



Center for Nanotechnology in Society

NSF SES 0531184

Nanoscale Science and Engineering Center at

University of California, Santa Barbara

Year 4 Annual Report

for the period

March 16, 2008 to March 15, 2009

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3. PROJECT SUMMARY

The center addresses questions of nanotech-related societal change through research that encompasses four main areas: **IRG-1: Historical Context of Nanotechnologies** seeks to develop an understanding of the historical underpinnings of the contemporary nano-enterprise, including recent histories of its scientific communities and institutions, instrumentation, policy and public support; **IRG-2: Innovation & Intellectual Property** examines the nanotechnology innovation system, with a specific focus on solar technologies and identification of impediments to full and rapid realization of research & development goals for the industry; **IRG-3: Risk Perception and the Public Sphere** studies risk perception and social response to emerging nanotechnologies, with attention to expert judgments, media coverage and framing, and public benefit and risk perception of nanotechnologies for health/enhancement, energy, and food, along with themes of environment, privacy, and inequality, in comparative US-UK focus; and **IRG-4 Globalization of Nanotechnologies** addresses global industrial policy and development of nanotechnology, with a particular focus on China, Japan & India and pathways to the use of nanotechnologies to spur equitable development. The Center's four IRGs combine expertise in many fields: technology, innovation, culture, health, global industrial development, gender and race, environment, space/location, and science and engineering. In combination, these four 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 the CNS approach are participatory research and engagement with nanoscientists; a focus on specific nanotechnologies; comprehensive consideration of their applications in industries like electronics, energy, food, environmental, and health; and employment of spatial analytic methods and a global framework for analysis. **IRG 3's** research also develops methods for cross-national comparative study of public participation in dialogue about nanotechnology's future. Collaborators in the CNS are drawn from UC Berkeley, the American Bar Foundation, the Chemical Heritage Foundation, Duke University, Quinnipiac University, Rice University, SUNY Levin Institute, SUNY New Paltz, University of Washington, and internationally from Beijing Institute of Technology (China), Cardiff University (UK), University of British Columbia (Canada), University of East Anglia (UK), University of Edinburgh (UK), and Venice International University (Italy). The Center is a lead partner in the NSF Network for Nanotechnology in Society; this group is founding a new international scholarly organization that will hold its first meeting in Seattle in Sept 2009. CNS-UCSB is also a research and education partner in the newly founded NSF/EPA UC Center for Environmental Implications of Nanotechnology.

Education and Public Engagement programs at CNS-UCSB aim to nurture an interdisciplinary community of nano scientists, social scientists, and educators who collaborate in CNS IRGs and to achieve *broader impacts* through engagement of diverse audiences in dialogue about nanotechnology and society. The CNS-UCSB provides fellowships for graduate students in social science and nanoscale science and engineering to participate jointly in CNS weekly seminars and IRG research; a similar approach for undergraduate internships integrates university and California community college students into CNS activities. Through a year-round weekly/biweekly seminar program, a speakers series, conferences, visiting scholars, informal science education events for the public (Nano-Meeters), and electronic dissemination of a popular nano and society-related Weekly News Clips service to about 500, the CNS is gaining a solid following of campus, local, and national and international media, as well as interest by government, industry, NGOs, and the general public. In September 2008, CNS co-convened a conference for educators interested in adding societal aspects into their science curricula. In November 2009, CNS-UCSB will convene a large international conference in Washington DC on *Emerging Technologies/Emerging Economies: [Nano]technologies for Equitable Development* in collaboration with the Woodrow Wilson International Center, and with strong support from the NSE community.

In 2008-09 CNS-UCSB has made substantial progress in research on pathways and impediments to socially and environmentally sustainable futures for nanotechnologies. CNS research teams produced 38 new publications in the past year, bringing total publications to 53 since inception 3 years ago, and made 99 presentations this year at academic, industry, policymaker, and community venues for a cumulative total of just under 240. CNS's paper on the first ever cross-national comparison of public deliberation processes was published in Feb 2009 as one of three social science research articles ever published in the journal *Nature Nanotechnology*. In March 2009, CNS principals Appelbaum, Harthorn, and Pidgeon each gave testimony before national policymaking bodies (a US Congressional Committee, a US Congressional Caucus, and the UK House of Lords, respectively).

4A. LIST OF CENTER PARTICIPANTS

UCSB

David Awschalom	Professor	Physics, CNSI
Richard Appelbaum	Professor	Sociology, Global & Int'l Studies
Bruce Bimber	Professor	Political Science, Communication
Tim Cheng	Professor	Electrical and Computer Engineering
Brad Chmelka	Professor	Chemical Engineering
Julie Dilleuth	Education Coordinator/ Education Director	CNS
Fiona Goodchild	Education Assoc Dir	CNSI, CNS
Michael Goodchild	Professor	Geography
Craig Hawker	Professor, Director	Materials Research Laboratory, Chemical Eng.
Barbara Herr Harthorn	Associate Professor	Feminist Studies, Anthropology, Sociology
W. Patrick McCray	Professor	History of Science
John Mohr	Professor	Sociology
Meredith Murr	Acad. Coordinator	CNSI
Christopher Newfield	Professor	English
David Seibold	Professor	Communication
Susan Stonich	Professor	Environmental Studies, Anthropology

Collaborators

Gerald Barnett	<i>Univ of Washington, Director</i>	University technology transfer
Karl Bryant	<i>SUNY New Paltz, Asst. Professor</i>	Sociology & Women's Studies
Cynthia Cannady	<i>Private sector, IPSEVA, lawyer</i>	International IP expert
Cong Cao	<i>SUNY Levin Institute, Res. Assoc</i>	Sociology, China
Hyungsub Choi	<i>Chemical Heritage Foundation</i>	History of Science
Joseph Conti	<i>American Bar Foundation, Postdoc</i>	
Zhu Donghua	<i>Univ of Wisconsin, Asst. Prof</i>	Sociology and Law
Gary Gereffi	<i>Beijing Institue of Tech., Vice Dean</i>	Management and Economics
Chains	<i>Duke University, Professor</i>	Sociology, Global Value
Hillary Haldane	<i>Quinnipiac Univ, NY, Asst Prof</i>	Anthropology
Patrick Herron	<i>Duke University, Researcher</i>	Data mapping and
visualization		
Milind Kandlikar	<i>Univ of British Columbia, Asst Prof</i>	Science Policy & Regulation
Timothy Lenoir	<i>Duke University, Professor</i>	History, Data visualization
David Mowery	<i>UC Berkeley, Professor</i>	Economics
Cyrus Mody	<i>Rice University, Asst Prof</i>	History, Technology Studies
Nicholas Pidgeon	<i>Cardiff Univ, Wales, UK, Professor</i>	Social Psychology, Env. Risk
Tee Rogers-Hayden	<i>Univ of East Anglia, UK, Fellow</i>	Environment, Deliberation
Terre Satterfield	<i>Univ of British Columbia Assoc Prof</i>	Culture, Risk & Environment
Suzanne Scotchmer	<i>UC Berkeley, Professor</i>	Economics

UCSB

Postdoctoral Scholars

Phil McCarty	Sociology
Mikael Johansson	Social Anthropology
Yasuyuki Motoyama	City and Regional Planning
Jennifer Rogers	Sociology

<i>Graduate Fellows</i>	<i>Discipline</i>	<i>Department</i>
Kasim Alimahomed	Communication	Communication
Karl Bryant	Sociology	Sociology
Yiping Cao	Environmental Science	Bren School of Environmental Sci
Meredith Conroy	Political Science	Political Science
Joseph Conti	Sociology	Sociology
Scott Ferguson	Mechanical Engineering	Mechanical Engineering
Alan Glennon	Geography	Geography
Summer Gray	Sociology	Sociology
Hillary Haldane	Anthropology	Anthropology
Indy Hurt	Geography	Geography
Mary Ingram	Sociology	Sociology
Erica Lively	Electrical engineering	Electrical & Computing Engineering
Gerald Macala	Chemistry	Chemistry
Tyronne Martin	Chemistry	Chemistry
Rachel Parker	Sociology	Sociology
Alexis Ostrowski	Chemistry	Chemistry
Claron Ridge	Chemistry	Chemistry
Aaron Rowe	Chemistry	Chemistry
Kim Stoltzfus	Communication	Communication
Joseph Summers	Electrical engineering	Electrical & Computing Engineering
David Weaver	Political Science	Political Science

Affiliated Postdoctoral Scholars

Adam Corner, Cardiff University, UK
Tee Rogers-Hayden, University of East Anglia, UK
Elena Simakova, Cornell University

Affiliated Grad Researchers

Christian Beaudrie, University of British Columbia, Canada
Vincent Dorie, Duke University
Eric Giannela, Stanford University
Ryan Ong, Duke University
Stacey Frederick, Duke University

Undergrad Interns & Researchers:

Beatrice Balfour
William Bausman
Brian Billones
Sarah Bunch
Lamar Bush
Jason Cannon
Staci Chirchick
Josie Garong
Gary Haddow
Jon Lo Kim Lin
Christian McCusker
Dayna Meyer
Carlos Perez

Olivia Russell
Sarah Schultz
Nicole Tyler
Guanglei Zhang
Adélaïde Veyre
Adélaïde Chopard

CNS staff
Jaquelyn Bernuy
Marisol Cedillo Dougherty
Eric Davila
Anna Davison
Justin Dodds
Barbara Gilkes
Emily Kang
Michelle Olofson
Jessica Suseno
Valerie Walston

CNS Graduate Student Assistants
Moirá O’Neil, ABD, Sociology
Mario Guerrero, Political Science
Margaret Moody, Education
Olivier Dufault
Emily Tumpson Molina
Roger Early-Pryor

Participants affiliated, not receiving Center support:

UCSB

Kevin Almeroth	Associate Professor	Computer Science
James Blascovich	Professor	Virtual Environments, Psychology
Daniel Blumenthal	Professor	Electrical & Computer Engineering
David Clark	Professor	Materials, Mechanical Engineering
William Freudenburg	Professor	Environmental Studies, Sociology
Arthur Gossard	Professor	Materials, ECE
Anita Guerrini	Professor	History & Environmental Studies
Elisabeth Gwinn	Professor	Physics
Stephanie Hampton	Deputy Director	Center for Ecol Analysis & Synthesis
Craig Hawker	Professor, Director	Materials Research Lab & MRSEC
Trish Holden	Professor	Microbiology, Environment Science
Evelyn Hu	Professor	Materials & CNSI
Umesh Mishra	Professor	Electrical & Computer Engineering
Laury Oaks	Associate Professor	Anthropology, Women's Studies
Jim Reichman	Professor, Director	NCEAS; Ecology
Ram Seshadri	Professor	Materials, Chemistry & Biochemistry
Hyongsok Soh	Associate Professor	nv Engineering
Nicola Spaldin	Professor	Materials
Matthew Tirrell	Professor, Chair	Chemical Engineering & Materials
Win Van Dam	Assistant Professor	Computer Science
Robert Ackland	<i>Australian Nat'l Univ, Res.faculty</i>	Economics
Mathiu O'Neil	<i>Australian Nat'l Univ, Postdoc</i>	Computer science, sociology
Francesca Bray	<i>Edinburgh Univ, UK, Professor</i>	Gender & Technology, China
Magali Delmas	<i>UCLA, Associate Professor</i>	Corporate Environmental Mgmt.
Vladi Finotto	<i>Venice Int'l Univ, IT Researcher</i>	Economics
Stefani Micella	<i>Venice Int'l Univ, Director</i>	Technologies in Distributed Systems
Stéphanie Lacour	<i>Centre National de la Recherche Scientifique, France, Research Fellow</i>	IP, Law & New Technologies
Ismael Rafols	<i>Sussex Univ, Researcher</i>	

Nanotechnology in Society Network Pls:

David Guston, CNS-ASU
 Davis Baird, University of South Carolina
 Richard Freeman, Harvard University
 Lynne Zucker, UCLA

4B. EXTERNAL ADVISORY BOARDS

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](#)

Julia Moore, Deputy Director of Foresight and Governance Project at the Woodrow Wilson International Center for Scholars), [Board Co-Chair](#)

Ann Bostrom, Associate Professor and Dean in School of Public Policy at University of Washington, Seattle (formerly, Georgia Tech)

Craig Calhoun, 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

Martin Moskovits, AIP Nanotronics and Professor of Physical Chemistry, UCSB

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

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

Thomas Kalil, UC Berkeley, currently a team Lead of the Executive Office of the President, Co-Lead of the White House OSTP Review Team, and a member of the Technology, Innovation & Government Reform Policy Working Group in the Obama administration, [Board Chair Emeritus](#), 2007-2008

4D. LIST OF PARTICIPATING ACADEMIC INSTITUTIONS

Allan Hancock Community College
Arizona State University
Australian National University, Canberra, Australia
Beijing Institute of Technology
Cal Poly San Luis Obispo
Cardiff University-Wales, UK
Cornell University
Cuesta Community College
Duke University
Harvard University
Howard University
Jackson State University
Michigan State University
Oxnard Community College
Santa Barbara City College
SUNY Levin Institute
SUNY New Paltz
University of British Columbia, Vancouver, Canada
University of California, Berkeley
University of California, Los Angeles
University of California, Santa Cruz
University of East Anglia, Norwich, UK
University of Edinburgh, UK
University of South Carolina
University of Southern Florida
University of Washington
Venice International University, Venice, Italy
Ventura College
CNRS-France

4D. LIST OF PARTICIPATING NON-ACADEMIC INSTITUTIONS

American Bar Foundation
American Institute of Physics
Chemical Heritage Foundation
Cynthia Cannady Legal Services
Environmental Defense Fund
International Council on Nanotechnology (ICON)-Rice University
International Risk Governance Council (Switzerland)
Meridian Institute
Nanoholdings, LLC (NY)
Nanoscale Informal Science Education (NISE) network
Northwest Survey and Data Services
Woodrow Wilson International Center, Project on Emerging Nanotechnologies

Table 1: Quantifiable Outputs						
		Jan-Mar06	Mar06-Mar07	Mar07-Mar08	Mar08-Mar09	
Outputs	Reporting Year - 4	Reporting Year - 3	Reporting Year - 2	Reporting Year - 1	Reporting Year	Total
		CNS Yr1	CNS Yr2	CNS Yr3	CNS Yr4	
Publications resulted from NSEC Support		1	5	9	38	53
in Peer Reviewed Journals		1	4	6	22	33
in Peer Reviewed Conference Proceedings			1		1	2
in Peer Reviewed Book Chapter					9	9
Technical Reports						0
Working Papers						0
Books (including edited volumes)						0
With Multiple Authors		1	2	6	20	29
co-authored with NSEC faculty		1	2	6	20	29
Degrees to NSEC Students						
Bachelors Degrees Granted						
Masters Degrees Granted			1	1		2
Doctoral Degrees Granted			1	2	2	5
NSEC Graduates Hired By						
Industry						
NSEC participating Firms						
Other US Firms						
Government						
Academic Institutions			1	3	1	5
Other					1	1
Unknown						
NSEC Influence on Curriculum (if applicable)						
New Courses Based on NSEC Research			1	3	1	5
Courses Modified to Include NSEC Research				6	8	14
New Textbooks Based On NSEC Research						
Free-standing Course Modules or Instructional CDs						
New Full Degree Programs (specify name of program and where implemented in footnote)						
New Degree Minors or Minor Emphases (specify in name of program and where implemented in footnote)			2			2
New Certificate (specify name of program and where implemented in footnote)						
Information Dissemination/Educational Outreach						
Workshops, Short Courses to Industry			2			2
Workshops, Short Courses to Others					1	1
Seminars, Colloquia, etc.		17	41	17	83	158
World Wide Web courses						
Following is a breakdown of information dissemination categories:						
Conferences		0	0	1	1	2
Visiting Speakers		1	6	6	5	18
Nano-Meeters		0	0	3	2	5
Community Speaking Engagements		5	9	8	8	30
Academic Presentations		23	50	61	69	203
Newsletters		0	0	1	1	2
Podcasts		0	0	3	0	3
Press Releases		2	4	12	6	24
Academic Publications		2	10	15	70	97
Weekly Clips		0	4	47	44	95
Blog Posts		0	71	69	20	160
footnote:						
New Degree Minor or Emphasis: PhD Emphasis in Technology and Society; Undergraduate minor in Technology and Society						

6. MISSION AND BROADER IMPACTS

Nanotechnology Origins, Innovations, and Perceptions in a Global Society

The global vision to have nanotechnology mature into a transformative technology depends on an array of interconnected and complex factors situated within a rapidly changing international economic, political, and cultural environment. These include the resolution of scientific and technological questions, the safe creation, development, and commercialization of nano-products, and the acceptance of nanotechnology by diverse publics. The NSF Center for Nanotechnology in Society at UCSB provides a clear and comprehensive approach to understanding the challenges to the successful development of nanotechnology in the US, Europe, Asia and other regions. Through a mixed and complementary portfolio of interdisciplinary research, education, and engagement activities, the CNS-UCSB produces basic knowledge about a linked set of social and environmental issues at a time of sustained technological innovation. This is achieved through close examination of the development, commercialization, production, consumption, and control of nanoscale technologies. The Center also addresses education for a new generation of social science and nanoscience professionals as it fosters research on the origins of the nano-enterprise, the innovation systems for nanotechnology, globalization, cooperation and competition in the development of nanotechnology, and the social response, media framing, and the publics' emerging risk perceptions of nanotechnology. With an outlook that is global in scope, detailed in its focus, and rigorous in its methodologies, the CNS-UCSB uses its evolving international research infrastructure to create a genuine learning community of diverse participants who can pool their knowledge for the simultaneous benefit of society and technology.

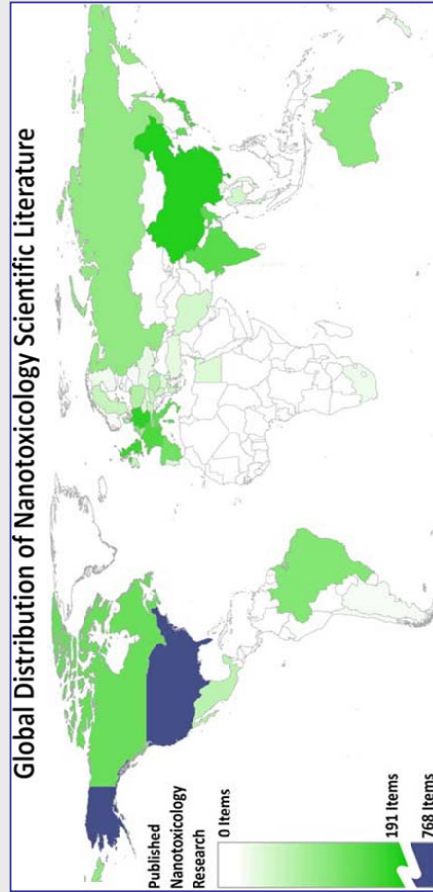
Broader Impact

CNS'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 and research assistantships (11 social science/humanities fellows; 9 NSE fellows to date); graduate research assistantships (2 at UCSB; 4 w/ external collaborators), undergraduate summer research internships to regional community college students (3 in the past year, 8 since inception) and UCSB undergrads (2 in 2008, 8 total since 2006) who are mentored by UCSB graduate students (16 mentorships to date), and 1-2 interdisciplinary social science postdocs per year (n=3) since 2007-08. CNS convenes a year-round graduate seminar for credit that includes scholarly discussion, professional training and development, research colloquia, and other activities. CNS develops new courses for undergraduate and graduate curriculum in science and technology studies (3 new; 14 content added), and CNS-UCSB is initiating plans for a new program to prepare educational modules for introduction of CNS-UCSB research materials into the NSE undergrad science and engineering curriculum, community college science and social science curricula, and for California high school teachers to use in social science and science classes. 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 2008-09 held 2 Nano-Meeters, 1 public nano science fiction discussion, and 2 annual NanoDays with nearly 285 adults and children). CNS-UCSB commits significant resources to conferences and workshops for diverse audiences, alternating smaller, more specialized meetings for educators (Nano societal implications education 2008) and researchers (Nanotech risk perception 2010) with larger-scale international conferences and workshops (large international conference on Nanotechnology Equitable

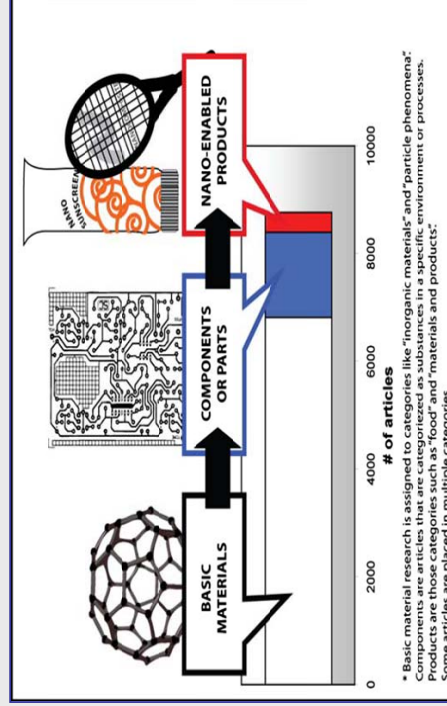
Global Development in planning for Nov,2009 in Washington DC). CNS serves as a key connection hub in the growing nano in society network, via speaker series, short- and medium-term visiting scholars, a founding role in the new society, S.NET, and a dissemination point for research results (as requested 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 Weekly Clips (44 weeks of transmission in 2008-09), our blog (cns.ucsb.edu), podcasts of interviews with researchers, and media briefings, and anticipated new media methods in the future. The CNS also engages and informs policymakers and governmental agencies (e.g., Rich Appelbaum to the US-China Economic Security Commission, March, 2009; Barbara Herr Harthorn to the US congressional caucus, March, 2009; Nick Pidgeon with the UK House of Lords in March 2009 and the International Risk Governance Committee in summer 2008). Plans for the coming year include initiating development of a new program of policy briefs will extend this reach as the research mission matures. CNS' distinguished National Advisory Board allows regular consultation with leaders of all stakeholder constituencies, at all phases of research and dissemination. In years 6-10, in collaboration with the UC CEIN, CNS proposes to work with government and industry to develop risk communication for particular audiences grounded in empirical knowledge of the public, emerging views of nanotech, and past risk controversies.

Nanotoxicology: Characterizing the Scientific Literature

Assessing the state of knowledge about nanotoxicology is an important step in promoting comprehensive understanding of the health and environmental implications of nanomaterials. We employed bibliometric techniques to characterize the prevalence and distribution of the current scientific literature. The nanotoxicological literature is dispersed across a range of disciplines, sub-fields and countries. Articles were analyzed by a variety of methods. In the figure below, the country of origin and number of publications are shown.



Ostrowski, A.D., Martin, T.L., Conti, J., Hurt, I., Harthorn, B.H.
J Nanopart Res (2009) 11:251–257



The literature is currently focused on basic materials, acute toxicity and mortality, and on *in vitro* studies on mammalian models but not consumer products, chronic exposure and morbidity. Most articles do not specify an exposure pathway and there is little research on environmental fate. These findings provide a baseline account of peer-reviewed nanotoxicology publications and identify gaps, which have significant implications for experts, regulators, and the public.

Exploring Institutions of Interdisciplinarity

This on-going project focuses on the history of interdisciplinary centers in the United States and their role in the history of nanotechnology starting in the late 1950s.

Interdisciplinary academic institutions form the backbone of the US government's involvement in nanotechnology. The present configuration of nanotechnology can only be understood in the context of a long history of attempts to stimulate academic interdisciplinarity by federal agencies (and, before that, by philanthropic foundations).

The ultimate aim of the project will be a better, more historicized assessment of how interdisciplinarity actually affects research; how interdisciplinarity has affected the traditional disciplines; what role institutions play in fostering interdisciplinarity; and what role the NSF has played in the development of interdisciplinary nanoscale research.

Some Representative Publications that Address Interdisciplinarity:

- H Choi and CCM Mody, "The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology," *Social Studies of Science* 39 (2009), 1.
- CCM Mody, "Instruments of Commerce and Knowledge: Probe Microscopy, 1980-2000," in *Science and Engineering Workforce Project Proceedings*, ed. Richard Freeman and Daniel Goroff (Chicago: University of Chicago Press, forthcoming): 291-319.
- CCM Mody, "Institutions as Stepping Stones: Rick Smalley and the Commercialization of Nanotubes" (Göteborg, Sweden: Chalmers Institute of Technology Nanoscience seminar, October 13, 2008).

Early Cold War

- Archival research on the first three MRLs (Penn, Cornell, Northwestern)
- Archival research on early second-wave MRLs (MIT, Stanford)
- Extended oral histories with early figures in the Penn LRSM
- Study of contemporary debates about materials science (von Hippel v. Slater)

Late Cold War

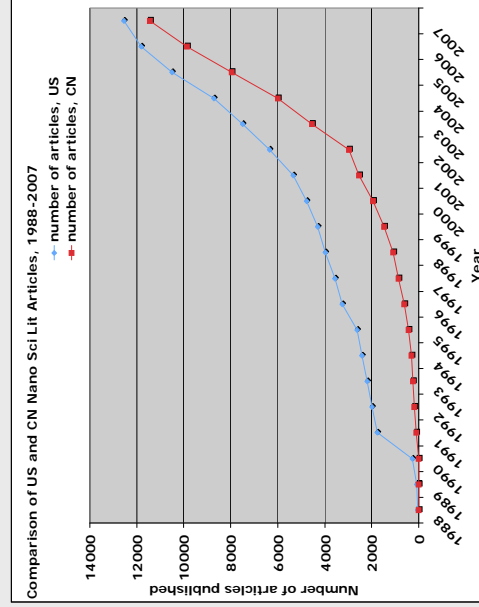
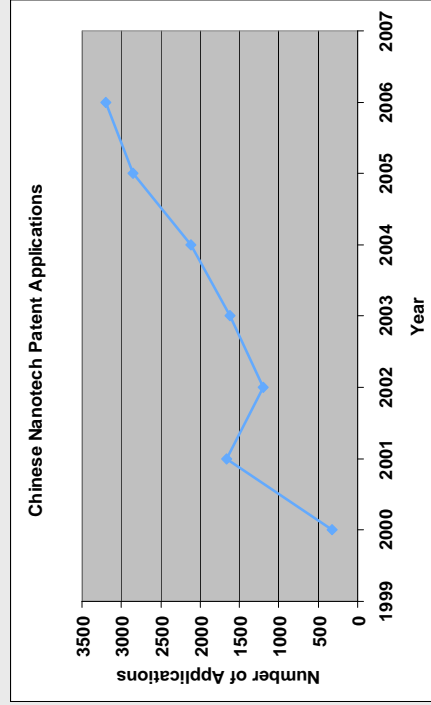
- Archival research on early NNUN and other microfabrication centers (Cornell, MIT, Stanford, Howard)
- Interviews with leading microfabrication specialists of the '70s and '80s
- Study of the role of the Gordon Research Conference on Microstructure Fabrication and other meetings in the development of micro/nanofabrication

Post-Cold War

- Archival research at Rice and Chemical Heritage Foundation on Rice Quantum Institute, Center for Nanoscale Science and Technology, and Center for Biological and Environmental Nanotechnology
- Interviews with members of RQI, CNST, and CBEN
- Study of commercialization of carbon nanotubes, to be published as CHF white paper and edited volume chapter

China's Commitment to Nanotechnology

- China has made nanotechnology one of four science “megaprojects” that will carry the country into its high-tech future.
- China has aggressive state-led investment in basic research but also in R&D activities at the commercial end of the value chain.



- Richard P. Appelbaum, Rachel A. Parker, Cong Cao, and Gary Gereffi “China’s (Not So Hidden) Developmental State: Becoming a Leading Nanotechnology Innovator in the 21st Century” in Fred Block and Matthew R. Keller, eds. *Half Empty and Half Full: Perspectives on U.S. Innovation Policy 1969-200*, Forthcoming

Deliberating the Risks of Nanotechnologies in Energy and Health Applications in the US and UK

Published Work: Context Matters¹

- Four parallel deliberative workshops were conducted in February 2007, two in the US and two in the UK. Workshops focused on dialogues about nanotechnology applications in either energy or health & enhancement.
- Formal and self-directed learning were incorporated through Powerpoint presentations and World Café-style small group discussions.



Photo: www.notio.com

Results:

- Public views in both countries focused on benefits rather than risks.
- Application context was more salient than nation as a source of difference, with nanotech energy viewed in a more positive and urgent light than health and human enhancement technologies.
- Subtle differences across countries emerged in views about equitable distribution, trustworthiness of government & industry, and in consumerist attitudes. Overall, such social risks trumped concerns about technological risks.

¹Pidgeon, N. (Cardiff), Harthorn, B.H. (UCSB), Bryant, K. (SUNY-NP), & Rogers-Hayden, T. (U East Anglia). 2009. "Deliberating the Risks of Nanotechnologies for Energy and Health Applications in the United States and United Kingdom." *Nature Nanotechnology* 4(2): 95-98.

Next Steps: Gender, Race, and Equitable Participation²



Photo:
www.iClicker.com

In **Summer 2009**, the next phase begins with an experimental workshop on nanotechnology deliberation using polling devices.

- By immediately projecting polling results,

the study will explore effects of making minority voices known on the "white male effect" and the dominance of particular voices.

* * * * *

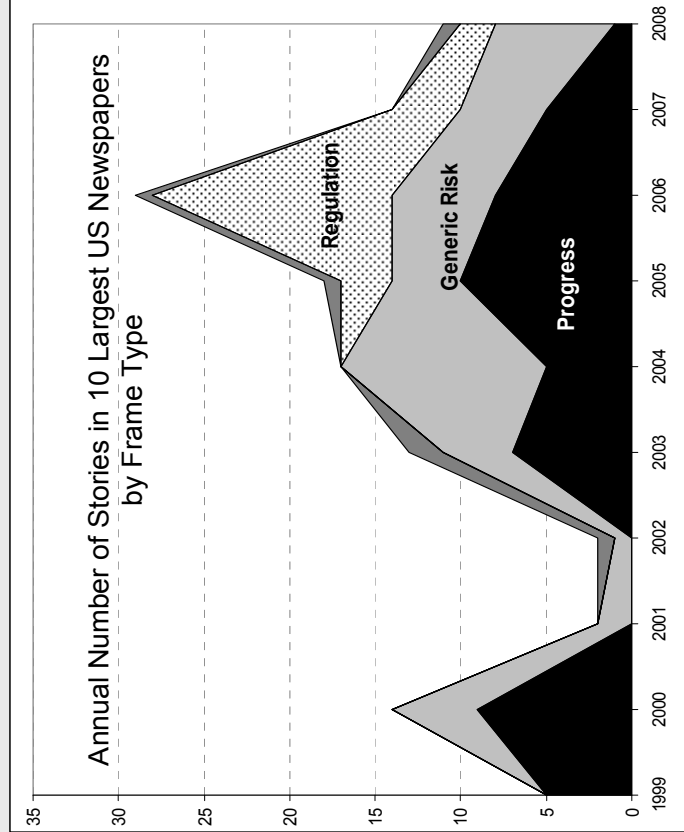
In **Fall 2009**, a new study will focus on gender and risk perception in six deliberative workshops on nanotechnology energy and health applications.

- This study will examine how gender and race/ethnicity affect interaction and risk perception in deliberative forums in the US.
- Comparative analysis with our 2007 US workshops will allow depth analysis of changing views about benefits and risk.

²Harthorn, B.H. (Anthro, UCSB), Rogers, J.R. (Soc, UCSB), Hurt, I. (Geog, UCSB), Martin, T. (Chem, UCSB). 2009. *In Progress*.
NSF SES-0824042 and NSF SES-0531184

Hitting Headlines: How Media Tell the Story of Nanotechnologies

Coverage of nanotechnologies in the media has waxed and waned over the last decade. Generally, heavier coverage has been a response to action involving government agencies such as the EPA. Since 2003, newspaper stories on nanotechnologies have been dominated by three frames: progress, regulation, and generic risks and benefits of nanotechnology.



The New York Times
The Future, Now Available in Stores
By BARNABY J. FEDER.

Study Raises Concerns over Buckyballs
Brain Damage Found in Fish Exposed to Nanotechnology

By ERIC BERGER, Houston Chronicle
New research suggesting that buckyballs - the super tiny, soccer ball-shaped form of carbon that helped start a revolution in materials science -

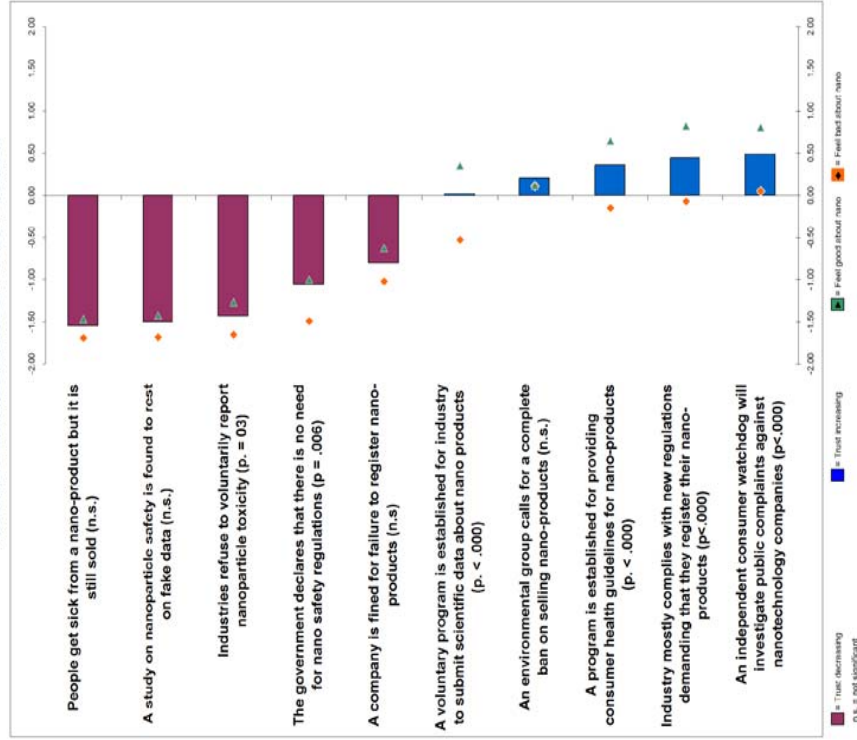
- Weaver, D., Lively, E., and Bimber, B. 2009. Searching for a frame: Media tell the story of technological progress, risk, and regulation in the case of nanotechnology. (Under review)
- Weaver, D., and Bimber, B. 2008. Finding news stories: A comparison of searches using LexisNexis and Google News. *Journalism and Mass Communication Quarterly*, 83 (3), 515-530.

Affective-Trust and Asymmetry in Nanotechnology Regulation

- Studying public perceptions of nanotechnology under conditions of low awareness and a priori any stigmatizing risk events necessitates relying on known predictors of risk. Two well-known predictors of risk perception are measures of trust and affect. The former includes trust judgments about reports on different management practices whereas the latter [affect] refers to rapid pre-conscious or pre-analytic judgments expressing strong or weak feelings about the “goodness” or “badness” of an object [nano].
- Reporting on a nationally representative phone survey of U.S. residents (N=1,100), participants were asked (1) their affective response to nanotechnology and (2) their trust judgments of different risk management practices. Management scenarios were intentionally balanced from extremely positive to extremely negative. Findings illuminate the fact that affective ratings largely enhance the principle of trust asymmetry – that trust is easier to destroy than gain. Enhancing trust (blue bars) is more difficult to achieve than the reverse (red bars), and even in the best scenarios those who offered negative affective judgments were not converted to trusting positions in the face of trust-enhancing events.

Satterfield, T.; Conti, J.; Pidgeon, N.; Harthorn, B.H. *in preparation*

Affective Enhancements of Trust/Distrust



Graduate Fellows Engage Public During NanoDays 2008

On a Saturday in April, more than 85 people of all ages came to UCSB for NanoDays – a collaboration with the California NanoSystems Institute at UCSB.

Visitors enjoyed the interactive 'Too Small to See 2' exhibit and talked with CNS-UCSB Graduate Fellows about research, nanotechnology in consumer products, and nanoscale science and engineering concepts.

Former Fellow Kim Stolzhus, pictured in the upper left photo, returned to UCSB for the occasion, and remarked, "People asked many questions about what is already on the market, what nanoscience is being conducted at UCSB, the future of nanoscience, ethics, risks, benefits, what nanoscience means. A lot of those I spoke to wanted to know how they could learn more and attend future forums on these issues."



Graduate Fellows in social science and science and engineering present research, discuss nano-enabled products, and demonstrate NSE concepts during NanoDays

Scientists and Engineers Without Disciplinary Borders:

Social science and science/engineering Graduate Fellows collaborate on research

A unique and truly interdisciplinary program at CNS-UCSB trains science and engineering graduate fellows in social science research, and provides social science and humanities students access to the expertise and knowledge of their NSE peers. Graduate Fellows work in Interdisciplinary Research Groups mentored by a CNS-UCSB faculty PI, and publish together. More importantly, they gain an appreciation of how different fields approach problems, they learn to communicate across disciplines and points of view, and they take a broader perspective back to their own research and their departments.

Some comments from Graduate Fellows:

- “I have started to see things (science) in a more political and social way, which I think is a more accurate view... especially when it comes to policy/decision-making.”
- “It’s nice to be able to get feedback from someone with a completely different perspective from my own and be able to bounce ideas off of someone with a different disciplinary background - a good way to make sure things “make sense.”



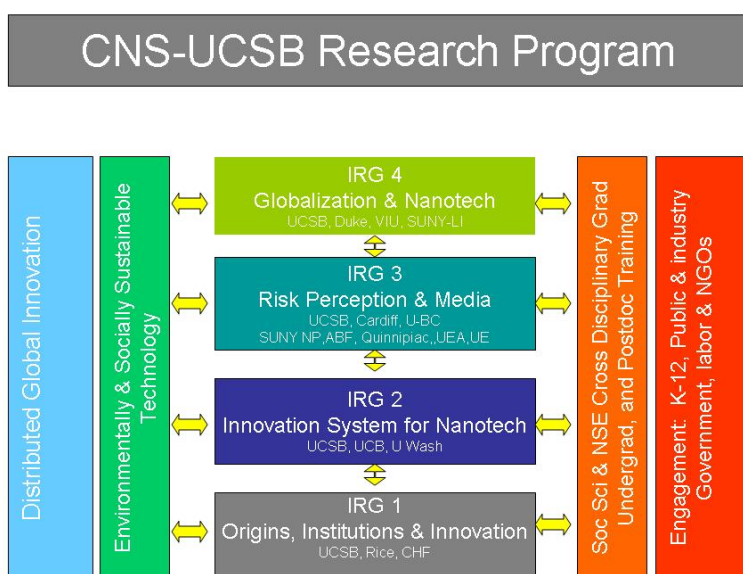
*Top: CNS-UCSB Graduate Research Fellows
Bottom: Science and Engineering Graduate Fellows
tour their social science peers through the
Nanofabrication Facility cleanroom at UCSB.*

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) innovation and technology transfer systems for successful commercialization, globalization as a key factor in comparative economic development in East and South Asia, and emerging social perceptions of nanotechnologies as media and diverse publics become aware of them. Research in the past year has been slightly reorganized into four 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 – the *Innovation Group*** looks at collaboration and innovation, patenting systems, and technology transfer in the leading edge California innovation system and in comparison to UK, France, Germany, and other sites; **IRG 3--*Risk Perception and Media***--focuses on publics' and experts' perceptions and social intelligence about nanotechnologies, media framing of nanotech risks and benefits, social amplification and attenuation of risk, methods for public deliberation, and collective action in response to emerging nanotechnologies. **IRG 4 -- *Globalization and Nanotechnology*** examines nanotechnology development under differing governmental approaches in China, Japan, and elsewhere in E. and S. Asia, to ask how different industrial policies in combination with international cooperation and collaboration among researchers, shape distinctive nanoscience and industry outcomes. Together these provide a comprehensive understanding of current processes for successful innovation, 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 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; and employment of advanced spatial analytic methods and a global framework for analysis.

CNS-UCSB views the linked set of foci of the CNS-UCSB on the scientific invention and economic development aspects of new nanotechnologies (IRGs 2 & 4), the meanings for risks and benefits that accrue on the societal side through media, expert & public processes (IRG 3), 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 4 IRGs that form the core of CNS research are connected by numerous threads of common interests, some shared personnel, and the processes for integration that CNS-UCSB as a centralized, single campus center provides and continues to refine and develop. One aspect of these processes in the past year is the decision to separate the two innovation-focused groups that originally formed IRG 2 into two separate IRGs, consistent with their original conceptualization. IRG 2 takes a case-study approach, focuses increasingly on a specific application area (3rd Generation Solar with a range of nanoscale enabling technologies), and attempts to analyze the content of patents to determine lines of development and of commercialization interest. IRG 4 is working at the level of nanotechnological aggregates, conducting a comparative analysis of differing industrial policies on nanotechnology innovation and commercialization. The two groups' methods are complementary, as are the regions on which they focus: for example, IRG 2 uses the USPTO and European Patent Office databases, and pays particular attention to assignees and technology developers that are based in the US and the EU. IRG 4 led by Rich Appelbaum has focused from the start on carefully collected and interpreted Chinese patent data and firms, as part of its emphasis on Asian and Pacific Rim developments. All of the industries that both groups will look at are

fundamentally global, and the combination of their respective data and analyses will contribute to an integrated picture of selected global nano-enabled industries. IRG 3's research is moving more explicitly 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 a new award in 2008 to PI Harthorn will allow a closer focus on gender as a factor in risk perception and interactions in small group deliberative settings. Altogether, the CNS focuses on globalization, innovation, and risk, with central themes of inequality, vulnerability, product stigma, environment, and the production of policy-relevant results. CNS teams use a variety of comparative case analyses across specific nations (US, EU, E Asia), across applications for energy, 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 collaborates extensively with the CNSI, newly strengthened ties with the UCSB Materials Research Laboratory (MRSEC) and the College of Engineering and new Institute for Energy Efficiency (see attached letters of support), NSE participation on our National Advisory Board, and the funded collaboration of the CNS-UCSB with the UC CEIN (and with the CEINT at Duke, through our collaborator Gereffi) serve to provide a strong web of connections to the NSE, nanotoxicology and materials research communities. The renewal phase will serve to further develop and strengthen these ties, for example through shared course development with the MRL's IGERT program, through joint programming, and many other means. These connections and the highly interdisciplinary exchanges that are resulting from them are absolutely essential to the fulfillment of the CNS-UCSB research and education mission. Science and society work of the sort that is expected from the CNS requires the development of mutual regard and understanding across very great disciplinary divides, a process we as social scientists 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 take a number of forms. Years 1-5 will culminate with the production of numerous publications, reports, and other materials that contribute to cutting edge theoretical and substantive issues in disciplinary research as well as the interdisciplinary space constructed by a highly multi-disciplinary national center such as CNS-

UCSB. At the IRG level, this includes plans in year 5 to conduct state of the art analyses based on cumulative knowledge from the first 5 years of funding. For example, IRG 3 proposes to produce a synthesis piece on nanotechnology upstream and midstream deliberation, based on what they will have learned from conceptual work by Pidgeon and Rogers-Hayden in the UK, two sets of deliberative workshops in 2007 and 2009 by the full team (Harthorn, Pidgeon et al.), and meta-analysis of the published literatures. IRG 3 also plans a specialist meeting in year 5 to assess the state of knowledge about nanotech risk perception that will result in a special journal issue. Center funding with its longer horizons and IRG collaborative enterprise thus enable a focused, summative evaluation of research that is not possible at the individual project level. Results will be disseminated via policy briefs to policy makers and to the public through traditional and new media, as well as to scholarly audiences. IRG 4 will build on its analysis of Chinese publications, focused on output, to analyze the determinants of high-impact publications – particularly the role of international co-authorship, an index of international collaboration. During the past year IRG 4 acquired a dataset of Chinese patents for the period 1985-2007. This will be updated during coming years, and analyzed to ascertain trends by patent categories, as well as provide information on Chinese nanotech companies that will provide case studies.

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 proposes to culminate the first 5 years of Center support by producing an edited volume, tentatively entitled *The Social Life of Nanotechnology*, edited by CNS Director Harthorn and sociologist John Mohr. The volume will bring together original work from the research groups, will include education for nanotechnology in society, and will include reflexive examination of the origins and sociology of the Center for Nanotechnology in Society at UCSB and its interactions with the NSE community. We plan to ask board Chair John Seely Brown (author of *The Social Life of Information*, Harvard, 2000) to author a foreword to the book, which we hope will be consistent with the aims of his text to remind scientists, technologists, business and government that the social contexts of technologies demand close and careful attention and understanding.

As the CNS develops a robust set of empirical data we plan a stepped up plan for interaction with and dissemination to diverse audiences from NSE researchers and students, to policy makers, to the diverse publics we study in our research. The parallel science journalism program CNS researchers lead in the UC CEIN will allow a thoughtful and effective approach to reaching key government, industry, labor, environmental, and public audiences with the implications of our research. Currently, for example, IRG 3 survey research provides experimental evidence that it may be harmful to public acceptance to focus exclusively on the presentation of information about a new nanotechnologies' benefits, something many in both science and industry assume as the preferred approach. We hope to work with government and industry to use research to develop risk communication for specific audiences. All IRGs are using center resources to develop and consolidate policy relevant results that Center infrastructure in turn will enable us to disseminate effectively.

9. RESEARCH PROGRAM, ACCOMPLISHMENTS, & PLANS

IRG-1: Historical Context of Nano-enterprise

[W. Patrick McCray](#), Leader
[Cyrus Mody](#)

History
History

UC Santa Barbara
Rice University

Affiliates

[Hyungsub Choi](#)
[David Brock](#)

History
History

Chemical Heritage Foundation
Chemical Heritage Foundation

1 Postdoc, 2 Grads, 3 Undergrads

Postdoc: Mikael Johansson, Anthropology

Graduate students: Social Science: Mary Ingram-Waters, Sociology
Summer Gray, Sociology

Undergraduate students: UCSB: Olivia Russell, Roger Pryor and Olivier DuFault

The goal of IRG 1 is to produce and integrate a diverse range of historical sources and research tools in order to understand specific facets of the nano-enterprise's history. Understanding nanotech's societal implications is predicated on possessing a clear and comprehensive understanding of its historical context. This requires examining nanotech's history at multiple levels of analysis – scientists' careers, research communities, instrumentation, national and state policy, and the role of public imagination and interest in "visionary engineering ideas."

Our working group in Year Four was composed primarily in Year Two of [W. Patrick McCray](#) (Professor of History, UCSB) and [Cyrus Mody](#) (Asst. Professor of History, Rice University). We also had the participation of CNS Graduate Research Fellows: [Mary Ingram-Waters](#) (CNS Graduate Student Fellow in Sociology, through June 2008) and [Summer Gray](#) (CNS Graduate Student Fellow in Sociology, started September 2008). In August 2008, we added another primary researcher, [Hyungsub Choi](#), a historian of science and technology at the Chemical Heritage Foundation whose specialty is modern technology and instrumentation related especially to semiconductor manufacturing in the US and Asia. We have also begun a modest level of collaboration with [David Brock](#), a historian of science who consults for Chemical Heritage. Finally, Postdoctoral Scholar Mikael Johansson joined CNS in January 2009; he is mentored by McCray and is affiliated with IRG1.

IRG 1 has been remarkably productive during the first four years of the CNS. In Year Four, our IRG has written, published or submitted for publication some 16 articles, reports, essays, opinion pieces, book chapters, and reviews. Included among these are several peer-reviewed articles in major science journals including *Nature Nanotechnology* and a high-profile piece by [Mody](#) in *Physics Today* as well as flagship publications in the STS field such as *Social Studies of Science*, and *Technology and Culture*. In addition, researchers from IRG 1 gave 12 talks at conferences including meetings in Sweden and France.

In the period between March 2008 and March 2009, Working Group 1 performed work in the main areas detailed below.

IRG 1-1: Semiconductor Technologies and the Road to Nanoelectronics

Project Leader: [Hyungsub Choi](#)

Members: [W. Patrick McCray](#), [Cyrus Mody](#), [Hyungsub Choi](#)

Activities to Date:

During the last three years, McCray, Mody, and Choi have been active in this area, making this a productive line of work. Choi and Mody's article on molecular electronics is forthcoming in *Social Studies of Science*; McCray's articles on spintronics have been published in *Technology and Culture* and *Nature Nanotechnology*.

Although we anticipated suspending this line of work in our last report, it appears that there are renewed activities in the broad field of the history of nanoelectronics—or the interface between conventional semiconductor technologies and nanotechnology in the 1990s and beyond. There are three projects that will engage the members during the next two years. First, McCray and David Brock (a consultant for Chemical Heritage) have begun working on the development of thin-film technology for the semiconductor industry, in the form of molecular beam epitaxy (MBE), for the “Instruments in Manufacturing” conference at Rice University organized by Mody and Ann Johnson (USC). Second, Choi and Brock are working on a more detailed history of semiconductor roadmaps in the mid-1980s, which will serve as a meta-level study for the other projects in this area. Finally, Mody is continuing his research on the Josephson junction at IBM, which is a spinoff from his research on STM.

Collectively, this project area will examine the various “beyond the wall” technologies in semiconductors during the 1980s and 1990s, which were institutionalized under the semiconductor roadmapping exercise at Sematech and eventually subsumed under the rubric of “nanoelectronics.”

IRG 1-2: Nanotechnology Oral History Project

Project Leaders: Patrick McCray and Hyungsub Choi

Members: W. Patrick McCray, Cyrus Mody, Hyungsub Choi

Activities to Date:

In Year 4, processing of outstanding oral histories at Chemical Heritage continued. Mody also strategized about his next round of interviews which resume in Summer 2008. Transcription has also begun on a series of interviews Mody conducted previously with microfabrication specialists and nanotechnology policymakers. All of these will be circulated within IRG-1. Two of them (James Murday, formerly with the Office of Naval Research; and Robert Buhrman of Cornell) were processed into oral histories in due course. IRG-1 is anticipating working more closely with Chemical Heritage Foundation and Choi as they undertake interviews related to the University of Pennsylvania’s materials science center.

For the remaining two years of CNS, we will keep the PSA with CHF active and focus efforts to conclude the backlog of about 6-8 outstanding oral histories already collected by Mody and Choi. This work will be jointly supervised by McCray and Choi for now. For the next 5 years (after 2010), we plan to continue funding for oral history work and have it focus on “pioneers of nanotechnology;” the plan is to ask David Brock, also connected with Chemical Heritage, to serve as the point person and manager of this work if he is willing. We all recognize the value of oral histories, not just as a research tool, but also as a service component for the CNS.

IRG 1-3: Institutions of Interdisciplinarity

Project Leader: Cyrus Mody

Members: Cyrus Mody, Hyungsub Choi, Summer Gray (advised by McCray)

Activities to Date:

This area is emerging as one of the major research topics for IRG1 for the next few years and possibly into the second 5 years of CNS funding.

The central premise for this work is that the present configuration of nanotechnology can only be understood in the context of a long history of attempts to stimulate academic interdisciplinarity by federal agencies (and, before that, by philanthropic foundations). The NSF's vision for nanotechnology largely focuses on the creation of new institutions that will foster an interdisciplinary approach to nanoscale approach. Today's Nanoscale Science and Engineering Centers join a long line of interdisciplinary center programs at NSF, reaching back to the early 1970s, when the NSF inherited the Materials Research Laboratories from the Advanced Research Projects Agency. The NSF suddenly became much more invested in academic centers and in interdisciplinary research. In a classic case of institutional isomorphism, the NSF began funding multiple waves of academic centers (e.g. NSECs).

Area 3's work has been directed at producing a history of these NSF interdisciplinary centers and their role in the history of nanotechnology. The project will also study more localized interdisciplinary institutions—such as conference series, journals, and locally-funded academic research centers—that have contributed to nanotechnology. The ultimate aim of the project will be a better, more historicized assessment of how interdisciplinary actually affects research; how interdisciplinarity has affected the traditional disciplines; what role institutions play in fostering interdisciplinarity; and what role the NSF has played in the development of interdisciplinary nanoscale research. Presently, work is taking place in three main areas which are discussed below.

IRG 1-3a: The Origins of Academic Interdisciplinarity Research: Emergence and Transformation of Materials Research Laboratories, 1960-1975 (led by Hyungsub Choi)

This project began examining the institutional developments in three materials research laboratories (MRLs) initially funded by ARPA in 1960 (Penn, Cornell, Northwestern), focusing on the emergence of academic interdisciplinary research. The MRLs were the product of ARPA in the late 1950s emphasizing interdisciplinary research on advanced materials, which was one of the key reverse salients of the postwar period. ARPA provided multi-million dollar grants to three MRLs in 1960 that paid for new buildings and provided lavish research funds. This transformed the research dynamics on campus throughout the 1960s. Due to the Mansfield Amendment, funding for MRLs was transferred from ARPA to NSF in 1972. This was an important turning point for federal R&D funding patterns as well as materials research. The seemingly unrestricted funding of the 1960s became more restricted in the 1970s as the economy slowed down. More importantly, MRLs became the institutional template for NSF's Engineering Research Center program in the early 80s. The story of MRLs during the first two decades will capture the institutional transformation of university-government relationships in the 1960s and 70s, which laid the foundation for the Nanoscale Science & Engineering Centers (NSECs) in the 21st century. In Year 4, Choi began pilot interview with people connected with the Penn center and also began a close examination of archival material held at Penn and other east coast repositories.

IRG 1-3b: Building Interdisciplinary Institutions, 1975-2005 (led by Cyrus Mody)

Area 3b examined the new crops of interdisciplinary centers that the NSF began funding after it inherited the MRLs. The aim of this sub-project is to understand how scientists and engineers latched onto the NSF's new interest in founding centers as a way to advance their own local or communal interests. The first part of this sub-project looks at the beginnings of the National Nanotechnology Infrastructure Network with the founding of the National Submicron Facility at Cornell in the 1970s. The Submicron Facility was one of several institutions that solidified the

microfabrication community as a growing, dynamic research field. Other institutions included the Gordon Research Conference on Microstructure Fabrication, the Three Beams Conference, the Microstructures Laboratory at MIT, and the Center for Integrated Systems at Stanford. This part of the sub-project follows the microfabrication community and its institutions as they evolved toward nanotechnology over the course of the '80s and '90s.

The second part of the sub-project looks at the beginnings of the Nanoscale Science and Engineering Centers with the founding of the Center for Nanoscale Science and Technology at Rice in the 1990s. Beginning in the mid-'80s, Rice decided that interdisciplinary centers held the best promise in helping a small research university compete with its much larger peers. The centerpiece of Rice's interdisciplinary thrust, the Rice Quantum Institute, was also instrumental in keeping a star scientist, Rick Smalley, from being poached by other universities at a time when his star was rising. In the early '90s, the same confluence of events that allowed the founding of the RQI recurred, but this time Smalley used those events to promote his vision for a new field of "nanotechnology". The resulting institutions later served as a template for the NSF NSEC program.

IRG 1-3c: The Contested Nature of Interdisciplinarity in Nanoscience (led by Summer Gray; advised by McCray and Mody)

One of the goals of nano policy in the U.S. was to foster interdisciplinarity in nanoscale research. Over a decade later, the question remains—has that goal been successful? To what degree has interdisciplinarity in nanoscience succeeded or failed and why? IRG 1-3c will examine the question of interdisciplinarity in present-day nanoscale research by focusing on a variety of actors and spaces in the nanoscience community. So far, the research on interdisciplinarity in nanotechnology is focused solely on analyzing journals and publications for disciplinary dynamics. While this is helpful for understanding past and present states of integration among the sciences in nanoscale research, this method overlooks institutional dynamics that can foster or hinder interdisciplinarity. What happens on the ground among policy makers, scientists and patrons is important for understanding interdisciplinarity in nanoscience. The rise of nanoscience research centers at universities across the United States provides an opportunity to study interdisciplinarity on the ground. By looking at NNI research centers created for the purpose of conducting nanoscale research a more complex understanding of interdisciplinary unfolds.

Building on the work of Hyungsub Choi and Cyrus Mody, Gray has started to explore NNI research centers at various locations across the United States, looking specifically at the users and patrons of such facilities. In addition, this project will also look into pedagogical trends in nanoscience by examining course syllabi at universities with nanoscale research centers.

IRG 1-4: (Nano)Technological Enthusiasm and the Public Imagination

Project Leader: Patrick McCray and Mary-Ingram Waters (through June 2008)

Members: Patrick McCray with help from Olivia Russell, Roger Pryor and Olivier DuFault (research interns)

Activities to Date:

Paradigmatic histories of American technology have often noted that "technological enthusiasm"—often possessing a utopian strain—is one hallmark of the modern American experience. Nanotechnology is no exception. This line of work has investigated historical cases and explores 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 enthusiasm, ideas about technological utopias, and how public imaginings of future technologies have intersected with public policy. During the 1970s and 1980s, futuristic technologies including nascent ideas about nanotechnology stimulated the creation of privately funded research institutes and investment from high-tech entrepreneurs. While some of these futuristic visions (including those for early forms of molecular manufacturing/engineering) may seem unusual today, they were taken seriously at the time and, we would argue, had some degree of influence over public perception and 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 work is explicating a clearer understanding of modern technological utopias emerges. This story is relevant not just for understanding how radical new technologies are proposed but also how the public and media engage, accept, and reject them. By virtue of their impact on people's expectations for what tomorrow's technological future would hold, our research has explored how these visions played a role in shaping public imagination and perhaps feeding a cycle of anticipation, excitement, expectation, and disappointment. By considering a range of interrelated exploratory technologies, including nanotechnology, we have developed a better understanding of how people imagined the technological future and how these expectations changed over time.

McCray's research will result in the writing of a book which is already under contract with Princeton University Press. The completed manuscript will be delivered in late 2010 or early 2011. The book examines the network of entrepreneurs and high-tech enthusiasts who pursued speculative technologies during the Carter-Reagan era and follows their activities up to the present. This cohort of "visioneers" – a term used to describe people who imagined, designed, and even developed exploratory technologies – was an important (and hitherto unexamined) part of the technological ecosystem in the United States. Their exploratory engineering efforts selectively blended countercultural ideals and prolepsis with entrepreneurship and political libertarianism. At the same time, they worked to fend off detractors who branded their ideas as hopelessly optimistic.

While skeptics saw endeavors such as space colonization and life extension through nanotechnology as hubristic hallucinations expressed by an over-technological society, a fundamental historical fact remains: Whatever disappointments and disenchantments follow in their wake, these visions of utopias built on ideas from the frontiers of technology fascinated scientists, the media, and the public. At the same time, the characters in my story had established credibility against detractors who labeled their work, as one critic said, "part of the boundless freak show of technological optimism." Despite the darker visions that accompany these futuristic visions and their dubious claims to success, exploratory technologies from the 1970s and 1980s attracted many believers. By virtue of their impact on people's expectations for what tomorrow's technological future would hold, these visions also played a large role in shaping the public imagination and perhaps feeding today's all-too familiar cycle of anticipation, excitement, expectation, and disappointment.

This book focuses on the interconnected community of researchers, futurists, and businesspeople who worked at the border between scientific fact and fiction in the 1970s and 1980s. 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, a clearer understanding of how we view modern technological utopias emerges along with its connections to technological enthusiasm after 1970.

In year 4, research efforts were directed toward examining documents in established university and government archives (Stanford, NASA, et al.) as well as private collections in Silicon Valley and Princeton, New Jersey. Interviews were also conducted with people seen as important in promoting exploratory technologies in the 1970s and 1980s including nascent forms of nanotechnology.

IRG 1-5: CNS Postdoctoral Scholar Research: Exploring International Communities of Nano-Advocacy

Project Leader: Mikael Johansson

Mikael Johansson initiated his Postdoctoral position in January, 2009 and during the first quarter he has instigated interviews with nano advocates in the publishing sphere as well as with nano advocates in the scientific sphere. He has also started anthropological fieldwork among the UCSB nanoscientists with the purpose of conducting a comparative study, based on his previous work among nanoscientists in Sweden. Since joining CNS in January 2009, he has been getting acquainted with the Center as well as its people and research areas; he is also developing his plans and methodology for the research he will be doing in the coming months.

IRG 1: Publications and Presentations in 2008-09

1. **Hyungsub Choi** and **Cyrus C.M. Mody**. "The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology," forthcoming early 2009 in *Social Studies of Science*.
2. **Cyrus C.M. Mody**. "Instruments of Commerce and Knowledge: Probe Microscopy, 1980-2000," *Science and Engineering Workforce Project Proceedings*, edited by Richard Freeman and Daniel Goroff (U. Chicago Press), 2008.
3. **Hyungsub Choi**, Sarah Kaplan, **Cyrus C.M. Mody**, Jody Roberts. *Setting an Agenda for the Social Studies of Nanotechnology*, white paper on last year's Symposium on the Social Studies of Nanotechnology (Wharton School).
4. **Cyrus C.M. Mody**. "How I Learned to Stop Worrying and Love the Bomb, the Nuclear Reactor, the Computer, Ham Radio, and Recombinant DNA." *Historical Studies in the Natural Sciences*. 38.3 (2008).
5. **Cyrus C.M. Mody**. "Nano Pop." *Chemical Heritage* 25.4 (2007): 45.
6. **Cyrus C.M. Mody**. "Garden of Nanotech: A Role for the Social Sciences and Humanities in Nanotechnology," *Chemical Heritage* 25.3 (2007): 38-39.
7. **C.M. Mody**. 2008. "The Larger World of Nano." *Physics Today* 61.10: 38-44.
8. **Hyungsub Choi** & Chigusa Kita, "Hiroshi Wada: Pioneering Electronics and Computer Technologies in Postwar Japan," *IEEE Annals of the History of Computing* 30 (July - September 2008): 84-89.
9. **W. Patrick McCray**. "From Lab to iPod: A Story of Discovery and Commercialization in the Post-Cold War Era," *Technology and Culture*, 50, 1 (2009): 58-81.
10. **W. Patrick McCray**. "How Spintronics Went from the Lab to the iPod," *Nature Nanotechnology*, 4, 1 (2009): 1-3.
11. "Tomorrow's Innovation Policy Needs the Historical Dimension," (**Mody** and **McCray**), forthcoming for *Science Progress*, early 2009.

2008-09 Presentations

1. Ingram-Waters, Mary. "From Spaceflight to Foresight: Knowledge Production through Collective Action," Occasional Speaker Series, NSF Center for Nanotechnology and Society, Arizona State University. March 2008.
2. **Choi, Hyungsub.** "Contextualizing Technological Relationships: Early US-Japanese Semiconductor Industry in Transnational Perspective," Association for Asian Studies, Atlanta, GA, April 2008.
3. **Cyrus C.M. Mody.** "Some Early Historical Observations on the Commercialization of Nanotubes" (Washington, DC: US-France Young Engineering Scientists Symposium '08, July 8, 2008).
4. **Choi, Hyungsub.** "Technology Importation, Corporate Strategies, and the Emergence of the Japanese Semiconductor Industry," The 12th International Conference on the History of Science in East Asia, Johns Hopkins University, Baltimore, MD. July 14-18, 2008.
5. **Cyrus C.M. Mody.** "History of Nano: A Half-Century Arc" (Arlington, VA: NSF Nano in Society Pls Meeting; July 2008).
6. Gray, Summer. "Key Questions in STS (Science and Technology Studies)," CNS Seminar, UCSB. August 6, 2008.
7. Ingram, Mary & and Jerry Macala. "From Space Colonies to Nanobots: Exploring the Space-Nano Connections," Poster presented at the Gordon Conference on Science and Technology Policy, Big Sky Montana. August 2008.
8. **Cyrus C.M. Mody.** "The Long Arm of Moore's Law: The Microelectronics Industry and Nanotechnology" (Stockholm, Sweden: KTH Departments of Industrial Management and History of Science and Technology joint seminar, October 16, 2008).
9. **Cyrus C.M. Mody.** "Between Success and Scandal: Visionary Scientists and Molecular Electronics" (Göteborg, Sweden: Göteborg University Science and Technology Studies Section seminar, October 14, 2008).
10. **Cyrus C.M. Mody.** "Institutions as Stepping Stones: Rick Smalley and the Commercialization of Nanotubes" (Göteborg, Sweden: Chalmers Institute of Technology Nanoscience seminar, October 13, 2008).
11. **W. Patrick McCray.** "'My God! Its Full of Stars': Science, Computers, and the Coming Data Deluge," invited talk given at *Institut Méditerranéen de Recherches Avancées*, Marseille, France, November 2008.
12. **W. Patrick McCray.** "Of Fringes and Futures: California's Technological Enthusiasts, 1970-1990," paper presented at *Mind and Matter: Technology in California and the West*, Pasadena, March 2009.

IRG 2: Innovation Group

Chris Newfield , Leader	English/American Studies	UC Santa Barbara
Gerald Barnett	Technology Transfer	Univ of Washington
John Mohr	Sociology	UC Santa Barbara
David Mowery	Haas Business School	UC Berkeley
Suzanne Scotchmer	Public Policy and Economics	UC Berkeley

Affiliates

Ismael Rafols	Info & Science Policy	University of Sussex, UK
Stéphanie Lacour	Law	CNRS, France
Shayama V. Ramani	Economics	INRA & Ecole Polytechnique, Ivry, Paris

4 Grads, 2 Undergrads

<i>Graduate students:</i>	Social Science: Kasim Alimahomed, Communication
	Nano-Science: Gerald Macala, Chemistry
	GSR: Emily Thumpson-Molina, Sociology
	Adélaïde Chopard, Institut d'Etudes Politiques Grenoble
<i>Undergraduate students:</i>	Univ: Carlos Perez
	Community College: Beatrice Balfour

IRG 2 --Overview: In 2008, the overarching *goal* of this group continued to be to understand the impact of the current US innovation system on nanoscale research. We are working towards an integrated understanding of the social and cultural factors that affect scientific and technological innovation. Our distinctive emphases include development pathways of which intellectual property rights is one of various options, relationship-based (as a supplement to transaction-based) research communities, narrative accounts of nanoscale discovery and development that go beyond standard metrics such as patent and publication counts, and the social components of sustainable technological development. In addition, our group has been testing a multi-centered collaboration practice that we describe below.

Our 5-year general *strategy* is to offer unique perspectives in four ways: by integrating qualitative and quantitative methods; by linking the micro, meso, and macro-levels of this system; by comparing the US system to selected systems abroad; and by incorporating a fourth level that we call *innovation culture* into our analysis of the innovation system in the US. Our research brings insights about innovation from the humanities and social sciences into science practice; conversely, some of our publishing brings research on nanoscale innovation to humanities audiences that are generally out of reach of the NSF.

The social levels that we are integrating are as follows:

1. The *micro* level of nanoscale laboratories and their networks through surveys about the interdisciplinary and multi-institutional collaboration process.
2. The *meso* level at which scientific research conducted in a number of laboratories affects an industrial application area. Our case study is quantum dots (including nanocrystals and related structures oriented around quantum confinement), particularly as they are developed and adopted by the photovoltaic solar industry.

3. The *macro* level of technology transfer policy, as well as state and federal commercialization frameworks, where we pay particular attention to the university-industry interface and patenting practice.
4. The *cultural environment*, which influences the functioning and outcome of the institutions, financing, and protocols of scientific and technological innovation.

Our overall interest is to enhance nanoscale research culture that is scientifically effective, addresses social needs, and takes advantage of—rather than struggles against—the benefits of flexible group organization in a democratic society.

Summary of 2008-09. Our primary activities have been as follows: Mowery delivered, submitted, or published 9 papers on various aspects of research policy: the effects of patent continuations, mission-oriented federal agencies, legislative earmarking, and intellectual property rights. Scotchmer added research on “cap-and-trade” policies in the energy industry to her existing research on prizes as an alternative to IPR, and lectured in the US and Europe on the role of IP in alternative energy policy. Barnett interviewed technology transfer professionals on pathways through which quantum dots and other nanoscale technologies are being adopted by industry, and began to construct new research alliances in the Seattle area, implementing principles that he developed in talks and workshops during this period. Alimahomed supervised Balfour in creating a value-chain analysis of several solar energy companies, conducted quantum dot patent research, took a course in UCSB’s Materials department in order to deepen his understanding of the scientific side of solar photovoltaic development, and analyzed the collaboration survey data. Thompson-Molina joined the group and conducted research on professional identity theory and other aspects of collaboration theory in various domains. Macala completed work on the quantum dots patent analysis, and developed an application categorization scheme that identifies potential application areas in part through qualitative analysis. Mohr joined the group to take the lead on the design and implementation of the collaboration survey in its second, national round, 2009-2010. Newfield coordinated the group, developed new research partnerships in France, and Britain, conducted interviews in those countries on nano-enabled solar photovoltaic research, and delivered, submitted, or published 11 papers on the collaboration survey, technology transfer mechanisms, NNI-funded research uptake into product development, and on the group’s fourth “level”—on how recent cultural dynamics have affected the psychological and institutional capacity for nanoscale innovation in the United States.

Personnel Notes: Barnett stepped down as director of the Office of Management of Intellectual Property at UC Santa Cruz to found and direct the Research Technology Enterprise Initiative at University of Washington. He is currently funded by the Ewing Marion Kauffman Foundation. IRG leader Newfield began two years of full-time administrative duties for the University of California on July 1, 2008.

Our research streams are as follows:

IRG 2-1: On the micro level, we are investigating laboratory dynamics through our collaboration surveys. This year, we continued and completed the analysis and reporting of the data for our first round survey. The survey investigated three principal questions.

The first concerned the possible emergence of nanotechnology as a professional identity. We hypothesized that if nanotechnology is going to take off as a socially-recognizable category of

activity, a term like “nanotechnologist” would need to emerge as an understandable label for the researchers engaged in the relevant work. In our initial discussions and interviews, researchers preferred to use the names of established disciplines and to describe their specific area of research with the one or two disciplines in which they were trained and/or have regular contact. Thus we sought to test our first hypothesis, which was that “nanotechnology” currently functions less as a professional identity than as a term for a subset of specific research activities. In the first-round survey, this hypothesis was confirmed. It suggests that making nanotechnology into a public category will take time and, most likely, additional institutional strategizing.

Our second hypothesis addressed the question of whether nanotechnologists engage in higher levels of interdisciplinary collaboration than do other scientists. Nanotechnology has been repeatedly and systematically defined as a field that both consists of and enables interdisciplinary collaboration. We sought evidence that this was in fact the case, and our initial survey suggested that researchers that define themselves as involved in nanoscale research are indeed more inclined to collaborate across interdisciplinary lines.

Third, we were interested in testing claims that nanoscale research supports and enables collaboration of novel types across disciplinary lines. We made our first approach to this question by asking our subjects to characterize their attitudes towards collaboration across disciplines, and then comparing their responses to identical questions posed for collaboration within their own discipline. We found that attitudes towards interdisciplinary collaboration are not significantly more positive than attitudes towards collaboration within disciplines. At the same time, interdisciplinary collaboration is not seen as significantly more difficult. Though our subjects were receptive to interdisciplinary collaboration at the nanoscale, and could identify some limited benefits, we conclude on the basis of our first survey that nanotechnological research has not so far created compelling arguments or experiences that would increase or transform existing rates and types of scientific collaboration.

All three of these hypotheses require additional testing, and we are continuing our data analysis (led by Mohr and Alimahomed) in order to revise and extend such testing in the national survey we plan to run in 2009-2010.

IRG 2-2: On the meso level of the nanoscale innovation system, we have continued and completed our analysis that seeks research lineages in and commercial uptake of patents in quantum dots and nanocrystals.

Our objective in this study began with an interest in determining the scientific and commercial impacts of the obvious growth in nanotechnological publications and patenting over the past decade. It has become common to use aggregate growth in publication and patent rates as a measure of research and development progress, using patent office such as the USPTO’s 977 nanotechnology classification, keyword searches (e.g. “full text” and/or “title-claims”), and similar techniques. Our goal has been to understand how intellectual property rights (IPR) were affecting technological development at the nanoscale, and more specifically, the developmental pathways through which high-impact nano-enabled technologies were developing. What technology platforms were in formation in key areas—systems of materials, fabrications methods, standards, etc.--were in formation in key areas that could be used by multiple firms to develop specific products?

As previously reported, our research in 2007 found that the larger “nano” category contained too many diverse and even unrelated developments to be studied as an aggregate group. We then

moved to study a specific, high-impact area. We thus settled on quantum confinement because of its great scientific importance coupled with equally significant technological promise in medical and energy applications, among others. Quantum dots were one of the most important of the quantum structures that allowed the control of matter and its physical effects at the nanoscale.

We had reported that in November 2007 we entered a trial partnership with a noted data-mining expert (Alan Porter of Georgia Tech) to conduct a large-scale analysis of quantum dots, starting with publications. We entered a second partnership at the same time, with Ismael Rafols of the Science Policy Research Unit (SPRU) at the University of Sussex, who prepared a cluster analysis of a large set of quantum dot publications. In the spring of 2008 we reviewed the publication category breakdowns and the cluster maps with five nanoscale scientists who worked at three campuses of the University of California. The responses of the scientists were negative. They indicated that they did not find the quantitative growth in patents to tell them useful things about the development of a specific field of interest. They also stated that the categorized publication lists and the cluster maps did not reflect their understanding of the science domains--that in the absence of domain expertise the publication topic breakdowns and the cluster maps were "comparing apples and oranges."

This small-sample, focused contact between social scientists and scientists confirmed our existing concern that aggregate patent statistics were of limited use, and that concrete technological pathways could not be identified without qualitative interpretation, or by "reading the patents" as attorneys and patent consultants do. We concluded that accurate assessment of nanoscale technology pathways would require the combination of scalable quantitative methods and qualitative interpretation with the help of legal and scientific experts. We continued to attempt to use several standardized and commercial services, but these had similar problems: unwanted records that needed to be hand-scrubbed from the data set; a 50-60% overlap in the patent lists emerging from identical searches using different data mining software (this figure was validated by analogous results communicated by experienced dataminers in a meeting at SPRU in Sussex in February 2009), data that is not up-to-date; and opaque and/or proprietary search algorithms.

We thus decided to conduct our study by obtaining our data directly from the US Patent and Trademark Office (USPTO). This approach has various advantages: it is public data available at no cost to anyone; it is more up-to-date than commercial products (with at least one very costly exception); and the search methodology does not rely on any commercial intermediary with proprietary interests. Because of the USPTO website's limitations, we wrote a PHP script for downloading data, obtained close to 90% intact formatting, hand-cleaned the data, and organized quantum dot and, later, nanocrystal patents by subcategories (977-257, 438, 428, 117, 372, 385, 435, 252, 436, 250, 423, 359, 136, 365, 427, 430, 313). (Macala took the lead on this work.) We then reviewed our final set of 619 patents one at a time. We read our patent set from two directions: from the patents themselves, starting with the earliest, and from existing commercial firms holding quantum dot /nanocrystal patents. We identified developmental patterns and specific pathways in which patents were acquired for development and use. These findings will be integrated into our existing Google Earth quantum dot patent maps on the CNS website, but we have not had the resources to develop them this year.

This year's findings in this area are as follows. First, aggregate patent counts often mingle "apples and oranges" in ways that do not assist the study of specific technological pathways, even as such counts index activity and general interest. Second, attempts to move beyond

aggregate counts involve an interpretative stage that requires significant scientific expertise. These two findings have major implications for current approaches to measuring the effectiveness of the NNI and other technology development projects.

A third methodological finding—confirming studies in other scientific domains—is that a large gap exists between inventor-assignee patent information and product development: *licensing* information is almost completely unavailable unless voluntarily (and usually strategically) disclosed by a firm, and we have found major discrepancies between IP information provided in a partial and often strategic way by firms on the one hand, and public patent data on the other.

A further finding, pertaining to the content of the quantum dot and nanocrystal patents, is that this field has been in development for nearly fifty years (and in solar applications for over thirty); advancements are steady but without obvious recent accelerators. In addition, we have been able to find only one clear product-oriented patent portfolio, which is now being litigated (eBioscience Corp v. Invitrogen, Quantum Dots Corporation and Molecular Probes, case 3:2008cv01729, California Southern Federal District Court; this is Invitrogen's 9th distinct formal involvement in IP litigation since 2005). We have reason for preliminary concern that handful of companies involved in the US development of quantum dots for biological tagging are involved in suing each other, and we will monitor this situation. In our area of dominant application interest, solar photovoltaic applications of quantum confinement, the field has not yet converged around dominant processes, materials, and usages in products.

The larger issue that we will pursue is how to improve on existing abilities to track intellectual property from the patent through its use in a commercial product. A final methodological finding is that neither the USPTO nor federal granting agencies maintain data on the federal funding sources of issued patents (as “subject inventions” under Title 37 of the Code of Federal Regulations) or on the licensing of patents for product development. The Association of University Technology Managers (AUTM) maintains a Statistics Access to Tech Transfer (STATT) Database, but it also lacks this information. Based on this year's research, we will prepare a report that recommends and describes a federal repository of research outcomes--discoveries, patents, licenses, products with commercial sale or use. Better records of technology will improve the country's understanding of the research process, and enable accessible narratives of technology development stories that would increase public interest and support.

In February of 2009, Newfield initiated a new partnership with Martin Meyer and Ismael Rafols of SPRU at Sussex for the analysis of nanoscale patents, starting with our existing quantum dot database. Rafols will be spending part of each year with datamining expert Alan Porter at Georgia Tech—an associate of our sister CNS at ASU. We expect this research to accelerate this year and next.

IRG 2-3: The *macro level--technology transfer policy*. Since the passage of the Bayh-Dole Act and related legislation starting in 1980, US technology transfer from university to industrial contexts has been governed by the wish to support “use-directed” basic research via intellectual property rights. The combination is assumed to be socially beneficial. In recent years, economists have produced more mixed opinions as to the effects of IPR, focusing on such issues as the heterogeneity of the quality, the cost, and the scarcity of ideas, and on conflicts between private and social optimality (Scotchmer has been a leading voice in these areas). Parallel concerns have arisen about the institutional systems through which inventions and IP are transmitted and developed (Mowery as a scholar and Barnett as a practitioner have played

exemplary roles). This year, we continued our investigations of the optimality of IPR and tech transfer institutions by breaking the overall issue down into smaller, testable pieces.

A portion of Mowery's CNS-funded research focused on patenting as a business strategy, and found that post-1995 patent continuation filings could be correlated with lower-quality patents (defined as a lower number of forward citations). This work established an important baseline for our reading of quantum dots /nanocrystal patents. Another paper pointed out the limits of mission-oriented funding agencies and the importance of procurement; the implication here is that the impact of the National Nanotechnology Initiative may be limited in the absence of major federal commitments to procure the civilian applications of NNI-funded research. On a related matter, Mowery's research as published in *Science* shows that legislative processes do not in themselves damage peer review, thus confirming that funding targeted at particular uses or solutions need not degrade mechanisms that protect the quality of the funded science.

Scotchmer's presentations extended her work on the impact of the scarcity of ideas of IP effectiveness to patents in the area of renewable energy. This research suggests that areas in which science progress is especially slow or difficult require more generous standards for nonobviousness. Some commentators have complained that examiners at the USPTO have lowered their thresholds for the granting of patents in nanotechnology. But the science in areas such as quantum confinement has been slow and difficult, and thus Scotchmer's research suggests that greater flexibility in the granting of nanoscale patents may not simply increase the likelihood of hold-up behaviors, but may in fact accelerate innovation.

Technology transfer depends in large part on the activities of licensing professionals, and this year Barnett identified and interviewed members of two key groups: licensing officers (LOs) at universities with significant nanoscale funding, and coordinators of NNI-funded research centers. He asked his subjects about the progress of nanoscience into applications, general levels of industry and venture funding, and perceptions of whether nanoscale research requires new structures and procedures for technology transfer. So far Barnett has found that LOs do not believe that the tech transfer system needs to be changed specifically for nanoscale research, though they have a range of ideas for reform in general. He has sparked interest in his suggestions that technology development in key areas such as nano-enabled alternative energy needs to shift from an IP-based transfer approach to one that creates use-oriented research communities, communities that are open to variable strategies— non-exclusive licensing, the waiving of IP rights, commons development, and the voicing of public needs.

In addition to multiple project coordination duties, Newfield conducted three interlocking studies in the domain of nano-enabled solar photovoltaic R&D. He sought information on NNI-sourced grants that have funded research leading to invention disclosures, patenting, and industrial development. In a related project, he developed a list of approximately 150 solar energy companies, identified those that focus on “post-silicon” (variously nano-enabled) technologies, and developed a news tracking system for industry developments. Starting in 2009, he began a series of interviews with academic PV researchers in Britain and France (11 in the first round), including members of the UK EPSRC's “Supergen Excitonic Solar Cell Consortium.” The selection has a particular focus on researchers with industry ties.

The NNI R&D trail has been surprisingly difficult to reconstruct, and these difficulties have reinforced the recommendation for a repository noted in #2 above. They have also led to our increased reliance on the ongoing interview results. The main findings from this group of studies of nano-enabled solar R&D are that (1) a consensus has not yet emerged about which

technology pathways are the most promising (materials, e.g. conducting polymers vs. CIGS vs. nitride system compounds); or techniques of performance enhancement (spectrum splitting, cell stacking, multiple energy thresholds, multiple electron hole pairs, etc.); (2) large firms, firms which are best positioned to sustain and expand investments during the current financial crisis, are generally *not* pursuing nano-enabled emerging PV technologies; and therefore (3) governments need to expand direct funding for nano-scale R&D. We will recommend that stimulus funds should be used for this purpose during this critical time, when the Obama administration presents an opportunity for upgraded federal research policies that support large, high-social-value projects with the potential for creating popular constituencies, jobs, and major impacts in transport, electricity, and energy efficiency, among many others.

In late 2008 and early 2009, Newfield began to expand this project into the European Union. In addition to the UK activities already mentioned, he began an association with Stéphanie Lacour, a legal academic posted with France's CNRS unit in Ivry-sur-Seine and the leader of a unit studying IP standards in emerging technologies ("Normativités et nouvelles technologies"). We are initiating a comparative study of IP regimes in the US, France, Germany, and the UK, extending the case-study method we have been developing in the group. A parallel collaboration is underway with Dr. Shyama V. Ramani of the Department of Economics, INRA & Ecole Polytechnique outside of Paris. Ramani is a specialist in innovation economics with experience on feasibility studies of low-cost technologies for everyday needs, including important work on the diffusion of toilets in the Indian countryside. She will work with Newfield and Chopard on models of low-cost solar PV diffusion.

IRG 2-4: Cultures of innovation. Publication in this area (particularly Newfield's book-length study, *Unmaking the Public University*, Harvard University Press, 2008), is technically outside of the scope of this NSF grant, but nanoscale R&D does not escape the scope of American innovation culture, which is often regarded as the world leader but which has undergone serious critiques in recent years (e.g. the National Academies' publication "Rising Above the Gathering Storm" (2005, 2008)). For research developments to have a major social and economic impact, innovation needs to exist not only in the laboratories, campuses, firms and communities directly or indirectly involved with the R&D, but also in the everyday cultural practices and expectations of the society at large. Newfield published a book in 2008 that demonstrated how battles about culture, science, and research budgets were designed to separate economically valuable technology development from a broader, democratic innovation culture, to the detriment of democracy and technology alike. This work dovetails with the research of innovation scholars who have shown the impact of lead-users on a firm's internal innovation processes (e.g. Von Hippel). Historians of science have shown that the majority of a given technology's transformative impact occurs far downstream, in the hands of its widely dispersed "ordinary" users who innovate continuously (e.g. David Edgerton in the *Shock of the Old* – reviewed by Newfield at <http://centernanosociety.blogspot.com/2008/01/shock-of-old-review.html>). In the case of solar energy, sociologists of innovation such as Fred Block and Matthew Keller have shown that the uptake of nano-enabled technological developments will require the coordination of multiple governments with a mind-boggling range of local non-governmental actors who can come together productively only if enabling forms of cultural expectations are in place. The research of the Innovation Group also aims at making concrete suggestions for enhancing a culture in which innovation is natural, widespread, sustainable, and pleasurable.

Finally, it is worth pointing out that many of Newfield's publications are in part geared toward disseminating the results of NSF research to non-NSF communities in the human sciences, in

order to improve communication across the “two cultures” divide that limits the broader impacts of the sciences and humanities alike.

IRG 2: Publications and Presentations in 2008-09

- 1) Hegde, Deepak, and **Mowery, David C.** (2008). “Politics and Funding in the U.S. Public Biomedical R&D System” *Science* 322 (5909) 1797-1798.
- 2) **Mowery, David C.**, “Notes on IPR and US economic ‘catchup’,” presented at the Graduate Institute for Policy Studies conference on “Intellectual Property Rights and Economic ‘Catchup,’” Tokyo, Japan, November 16-17, 2008 (forthcoming in conference proceedings to be published by Oxford University Press, 2009).
- 3) **Mowery, David C.**, “National Security and National Innovation Systems,” *Journal of Technology Transfer* (under review).
- 4) **Mowery, David C.**, “What Does Economic Theory tell us about Mission-Oriented R&D?” forthcoming in D. Foray, ed., *The New Economics of Technology Policy* (Edward Elgar) (under review).
- 5) **Mowery, David C.**, “*Plus ça change*: Industrial R&D in the ‘Third Industrial Revolution’,” *Industrial and Corporate Change* (forthcoming).
- 6) **Newfield, Christopher**, “Is the Corporation a Social Partner? The Case of Nanotechnology,” in *Cultural Critique and the Global Corporation*, ed. Purnima Bose and Laura E. Lyons (Indiana University Press, forthcoming 2009).
- 7) **Newfield, Christopher**, “Fixing the Developmental University: the Case of the National Nanotechnology Initiative,” in Fred Block and Matt Keller, *State of Innovation: U.S. Federal Technology Policies, 1969-2008* (under review).
- 8) **Mowery, David C.**, “Alfred Chandler and knowledge management within the firm,” *Industrial and Corporate Change* (under review).
- 9) **Mowery, David C.**, “Pioneering Inventors or Thicket-Builders: Which U.S. Firms use Continuations in Patenting?” (with D. Hegde and S.J. Graham), *Management Science* (forthcoming).
- 10) **Newfield, Christopher**, “Why Public is Losing to Private in American Research,” *Polygraph* 21 (forthcoming 2009).
- 11) **Newfield, Christopher** (with Kasim Alimahomed, Jerry Macala, and Kim Stoltzfus), “Is Nanotechnology Changing Scientific Collaboration? Survey Evidence from a Nano-intensive Campus,” *Nature Nanotechnology* (under review 2009).
- 12) **Mowery, David C.**, “Innovation, Path-Dependency, and Policy: The Evolution of Norway’s National Innovation System” (with J. Fagerberg and B. Verspagen), *Science and Public Policy* (under review 2008).

Presentations:

- 1) **Barnett, Gerald**, “Model Agreements as Interventions,” 2008 ASEE ERC Workshop Washington DC, March 2008
- 2) **Newfield, Christopher**. “Budgetary Trends at the University of California” (Problems for Basic Research), Meeting of the Council of Chancellors, the University of California. March 2008.
- 3) **Scotchmer, Suzanne**, “What we Don’t Know about Entrepreneurship,” IP and Entrepreneurship Symposium, Boalt School of Law. March 2008.
- 4) **Mowery, David C.** “What don’t we know about university-industry technology transfer and does it matter? University-Industry Relationships” at the Franco-Norwegian Center for Research Cooperation, Paris. March 24, 2008.

- 5) **Mowery, David C.** "The Geographic Reach of Market and Nonmarket Channels of University Research Commercialization" (with A. Ziedonis), presented at the Conference on Corporate Strategy, Fuqua School of Business, Duke University. April 4 -5, 2008.
- 6) **Newfield, Christopher**, "The Problem with Privatization," Philosophy Department, University of North Texas. April 2008.
- 7) Macala, Jerry, "From Lab to Society: NanoTech Transfer of Quantum Dots". Poster presented at the Center for Nanotechnology in Society NSF site visit, UCSB, April 2008.
- 8) **Newfield, Christopher**, "The Problem with Privatization," Philosophy Department, University of North Texas April 2008
- 9) **Scotchmer, Suzanne**, "Picking Winners in Rounds of Elimination," "Inventing a Cleaner Future, Climate Change the Opportunities for IP," European Patent Forum, Slovenia, May 2008.
- 10) **Newfield, Christopher**. "Budgetary Trends at the University of California" (Problems for Basic Research), Meeting of The Regents of the University of California. May 2008.
- 11) Macala, Gerald S. & Alimahomed, K. (Carlos Perez & **Christopher J. Newfield**). "From Lab to Society: NanoTech Transfer of Quantum Dots." Poster presented at the Inauguration of spatial@ucsb, Perspectives for Teaching and Research. May 29, 2008. Corwin Pavilion, University Center, University of California, Santa Barbara.
- 12) **Newfield, Christopher**, "DARPA's Impact on Photovoltaic Research," Conference on Tracking the Hidden Developmental State, Institute for International Studies, UC Berkeley, June 2008
- 13) **Scotchmer, Suzanne**, "Picking Winners in Rounds of Elimination," Kauffman Summer Legal Institute at Dana Point, July 10-13, 2008.
- 14) Alimahomed, K. (Gerald S. Macala, Kimberly A. Stoltzfus, & **Christopher J. Newfield**). "Innovation and Collaboration in the Nanoscale Research Laboratory." Poster presented at the Gordon Research Conference on Science and Technology Policy. August 17th-22nd, 2008. Big Sky, MT.
- 15) Mary Ingram-Waters and Macala, Jerry, "From Space Colonies to Nanobots: Exploring the Space-Nano Connections". Poster presented at the Gordon Conference on Science & Technology Policy, Big Sky MT, August 2008.
- 16) **Scotchmer, Suzanne**, "Innovation Policy," Helsinki Center for Economic Research, August 2008.
- 17) **Newfield, Christopher**, "Accelerating the Crisis: The American University Abroad," Amerian Studies Association Convention, Albuquerque, NM, October 2008.
- 18) **Newfield, Christopher**, "Can Industry Funding Save Research: Comparing the United States and France," Université de l'Automne de Sauvons la Recherche, Conseil régional de Midi-Pyrénées, Toulouse, October 2008.
- 19) **Newfield, Christopher**, "Studying Innovation Networks: Internet is Better as Form than Function," Institut Méditerranéen de Recherches Avancées, Marseille, France, November 2008
- 20) **Newfield, Christopher**, "Ending the Budget Wars: Funding the Humanities during a Crisis in Higher Education," Modern Languages Association, San Francisco, December 2008.
- 21) Alimahomed, K. "The Commercialization of Organic Solar Cells." Presentation for Materials Science 287B, Seminar in Organic Semiconductors, Dr. Gui Bazan, December 5, 2008.
- 22) **Newfield, Christopher**, "The Obama Administration and the Knowledge Economy," University of Paris 10 – Nanterre, January 2009.
- 23) **Mowery, David C.** "University-industry collaboration and technology transfer in Hong Kong and knowledge-based economic growth," Savantas Policy Institute conference, Hong Kong, January 2009.

- 24) **Barnett, Gerald**, Information Asset Management for Technology Transfer, Workshop Designer and Leader, Portland, OR, February 1-2, 2009.
- 25) **Barnett, Gerald**, Panelist, Beyond Open Source, 2009 AUTM National Meeting Orlando, FL, February 14, 2009.
- 26) **Barnett, Gerald**, Fueling the Knowledge Economy: Innovative IP Management and Licensing Models for Universities, Panelist, 2009 AUTM National Meeting Orlando, FL, February 13, 2009.
- 27) Macala, Gerald S. & Alimahomed, K. "Nanotechnology and Society." Presentation made on "The Science Guys" radio show, KCSB 91.9 FM in Santa Barbara, March 12, 2009, 8am.

IRG 3: Multiple Party Risk Perception and Nano in the Public Sphere

B. Herr Harthorn , Leader	Anthropology	UC Santa Barbara
B. Bimber	Political Science	UC Santa Barbara
N. Pidgeon	Social Psychology	Cardiff University, UK
T. Satterfield	Anthropology	University of British Columbia, CA
M. Kandlikar	Science policy &	University of British Columbia, CA
J. Mohr	Sociology	UC Santa Barbara

Affiliates

F. Bray	Anthropology	Edinburgh University, UK
K. Bryant	Sociology	SUNY New Paltz
J. Conti	Sociology, Law	American Bar Foundation
W. Freudenburg	Sociology	UC Santa Barbara
E. Gwinn	Physics	UC Santa Barbara
H. Haldane	Anthropology	Quinnipiac University
T. Holden	Microbiology	UC Santa Barbara
T. Rogers-Hayden	Environmental risk	University of East Anglia, UK
S. Stonich	Anthropology	UC Santa Barbara
J. Summers	Physics, Engineering	Mount Holyoke

2 [3] Postdocs, 8 Grads, and 3 Undergrads

Post-doctoral researchers: Philip McCarty (to Sept 08), [co-funded: Jennifer Rogers (beginning Nov 08)]

Graduate students: International: Adam Corner (Sept 08; Cardiff UK)
Social science: Meredith Conroy, Poli Sci (as of Sept 08),
Joe Conti, Sociology (to Aug 08)
Indy Hurt, Geography (beg Sept 08)
David Weaver, Poli Sci (to Aug 08)
Nanoscience: Alexis Ostrowski, Chemistry (to Sept 08)
Tyronne Martin, Chemistry
Erica Lively, Electrical Engineering
International: Christian Beaudrie (UBC Doctoral student)

Undergraduate students: UCSB: Dayna Meyer, Christian McCusker
Community college: Brian Billones

The IRG-3 risk perception group aims to use mixed qualitative and quantitative methods to study the views and beliefs about emerging nanotechnologies by multiple parties, by which we mean people in numerous social locations and positions—nanoscale scientists and engineers, nano risk assessment experts, regulators, industry, NGOs or other social action and special interest groups, and members of the public who differ by gender, race/ethnicity, class, occupation, education, and age, as well as nation. In the past year, researchers in this group in IRG-3 performed work in the main areas detailed below.

The Nano in the Public Sphere team in IRG-3 aims at understanding the processes by which nanotechnologies come to be recognized by the public as an object of politics and societal relevance, with a focus on processes of framing and agenda-building. In the first two and half years, this group focused on how the media, NGO's, and government institutions frame ideas about nano. In the last year, this group found the most promising research opportunities to lie in

analysis of the media, and so re-prioritized to de-emphasize work on government institutions and NGOs.

Members of this team use several approaches to collecting and analyzing evidence about nano in the public sphere. These involve: a) identifying public communication about nano by news media over time; coding the content of this communication by hand and via automated text-reading algorithms; conducting statistical tests and cluster analyses to identify narrative approaches, frames, and extent of attention to nano; and preparing a survey to examine how various frames affect measurable attitudes in citizens.

IRG 3-1: Risk Perception. Expert Judgments about Nanotechnologies' Benefits and Risks
Harthorn, Satterfield, Kandlikar, (leaders); Beaudrie, Bryant, Conti, Haldane, Holden, Martin, Ostrowski, Pidgeon, Summers.

IRG 3-1a: *Nanoscale scientists and engineers*

In 2008-09, the UCSB team has continued analysis and write up of 90-minute expert interviews conducted in California in 2006-07 and initially presented in 07-08. A paper summarizing these results is in preparation to submit for publication (Harthorn, Bryant & Haldane, in prep). We have completed extensive preliminary analysis of the US interviews using NVivo, focusing on cross-disciplinary comparisons, conceptualization of the nano scientific and technological fields, and possible expert attenuation effects. We have done a preliminary analysis of the Canadian data looking primarily at nano risk object characteristics. There seem to be several different forms of expert risk attenuation in evidence, and although the upstream context and scientific uncertainty of near-term hazards make assessment complex, it is also potentially crucial as an interaction in any process of 'responsible development' of nanotechnologies. Over the same period, the UBC team completed several more interviews, transcription, and analysis, and is using these results (and the US comparative results) in development of a new survey instrument for use in a planned web survey of NSE and nanotoxicology experts. The surveys will allow interaction with a much larger pool of respondents, validation of more in-depth interview findings, and ability to compare with our public survey results.

IRG 3-1b: *Nanotoxicologists*

We are also conducting a similar study, using a modified protocol, with experts whose work focuses on possible toxicities and ecological impacts of nano materials. Building on preliminary interviews in California, we anticipate completing another 10-15 researcher interviews, focusing on the West Coast and the Upper East by mid-2008. With the new UC CEIN project, we anticipate a number of synergistic activities and extending this work to better understand disciplinary and other differences among the emergent risk assessment community and their counterparts in basic and applied NSE. This work builds on the foundational work of Satterfield's collaborator, Paul Slovic, on comparative toxicological assumptions of experts and lay persons.

In conjunction with our nanotoxicologist research, and to help address ongoing public and other requests for summary data on nanotoxicology, chemists Ostrowski and Martin, with sociologist Conti and geographer Hurt, have assisted in this work, co-authoring a publication that is a background literature review for the study. We presented a poster (Conti, Ostrowski, Martin, & Harthorn) at the Gordon Conference on Science and Technology Policy at Big Sky, Montana in Aug 2008.

The on-campus group meets weekly; the international team confers weekly by e-mail and every few weeks by teleconference. Face-to-face group meetings were held quarterly over the 2008-

09 year. The West Coast location of the principals and co-involvement on other IRG-3 projects facilitate more regular contact.

IRG 3-1c: Regulators

A third component of the expert study has been in development over the past year. In 2009, law and society scholar Joe Conti (Postdoc Fellow, American Bar Foundation) will initiate a series of interviews with US regulators to explore their comparative interagency views. His prior work with IRG3 as a key collaborator on the public survey research has attuned him to the protocols and risk perception issues of interest, and his unique background as an expert on international governance provides particular strength. He will be joining the faculty of the University of Wisconsin-Madison in Fall 2009 in their top ranked Sociology department.

Co-funding: The main UC CEIN funding will allow us to extend our research on nanotoxicologists, nanotoxicology, and public response to the EHS issues, and to add to the team the expertise of UCSB environmental sociology and risk perception scholar, William Freudenburg.

We presented this work at the World Risk Congress in June 2008 (Conti & Holden), and at the Gordon Conference in Aug 2008 (Conti, Ostrowski, Martin & Harthorn). Publications include Conti et al. 2008; Jae-Young, C. Ramachandra, G, Kandlikar, M. 2009. ; Ostrowski et al. 2009.

IRG 3-2: Risk Perception. Public Participation in Nanotechnology R&D: Deliberation Research (Harthorn, Pidgeon, Bryant, Rogers-Hayden, Satterfield, Rogers, Hurt, Martin)

The first set of CNS-UCSB comparative deliberations in California and the UK were completed in 2007, and extensive data analysis in NVivo was conducted over the remainder of the year and into 2008. In 2008, we prepared the first publication, submitted it in April to *Nature Nanotechnology*, which accepted it in Sept and published it on-line in early December. An additional 3 papers are far along in preparation. The key analyses have focused on: a) the cross-national US-UK comparison, particularly in light of the extensive history of public analytic-deliberative efforts in the UK and lack of comparable history in the US; b) the health and energy cross-application comparison, where we found striking differences in views; c) a cross-health group comparison focused on gender (and race) effects as a means of addressing the importance of participant characteristics in driving discussion and debate; and d) methodological implications for effective public deliberation in the US. Our analyses have found subtle cross-national differences in risk perceptions and technological determinism but profound differences by public participants in both nations regarding the acceptability of different applications, with energy applications universally seen as urgent and necessary regardless of social, health, or environmental risks, and medical and enhancement applications regarded with greater ambivalence. This research also provides evidence that factors such as recruitment methods and group sociodemographic composition, past experience with deliberative forums, facilitator effects, issue framing, and visual representations of technologies affect elicited views. These findings have a number of direct implications for public participation mechanisms and science policy in the US and abroad. We expect to conclude paper preparation from this work in summer 2009.

Co-Funding*: To extend this work and follow the very suggestive gender differences that emerged within all the groups, Harthorn and Bryant applied for a new award from NSF in Feb 2008 to fund new research that could explore these phenomena more systematically (see

below). Combining work on gender and risk perception with research on women in science and public attitudes to science and technology, the new study, funded in Aug 2008, will look at gender as a between group variable as we conduct 6 more comparative workshops in the US in 2009. Postdoctoral scholar feminist sociologist Jennifer Rogers joined this project in January 2009. The project will use a modified version of the same protocol and very similar approach for a set of 6 deliberative workshops in California in Sept-Oct 2009, focused again on health and energy applications, and varying group composition by gender (a 2x3 design with all women, all men, and mixed gender groups). Karl Bryant is an unfunded collaborator on this project. A 7th pilot workshop is planned for summer 2009 by Rogers, Hurt, and Martin to explore effects of use of electronic polling devices in small group deliberation.

The group confers every few weeks by teleconference, and we've met three times in the past year, twice in 2008 (in Guadalajara, Mexico in June 2008 at the World Risk Congress, and some of us in San Francisco in October 2008) and once in January 2009 for the CNS Research Summit.

We presented 2 papers (Pidgeon; Harthorn, Rogers-Hayden, Pidgeon, & Bryant) at a panel on nanotechnology risk perception co-chaired by Harthorn and Pidgeon and at the World Risk Congress in Guadalajara in June 2008. Harthorn and Bryant and Satterfield presented papers on the gendered processes in risk perception in a panel chaired by Harthorn at the American Anthropological Assoc. meetings in Nov 2008. Pidgeon and Harthorn presented findings in a nanotechnology panel at the Society for Risk Analysis in Dec 2008. Publications include Pidgeon 2008; Rogers-Hayden & Pidgeon 2008; Pidgeon et al. 2009.

IRG 3-3: Risk Perception. Emergent Public Perceptions of Benefits and Risks (national survey) (Satterfield, Pidgeon, Conti, Harthorn, Kandlikar, Hurt, Beaudrie)

We developed and put in the field Jun-Aug 2008 a new national US survey of public perceptions of nanotech benefits and risks. The phone survey had a representative sample of 1100 with no oversamples. The instrument we developed and piloted included a number of experimental components using vignettes and brief narratives to examine the differential effects of provision of risk vs. benefit information in resultant risk judgments, and was designed to explore the effects of a number of theorized factors on risk (attitudinal variables re: science, worldviews & social vulnerability; sociodemographic variables--race & gender, religion, political orientation, cultural orientation; scales on vulnerability, stigma, trust; and more). We received the dataset from the survey in early Sept 2008, and have been in active data analysis since then. At our Jan 2009 Research Summit we extensively discussed the preliminary results, additional analyses to be conducted, and the main papers to be prepared initially. Unlike public opinion surveys on nano, this research is better characterized as experimental risk perception research that explores systematically the interactions of attributes of perceivers, several sets of factors (on trust, affect, vulnerability, attitudes toward science), and contextual variables such as application domain (health, energy, food, etc), on nano risk and benefit judgments. Initial results from the survey indicate a robust set of findings that will add to the growing literature refining public attitudes and perception of risk in response to particular frames and conditions.

As a part of this work and to ensure the distinctiveness and comparative merit of our own work, Satterfield and her UBC team have conducted a meta-analysis of survey research to date on nanotech attitudes and risk perception. This work is currently under review at *Nature Nanotechnology*.

The group presented one paper at the World Risk Congress in Jun 2008 in Harthorn & Pidgeon's session (Satterfield, Kandlikar, & Beaudrie). Harthorn presented some key findings from the metaanalysis and survey on perceived benefit and trust at her presentation to the US Congressional Nanotechnology Caucus on Mar 9, 2009, and Pidgeon presented a lengthier set of findings to the UK House of Lords in expert testimony on March 24, 2009. A series of publications are planned for 2009 to a range of risk analysis, STS, and environmental risk, and NSE journals.

IRG 3-4: Nano and the Media Agenda (Bimber, Weaver)

In this work we examine attention to societal implications of nano in global English language news media. Our research questions combine descriptive and methodological concerns. First, we ask: what developments or events drive news coverage of societal implications of nanotechnologies? Second, we ask: how does the answer to this question vary depending on the index used to gauge level of attention to nano by journalists. Our expectations from theory are that actions associated with public officials would dominate news coverage, especially in the case of conflict among officials, while actions and events without involvement of public officials would be relatively less significant in news coverage. Our method was to develop Boolean search constructs including about two dozen societal implications terms and several nano-related terms, and then to employ the customary academic source for news data, the Lexis-Nexis news database, with a novel and academically untested source, Google News. Using these we collected about three thousand news stories from 2006 to the present. Our results show no net increase in attention to nano issues in the two year period beginning in 2006, and distinctly episodic coverage associated with actions involving government agencies (FDA, EPA, City of Berkeley), and release of expert reports. Comparison of the two databases reveals substantial differences in results that are accounted for chiefly by news wire services and syndicated news stories, which comprise a significant fraction of news coverage of nano so far. The discovery of substantial differences in search results for Google News and LexisNexis was itself significant and resulted in a methodological publication (Weaver and Bimber 2008).

We also conducted a preliminary analysis of issue framing in these data, testing for the presence of clustering among via our search terms, which would suggest the development of specific frames and narrative approaches to news about nano issues, such as a focus on environmental issues, health risks, threats from self-replication or technologies associated with surveillance, and the intersection of these with discussion of public policy, regulation and the like. Cluster analysis techniques on hand-coded news stories showed no significant clustering of terms or discernable focus in news coverage.

IRG 3-5: Nano and NGO's Online. (Bimber, Ackland, O'Neill)

In this study we partnered with Australian National University (ANU)'s Virtual Observatory for the Study of Online Networks (VOSON), in order to develop a map of web links among environmental organizations with a potential interest in nanotechnologies. Most of this work was conducted in 2005 and 2006, using webcrawling and network-analysis tools to identify online networks engaged in discussions or political action regarding nanotechnology, and to identify the structure, location, and interlinkages among non-profit, ngo groups engaged with nanotechnology issues. This work has been helpful in producing a schematic understanding of activist networks, and produced several papers and presentations, as well as an article manuscript, which we reported in the previous CNS annual report. In 2007, this work effort was largely in hiatus. Papers from this project did not result in publications and we suspended the project in 2008. This project will be reinvented and sent in a new direction in the renewal.

IRG 3-6: Variation in the Framing of Nano. (Bimber, Mohr, McCarty, Weaver, Lively)

Following the preliminary analysis of framing in IRG 3-4 above, we recruited Mohr and McCarty to join CNS and bring their expertise in frame analysis to our efforts in IRG-3: Nano in the Public Sphere group, with a view toward expanding the framing analysis to the work of other projects at CNS. Our research questions include the following: What major narrative frames now exist for describing societal implications of nanotechnology by the media? How have frames changed over time, and why? We have produced an article manuscript now under review (Weaver, Lively & Bimber 2009).

We also conducted an analysis of framing by government institutions, using automated content analysis techniques developed by Phil McCarty. We tested whether particular frames for discussing nano are discernable between the NNI and regulatory agencies. To identify the presence of these frames in various messages, our method involves collecting primary documents from the institutions and organizations of interest, and then subjecting these to two approaches to analysis. We have begun with every US government report dealing chiefly with societal implications of nanotechnology since 2000, subdivided into regulatory agencies and others (prominently the NNI), along with news coverage in the ten-largest circulation newspapers during the same period. We then employed automated full-text searching of our entire population of documents, along with multi-dimensional scaling analysis to identify frames via clustering of terms (McCarty et al. 2008). A significant challenge we have set for ourselves is to connect our traditional, hand-coding of documents with the automated analysis, and to report a reliability score comparing the automated analysis with two human coders. This effort is in progress at the time of this report, and will hopefully produce reportable findings on methodological grounds. This effort is being led by John Mohr.

IRG 3-7: Framing Theory. (Bimber, Mohr, McCarty, Weaver, Lively, Conroy)

Studying nanotechnology in the public sphere provides an unusual opportunity to observe the political system responding to a novel or apparently novel issue. Most important from our perspective is the hypothesis that no dominant frames and categories advanced by media have yet shaped how the public thinks about nano. This provides a useful opportunity to examine some theoretical questions regarding how people thinking about novel political objects, and how their thinking is shaped by framing. We have developed a theoretical framework combining research in psychology on cognitive biases with theories of framing in political science and communication. Our theory involves “anchoring effects,” which are a well-known phenomenon by which an arbitrarily given number affects a recipient’s judgment in a later quantitative task. We extrapolate to judgments about risk comparisons not involving explicit quantitative judgments, and we suspect that apparently innocuous comparisons between nano and other technological products many produce an anchoring effect in the ways that people judge nano, and well as reason among other comparisons of public issues. We are presently planning quasi-experimental research to test our theory. We plan a pilot in 2009, to be followed by a full study in 2010.

Co-funding:

Leverage:

1) Harthorn (NSF SES-0824042), “Deliberating Nanotechnologies in the US: Gendered Beliefs about Benefits and Risks as Factors in Emerging Public Perception and Participation,” 2008-2010.. Rogers is postdoc researcher; predoc fellow tbd.

2) Nel, Andre et al. (NSF), “UC Center for Environmental Implications of Nanotechnology,” Harthorn is IRG 7 (“Environmental Risk Perception and Communication) leader and member UC CEIN Research Executive Committee, 2008-2013; Satterfield, Pidgeon, Freudenburg, and Kandlikar, are IRG 7 senior personnel. The IRG 7 funding in the UC CEIN will provide funds for new survey research on nano environmental risk perception, so we are using public survey results from CNS IRG 3 to begin planning that first survey, to be conducted in late 2009/early 2010.

3) Pidgeon, et al. (Leverhulme; ESRC—pending)

4) Kandlikar et al., pending proposal for co-funding: University of California Office of the President (UCOP) and ISTP Canada have completed the eligibility assessment of all LOI submissions to the CCSIP Call for Proposals, and our initial submission has passed first stage review.

IRG 3: Publications and Presentations in 2008-09

- 1) Conti, Joseph A. Keith Killpack, Gina Gerritzen, Leia Huang, Maria Mircheva, **Magali Delmas**, **Barbara Herr Harthorn**, **Richard P. Appelbaum**, and **Patricia A. Holden**. 2008. “Health and Safety Practices in the Nanotechnology Workplace: Results from an International Survey.” *Environmental Science & Technology*. 42(9): 3155-3162.
- 2) **Pidgeon, N.F.** (2008) Risk, uncertainty and social controversy: from risk perception and communication to public engagement. In G. Bammer and M. Smithson (Eds.). *Uncertainty and Risk: Multidisciplinary Perspectives*. London, Earthscan, pp. 349-361.
- 3) **Rogers-Hayden, T.** and **Pidgeon, N.F.** (2008) Developments in nanotechnology public engagement in the UK: ‘upstream’ towards sustainability? *Journal of Cleaner Production*, 16, 1010-1013
- 4) **Rogers-Hayden, T.** and **Pidgeon, N.F.** (2008) Upstream engagement. *Science and Public Affairs*, June, p11.
- 5) Weaver, D., and **Bimber, B.** (2008) Finding news stories: A comparison of searches using LexisNexis and Google News. *Journalism and Mass Communication Quarterly*, 83 (3), 515-530.
- 6) Philip McCarty, P., Lively, E., Weaver, D., **Mohr, J.**, and **Bimber, B.** 2008. The role of governmental and non-governmental institutions in framing nanotechnology as a social issue. CNS Technical Working Paper.
- 7) Alexis D. Ostrowski, Tyronne Martin, Joseph Conti, Indy Hurt, **Barbara Herr Harthorn**. (2009). Nanotoxicology: characterizing the scientific literature, 2000–2007. *Journal of Nanoparticle Research* 11:251-257.
- 8) **Pidgeon, N.**, **Harthorn, B.**, **Bryant, K.**, **Rogers-Hayden, T.** (2009). Deliberating the risks of nanotechnologies for energy and health applications in the United States and United Kingdom. *Nature Nanotechnology* 4:95-98. [Online publication 7 Dec 2008, DOE 10.1038/NNANO].
- 9) Jae-Young, C. Ramachandra, G, **Kandlikar, M.** (2009). The impact of toxicity testing costs on nanomaterial regulation. *Environmental Science & Technology* **Article ASAP** • DOI: 10.1021/es802388s • Publication Date (Web): 20 February 2009, <http://pubs.acs.org/doi/full/10.1021/es802388s>
- 10) Godwin, H., K, Chopra, K. Bradley, Y. Cohen, **B. Harthorn**, E. Hoek, P. Holden, A. Keller, H. Lenihan, R. Nisbet, A. Nel (Forthcoming) The University of California Center for the Environmental Implications of Nanotechnology. *Environmental Science & Technology*.
- 11) Weaver, D., Lively, E., and **Bimber, B.** 2009. Searching for a frame: Media tell the Story of technological progress, risk, and regulation in the case of nanotechnology. (Under review).

- 12) **Satterfield, Theresa, Milind Kandlikar**, Christian Beaudrie, **Joseph Conti**, and **Barbara Herr Harthorn**. "Anticipating the Perceived Risk of Nanotechnologies: Will They Be Like Other Controversial Technologies?" (Under review at *Nature Nanotechnology*).

In preparation:

- 1) **Bryant, Karl**, and **Barbara Herr Harthorn**. "Differences that Matter in Public Participation: Gender and Race as Factors in Debating Nanotech Health Applications in the US." In preparation for submission to *Gender & Society*.
- 2) **Harthorn, Barbara Herr, Karl Bryant, Nick Pidgeon, & Tee Rogers-Hayden**. "Deliberating Nanotechnologies: US and UK Perspectives on their Potential Roles for Health and Energy Futures." In preparation for submission to *Science Communication*.
- 3) **Satterfield, Conti, Pidgeon, Harthorn**, survey papers (3)
- 4) **Harthorn, Bryant & Haldane**, expert judgment paper

Presentations 2008-09

- 1) **Barbara Herr Harthorn**, Host & Lead presenter, National Advisory Board meeting, Center for Nanotechnology in Society, Upham Hotel, Santa Barbara, April 10-12, 2008.
- 2) Martin, Tyronne. "Viral assembly of nanowires," CNS Seminar, UCSB. April 22, 2008.
- 3) **Barbara Herr Harthorn**, PI and Lead presenter, NSF Site Visit, UCSB, May 15-17, 2008.
- 4) **Satterfield, Terre**. "IRG-7." Presentation in Reverse Site Visit review of UC Center for Environmental Implications of Nanotechnology, NSF, May 15, 2008. Arlington, VA.
- 5) **Barbara Herr Harthorn & Nick Pidgeon**, Co-Chairs, Mini-Symposium on "Risks, Perceptions, and Governance of Emerging Nanotechnologies" World Congress of Risk, Guadalajara, Mexico, June 8-12, 2008.
- 6) **Nick Pidgeon**, "Nanotechnology Risks: Perceptions, Communication and Public Engagement." Presentation in Mini-Symposium on "Risks, Perceptions, and Governance of Emerging Nanotechnologies," World Congress of Risk, Guadalajara, Mexico, June 8-12, 2008.
- 7) **Barbara Herr Harthorn, Nick Pidgeon, Tee Rogers-Hayden**, and **Karl Bryant**. "Public Deliberations on Nanotechnology Risks and Governance: A UK – US comparative study," Mini-Symposium on "Risks, Perceptions, and Governance of Emerging Nanotechnologies" World Congress of Risk, Guadalajara, Mexico, June 8-12, 2008.
- 8) **Terre Satterfield, Milind Kandlikar**, & Christian Beaudrie, Meta-Analysis of Nanotech Risk Perception Survey Literature. Mini-Symposium on "Risks, Perceptions, and Governance of Emerging Nanotechnologies" World Congress of Risk, Guadalajara, Mexico, June 8-12, 2008.
- 9) Joseph Conti and **Patricia Holden**, Risk Beliefs and Safety Practices in the Nanomaterials Workplace: Results from an International Survey. Mini-Symposium on "Risks, Perceptions, and Governance of Emerging Nanotechnologies" World Congress of Risk, Guadalajara, Mexico, June 8-12, 2008.
- 10) **Harthorn, B. H.**, US Co-Chair, US-France, Nanotechnologies: The Next Generation, Young Engineering Scientists Symposium 2008. Chair/discussant Societal Dimensions & Impacts sessions. July 7-9, 2008 - Embassy of France, Washington DC [outreach]
- 11) **Kandlikar, M.** "The impact of toxicity testing costs on nanomaterial regulation." In Nanotechnologies: The Next Generation, Young Engineering Scientists Symposium 2008. July 7-9, 2008 - Embassy of France, Washington DC
- 12) **Pidgeon, Nick**, "Risk and Perception of Nanotechnology" presentation at American Society of Mechanical Engineers/Institute of Mechanical Engineers summer school on nanotechnology. London, July 2, 2008. [outreach]

- 13) **Harthorn, B.** Panelist, Formal and Informal Nanotechnology Education, Nano in Society PI meeting, NSF, Jul 28-20, 2008.
- 14) **Harthorn B.**, Panelist, Public Understanding of Nanotechnology and Risk Perception, Nano in Society PI meeting, NSF, Jul 28-29, 2008.
- 15) **Joseph Conti**, Alexis D. Ostrowski, Tyronne Martin, and **Barbara Herr Harthorn**. Nanotoxicology and Governance: The Social and Technical Construction of an Expert Knowledge Field. Poster presented at the Gordon Conference on Science and Technology Policy, Aug 17-22. Big Sky, MT.
- 16) **Harthorn, B.** Discussant, Panel on Public Participation in Nanotechnology, Gordon Conference on Science and Technology Policy, Aug 17-22. Big Sky, MT.
- 17) **Harthorn, B.**, IRG 7—Environmental Risk Perception & Nanotechnology. Presentation in UC CEIN kick off meeting, UCLA, Sept 19, 2008.
- 18) **Hurt, Indy.** “Indy does what? Spatial thinking, spatial analysis and data visualization with GIS,” CNS Seminar, Soc 591, UCSB. October 22, 2008.
- 19) Ostrowski, Alexis. “Understanding Quantum Dots,” CNS Seminar, UCSB. November 5, 2008.
- 20) **Harthorn, B.** & L. Oaks, Co-Chairs, session at American Anthropological Assoc. meetings, New Technologies, Gendered Meanings, and Social Inequalities, San Francisco, CA 11/20/08.
- 21) **Harthorn, B & K. Bryant**, The “White Male Effect” and Gendered Risk Beliefs about Emerging Nanotechnologies in the US, AAA meetings, SF, CA 11/20/08
- 22) **Satterfield, T** , Crude Proxies, Racializing Narratives, and Backdoor Curiosities: Reflections across a Few Studies of Race, Gender, and Risk, AAA meetings, SF, CA 11/20/08
- 23) **Rogers, Jennifer.** “Preserving Culture and Identity: Emerging Technologies, Gender and Resistance,” Workshop on Nanotechnology, Equity and Equality, Arizona State University, Tempe, Arizona. November 20-22, 2008.
- 24) **Harthorn, B.** “The legacy and future of societal dimensions research”. NSEC PI meeting, NSF, Arlington VA Dec 3, 2008.
- 25) **Pidgeon, N. & B. Harthorn.** Nanotechnologies: Perception of Technological Risk & Constraints on Benefit among Comparative US/UK Publics. Society for Risk Analysis, Boston, Dec 7-10, 2008.
- 26) **Rogers, Jennifer.** “The Ma(i)ze of Globalization: A Research Trek from Corn to Nano,” CNS Seminar, UCSB. January 12, 2009.
- 27) **Harthorn, B.** Nanotechnologies: Perception of Technological Risk & Constraints on Benefit among Comparative US/UK Publics. Faculty lecture, Center for Information Technology and Society, UCSB, 1-15-09.
- 28) CNS Research Summit, Harthorn lead/host; posters (6) by Satterfield, Pidgeon, Harthorn, Kandlikar, et al., SB, 1-22/23-09.
- 29) **Harthorn, B.** and **J. Conti**, “Context Matters in Nanotech Risk Perception Data for Decisionmakers,” Data for Decisionmakers, panel presentations for NNCO and Congressional staff, Washington, DC, March 8, 2009.
- 30) Johansson, Mikael. “Offering next to nothing – an anthropological view of Nanotechnology and Nanoscience,” CNS Seminar, UCSB. March 9, 2009.
- 31) **Pidgeon, N.** Public Perceptions and Engagement with Nanotechnologies. Expert Witness, UK House of Lords, London, March 24, 2009.
- 32) Hurt, Indy. “Leveraging Technology in the Classroom: Content Organization, Delivery and Grading,” Association of American Geographers, Las Vegas, NV. March 23, 2009.

Meetings:

- 1) **Nick Pidgeon** attended further meetings of the UK Royal Society / Nanotechnology Industries Association working group developing a code of practice for responsible development of nanotechnologies.
- 2) In June **Pidgeon** attended a meeting of Working Group 5 of the UK government's Environment Department (DEFRA) Task Force on social and ethical issues in nanotechnologies.

IRG 4: Globalization and Nanotechnology

R. Appelbaum , Leader	Sociology, Global & Int'l	UC Santa Barbara
G. Gereffi	Sociology	Duke University
T. Lenoir	History	Duke University
C. Cannady	Law	Private sector IPSEVA

Affiliates

C. Cao	Sociology	SUNY Levin Institute
B. Chmelka	Chemical Engineering	UC Santa Barbara
T. Cheng	Electrical & Computer Engin	UC Santa Barbara
S. Micella	Economics	Venice International Univ
V. Finotto	Economics	Venice International Univ
P. Herron	Computer Sci	Duke University

1 postdoc, 4 grads, 1 undergrad

<i>Postdoctoral scholar</i>	Yasuyuki Motoyama, Sociology
<i>Graduate students:</i>	Social Science: Rachel Parker, Sociology
	Nano-Science: Scott Ferguson, Electrical Engineering (to Aug 2008)
	Claron Ridge, Chemistry/Biochemistry
	Collaborating: Stacey Frederick (Duke)
<i>Undergraduate students:</i>	Univ: Sarah Bunch

IRG 4-1: China's Developmental State: Becoming a 21st Century Nanotech Leader ([Appelbaum](#), Parker, [Cao](#), [Gereffi](#))

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. Our research examines the ways in which the debate over innovation is shaping national development in China, with nanotechnology providing a case study. We seek to better understand whether China's relatively government-centered approach toward science and technology policy can succeed in creating the bases for genuine innovation, in light of its distinctive approach to technological leapfrogging, the institutional features of its innovation system, and nanotechnology's status as

an early stage emerging technology. This past year we did not make a summer research trip to China (as during the previous two years), instead focusing on presenting our results to date and professional meetings, and writing them up for publication.

IRG 4-2: Comparative Study of State Nanotechnology Policy: U.S., China, Japan
([Appelbaum](#), Parker, [Gereffi](#), Ridge, Motoyama)

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. The first step is to develop a framework that will enable us to assess the efficacy of different governmental approaches (“industrial policy”). We will be exploring such questions as: What are the key differences in the historical development nanotechnology between the three countries? What is the relative payoff, in terms of commercialization, among the different approaches? We hope to develop a comparative methodology that will use similar kinds of data (for example, public documents, published reports and studies, differences in IP protection law, analysis of patent and publication data). We are in the beginning stages of this project, focusing on the U.S. NNI in an effort to better understand the budgeting process that determines how total NNI funding is determined and allocated across principal recipient agencies, and how subsequent funding allocations are made within those agencies. Ideally, we would distinguish funding along the value chain, from basic research to commercialization. To simplify this research, we will likely focus on a single agency (the NSF), as well as some key end-use application sectors (solar, water filtration, nanobio/pharmaceuticals). The U.S. case study will be submitted for inclusion in Fred Block and Matt Keller, *State of Innovation: U.S. Federal Technology Policies, 1969-2008* (under review at Cornell University Press). Our post-doc, Yasuyuki Motoyama, will be using this framework for one of his projects, a comparative study of nanotechnology policy in the U.S. and Japan (his hypothesis is that, contrary to conventional thinking, the U.S. has a more aggressive industrial policy in this area than Japan). Appelbaum, Parker, and Cao will then extend the analysis to China. This summer we hope to include Singapore, Taiwan, and South Korea as well.

IRG 4-3: Nanotechnology and Sustainable Development: A Comparative Study of India and China (Parker, [Appelbaum](#))

This research stream builds on previous and ongoing work in China, described above. In July 2008 preliminary field work was conducted in Bangalore, Mumbai, and Chennai, India to start working toward a comparison to the China case study. This research looks at how the world's two fastest growing economies are approaching sustainable economic development through investment in high-technology sectors through national nanotechnology initiatives from both a policy perspective, as well as how nanotechnologies are being commercialized in those countries to help facilitate development. Rachel Parker has received funding from the Chemical Heritage Foundation to conduct a case study of Seldon Technologies, a US start-up working on a nano-enabled water filtration technology. Seldon is currently expanding to many emerging markets, including, potentially, India, where there is considerable need for low-cost, low-energy (the Seldon media runs on gravity) solutions to the country's water crisis. Rachel Parker also received a George Mason University Science & Trade Policy Program Young Scholar Award to attend a conference in India in connection with her research on this topic (July 5-8, 2008, Bangalore, India). Her project included a field trip to Seldon Technology's home offices in Windsor, Vermont, to conduct interviews.

IRG 4-4: The Role of International Collaboration in Fostering High-Impact Chinese Nanotechnology Research (Appelbaum, Motoyama, Parker, Lenoir, Herron)

A related project we are currently working on is the analysis of publication data, as one indication of the factors that help to shape high-impact research in Chinese nanotechnology. Our hypothesis is that co-authorship is an important factor. We hope to tease out the nationality of co-authors in an effort to refine this measure. We are looking at the impact score for nanotechnology articles with at least one Chinese co-author, both for nanotechnology as a whole, as well as particular subfields (CNTs, filtration, energy). Preliminary analysis has been done by Patrick Herron, looking at the 10% most heavily cited nanotech articles (representing roughly half of all citations). This project was the subject of a poster that was presented in August 2009 at the Gordon Research Conference on “governing emerging technologies” in Big Sky, Montana.

Study 5: Drivers of Nanotechnology Commercialization in China: Patent Analysis (Appelbaum, Motoyama, Lenoir, Herron, Ridge, Cannady)

We have acquired a dataset of Chinese nanotech patent data from Donghua ZHU, Vice Dean, School of Management and Economics, and Director, Laboratory of Knowledge Discovery and Data Analysis at Beijing Institute of Technology (his lab is the lead agency in China analyzing such data). Our purpose is to better understand the prospects for commercialization in China, and possibly to identify particular firms or researchers for follow-up interviews. The data-set of Chinese nanotechnology patents based on a random sample, and would additionally includes the abstracts of all nanotech patents issued in China for the period 1985-2008. In addition to the raw data, we were provided with a 74 page “Analysis Report of Nanotechnology Chinese Patents,” as well as the complete patents (in Chinese) in four areas: thin films, quantum dots, carbon nanotubes, and nanoporous filtration. Cynthia Cannady (technology lawyer and former Director of the Intellectual Property and New Technologies Division at the World Intellectual Property Organization, WIPO. in Geneva, Switzerland) has prepared an analysis of the report, concluding that:

- Chinese patents in this field are coming from research institutions, rather than the private sector. This is important to understand as a policy matter and distinguishes the Chinese approach from European strategy.
- China is following the historic US innovation model of tech transfer: using massive government cash infusions into basic research clusters in order to stimulate new applied research and subsequent innovation/commercialization.
- Certain cluster areas appear to have been defined by the Chinese in nanotech.
- There is evident understanding by the Chinese of patent power and strategy.
- China may be poised to be dominant in a broad platform technology that affects many fields, and therefore could create a de facto standard, and extract rents (royalties) from US research institutions and businesses in the future.
- The lists of Chinese research institutions and inventors that apparently are active in this area is impressive and could be a base for further study.
- China may be refraining from public disclosure or translation of recent nanotech related inventions as a way to secure a head start.

Our next steps include identifying key firms in China for this coming summer’s research (which will focus on the commercial end of the value chain), and analyzing the acquired patent data. The latter will involve an analysis of all data, charting changes in IPC (International Patent Classification) codes, key patenting organizations, and the emergence of geographically-based

nanotech clusters over time – as well as a more detailed analysis of selected nanotech areas (for example: filtration, energy, CNTs, pharmaceutical).

Study 6: The Nanotechnology Value Chain: A Case Study of a Chinese Solar Company
(Appelbaum, Parker, Frederick, Bunch)

Sun-Tech Power Holding Co., Ltd is one of the worldwide leaders in the manufacturing and innovation of photovoltaic solar cells (PV cells) and other solar power producing products (sun-techpower.com). Dr. Zhengrong SHI founded Sun-tech in 2000; the company was incorporated in January 2001. The company primarily produces monocrystalline and multicrystalline silicon PV solar cells as well as Building Integrated Photovoltaics (BIPV). Their success with these products had been partly due to their ability to produce high efficiency products at low cost per watt and PV cells and modules with high conversion efficiencies. With the creation of its new Pluto technology in 2007 (next generation PV technology which uses a larger surface area cell), Sun-tech was able to achieve a range of 18%-19% efficiency of monocrystalline silicon wafers. The company's next step—although it is as yet unclear (to us) whether they plan to move in this direction—is to move into 3rd generation PVs that rely on true nanoscale technologies. Our research to date grew out of CNS's summer (2008) undergraduate internship program, in which a UCSB microbiology major, under supervision by Rachel Parker and Stacey Frederick, began to map the Suntech value chain. Research has continued with the examination of publicly available documents, as well as interviews with Polly Shaw (Suntech America Director of External Relations) and Nader Jandaghi, Regional Manager, Suntech China. For background information on the solar industry and nanotechnology, we also interviewed UCSB Physicist (and Nobel Prize winner) Walter Kohn, creator of the award-winning film "Power of the Sun," and UCSB Physicist (also a Nobel Prize winner), Alan Heeger, a principal in the firm Konarka, which is involved in 3rd generation (nanoscale) PV technology. Our plans are to complete the study of the Sun Tech value chain, thereby shedding light on how a Chinese company has been able to emerge as a global leader in the highly competitive solar industry.

IRG 4-7: Occupational Health and Safety for Nanotech Workers in Labs and Commercial Enterprises (Appelbaum, Harthorn, Parker, Ferguson)

As noted in a previous annual report, Richard Appelbaum was lead organizer of a conference at UCSB in Nov 15-17, 2007, bringing together industrial hygienists, social scientists, public policy officials, and scientists to examine issues relating to the regulation of potential risks in nanotechnology laboratories and workplaces. The unifying theme of the conference was that labor and management should pay close attention to the new technology and scientific evidence about its risks; and that the scientific community should be aware of workplace concerns and the history of occupational health and safety issues that have been important with past technologies. The conference included reports on the experience of previous technologies, where this message was not fully appreciated. It was hosted jointly by CNS; Harvard Law School's Labor and Worklife Program; UCLA's Centers for Occupational and Environmental Health and International Science, Technology, and Cultural Policy; and UC Lead Campus for NanoToxicology Research and Training. Co-organizers were Appelbaum & Harthorn (CNS-UCSB), Freeman & Trumpbour (Harvard), Zucker & Froines (UCLA). The conference included 38 presenters and discussants, including government (federal: EPA, FDA, NIOSH; state: California Health Hazard Assessment, Massachusetts Department of Environmental Protection; Cal-OSHA; local: Cambridge, MA; Berkeley, CA); Business (Dupont; Swiss Re; Research Lux; Moldex-Metric; Porter Wright Morris and Arthur); labor (Steelworkers; United Food and Commercial Workers; British Trade Union Congress); and university experts (Imperial College

London, Harvard, Illinois Institute of Technology, CUNY Hunter, Michigan State University, University of Wisconsin, UCSB, UCLA, UCI). More than 50 spectators from across the U.S. and several other nations registered for the conference, along with drop-ins from UCSB. We are in the process of writing a working paper based on the conference proceedings for publication, and will be submitting a manuscript proposal for *Nanotechnology, Social Change, and the Environment*, a book to be published by Rowman and Littlefield in 2009.

IRG 4-8: Emerging Technologies/Emerging Economies: [Nano]Technology for Equitable Development, conference to be held in Washington, D.C. November 4-6, 2009 (Appelbaum, Parker, Bimber, Harthorn)

Emerging technologies hold the promise of solving some of the world's most critical problems. Nanotechnology, along with information technology, biotechnology and other new technologies, has great potential for addressing such challenges as energy and environmental degradation, providing clean water, increasing the availability of sustainable food resources, and combating pandemic diseases. Moreover, increased international collaboration on technological innovation will both help to advance our understanding in these areas, and lessen inequality between the global North and South. *Emerging Technologies/Emerging Economies* (<http://nanoequity2009.cns.ucsb.edu/>) is a joint effort between UCSB's Center for Nanotechnology in Society (CNS) and the Woodrow Wilson International Center for Scholars (which will host the conference). The conference will convene leaders from NGOs, government, the private sector, science and technology, and academia, to discuss new pathways for technology-based solutions to problems in four inter-related areas: energy/environment, water, food security, and health. Participants will come from the United States, Europe, and Japan; three of the largest emerging economies (China, India, and Brazil); and other developing countries. The goal of the conference is to aid in the exchange of ideas and experiences between the development stakeholders mentioned above. We hope to initiate a dialogue between the research community and on-the-ground actors working to find solutions to the world's most pressing challenges. The goal is to bridge the gap between the developed and developing worlds, by promoting a two-way exchange of ideas about the ways in which innovation in emerging technologies might better contribute to equitable development outcomes in the four conference areas. Specific results will include an edited volume and published papers, as well as a series of policy statements aimed at government officials in participating countries. The conference will also afford an opportunity for networking among the diverse groups of participants, including a limited number of graduate students, whose participation will provide them with an opportunity to interact with the leaders in their fields.

IRG 4: Publications and Presentations in 2008-09

Publications

- 1) **Richard Appelbaum** and Rachel Parker, "China's Bid to be a Global Nanotech Leader: Advancing Nanotechnology Through State-Led Programs and International Collaborations," *Science and Public Policy* 35:5 (June 2008): 319-334
- 2) **Cong Cao**, Richard P. Suttmeier, and Denis Fred Simon. "Success in State Directed Innovation? Perspectives on China's Plan for the Development of Science and Technology," pp. 247-264 in Govindan Parayil and Anthony P. D. Costa (eds.), *The New Asian Innovation Dynamics: China and India in Perspective*. London: Palgrave Macmillan, 2009
- 3) **Richard Appelbaum**, Rachel Parker, **Cong Cao**, and **Gary Gereffi**, "China's (Not So Hidden) Developmental State: Becoming a Leading Nanotechnology Innovator in the 21st

Century,” to appear in Fred Block and Matt Keller, *State of Innovation: U.S. Federal Technology Policies, 1969-2008* (under review at Cornell University Press)

- 4) **Patrick Herron** and **Timothy Lenoir**, “Mapping the Recent Rise of Chinese Bio/pharma Nanotechnology,” under review, *Journal of Biomedical Discovery and Innovation* (2009)

In Preparation

- 5) Rachel Parker, “The Potential of Nanotechnology for Low-Cost Water Filtration: Value Chain Analysis of a Case Study in India,” paper under commission for the Chemical Heritage Foundation Gore Innovation Project, to be published in *Gore Materials Innovation* white paper series (2009)
- 6) Rachel Parker, Stacey Frederick, **Rich Appelbaum**, Sarah Bunch “The Rise of Chinese Solar Power: Sun-Tech Power Holdings in the Global Photovoltaic Market,” in preparation, to be submitted to special edition (The Globalization of Chinese Enterprises: Environment, Strategy and Performance) of *Management and Organization Review*
- 7) **Richard Appelbaum** and Rachel Parker, “Nanotechnology in the Lab and Workplace: 21st Century Challenges, 20th Century Regulations,” chapter under development to be included in Kenneth Gould and Robert Torres, *Nanotechnology, Social Change, and the Environment* (Rowman and Littlefield)

Presentations

- 1) AAAS Annual Meetings, Boston (February 14-18, 2008), **Richard Appelbaum**, chair, panel on “Global Diffusion of Nanotechnology: Lessons from China, Italy, and the United States.”
- 2) Rachel Parker and **Richard Appelbaum** (UCSB), “Nanotechnology, Science-led Development, and Technological Leapfrogging in China,” AAAS Annual Meetings, Boston (February 14-18, 2008), paper presented in panel on “Global Diffusion of Nanotechnology: Lessons from China, Italy, and the United States.”
- 3) **Gary Gereffi** (Duke), “Nanotechnology, Commercialization, and Risk Management: The Case of North Carolina,” AAAS Annual Meetings, Boston (February 14-18, 2008), paper presented in panel on “Global Diffusion of Nanotechnology: Lessons from China, Italy, and the United States.”
- 4) **Stefano Micelli** (Venice International University, Italy), “Nanotechnology from Below: The Role of Small and Medium Enterprises and Regional Promotion in Italy,” AAAS Annual Meetings, Boston (February 14-18, 2008), paper presented in panel on “Global Diffusion of Nanotechnology: Lessons from China, Italy, and the United States.”
- 5) **Tim Lenoir** (Duke), “Using New Visualization Technologies to Illustrate the Global Diffusion of Nanotechnology,” AAAS Annual Meetings, Boston (February 14-18, 2008), paper presented in panel on “Global Diffusion of Nanotechnology: Lessons from China, Italy, and the United States.”
- 6) **Richard Appelbaum** and Rachel Parker, China’s (Not So Hidden) Developmental State: Becoming a Leading Nanotechnology Innovator in the 21st Century,” Great Transformations Workshop, University of California, Berkeley (June 20-21, 2008)
- 7) **Richard Appelbaum**, China’s (Not So Hidden) Developmental State: Becoming a Leading Nanotechnology Innovator in the 21st Century,” conference on China, Taiwan, and the Future of the Developing World, Taiwan National University, National Chengggchi University, and Academia Sinica; Taipei, Taiwan (September 19-20, 2008)
- 8) **Richard Appelbaum**, “China’s Developmental State: Becoming a 21st Century High-Tech Innovator,” Fifth Annual Seminar on Nanotechnology, Society, and the Environment; Natal, Brazil (October 13-18, 2008) (presented by video hookup)

- 9) Parker, Rachel, Nanotechnology in China: The role of Central Government in directing R&D. Poster presented at the Gordon Research Conference, Big Sky, Montana (August 17-22, 2008)
- 10) **Lenoir, Timothy & Herron, Patrick.** Mapping Chinese Nanotechnology and Pharmacogenomics: Sticky Ontologies and Social Networks. Power point presentation delivered at the Writing Genomics Workshop, Max Planck Institute for the History of Science.(October, 2008)
- 11) Motoyama, Yasuyuki. "From Dissertation to Now," CNS Seminar, UCSB. February 2, 2009.
- 12) **Appelbaum, Richard.** "China's Not-So-Hidden Developmental State," Conference on Modern Chinese Science and Technology, Harvey Mudd College, Claremont, California. February 27, 2009.
- 13) Parker, Rachel. "Nano-enabled water filtration: from carbon nanotubes to nanomesh - a new materials innovation case study," Gore Innovation Project Working Paper Presented at Chemical Heritage Foundation, Philadelphia. February 27, 2009.
- 14) **Richard Appelbaum,** "China's Developmental State: Implications for U.S. Jobs and Economy," testimony before the U.S.-China Economic Security Commission, hearings on "China's Industrial Policy and Its Impact on U.S. Companies, Workers, and the American Economy," Russell Senate Office Building (March 24, 2009)

NSEC Table 2: Program Support

(Table Withdrawn)

10. CNS-UCSB DIVERSITY PLAN

CNS-UCSB recognizes from experience that diversity strengthens the quality of research and the capacity to disseminate to a wide range of community audiences. Our diversity mission is focused on creating a diverse Center of outstanding researchers, staff, and advisors of different gender, racial, ethnic and disciplinary and family educational backgrounds that represent/reflect the communities we serve in our research mission.

(i) Current status and progress this reporting year and since 2006

Undergraduate

The summer undergraduate internship program has an increasingly strong record of diversity. For the current reporting year, the interns included 2 male and 3 female students, 1 Asian-American female, 1 African-American female, and one student of mixed NA, PI, AA racial origins. At least 1 student will be the first in her family to graduate from college (data not available for INSET REU students). Cumulatively since 2006, students from underrepresented groups are noted in Table f-1. In addition, at least 5 of the sixteen interns were first in their family to graduate college, and one intern was disabled. Half of our interns have been from California community colleges, and half from UCSB. Interns also contribute to the academic diversity of CNS, with majors or minors in social science, humanities and science departments that have in the past included Anthropology, Biology, Economics, Literature, Mathematics, Microbiology, Philosophy, Physics, and Sociology.

Table f-1: Diversity information, 16 Summer Undergraduate Interns, 2006-2008

Female	African-American	Asian	Latino	Mixed racial origins
7	1	2	1	3

[Current reporting year: summer 2008: We received applications from 23 students, for 2 internship positions. Applicant statistics: 9 female, 14 male; 5 African-American, 5 Asian, 1 Latino, and 1 Native American/Alaskan. Three will be first in their family to graduate from college. The applicants represented 14 departments with their majors.]

Graduate

The Graduate Research Fellowship program significantly improved the diversity of participants by this past year. Diversity data for the complete cohort of 9 graduate fellows for the 2008-2009 year (5 Social Sciences and 4 Science and Engineering Fellows) is as follows: 4 male, 5 female; 5 Caucasian, 2 African-American, 1 Latino, 1 mixed Asian/Caucasian; 5 are first in their family to graduate college, and 6 are first to receive a graduate degree.

Table f-2: Diversity information, 20 Graduate Research Fellows, 2006-2008

Female	African-American	Asian	Latino	Mixed racial origins
9	2	1	1	1

[Current reporting year: Application data for the 2008-2009 Fellows in the Social Sciences and Humanities. Nine graduate students submitted applications for three positions (1 additional withdrew her application). Statistics on the applicant pool: 5 male, 4 female; 4 Caucasian, 3 African-American, 1 Latino, 1 Asian; 5 are first in their family to graduate from college and 6 are first to receive a graduate degree.]

Postdoctoral

CNS has just begun its postdoctoral program due to previous lack of funds. The 3 postdocs have included one Asian and one European participant. One postdoctoral scholar affiliated with CNS through a co-funded project to director Harthorn is female.

Leadership: Pls, Advisory Board, Senior Personnel

At all junctures in its development, the CNS 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 member of the governing boards of the UCSB Institute for Chicano Studies and the UCSB Center for Black Studies, and current member of the Advisory Committee for the new Center for Latina/o Health, Education & Research. The Executive Committee has a record of gender balance (3 out of 7 members were women) and some ethnic diversity. With changes in the Committee during the current reporting year, however, we have lost some of the gender and diversity balance, and are cognizant of this issue. The additions of Education Director Dilleuth and Assistant Director Gilkes, both women, as ex officio members restores gender balance; the CNS will seek to add ethnic diversity at this management level.

The composition of our center staff also reflects diversity. Our CNS Office Manager is a 1st generation Latina of Mexican origin, our Financial Administrative Analyst is South American, and our Education Director is a woman with an advanced degree in geography (a field predominated by men). Our Computer Network Technologist is a woman.

In addition to racial, ethnic and gender diversity, disciplinary diversity is a hallmark of CNS, as noted above in our student participants. CNS participants represent a wide breadth of educational background and disciplinary experience. Including department affiliations, the CNS Executive Committee bring expertise and perspectives from Anthropology, 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: Engineering, Environmental Studies, Geography, Microbiology, and Physics. And our collaborators at other universities and settings add Asian Studies, Business, Economics, Law, 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 50% women, including 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), an associate professor and associate dean for research at Evans School of Public Affairs, University of Washington (Ann Bostrom), 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. The current co-chair of the Board is Julia Moore, Deputy Director of the Wilson Center's Project on Emerging Nanotechnologies. Board member Willie Pearson is African-American, and also contributes strongly to CNS goals of improving diversity. CNS will be discussing possible additions to the Board at its upcoming meeting (Apr 20-21, 2009), and we will continue to pursue diversity goals in recruitment.

Senior personnel from collaborating institutions, many of them international, have contributed to the cultural diversity of the CNS; fewer contribute to gender/ethnic/racial diversity, although 2 collaborators are Asian American and one is a woman. Remedying this imbalance has been a goal in recruiting new participants for the renewal period, years 6-10 of the Center.

Connections to national organizations committed to diversity goals

Chaired by CNS collaborator John Mohr, UCSB hosted the national NSF SBES AGEF meeting in Spring, 2007, in which CNS director Harthorn gave an invited presentation on the CNS' unusual program of co-educating science and engineering with social science graduate students. This program appears to be effective in attracting women and minority STEM students who are particularly interested in the kinds of social and equity issues research in the CNS portfolio. The program drew particular praise from the SBES AGEF program leaders and seems likely to become a model for others. As a direct result of this presentation, Harthorn was invited to become a member of the AAAS Committee on Opportunities in Science, which she joined for a 3-year term in 2009. This national service provides CNS with direct access to many of the leading programs in the country for expanding opportunities for women, minorities, and persons with disabilities.

(ii) Plans for the next reporting period**Undergraduate and Graduate Participants**

One primary strategy for improving diversity is to start with a diverse pool of strong applicants for our programs. Therefore, a current and future goal to recruit as large and diverse a pool of students as we can enables us to create a diverse community of outstanding young scholars in our programs. The following strategies reflect those we have used with success over the past 3.25 years, as well as new or anticipated strategies for enhancing diversity. Fortunately, UCSB and the central coastal California area in which it is located, are highly diverse, particularly reflecting the growing Latino population, but also have notable Native American, Asian American, and African American population bases. As a rising Research 1 campus in a beautiful coastal setting, UCSB is extremely successful in recruiting a diverse student body. UCSB is an emerging Hispanic Serving Institution (HSI). California currently has 73 HSI schools in the community college and state university system, and CNS is drawing from neighboring organizations in its undergraduate intern recruitment.

Strategies:

- Open recruitment process

A competitive, open recruitment process for our undergraduate, graduate and postdoctoral programs has allowed us to attract a broad range of applicants. Program opportunities have been advertised by email and fliers to all pertinent UCSB departments to disseminate to students, and announcements to UCSB Diversity Coordinators, 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, ensure that students from underrepresented groups find out about our opportunities.

- Collaborating with NSF diversity programs and campus organizations

Since its inception CNS has 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 2007) at UCSB.

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

throughout the 2007-2008 year as an Associate Fellow and is now a Graduate Fellow with plans to continue a second fellowship year with CNS in 2009-10.

A new NSF Bridges to the Doctorate program proposal has been submitted by CNSI, with the goal of connecting students to NSF funded opportunities; if funded CNS will participate in this network of programs that seek to recruit and retain excellent scholars from underserved populations.

In addition, CNS researchers and 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.

CNS will seek to collaborate with new diversity programs that may begin at UCSB. CNS Director Harthorn is a co-investigator on a plan to resubmit an institutional ADVANCE proposal to the NSF to focus attention on institution building to overcome barriers to gender equity in the scientific and engineering fields at UCSB.

- Partnering with California Nanosystems Institute (CNSI) Internships in Nanosystems Science, Engineering and Technology (INSET) REU program for recruiting California community college students

INSET is a unique REU program in that it is specifically designed for community college students, a high percentage of which are from underrepresented racial and ethnic groups. Since 2006, half of all of our undergraduate summer interns (eight out of sixteen) have been in the INSET program. In 2006 and 2007, the entire group of CNSI INSET interns were 55% minority, 37% female and 3% disabled (diversity data not available for individuals).

Diversity reproduces itself. Diversity in our CNS graduate fellows 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. We believe CNS has created a climate of cross-cultural and cross-ethnic acceptance at all levels.

We will continue to seek innovative ways to disseminate the undergraduate curriculum (INSCITES) so that we can create a network of faculty who teach at higher education institutions that serve significant numbers of underrepresented students. CNS faculty and Education staff recently partnered with CNSI in submitting an NSF STS Proposal to introduce INSCITES modules to Santa Barbara City College. The proposal outlines a plan to recruit UCSB graduate students to start to build this network through teacher training and support. In addition, we anticipate the adoption of the INSCITES courses in the UCSB Gevirtz Graduate School of Education's new Science and Math Initiative (SMI) undergraduate minor program.

Postdoctoral

Our postdoctoral program remains modest due to funding constraints. All CNS postdoctoral positions are recruited in an open, competitive process. 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, have sent our advertisement to specialty groups serving women and minorities. Going forward, we will continue to broaden our reach to connect with as diverse a group of potential applicants as we can.

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. Senior personnel have included those of Asian and mixed Asian and Caucasian racial identities. In planning for renewal for years 6-10, diversity at the Senior Personnel level has been enhanced with five new female senior personnel. One of the proposed additions is a disability research expert. We also have expressly sought to include those earlier in their careers and are adding two assistant professors at UCSB and another at Univ of Wisconsin. Disciplinary diversity continues as we will add at UCSB: Chicana and Chicano studies, communication, economics, and environmental studies; including collaborators we add science journalism and law.

Virtually all the current Advisory Board members have committed to continued service for the next reporting period, and going into the next five-year funding period. 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 a Diverse Public

In order to ensure that all groups in the Santa Barbara area are aware of CNS activities, we will continue to plan and organize our community events, including speakers and NanoMeeters, in order to reach and represent the interests of the wide range of diverse groups in the population in Southern California. In research, we have and will continue to recruit public deliberation participants in panels that reproduce the socio-demographic diversity of the communities in which we will conduct them (Santa Barbara, Vancouver, and Cardiff, UK). Studying the effects of such diversity on public participation and group dynamics is an important component of the research.

11. EDUCATION

The CNS brings together researchers and students in the social sciences, humanities, engineering, and science to create new, critically-needed collaborative education programs. It sponsors graduate fellowships and undergraduate internships, and new undergraduate curriculum. Many of these events and activities take place in collaboration with the California NanoSystems Institute (CNSI).

The Education program is led by Dr. Julie Dillemath. Effective December 2008, after a six month leave of absence CNS Associate Director for Education Dr. Fiona Goodchild stepped down from this position, and Dr. Dillemath was promoted to CNS Education Director. Dr. Dillemath provides the day-to-day coordination of CNS educational and engagement activities as well as strategic planning for the education program, and continues to work in collaboration with Dr. Goodchild in her position as CNSI Education Director, which enables a high level of integration of CNS efforts with nanoscience education on campus.

CNS Education Program Objectives & Key Programs



CNS Graduate Research Fellowships in Social Science and Humanities and Science and Engineering

CNS-UCSB awards fellowships to outstanding graduate students pursuing research in the social sciences and humanities and science and engineering. Graduate research fellows take lead roles in the Center's research and education initiatives, and are trained within the interdisciplinary research groups in a unique co-educational context of joint social science and nanoscale science and engineering research and training.

CNS Graduate Fellows for 2007/2008

Fellow	Department	Affiliation
Kasim Alimahomed	Communication	WG2
Joe Conti	Sociology	WG3
Scott Ferguson	Mechanical Engineering	WG2
Summer Gray	Sociology	Associate
Mary Ingram	Sociology	WG1
Erica Lively	Electrical & Computer Engineering	WG3
Jerry Macala	Chemistry	WG2
Tyronne Martin	Chemistry	WG3
Alexis Ostrowski	Chemistry	WG3
Rachel Parker	Sociology	WG2
David Weaver	Political Science	WG3

CNS Graduate Fellows for 2008/2009

Fellow	Department	Affiliation
Kasim Alimahomed	Communication	IRG-2
Meredith Conroy	Political Psychology	IRG-3
Summer Gray	Sociology	IRG-1
Indy Hurt	Geography	IRG-3
Erica Lively	Electrical & Computer Engineering	IRG-3
Jerry Macala	Chemistry	IRG-2
Tyronne Martin	Chemistry	IRG-3
Rachel Parker	Sociology	IRG-2
Claron Ridge	Chemistry	IRG-2

The reporting period covers two fellowship years; the 2007/2008 Graduate Fellows participated from June 2007 to Sept 2008 (including an additional summer, since we moved the start date of the fellowship to Fall for 2008/2009 Fellows; discussed below), and are discussed in detail in the Year 3 (2007-2008) Annual Report.

For 2008/2009, nine graduate research fellowships were awarded for a 12-month term beginning Fall quarter 2008; five graduate students in social sciences and four in science and engineering (listed in table above). Two social science Fellows and two science and engineering Fellows continued from the previous year (shaded in gray in the table above). The Graduate Fellows program is a major component of CNS-UCSB's mission to produce and encourage excellent and innovative scholarship that addresses the intersection of nanotechnologies with society. Fellows, in residence at UCSB, work directly with a faculty mentor in one of the IRGs, and each PI (with one exception) has one social sciences and one science/engineering Graduate Fellow. For 2008-2009, Fellows came from six different departments and disciplines.

Summary demographic information (out of 9 total):

- 5 Female
- 2 African-American
- 1 Latina
- 1 S. Asian (Indian)
- 5 First in family to graduate college
- 6 Will be first in family to receive graduate degree

The Graduate Fellows contribute to the diversity of CNS. The group of nine includes 5 women, and Fellows who are African-American, Asian, and Latina. Five are the first in their family to graduate from college, and six will be the first in their family to receive a graduate degree.

One modification to the program this year was starting the fellowships in Fall quarter, rather than at the beginning of summer. One benefit is that fellows have a full academic year of CNS experience before they mentor undergraduates in the summer. Matching the fellowship term to the academic year makes sense on many levels, particularly in that new fellows can feel integrated into the Center more quickly when they have the seminar course starting when they start, and when all CNS participants are on campus (not always the case in summer given fieldwork schedules). The fellowship term began with an intensive two-day orientation workshop, which is described in detail in the Curriculum section below.

In the past year, Fellows continued to meet weekly, year-round in a graduate seminar with faculty researchers, visiting scholars, and other interested members of the campus community. In Fall 2008, this seminar became an official course, Soc 591 BH, 1-4 units (discussed more in the Graduate Curriculum section below). The seminars are an important way to develop an interdisciplinary community of scholars with special expertise and the ability to communicate effectively across significant disciplinary boundaries. Seminars address a wide range of issues of emerging nanotechnologies and society including social science and NSE research methods, safeguarding human subjects, science and technology studies, professionalism, and substantive research within the IRGs. Starting January 2009, the frequency of meetings was changed from weekly to bi-weekly, to emphasize quality and full participation over quantity. This more flexible meeting schedule can accommodate researchers' travel schedules as well as other commitments that conflict with a weekly time, allowing us to have full attendance for each presentation or discussion. Evaluations conducted at the end of the Winter term verified that biweekly format was preferred over weekly frequency.

Evaluation

As part of ongoing formative and summative evaluation of Education activities, surveys on the Graduate Fellows program were given in September (concerning total CNS experience) and December 2008 and March 2009 (concerning those quarters' seminar program). Program strengths and weaknesses were identified; those pertinent to the day-to-day program execution are reported here, while broader implications of the program are reported in a separate Evaluation section below. The quarterly survey will be an ongoing quarterly evaluation activity, with a new web-based form that facilitates data collection.

Program Component Ratings by 2008-2009 Graduate Fellows:

mean responses reported (1 = poor, 2 =satisfactory, 3=good, 4=excellent)

	2007-08	Dec. 08	Mar 09
the quality of the CNS Seminar	2.7	3.3	3.4
the quality of interaction among the Fellows	2.8	3.7	3.2
the quality of interaction with IRG leader	3.8	n/a	n/a
the quality of interaction with other CNS faculty	2.6	3.7	3.4
the quality of interaction with CNS speakers/visitors	2.6	2.8	3.0

Graduate Fellows' ratings of the quality of interaction with their IRG leader continue to be excellent. The quality of the CNS seminar and interactions with other fellows and faculty remain strong, with some room for improvement. Interaction with CNS visitors is the weakest point, rated between "satisfactory" and "good", but showing a trend of improvement over the past year. Strengths of the CNS seminar as identified by participants are research presentations by fellows and professional development topics, such as the workshop/discussion on publishing held in November. A criticism voiced by several was that a weekly meeting was more frequent than necessary, and sometimes seemed like a meeting "just to meet". Now that the social science fellows are housed in a shared office, there is more opportunity to talk in day-to-day interactions, which was a role that the seminar played prior to the rearrangement of offices.

Graduate Curriculum

In September 2008, CNS held a new orientation workshop providing intensive instruction for incoming and continuing graduate fellows. The workshop was held for two days, preceding the beginning of classes, and engaged students in readings and discussion of science and society research approaches to studying nanoscience and nanotechnologies, mixed social science/humanities research methods, and specific background on the IRG research programs. The intent of this new program was to facilitate the development of common language, shared goals, and social integration among all the fellows and researchers.

The CNS Seminar Soc 591 (also noted above) is our focal point for graduate curriculum. Highlights from the seminars during the reporting year include, "Viral Assembly of Nanowires" talk by Science & Engineering Fellow Tyronne Martin, discussion with officers from Engineers Without Borders to identify areas of potential collaboration, a presentation on the Science and Technology Studies (STS) discipline by Social Science Fellow Summer Gray, a cleanroom tour of the UCSB Nanofabrication Facility (NNIN) hosted by a project scientist and Science & Engineering Fellow Erica Lively, a "Spatial Thinking, Spatial Analysis, and Data Visualization with a Geographic Information System" talk by Social Science Fellow Indy Hurt, an "Understanding Quantum Dots" talk by former Science & Engineering Fellow Alexis Ostrowski, and a pre-election discussion of the presidential candidates' positions on science and technology. In addition, each of the new CNS Postdoctoral Scholars presented their dissertation research and research plans for their work with CNS in the seminar. The CNS Speakers Series, discussed further in the next section, hosted Dr. Fred Block (UC Davis), Dr. Elena Simakova (Cornell), Dr. Atul Wad (Sustainable Technology Ventures), and Dr. Dan Kahan (Yale University).

Students in CNS have the opportunity to participate in an interdisciplinary doctoral emphasis program in Technology and Society, organized through the UCSB Center for Information Technology and Society (CITS). CNS faculty Bimber, Harthorn, and McCray are affiliated with CITS, and a close working relationship exists between the two Centers. The doctoral emphasis,

which is of interest to some of our Fellows, 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.

Seven graduate courses that included CNS material in the reporting year were offered by CNS faculty at UCSB and external collaborators at their institutions, including:

- Global 201 UCSB, *Graduate Gateway Seminar* (Appelbaum, Global Studies PhD emphasis, 15-20 students, annual)
- Env-M552, University of East Anglia, *Participatory Decision Making* (Tee Rogers-Hayden, Environmental Sciences, Masters Course)
- Soc 261, UCSB, *Sociology of Development* (Appelbaum, 20 students, biennial)
- Soc 591 (BH), *CNS Graduate Seminar* (Harthorn)
- PolS 594N UCSB, *Technology & Politics* (Tech. & Society Gateway Seminar) (Bimber)
- Eng 235, UCSB, *Pre-Civil War American Literature* (Intersections of literary, cultural, and scientific understandings of innovation, with special attention to the development of intellectual property, Newfield, 8 students)
- Materials 287B *Seminar in Organic Semiconductors*, (Graduate Fellow Alimahomed presentation of CNS research)

CNS-UCSB Postdoctoral Scholars Program

CNS-UCSB has just recently initiated an on-site Postdoctoral Scholar program (yr 3, 2008) with one postdoctoral scholar in 2007-08 (McCarty), and two Postdoctoral scholars who have begun in year 4, 2009 (Johansson, Motoyama). We are currently recruiting for a third. In addition, CNS-UCSB has partially supported two postdoctoral researchers at Cardiff (Tee Rogers-Hayden, Adam Corner). CNS is committed to providing quality mentorship in research and professional skills towards postdocs' career and personal goals as an integral part of our plans to involve postdoctoral level scholars in our research, education, and outreach programs.

CNS provides a variety of mentoring and professional development opportunities for Postdoctoral Scholars at UCSB. On the academic side, our postdoctoral scholars give formal research presentations in the CNS Seminar, are encouraged to submit to and present at conferences, and prepare and present research posters for the annual CNS Research Summit and National Advisory Board meeting. At these meetings, they have the opportunity to engage with CNS external collaborators and elite board members, which develops and expands their networks. CNS provides postdocs with funding for research presentations at conferences as well as opportunities to represent the CNS at workshops, meetings and conferences. The CNS Graduate Seminar (discussed above), attended by CNS faculty, postdocs and graduate fellows, includes academic and professional development discussions on various topics such as interdisciplinary collaboration; social science, humanities and science/engineering methodologies; publishing; training on oral and poster presentation design and communication; and other topics identified through regular evaluation surveys.

On a day-to-day level, postdoctoral scholars meet regularly with their mentors. The structure of the IRGs, with all leaders based on the UCSB campus, promotes close collaboration and mentorship with PIs, including interdisciplinary collaboration, at both the postdoc and graduate fellow level. Postdocs are also kept well-informed about events and activities in related departments and programs on UCSB campus. The Education Director forwards relevant lecture and visitor announcements from NSE departments, the Bren School of Environmental Science

and Management, the UCSB Center for Information Technology and Society (CITS), as well as social science and humanities departments.

Apart from academic mentoring, CNS-UCSB supports postdoctoral scholars in personal development toward their career objectives. Postdocs and their mentors are provided and strongly encouraged to use 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 as an effective framework for identifying and meeting professional development needs and career objectives. Campus programs provide broader support: CNS postdocs will be able to participate in a new Professional Development Program for Postdoctoral Scholars, sponsored by the California Nanosystems Institute (CNSI), scheduled to begin by Fall 2009, as well as the UCSB Society of Postdoctoral Scholars, which provides training and other development opportunities for campus postdocs. For support materials, articles, and guides on mentoring and career development, the UCSB Graduate Division provides an extensive online collection

(<http://www.graddiv.ucsb.edu/postdoctoralscholars/careers.htm>,
<http://www.graddiv.ucsb.edu/postdoctoralscholars/mentoring.htm>).

We will evaluate the postdoctoral program on an annual basis with a survey to our current and past postdoctoral participants assessing their experience and rating of program components. Postdoctoral scholars also complete the quarterly surveys, which monitor the quality of the CNS Graduate Seminar and participant interactions and ask for specific needs or ideas that we can implement going forward.

CNS-UCSB Undergraduate Summer Internship Program

CNS offers internships to UCSB undergraduate social science and humanities majors who are interested in gaining social science research experience. CNS also collaborates with the NSF funded Interns in Science, Engineering and Technology (INSET) REU program at the California Nanosystems Institute to recruit community college students to an 8-week summer research experience on the UCSB campus.

The five 2008 Interns gained first-hand experience investigating the societal issues relating to nanotechnology in a new approach that we called 'Traveling Nanotechnologies'. The students were matched individually with faculty and graduate fellow mentors, but worked in two teams researching the Global Value Chain of specific nanomaterials and nano-enabled products. One team was assigned solar technologies, to complement the work of Rich Appelbaum and Chris Newfield in IRG 2. The other team chose nanosilver as their material, and investigated medical applications (bandages, personal care), the Samsung SilverCare washing machine, and the Pure Plushy antimicrobial stuffed toy. This project was modeled after a course taught by CNS collaborator Gary Gereffi (Duke University). Graduate student Stacey Frederick, who works with Dr. Gereffi and was involved in teaching the course after which this project was modeled, visited CNS at the beginning of the summer to provide training and guidance for both interns and mentors on the Traveling Nanotechnologies project.

After an orientation to the Global Value Chain (GVC) research method, which considers all the inputs and activities that go into creating a product or an industry – from R & D, design, and raw materials, to production, manufacture, marketing and distribution (see Global Value Chains Initiative, www.globalvaluechains.org) and gaining basic background knowledge for the project, interns started by investigating the science and engineering behind the nanotechnology. Then, with guidance from their mentor and in collaboration with the other interns, they researched the components of the Global Value Chain for their product, and chose a societal implications area

to pursue more deeply. At the end of the eight week summer program, interns told the story of their nanomaterial and nano-enabled product, presenting their results in a research poster and oral powerpoint presentation, and summarizing their findings in an information card for their product that can be used for CNS public engagement activities.

The internship provided undergraduates training in societal implications research as well as ongoing mentoring, IRG participation and interaction, and professional development. In addition to research, the interns attended weekly CNS seminars, participated in group meetings, and developed communication and presentation skills. The culmination was an oral research presentation for CNS and research poster colloquium with all science and engineering summer interns. The two INSET interns also attended the Sigma Xi conference in Washington DC in November, presenting their research posters at this national meeting. Two of the UCSB interns continued involvement in the CNS in the 08-09 school year, and those interns submitted posters to the UCSB Undergraduate Research Colloquium in April 2009.

This new project approach was successful in that 1) students were motivated by working with commercial products in everyday use or on the leading edge of technology, 2) interns were able to be self-directed and make research decisions based on a guiding framework and theoretical foundations, and 3) the project inherently integrated nanoscale science and engineering with societal implications, giving students a 'big picture' around which they can start to understand the relationships of the technology to society.

Summer 2008 CNS Summer Interns

Intern	University	Grad Mentor	PI	IRG
Beatrice Balfour	Santa Barbara CC	Kasim Alimahomed	Chris Newfield	2
Brian Billones	Alan Hancock CC	Erica Lively	Bruce Bimber	3
Sarah Bunch	UCSB	Rachel Parker	Rich Appelbaum	2
Christian McCusker	UCSB	Joe Conti	Barbara Herr Harthorn	3
Dayna Meyer	UCSB	Alexis Ostrowski & Tyronne Martin	Barbara Herr Harthorn	3

Summary demographic information (out of 5 total; generation and race data not available for INSET students):

2 Community College

3 Female

1 First in family to graduate from College

1 African-American

1 Mixed Asian & Caucasian

Evaluation

Evaluations completed by both interns and mentors point to a successful summer and also specific ways to improve the project. Interns were very satisfied with the research they conducted, how much they learned, and the level of guidance and training they received. They reported increased confidence in their knowledge, research skills, and communication and presentation skills as a result of participating in the program. Particular challenges they reported were learning the Global Value Chain (GVC) methodology, understanding the science, narrowing down the amount of information and knowing what to focus on, having confidence to share findings, and working in a group. But the most enjoyable aspects were working and

collaborating with their mentors, PIs, and fellow interns, a comfortable, non-intimidating and diverse atmosphere, and seeing professors and grad students as people, not just instructors.

Mentors evaluated their experience positively, and the Traveling Nanotechnologies project an improvement over the structure of the previous year. Reported challenges centered around training and the learning curve for the GVC approach, and graduate mentors provided several suggestions for mitigating those issues in the future. Mentors particularly enjoyed having a leader/advisor role, watching the students get excited about the research and seeing their knowledge and confidence grow, and contributing to an overall great experience for their intern.

The feedback on training and material/product selection will be directly incorporated into planning for summer 2009, to improve the program. Fellows who continued for another fellowship year will help provide guidance and continuity since they can draw on their experience to help with improving the second iteration.

Undergraduate Curriculum

As a result of an NSF Distinguished Teaching Scholar Award to Dr Evelyn Hu, graduate teaching scholars design and teach INSCITES (Insights on Science and Technology in Society), courses at UCSB that explore the impact of technology in society. These graduate teaching scholars are selected from social sciences, humanities and the science and technology disciplines. The INSCITES course ran for the first time in Spring 2007 and focused on the technology of surveillance. The second course, given Spring 2008, focused on green technologies. CNS faculty and education leaders are involved in all aspects of the course. Community colleges have expressed strong interest in adapting this course model for their undergraduate students, and an NSF STS proposal has been submitted by CNSI with CNS faculty and Education Director as co-PIs.

In Fall 2008, Professor Harthorn taught a new upper division undergraduate course that she developed last year, Gender, Science and Technology, in the Feminist Studies program (WS 132). This annual course includes significant attention to nanotechnology. She actively recruited students in the nanoscale sciences and engineering along with social science students and feminist studies majors.

CNS-UCSB faculty and external collaborators taught 8 courses that incorporated Center research:

- Bio 3C6Y, University of East Anglia, Science Communication, course about nanotechnology and upstream engagement (Tee Rogers-Hayden-IRG3)
- Chem 235/Anth 235/Hist 237, Rice University, "Nanotechnology: Content and Context" (Cyrus Mody--IRG1 and Kristen Kulinowski--Rice chemistry/CBEN/ICON, 35 students, annual).
- ECE 94r, UCSB, Insights on Science and Technology for Society (INSCITES) (McCray and others, 18 students)
- Feminist Studies 132, Gender, Science and New Technologies (Harthorn) F07, annual, enrollment 25 (formerly WomStud186BH)
- Fm St 182, UCSB, Feminist Methodologies, (Harthorn, 20-25 students, annual)
- Global 2, Introduction to Global Studies Politics and Economics (Appelbaum, 300 students, annual)
- Global 130, UCSB, Global Political Economy (Appelbaum, 200 students) annual

- Soc 156B, UCSB, Women Culture Development, (Bhavnani; Appelbaum guest lecture, 25 students, W09)

CNS Education Program Evaluation

CNS education and public engagement staff collect data about and from participants in CNS events that enable us to assess formative progress and summative achievements for each of the objectives listed earlier.

With respect to the Fellowship program we collect feedback from fellows regarding their initial expectations, their response to the regular seminar series and undergraduate mentoring and their general level of satisfaction regarding their CNS research experience and progress. A survey was administered to all CNS fellows, past and present, in September 2008 via an online form. Of the 15 people invited to complete the survey, 13 responses were submitted--6 from social scientists and 7 from scientists or engineers.

Responses identify particular strengths as well as areas for improvement in the Fellowship Program, and the feedback is used in planning programming that meets the needs of the participants.

Mean responses (1 = poor, 2 =satisfactory, 3=good, 4=excellent) of Graduate Fellow Participants' ratings of the quality of...

	All (n=13)	Social Sci	Sci/Engr
...interaction with IRG leader	3.8	3.8	3.9
...their IRG experience	3.6	3.7	3.6
...interaction among the Fellows	2.8	3.0	2.6
...the CNS Seminar	2.5	2.3	2.7
...interaction with other CNS faculty	2.5	2.3	2.6
...interaction with summer intern	2.4	2.3	2.6
...interaction with CNS visitors	2.5	2.5	2.4

The strong positive feedback around the overall research experience and quality of interactions with PIs continued from the previous year and is indicative of a successful program. In response to open-ended questions, Graduate Fellows indicated that interdisciplinary training is a highlight of the fellowship program, reporting, "the interdisciplinary graduate fellows meetings were great. I learned so much from my science partner and from the other science fellows." Fellows commented on learning "how to work with people who do not share the same assumptions about what research is and how to go about it" and recognized that it is, "nice to be able to get feedback from someone with a completely different perspective from my own and be able to bounce ideas off of someone with a different disciplinary background."

One question we are particularly interested in monitoring is, how does participation in a CNS research fellowship influence future career directions? In an open-ended response, four out of seven Science and Engineering fellows identified an interest in or plan to include science policy in their career path. All seven responded that CNS has had a positive influence on their academic research and career goals, with an emphasis on the career side. An exception to this, which shows an impact on the research side, is that Science and Engineering Fellow Tyronne Martin is including a chapter in his dissertation on his CNS toxicology and risk research. For Social Science Fellows, the positive impact is reported as being mainly on the

research side, with five out of six reporting the CNS experience as enhancing their research and academic experience. As fellows graduate, their CNS experience proves to be valuable. As one Social Science Fellow recently hired into a tenure-track faculty position reflected on his interview experience, “my time with CNS served as an incubator for ideas about what kind of research I wanted to do; it gave me an opportunity to think broadly about what kinds of exciting things need to be studied that both match my interests and those of CNS. CNS gave me training and familiarity with working inside a large project with ambitious goals, such that when it came time for me to say what I wanted to do, I was already thinking big and bold. That served me well.”

Extending one’s network, learning different methodologies, new ideas for research, a broader awareness of different disciplines’ research approaches, and “learning the lingo” were also cited as benefits of CNS participation.

Challenges, issues and suggestions for improvement identified by fellows included:

- Communication challenge: deciphering jargon, understanding others’ points of view
- too frequent seminar meetings, which dilutes the meeting quality and takes too much time
- low visibility on campus, not feeling integrated with the campus as a whole
- desire for more science, such as in presentations, projects that involve nanoscale science more directly
- challenge of not being in one space—walking all over campus takes time
- desire for more activity on the blog
- desire to pursue own research project, relating it to science/engineering dissertation research

Some of these challenges have started to be addressed. In Winter quarter, we reduced the frequency of the seminar meetings to biweekly, reducing quantity by emphasizing quality, which was a change that was positively received. The communication challenge is inherent to interdisciplinary research, but having a group of fellows who are not afraid to ask questions, and continuing to program seminar presentations from both social science and science and engineering fellows helps address this ongoing issue.

With regard to the “more science” request, last quarter we toured the Nanofabrication Facility cleanroom with Erica Lively and a research scientist and had a presentation by former Fellow Alexis Ostrowski on quantum dots. Next quarter, Tyonne Martin has volunteered to present on his nanoscience research. The idea of pursuing an independent project is one we have included in the renewal proposal, as a kind of capstone project for Fellows who have at least one year’s experience in the Center.

Campus visibility is something that we are working to increase. We have been doing more on-campus advertising of our Lecture Series talks with visiting researchers as well as regular seminars when the topic is of interest to a broader audience. Inviting Engineers Without Borders to a seminar, and presenting about CNS to the *Los Ingenieros* undergraduate organization are activities that increase visibility and raise awareness about CNS as a potential resource for students and programs.

Reports to the National Advisory Board

CNS faculty and staff report on the evidence of progress towards completion of the objectives listed above at the annual meeting of the National Advisory Board. Specific questions raised by

the evaluation data are discussed with a view to identifying problems and devising appropriate modifications.

Evaluation Databases

CNS maintains a database of all participants in fellowship, internship and public outreach events so that we can provide evidence of the nature of the population who take an active part as well as those who express interest in learning more about this field. We will use the information gleaned from participants at conferences, public events and seminars to guide our future plans for both research and education.

The CNS website serves as an archive for all significant documents that are created by the Center faculty, staff and students. The web site also serves to inform that public about highlights in the field and to advertise future events that the center is hosting (see Outreach and Knowledge Transfer section for more information on the website).

Table 3A: Education Program Participants – All, irrespective of citizenship

Student Type	Total	Gender			Citizenship Status		Race: regardless of citizenship status								Hispanic Ethnicity		Disabled
		Male	Female	Not Reported	US/Perm	Non-US	NA	PI	AA	C	A	Mixed - inc. NA, PI, AA	Mixed - C, A	Not Provided	US/Perm	Non-US	
Enrolled in Full Degree Programs																	
Subtotal																	
Undergraduate	5	2	3		5				1	1		1	1	1			
Masters																	
Doctoral	14	7	7		13	1			2	10			1	1	1		
Enrolled in NSEC Degree Minors																	
Subtotal																	
Undergraduate																	
Masters																	
Doctoral																	
Enrolled in NSEC Certificate Programs																	
Subtotal																	
Undergraduate																	
Masters																	
Doctoral																	
Practitioners taking courses																	
K-12 (Precolleges) Education																	
Subtotal																	
Teachers																	
Students																	
Total																	

Table 3B: Education Program Participants -- US Citizens and Permanent Residents

Student Type	Total	Gender			Race data								Ethnicity -- Hispanic	Disabled
		Male	Female	Not Reported	NA	PI	AA	C	A	Mixed - inc. NA, PI, AA	Mixed - C, A	Not Provided		
Enrolled in Full Degree Programs														
Subtotal														
Undergraduate	5	2	3				1	1		1	1	1		
Masters														
Doctoral	13	6	7				2	9			1	1	1	
Enrolled in NSEC Degree Minors														
Subtotal														
Undergraduate														
Masters														
Doctoral														
Enrolled in NSEC Certificate Programs														
Subtotal														
Undergraduate														
Masters														
Doctoral														
Practitioners taking courses														
K-12 (Precollege) Education														
Subtotal														
Teachers														
Students														
Total														

12. OUTREACH & KNOWLEDGE TRANSFER

The CNS-UCSB pursues a multi-layered outreach and knowledge transfer program. Because of the novel work being pursued by CNS-UCSB, knowledge transfer is required at the levels of campus and academic communities as well as to general audiences, public policy makers and industry experts. In addition to initiating outreach activities and dialogue opportunities between the general public and nanoscale researchers (enumerated below), CNS-UCSB has been a connector for the growing nano in society community and is increasingly seen as a research hub and dissemination portal for that community. Because “knowledge transfer” implies a one-way (and linear) process of knowledge deposition that is at odds with our views about the absolute necessity of two-way interaction between science and society, we prefer to indicate some mutuality in the interactions by referring to them as “engagement.”

In December 2008 Valerie Walston stepped down as CNS Media and Events Coordinator. The position was reconstituted as a 0.50 FTE position focusing solely on media coordination and information dissemination. Following a highly competitive search, CNS hired Anna Davison as Media Coordinator, beginning just a week before the end of this reporting cycle.

Public Engagement Objectives

CNS has pursued the following objectives through its initial 3.25 years of funding.

- To host visiting speakers to UCSB who will raise interest and participate in collaborative scholarship about critical issues related to the impact of nanotechnologies in society.
- To create a series of events that engage members of the general public in the societal implications of nanotechnologies.
- To create new contexts for “3-way” science-social science-public interaction that will serve to provide informal science education, to familiarize nanoscale scientists and social scientists with the public’s concerns, and to situate societal knowledge within ISE
- To maintain a presence on the Web and, increasingly in the next funding cycle, in new media, that informs about the above objectives and serves to update the public and special interest groups such as industry, government, media, labor, and NGOs about significant research and policy findings.
- To disseminate policy-relevant research findings and recommendations about nanotechnologies’ development and societal interactions to appropriate local, state, national, and international policy makers.

Nano-Meeter:

CNS (with CNSI) continued to utilize the informal nanoscale science discussion forum, the NanoMeeter (formerly called NanoCafé) to connect researchers with the public. NanoMeeters are held on weekday evenings for roughly an hour, in the community in coffee shops or other publicly accessible sites on a quarterly basis; audiences range in size from approximately 25-50. NanoMeeters are jointly facilitated by CNS and CNSI researchers, and staffed by CNS.

In August 2008 the topic of ‘Green Nanotechnology: What is it?’ examined ‘green’ nanotechnologies and sustainable manufacture of nano-enabled products. Presenters were UCSB colleagues from the new UC Center on the Environmental Impacts of Nanotechnology, Trish Holden (Professor of Environmental Microbiology), Arturo Keller (Professor of Biogeochemistry), and Bill Freudenburg (Dehlsen Professor of Environmental Studies and Sociology), and Director Harthorn served as moderator. The Fall 2008 NanoMeeter was held in November and featured Alan Heeger (2000 Nobel Laureate in Chemistry and UCSB Professor

of Physics), Craig Hawker (Director of the Materials Research Laboratory and UCSB Professor of Chemistry, Biochemistry and Materials), and Dan Colbert (Executive Director of the UCSB Institute for Energy Efficiency) on the topic of 'Energies and Nanotechnologies. This event was also moderated by Harthorn. This discussion considered our future energy needs and how nanotechnologies might change the ways we generate, store, and conserve energy. The interdisciplinary combination of a physicist, chemist, and engineer generated lively discussion and gave the audience insight into different disciplinary perspectives on this socially relevant topic.

We plan to continue this series, which is popular with both audiences and speakers, on a roughly quarterly basis.

Speakers series:

The CNS hosts quarterly visiting speakers who present to the Fellows Seminar and wider campus and public audiences on a range of topics. During the reporting year CNS hosted Fred Block (Professor of Sociology, UC Davis), Elena Simakova (Postdoctoral Associate, Cornell Center for Nanoscale Systems in Information Technologies), Atul Wad (Sustainable Technology Ventures President, and CENTRIM Visiting Fellow, University of Brighton), Roger Witherspoon (environmental journalist), and Dan Kahan (Elizabeth K. Dollard Professor of Law at Yale Law School).

These lectures were advertised to the wider campus community. CNS hosted many of these events on the Engineering side of campus to draw interested members of the College of Engineering community. The Center is making significant headway in gaining a supportive and interested constituency among Science and Engineering colleagues.

In addition to the above events, on March 8, 2009, CNS co-hosted (with the Orfalea Center for Global & International Studies) a semi-private session with New York Times columnist, Thomas Friedman. At CNS's invitation, Friedman discussed technology and society issues with campus NSE leaders (including Michael Witherell, UCSB Vice Chancellor for Research, Matt Tirrell, Dean of the UCSB College of Engineering, John Bowers, Director of the Institute for Energy Efficiency, and Evelyn Hu, former Director of CNSI), graduate students from CNS and from Global and International Studies, and community and industry leaders (including Santa Barbara Mayor Marty Blum, philanthropists Paul Orfalea and Michael and Anne Towbes, SAGE Publications founder and philanthropist Sara Miller McCune, and several venture capitalists). This discussion aimed to provide background for the Fall 2009 international conference CNS plans in Washington DC on equitable development of nanotechnologies.

Public Presentations:

CNS researchers 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 included: CNSI/CNS Educators Workshop (September 2008); Fellow Kasim Alimahomed presenting his research in Materials Science 287B course (December 2008); engagement with underrepresented students via *Los Ingenieros* undergraduate campus organization (February 2009) and the W.E.B. Du Bois Event, a yearly presentation to introduce Academic Communities for Excellence (ACE) students to graduate school (February 2008); and via "The Science Guys" radio show, KCSB 91.9 FM in Santa Barbara. Former CNS Science and Engineering Graduate Fellows (Ferguson, Rowe) continue to participate in CNS engagement events.

Weekly Clips:

Another popular continuing outreach effort is the CNS-UCSB Weekly Clips. Leading breaking news stories on nanotechnology and societal issues are tracked and circulated electronically. Forty-four Weekly Clips compilations were sent out during the reporting period to a growing list of nearly 500 interested colleagues, students, government and policy people, industry contacts, NGO leaders and members of the general public. UC CEIN has asked us to partner with them in disseminating environmental toxicity news as a part of this program.

Biannual Newsletter:

CNS-UCSB aims to distribute an electronic newsletter on a regular basis, including research items, education program highlights, past event recaps, upcoming event teasers, and a student spotlight. Distribution will include interested colleagues, students, government leaders and policy makers, industry contacts, nongovernmental organizations and members of the general public. The Center produced one newsletter in Summer 2008 for electronic dissemination and posting on the website. We aim to increase the regularity and frequency of this activity in the coming year.

Conferences:

In its mode of alternating large-scale international conferences (Nano OHS 2007) with smaller, more specialized meetings, CNS collaborated with CNSI to offer the Educators Workshop, September 10-12, 2008, which focused on the topic of designing undergraduate courses that integrate nanotechnology and society. Twenty-two participating science educators and education administrators from 12 different institutions, roughly half from community colleges and half from universities, came to UCSB for the two-day workshop. Examples of NSE education courses focused on societal implications of technologies were featured as presentations, including a presentation by CNS Education Director and two CNS Graduate Fellows. Significant time was dedicated to brainstorming NSE and society curriculum for community college and university audiences, the results of which inform CNS' Educational development plans.

CNS has spent significant time and effort in the current year designing and planning a large international conference entitled Emerging Technologies/Emerging Economies: (Nano)technologies for Equitable Development, to be held in November 2009 in Washington DC to examine nanotechnology applications for solving intractable human problems (for clean water, safe energy, sustainable food, and health) and their implementation in the developing world. The conference organizing team is led by IRG 4 leader, Rich Appelbaum, and includes Fellow Rachel Parker, Director Harthorn, and research Bruce Bimber as well as CNS Assistant Director Gilkes. The group has so far successfully recruited the Woodrow Wilson International Center to co-host the event, has raised funding from UCSB and Rice Univ to support the conference, with a pending supplement request to NSF. Meridian Institute is partnering with CNS as well to provide expert facilitation and planning to fully involve developing world participants. The event will bring approximately 60 participants to the intensive 3-day workshop.

Additionally in Year 4 CNS administered funds and coordinated an NSF Nano in Society PI meeting at the NSF in July 2008. This is the 2nd year in a row NSF has asked CNS-UCSB to host this event.

NanoDays:

CNS participates in "NanoDays," the annual national education effort of the Nanoscale Informal Science Education (NISE) Network. On Saturday, April 5th, 2008, CNS and CNSI co-hosted a

“NanoDays” event for ages 8 and up. The event was held on the UCSB campus in coordination with the Too Small to See 2 interactive museum exhibition at CNSI. Activities designed to engage and promote understanding of the nanoscale and nanotechnology were led by CNS Graduate Fellows who also presented research posters. Over 85 people of all ages and from throughout the local community attended. In 2009 (outside the scope of this report) CNS took NanoDays activities into the community, with one event held on campus and one in downtown Santa Barbara at the local Farmers Market. These events are popular with the public, science students, and social science students, and we anticipate continuing to participate in them.

Public Policy Presentations:

In March 2009 three CNS senior personnel were tapped as nanotechnology societal implications experts and asked to present to policy makers on their work. On March 9, 2009, PI Harthorn gave testimony to the US Congressional Nanotechnology Caucus, about the public and risk perception, based on her group’s research; on March 24, 2009 IRG 3 collaborator Pidgeon was an Invited Expert Witness to the UK House of Lords Science and Technology Committee, Nanotechnologies and Food Inquiry in London. March 24, 2009 also saw Rich Appelbaum, IRG 4 leader, presenting to the US-China Economic and Security Review Commission hearings on China’s Industrial Policy in Washington DC.

Web Site:

The CNS Web site (www.cns.ucsb.edu) serves as the main portal for information dissemination to and contact with the various constituencies the CNS aims to serve and as such requires continual updating. Through this portal we aim to share the tools and resources generated for our own research, education and public outreach programs to a wider audience. Such resources include: identification and links to other researchers and their interests; sharing of emergent publications and bibliographies in annotated and/or classified format; clipping service of public media coverage; all CNS reports and products; and educational resources from UC Santa Barbara and elsewhere, with necessary permissions, such as syllabi of nano-society courses.

In late 2008 CNS developed a web presence (nanoequity2009.cns.ucsb.edu) for the upcoming NanoEquity conference, scheduled for Fall 2009. Work on this virtual presence will continue as the conference program progresses.

The CNS Web site is mounted on our host server in the UC Santa Barbara Institute for Social, Behavioral, and Economic Research (ISBER), which provides a secure and stable backbone for maintenance of our system. Computer and network support from ISBER have enabled us to incorporate new functionalities and information so far, and we have achieved significant economies and efficiencies through this partnership. As data collection increases and collaborations become more extensive around the globe, the need will increase for the CNS to serve as a “collaboratory.” We will continue to review and modify the formats, functionalities and capacities of the Web site to meet its mandate as a clearinghouse. The website links to a blog as well, hosted primarily by PIs McCray and Newfield. This has not been a focus for much activity in the past year (20 blog posts in the past year, as efforts have been redirected on the advice of our Board to following and contributing to blogs that are already well established (e.g., Science Progress, to which McCray has successfully contributed more than once in the past year).

With a recent hire of a new media coordinator, in the coming year we look to further develop tools and processes for engagement with various constituencies.

Media program:

CNS has an active media objective of translating academic results to a general audience, using media contacts and dissemination processes. Media Coordinator Davison, who has direct experience in this area, will take the lead in pursuing these goals.

Publicity:

With each event, publication, or major announcement, CNS-UCSB launches a publicity campaign. This campaign includes wide distribution of a press release to local and trade media; national science editors and reporters; CNS-UCSB collaborators; UC Santa Barbara deans and affiliated faculty; community, business and government leaders; INSN; and the CNS-UCSB National Advisory Board. Efforts are currently being explored to include industry within a wider distribution. Additionally, CNS-UCSB generates occasional podcasts, available on iTunes. These podcasts may be CNS faculty researchers or graduate fellows discussing research, or audio from visiting speakers or public events. CNS researchers also contribute op-ed pieces to various local, regional and national newspapers and blogs. CNS produces a newsletter that is distributed electronically to a widespread audience.

CNS Media Plan for 2009

The primary steps we plan to pursue in the coming year are:

- Increased networking with regional and national media to secure better placement, promotion of CNS news items.
- Better posting of CNS op eds and opinion pieces to other prominent blogs (e.g., *Science Progress*).
- More opportunistic launching and placing of press releases, in a context of rapidly changing news publishing.
- Improving the CNS-UCSB website for more effective interaction and information retrieval, including showcasing CNS research, and developing a rotating segment on student activities.
- Better promotion of the CNS Blog.
- Utilizing analytical tools to track traffic patterns to specific areas of our website.
- Podcasts of CNS events of interest to different groups.
- Assess requirements for implementing new media tools for engagement (e.g., short video clips on research findings of interest to different audiences).

CNS Engagement with Nanoscientists and Engineers

Engagement with nanoscientists and engineers is a central and distinctive aim of the CNS-UCSB. The reasons for engagement are multiple. CNS aims: 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 between nano-science, social science, and society. We have pursued this mission in a number of ways:

- **Executive Committee:** In December 2008 CNS Executive Committee added UCSB MRSEC Director Craig Hawker, a leading nanoscale researcher (former CNSI Director Evelyn Hu preceded Hawker in this role). Hawker is a full participant in decisions and planning for the CNS.

- **National Advisory Board (NAB):** The NAB of the CNS-UCSB was chaired until Dec 2008 by Tom Kalil, UC Berkeley, until he was drafted to join the Obama White House in science and technology policy. Current Board Co-Chair John Seely Brown is extensively involved in nanotech start ups and global nanotech development; the board also includes Rice University nanochemist and national center (CBEN) leader, Vicki Colvin, Harvard nanoscientist and NSEC director, Robert Westervelt, and Martin Moskovits, a leading nanoscience chemist with industry and academic ties. Engineer Susan Hackwood is an engineering professor and leading science policy expert in California as Director of the California Council on Science and Technology Policy.
- **Location and Proximity:** CNS-UCSB is currently partially located in the CNSI building, where our education staff interacts closely with theirs. The CNSI provides formal and informal meeting contexts for CNS and CNSI researchers, students, and staff. Nano-Days was held there in April 2008, and CNS weekly seminars are routinely held in CNSI conference space when outside visitors are involved.
- **Research Program:** All four IRGs of the CNS involve plans for fine grained social science research with nanoscientists and engineers at UCSB and elsewhere. We have collaborative ties with a number of researchers on campus, and we are successfully drawing top science graduate students as applicants to our Research Fellows program; and they come with the endorsement of their advisors, strong evidence of the estimation of the CNS by our colleagues in science and engineering fields.
- In all cases, the NSE community has been receptive to our working with them on this research, has made significant commitments of their time, their students', and their knowledge in support of our work, and the numbers of interactions continue to grow over time. Support letters indicate the extent of this support and its importance to us.
- **Education Program:**
Our recruitment and summer internship programs are closely coordinated with CNSI's, providing a strong, deep interconnection between our two programs, and direct links as well to a number of other acclaimed science education and outreach programs on campus that involve nanoscientists and engineers, for example through the NNIN, of which UCSB is a member, through the MRSEC housed in the Materials Research Laboratory (MRL), and the Let's Explore Physical Science (LEAPS) program, among numerous others.

More directly, and as a result of extensive consultation with campus nanoscientists, the CNS has an interdisciplinary program of CNS Graduate Research Fellowships that involves nanoscale science and engineering graduate students (6 in the reporting year) and social science graduate students (8 in the reporting year) directly in CNS IRG research programs. Fellows work alongside and in close contact with other Fellows and with faculty researchers. Disciplinary differences inform student approaches to the weekly fellows meetings and IRG meetings, and mechanisms to supersede those differences are developed in the collaborative atmosphere fostered by the Center. All CNS Graduate Fellows take an active role in the research, as evinced by the 5 papers or chapters (published or accepted for publication) that CNS graduate students co-authored with CNS senior researchers in the last year. Of those, three publications were in research outside the Fellow's primary discipline, and CNS Fellows were first author on three of the publications.

There is increasing evidence that through their students, faculty scientists are gaining insight into our work, appreciation for our social scientific methods, and enhanced interest in engaging with us. Also nanoscale S&E Fellows demonstrate an ongoing commitment to

CNS, as witnessed by ongoing participation in public engagement events (Ferguson, Rowe) and CNS seminars (Rowe, Ostrowski) after the Fellowship term has ended.

CNS is also involved with CNSI in the innovative education program that gives the opportunity for graduate students in the science, engineering, and the social sciences to formulate a course for undergraduates that integrate nanoscience research (including labs) with the historical and social context in which this technology is being developed. INSCITES (Insights on Science and Technology for Society) funding is provided through an NSF Distinguished Teaching Scholar award to former CNSI Director and former CNS Associate Director for Nanoscience and Co-PI, Evelyn Hu. Again this year CNS Co-PI Patrick McCray co-taught the INSCITES course. Though the funding for this program ends in 2009, a pending NSF STS Proposal would bring INSCITES to community college in collaboration with Santa Barbara City College, and the UCSB Gevirtz School of Education has expressed interest in adopting the course in their new Science and Math Initiative minor.

CNS-UCSB Education Director Dr. Julie Dillemath engaged with a national and international network of NSE educators via a poster presentation at the Global Nanoscale Science and Engineering Education 2008 Workshop (November 2008), which brought together NSE researchers from universities, community colleges, industry, and informal science venues. Plans for the coming year include participating in the NSF-funded Partnership for Nanoeducation Workshop in April 2009, and the Society for the Study of Nanoscience and Emerging Technologies (S.NET) conference in September.

- **Research collaborations between CNS and nanoscientists and engineers:** CNS is a funded partner in the newly funded UC CEIN in which Director Harthorn leads an IRG and serves on the Executive Committee. In addition, Harthorn is again collaborating with Patricia Holden in the Bren school to conduct a 2nd industry survey about safe handling practices for nano materials, to be run in summer & fall 2009. CNS postdoc Johansson is conducting lab ethnography in the NINN facility on campus—the ESB clean room---and CEIN toxicologists' labs. CNS has been asked to partner with Notre Dame on a PIRE program to Ireland, collaborating with former UCSB faculty Jim Merz (pending). And CNS is partner with CNSI on several funding proposals to extend the educational mission.
- **CNS Nanotechnology in Society Network Activities:** Harthorn has regularly participated as CNS-UCSB PI in Nanotechnology in Society Network (NSN) conference calls. With the start up of the new professional society, S.NET, the network is expanding greatly and conference calls are less suitable. PI Harthorn is a founding executive committee member of S.NET, and CNS-UCSB will take a lead role in the new organization, including offering to host a regular annual meeting of the organization in the near future. The network offers many possibilities for dialogue. Again in 2008, CNS-UCSB served as the administrative unit for the NSN PI meeting at NSF (June 2008). Harthorn chaired the session in the 3-day workshop on societal dimensions/impacts. At the request of the NSF, Director Harthorn co-chaired a joint France-US NSF meeting in July 2008 at the French Embassy in Washington, DC, that brought together 60 “young scientists” (including IRG 1 researcher, Cyrus Mody) to discuss nanotechnologies.

Presentations 2008-2009

- 1) Macala, Gerald S. and Kasim Alimahomed. "Nanotechnology and Society," Presentation made on "The Science Guys" radio show, KCSB 91.9 FM in Santa Barbara. March 12, 2009, 8am.
- 2) CNS Fellows/Education Program, Nano Days event, Elings Hall, UCSB, April 5, 2008
- 3) Macala, Gerald S. and Kasim Alimahomed (Carlos Perez and **Christopher J. Newfield**). "From Lab to Society: NanoTech Transfer of Quantum Dots," Poster presented at the Inauguration of spatial@ucsb, Perspectives for Teaching and Research, Corwin Pavilion, University Center, University of California, Santa Barbara. May 29, 2008.
- 4) **Harthorn, Barbara Herr**. US Co-Chair, US-France, Nanotechnologies: The Next Generation, Young Engineering Scientists Symposium 2008. Chair/discussant Societal Dimensions & Impacts sessions. Embassy of France, Washington DC. July 7-9, 2008.
- 5) **Mody, Cyrus C.M.** "Some Early Historical Observations on the Commercialization of Nanotubes," US-France Young Engineering Scientists Symposium 2008, Washington, DC. July 8, 2008.
- 6) Balfour, Beatrice. CNS INSET undergraduate intern presentation, UCSB. August 13, 2008.
- 7) Billones, Brian. CNS INSET undergraduate intern presentation, UCSB. August 13, 2008.
- 8) Bunch, Sarah. CNS undergraduate intern presentation, UCSB. August 1, 2008.
- 9) McCuster, Christian. Sarah. CNS undergraduate intern presentation, UCSB. August 1, 2008.
- 10) Meyer, Dayna. CNS undergraduate intern presentation, UCSB. August 1, 2008.
- 11) Dillemath, Julie, Erica Lively, and Rachel Parker. "Traveling Nanotechnologies' CNS Undergraduate Internship Program Summer 2008." Panel presentation at Educators' Workshop, co-sponsored by CNS and CNSI, UCSB. September 12, 2008.
- 12) **Bimber, Bruce** (discussion leader). *Technological Determinism is Dead; Long Live Technological Determinism*, Chapter 7 of STS Handbook, CNS Graduate Fellow Intensive Training, UCSB. September 23, 2008.
- 13) **Mohr, John** (discussion leader). *A Textbook Case Revisited - Knowledge as a Mode of Existence*, Chapter 4 of STS Handbook, CNS Graduate Fellow Intensive Training, UCSB. September 24, 2008.
- 14) Dillemath, J., **Goodchild, F.** and **Harthorn, B. H.** (2008) "Education and Public Engagement Programs at the Center for Nanotechnology in Society at University of California, Santa Barbara" Poster, Global Nanoscale Science and Engineering Education Workshop, Nov. 13-14, Arlington, VA.
- 15) Dillemath, J., **Harthorn, B. H.** and **Goodchild, F.** (2008) "Traveling Nanotechnologies: an Undergraduate Internship Program in Nanotechnology and Society" Poster, Global Nanoscale Science and Engineering Education Workshop, Nov. 13-14, Arlington, VA.
- 16) **Bimber, Bruce**. Seminar discussion on academic publishing, CNS Graduate Fellows Seminar, UCSB. November 19, 2008
- 17) Billones, Brian. Poster presentation, Sigma Xi: The Scientific Research Society conference, Washington, DC. December 2, 2008.
- 18) Balfour, Beatrice. Poster presentation, Sigma Xi: The Scientific Research Society conference, Washington, DC. December 2, 2008.
- 19) Alimahomed, Kasim. "The Commercialization of Organic Solar Cells," Presentation for Materials Science 287B, Seminar in Organic Semiconductors (Dr. Gui Bazan). December 5, 2008.

- 20) **Harthorn, Barbara Herr.** "Nanotechnologies: Perception of Technological Risk & Constraints on Benefit among Comparative US/UK Publics," Invited faculty lecture, Center for Information Technology and Society, UCSB. January 15, 2009.
- 21) Hurt, Indy. Presentation to the W.E.B. Du Bois Event, annual event to introduce Academic Communities for Excellence (ACE) students to graduate school. February 2009.
- 22) Lively, Erica. "The intersection of nanotechnology and media: why should you care?" Presentation to UCSB undergraduate engineering student group, *Los Ingenieros Meeting*, UCSB. February 26, 2009.
- 23) Johansson, Mikael. "Nano Culture," Presentation to UCSB undergraduate engineering student group, *Los Ingenieros Meeting*, UCSB. February 26, 2009.
- 24) Dilleuth, Julie. "The UCSB Center for Nanotechnology in Society," Presentation to UCSB undergraduate engineering student group, *Los Ingenieros Meeting*, UCSB. February 26, 2009.
- 25) Ferguson, Brian Scott. "Confronting the Impact of our Scientific Research," Presentation to UCSB undergraduate engineering student group, *Los Ingenieros Meeting*, UCSB. February 26, 2009.
- 26) Rowe, Aaron, "Entrepreneurial Nano," Presentation to UCSB undergraduate engineering student group, *Los Ingenieros Meeting*, UCSB. February 26, 2009.
- 27) **Harthorn, Barbara Herr.** "Context Matters in Nanotech Risk Perception Data for Decisionmakers," Testimony given in panel presentation "Data for Decision Makers," US Congressional Nanotechnology Caucus, Washington, DC. March 8, 2009.
- 28) Macala, Gerald S. and Kasim Alimahomed. "Nanotechnology and Society," Presentation made on "The Science Guys" radio show, KCSB 91.9 FM in Santa Barbara. March 12, 2009, 8am.
- 29) **Pidgeon, Nick.** Invited Expert Witness, Nanotechnologies and Food Inquiry, UK House of Lords Science and Technology Committee, Nanotechnologies and Food Inquiry, London, UK. March 24, 2009
- 30) **Appelbaum, Richard.** Testimony on China's Investment in Nanotechnology and Its Likely Impact on the U.S., US-China Economic and Security Review Commission hearing on China's Industrial Policy, Russel Senate Office Bldg, Washington, D.C. March 24, 2009.

13. SHARED AND OTHER RESEARCH FACILITIES

The infrastructure needs for the societal implications research proposed by CNS-UCSB in the renewal phase are well met through UCSB and partner organizations.

1) CNS-UCSB

The main facility for CNS in the first period has been a set of research and administration offices at UCSB in North Hall and the California NanoSystems Institute. As noted in our last external site visit (2007), the dispersed nature of these offices has been less than ideal for running a collaborative interdisciplinary center. We have overcome these potential problems by structuring frequent face-to-face meetings and informal gatherings, in addition to the regular seminar group meetings. However, beginning in 2010, well before the beginning of the renewal period in 2011, the CNS will relocate into a suite of contiguous offices, staff and infrastructure, and conference space in a centrally located building on campus that will allow more effective coordination and communication among all participants. This commitment of space by the Executive Vice Chancellor, Vice Chancellor for Research, and Dean of Social Sciences to the CNS on our very space-starved campus is a strong mark of support for our interdisciplinary research and education efforts. We will continue to have shared access to space for meetings, conferences, seminars, and other gatherings in shared use spaces within the Institute for Social, Behavioral & Economic Research (ISBER) in North Hall. ISBER additionally provides the 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 capacity.

2) California NanoSystems Institute (CNSI)/Materials Research Laboratory (MRL) (UCSB)

The CNSI offers a unique set of resources that will contribute to the collaborative, interdisciplinary nature of the Center. Completed early in the first 5 years of support, CNSI is a dedicated Institute building that serves as a state-of-the-art laboratory facility and hub for the many nanoscientists 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 (www.nanotech.ucsb.edu) 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. Three offices of the CNS are currently located in the CNSI building, providing CNS researchers and educational outreach with direct access to the nanoscience research community and the public. Although CNS's relocation to consolidated space in another building will remove us from direct daily contact with CNSI personnel, the foundation created by our residence there for several years of the first period will endure, and we will 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, <http://www.mrl.ucsb.edu/>, and related websites.

3) 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 new spatial center's director, Michael Goodchild, is a key advisor and resource for the CNS. In its new configuration, spatial@ucsb, the center provides free consulting services on GIS, cartographic and other spatial research. In the renewal period, 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.)

4) 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 in IRG 2 (and IRG 3, formerly), and Associate Director, sociologist Paolo Gardinali. It is currently housed in 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 support services for CNS deliberative workshops, web and phone survey, and data analysis consulting. They will move into a new social science building in 2009, which will provide more space and increase their capacity for service. Campus research services infrastructure greatly reduce the cost of such data acquisition while providing a reliable and IRB-safe mode. For more information see <http://www.survey.ucsb.edu>

5) 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. 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. 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. <http://cits.ucsb.edu/>

6) 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 4's work on nanotechnology, globalization and E. Asia, as well as to the CNS undergraduate education program's project of the Global Value Chain. See <http://www.cggc.duke.edu/>

7) Chemical Heritage Foundation (CHF), Philadelphia

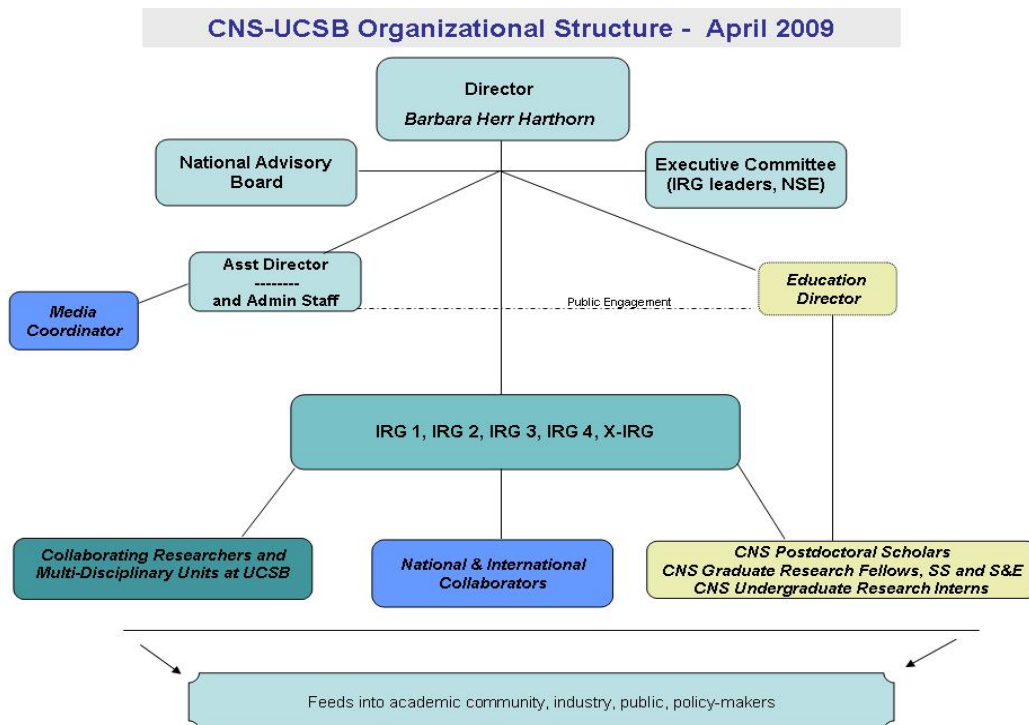
The Chemical Heritage Foundation is a library, museum, and center for scholars. Located in Philadelphia, CHF maintains world-class collections, including instruments and apparatus, rare books, fine art, and the personal papers of prominent scientists, all related to the chemical and molecular sciences. 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 collaborator, Cyrus Mody, and current home to IRG 1 new collaborator Hyungsub Choi. 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, and currently partners with CNS in the publication of a series of commissioned research briefs, including some involving CNS researchers. <http://www.chemheritage.org/>

8) The Jenkins Collaboratory, Duke University (Tim Lenoir) is a 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. <http://www.jhfc.duke.edu/jenkins/>

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 (1.0 FTE), an Education Director (.65 FTE), a Media Coordinator (0.5 FTE), a Financial Analyst/Events Coordinator (1.0 FTE), a Travel and Purchasing Administrative Assistant (.5 FTE) and a Computing Specialist (.25 FTE). Harthorn is assisted by 5 additional co-PIs (Appelbaum, Bimber, Hawker, McCray, Newfield) on the CNS Executive Committee, on which the CNS Assistant Director and Education Director serve *ex officio*. The 4 IRG leaders (McCray, Newfield, Harthorn, and Appelbaum) are all located on the UCSB campus and meet frequently with their IRG research teams, so IRG leaders can integrate their research issues and needs through the Exec and regular senior researcher meetings.

Dr. Harthorn is responsible for all official agency contact with the CNS-UCSB, for 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' 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 PI, Dr. Harthorn also represents the CNS in NSF Nanotechnology in Society Network and NSEC interaction. The Executive Committee meets monthly or more often on a face to face basis, dialing in those who may be off site, and communication takes place on an almost daily basis on matters practical and intellectual.



Changes in the current reporting period and the renewal period

Executive Committee.

(i) In Spring 2008, Evelyn Hu announced her plans to step down as Director of the CNSI (effective July 1, 2008) and that she would be leaving UCSB in 2009 to move to Harvard University. She was co-PI of the CNS, our Associate Director for Nanoscience, a member of our Executive Committee, and a trusted advisor on many important matters. While we were very sorry to lose her from the CNS and campus, we have been most fortunate that Dr. Craig Hawker, Director of the UCSB Materials Research Laboratory (MRSEC) and Professor of Chemistry and Materials, has agreed to serve in her place on the CNS Executive Committee (he began in late 2008). Dr. Hawker came to UCSB in 2004 after 11 years as a scientist at the IBM Almaden Research Center in San Jose, CA. He brings a distinguished career, industry as well as academic experience, and a commitment to solving energy problems through technological development to the CNS. We anticipate his involvement will enable new connections for the CNS on the engineering and physical side of campus, and we are grateful for his willingness to contribute time and effort to the CNS.

Staffing.

(i) Assistant Director. In our 2007 external review, the site team strongly recommended the addition of a new senior staff position to the CNS to provide executive 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. Director Harthorn applied to NSF for a supplement for this position in Summer 2007 (unsuccessful) and again in Fall 2007, which was awarded in Spring 2008 (year 3). Following a successful and highly competitive recruitment, CNS hired Barbara Gilkes to serve as CNS Assistant Director. She brought extensive university and international experience to the position as a former Regional Director for Latin America and Spain of the UC systemwide Education Abroad Program. She began work in June 2008. The addition of her position has made an immediate, significant difference to the capable running of the CNS and particularly to the Director's work overload situation identified by the review team as a problem requiring intervention.

Accomplishments to date include that Assistant Director Gilkes has: maximized use of our existing space, better to facilitate research and allow admin staff to support research and outreach efforts; converted (in progress) to financial tracking program that is tied into UCSB automated systems, to improve efficiencies and reduce redundancies; provided consistent admin core during frequent and necessary travel of the CNS Director; coordinated the recruitment process of three new post-doctoral positions, enabling fully open recruitment (contributes to Center diversity); restructured staffing on an expertise basis to contribute to the Center's increased sophistication in areas such as large-event coordination, media outreach, and networked-research support; expanded CNS networking among administrative units on campus (and beginning to do this nationally), to identify areas for increased operational efficiencies, and better connect CNS to other key research and administrative units on campus. In the future she will move to make these connections on a national level, consistent with CNS-UCSB's role as a national center.

(ii) Education Director. In the first 3 years of CNS (2006-2008), Dr. Fiona Goodchild, Director of Education for the CNSI, allocated a portion of her time throughout the year as CNS Associate Director of Education. In 2007, she recruited and hired Ms. Julie Dilleuth to work as Education Coordinator. Dr. Goodchild is choosing to conclude this phase of a long and award-winning career by retiring in June 2009. In anticipation of this change, CNS moved to promote Ms.

Dillemuth, now Dr. Dillemuth, in January 2009, to assume the Education Director position. Dr. Fiona Goodchild has agreed to continue on in a consulting capacity to CNS and to Education Director Dillemuth indefinitely.

(iii) Media Coordinator. After extensive analysis and close consultation with the Executive Committee, Assistant Director Gilkes determined in Fall 2008 that the experimental configuration (since June 2007) of a combined media coordinator/event coordinator held by Ms. Valerie Walston was not effective. We reduced the position to a half-time media position (with event coordination duties reallocated to Analyst Marisol Cedillo-Dougherty, as part of the reorganization resulting from the Assistant Director position creation). When Ms. Walston resigned in December 2008, we commenced recruitment for a replacement, concluding an extraordinarily competitive process with a hire at the beginning of March 2009 of Ms. Anna Davison, a highly experienced science and technology journalist and environmental policy analyst. Ms. Davison brings expertise and know how to the CNS that we have long needed, and we anticipate expediting CNS' proposed moves farther into new media, improved relations with local and national press, and a skilled interlocutor to help us translate our research into suitable language and venues for public, industry, government, and NSE accessibility and engagement.

CNS leverages NSF resources in a number of ways to achieve savings without sacrificing capability. UCSB cash contribution to the CNS covers almost much of staff salaries and fringe benefits except the Assistant Director's. CNS staff draws 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.

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). Previous CNS Board Chair, **Tom Kalil**, stepped down in Dec 2008 to take up a new high ranking post for Obama's White House. Board members **John Seely Brown** and **Julia Moore** agreed to take over as Board Co-Chairs in January 2009. The board meets annually 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. We do plan to seek suggestions from the Board at our upcoming meeting (Apr 20-21, 2009) for possible additions to the Board to increase representation from key nodes for the renewal period such as industry, NGOs and government.

Center as Infrastructure for Societal Implications Researchers

CNS-UCSB co-hosted with the NSF the Nano in Society Pls meetings in Arlington, Mar 15-16, 2007 and Jul 28-29, 2008. This has entailed submission of supplement requests by PI Harthorn for the funds to hold the meetings, coordination with NSF staff for the hosting of the event, and reimbursement processing by CNS staff of all travel expenses for the approximately 30

participants in each meeting. Thus the infrastructure investment by NSF in the CNS-UCSB is benefiting a wider community of scholars and researchers, and the multi-agency NNI as well.

Management and operation of Research Program

CNS has established an effective infrastructure for managing the collaborative research efforts of the CNS. CNS' base on a single campus simplifies these processes.

- Executive Committee meetings on a monthly basis allow reporting to the group of both administration and research issues
- IRG meetings take place on a roughly weekly basis at UCSB, often dialing in collaborators for teleconference participation.
- The CNS Graduate Seminar meets weekly or bi-weekly and provides an established forum for sharing of research issues, regular rotating presentations by senior personnel and grads, for discussion and training on research methods, IRB issues, as well as informal interaction
- Grad Fellows work together in common space, which facilitates information sharing across the groups
- 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
- Annual Research Summit meets for 2 full days and allows free flow of ideas among all CNS collaborators, students, and personnel.
- Management of projects—CNS requires quarterly reporting and invoicing from all subcontractors and IRGs.
- IRB—CNS operates under a blanket human subjects protocol in PI Harthorn's name and individual project approvals, at UCSB and other campuses as appropriate. Staff maintain a centralized database to ensure full compliance, upcoming expirations of existing protocols.
- Annual process for IRG budget review and allocation—CNS Director Harthorn solicits annual budget proposals for 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.
- 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
- Funder required annual reporting and site visits provide significant impetus to aggregate and synthesize data within and between research groups

Clear and regular communication is essential to the management of any organization. To achieve this end, CNS-UCSB researchers and staff are in regular communication with one another. 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. We hope in the future to increase the cyberinfrastructure of the CNS for more effective data sharing and project report generation.

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 formatively and summatively at several levels of aggregation: within each working group on a regular (monthly to quarterly basis), at the steering committee level also on a quarterly basis, and at the level of the National Advisory Board on an annual basis.

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 monthly at UCSB and quarterly from all subcontractors/collaborators. Quarterly progress reports by the working group project leaders are circulated to the full CNS executive committee. Monthly face-to-face meetings of the Executive Committee have proven invaluable for appraising progress toward goals. Additional meetings among working group personnel are also ongoing, both to coordinate research within groups and to integrate efforts between groups. The education and outreach program also provides quarterly reports, monthly updates, weekly or biweekly meetings with all graduate fellows and postdocs, and provides extensive programmatic support to undergraduate interns. (See Education and Outreach Program section for specific education program evaluation methods and goals.)

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 or more frequent 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, other senior personnel, staff, and students, primarily by electronic media. We are using on-line methods to facilitate this process as possible.

The CNS staff members are involved in the monthly Executive Committee meetings and managed on a day-to-day basis by the Assistant Director, under the Director's general oversight. Education program staff have been supervised by the Associate Director of Education in the past, with the shift to an Education Director effective Jan 2009. Staff are being provided with extensive assistance and managerial oversight by the experienced and knowledgeable professional staff of the Institute for Social, Behavioral, and Economic Research (and, in the case of the Education Coordinator/Director, the CNSI), with whom they occupy adjacent space. Regular work performance evaluation is mandated for all as 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, manager and director are in near daily consultation about budget matters, and, as needed, with all personnel, subcontractors, and service providers.

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), annual meetings with the NAB, the annual Research Summit instituted in 2008, and an annual retreat of principals and staff. 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 in Santa Barbara and provides detailed commentary, advice, and criticism both in person and in a written report. A key part of the NAB process is 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. NSF observers are invited to attend these meetings as observers, and, if the NAB is willing, are free to provide commentary.

NSF annual reviews provide an opportunity for summative evaluation. Annual retreats of the CNS Executive Committee and staff follow the NSF site review process. In 2008, the CNS held a day-long retreat in mid-July to discuss the plans for the renewal period, considerations from the 2008 site visit, site visit report, and NAB meeting.

Additional summative measures are drawn at any natural junctures, for example, the completion of a particular research program, or the completion of a round of fellows. Entry and exit interviews are being conducted with all graduate fellows as they begin and complete their fellowships, and follow up on all fellows will be pursued on an annual basis to track effects of their involvement in the CNS program. Similar assessment of interns' experiences and knowledge acquisition is being conducted as they begin and conclude participation.

Prepare to meet changing conditions, emerging issues

This challenge of meeting changing conditions is particularly great in the context of studying nanotechnology in society, as the issues are far ranging and many of them still in development. Uncertainty about public reception to emerging technologies complicates this picture. We will be tracking change, both in the nanoscience and in the social world, and we will address these issues as they emerge. In particular, IRG 3 is tracking media uptake of nano and society, emerging social group formation and action, and fluctuations in public perceptions. These data do provide empirical data about the changing economic, political and social worlds in which nanotechnologies will unfold. The annual rotation of grad fellows provides one mechanism to respond to new research opportunities. Our new postdoctoral researcher program also brings in new scholars and new ideas. The annual National Advisory Board meeting is a particularly important context for discussing, brainstorming, and troubleshooting new ideas and new directions for the CNS.

Table 4: NSEC Personnel		Race: regardless of citizenship status										Citizenship Status		Ethnicity: Hispanic		Disabled
Personnel Type	Total	Gender		NA	PI	AA	C	A	Mixed - inc. NA, PI, AA	Mixed - C, A	Not Provided	US/Perm	Other Non-U.S.	US/Perm	Non-US	
		Male	Female													
Leadership, Administration/Management																
Subtotal	14	5	9	0	0	0	12	0	0	0	2		0	2	0	0
Director(s)1	1		1				1									
Thrust Leaders1	5	4	1				5									
Administrative Director and Support Staff	8	1	7				6				2			2		
Research																
Subtotal	61	43	18	0	0	3	19	3	0	2	34		6	2	0	0
Senior Faculty1	26	22	4				3	1			22		1			
Junior Faculty1	3	3					1			1	1					
Research Staff	2	2						1			1		1			
Visiting Faculty1	0															
Industry Researchers	1		1								1					
Postdocs1	5	4	1				3	1			1		2			
Doctoral Students1	21	11	10			2	11			1	7		2	2		
Master's Students1	0															
Undergraduate Students1	3	1	2			1	1				1					
Curriculum Development and Outreach																
Subtotal	0	0	0	0	0	0	1	0	0	0	0		0	0	0	0
Senior Faculty1	0															
Junior Faculty1	0						1									
Research Staff	0															
Visiting Faculty1	0															
Industry Researchers	0															
Postdocs1	0															
Doctoral Students1	0															
Master's Students1	0															
Undergraduate Students1	0															
REU Students																
Subtotal	5	2	3	0	0	0	1	0	1	1	1		0	0	0	0
NSF REU Program1	0															
NSF/NSEC Program REU1	5	2	3			1	1		1	1	1					
NSEC's Own REU	0															
Other Visiting College Students1	0															
Precollege (K-12)																
Subtotal	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
Students	0															
Teachers—RET	0															
Teachers—Non-RET	0															
Total	80	50	30	0	0	0	4	33	3	1	3	37	6	4	0	0

15. PUBLICATIONS

2008-09

Papers in Journals: 13 published; 3 forthcoming; 6 under review

Chapters in Books: 3 published; 3 forthcoming; 3 under review

Conference Proceedings: 1 forthcoming

Other: 5

15-A: PAPERS IN JOURNALS

- Rogers-Hayden, Tee, & Pidgeon, Nick** (2008). "Developments in Public Participation in Nanotechnology: towards Sustainability." Nanotechnology Development in Light of Sustainability H Kastenholz and A Helland (eds.). *Journal of Cleaner Production, Special Issue* 16: 1010-1013.
- Conti, Joseph A.**, Killpack, Keith, Gerritzen, Gina, Huang, Leia, Mircheva, Maria, Delmas, Magali, **Harthorn, Barbara Herr, Appelbaum, Richard P.** and **Patricia A. Holden** (2008). "Health and Safety Practices in the Nanotechnology Workplace: Results from an International Survey." *Environmental Science & Technology*. 42(9): 3155-3162. [Online publication April 2008, 10.1021/es702158q]
<http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/asap/abs/es702158q.html>
- Appelbaum, Richard** and Parker, Rachel (2008). "China's Bid to be a Global Nanotech Leader: Advancing Nanotechnology Through State-Led Programs and International Collaborations" *Science and Public Policy* 35(5): 319-334.
- Mody, C.M** (2008). "The Larger World of Nano." *Physics Today* 61 (10): 38-44.
- Weaver, D., and **Bimber, B.** (2008) "Finding news stories: A comparison of searches using LexisNexis and Google News." *Journalism and Mass Communication Quarterly* 83 (3):515-530.
- Hegde, Deepak, and **Mowery, David C.** (2008). "Politics and Funding in the U.S. Public Biomedical R&D System" *Science* 322 (5909) 1797-1798.
- McCray, W. Patrick** (2009). "How Spintronics Went from the Lab to the iPod." *Nature Nanotechnology* 4 (1): 1-3. [Online publication doi:10.1038/nnano.2008.380
<http://www.nature.com/nnano/journal/v4/n1/full/nnano.2008.380.html>]
- Ostrowski, Alexis D., Martin, Tyronne, Conti, Joseph, Hurt, Indy and **Harthorn, Barbara Herr** (2009). "Nanotoxicology: characterizing the scientific literature, 2000–2007." *Journal of Nanoparticle Research* 11:251-257.
- McCray, W. Patrick** (2009). "From Lab to iPod: A Story of Discovery and Commercialization in the Post-Cold War Era." *Technology and Culture* 50 (1): 58-81.
- Pidgeon, Nick, Harthorn, Barbara**, Bryant, Karl, Rogers-Hayden, Tee (2009). "Deliberating the risks of nanotechnologies for energy and health applications in the United States and United Kingdom." *Nature Nanotechnology* 4 (2):95-98. [Online publication 7 Dec 2008, DOE 10.1038/NNANO]. <http://www.nature.com/nnano/journal/v4/n2/full/nnano.2008.362.html>
- Choi, Jae-Young, Gurumurthy Ramachandran, and **Milind Kandlikar** (2009). "The Impact of Toxicity Testing Costs on Nanomaterial Regulation." *Environmental Science and Technology, Article ASAP* • DOI: 10.1021/es802388s • Publication Date (Web): 20 February 2009, <http://pubs.acs.org/doi/full/10.1021/es802388s>
- Hyungsub Choi** and **Cyrus C.M. Mody** (2009). "The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology." *Social Studies of Science* 39 (1): 11-50.
<http://sss.sagepub.com/cgi/content/abstract/39/1/11>
- Mowery, David C.** (2009). "Plus ça change: Industrial R&D in the 'Third Industrial Revolution.'" *Industrial and Corporate Change*, vol. 18, #1.

Forthcoming, 2009

W. Patrick McCray. "Over the Red Brick Wall: Spintronics, Novelty, and Over-the-Horizon Technologies," Forthcoming. *Technology and Culture*, accepted April, 2008.

Mowery, David C., "Pioneering Inventors or Thicket-Builders: Which U.S. Firms use Continuations in Patenting?" (with D. Hegde and S.J. Graham). *Management Science* (forthcoming)

Godwin, H., K. Chopra, K. Bradley, Y. Cohen, **B. Harthorn**, E. Hoek, P. Holden, A. Keller, H. Lenihan, R. Nisbet, A. Nel . The University of California Center for the Environmental Implications of Nanotechnology. *Environmental Science & Technology* (Forthcoming, 2009).

Under Review, 2009

Lenoir, Tim. "Tracking the Current Rise of Chinese Pharmaceutical Bionanotechnology,"(with Patrick Herron) submitted to *Journal of Biomedical Discovery and Innovation*.

Satterfield, Theresa, Milind Kandlikar, Christian Beaudrie, Joseph Conti, and **Barbara Herr Harthorn.** "Anticipating the Perceived Risk of Nanotechnologies: Will They Be Like Other Controversial Technologies?" Under review at *Nature Nanotechnology* 2009.

Weaver, David, Lively, Erica, and **Bimber, Bruce** (2009). "Searching for a frame: Media tell the story of technological progress, risk, and regulation in the case of nanotechnology." (Under review).

Mowery, David C., "National Security and National Innovation Systems." *Journal of Technology Transfer* (under review 2009).

Mowery, David C., "Alfred Chandler and knowledge management within the firm," *Industrial and Corporate Change* (submitted).

Mowery, David C., "Innovation, Path-Dependency, and Policy: The Evolution of Norway's National Innovation System" (with J. Fagerberg and B. Verspagen), *Science and Public Policy* (submitted 2008).

15-B: CHAPTERS IN BOOKS

Pidgeon, Nick (2008). "Risk, uncertainty and social controversy: from risk perception and communication to public engagement." In *Uncertainty and Risk: Multidisciplinary Perspectives* G. Bammer and M. Smithson eds. pp. 349-361. London: Earthscan.

Mody, Cyrus C.M. (2008). "Instruments of Commerce and Knowledge: Probe Microscopy, 1980-2000" In *Science and Engineering Workforce Project Proceedings*, edited by Richard Freeman and Daniel Goroff. Chicago: University of Chicago Press.

Cao, Cong, Suttmeier, Richard P. and Simon, Denis Fred (2009). "Success in State Directed Innovation? Perspectives on China's Plan for the Development of Science and Technology." In *The New Asian Innovation Dynamics: China and India in Perspective* Govindan Parayil and Anthony P. D. Costa eds. pp. 247-264. London: Palgrave Macmillan.

Forthcoming, 2009

Lenoir, Timothy and Gianella, Eric (2008). "Technological Platforms and the Layers of Patent Data." In *Con/Texts of Invention: Creative Production in Legal and Cultural Perspective* Eric Giannella, Mario Biagioli, Peter Jaszi, Martha Woodmansee, Eds. Chicago: University of Chicago Press (in press).

Newfield, Christopher, "Is the Corporation a Social Partner? The Case of Nanotechnology." In *Cultural Critique and the Global Corporation*, ed. Purnima Bose and Laura E. Lyons (Indiana University Press, forthcoming 2009).

Putnam, L., Kisselburgh, L.G., Berkelaar, B.L., Buzzanell, P.M., Mastronardi, M., Jackson, M., Stoltzfus, K., Jorgenson, J., & Wang, J. "21st century STEM careers: Communication

perspectives and research opportunities.” In L. Harter & M.J. Dutta eds. *Engaging Communication Theory, Research, and Pedagogy to Communicate for Social Impact*. Hampton Press (forthcoming).

Under Review, 2009

Newfield, Christopher, “Fixing the Developmental University: the Case of the National Nanotechnology Initiative,” in Fred Block and Matt Keller, *State of Innovation: U.S. Federal Technology Policies, 1969-2008* (under review at Cornell University Press)

Appelbaum, Richard, Rachel Parker, **Cong Cao**, and **Gary Gereffi**, “China’s (Not So Hidden) Developmental State: Becoming a Leading Nanotechnology Innovator in the 21st Century,” to appear in Fred Block and Matt Keller, *State of Innovation: U.S. Federal Technology Policies, 1969-2008* (under review at Cornell University Press)

Mowery, David C., “What Does Economic Theory Tell us about Mission-Oriented R&D?” in D. Foray, ed., *The New Economics of Technology Policy* (under review).

15-C: CONFERENCE PROCEEDINGS

Mowery, David C., “Notes on IPR and US economic ‘catchup’,” presented at the Graduate Institute for Policy Studies conference on “Intellectual Property Rights and Economic ‘Catchup,’” Tokyo, Japan, November 16-17, 2008 (forthcoming in conference proceedings to be published by Oxford University Press, 2009).

OTHER (Book Reviews, Commentary, Opinions, Letters to Editor, Technical Reports)

Rogers-Hayden, T. and **Pidgeon, N.F.** (2008). Upstream engagement. *Science and Public Affairs* June: 11.

Mody, Cyrus C.M (2008). “How I Learned to Stop Worrying and Love the Bomb, the Nuclear Reactor, the Computer, Ham Radio, and Recombinant DNA.” *Historical Studies in the Natural Sciences* 38 (3): 451-461.

McCarty, Philip, Lively, Erica, Weaver, David, Mohr, John, and **Bimber, Bruce** (2008). The role of governmental and non-governmental institutions in framing nanotechnology as a social issue. Technical Working Paper.

McCray, W. Patrick (2008). “It’s Like That, Only Different,” *Science Progress*.

Mody, Cyrus and **McCray, W.Patrick** (2009). “Big Whig History and Nano Narratives: Effective Innovation Policy Needs the Historical Dimension.” Opinion in *Science Progress*, April 6. <http://www.scienceprogress.org/2009/04/big-whig-history-and-nano-narratives/>

16. BIOGRAPHICAL INFORMATION, New Senior Personnel

BIOGRAPHICAL SKETCH

CRAIG J. HAWKER

Professional Preparation.

University of Queensland, Aust
University of Cambridge, UK

Chemistry
BioOrganic Chemistry

B.Sc. 1984
Ph.D. 1988

Appointments.

2004-present	Professor of Materials, Chemistry and Biochemistry, University of California, Santa Barbara; Director of Materials Research Laboratory
1993-2004	Research Staff Member, IBM Almaden Research Center
1990-1993	Associate Professor, Department of Chemistry, University of Queensland, Australia
1988-1990	Post-doctoral Research Assistant, Cornell University, Department of Chemistry.

Current NSF grants

Materials Research Science and Engineering Center at UCSB, DMR 0520415,
10/01/2005 – 9/30/2011
IGERT: ConvEne -- Conversion of Energy Through Molecular Platforms, 08/01/2008 –
07/31/2009
Highly Efficient and Versatile Synthesis of Polymeric Materials Using Click Chemistry,
03/01/2005 – 07/31/2009

Publications (out of 280 peer reviewed and 42 patents)

List of 5 publications most closely related to the proposed project:

Tang, C.; Lennon, E.M.; Fredrickson, G.H.; Kramer, E.J.; Hawker, C.J. "Evolution of Block Copolymer Lithography to Highly Ordered Square Arrays", *Science*, 2008, 322, 429 – 432.

Killops, K.L.; Campos, L.M.; Hawker, C.J. "Robust, efficient, and orthogonal synthesis of dendrimers via thiol-ene "Click" chemistry", *J. Am. Chem. Soc.*, 2008, 130, 5062-5064.

Fukukawa, K.I.; Rossin, R.; Hagooly, A.; Pressly, E.D.; Hunt, J.N.; Messmore, B.W.; Wooley, K.L.; Welch, M.J.; Hawker, C.J. "Synthesis and characterization of core-shell star copolymers for in vivo PET imaging applications", *Biomacromolecules*, 2008, 9, 1329-1339.

Shi, Q.; An, Z.; Tsung, C.K.; Liang, H.; Zheng, N.; Hawker, C.J.; Stucky, G.D., "Ice-Templating of Core/Shell Microgel Fibers through "Bricks-and-Mortar" Assembly", *Adv. Mater.*, 2007, 19, 4539-4543.

Kim, Bumjoon J.; Bang, Joona; Hawker, Craig J.; Chiu, Julia J.; Pine, David J.; Jang, Se Gyu; Yang, Seung-Man; Kramer, Edward J.; "Creating surfactant nanoparticles for block copolymer composites through surface chemistry", *Langmuir*, 2007, 23, 12693-12703.

Graduate and Postdoctoral Advisors:

Sir Alan Battersby, Ph.D. Advisor (University of Cambridge)
Professor Jean M. J. Fréchet, Postdoctoral Advisor (University of California, Berkeley)

BIOGRAPHICAL SKETCH

CYRUS C.M. MODY

History Department, MS #42
Rice University
PO Box 1892
Houston, TX 77251-1892

Professional Preparation:

- Ph.D. Science and Technology Studies, Cornell University – Ithaca, NY (2004)
- M.A. Science and Technology Studies, Cornell University – Ithaca, NY (2000)
- A.B. Engineering Sciences, Harvard University – Cambridge, MA (1997)

Appointments:

2007 – Present	Assistant Professor, Department of History, Rice University, Houston, TX
2005 – 2007	Program Manager, Chemical Heritage Foundation, Philadelphia, PA
2004 – 2005	Gordon Cain Fellow, Chemical Heritage Foundation, Philadelphia, PA

Area of Professional Expertise:

History of modern science and engineering; applied history for policy; laboratory ethnography; oral history.

No Current NSF grants

Selected Publications:

1. Choi, Hyungsub & Mody, Cyrus C.M., "The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology", *Social Studies of Science*, 39, 11-50, 2009.
2. Mody, Cyrus C.M., "The Larger World of Nano", *Physics Today* 61.10, 38-44, 2008.
3. Mody, Cyrus C.M., "Corporations, Universities, and Instrumental Communities: Commercializing Probe Microscopy, 1981-1996", *Technology & Culture* 47, 56-80, 2006.
4. Mody, Cyrus C.M., "Small, But Determined: Technological Determinism in Nanoscience", *Hyle* 10, 99-128, 2004.

Graduate advisors and post-doctoral sponsors

Michael Lynch (Cornell, graduate advisor)
Ronald Kline (Cornell, graduate committee member)
Trevor Pinch (Cornell, graduate committee member)
Arthur Daemmrich (Harvard, postdoctoral mentor)

BIOGRAPHICAL SKETCH

CONG CAO

Professional Preparation

Shanghai Institute of Chemical Engineering, P. R. China

Diploma (Analytical Chemistry), 1981

Institute of Scientific and Technical Information of Shanghai, P. R. China

M.S. (Science and Technology Policy), 1989

Columbia University

M.A., 1992; M.Phil., 1996; Ph.D. (Sociology), 1997

University of Oregon

Postdoctoral Training (Science and Technology Policy and China Studies), 1997–2001

Areas of Expertise

Science, technology, and innovation policy; technological entrepreneurship; sociology of science/social studies of science and technology; China studies; media studies; social science research methods.

Appointments

Senior Research Associate, Neil D. Levin Graduate Institute of International Relations and Commerce, State University of New York, 2005–present; Coordinator, Global Talent Index™ Project, 2007–present; Director, Center for Science, Technology, and Innovation in China, 2008–present.

Research Associate, Center for Asian and Pacific Studies, University of Oregon, 2004–2006.

Research Fellow, East Asian Institute, National University of Singapore, 2002–2004.

Research Associate, Center for Asian and Pacific Studies, University of Oregon, 1997–2001.

Research Assistant and Teaching Assistant, Columbia University, 1992–1995.

Science and Technology Policy Analyst, Research Center for S&T Policy, Institute of Scientific and Technical Information of Shanghai, P. R. China, 1986–1991.

No Current NSF grants

Publications Most closely related

Cong Cao. 2004. China's Scientific Elite. London and New York: RoutledgeCurzon.

Richard P. Suttmeier and Cong Cao. 2004. "China's Technical Community: Market Reform and the Changing Policy Cultures of Science." Pp. 138–157 in Chinese Intellectuals between Market and State, edited by Edward Gu and Merle Goldman. London and New York: RoutledgeCurzon.

Cong Cao, Richard P. Suttmeier, and Denis Fred Simon. 2006. "China's 15-Year Science and Technology Plan." Physics Today December:38–43.

Richard P. Suttmeier, Cong Cao, and Denis Fred Simon. 2006. "'Knowledge Innovation' and the Chinese Academy of Sciences." Science 312:58–59.

Denis Fred Simon and Cong Cao. 2009. China's Emerging Technological Edge: Assessing the Role of High-End Talent. Cambridge and New York: Cambridge University Press.

Doctoral and Post Doctoral Dissertation Advisors

Jonathan R. Cole, Columbia University; Harriet Zuckerman, Andrew Mellon Foundation (Doctoral Dissertation Advisors).

Richard P. Suttmeier, University of Oregon (Post-Doctoral Advisor).

BIOGRAPHICAL SKETCH

HYUNGSUB CHOI

Professional Preparation

Seoul National University	Materials Science & Eng.	BS 1998
Georgia Institute of Technology	History of Technology	MS 2002
Johns Hopkins University	History of Science	PhD 2007

Area of Professional Expertise

History of Science

Appointments

2007-present	Senior Manager, Innovation Studies, Center for Contemporary History and Policy, Chemical Heritage Foundation
2006-2007	Program Manager, Electronic Materials, Center for Contemporary History and Policy, Chemical Heritage Foundation

No Current NSF grants

Publications

Hyungsub Choi and Cyrus C. M. Mody, "The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology," *Social Studies of Science* 39 (February 2009): 11-50.

Hyungsub Choi and Chigusa Kita, "Hiroshi Wada: Pioneering Electronics and Computer Technologies in Postwar Japan," *IEEE Annals of the History of Computing* 30 (July - September 2008): 84-89.

Hyungsub Choi, "Technology Importation, Corporate Strategies, and the Rise of the Japanese Semiconductor Industry in the 1950s," *Comparative Technology Transfer and Society* 6 (August 2008): 103-126.

Hyungsub Choi, "The Boundaries of Industrial Research: Making Transistors at RCA, 1948-1960," *Technology and Culture* 48 (October 2007): 758-782.

Hyungsub Choi, "Rationalizing the Guerilla State: North Korean Factory Management Reform, 1953-1961," *History and Technology* 20 (March 2004): 53-74.

Graduate and Postdoctoral Advisors

Stuart W. Leslie, Johns Hopkins University
Louis Galambos, Johns Hopkins University
John Krige, Georgia Institute of Technology
Steven W. Usselman, Georgia Institute of Technology

BIOGRAPHICAL SKETCH

WILLIAM R. FREUDENBURG

freudenburg@es.ucsb.edu

Dehlsen Professor of Environment and Society, UCSB

Phone: 805-893-8282 Fax: 805-893-8686

Professional Preparation:

Undergraduate University of Nebraska-Lincoln BA1974, Integrated Studies/Communication
Graduate Yale University, Sociology MA1976, M.Phil.1977, Ph.D.1979

Areas of Professional Expertise:

Risk Assessment/Management; Risk Perception; Hazards and Disasters; Society-Environment Relationships; Resource-Dependent Communities and Regions

Appointments:

2002-present Dehlsen Professor of Environmental Studies and Sociology, UCSB
1986-2002 Associate Professor/Professor, Department of Rural Sociology and Institute of Environmental Studies (IES), Univ. Wisconsin-Madison.
1984-1985 Visiting Associate Professor, University of Denver.
1983-1984 American Sociological Association Congressional Fellow, Committee on Energy and Commerce, U.S. House of Representatives.
1978-1986 Assistant /Associate Professor, Dept. Rural Sociology, Washington State Univ.

Current NSF Grants

NSF/EPA CEIN-Predictive Toxicological Assessment and Safe Implementation of Nanotechnology in the Environment, EF 0830117. Senior Investigator, UCSB IRG 7 subcontract.

Five Selected Publications:

Freudenburg, William R. 1988. Perceived Risk, Real Risk: Social Science and the Art of Probabilistic Risk Assessment. *Science* 242 (October 7): 44-49.
Freudenburg, William R. and Margarita Alario. 1999. What Ecologists can Learn from Nuclear Scientists. *Ecosystems* 2: 286-91.
Freudenburg, William R. 1993. Risk and Recreancy: Weber, the Division of Labor, and the Rationality of Risk Perceptions. *Social Forces* 71 (#4, June): 909-32.
Freudenburg, William R. 2008. Rethinking Threats to Scientific Balance in Contexts of Litigation and Regulation. *Environmental Health Perspectives* 116 (#1, Jan.) 142-47.
Freudenburg, William R, Robert Gramling and Shirley Laska. In Press. *Catastrophe in the Making: The Engineering of Katrina and the Disasters of Tomorrow*. New York: Island Press (expected Sept. 2009)

Graduate Advisors:

Kai Erikson, William R. Burch, Jr., and Jerome Myers, all now Emeritus, Yale University

17. HONORS AND AWARDS

Year 3 - 2008

Ostrowski, Alexis. MRS Spring Meeting Graduate Student Silver Award, March 2008

Conti, Joseph. Honorable Mention. Graduate Student Paper Award, Law & Society Association, for "The Good Case: Decisions to Litigate at the World Trade Organization." Nominated by John Sutton, April 2008.

Dillemoth, Julie. UCSB Geography Excellence in Research Award, May 2008.

Parker, Rachel. Young Scholar, George Mason University Science and Trade Policy Program, China-India-US Science, Technology and Innovation Policy Workshop, Bangalore, India. July 2008.

Choi, Hyungsub. Awarded six-month Postdoctoral Fellowship; jointly administered by the Social Studies Research Council and the Japan Society for the Promotion of Science. 2008.

Macala, Gerald. PIRE-ECCI (Partnership for International Research and Education - Electron Chemistry and Catalysis at Interfaces) Fellowship for research and cultural exchange in China. Fall 2008

Beaudrie, Christian. NSERC (Natural Sciences and Engineering Research Council of Canada) - Alexander Graham Bell Canada Graduate Scholarships (CGS) for 3 years to support research in nanomaterial life-cycle risk assessment.

Conti, Joseph. Awarded postdoctoral fellowship at the American Bar Foundation. September 2008 – August 2009.

Ostrowski, Alexis. Awarded an NSF IGERT Fellowship in the ConvEne Program at UCSB. 2008-09.

Pidgeon, Nick. Appointed to UK Economic and Social Research Council, Climate Leader Professorial Fellowship. October 8, 2008.

Gereffi, Gary. Appointed Adjunct Professor of Business Administration and Corporate Sustainability by the Fuqua School of Business, Duke University. 2008.

Lenoir, Tim. MacArthur Digital Millenium Innovation Award of \$238,000 from the John P. and Catherine D. MacArthur Foundation for the project, Virtual Peace. 2008-2009.

Harthorn, Barbara Herr. Invited discussant, Gordon Research Conference on Science and Technology Policy, Big Sky, Montana. August 2008.

Alimahomed, Kasim, Joe Conti, Rachel Parker, and Mary Ingram Waters (CNS Social Science Graduate Fellows). Invited to present research posters at Gordon Research Conference on Science and Technology Policy, Big Sky, Montana. August 2008.

Harthorn, Barbara Herr. Founding Executive Committee Member, Society for the Study of Nanoscience and Emerging Technologies (S.NET). May, 2008.

Year 4 - 2009

Parker, Rachel. Chemical Heritage Foundation funding for case study of Seldon Technologies, a US start-up working on a nano-enabled water filtration technology. February 2009.

Harthorn, Barbara Herr. Invited member, AAAS Committee on Opportunities in Science (COOS). 2009-2012.

Motoyama, Yasuyuki. Sloan Foundation Industry Studies travel grant. March, 2009

Harthorn, Barbara Herr. Invited witness, US Congressional Nanotechnology Caucus. March 9, 2009.

Pidgeon, Nick. Invited Expert Witness, UK House of Lords Science and Technology Committee, Nanotechnologies and Food Inquiry. March 24, 2009

Appelbaum, Richard. Invited testimony on “China’s investment in Nanotechnology and Its Likely Impact on the U.S.,” US-China Economic Security Commission hearing, Washington, DC. March 24, 2009.

Hurt, Indy. UCSB Academic Senate Outstanding Teaching Assistant Award. April 2009.

18A. STATEMENT OF UNOBLIGATED FUNDS

(Withdrawn)

18B. BUDGET SUMMARY

(Withdrawn)

19. COST SHARING

(Withdrawn)

20. LEVERAGE

(Withdrawn)

NSEC Table 5: Other Support

(Table Withdrawn)

Table 6: Partnering Institutions									
Center for Nanotechnology in Society									2008/09
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	Museum Partner	International Partner
I. Academic Partnering Institution(s)	Allan Hancock			Y					
	Arizona State University								
	Australia National University								Y
	Beijing Institute of Technology	Y							Y
	Cal Poly San Luis Obispo								
	Cardiff University	Y							Y
	Cornell University							Y	
	Cuesta Community College								
	Duke University	Y							
	Harvard University		Y						
	Howard University			Y					
	Jackson State University			Y					
	Michigan State University								
	Oxnard Community College			Y					
	Santa Barbara City College								
	SUNY Levin Institute								
	SUNY New Paltz	Y							
	University of British Columbia, Vancouver, Canada	Y							Y
	University of California, Berkeley	Y							
	University of California, Los Angeles		Y						
	University of California, Santa Cruz	Y							
	University of East Anglia, Norwich, UK								Y
	University of Edinburgh, UK								Y
	University of South Carolina								
	University of Southern Florida								
	University of Washington	Y							
	Ventura College								
	Venice International University								Y
	CNRS - France								Y
Total Number of Academic Partners	29	8	2	4	0	0	0	1	8
II. Non-academic Partnering Institution(s)	American Institute of Physics Incorporated								
	Chemical Heritage Foundation	Y					Y		
	Cynthia Cannady, Legal Services	Y							
	Environmental Defense Fund								
	International Council on Nanotechnology (ICON), Rice University								
	International Risk Governance Council, Switzerland								
	Nanoscale Informal Science Education (NISE) network							Y	
	Woodrow Wilson International Center								
	Meridian Institute								
	American Bar Foundation								
	Nanoholdings, LLC (NY)	Y							
Total Number of Non-academic Partners	11	3	0	0	0	0	1	1	0

21. CURRENT AND PENDING SUPPORT

(Withdrawn)