, November 11, 2011.
- Shearer, Christine. "Climate Change Health and Environmental Risks and Perceptions in Kivalina, Alaska." American Anthropological Association annual meeting, Montreal, QC Canada, November 19, 2011.
- Newfield, Christopher.** "Solar Innovation: The Case of Germany," American Anthropological Association, Montréal, Québec, November 19, 2011.
- Beaudrie, Christian. "Expert opinion and lifecycle regulation for emerging nanomaterials." Presentation at the Society for Risk Analysis, December, 2011.
- Harthorn, Barbara Herr.** "Public Participation in Nanotechnology Risk Governance: Best Practices for Best Outcomes." Keynote address, NSEC PI meeting, Arlington, VA, Dec 5-7, 2011.
- Frederick, Stacey, Gereffi, Gary. Nanoinformatics Conference, Arlington, VA, December 7-9, 2011.
- Appelbaum, Richard.** "The Chinese Century? Some Policy Implications of China's Move Towards Indigenous Innovation," China Rising Conference, Bristol University, Bristol, England, December 5, 2011.
- Eisler, Matthew. "Innovation and Ideology: Producing and Interpreting Facts from Lab to Policy Salon in the Energy R&D Sector," Science, Technology, and Society Program, University of Puget Sound, January 1, 2012.
- Eisler, Matthew. "Boundaries of Science Policy Communication: Nanotechnologizing Materials Science in the Department of Energy," Eighth Laboratory History Conference (LH8), Georgia Institute of Technology, Atlanta, GA, March 1, 2012.

- Mody, Cyrus.** "University in a Garage: Instrumentation and Innovation from UC Santa Barbara," Edited Volume Workshop, UC Berkeley, CA, March 1, 2012.
- Eardley-Pryor, Roger, **McCray, Patrick.** "Take a Little Risk? Historical Analogies and the Regulation of Nanotechnology," Business History Annual conference, Philadelphia, PA, March 1, 2012.
- Harthorn, Barbara Herr.** "Theme 7: Risk Perception, Regulation and Outreach" presentation to the UC CEIN Executive Committee, Camarillo, CA, Mar 10, 2012.
- Shearer, Christine. "The Political Economy of Risk Perception: A socio-historical look at the climate change lawsuit /Native Village of Kivalina v. ExxonMobil et al." Guest Lecture, Sociology Department Colloquium, UCSB, March 14, 2012.
- Mody, Cyrus.** "Emerging Technology: The Coevolution of Performances, Regulations, and Markets," Business History Conference, Philadelphia, PA, March 31, 2012.
- McCray, Patrick.** "Did California Invent Nanotechnology?" invited talks, versions given multiple times at various venues including Georgia Institute of Technology; University of California, San Diego; Johns Hopkins University; University of Pennsylvania; UCLA; throughout 2011 and 2012. (n=5)
- Harthorn, Barbara Herr, Nick Pidgeon, Terre Satterfield.** Organizers & Chairs. "Nanotechnology Risks—Intersections across the Social Sciences." Session at the Society for Risk Analysis Europe Annual Meeting 2012, Zurich, Jun 18-20.
- Collins, Mary & Engeman, Cassandra, Organizers & Chairs, "Social Location and Nanotechnology Risk Perception" Session proposal for 4S, Nov 2012, Copenhagen.
- Cortes-Lobo, Rodrigo (GA Tech), and Engeman, Cassandra (UCSB), Organizers & chairs, "Public Interest Groups: The Role of Organizational Participation in Nanotechnology" Development" Session proposed for SNET 2012, Oct, Twente, The Netherlands.

13. SHARED AND OTHER FACILITIES

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

1) CNS-UCSB

The main facilities for CNS located in a suite of contiguous offices in Girvetz Hall, providing housing for all CNS personnel in proximity among researchers, staff and infrastructure and a suitable conference and meeting space. The CNS site is in a centrally located building on campus that allows effective coordination and communication among all participants. This space commitment by the Executive Vice Chancellor, College of Letters and Science, and Dean of Social Sciences to the CNS on our very space-constrained campus is a strong mark of support for our interdisciplinary research and education efforts. In 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 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 for our offices and our work, 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)

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 Nanostructures Imaging and Characterization Laboratory, equipped with NMR, electron microscopes, scanning probe tools, optical and electrical characterization and surface analysis capability. A BioNanofabrication facility will complement the existing NNIN facility --11,000 sq. ft. cleanroom (see below) by focusing on new chemical and biologically-templated means of forming nanostructured devices. The CNSI building also houses the Allosphere, a 360 degree, 3-story data-visualization space, and extensive exhibition space that accommodates 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. More information on CNSI, the MRL, and UCSB nanoscale shared research facilities can be found at www.cnsi.ucsb.edu.

3) Materials Research Laboratory (MRL) (UCSB)

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 coordinate a campus-wide summer Undergraduate Research Intern Seminar Series, which CNS interns attend and in which CNS Education staff and faculty have presented.

<http://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's 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 director, Michael Goodchild, is a key advisor and resource for the 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 <http://www.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 is 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 a generous space in the new social science building on campus 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 services or components of projects. For more information see <http://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, Bimber and McCray 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 Flanagan confers regularly with the CNS executive committee. Longterm plans under discussion for the CNS include possible collaborative institutionalization with CITS. <http://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 began a 5-year, \$24 million nanotechnology risk-assessment project funded by the National Science Foundation (NSF) and the U.S. Environmental Protection Agency (EPA), in which CNS IRG 3 researchers have an active, funded role. The UC Center for the Environmental Implications of Nanotechnology (UC CEIN) 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 since 2006 and joined the Executive Committee in Fall, 2011. <http://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. CNS-UCSB Director Barbara Harthorn co-leads UC CEIN Theme 7 - Risk Perception, Regulation and Outreach with co-PI chemist Hilary Godwin, UCLA.

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. 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. <http://www.cein.ucla.edu/>

10) Center on Globalization, Governance, and Competitiveness (CGGC) (Duke University)

This Center, led by CNS IRG 4 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 <http://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 and Hyungsub Choi, and current home to IRG 1 former postdoc, Matthew Eisler. CHF is a generous 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).

<http://www.chemheritage.org/>

12) The Jenkins Collaboratory, Duke University is 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. <http://www.jhfc.duke.edu/jenkins/>

13) The Institute for Resources, Environment and Sustainability (IRES) at the University of British Columbia (UBC)

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.

14) Science Journalism program/ Lehigh University

Through the 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.

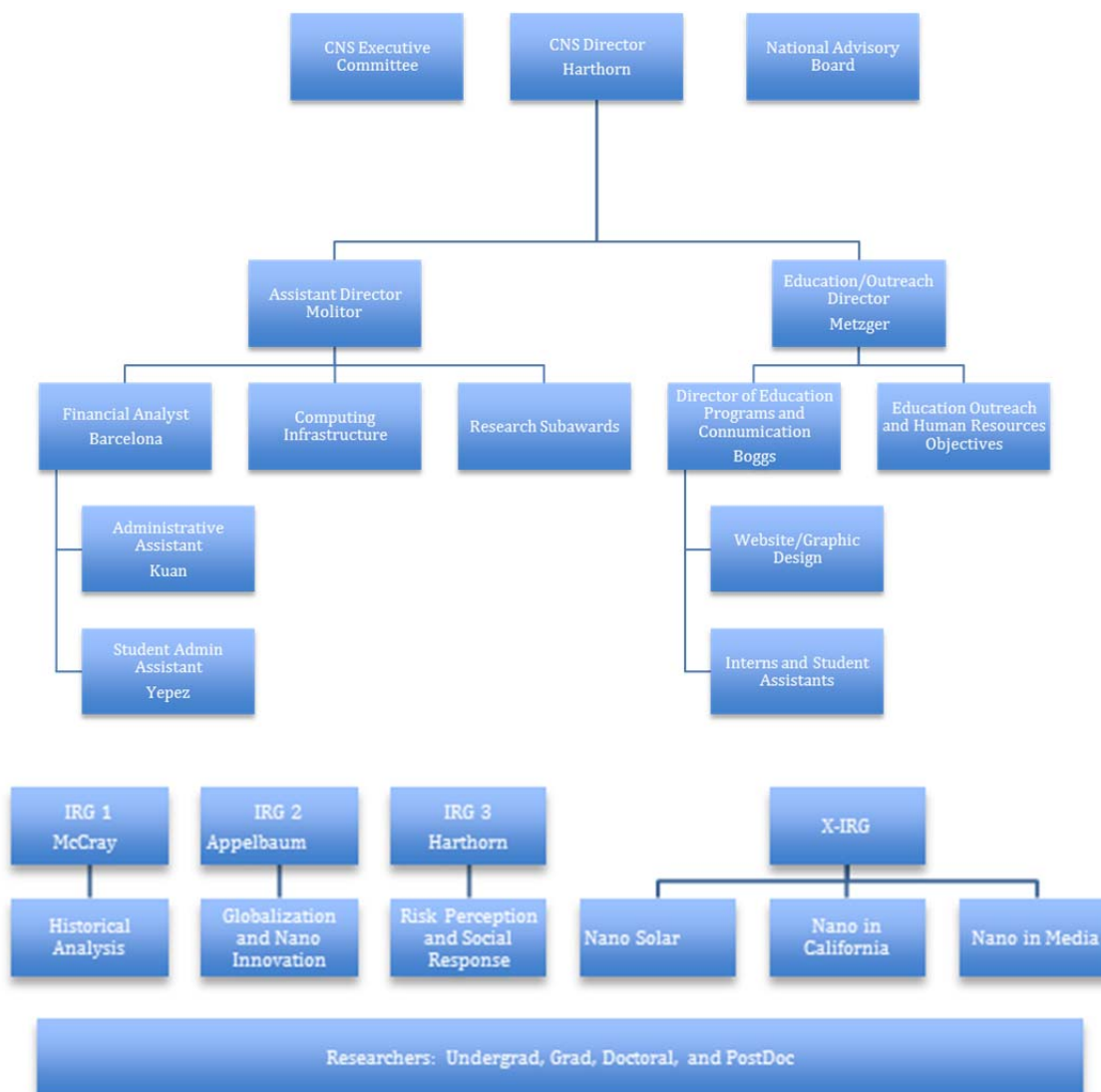
15) Decision Research, Eugene, Oregon, is a non-profit research organization investigating human judgment, decision-making, and risk. They conduct both basic and applied research in a variety of areas including aging, aviation, environmental risk, finance, health policy, medicine, and law. Founded in 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. <http://www.decisionresearch.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, California NanoSystems Institute, NNIN site, 2 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 Barbara Herr Harthorn is assisted by an Assistant Director (Molitor, 1.0 FTE), a Director of Education Programs and Communication (Boggs, .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 (Lim, .25 FTE). Harthorn works collaboratively with 3 co-PIs (Appelbaum, McCray, and MRL/MRSEC Director Hawker) and an active, engaged CNS Executive Committee, which includes the 4 PI/co-PIs and former co-PI Bimber, a new faculty Director of Education Metzger, and CEIN collaborator, Holden; CNS Assistant Director Molitor and DEPC Boggs serve *ex officio*. The 3 IRG leaders (McCray, Appelbaum, and Harthorn) 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 Exec 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. In these capacities, she is responsible for oversight of fiscal management, campus matching funds, CNS subcontractors, 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 interaction. The CNS Executive Committee meets monthly on a face to face basis, dialing 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 Org Chart



Changes in the current reporting period

Executive Committee

This reporting period saw the welcome addition of two new members to the CNS executive committee. First, on the basis of extensive discussion, the Committee decided to take the opportunity created by changing education program personnel to make a change in Education program leadership. To that end, we successfully recruited colleague Miriam Metzger, an Associate Professor in Communication, to join the CNS Executive Committee and take on faculty leadership of the CNS Education and Outreach Programs as its Director. Her full bio is available above in Section 11. The goal of this change was to return to an effective structure that was in place in the early years of the CNS, since lost to personnel changes (Fiona Goodchild retirement; promotion of relatively junior program coordinator Dilleuth to the leadership role, leaving us with a single position where there formerly had been two). Having a

faculty director who is also a full member of the Executive Committee and who can work closely with Education and Outreach program staff reflects our commitment to this vital part of CNS work. We note this replicates the structure in many other NSECs, and creates collaborative dedicated leadership to these important efforts rather than having the CNS Director do this as part of an already overtaxed work profile.

Second, in order to increase on-campus participation in the CNS at the highest level and further ties with the environmental science community, we invited microbiologist/engineer Patricia Holden, a professor in the Bren School of Environmental Science and Management, a UCSB co-PI of the UC CEIN, and Director of the UCSB Natural Reserve System, to join the Executive Committee. This is a natural outgrowth of collaborative research efforts on industry safety in the global nanomaterials industry between Holden and Harthorn and Appelbaum since 2006, and is a welcome addition of perspective and experience. Both Metzger and Holden began service in Fall 2011. The Executive Committee has discussed adding yet more participants as part of the planning for CNS2 (post-Yr 10).

Staffing

This has been a year of major transition for CNS administrative staff, and there has been some disruption along the way. However, the staff is now fully reconstituted, working very effectively as a team, with needed expertise in critical areas. We anticipate a smooth and productive year ahead.

(i) Assistant Director. In 2008, with strong NSF support and a supplement to fund the position, CNS added a new senior staff position to provide executive level assistance to the Director, stable day-to-day management of the center during the Director's frequent travel, coordination of the many facets of CNS duties, and supervision of staff. Particularly critical tasks are oversight of the cooperative agreement and all subcontracts and professional service agreements, as well as management of the complex accounting system in place to track and report on expenditures. After 3 years of service, former Assistant Director Barbara Gilkes resigned in May 2011 and departed in June 2011 to accept a promotional opportunity as an Assistant Dean in the College of Letters and Science. She is located on campus and available for consultation. In order to secure a suitably skilled person to manage the administrative complexity of the CNS, Director Harthorn successfully pursued a reclass of the position from an Analyst 4 to Analyst 5 with the help of the Office of Research. Recruitment began in July, interviewing took place in August (with the participation of UC CEIN Chief of Operations, David Avery), and our new Assistant Director, Bonnie Molitor, began work in mid-October. She came to CNS from a lead position in the sponsored projects office at Cal State Channel Islands, with extensive project management and accounting as well as people skills, and national diversity training. Her full profile is available on our website.

(ii) As noted above, former Education Director, Dr. Julie Dillemath resigned from the CNS in May 2011 for personal reasons, leaving at the end of June. She was on family leave Jan-March 2011, and on reduced time while in the CNS in the interim. Before her departure in June, Dr. Dillemath completed work with Co-PI McCray et al. on the curriculum development project that developed a community college course that embeds societal dimensions in nanoscience education; the course was taught during SBCC's spring semester 2011 (see Section 11 for details).

CNS was very fortunate to hire Dr. Cathy Boggs on an acting basis in late May 2011 to serve as the Education Coordinator/Acting Director of the Education and Outreach program. See full details on her bio in Section 11. An advanced Communication scholar, teacher and writer, she

stepped into this position and effectively ran our summer interns program and seminar, providing invaluable anchoring of the program at a critical juncture. With Prof. Metzger's addition to the Executive Committee, we planned the scope and duties of the staff position, renamed to Director of Education Programs and Communication and conducted an open recruitment in Fall Quarter, interviews in Jan, 2012, and completed the hire of Dr. Boggs in a more permanent post in early Feb. She and Prof. Metzger work closely together, and are beginning to make new plans with the program, in addition to carrying on the key components.

(iii) In late June 2011, following the departure of the Assistant Director, Center Administrator Shawn Barcelona was invited to interview for another job on campus at a higher level; we responded swiftly by requesting and receiving a reclassification of her position from Analyst I to Analyst II.

(iv) Finally, in Sept 2011, the travel and purchasing assistant, Sage Briggs, was offered a promotional opportunity. We were unable to reclass her position or retain her, so we conducted a new recruitment in Fall 2011 and hired our new assistant, Valerie Kuan in Jan 2012. She has quickly mastered key aspects of the position and is contributing well in the team.

Thus, after a year of considerable change, we have revamped programs where desirable to achieve other goals, recruited excellent new personnel, returned to full staffing and now look forward to a productive year ahead.

CNS leverages NSF resources in a number of ways to achieve savings without sacrificing capability. UCSB cash contribution to the CNS covers a significant portion of staff salaries and fringe benefits. CNS staff draws regularly on the expertise of the staff of CNS' immediate control point, the Institute for Social, Behavioral, and Economic Research, for assistance in all aspects of extramural award submissions and administration, accounts management, personnel action, travel accounting, purchasing, 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, the CNS shares computer technology staffing with ISBER, which gives the CNS access to versatile skills when needed, without having to commit full-time salary expenditures. CNS has networked and further draws from expertise on the UCSB campus by contracting specific tasks (e.g., re-building the web platform, 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 will meet face-to-face in biannual meetings in Santa Barbara 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 serves 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, and CNS plans no changes to this basic approach. The last Board meeting was held on April 4, 2011. Board members are willing and available for 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.

Center as Infrastructure for Societal Implications Researchers

The Center has taken a leadership role, with CNS-ASU, in development of the new Society for the Study of Nanoscience and Emerging Technologies (S.NET). The 2 CNS Centers partnered to co-sponsor, co-host the S.NET 2011 conference, held in Tempe, Arizona, in Nov 2011. CNS-UCSCB hosted the website for the conference and the conference program committee, which Director Harthorn co-chaired with CNS-ASU Director Guston (see highlight, this report). The infrastructure investment by NSF in the CNS-UCSB is benefiting a much wider community of scholars and researchers, and the multi-agency NNI as well. In collaboration with CNS-ASU, CNS-UCSB is taking a leading role in many structured interactions among NSE and societal dimensions researchers and more are in development in the future.

Management and Operation of Research Program

CNS has established an effective infrastructure for managing its collaborative research efforts. CNS' base on a single campus and consolidated and generous space arrangements in Girvetz Hall (since Dec 2009) 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 meetings take place on a roughly weekly basis at UCSB, often dialing in collaborators for teleconference participation.
- The CNS Graduate Seminar (Soc 591 BH) meets 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. Summer interns are incorporated into the seminar during the 8-week summer internship program.
- Grad Fellows and Graduate Student Researchers work together in common space, which facilitates information sharing across the groups.
- Postdoctoral Fellows work in shared and adjacent space, which also serves to promote interactions; in the past the postdocs have taken the lead in instituting regular weekly gatherings for tea that include all CNS researchers and staff in informal exchange
- Visiting Scholar/Lecture Series brings together CNS researchers with extramural visitors for formal and informal interactions, sharing; visitors are selected by grads, researchers, and education program
- Research Summit meetings are held in Santa Barbara and allow the free flow of ideas among all CNS collaborators, students, and personnel from the 18 institutions actively involved in core CNS research. The last Research Summit took place in May 2011 and was well received; the next session is planned for Fall 2012.
- Management of projects—CNS requires semi-annual reporting and invoicing from all subcontractors, and similar reporting from all IRGs, 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 and individual project approvals for all projects involving human subjects, at UCSB and other campuses as appropriate. Assistant Director Molitor maintains a centralized database to ensure full compliance and to monitor upcoming expirations of existing protocols; the UCSB campus moved to an online system 2 years ago that also provided notification of

approaching deadlines and simplifies 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.

- Annual process for IRG budget review and allocation—CNS Director Harthorn solicits annual budget proposals from IRGs, allocates funds based on performance, unexpended funds carried forward, and competing needs. Budgets are then discussed in Executive Committee. Budgets are gauged to different research methods and needs, as well as progress toward goals.
- New postdocs are required to submit a research proposal to the CNS Exec within a month of their arrival and to provide milestones for assessing progress. Postdoc evaluation 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 UC postdoctoral scholars.
- Funder required annual reporting and site visits provide significant impetus to aggregate and synthesize data within and between research groups
- Annual retreats of the Executive Committee and staff to discuss NSF review results have facilitated group assessment through SWOT analysis and other mechanisms and collective decision making and will be implemented on an as needed basis in the future. The most recent retreat was held in Jan, 2012 at the Mosher House and also brought in most of the upper administration of campus to discuss 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.

B. Evaluation plan for CNS-UCSB

The evaluation plan for the CNS-UCSB is to evaluate performance against our goals in the main functional areas--research, education and public outreach, the network with other nanotechnology in society programs, international collaboration, and the clearinghouse. We evaluate work using formative and summative processes at several levels of aggregation: within each working group on a regular, semi-annual basis (some groups do this quarterly), at the Executive Committee level also on a regular basis, and at the level of the National Advisory Board on an annual or bi-annual basis. 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.

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 working groups, the mechanism for this is now standardized 6-month progress reports by the working group project leaders and specific projects within IRGs that are available for review by the full CNS executive committee. All subcontractors 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, meeting bi-weekly with all graduate fellows and postdocs, and provides extensive programmatic support to undergraduate interns. (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 meetings are largely face to face (although traveling members may be on conference call) and take place on a monthly basis. The Director maintains oversight of this process. The 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, staff, postdocs, and students, primarily by electronic media. We are using on-line methods to facilitate this process, and we will be conducting ongoing analysis of their effectiveness.

The CNS Assistant Director and Education Programs and Communication Director are involved in the monthly Executive Committee meetings and report to the Director. CNS staff 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, subcontractors, and service providers. CNS accounts were included in a campus audit in 2010 and were found to be entirely satisfactory.

Semi-annual reporting is required from all CNS research teams, UCSB and extramural subcontractors. This is a requirement in conjunction with invoicing for subcontractor payments, and these documents are circulated to all CNS principals. 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. 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 annually or bi-annually in Santa Barbara and is 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. At the most recent meeting (Apr 4 2011) the Board declined to meet without the executive committee and chose instead to have open discussion with us, providing praise for the progress on all fronts and suggestions for long range planning processes.

NSF annual reviews provide an opportunity for summative evaluation. Annual day-long retreats of the CNS Executive Committee and staff in conjunction with the NSF site review process include SWOT analysis, the most recent in Jan 2012.

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 the Fall, after the fellowship year has concluded. 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—it is a dynamic system that is under study. Uncertainty about both the economic forecast, technical risks and public reception to these emerging technologies complicates this picture. We are tracking changes, in both the nanoscience, economic, and social worlds, and we will 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). These data do provide empirical data about the changing economic, political and social worlds in which nanotechnologies are unfolding. The annual rotation of (some) grad fellows provides one mechanism to respond to new research opportunities. The addition of subawards provides another. The CNS postdoctoral researcher program also brings in new scholars and new ideas, and CNS is continually expanding its network of collaborators. The National Advisory Board meeting is a particularly important context for discussing, brainstorming, and troubleshooting new ideas and new directions for the CNS. After extensive discussion in retreat and Executive Committee, in Yr 8 (2012-2012), CNS plans to initiate a 2-yr Seed Grant program to draw participation of new faculty, especially junior faculty, in CNS research and activities. This is seen as a vital step in development toward the longterm 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	19	9	10	0	0	0	13	2	2	1	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	13	5	8	0	0	0	7	2	2	1	0	2	0	86%	
Research															
Subtotal	114	64	50	1	0	3	69	11	3	2	24	5	0	0%	
Senior Faculty ¹	31	21	10	0	0	0	15	4	1	0	11	1	0	55%	
Junior Faculty ¹	14	10	4	0	0	1	8	1	0	2	2	1	0	50%	
Research Staff	9	4	5	0	0	0	5	0	0	0	4	0	0	56%	
Visiting Faculty ¹	2	0	2	0	0	0	1	1	0	0	0	0	0	0%	
Industry Researchers	4	4	0	0	0	0	3	0	0	0	1	0	0	100%	
Post Docs ¹	11	7	4	0	0	0	5	1	1	0	4	1	0	64%	
Doctoral Students ¹	22	11	11	0	0	2	17	1	0	0	2	0	0	95%	
Master's Students ¹	6	2	4	0	0	0	6	0	0	0	0	0	0	100%	
Undergraduate Students (non-REU) ¹	15	5	10	1	0	0	9	3	1	0	0	2	0	93%	
High School Students	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	
Curriculum Development and Outreach															
Subtotal	12	2	10	0	0	0	9	0	0	1	2	0	0	0%	
Senior Faculty ¹	4	2	2	0	0	0	3	0	0	0	1	0	0	50%	
Junior Faculty ¹	0	0	0	0	0	0	0	0	0	0	0	0	0	0%	
Research Staff	4	0	4	0	0	0	3	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	4	0	4	0	0	0	3	0	0	1	0	0	0	100%	
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	6	6	0	0	0	0	4	0	0	0	0	2	0	0%	
REU students participating in NSEC Research ¹	3	3	0	0	0	0	2	0	0	0	0	1	0	100%	
NSEC Funded REU Students	3	3	0	0	0	0	2	0	0	0	0	1	0	100%	
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	-	
Teachers—RET	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	-	
Total ¹	151	81	70	1	0	3	95	13	5	4	26	9	0	0%	

Personnel Type	Total	Gender		Race Data								Ethnicity: Hispanic	Disabled	% NSEC Dollars
		Male	Female	A/AN	NH/PI	B/AA	W	A	More than one race reported, A/AN, B/AA, NH/PI	More than one race reported, W/A	Not Provided			
Leadership, Administration/Management														
Subtotal	17	8	9	0	0	0	11	2	2	1	1	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	11	4	7	0	0	0	5	2	2	1	1	2	0	91%
Research														
Subtotal	100	55	45	1	0	3	64	8	3	2	20	4	0	0%
Senior Faculty ¹	27	18	9	0	0	0	14	3	1	0	9	1	0	52%
Junior Faculty ¹	12	8	4	0	0	1	8	0	0	2	1	0	0	50%
Research Staff	8	4	4	0	0	0	5	0	0	0	3	0	0	63%
Visiting Faculty ¹	1	0	1	0	0	0	1	0	0	0	0	0	0	0%
Industry Researchers	4	4	0	0	0	0	3	0	0	0	1	0	0	100%
Post Docs ¹	7	3	4	0	0	0	3	1	1	0	2	1	0	71%
Doctoral Students ¹	21	11	10	0	0	2	16	1	0	0	2	0	0	95%
Master's Students ¹	6	2	4	0	0	0	6	0	0	0	0	0	0	100%
Undergraduate Students (non-REU) ¹	14	5	9	1	0	0	8	3	1	0	2	2	0	92%
Curriculum Development and Outreach														
Subtotal	12	2	10	0	0	0	9	0	0	1	2	0	0	0%
Senior Faculty ¹	4	2	2	0	0	0	3	0	0	0	1	0	0	50%
Junior Faculty ¹	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Research Staff	4	0	4	0	0	0	3	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	4	0	4	0	0	0	3	0	0	1	0	0	0	100%
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	129	65	64	1	0	3	84	10	5	4	23	6	0	0%

15. PUBLICATIONS AND PATENTS

2011-2012

Primary Publications: 17 Journals; 36 Books, Chapters, Reports & Other Publications;

Leveraged Publications: 6 Journals; 7 Books, Chapters, & Other Publications

Submitted / In Preparation Publications: 50 Primary; 12 Leveraged

Total: 128

Primary Publications: Journals

Appelbaum, Richard P., Parker, Rachel, & Cao, Cong. (2011). Developmental state and innovation: Nanotechnology in China. *Global Networks*, 11(3), 298–314. doi: 10.1111/j.1471-0374.2011.00327.x

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Dillemath, Julie, Frederick, Stacey, **Parker, Rachel, Gereffi, Gerry, & Appelbaum, Richard.** (2011). Traveling Technologies: Societal Implications of Nanotechnology through the Global Value Chain. *Journal of Nano Education*, 3(1-2), 36-44.

Engeman, Cassandra D., Baumgartner, Lynn, Carr, Benjamin M., Fish, Allison M., Meyerhofer, John D., **Satterfield, Terre A., Patricia Holden, Harthorn, Barbara Herr.** (2012). Governance implications of nanomaterials companies' inconsistent risk perceptions and safety practices. *Journal of Nanoparticle Research*, 14(749), 1-12. doi: 10.1007/s11051-012-0749-0

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Eisler, Matthew N. (forthcoming). *Overpotential: Fuel Cells, Futurism, and the Making of a Power Panacea* Piscataway, NJ: Rutgers University Press.

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Foladori, Guillermo, & Invernizzi, Noela (2012). Social and Environmental Implications of Nanotechnology Development in Latin America and the Caribbean. Zacatecas, Mexico and Curitiba, Brazil: ReLANS.

Mody, Cyrus C.M. (2012). Conversions: Sound and Sight, Military and Civilian. In Trevor Pinch & Karin Bijsterveld (Eds.), *Oxford Handbook of Sound Studies* (pp. 224-248). New York: Oxford University Press.

Mody, Cyrus C.M. (2011). *Instrumental Communities: Probe Microscopy and the Path to Nanotechnology*. Cambridge: MIT Press.

Submitted or in preparation publications: Primary

Beaudrie, C.E.H, **Kandlikar, M, & Satterfield, T** (submitted). Engineered nanomaterials and life-cycle regulation: A review of Federal Regulatory Oversight from Cradle-to-Grave. *Environmental Science & Technology*.

- Beaudrie, C.E.H, **Satterfield, T, Kandlikar, M, & Harthorn, B. H.** (in preparation). Nanotechnology and Regulation: Experts views on regulator preparedness for managing risks from engineered nanomaterials. *Nature Nanotechnology*.
- Beaudrie, C.E.H, **Satterfield, T, Kandlikar, M, & Harthorn, B. H** (in preparation). Scientists vs Bureaucrats: Precaution, Novelty, & Politics as predictors of perceived risk of ENMs. *Risk Analysis*.
- Bimber, B, Conroy, M, & Lively, E.** (submitted). Priming Effects and Contrast in Issue Comparisons.
- Boudreaux, Daryl. (in preparation). Evolution of Innovation Pathways: Impact on Solar Energy. In Chris Newfield & Daryl Boudreaux (Eds.), *Can Rich Countries Still Innovate?*
- Brock, David, & Lécuyer, Christophe. (submitted). Silicon gate MOS technology – the mainstay of microfabrication in the semiconductor industry since the 1970s. *Technology and Culture*.
- Brock, David. (in preparation). "James Von Ehr." Oral History Interview.
- Brock, David. (in preparation). "Nadrian Seeman." Oral history interview.
- Brock, David. (in preparation). "Thomas Everhart." Oral history interview.
- Bryant, Karl, Barbara Herr Harthorn, Christine Shearer and Jennifer Rogers-Brown.** (in preparation). "Deliberating Socio-Techno Presents and Futures: Making Sense of New Technology through the Lens of Inequality, Risk, and Difference."
- Bryant, Karl, Barbara Herr Harthorn, Jennifer Rogers-Brown,** and Christine Shearer. (in preparation). Deliberating New Technologies and the Production of Gendered Risk Perception.
- Cao, Cong, Appelbaum, Richard, & Parker, Rachel.** (submitted). Research is High and the Market is Far Away - Commercialization of Nanotechnology in China. *Technovation*.
- Choi, Hyungsub.** (in preparation). Solid State Electronics. In Hugh Slotten (Ed.), *The Oxford Encyclopedia of American Scientific, Medical, and Technological History*. New York: Oxford University Press.
- Choi, Hyungsub, & Otani, Takushi.** (in preparation). The Japanese Integrated Circuit and the Limits of Technology Followership. *IEEE Annals of the History of Computing, (special issue on the history of integrated circuits)*.
- Conti, Joseph, & Becker, Sean.** (in preparation). Regulatory Risk Judgment: How the EPA confronts scientific uncertainty and the challenges of Nanotechnology.
- Copeland, Lauren. (in preparation). Conceptualizing Political Consumerism.
- Copeland, Lauren, & **Bimber, Bruce.** (in preparation). New Technology and Political Consumerism: Predicting Aversive Behavior in the Market to Nanotechnology.

- Copeland, Lauren, **Bimber, Bruce**, & Earl, Jennifer. (in preparation). Collective Action and Political Consumerism.
- Cranfill, Rachel, Christine Shearer, Karl Bryant, Jennifer Rogers, Shannon Hanna, Amanda Denes, Barbara Herr Harthorn. (in preparation). Indexing Expertise in a Deliberative Setting: A Comparison
- Denes, Amanda, Rachel Cranfill, Barbara Herr Harthorn, Christine Shearer, Julie Whirlow, and Shannon Hanna. (in preparation). Talking Nano: The Importance of Gender, Race, and Power in Deliberations on the Risks and Benefits of Nanotechnology
- Eardley-Pryor, Roger. (in preparation) "Take a Little Risk? Historical Analogies and the Regulation of Nanotechnology."
- Eisler, Matthew N. (submitted). Boundaries of Science Policy Communication: Nanotechnology and the Discourse of Revolutionary Applied Science. *Minerva*.
- Engeman, Cassandra, Lynn, Baumgartner, **Holden, Patricia**, & **Harthorn, Barbara Herr**. (in preparation). Environmental safety practices and implications for workers in the international nanomaterials industry.
- Foladori, Guillermo**, Lau, Edgar Záyago, Sandoval, Remberto, **Appelbaum, Richard**, & **Parker, Rachel**. (submitted). Mexico-U.S. Collaboraton in MEMS/NEMS. *NanoEthics*.
- Horton, Zach. (in preparation). Pursuing The Right To Maximal Innovation: Open Source, Energy Crisis, and Social Narrative.
- Lenoir, Timothy**, & Herron, Patrick. (in preparation). Comparative nanotech: China, US, India, Korea, Japan, Singapore, France, and Germany.
- Lenoir, Timothy**, & Herron, Patrick. (in preparation). Rising trends ion Chinese patent sets.
- Lenoir, Timothy**, & Herron, Patrick. (in preparation). Star Scientists in the Takeoff of Bionanotechnology: Comparisons with the Role of Federal Funding in the First Biotech Revolution.
- McCray, W. Patrick**. (in preparation). Timothy Leary's Transhumanist SMI²LE. In David Kaiser (Ed.), *Groovy Science: The Counter-Cultures and Scientific Life, 1955-1975*.
- Mody, Cyrus C.M.** (in preparation). An Electro-Historical Focus with Real Interdisciplinary Appeal: Interdisciplinarity at Vietnam-Era Stanford. In David Kaiser (Ed.), *Groovy Science: The Counter-Cultures and Scientific Life, 1955-1975*.
- Mody, Cyrus C.M.** (in preparation). Instrumentation and Innovation from UC Santa Barbara. In David Mowery & Martin Kenney (Eds.), *Volume on technology transfer, economic development, and scientific instrument commercialization in the UC system*.
- Mody, Cyrus C.M.**, & **Choi, Hyungsub**. (in preparation). From Materials Science to Nanotechnology: Institutions, Communities, and Disciplines at Cornell University, 1960-2000. *Historical Studies in the Natural Sciences*.

- Mody, Cyrus C.M.** (submitted). Nanotechnology. In Hugh Sloten (Ed.), *The Oxford Encyclopedia of American Scientific, Medical, and Technological History*. New York: Oxford University Press.
- Mody, Cyrus C.M.** (submitted). University in a Garage: Instrumentation and Innovation from UC Santa Barbara. In Martin Kenney, David Mowery & Mary Walshok (Eds.), *Volume on Tech Transfer and Economic Development in the University of California System*. Stanford: Stanford University Press
- Mody, Cyrus C.M.** (submitted). Essential Tensions and Representational Strategies. In Michael Lynch, Steve Woolgar, Janet Vertesi & Catelijne Coopmans (Eds.), *Representation in Scientific Practice II*. Cambridge, Mass: MIT Press.
- Motoyama, Yasuyuki. (submitted). Long-Term Collaboration between Universities and Industry: A Case Study of Nanotechnology Development in Japan. *Review of Policy Research*.
- Motoyama, Yasuyuki, & **Appelbaum, Richard**. (submitted). Observing Regional Divergence in Chinese Nanotechnology Centers *Technological Forecasting and Social Change*.
- Newfield, Chris**, & Boudreaux, Daryl (Eds.). (in preparation). *Can Rich Countries Still Innovate? (Lyon volume)*.
- Newfield, Chris**, & Boudreaux, Daryl. (in preparation). Introduction. In Chris Newfield & Daryl Boudreaux (Eds.), *Can Rich Countries Still Innovate?*
- Newfield, Chris**. (in preparation). Are Strong Intellectual Property Rights Helping Nanoscale Research? Results from a Quantum Dot Case Study. *Can Rich Countries Still Innovate? (Lyon volume)*
- Newfield, Chris**. (in preparation). Learning From Solyndra: Filling Gaps in the US Innovation System.
- Newfield, Chris**. (in preparation). Solar Energy Funding After the Crisis: Has the Obama Administration Made a Difference?
- Newfield, Chris**. (in preparation). Solar Innovation: the Case of Germany.
- Newfield, Chris**, & Boudreaux, Daryl. (in preparation). Learning From Solyndra: Filling Gaps in the US Innovation System.
- Newfield, Chris**, & Boudreaux, Daryl. (in preparation). Solyndra, the Symptom not the Disease.
- Satterfield, Terre**, Corner, Adam, **Pidgeon, Nick**, **Conti, Joseph** and **Harthorn, Barbara Herr**. (submitted). Affective Ambivalence and Nanotechnologies.
- Satterfield, Terre**, **Conti, J**, Pitts, A, & **Harthorn, Barbara Herr**. (submitted). Understanding Malleable Perceptions of Nanotechnologies' and their Implications for Science and Policy Dialogues about Emerging Technologies. *Science and Public Policy*.
- Shah, Sonali K., & **Mody, Cyrus C.M.** (submitted). Innovation, Social Structure, and the Creation of New Industries. *Academy of Management Journal*.

Shearer, Christine, Jennifer Rogers-Brown, Karl Bryant, Rachel Cranfill, and Barbara Herr Harthorn. (in preparation). Power and Vulnerability: Reexamining "Low Risk" Perceptions of Environmental and Health Hazards.

Walsh, James. (in preparation). Foreign Talent and its Contribution to American Science and Innovation: the Case of Nanotechnology.

Submitted or in Preparation Publications: Leveraged

Collins, M, & **Freudenburg, W.** (in preparation). Technological Risk Messages: Comparing Nuclear Power and Nanotechnology.

Collins, M, & **Freudenburg, W.** (in preparation). Temporal Myopia: A Case of Promising New Technologies, the Federal Government, and Inherent Conflicts of Interest.

Collins, Mary, Hanna, Shannon, **Harthorn, Barbara, & Satterfield, Terre.** (in preparation). Nanotechnology Risk Judgement Analysis: Consumer Product Safety and Environmental Attitudes.

Collins, M, **Harthorn, B., & Satterfield, T.** (in preparation). Nanoremediation: Are there equity concerns?

Corner, Adam, **Pidgeon, Nick,** & Parkhill, K. (submitted). Perceptions of geoengineering: Public attitudes, stakeholder perspectives & the challenge of 'upstream' engagement. *Wiley Interdisciplinary Reviews (WIREs) Climate Change*.

D'Arcangelis, Gwen, DeVries, Laura, **Satterfield, Terre, & Harthorn, Barbara Herr.** (in preparation). Cultural models of environment and hazard in the US and Canada: Exploring emergent views on engineered nanomaterials. *Journal of Environmental Ecology*.

Keller, Matthew R., & **Block, Fred.** (submitted). Explaining the Transformation in the U.S. Innovation System: The Impact of a Small Government Program. *Socio-Economic Review*.

Mody, Cyrus C.M. (submitted). Review of Gravity's Ghost: Scientific Discovery in the Twenty-First Century, by Harry Collins *Contemporary Sociology*.

Mody, Cyrus C.M. (submitted). Review of Makers of the Microchip: A Documentary History of Fairchild Semiconductor by Christophe Lécuyer and David C. Brock *Isis*.

Mody, Cyrus C.M. (submitted). Review of Science-Mart: Privatizing American Science by Philip Mirowski *Journal of American History*.

Parkhill, K. A, **Pidgeon, N. F,** Corner, A, & Vaughan, N (submitted). Geoengineering. In Owen (Ed.), *Responsible Innovation*.

Satterfield, Terre, Pitts, Anton, & Harthorn, Barbara Herr. (in preparation). Resilience as a Primary Factor in the Perceived Environmental Risk. *Ecology and Society*.

16. BIOGRAPHICAL INFORMATION

No new investigators this reporting period.

17. HONORS AND AWARDS

Beaudrie, Christian, Student Scholarship, Nano OEH Conference, Boston, Aug 2011

Bimber, Bruce, elected to fellowship, AAAS.

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

Collins, Mary. 2012 UCSB ISBER Graduate Research Award for Social Science Surveys (GRASSS) and funding match from the Bren School of Environmental Science and Management, (\$5,000).

Copeland, Lauren, nominated for the UCSB Academic Senate's Outstanding Teaching Assistant Award.

Copeland, Lauren, nominated for the UCSB Graduate Student Association's Excellence in Teaching Award.

Copeland, Lauren, travel grant, UCSB Department of Political Science.

Cranfill, Rachel, Jacob Javits Fellowship, 2011-1015, UCSB Department of Linguistics.

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

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

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

Denes, Amanda, Graduate Collaborative Research Grant, Interdisciplinary Humanities Center (\$850).

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

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

Denes, Amanda, Santa Barbara Pro-Choice Coalition (\$1,000).

Denes, Amanda, UC President's Dissertation Year Fellowship (\$18,000).

Denes, Amanda, UC Humanities and Social Science Research Grant (\$ 2,000).

Eardley-Pryor, Roger, "Better to Cry than Die? The Paradoxes of Tear Gas in the Vietnam Era and Today," Lawrence Badash Prize (\$500).

Eardley-Pryor, Roger, CNS graduate fellowship renewal (\$35,000).

Eardley-Pryor, Roger, Dick Cook Memorial Award (\$500).

Eardley-Pryor, Roger, Rockefeller Foundation Travel Grant (\$1000).

Eisler, Matt, Postdoctoral Fellowship at the Chemical Heritage Foundation.

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

Engeman, Cassandra, Student Scholarship to Nano OEH Conference, Boston, Aug 2011.

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

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

Hawker, Craig. 2011 Named Director of the Dow Materials Institute, University of California, Santa Barbara, which was created with a \$15 million award from Dow Chemical Company.

Hawker, Craig. 2011. Arthur C. Cope Scholar, American Chemical Society.

Hawker, Craig. KFUPM Chair Professor, King Fahd University of Petroleum and Minerals, Saudi Arabia. 2011.

McCray, Patrick, elected to Fellowship in AAAS for History and Philosophy of Science Section. November 2011.

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

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

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

Annual Report -- 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			Y				Y	
	Arizona State University	Y							
	Beijing Institute of Technology	Y							Y
	California Polytechnic State University San Luis Obispo							Y	
	Cardiff University, UK	Y							Y
	CNRS - France							Y	Y
	College of the Canyons			Y					
	Cornell University							Y	
	Cuesta Community College							Y	
	Duke University	Y							
	Ecole Polytechnique, Paris								Y
	Georgia Institute of Technology								
	Jackson State University			Y				Y	
	Kibi International University, Japan								Y
	Lehigh University	Y	Y						
	Long Island University	Y	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								
	Rice University								
	Santa Barbara City College	Y						Y	
	Seoul National University, South Korea								Y
	Southeastern Louisiana University			Y					
	Southern Methodist University								
	SUNY Levin Institute	Y							
	SUNY New Paltz	Y							
	Universidad Autónoma de Zacatecas, Mexico								Y
	Université de Lyon 2, France								Y
	Université de Lyon 3, France		Y						Y
	University of Arizona	Y							
	University of British Columbia, Vancouver, Canada	Y							Y

	University of California, Berkeley	Y							
	University of California, Davis	Y							
	University of California, Los Angeles		Y						
	University of Edinburgh, UK		Y						Y
	University of Exeter, UK								
	University of Gothenburg, Sweden								
	University of Minnesota		Y						
	University Nottingham, UK		Y						Y
	University of Pennsylvania								
	University of South Carolina	Y							
	University of Southern Indiana								
	University of Sussex, UK								Y
	University of Toronto, Canada		Y						
	University of Washington	Y							
	University of Wisconsin-Madison	Y							
	Ventura College			Y				Y	
Total Number of Academic Partners	51	20	8	7	0	0	0	9	14

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								
	Boudreaux and Associates	Y					Y		
	Chemical Heritage Foundation	Y					Y		
	Compass Resource Management	Y							Y
	Decision Research	Y							
	Environmental Defense Fund								
	International Council on Nanotechnology (ICON), Rice University		Y						Y
	International Risk Governance Council, Switzerland								Y
	Kauffman Foundation						Y		
	Knowledge Networks	Y							
	Latin American Network of Nanotechnology and Society (ReLANS), Mexico								Y
	Meridian Institute	Y							Y
	Nanoscale Informal Science Education (NISE) network							Y	
	Santa Barbara Museum of Natural History							Y	
	Center for Science and Technology Policy Studies								
	Woodrow Wilson International Center	Y	Y						Y
	You Gov	Y					Y		Y
Total Number of Non-academic Partners	18	8	2	0	0	0	4	2	7