



Center for Nanotechnology in Society

NSF SES 0531184

Nanoscale Science and Engineering Center at

University of California, Santa Barbara

Annual Report

for the period

April 1, 2007 to March 31, 2008

[This period reflects 9 months of year 2 & 3 months of year 3]

{Edited for Broader Distribution}

TABLE OF CONTENTS

1.	PROJECT SUMMARY	4
2.	a. LIST OF CENTER PARTICIPANTS	6
	b. LIST OF ADVISORY BOARDS	9
	b. LIST OF PARTICIPATING INSTITUTIONS	10
3.	QUANTIFIABLE OUTPUTS (Table 1)	11
4.	MISSION & BROADER IMPACTS	12
5.	HIGHLIGHTS	15
6.	STRATEGIC RESEARCH PLAN	23
7.	RESEARCH PROGRAM, ACCOMPLISHMENTS, & PLANS	
	IRG 1	26
	IRG 2	32
	IRG 3	46
8.	CENTER DIVERSITY—PROGRESS & PLANS	60
9.	EDUCATION	62
10.	OUTREACH & KNOWLEDGE TRANSFER	69
11.	PERSONNEL	78
12.	PUBLICATIONS & PATENTS	86
13.	BIOGRAPHICAL INFORMATION	89
14.	HONORS & AWARDS	90
15.	a. STATEMENT OF UNOBLIGATED FUNDS	<i>(Withdrawn)</i>
	b. BUDGET	<i>(Withdrawn)</i>
16.	COST SHARING	<i>(Withdrawn)</i>
17.	LEVERAGE	<i>(Withdrawn)</i>
18.	CURRENT AND PENDING SUPPORT	<i>(Withdrawn)</i>

1. PROJECT SUMMARY

The Center for Nanotechnology in Society at UCSB provides a critical role in promoting the study of societal issues connected with emerging nanotechnologies in the US and around the globe. It serves as a national research and education center, a network hub among researchers and educators concerned with societal issues about nanotechnologies, and a resource base for studying these issues in the US and abroad. The work of the CNS-UCSB is intended to include diverse communities in the analysis of nanotechnologies in society and in discussion about their outreach and education programs that include students and teachers and extend to industry, community and environmental organizations, policymakers, and the public.

The center addresses questions of nanotech-related societal change through research that encompasses three areas: **IRG-1: Historical Context of Nanotechnologies** seeks to develop an understanding of the recent past and current landscape of the nano-enterprise. **IRG-2: Innovation, Intellectual Property, and Globalization** examines the institutional and industrial processes of technological innovation of nanotechnologies along with their global diffusion and comparative impacts, with a particular focus on East Asia. **IRG-3: Multiple Party Risk Perception and the Public Sphere** uses mixed methods to study comparative public and expert perception of nanotechnologies and media and regulatory issue framing within the context of social processes of amplification and attenuation of risk. The Center's three 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 three efforts address a linked set of issues regarding the domestic US and global creation, development, commercialization, production, and 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, 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 IRGs are drawn from UC Santa Cruz and UC Berkeley, Duke University, and Rice University, and internationally from the Australian National University (ANU), Cardiff University (Wales, UK), University of British Columbia (UBC, Vancouver, Canada), University of East Anglia (UK), University of Edinburgh (UK), and several sites in China. The Center also is a lead partner in the NSF Network for Nanotechnology in Society, which includes partners at Arizona State University (CNS-ASU), Harvard University, and University of South Carolina.

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 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. For example, in November, 2007, CNS-UCSB convened a major international research conference on Nanotechnology Occupational Health and Safety, co-sponsored by network partners Harvard and UCLA, the first to include representatives from multiple labor organizations.

In 2007-08 CNS-UCSB has made substantial progress in research on pathways and impediments to socially and environmentally sustainable futures for nanotechnologies. CNS research teams have thus far produced 39 new publications, have another 16 currently under review, and have made over 92 presentations at academic, industry, and community venues. CNS has completed the first ever cross-national comparison of public deliberation processes, and has published results from a pioneering project

on China's role in nano development and an international survey of nanofirms' safe handling practices and unmet needs for regulatory guidance.

2. (a) LIST OF CENTER PARTICIPANTS

Participants receiving Center support:

UCSB

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

Collaborators

David Mowery	<i>UC Berkeley</i> , Professor	Economics
Suzanne Scotchmer	<i>UC Berkeley</i> , Professor	Economics
Gerald Barnett	<i>UC Santa Cruz</i> , Director	Technology Transfer Office
Gary Gereffi	<i>Duke University</i> , Professor	Sociology, Global Value Chains
Timothy Lenoir	<i>Duke University</i> , Professor	History, Visual Art, Data visualization
Patrick Herron	<i>Duke University</i> , Researcher	Data mapping and visualization
Cyrus Mody	<i>Rice University</i> , Asst Prof	History, Technology Studies
Cong Cao	<i>SUNY Levin Institute</i> , Research Assoc	Sociology, China
Karl Bryant	<i>SUNY New Paltz</i> , Assistant Professor	Sociology & Women's Studies
Nicholas Pidgeon	<i>Cardiff Univ</i> , Wales, UK, Professor	Social Psychology, Env. Risk
Milind Kandlikar	<i>Univ of British Columbia</i> , Asst Prof	Science Policy
Terre Satterfield	<i>Univ of British Columbia</i> Associate Prof	Sustainable Resources & Environment,
Tee Rogers-Hayden	<i>Univ of East Anglia, UK</i> , Fellow	Environment, Public participation

UCSB

Postdoctoral Scholars

Phil McCarty	Sociology
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Graduate Fellows

Kasim Alimahomed	Communication	Communication
Karl Bryant	Sociology	Sociology
Yiping Cao	Environmental Science	Bren School of Environmental Sci
Joseph Conti	Sociology	Sociology
Scott Ferguson	Mechanical Engineering	Mechanical Engineering
Alan Glennon	Geography	Geography
Summer Gray	Sociology	Sociology
Hillary Haldane	Anthropology	Anthropology
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
Aaron Rowe	Chemistry	Chemistry
Kim Stoltzfus	Communication	Communication
Joe Summers	Electrical engineering	Electrical & Computing Engineering
David Weaver	Political Science	Political Science

*Affiliated Grad Researchers***Christian Beaudrie**, *University of British Columbia, Canada***Vincent Dorie**, *Duke University***Eric Giannella**, *Stanford University*Ryan Ong, *Duke University**Undergrad Interns & Researchers:***William Bausman****Lamar Bush**

Jason Cannon

Staci Chirchick**Josie Garong**

Gary Haddow

Jon Lo Kim Lin

Carlos Perez**Olivia Russell**

Sarah Schultz

Nicole Tyler

Guanglei Zhang

*CNS staff***Jaquelyn Bernuy****Marisol Cedillo Dougherty**

Emily Kang

Michelle Olofson**Moir O'Neil (ABD, Sociology)**

Jessica Suseno

Valerie Walston

Participants affiliated, not receiving Center support:*UCSB*

Kevin Almeroth	Associate Professor	Computer Science
James Blascovich	Professor	Virtual Environments, Psychology
David Clark	Professor	Materials, Mechanical Engineering
Magali Delmas	Associate Professor	Corporate Environmental Management
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	Assistant Professor	Materials Engineering
Hyongsok Soh	Assistant Professor	Mechanical & Env 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,</i>	Economics
Mathiu O'Neil	<i>Australian Nat'l Univ</i>	Computer science, sociology
Francesca Bray	<i>Edinburgh Univ, UK, Professor</i>	Gender & Technology, China
Vladi Finotto	<i>Venice Int'l Univ, IT Researcher</i>	Economics
Stefani Micella	<i>Venice Int'l Univ, Director</i>	Economist, Technologies in Distributed Systems

Nanotechnology in Society Network PIs:

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

2. (b) LIST OF ADVISORY BOARDS

National Advisory Board

Thomas Kalil, UC Berkeley and former Deputy Assistant to the White House for Technology and Economic Policy, [Board Chair](#) 2007-2009

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

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)

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

Julia Moore, Deputy Director of Foresight and Governance Project at the Woodrow Wilson International Center for Scholars

Martin Moskovits, AIP Nanotronics (former Dean of Science and on leave 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

2. (c) LIST OF PARTICIPATING INSTITUTIONS

i. Academic Participating Institutions

Allan Hancock Community College
Arizona State University
Australian National University, Canberra, Australia
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

ii. Non-academic participating institutions

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

Table 1: Quantifiable Outputs

	Reporting	Reporting	Reporting	Reporting	Reporting	
Outputs	Year - 4	Year - 3	Year - 2	Year - 1	Year	Total
Publications resulted from NSEC Support		16	16	7		39
in Peer Reviewed Journals		5	11	5		21
in Peer Reviewed Conference Proceedings		3	2	1		6
in Peer Reviewed Book Chapter		5	1			6
Technical Reports			2			2
Working Papers				1		1
Books (including edited volumes)		3				3
With Multiple Authors		8	10	4		22
co-authored with NSEC faculty		8	10	4		22
Degrees to NSEC Students						
Bachelors Degrees Granted						
Masters Degrees Granted			2			2
Doctoral Degrees Granted			3			3
NSEC Graduates Hired By						
Industry						
NSEC participating Firms						
Other US Firms						
Government						
Academic Institutions		1	3			4
Other						
Unknown						
NSEC Influence on Curriculum (if applicable)						
New Courses Based on NSEC Research			3			3
Courses Modified to Include NSEC Research		1	3			4
New Textbooks Based On NSEC Research						
Free-standing Course Modules or Instructional CDs						
New Full Degree Programs						
New Degree Minors or Minor Emphases *			2			2
New Certificate						
Information Dissemination/Educational Outreach						
Workshops, Short Courses to Industry			2			2
Workshops, Short Courses to Others						
Seminars, Colloquia, etc.			41	17		58
World Wide Web courses						
Conferences	N/A	0	1	0		1
Visiting Speakers	N/A	6	6	1		13
Nano-Meeters	N/A	0	3	0		3
Community Speaking Engagements	N/A	0	2	0		2
Academic Presentations	N/A	8	51	23		82
Newsletters	N/A	0	2	0		2
Podcasts	N/A	1	2	0		3
Press Releases	N/A	1	14	11		26
Academic Publications	N/A	10	9	7		26
Weekly Clips	N/A	11	45	0		56
Blogs	N/A	11	83	55		149
* New Degree Minor or Emphasis: PhD Emphasis in Technology and Society; Undergraduate minor in Technology and Society						

4. MISSION AND BROADER IMPACTS

The NSF Center for Nanotechnology in Society at UCSB serves as a national research and education center, a network hub among researchers and educators concerned with societal issues concerning nanotechnologies, and a resource base for studying these issues in the US and abroad. The Center addresses education for a new generation of social science and nanoscience professionals, and it conducts research on the historical context of the nano-enterprise, on innovation processes and global diffusion of nanotech, and on risk perception and the public sphere. CNS-UCSB researchers address a linked set of social and environmental issues regarding the domestic US and global creation, development, commercialization, production, consumption, and control of specific kinds of nanoscale technologies

The intellectual aims of CNS-UCSB are twofold: to apply knowledge of human behavior, social systems, and history to identify societal implications of nanotechnologies; and to deepen basic knowledge about the global human condition in a time of sustained technological innovation through close examination of the emergence of nanotechnologies. These aims motivate research from many theoretical and methodological perspectives, provide the basis for industry-labor-government-academic-NGO dialogue, and organize the mentoring of graduate, undergraduate, and postdoctoral students. The Center draws on UCSB's renowned interdisciplinary climate to integrate the work of nanoscale engineers and physical and life scientists with social scientists studying nanotechnology in society. Close ties with the internationally prominent nanoscale researchers connected with the California NanoSystems Institute and with social science research centers at UCSB focused on relations among technology, culture, and society are enhanced by social science collaborators at UC Santa Cruz, UC Berkeley, the Chemical Heritage Foundation, Duke University, Rice University, SUNY Levin Institute, and SUNY New Paltz in the US, and Cardiff University, UK, University of British Columbia, Canada, University of Edinburgh, UK, University of East Anglia, UK, and a number of institutes and centers in China and East Asia.

The CNS-UCSB began its operations in January 2006. In 2007-2008, the Center has moved from start up mode to full scale implementation and production of a mixed portfolio of interdisciplinary research, education, and engagement activities that address issues of equity, global distribution of technological benefits and risks, and possibilities for social and environmental sustainability of new technologies. The CNS-UCSB is situated at the nexus of all four of the University of California at Santa Barbara's main strengths identified in its long range plan: international and global studies; new technology; environment; and a renowned capacity for interdisciplinarity. The CNS-UCSB also conducts comparative research on successful methods for public participation in dialogue about nanotechnologies' futures in the US and abroad, and engages directly with the multi-local communities who are and will be involved in nanotechnology through work, consumption, and environment. The CNS aims to use these institutional resources to create a genuine learning community of diverse participants who can pool their knowledge for the simultaneous benefit of society and technology.

The Center 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. It does this through public engagement in dialogue between academic researchers from diverse disciplines with regulators, educators, industrial scientists, and policy makers, as well as community-based organizations and ngos. The Center's education and outreach programs, which are central to its mission, include a diverse range of students and participants, and engage industry, government, and NGO partners.

The CNS has the potential to make significant contributions to the primary academic disciplines involved with it as well as to education and human resource development. For example:

- The ephemeral nature of materials to document and understand the nano-enterprise poses a challenge to historians and other STS scholars. The tools and methodologies developed and used by CNS researchers will provide an example for documenting the development of other contemporary emerging technologies that, like nanotechnology, will be important in the 21st century.
- IRG-2's research on the distributed, multi-local global innovation system for new technologies ranges from the individual laboratory to the academic-corporate nexus to the global setting, combining contributions from the social sciences and humanities to better understand how new technologies are created and transmitted. The international and global scope of CNS-UCSB's research focus and its international collaborations in pursuit of that focus provide a powerful dual strength.
- IRG-3 is poised to contribute to both the scholarly and practical understanding of emergent risk through collection of vital baseline data about different communities' risk perceptions, technological values, and beliefs, tracking of ongoing media framing (and reframing) of these new emerging technologies, and following unfolding social response at the level both of the individual and of collective action. New work on automated methods for framing analysis promise even more.
- The social science research of the CNS will be done in close collaboration with members of the engineering and science communities at UCSB and elsewhere. The information and research generated by the CNS, as well as the interactive process through which this takes place, will enable the science and engineering communities to better understand the social, economic, political, and cultural contexts of their research.
- The CNS's education and engagement programs aim to train a next generation of science-minded social scientists and social science-minded scientists. These efforts are being leveraged with other education programs at UCSB including those of the California NanoSystems Institute. Innovative new courses and programs such as INSCITES offer students the opportunity to gain a more comprehensive understanding of key technologies in the societal contexts. In addition, to date over 30 graduate and undergraduate students have been given the opportunity to participate directly and extensively in CNS research through its Graduate Research Fellowship and Summer Internship programs. Students involved are drawn from a wide range of disciplinary backgrounds and life experiences and are enabled to learn new epistemologies and methodologies through working in an interdisciplinary, collaborative context between traditional academic boundaries.
- CNS educational outreach builds on a strong set of institutional ties with regional California community colleges that serve Latina/o students, an AGEP program with Jackson State University, the NSF-funded UC-DIGSSS program to enhance recruitment of talented underrepresented social science graduate students, and award winning K-12 programs.
- In its research, education, and outreach efforts, the CNS has worked to engage a diverse range of public communities with attention to diversity of ethnicity, gender, and

experience. This has been especially successful thus far in the recruitment of student research fellows and interns

The CNS also has the capacity to engage and inform policymakers and governmental agencies involved in the development of public engagement and public participation programs (for example, the NNCO), to serve as both a forum and a moderator/facilitator in discussion and debate among diverse nanoscience experts and publics, and to serve as a resource base to the public policy and research communities. We have purposely included a number of public policy experts on science and technology policy on our National Advisory Board, and we draw on their expertise in developing and delivering this part of our program.

CNS-UCSB acknowledges the support from NSF under SES-0531184 and requests the fourth increment of funding for the project for the period 1 January 2009 through 31 December 2009.



NSF SES 05-31184

Health and Safety Practices in the Nanomaterials Workplace: Results from an International Survey

Researchers at University of California, Santa Barbara, in a study funded by the International Council on Nanotechnology (ICON), surveyed 82 nanomaterials firms and labs in 14 countries regarding their environmental health and safety (EHS) programs, practices, and risk beliefs about nanomaterials. Most nano-specific EHS programs were found to build upon general EHS programs, but also included nano-specific workplace engineering controls, and recommendations for protective clothing, gloves, eye protection and respirators. However, workplace monitoring and nano-specific waste disposal were only found in the subset of organizations believing in special risks related to nanomaterials. A majority of organizations expressed need for toxicological information and EHS guidance. Improved risk communication is thus needed to further implementation of related programs. The study concludes that organizations that are wholly inattentive to EHS would likely engage in nano-specific EHS upon implementing a staffed, general EHS program.



(Photo: Paul Schulte, NIOSH)

Conti, J.A.,¹ K. Killpack,² G. Gerritzen,² L. Huang,² M. Mircheva,² M. Delmas,² B.H. Harthorn,¹ R. Appelbaum,¹ & P.A. Holden,² *Environ. Sci. Technol.* 10.1021/es702158q Web Release Date: Apr 1, 2008.
CNS-UCSB,¹ UCSB;² Donald Bren School of Environmental Sci & Management, UCSB²



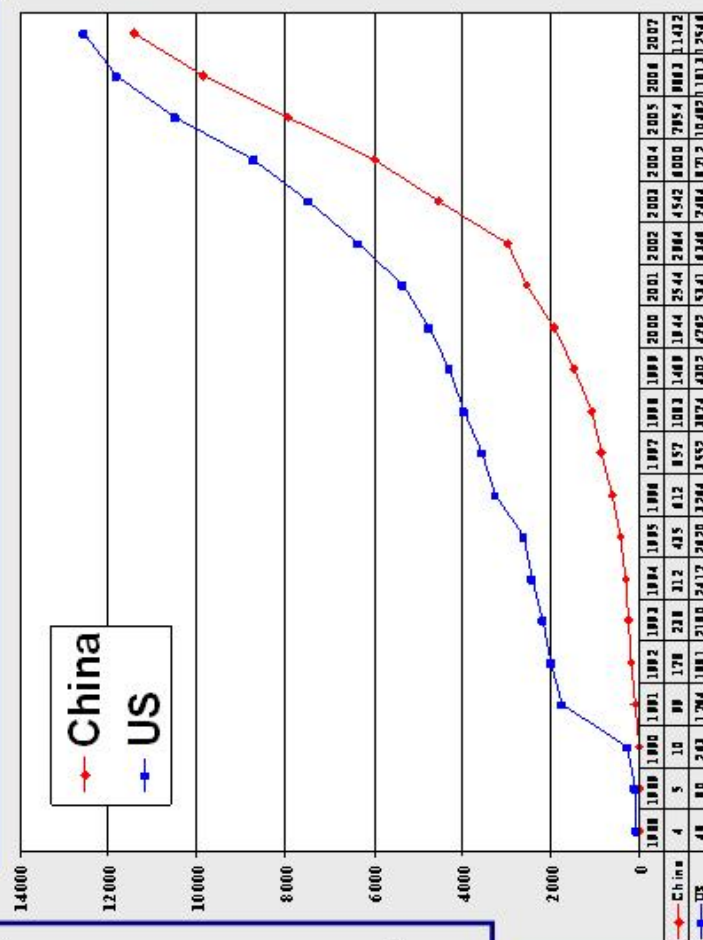


Chasing a \$3 Trillion Industry: China's Bid to Become a Major Nano Player

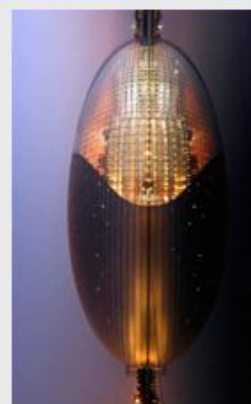
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Researchers at UCSB's Center for Nanotechnology in Society, Duke University's Center on Globalization, Governance & Competitiveness and SUNY's Levin Institute have examined China's efforts to become first movers in the projected \$3 trillion global nanotechnology industry. Analysis of Chinese nanotechnology publication data, Chinese government documents, and over sixty interviews with Chinese Academicians, scientists, engineers, and policy-makers finds that while the combination of international collaboration and public funding of nanotechnology R&D and commercialization holds promise, China remains – in the words of the head of its National Center for Nano-Science and Technology – "in the rear of the first echelon or the front of the second echelon, ranking fifth or sixth in the world."

China and US Nanoscience and Nanotech Publication Output



Beijing Concert Hall, constructed using self-cleaning glass, illustrates one of China's strengths in nanotechnology: commercialization of nano-intermediate products (*Photograph: China Daily/Reuters*).



R.P. Appelbaum and R. Parker (UCSB) Science & Public Policy 06/2008
G. Gereffi (Duke), C.Cao (SUNY Levin)



NSF SES 05-31184

Context Matters Too: First Ever US-UK Cross-National Comparison of Public Deliberation

While "size matters" is a ubiquitous theme in nanotech research, this comparative study found that the context, both national/cultural and type of application, matters a great deal in determining public response to specific nanotechnologies.

Four parallel deliberative

workshops were conducted in February 2007, two in the US and two in the UK. The workshops focused upon nanotechnology applications in energy and human health and enhancement.



Example of World Café session (photo credit: www.transitionculture.org)



Example of World Café session (photo credit: www.notto.com)

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, and in consumerist attitudes. Overall, societal implications trumped concerns about technological implications for risk.

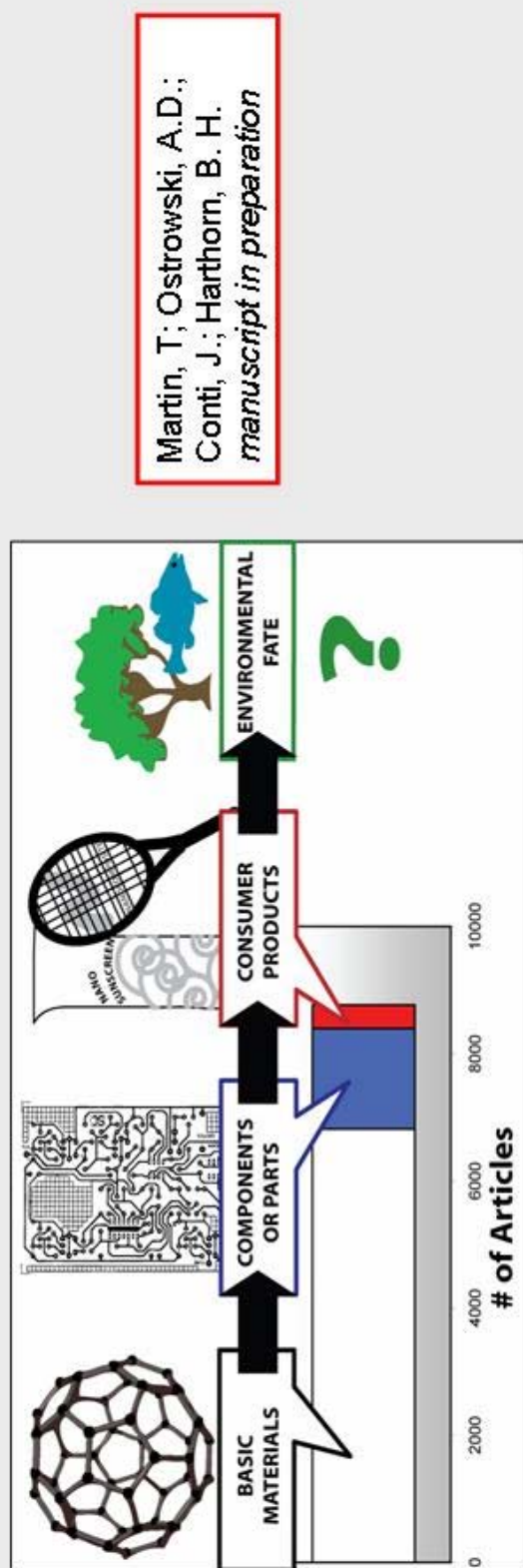
N Pidgeon (Cardiff), B. Harthorn (UCSB), K Bryant (SUNY-NP), T. Rogers-Hayden (East Anglia) under review at *Nature Nanotechnology* (2008)



NSF SES 05-31184

Nanotoxicology: A Literature Characterization

Peer-reviewed scientific journal articles are a primary source of information about the toxicology of nanomaterials. Using bibliometric techniques, UCSB researchers characterized the current state of the scientific literature on nanotoxicology and found that it is diffused across a range of sub-fields. It is largely focused on basic materials, acute toxicity and mortality, and on *in vitro* studies on mammalian models. Most articles do not specify an exposure pathway and there is little research on consumer products or 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.





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From Lab to iPod, from Molecular Electronics to Spintronics

Our recent research has demonstrated the salience of earlier nanoelectronics research and nanofabrication techniques from the 1970s and 1980s in laying the foundation for the main research thrusts of the National Nanotechnology Initiative. For example, we have noted the relevance early proto-nano work - such as research on molecular electronics and discovery of giant magnetoresistance in 1988 (and its subsequent commercialization) - for later nanotechnology initiatives in the US and abroad.

Peter Grünberg and Albert Fert, winners of 2007 Nobel in physics for their 1988 discovery of giant magnetoresistance. Their basic science discovery was successfully commercialized by IBM in 1997 and became the basis for a major increase in memory storage on computer hard drives. Lab-derived innovation such as these - based on making and characterizing novel nanostructured materials - are found in today's ubiquitous consumer products such as Apple iPods.



Hyungsuk Choi and Cyrus C.M. Mody. "The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology," *Social Studies of Science*, forthcoming 2008.

W. Patrick McCray. "From Lab to iPod: A Story of Discovery and Commercialization in the Post-Cold War Era," forthcoming, *Technology and Culture* 2008.





MBE as Important and Overlooked Example of Proto-Nanotechnology

NSF SES 05-31184

Molecular beam epitaxy is widely used in research and industry to fabricate semiconductor devices and structures. However, despite its ability to control matter with near-atomic precision, the technique is overlooked in most histories of nanoscience and nanotechnology. The origins of MBE lie in the early 1950s and the convergence of a number of research areas including solid-state physics, surface physics and materials science. By 1975, both IBM and Bell Labs funded several groups which were actively working to improve the MBE technology and study the new materials they could produce. Over time, it matured to become a common yet flexible tool essential for research in many areas of nanoscience and technology. Recognizing that nanotechnology has a 'hidden history' may be of value to policy makers and researchers grappling with concerns about society's reaction to nanotechnology.



Future National Medal of Science winner Al Cho, (right), fine-tuning an early MBE machine at Bell Labs, c. 1970.

Four MBE pioneers at Bell Lab researchers using MBE machine, c. 1978 to build new semiconductor structures. Future Nobelist Horst Stormer is second from left.



W. Patrick McCray, "MBE Deserves a Place in the History Books," *Nature Nanotechnology*, 2, 5, 259-261 (2007).



NSF SES 05-31184

Center for Nanotechnology in Society (CNS) Graduate Fellowships significantly impact graduate careers

UCSB sociology graduate student Rachel Parker's career illustrates how a graduate fellowship at CNS can create a successful research focus. She combines her interest in economic development with the societal implications of nanotechnology in her work with Professor Richard Appelbaum. Rachel did fieldwork on international collaboration and environmental remediation with nanotechnology in China as an NSF East Asia and Pacific Summer Institutes (EAPSI) Fellow.

Her presentation at the American Association for the Advancement of Science 2008 Meeting was highlighted by the national media and a podcast on her EAPSI experience is available on iTunes.

She will join the US delegation to the China-India-US Science, Technology and Innovation Policy Workshop in Bangalore, India as a George Mason University Science and Trade Policy Program Young Scholar in July.



Rachel Parker discusses her research on Chinese nanotechnology research and development



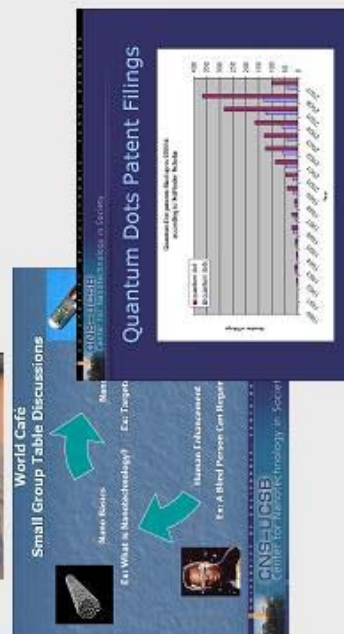
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Community College INSET Interns Research Societal Impacts of Nanotechnology

CNS community college interns have pursued social science research alongside peers from science and engineering in the INSET (Interns in Science, Engineering and Technology) program hosted by the California Nanosystems Institute at UCSB.

Staci Chirchick and Lamar Bush presented posters about their research at the annual Sigma Xi conference. Jason Cannon talked about his research at the SCCUR Conference (Southern California of Undergraduate Research) and Josie Garong at the annual SACNAS (Society for the Advancement of Chicanos and Native Americans in Science) meeting.

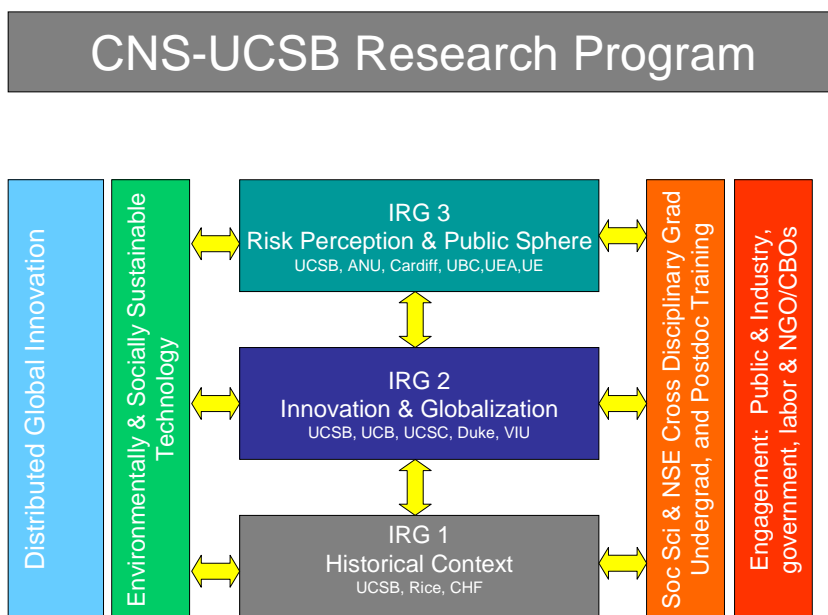
The successful integration of CNS student interns was an important component of the successful proposal to renew the INSET program as an NSF REU site for a further three years.



6. STRATEGIC RESEARCH PLAN

The Center's research program is designed as a systems-level analysis of nanoscale research and development, the global diffusion of nanotechnologies, and responses to nanotechnologies as they emerge. Research is organized within three interdisciplinary research groups: **IRG-1** -- Historical Context of Nanotechnologies, seeks to develop a rich understanding of the past and current landscape of the nano-enterprise; **IRG-2** -- Innovation, Diffusion, and Globalization of Nanotechnology, will develop a comprehensive understanding of the processes of innovation, global diffusion, and commercialization of nanotechnology; and **IRG-3**--Risk Perception and the Public Sphere--focuses on publics' and experts' perceptions and social intelligence about nanotechnologies, social amplification and attenuation of risk, methods for deliberation, and collective action in response to emerging nanotechnologies. Important features of our collective approach are an integrated, participatory relationship with nanoscientists; a focus on specific nanotechnologies such as nanoelectronics, nanoparticles such as quantum dots, and nanoporous materials; comprehensive consideration of their applications in industries like electronics, energy, environmental, and health; and employment of advanced spatial analytic methods and a global framework for analysis.

As of March, 2008, which is three months into our third year, all 3 IRGs are in active research, and we are generating research findings and disseminating them to a number of different kinds of audiences in publications and reports. Many more publications are in process, and we expect a sharp increase in results in the next twelve months. The following is a summary of our research integration efforts. Because this report represents a shift in reporting period from our first two reports, there is some overlap between this report and last year's report submitted July 1, 2007.



CNS-UCSB Research Integration and Synthesis

The Center integrates efforts among the three IRGs and the other Center activities through a number of formal and informal processes.

First, *within each IRG* we combine an interdisciplinary, tiered mentoring approach that incorporates UCSB social science researchers, UCSB nanoscience researchers, collaborators from other institutions and, in some cases, nations, graduate students from both the social sciences and the nanosciences, undergraduate interns from a range of disciplines, community college interns with diverse backgrounds and cultural experiences, and, in the future, K-12 teachers, as well as our collaborators in other locales. This structure facilitates mixing of disciplines, tiered mentoring, and the development of common language to discuss the work. The benefits of face-to-face interaction are clear as the work is developing; for those who are not on campus, other methods of contact (audio conferencing, video conferencing, convened meetings, mechanisms for data sharing) are in constant use. The CNS offers graduate research fellows opportunities to travel to IRG meetings and to make project research presentations, as well as co-authorship of publications and reports.

The *connections across IRGs* are likewise facilitated by frequent face to face interaction among IRG leaders (who all serve on the CNS Executive Committee), frequent communication between leaders with sharing of news, scholarly materials of interest, network opportunities, and research methods, data, and products, and on-campus CNS research and meeting space that enhances informal interaction as well. The CNS Graduate Fellows provide crucial cross-IRG connections, are working in shared research spaces and take lively interest in connections and differences among the different research areas. The Fellows seminar began as a bi-weekly meeting, but since Spring 2007 meets weekly over lunch throughout the year and provides vital, regular cross-IRG interaction, presentation of on-going research results, discussion of research methods, and sharing of new ideas for students and faculty researchers as well as regular engagement with campus and outside visitors to the CNS-UCSB. The importance of this weekly seminar cannot be overemphasized—it is an essential component of the CNS interdisciplinary community building effort and serves that effort in numerous ways.

Since Fall 2007, in order to further the integration process, the research team leaders began convening their own regular informal lunch meeting every three to four weeks to ensure sharing of ideas, knowledge, and strategies from the different research streams on an on-going basis. This has been highly beneficial for discussing longer term research aims and plans and is facilitating systematic planning for the renewal process.

Spatial analytic and other data visualization methods are also being used to integrate data across IRGs. As more and larger data sets become available (e.g., through survey research in IRG-2 and IRG-3), our capacity to perform this work on a larger scale is being enhanced. We are discovering and developing more and more interconnections among the IRGs and collaborators—for example, Tim Lenoir (Duke Univ) began as a collaborator with IRG-1 (McCray) but is now also working closely with IRG-2 (Appelbaum, Newfield, Gereffi), facilitated by his proximity at Duke to IRG-2 collaborator Gereffi. In another example, IRG-2 (Newfield) and IRG-3 (Bimber, Harthorn, Ackland) have piloted an experimental collaboration to look together at risk and innovation issues in nano-related organizations. And IRG-3's new seed project with sociologists Mohr and McCarty on automated methods for textual frame analysis is already generating benefits to the other IRGs, as all CNS researchers conduct textual analysis in some forms. The spatial analytic work in the CNS, under the guidance and advice of collaborator Mike Goodchild, will get a significant boost in the 2008-09 year as a new graduate research fellow in IRG-3 brings particular expertise in Geographic Information Science (GISci).

In response to feedback from our Board in April 2007, the NSF external site team in Spring 2007, and our nanoscience collaborators who have more experience in integration of large heterogeneous teams, we decided to convene annual meetings at UCSB of all CNS-UCSB collaborators and senior personnel. We held the first such **CNS Research Summit** in Santa Barbara for 2 full days on March 14-15, 2008. The last full group meeting was in May 2006 in conjunction with our center launch activities. The 2008 meeting included plenary meetings of the entire research and education, presentations on all projects, break out sessions for individual IRG meetings, and time for informal conversation and socializing. The next meeting is planned for January, 2009, as part of the CNS planning process for next year's external review and renewal process. Based on this year's meeting, we expect that these meetings will continue to provide numerous opportunities for integration and synthesis of the CNS-UCSB research efforts, training and networking opportunities for students, and the chance to introduce new researchers into the CNS research program. This year's meeting, for example, brought two new members from Lenoir's team at Duke (Herron, Dorie) into direct contact with IRG-1 and IRG-2 researchers; it brought a new IRG-2 globalization collaborator from Italy (Finotto) to meet and talk about their work on small and medium sized nanotech businesses; a China technology and development scholar from the Levin Institute (Cao) who has been part of IRG-2 into discussion with the larger group; a new member of IRG-2 who is an IP lawyer and international IP legal expert; brought economist Mowery into discussion with both Appelbaum and Lenoir's groups, and allowed new core team member of IRG-3 (Mohr) and new postdoc (McCarty) into engagement with our ANU colleague Ackland and the full CNS enterprise.

In addition, we have a number of mechanisms for **CNS-wide integration**, particularly at the monthly level at which joint planning of conferences, future panels, symposia, and publications takes place, and also where synthesis of our network collaboration activities takes place. As research projects mature, we will also be assessing and implementing other mechanisms for synthesis. We have close at hand and readily available to us the highly successful model of the NSF National Center for Ecological Analysis and Synthesis (NCEAS) at UCSB, and we continue in discussion with NCEAS about possible future collaborations in the convening of synthesis meetings on environmental aspects of nanotech and with their highly successful national program of distributed graduate seminars.

See section 11 for information on the CNS's overall evaluation plan.

7. RESEARCH PROGRAM, ACCOMPLISHMENTS, & PLANS

IRG-1: Historical Context of the Nano-Enterprise

W. P. McCray	History	History of science, materials, IRG Leader
C. Mody	Sociology	Science and Technology Studies

Affiliates

H. Choi	History	Chemical Heritage Foundation,
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4 Students

<i>Graduate students:</i>	Social Science: Mary Ingram-Waters (female)
<i>Undergraduate students:</i>	Univ: William Bausman, Olivia Russell (female)
	Community College: Josie Garong (female)

IRG-1 was composed primarily of [W. Patrick McCray](#) (Professor of History, UCSB), [Cyrus Mody](#) (Asst. Professor of History, Rice University, formerly of the Chemical Heritage Foundation), and Mary Ingram-Waters (CNS Graduate Student Fellow in Sociology) during the 2007/2008 reporting period. We also had participation from three undergraduate student interns throughout the reporting period.

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."

In the period between April 2007 and March 2008, IRG-1 performed work in the main areas detailed below.

"Over the Horizon" Technologies: The Case of Nanoelectronics; From Nanocrystals to Quantum Dots ([McCray](#), [Mody](#))

[McCray](#), with feedback from [David Awschalom](#) (USCB), continued to revise this spintronics narrative. In June 2007, he presented the results of this work at two different meetings. One was the joint Wharton School-CHF meeting in Philadelphia; the other was to an audience of scientists at the Spintech IV meeting in Maui.

In late June, [McCray](#) submitted a version of this paper for publication in the journal *Technology & Culture*. The final part of this project will be to complete the oral history interviews (Awschalom, Gossard, Flatte, and Loss); this work is still underway. [McCray](#) also continued to collect materials relevant to the history of nanoelectronics.

In response to the awarding of the 2007, Nobel prize in physics for GMR, [McCray](#) continued collecting documents and press releases relating to the prize. He integrated this material into his revised article on spintronics for T&C.

McCray also continued discussions with David Brock (Chemical Heritage Foundation) on the development of epitaxial tools for nanofabrication. McCray and Brock are considering writing a paper on tools like MBE drawing on their previous work.

Following acceptance of the spintronics paper, McCray will conclude research on spintronics and shift to a historical study of nanocrystals and quantum dots. This new direction, while essential in its own right, will also help link the study of MBE and nano-structured materials for electronics applications. This research, which will begin once the spintronics project is complete, will explore the science and technology behind the development of both MBE-grown and chemically synthesized nanocrystals (aka quantum dots).

Finally, McCray is preparing article on spintronics and the 2007 Nobel Prize for publication in a future issue of *Nature Nanotechnology*.

Nanotechnology Oral History Project (Mody, McCray)

Work continued at CHF under Mody's direction on the oral histories conducted last year. Stan Williams' and Alan Heeger's transcripts are ready to be bound and published, with copies going to the interviewees and to CNS-UCSB. Paul Hansma has returned his transcript; as soon as his changes are entered it also will be bound and published. Alan MacDiarmid's transcript is complete pending final approval from his widow. Only two transcripts are still with the interviewees – Mark Ratner and Jane Alexander.

Upcoming activities were in flux in Summer 2007 due to Mody's acceptance of a position at Rice. Since he will no longer be at CHF (and CHF will be deemphasizing nanotechnology), the oral history program will need to be revised after Year Two. However, Mody has completed interviews with Bob Buhrman (of Cornell – related to spintronics and microfabrication themes of IRG-1) and Jim Murday (formerly of ONR/NRL – related to policy/grant officer theme of IRG-1). Those interviews will be processed by Mody's research assistant, probably in late 2008. Mody also completed a background interview with Joe Bordogna, NSF administrator under Clinton and an influential figure in the founding of the NNI; this interview will provide material for the rest of IRG-1.

Before relocating to Rice, Mody made several transitions, from the Chemical Heritage Foundation to Alfred Nordmann's research group at Bielefeld University to a tenure-track post in the history department at Rice University. His final act at CHF was to co-host the two-day Symposium on Social Studies of Nanotechnology, which was attended by several CNS members (McCray, Ingram-Waters, Lenoir, Mowery). A white paper summarizing that event is being prepared and should be published by Wharton at the beginning of next year.

The Bielefeld group offered the opportunity to interact with a number of nano-STS scholars, including Nordmann, Ann Johnson, Hans Glimell, Johannes Lenhard, and Astrid Schwarz. Mody presented a paper on "Conference and the Development of Nanotechnology: Two Case Studies." Mody continued further research on this topic, partly in conjunction with CNS (e.g. expected interview of Tom Everhart), and hope to write an article next summer.

Since moving to Rice, most of Mody's time has been taken up with classes rather than research. Therefore, it is reasonable to expect some pause in CNS-related research as he gets settled in at his new institution. He is currently co-teaching a course on Nanotechnology: Content and Context, with

Kristen Kulinowski of the Center for Biological and Environmental Nanotechnology, and meeting some local nanoists. Mody hopes to begin a project on the history of Rice's Smalley Institute in the spring or summer, work which will likely continue his collection of oral histories.

Mody is rethinking his next round of interviews which will likely resume in Summer 2008. Transcription has also begun on a series of interviews Mody conducted 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) will be processed into oral histories in due course. We have also lent guidance to Chemical Heritage Foundation in the hopes that the collaboration we have with them will continue on at a modest level.

Meanwhile, McCray is overseeing the transcription of three interviews with people active in proto-nano research and popularizing in the 1980s and 1990s – Conrad Schneiker, Eric Drexler, and Ralph Merkle. These interviews will be used in conjunction with McCray and Ingram-Water's research on nano and futurism (described below).

Institutions of Interdisciplinarity (Mody, Choi) (NEW AREA)

This is a new area of research that Mody will be embarking on in 2008. This project will focus on the history of interdisciplinarity at Rice University, with an emphasis on Rick Smalley's role in the Rice Quantum Institute and various post-buckyball nanocenters at Rice. Current leadership at the Smalley Institute is enthusiastic about this project. Preliminary interviews have begun, including an extensive oral history with Nobel laureate Robert Curl. Mody also continued preparation of an article on the early microfabrication centers for publication in an edited volume. Interviews for that project have already been done and CNS will help defray transcription costs.

In addition to Mody's work, we are discussing a possible collaboration with Hyungsub Choi of the Chemical Heritage Foundation; Choi is interested in exploring the history of the University of Pennsylvania's materials science center. This center eventually became associated with nanotech research at Penn. Choi's work will help show the overlap between MSE and nanotechnology research and also provide insight into Mody's work on national nano centers.

Social Movement Spillover/Visioning (McCray, Ingram-Waters, Russell, Garong)

In 2007, this group primarily focused on data collection and processing and some data analysis. In April and May, Ingram-Waters and McCray contacted about twenty potential respondents that had already been targeted to be interviewed. They set up interviews with most of the respondents for dates throughout the spring and summer months of 2007. Ingram-Waters interviewed four of the respondents thus far. She also processed an earlier oral history interview conducted by McCray in late 2006.

Preliminary analysis of the five interviews has been included in a working paper by Ingram-Waters and McCray, entitled, "Spaceflight, frostbite, and Foresight: Exploring the connections between the pro-space, cryonics, and nano social movements." A poster of this paper was presented by Ingram-Waters at the Wharton-Chemical Heritage Foundation Joint Symposium on the Social Studies of Nanotechnology in early June 2007. We are proud to note that this won the conference's award for best student poster.

Data analysis continued on the huge collection of organizational texts that have been collected and organized throughout 2006 and 2007. Texts have been coded for thematic elements relevant to our working hypotheses about the links between the pro-space, cryonics, and nano social movements.

Ingram-Waters and McCray continued to interview respondents from the initial list that they derived earlier this year. Ingram-Waters interviewed respondents using Voice Over Internet Protocol (VOIP) while McCray interviewed several respondents over the telephone and several in person. For those interviewed in person, McCray typically conducted a more in-depth interview or life history. Most of these interviews have already been transcribed and approved for release by the interviewees. Both Ingram-Waters and McCray also continued to contact potential interviewees to schedule interviews. Over the course of the interviews, both Ingram-Waters and McCray employed the snowball sampling technique, meaning they asked interviewees to identify other appropriate respondents.

In Summer 2007, Ingram-Waters worked with one intern, Josie Garong, an undergraduate student from Oxnard College, over the summer quarter. Ingram-Waters and Garong's collaboration was facilitated under the auspices of CNS's relationship with CNSI's Internships in Nanosystems Science, Engineering and Technology program. Under Ingram-Waters' mentorship, Garong collected and organized more than one hundred primary source texts. These texts included organizational and promotional materials of early nanotechnology advocates who were involved with life extension technology agencies. Once these texts were collected, Garong organized the data using the Endnote program. She also coded one set of data using key words supplied by Ingram-Waters. Lastly, she scanned a set of fragile primary source documents and then transformed them into searchable PDF files.

Ingram-Waters and McCray spent a good amount of time this past year doing data analysis. These efforts yielded the following items: a loose network of all interviewees (both those already interviewed and those to be interviewed) and their affiliated organizations; a general timeline of events chronicling early nanotechnology advocates' participation in prior and concurrent pro-technology social movements; and a narrative account of the development of nanotechnology ideology as a "revolutionary" technology.

Ingram-Waters and McCray prepared two papers based on findings from the above-discussed research activities. McCray presented a co-authored paper on the nanotech-enabled Space Elevator to the Society for the History of Technology conference in October, in Washington, DC. Ingram-Waters presented their second co-authored paper, "From Spaceflight to Foresight: Tracing Social Movement Spillover between Space and Nano," at the annual meeting of the Society for the Social Studies of Science, also in October, in Montreal. Both of these conference papers have been purposefully written as initial drafts of research articles which will be sent out for review at scholarly journals.

In Fall 2007 and into 2008, Ingram-Waters and McCray continued to conduct interviews and to collect, organize, and analyze primary source documents. They were assisted by UCSB undergraduate Olivia Russell this quarter. Russell, who will be mentored primarily by Ingram-Waters, will assist in the collecting, organizing, and coding of primary source documents.

McCray spent much of his research time exploring various aspects of nanotechnology's early history. Much of this was focused on activities in the 1980s. This is in advance of writing a book length treatment of the topic. Tentatively titled *Visioneering: Entrepreneurs, Utopias, and the Roots of Techno-Libertarianism*, this book will examine the history of several overlapping and interconnected exploratory engineering movements from the 1970s and 1980s. Nanotechnology, as it existed and was

presented in the 1980s, will be a major focus. McCray interviewed several people for this work including science fiction author Ben Bova, Silicon Valley entrepreneur Gayle Pergamit, and Foresight director James C. Bennett. He also collected a substantial amount of primary historical evidence and did interviews, in Fall 2007, with K. Eric Drexler and Ralph Merkle.

McCray's book proposal was evaluated by three major university presses. Two made compelling offers and he recently signed a trade book contract with Princeton University Press. The manuscript is due in 2010 and much of CNS-related research time in the future will go towards the book's writing.

Exploring Nanotechnology's Hidden Histories (McCray)

In early 2007, McCray finished an article for *Nature Nanotechnology* on the history of molecular beam epitaxy. This was published in May 2007 and it addressed the evolution of MBE as a critical nanofabrication technique.

Feedback from both the National Advisory Board and the NSF site review on the "hidden history of nano" was very positive. IRG-1 was encouraged to consider other aspects of these so-called hidden histories which we are doing.

In terms of discrete hidden histories, one topic is that of the nano-enabled space elevator. The research entailed conducting several interviews with participants as well as reading the substantial body of technical and popular literature on the space elevator idea. Entitled "When Space Exploration and Nanotech Met Again at the Fountains of Paradise," this paper presents the history of the space elevator as an example of reconverging technologies. McCray presented his paper on the nano-enabled space elevator at the 2007 annual meeting of the Society for the History of Technology. Now that the research is done, he is converting the talk into an article for *Technology and Culture*. This work will also likely feed into his *Visioneering* book project.

IRG-1: Publications submitted for review, accepted, or published

- W. Patrick McCray, "MBE Deserves a Place in the History Books," *Nature Nanotechnology*, 2007, 2, 5: 2-4.
- W. Patrick McCray. "Over the Red Brick Wall: Spintronics, Novelty, and Over-the-Horizon Technologies," Forthcoming. *Technology and Culture*, accepted April, 2008.
- W. Patrick McCray, Cyrus Mody, and Jody Roberts, "Letter to the Editor Regarding Nanoethics," *The New Atlantis*, Summer 2007
- Cyrus Mody. Forthcoming. "Why History Matters in Understanding the Social Issues of Nanotechnology and Other Converging Technologies." *Nanoethics*.
- Cyrus Mody (with David Kaiser). "Scientific Training and the Creation of Scientific Knowledge." In *Handbook of Science and Technology Studies*, ed. Edward J. Hackett, Olga Amsterdamska, Michael Lynch, and Judy Wajcman, 3rd edition, pp. 377-402. Cambridge, Mass.: MIT Press.
- Hyungsub Choi and Cyrus C.M. Mody. Forthcoming. The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology," *Social Studies of Science*, 2008.
- Cyrus C.M. Mody. "Nanoethics," 4500 word invited article for *Physics Today*,
- Cyrus C.M. Mody. "Instruments of Commerce and Knowledge: Probe Microscopy, 1980-2000," Forthcoming. *Science and Engineering Workforce Project Proceedings*, edited by Richard Freeman and Daniel Goroff (U. Chicago Press), 2008.

- 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). April 2008.

IRG-1: Conferences, Panels and Presentations

- W. Patrick McCray "Spintronics, Novelty, and Over-the-Horizon Technologies," paper presented at the Spintech IV conference, Maui, June 2007.
- W. Patrick McCray "Over the Red Brick Wall: Spintronics as an Over-the-Horizon Technology," presented at Wharton-Chemical Heritage Foundation Symposium on Social Studies of Nanotechnology, Philadelphia, June 2007.
- Mary Ingram-Waters. "Spaceflight, frostbite, and Foresight: Exploring the connections between the pro-space, cryonics, and nano social movements." Presentation given to CNS Fellows Meeting, June 4, 2007.
- Mary Ingram-Waters. "Spaceflight, frostbite, and Foresight: Exploring the connections between the pro-space, cryonics, and nano social movements." Poster presented at the Wharton-Chemical Heritage Foundation Joint Symposium on the Social Studies of Nanotechnology, June 7, 2007.
- W. Patrick McCray. "Reconverging Technologies: Space, Nano, and Fountains of Paradise," (with Mary Ingram-Waters), presented at annual meeting of the Society for History of Technology, Washington, DC, Oct 16, 2007.
- Mary Ingram-Waters. "From Space Colonies to Nanobots: Exploring a Hidden History of Nanotech," (with W. Patrick McCray), presented at annual meeting of the Society for the Social Studies of Science, Montreal, Oct 11, 2007.
- Cyrus Mody. (with Michael Lynch), "From Dr. Göring to Nanotechnology: Test Objects as Reflexive Instruments," (Columbia, SC: Images of the Nanoscale: From Creation to Consumption workshop, October 27, 2007).
- Cyrus Mody. "Crazy or Brilliant or ... ? : Molecular Electronics and the Interpretive Flexibility of Personality," (Washington, DC: Society for the History of Technology annual meeting, October 19, 2007).
- Mary Ingram-Waters. "From Spaceflight to Foresight: Knowledge Production through Collective Action." Occasional Speaker Series, NSF Center for Nanotechnology and Society, Arizona State University, March 2008.

Awards to IRG-1 Researchers

- Mary Ingram-Waters. "Spaceflight, frostbite, and Foresight: Exploring the connections between the pro-space, cryonics, and nano social movements." Best Poster Award at the Wharton-Chemical Heritage Foundation Joint Symposium on the Social Studies of Nanotechnology, June 7, 2007.

IRG 2: Innovation, Commercialization, & Globalization

R. Appelbaum	Sociology	Globalization, global production IRG Co-Leader
C. Newfield	English	Innovation, technology transfer IRG Co-Leader
B. Chmelka	Chemical Engineering	Nanoscience and international collaboration
T. Cheng	Chemical Engineering	Nanoscience and international collaboration; China
G. Gereffi	Sociology	Science and Technology Studies
T. Lenoir	History	New technologies, development, and visual media
D. Mowery	Economics	Intellectual property and tech transfer
S. Scotchmer	Economics	Intellectual property and tech transfer
C. Cannady	Law	IP and energy development
G. Barnett	Tech Transfer	IP and university tech transfer

Affiliates

C. Cao	Sociology	China technology development
S. Micella	Economics	Distributed technologies and development
V. Finotto	Economics	Distributed technologies and development
P. Herron	Computer Sci	Data visualization tools development

14 Students

<i>Graduate students:</i>	Social Science: Rachel Parker (female), Kim Stoltzfus (female), Kasim Alimahomed, Haiyan Wang (female)
	Nano-Science: Scott Ferguson, Gerald Macala, Aaron Rowe
<i>Undergraduate students:</i>	Univ.: Carlos Perez; Guanglei Zhang
	Community College: Lamar Bush
	Duke: Eric Gianella
<i>Technical staff:</i>	Collaborating: Eric Giannella (Duke); Vince Dorie (Duke); Ryan Ong (Duke)

IRG-2: Globalization Group, [Richard Appelbaum](#), Co-PI, [Group Leader](#). IRG members: Rachel Parker, Brian Scott Ferguson, [Tim Cheng](#), [Brad Chmelka](#), Guanglei Zhang, Haiyan Wang (all UCSB); [Cynthia Cannady](#) (private sector), [Cong Cao](#), (SUNY, Levin Institute), [Gary Gereffi](#) (Duke University), [Tim Lenoir](#) (Duke University), [Stefano Micella](#) (Venice International University), [Vladi Finotto](#) (Venice International University).

IRG-2: Globalization. China Nanotechnology: Field Research and Interviews ([Appelbaum](#), [Cao](#), [Gerrefi](#), Parker, Ong, Wang)

This research presently aims at understanding where China stands in terms of innovation, R&D, and commercialization of nanotechnology, focusing on the effect of China's centralized approach to government funding for nanotechnology along the value chain, as well as the importance of international collaboration.

Like many countries involved in catch-up development, 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 top-down and 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.

To address these questions, our team conducted 35 interviews in Hong Kong, Taiwan, and China during the period July 24 through August 8, 2007. We also conducted 7 interviews in California, and attended one forum on Asia-US nanotechnology. (These supplement 28 interviews conducted during summer 2006.) A complete breakdown follows:

Taiwan: 8 interviews

- **Industrial Research Technology Institute (ITRI)'s Nanotechnology Research Center, Hsinghu:** *Tsung-Tsan SU*, General Director; *Tsing-Tang SONG*, CEO, National Nanoscience / Nanotechnology Program, Academia Sinica, Taipei
- **National Tsing Hua University:** *Jyuo-Min SHYU*, Dean of Electrical Engineering and Computer Science and former Executive Vice-President of ITRI (current president of Nanotechnology and Microsystem Association, Taiwan); *Tai-Bor WU*, Director of CNMM and Professor of Department of Materials Science and Engineering; *Chi-Young LEE*, Associate Director of the Center for Nanotech, Materials Science, and Microsystems (CNMM); *Sun-Zen CHEN*, post-doc and operations manager of CNMM; *Nyan-Hwa Daniel TAI*, Dep't of Materials Science and Engineering; *Long-Sheng FAN*, Professor and Chairman, Institute of MicroElectroMechanical Systems

Hong Kong: 5 interviews

- **Chinese University of Hong Kong:** *Jimmy Chia-Mei YU*, Director of Environmental Science Programme, Department of Chemistry
- **Hong Kong University of Science and Technology:** *Tony Eastham*, Acting Vice-President for Research and Development and Professor of Civil Engineering and Electronic and Computer Engineering; *Ping SHENG*, Head of Department of Physics and Institute of Nano Science and Technology; *K. M. NG*, Chemical Engineering Department and head of the HK Government NAMI (Nano and Advanced Materials Institute) Consortium; *Erik Baark*, Acting Head and Associate Professor, Social Science Division

Suzhou, China: 2 interviews

- **Chinese Academy of Sciences/Suzhou Institute of Nano-Technology and Nano-Bionics (Sinano):** *Ke XU*, researcher; *Hui YANG*, Director, Sinano

Hangzhou, China: 4 interviews

- **Zhejiang University / Zhejiang-California Nanosystems Institute (ZCNI):** *Jiaan CHENG*, head of ZCNI, former Vice-Chancellor, Zhejiang University; *Jin-Ming WU*, Department of Materials Science and Engineering
- **USTAR Biotechnologies:** *Michael HU*, Vice President and Chief Technology Officer
- **Harvest Consulting Company, Ltd:** *John YE* (investment management)

Shanghai, China: 5 interviews

- **Shanghai Nanotechnology Promotion Center:** *Simon ZHU*, General Manager/Engineer, Shanghai NML Nanotechnology Co., Ltd. and Chinese Industry Association for Antimicrobial Materials & Products; *Lefeng FU*, Technical Manager, Shanghai Sunrise Chemical Company; *Bo ZHANG*, Manager of Research & Production Department, Shanghai AJ Nano-Science Development Co., Ltd. (designers/manufactures of AFMs)
- **Shanghai Jiao Tong University Research Institute of Micro/Nano Science and Technology:** *Vivian FANG*, Director
- **Honeywell:** *Liao HANG*, Sensor Lab Director

Beijing, China: 11 interviews

- **Tsinghua University:** *Lan XUE*, Executive Vice President, Development Research Academy for the 21st Century; *Ling CHEN*, Assistant Director, Center for Industrial Development and Environmental Governance (CIDEG); *Soushan FAN*, Director, Tsinghua-Foxconn Nanotechnology Research Center, and Director of Condensed Physics Group
- **National Center for Nanoscience and Technology (NCNST):** *Sishen XIE*, Chief Scientist; *Chen WANG*, *Gang WANG*, and *Haizia ZHANG*
- **US NSF Office:** *Bill CHANG*, Director
- **National Natural Science Foundation of China:** *Ming LI*, Department of Engineering and Materials Science
- **Microsoft Research Asia (MRSA):** *Lolan SONG*, Director, University Relations
- **Beijing Institute of Technology:** *Donghua ZHU*, Vice Dean, School of Management and Economics, and Director, Laboratory of Knowledge Discovery and Data Analysis

California:

- **Roy Doumani:** CNSI-UCLA Advisory and Oversight Board; co-chair ZCNSI Advisory Board; Professor of Molecular and Medical Pharmacology at the UCLA's David Geffen School of Medicine
- **Peidong YANG**, ChevronTexaco Chair in Chemistry, UC Berkeley; Chinese Academy of Science Molecular Science Forum Lectureship
- **Wenyuan SHI**, Professor, School of Dentistry and Molecular Biology Institute and Department of Microbiology, Immunology and Molecular Genetics, UCLA; member, ZCNSI
- **Sean WANG**, Director, ITRI San Jose
- **Nelle Slack**, VEECO Metrology (Santa Barbara office)
- **Youli LI**, Materials Research Lab, UCSB
- **Cynthia Cannady**, former director, WIPO
- **ITRI Forum**, San Jose, CA (June 14)

We are also beginning to conduct interviews with UCSB scientists/engineers who have Chinese collaborators (the interview with Prof. Li at UCSB is the first such interview). All interviews from 2006 and 2007 have been uploaded and coded in NVivo, a qualitative data management software package. We are currently in the process of analyzing the interview data in NVivo, and will incorporate the interview data into a working paper that will lead to articles for publication. To date we have completed the sections on technological leapfrogging and innovation (theoretical framing) and China's S&T policy.

IRG-2: Globalization. China Nanotechnology: Impact Analysis of Research Publications (Appelbaum, Cao, Ferguson, Parker)

A related project we are currently working on is the analysis of publication data. We are looking at the impact score for nanotechnology articles with at least one Chinese co-author in which the focus of the technology is on environmental remediation. We have collected a sample of these Chinese authors' Curriculum Vitae and will begin to analyze career trajectories in relation to article impact, in an effort to determine whether international training is an influence on high impact publishing. This project will be the subject of a poster to be presented in August at the Gordon Research Conference on "governing emerging technologies" in Big Sky, Montana.

We have also initiated conversation with CNS-ASU collaborator Dietram Scheufele (University of Wisconsin, Madison) to work in partnership on a survey to be conducted in China. There is interest from NSF to conduct this survey. We will collaborate with IRG-3 and CNS-ASU Co-PI Elizabeth Corley and Dietram Scheufele on the survey design and implementation. The survey will be based on the Eurobarometer surveys and will ask questions about public attitudes toward nanotechnology.

IRG-2: Globalization. China Nanotechnology: Analysis of Patent Data (Appelbaum, Lenoir, Parker, Cannady, Herron, Dorie)

We are currently engaged in discussions with Donghua ZHU, Vice Dean, School of Management and Economics, and Director, Laboratory of Knowledge Discovery and Data Analysis at Beijing Institute of Technology, over acquisition of Chinese patent data (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. We hope to firm up a contract in the next month. ZHU would create a data-set of Chinese nanotechnology patents based on a random sample, and would additionally provide complete data for patents in the following three areas: (1) nanoporous filtration, (2) thinfilms, and (3) carbon nano tubes. (Depending on the number of patents, we may also have to sample from these three areas as well.) In addition to creating the data-set, ZHU will provide a translation of the patents in the three areas above, and will also provide a report which analyzes the patent trends in Chinese nanotechnology. We are working with CNS sub-contract Tim Lenoir, Kimberly Jenkins Chair for New technologies at Duke University, over the feasibility of using his propriety tool for analyzing patent networks (SparkIP). We have also met with Alan Porter (GaTech for CNS-ASU) and Ismael Rafols (visiting from SPRU, University of Sussex), in a meeting arranged by Chris Newfield, to learn about their program (Vantage Point).

Cynthia Cannady is the former Director of the Intellectual Property and New Technologies Division at the World Intellectual Property Organization (WIPO) in Geneva, Switzerland, where her responsibilities included direction of activities and training programs relating to IP strategy, licensing, technology transfer, valuation, IP asset management, and IP Strategy (2001-2007). She is currently principal and founder of IPSEVA, a firm that provides legal and business services to companies in the field of renewable energy technology. She is an expert in intellectual property strategy and technology licensing. She holds a JD degree from Harvard Law School and a BA degree from Stanford University. We are in the final stages of completing a contract for Cynthia to be hired and begin working with us in an official capacity. Her role will be to help us interpret the Chinese patent information, once we have translated it from the Chinese.

IRG-2: Globalization. Comparative Study of Selected Nanodistricts in California, North Carolina, and Europe (Appelbaum, Gereffi, Newfield, Parker, Micelli, Finotto)

Our Duke collaborators have been conducting research on the state of nanotechnology in the U.S. south. Their research seeks to determine the strengths and weaknesses of different regional centers, based on ten indicators (publications, patents, institutions, highly-cited researchers, prize winners, grants, etc.). We plan to do a parallel study in California. The Duke project is affiliated with similar research being done on the Veneto Nanodistrict by the Center for Studies on Technologies in Distributed Intelligence Systems (TeDIS) at Venice International University, and our intention is to have one set of measures that can produce a set of systematic data that can be easily used for comparison across cases. IRG-2 Co-PI Chris Newfield also plans to extend this research in selected sites in Europe (France, Amsterdam, Belgium) over the next year, since he will be based in Lyon, France.

IRG-2: Globalization. Conferences

Conference on Nanotechnology Occupational Safety and Health in Lab and Workplace

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-2-Globalization: Other Outreach Activities: In February, 2008 we hosted Professor Lan Xue from Tsinghua University (currently on sabbatical at the Harvard University Kennedy School) in conjunction with Dean of the UCSB Bren School, Ernst Von Weizsacker. He gave two public presentations while in residence at UCSB. The first, hosted by Bren was titled "Climate Policy Challenges and Prospects for U.S./China Cooperation: The View from China" and the second, hosted by CNS, titled "China's Science & Technology Policy: The Role of Nanotechnology." We held a research meeting with Professor XUE to begin to think about ways we can collaborate with his

institute (the Center for Industrial Development and Environmental Governance) at Tsinghua University. Both CNS and CIDEG are interested in issues relating to intellectual property, and nanotechnology patents in China and US.

Co-Funding: CNS Social Science Fellow Rachel Parker was awarded a National Science Foundation East Asia and Pacific Summer Institute (EAPSI) Fellowship for study in Beijing during the summer of 2007. While in Beijing she conducted research at Tsinghua University's Center for Industrial Development and Environmental Governance (CIDEG), focusing on international collaboration in nanotechnology and environmental remediation in China.

Parker has been selected as a 2008 Young Scholar, by George Mason University's Science and Trade Policy Program and will participate in the China-India-US Science, Technology and Innovation Policy Workshop in Bangalore, India.

Parker has applied for dissertation research funding through the University of California Pacific Rim Research Program. Her application was selected by a UCSB campus committee to be considered in the UC-wide fellowship pool. She is also waiting to hear back from the Institute for Global Competition and Cooperation at the University of San Diego, where she has also applied for dissertation funding.

Future Plans: We are considering two additional directions for the remainder of the current funding period. (1) Extend our research to Singapore, South Korea, and Japan, to provide a more extensive understanding of the development of nanotechnology in East Asia. (2) To trace the nanotechnology global value chain across the spectrum of activities identified in research stream #3 (nanoporous filtration, thinfilms, and carbon nano tubes), by selecting one product from each category. This research would enable us to tell a story that involves all of the issues than animate our IRG— the nature of innovation, the quality of R&D, the drivers of successful commercialization, the role of public investment, health and safety issues – all in the context of three specific products. A model for this approach is seen in the economist Pietra Rivoli's successful book, *Travels of a T-Shirt in the Global Economy*.

IRG-2: Innovation Group, Chris Newfield, Co-PI, Group Leader. IRG Members: Kasim Alimahomed, Gerald Macala, Aaron Rowe, Kim Stoltzfus, Carlos Perez, Gerald Barnett (UCSC), David Mowery (UCB), Susanne Scotchmer (UCB).

The Innovation Group is analyzing the strengths and weaknesses of the U.S. innovation system for nanoscale research as a prime instance of early-stage technology. We have a special interest in the university-industry interface, and in the interaction between intellectual property rights (IPR) and the institutional networks in which nanoscale R&D is performed. In Year 2 the Innovation Group focused on a specific area of nanoscale research - quantum dots - and tracked its extraordinary patenting boom. On the application side, we developed a focus on solar cell technology, and in the potential of quantum dots and related nanoscale structures to move photovoltaic cell technology from its current base in various forms of crystalline silicon into a new generation of nano-enabled organic materials. In Year 3, our main focus is mapping this environmentally and economically pivotal industry - solar energy - and understanding the dynamics by which knowledge is being transferred from nanoscale science - quantum dot and closely related research - to solar-related applications.

In Year 2, the group's principal members published analyses of the impact of IPR and research policy on technology transfer. In her CNS-sponsored paper last year, Suzanne Scotchmer showed that the social optimality of R&D investment would be enhanced were patenting offices to define "nonobviousness" via the scarcity of ideas, and thus favor inventions that respond to a "long-felt need." This paper is part of Scotchmer's comprehensive exploration of the mismatch between private and social measures of the value of an innovation, and part of her progress in quantifying each correctly.

In a set of papers on technology policy, David Mowery analyzed a series of often-overlooked institutional factors that shape research outputs. One of these is the low proportion of federally-sponsored R&D that is *not* directed at an agency mission. Another is procurement policy, which in the past offered large-scale support for the long-term development of early-stage technologies but which is not yet on the horizon for critical nanoscale research. A third is the wide range of non-market spillovers (non-contract-based exchanges of data and other aspects of research), which Mowery has found to be, in contrast to prior assumptions, less localized than are market ties. Gerald Barnett obtained a Kaufmann Foundation grant to develop next-generation forms of "technology translation" that will improve the capacity of current forms to sustain complex research networks and industry alliances. Christopher Newfield finished a long book on the current status of public research universities, about half of which is devoted to analyzing funding misconceptions that endanger the postwar "virtuous cycle" of R&D. Taken as a whole, the Innovation Group's published work offers an integrated picture of the challenges faced by high-risk, high-potential nanoscale science and technology development. We are working towards empirically-based recommendations about supporting nanoscale research through better patent review processes, institutional frameworks, application-focused public funding, research networks, and restored, refocused university support.

Our active research has three streams.

IRG-2: Innovation. Technology Transfer at the Nanoscale (Newfield, Mowery, Barnett)

In addition to the work described above, we finalized a semi-structured interview protocol on the impact of current tech transfer and intellectual property practices in research universities on specific nanoscale laboratories and research projects. We piloted portions of this protocol in ten interviews. These preliminary results suggest that both researchers and technology officers see no major differences between nano and non-nano research issues. The interviews have been on hold given major time commitments to projects 2 and 3 below. Newfield and Barnett continued the elaboration of a "beyond Bayh-Dole" tech transfer model that we plan to use as the basis of several papers. Newfield published a paper on the effects of commercially-oriented research on the American university funding system in *Le Monde Diplomatique* (September 2007).

IRG-2: Innovation. Mapping Nanoscale R&D Networks (Newfield, Perez, Macala)

This research is producing interactive maps for (1) California across technology areas; and (2) quantum dot research worldwide.

In fall quarter, we posted beta versions of the California and quantum dot maps on the CNS webpage. Several attendees at CNS's November conference mentioned that they have used these maps; attendees from regulatory agencies said they had little concrete information about nano-active labs and companies, and that even the basic version of these maps provide a useful service. We are contacting several of these attendees to get a better sense of their needs. At the moment, users can see areas of

regional concentration, and can use the time slider to track the emergence of both individual patents and concentrated networks over a twenty year period. Users will eventually be able to link patents, publications, and individuals, identify locations and collaborative relationships, and track the emergence of specific applications.

We are particularly interested in using patent analysis to identify pre-commercial patterns (Roadmaps, Tools, and Platforms). As noted, we decided to carve out a subdiscipline within nanoscale research in order to provide more meaningful detail of an R&D pathway. At the same time, we became increasingly interested in energy applications in general, and in solar power in particular: we decided to combine these interests. As mentioned at the start, we are focusing on quantum dots as our nanoscale scientific area and on solar cells as our primary application area. We are particularly interested in the capacity of quantum dots, in combination with other nanoscale structures, to move photovoltaic (PV) cells beyond the limitations of crystalline silicon technology into cheaper, more flexible, more adaptable nano-structured organic PVs (NOPVs).

Our 2007-2008 activity made us quite familiar with two problems with patent mapping: the incompleteness and variation of data from one database to the next, and unclear or opaque search methodologies. We organized all quantum dot patent records with different variables via SciFinder, identified top patenters, and created network diagrams of the top-10 patenters and their collaborators (@30). We tried and failed to automate the correlation of variables through our own script writing within Sci Finder. This led us to try a number of other search engines: Thompson's Micropatent, Patent iN sight Pro, MatheoPatent, available in various forms on a trial basis via commercial services like Delphion. We obtained a trial copy of Georgia Tech's proprietary Vantage Point software, and found it powerful but high-maintenance and expensive, meaning that it would require a great deal of hands-on labor to make it work effectively. We used the public version of a search and mapping-clustering service SparkIP.com, compared its methodology of creating "shingles" via co-co-citation patterns to that of other search engines.

We have extended our effort to partner with Georgia Tech, and hosted nine hours of meetings in Santa Barbara with Alan Porter, a Vantage Point principal and partner with CNS-ASU. This meeting greatly clarified Vantage Point's capabilities. We decided to divide the work between the large scale data-mining, where the Georgia Tech team has a clear comparative advantage, and our more focused, qualitative approach. Thus far we have provided Georgia Tech with one round of qualitative scientific input in order to help correct the aggregate categories that they obtained through textual analysis, but which were not found to be coherent to experts in the scientific domain. We plan to develop a division of labor in which the Georgia Tech team uses Vantage Point to do large-scale data mining, and our interdisciplinary analysis group - combining social and scientific expertise - offers reading of selected patents and publications and substantive analysis of scientific trends. This work will be assisted by David Mowery's group, which is studying continuations in the 977 patent class, and Suzanne Scotchmer's group, which is reading our list of USPTO QD patents for a finite list of "hold-up" behaviors. As far as we know, this combination of scientific-analytic and data mining expertise has not been used before. Our goal is to get a clear sense of the various pathways quantum dot research has been following, and the application "uptake" that is occurring in this finite field.

We have two major findings from this year. The negative finding is that the size and content of patent maps are dependent upon the search engine being used, and their methodologies are mostly unavailable. The positive finding is that the quantum-dot subfield is in the midst of an enormous boom in patent and application quantity. We are examining the contours of this boom this year.

IRG-2: Innovation. Survey Networks and Nanoscale Innovation (Newfield, Stoltzfus, Alimahomed)

We are interested in the human factors that affect nanoscale R&D. We have identified some key questions pertaining to this topic:

1. Is nano emerging as a scientific identity?
2. Is “nano” more collaborative across disciplines?
3. What are motives for and obstacles to collaboration?
4. Does nanoscale activity in laboratories correlate with IP incentives?

After several pilots of our collaboration survey instrument, we administered it to the UCSB science and engineering community in Fall 2007. We obtained over 400 responses; the survey closed November 21st, and we are analyzing the data. Preliminary results are as follows.

1. Even researchers who do a majority of their work at the nanoscale do *not* identify as nanotechnologists. One possible implication is that “nano” is not operating as a term of disciplinary convergence but as a post-hoc label that encourages communication and exchange across boundaries that remain in place. We will adapt our national survey to explore this question more carefully.
2. Nanoscale research is somewhat more collaborative in terms of frequency of interaction with researchers from other primary disciplines. But this difference is only somewhat significant. This finding correlates with bibliometric research that does not find noticeable convergence around nanoscale topics, though collaboration among distinct disciplines around instrumentation and specific issues is relatively common.
3. The primary obstacle to collaboration is the absence of time. Though this seems like an obvious problem, time emerges in innovation literature as a major determinant of both research effectiveness and researcher satisfaction, and we will determine how to ask better questions about this.
4. Researchers who do a majority of their work at the nanoscale are more likely to see intellectual property as a useful tool. This is another area we will explore in greater depth in the second, national round.

In Spring 2008, we are revising our survey instrument for administration to a national audience. Grad fellows Kasim Alimahomed and Kim Stoltzfus will deliver separate conference papers based on the data.

Overall, our work in this stream finds that “nanotechnology” is not emerging as a scientific identity. Instead, nanoscale research continues to be driven by discrete scientific problems and technology applications. This encourages us to continue our focus on a subset of nanoscale research - quantum dots - and our application area - post-silicon solar technology.

IRG 2: Tools for Mapping the Development of Nanotechnology

IRG 2: Mapping Tools Team Members: Tim Lenoir (Professor, PI Duke Subcontract to CNS), Patrick Herron, Vince Dorie, and Eric Giannella (Research Analyst, Duke through summer 07, now graduate student at Stanford). Working now with IRG-2, Lenoir’s group began work with IRG-1, mapping spintronics data.

The primary focus of the Mapping Tools work for the CNS has been to apply existing tools and if possible to develop new tools for quantitatively mapping and visualizing the development of nanotechnology and nanoscience. My work related initially to IRG-1, but in 2007-08 I have been working closely with the IRG-2-globalization group's comparative work on nanotechnology in the global environment with particular focus on the US, China, North Carolina, and Italy. Although my team has been slowed recently by a turnover in personnel, we are now making some very promising headway.

IRG-2: Mapping Tools: Spintronics

We began initially working closely with Patrick McCray's project on spintronics. Starting from a cluster of spintronics scientists closely affiliated with conferences at UC Santa Barbara and elsewhere, our goal was to chart the evolution of the field and the network of researchers, institutions, and funding sources. We provided a geomap (in Google Earth) of the research groups and their relationships to other spintronics groups over time. We wanted to see if the map would be a useful way to identify key figures and institutions in the network that would help us identify persons and themes to interview. We also did some exploratory work on mapping the development of nanotech in China with a view toward identifying the key areas in which China is having a major global impact, and we wanted to examine the role of Chinese researchers in international research teams.

This early work produced some interesting results, but revealed the need for much more powerful tools than we were working with. In addition, we wanted to be able to map relationships among various fields of nanotech, biotech, and other areas of science and technology rather than focusing on a single research area. We worked initially with Delphion for doing searches on patents and a product from Sandia Labs called VxInsight and some associated programs for mapping and visualizing scientific literatures. We worked with the SCOPUS database and the USPTO as data sources. These tools worked well for generating a macro picture of the field but turned out to be inadequate for exploring more fine-grained structures of relationships between the dense clusters of documents and patents that emerged; moreover, the tools we experimented with were ineffective at generating a temporal evolutionary mapping of related fields, a key objective our research.

The really big problem for making sense of this emerging domain has been identified by many researchers and has become the topic of almost every opening talk at conferences on nanotechnology; namely, what is (and what is not) nanotechnology? Unlike some fields where a core set of discoveries lead to a branching structure of scientific and technical innovation, nanotech covers a diverse spectrum of fields. The USPTO, for instance, includes nanotechnology in 214 different classifications. Only within the past few months has a separate category for nanotech been created at the USPTO, and that is likely not to capture a large part of the most interesting work. The issue here is that for purposes of creating useful detailed search results the standard approach is to begin by constructing a robust ontology of keywords, concepts, processes, etc., that are agreed upon by the relevant communities to capture the essential information of the field. Constructing these ontologies is for the most part a work of love infused with a lot of political committee work. Given the multiplicity of nanotech fields with apparent different and multiple origins, we wanted to approach the subject differently by starting from the "bottom-up" without applying an externally generated ontology. Such an approach is, obviously, computationally intensive; for patents it requires developing techniques for grouping closely related documents from within all patents issues since 1970 or so (roughly 3.5 million patents). The parallel problem for scientific and engineering literature is even larger (by several orders).

We approached this problem by applying algorithms developed for mining the link structure of the Web. Just as these researchers have been interested in mapping the nodal structure of the Web, we are

interested in the structure of the entire USPTO data set since 1970. We explore nanotechnology as a (hopefully dense) subgraph of this massive graph. In particular we adapted methods known as “shingling” developed by several researchers but most effectively for our purposes by a group of researchers at IBM Almaden. We worked closely with a commercial firm, [SparkIP](#) in Atlanta, GA, to develop the algorithms for generating densely related clusters of patent documents based on a restrictive criterion of co-citation, where the same two documents (patents) are referenced (co-cited) by two separate documents (patents), forming a “shingle”. The full-text documents clustered in this first pass are then analyzed with text-mining tools to perform content analysis. Frequency lists of co-occurring terms in the document cluster are used to organize the cluster into subclusters identified in terms of auto-generated sets of labels that provide a relational conceptual map of the large document cluster. The result is a set of interrelated subgraphs. Further types of analysis can be performed on the subgraphs, such as tracking the institutional relationships between authors/inventors, assignee relationships and other relationships of interest, e.g. funding patterns. Development of the tools to extract these social networks and institutional relationships will form the core of our research effort over the next year.

IRG-2: Mapping Tools: Analysis of Chinese Nanotechnology Research Literature

During the past few months our work has concentrated on developing automated ways of generating time-sequence mappings of the evolution of the clusters in our data sets. Vince Dorie has developed these methods. They were shared to the group at the Research Summit in March 2008 and drew great interest to everyone.

Another focus has been on mapping the literature of Chinese nanoscience. Our goal with the Chinese nanoscience literature has been to develop further our techniques for tracking the conceptual structure of the field. Patrick Herron has led the way in analyzing this problem. Our first goal in analyzing the Chinese nanotechnology scientific research literature is to gain an understanding of the dynamics of the Chinese nanotechnology document set's conceptual space by evaluating shallow term features over time in both numeric and visual ways while developing an analytical framework for such analyzes. Underlying motivations include discovering the general patterns of growth of terms and concepts in the short head of the total Chinese nanotechnology scientific literature. Of particular interest is to see how conceptual areas rise and fall over time in terms of how often such concepts are invoked and how many times documents with such labels & terms are cited.

We are completing the construction of a Chinese nanotechnology scientific literature database that includes citation data as well as full text abstracts and already performing frequency analyzes of ISI-assigned ID tags over time. Visualizations such as treemaps, bubble maps, geocoded maps and document clusters are being used to identify related document sets along with their meanings in the greater document set context. We will present these slides in the general meeting on Friday. These methods offer an excellent way to develop an historical sense of the structure and dynamics of explosions of research interests within isolated conceptual spaces and perhaps even begin to identify signals of future dominant nanotechnology research areas in China.

The second, third, fourth, and fifth goals—understanding patents, researchers, institutions, and grants—will be realized using the tools and methods currently being built and used to understand the conceptual space. Combining in different ways the results generated from realizing the five goals will allow for complementary, high-definition, and concise readings of the 55,000+-document Chinese nanotechnology research literature. It is by virtue of the combination of citation graphs, geomaps, document clusters, topic maps, text mining, frequency statistics, automatic labeling, and social graphs applied to different combinations of target data subsets that we believe we will show in great detail the

innovation diffusion realm of Chinese nanotechnology. We hope to be able to see such properties at different scales and begin to recognize the emergence of larger-scale patterns (e.g., platforms) out of similarly-structured smaller-scale patterns (e.g., conceptual convergences in new document sets from collaborating research institutions).

Given the full realization of such goals, we should become better equipped to improve the performance and evaluation of document clustering systems while developing a working prototype of a time-based innovation landscape analysis and visualization platform.

IRG-2: Mapping Tools: Where Would We Like to Take This? A Strategy for Investigating Nanotechnology in the Context of Post-Academic Science

Over the past three decades a new form of research identified by a number of analysts as “post-academic science” has begun to compete with and some would say displace traditional academic science. Post academic science is science done with a focus on utility, application and predicated upon intellectual property and patents. It is often large-scale and transdisciplinary. Most troubling to proponents of the “blue sky” traditions of earlier academic science that was for the most part self-policing is that in post-academic science, government agencies and industry are playing an increasing role in deciding not only what research should be conducted but also how it should be evaluated. While some scholars have voiced concern that these changes in the social structures of science are having consequent changes in the epistemology and in the kinds of knowledge produced, others have argued that the new private/public mix characteristic of post-academic science is having a positive effect on the growth of knowledge, particularly in areas such as biotechnology. We are interested in developing quantitative tools for assessing this issue and its policy implications for nanotechnology, which may be the most salient example of post-academic science to date.

In order to evaluate the size, importance, and impact (whether positive or negative) that the new close coupling of academic research, targeted government funding programs, and R&D done by commercial firms is having on academic science, it is necessary to expand and modify the earlier approaches to investigating the role of federal funding on academic research. During the 1980s and early 1990s in the initial years of the post-Bayh-Dole era attention was focused on university-industry technology transfer and knowledge spillovers mostly resulting from federally funded academic research. The results of those studies led economists to abandon the linear model of innovation which pictured a direct flow of innovation leading from scientific discovery to product development, ending with market introduction of new products. Following the pioneering work of Rosenberg and Kline, von Hippel, Jaffe, Henderson, and Trajtenberg, the linear model has been replaced with a “network” model that stresses the role of linkage, feedback, and co-evolution among the various stages of the innovation process from discovery through development to commercialization, and features interdependencies and dynamic learning across the various stages of the innovation process. According to this picture, innovation is a dynamic process drawing upon scientific and technical knowledge as well as from manufacturing experience, and insights from business services that provide financing, marketing, regulatory, and commercial knowledge.

Despite the support for the network model of innovation, there have been few examinations, and no systematic quantitative examinations we are aware of, treating the impact of industry-based R&D or of the broader technological infrastructure of a region on the research environment of universities. Most examinations of the role of external effects on the university research environment have focused on the impact of defense department funding on science and engineering research during the Cold War era, or on the potential (almost entirely negative) effects of corporate sponsorship of academic research

programs in biomedicine. The networked model of innovation described above, however, posits relatively porous boundaries between firms and academic research programs as one key element of an innovative region. The model suggests a bi-directional flow of input between university and industry innovation, in the form of licenses on inventions, personnel, and tacit knowledge flowing from (mostly federally funded) academic research programs, as well as a flow *from* industry *to* the universities of new technologies and research directions. Moreover, the model suggests that these bi-directional flows should not be considered as sequential; that is, originating in the university environment and diffusing outward to stimulate commercial innovations that subsequently reshape the academic research environment. Rather, the model suggests the possibility of mutual stimulation of research and invention in both industry and academe, operating as a positive feedback loop.

The flow of inventions into industry through the licensing of university-based patents has been well studied, but despite suggestions by researchers such as Jaffe, Trajtenberg, and Feldman of the need to consider the issue, the reverse phenomenon of the stimulation of university research through the absorption of new directions emanating from industry has yet to be investigated in much detail. Since most studies have focused primarily on the importance of federal funding of academic research, the potential importance of federal funding of non-academic organizations for stimulating innovation and new orientations within academic research environments has gone unexplored. A crucial element needed for effective assessment of so-called “post-academic” science is investigation of the role of federal funding of R&D to non-academic research organizations and private firms in stimulating new areas of scientific development.

There are several ways in which the federal government has acted to stimulate innovation through funding research and development in commercial firms that could potentially have a virtuous impact on academic research as well. One source has been direct funding through grants and contracts of research and development conducted by private firms, particularly of instrumentation and research technologies, computer, communications technologies, semiconductor research, imaging tools, robotics and much more. A second especially important mode of federal funding that has created synergies between university and industry researchers are the large federal initiatives such as the Human Genome Project and more recently the National Nanotechnology Initiative. An explicit demand of many of the calls for proposals under these programs is that research projects identify industry collaborators and partners to accelerate research and facilitate potential transfer of knowledge to industry. Independent of these large scale federal projects but working hand-in-hand with them has been the Small Business Innovation Research Program (SBIR) and the Small Business Technology Transfer (STTR) Program administered by the Small Business Administration. Launched in 1983 with \$45 million these programs grew to \$2 Billion by 2004 and have nurtured the launch of startup firms and the transfer of university-based research to industry.

There is some evidence supporting the claim that these different modes of federal funding for high-tech startups and new industrial development have also been significant in shaping the research agendas of academic programs. Lenoir and Giannella have shown that federal funding, particularly SBIR and STTR funding for high-tech startups and new industrial development was important at several phases in the early history of microarrays, and federal funding of academic researchers using prototype microarrays was fundamental both to improving and extending the performance of microarrays while transforming the research agendas of several fields within academe. This study shows that federal funds were the enabling factor for several key startups, such as Affymetrix and Symyx, and as the technology evolved, federal support for collaborative research projects using gene chips and microarrays was crucial to evolving the various microarray platforms and their supporting technologies. The study argues that companies developing microarray technologies such as Affymetrix

have functioned very much like research programs at universities, and in many ways the collaborative research going on in those firms with academics is more productive and has a greater impact than research in most university settings. Such findings suggest that the close interdependencies of industry, university, government associated with post-academic science might exercise a positive effect on innovation and the production of new knowledge. The question we would like to research through a comparative study of the US and China as part of IRG-2's program is whether nanotechnology qualifies as post-academic science and if so the policy implications this may have for the development of regional science and technology programs in the context of globalization.

IRG-2: Mapping Tools: Co-Funding

Lenoir has applied for grants from the NSF and from the Duke University Provost's Common Fund to support further development of our projects. The NSF application was to the SES (Studies of Policy, Science, Engineering and Technology) program at the NSF. The application to the Duke University Provost's Common Fund was successful. In part it supports his efforts to work closely with Gary Gereffi (IRG-2: Globalization) on mapping value chains in manufacturing related to nanotechnology, particularly in North Carolina. The project includes a group of colleagues from Computer Science and Engineering at Duke working in graphics and visualization. They also plan to map global value chains in nanotechnology. The grant is for one year.

IRG-2: Publications Submitted for Review, Accepted or Published

- Lenoir, Timothy. "The Emergence and Diffusion of DNA Microarray Technology," *Journal of Biomedical Discovery and Collaboration*, Vol. 1 (no. 10): August, 2006.
- Erkal, Nisvan and Suzanne Scotchmer, "Scarcity of Ideas and Options to Invest in R&D," *Institute of Business and Economic Research*, Paper E07-348 (2007).
- David C. Mowery. "The "Non-Globalization" of Innovation in the Semiconductor Industry" (with A. DeMinin and J. Macher), *California Management Review*, 2007.
- Newfield, Christopher, "Passé et passif de l'enseignement supérieur américain," *Le Monde Diplomatique* September 2007.
- Appelbaum, Richard P. and Parker, Rachel. "China's Bid to Become a Global Nanotech Leader: Advancing Nanotechnology Through State-Led Programs and International Collaborations," forthcoming, June 2008 *Science and Public Policy*.
- David C. Mowery. "What does economic theory tell us about mission-oriented R&D?," presented at the EPFL "Technology Policy" conference, Monte Verita, Switzerland, June 18 – 21, 2007; forthcoming in conference volume (title and publisher TBA).
- David C. Mowery. "Introduction: Running Faster to Keep Up" (with J. Macher), in D. Mowery and J. Macher, eds., *Running Faster to Keep Up: Globalization of R&D and U.S. Economic Welfare* (National Academies Press, 2008).
- David C. Mowery. "The "Non-Globalization" of Innovation in the Semiconductor Industry" (with A. DeMinin and J. Macher), in D. Mowery and J. Macher, eds., *Running Faster to Keep Up: Globalization of R&D and U.S. Economic Welfare* (National Academies Press, 2008).
- David C. Mowery. "Introduction: The Norwegian Innovation Paradox" (with J. Fagerberg and B. Verspagen), forthcoming in J. Fagerberg, D.C. Mowery, and B. Verspagen, eds., *Norway's Innovation System* (Oxford University Press, 2008).
- Christopher Newfield. *Unmaking the Public University: The 40-Year Assault on the Middle Class* (Cambridge: Harvard University Press, 2008).
- Lenoir, Timothy. "Technological Platforms and the Layers of Patent Data," with Eric Giannella, in Mario Biagioli, Peter Jaszi, Martha Woodmansee, eds., *Con/Texts of Invention:*

Creative Production in Legal and Cultural Perspective, Chicago; University of Chicago Press, 2008 (in press)

IRG-2: Conferences, Panels and Presentations

- Lenoir, Timothy “Contemplating Singularity: On Nanomachines and Postbiological Selves,” April 21, Interfaces and Visualizations: A State-of-the-Art Conference on the Humanities in Post-human Times, University of Illinois, April 20-21, 2007.
- Appelbaum, R. and Parker, R. “Nanotechnology in a Global Context: The Case of China” presented at the Duke University Conference on Nanotechnology and the emerging global knowledge economy: Challenges and opportunities in an international context.” March 29-30, 2007.
- Lenoir, Timothy “Contemplating Singularity: On Nanomachines and Postbiological Selves,” May 26, 2007. Media, Technology, and Society Program, Northwestern University School of Communication.
- David C. Mowery. “What does economic theory tell us about mission-oriented R&D?,” presented at the EPFL “Technology Policy” conference, Monte Verita, Switzerland, June 18 – 21, 2007; forthcoming in conference volume (title and publisher TBA).
- Lenoir, Timothy. Joint Wharton-Chemical Heritage Foundation Symposium on Social Studies of Nanotechnology, Wharton School, University of Pennsylvania June 7, 2007, Commentary on papers by Hyungsub Choi and Cyrus C.M. Mody and Frank Rothaermel and Marie Thursby.
- Christopher Newfield. “Budgetary Trends at the University of California” (Problems for Basic Research), Meeting of The Regents of the University of California, May 2007.
- Lenoir, Timothy. “Mapping Patents in Nanotechnology,” workshop on “Institutional fragmentation of scientific research” held at the Zentrum fuer Interdisziplinare Forschung (ZiF), Bielefeld, German, June 17, 2007.
- Stoltzfus, K “A Day in the Life of a Graduate Student: How to Prepare and What to Expect” Presentation for Internships in Nanosystems Science, Engineering, and Technology (INSET) program, UCSB, July 2007.
- Stoltzfus, K. and E. Lively “Nanotechnology: What It Is and What It Means For You” Presentation at Laguna High School Senior Assembly, Santa Barbara, 2007
- Stoltzfus, K “Broader Impacts of Nanotechnology: Diffusion and Ethics” Presentation for National Nanotechnology Infrastructure Network (NNIN), National Undergrad Convocation, 2007
- Appelbaum, R. “Innovation or Imitation? China’s Bid to Become a Nanotech Power,” EIG (Entrepreneurship, Innovation and Growth Fourth Annual Symposium, Menlo Park, California (October 4, 2007)
- Parker, R & R. Appelbaum “Nanotechnology in a Global Context: The Case of China.” Presented at the Society for Social Studies of Science Annual Meeting, Montreal, Quebec (October 11, 2007).
- D. Nawarathna, P. Kumaresan, Y. Zhang, B. Ferguson, S-H Oh, K.S. Lam, H.T. Soh “Continuous Magnetophoretic Enrichment of Rare Tumor Cells” Proceedings of MicroTAS Conference, (2007)
- E. Pavlovic, R.Y. Lai, B.S. Ferguson, T.-T. Wu, R. Sun, A.J. Heeger, K.W. Plaxco, H.T. Soh “Rapid Sequence Specific, Reusable Electronic DNA Sensor in Microfluidic Devices” Proceedings of MicroTAS Conference, (2007)

- Alimahomed, K., Seibold, D., Stoltzfus, K., Kang, P., & Patton, R. Defining creativity through dialectics. 93rd National Communication Association Annual Meeting, Chicago, IL, November 2007.
- Alimahomed, K., Seibold, D., Stoltzfus, K., Kang, P., Patton, R. & Sim, E. (2007). Creativity as structured heteroglossia: Towards a dialectical reformulation of group communication and creativity. Paper presented to the Group Communication Division at the National Communication Association Conference held in Chicago, IL.
- Appelbaum, R. "China's Role in Nanotechnology," CNS Nano-Meeter, with Alec Wodtke, UCSB Chemistry Department (November 29, 2007)
- Christopher Newfield. "The US Innovation System and Europe: Implications of Nanoscale Research," Central European University, Budapest, Hungary, December 2007
- Parker, R. & R. Appelbaum, Co-Chairs, "Global Diffusion of Nanotechnology: Lessons from China, Italy and the US" Panel convened at AAAS annual meeting with collaborators Gereffi and Lenoir from Duke University, and Vladi Finotto, from Venice International University. Feb 17, 2008.
- Parker, R & R. Appelbaum "Nanotechnology in a Global Context: The Case of China" (American Association for the Advancement of Science Annual Meeting, Boston, Massachusetts, February 17, 2008).
- Lenoir, Timothy. "Nanotech Landscapes: Visualization of top Nanotech patent clusters and cluster landscapes, US, 1970-present," AAAS Meeting, Boston, February 17, 2008
- Christopher Newfield. "Funding University Research in Early-Stage Technology: a US - EU Comparison," University of Paris X - Nanterre, February 2008.
- Christopher Newfield. "Budgetary Trends at the University of California" (Problems for Basic Research), Meeting of the Council of Chancellors, the University of California, March 2008.
- David C. Mowery. "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.
- David C. Mowery. "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.
- Alimahomed, K., Macala, G., Stoltzfus, K., & Newfield, C. (2008). Innovation and collaboration in the nanoscale laboratory. Poster to be presented at the Gordon Conference on Science and Technology Policy in Big Sky, MT.

Awards to IRG-2 Researchers

- R. Parker, 2007, National Science Foundation East Asia and Pacific Summer Institute (EAPSI) Fellowship for study in Beijing during the summer of 2007.
- Parker has been selected as a 2008 Young Scholar, by George Mason University's Science and Trade Policy Program and will participate in the China-India-US Science, Technology and Innovation Policy Workshop in Bangalore, India in summer 2008.
- Kim Stoltzfus, UCSB Dean's Fellowship, 2007-2008
- Brian Scott Ferguson, Center for Nanoscience Innovation for Defense Fellowship (CNID), Summer 2007
- Brian Scott Ferguson, Co-inventor: Microfluidic Magnetophoretic Device and Methods for Using the Same. U.S. Patent Application No.: 11/583,989.

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

B. Herr Harthorn	Anthropology	Race, gender & health; risk perception IRG Leader
B. Bimber	Political Science	Science and technology studies
K. Bryant	Sociology	Gender, science & society (as of Sept 07)
N. Pidgeon	Social Psychology	Social amplification of risk framework
T. Satterfield	Anthropology	Cultural and environmental risk perception
M. Kandlikar	Science policy?	Nanotoxicology, materials science, science policy
J. Mohr	Sociology	Quantitative content analysis; diversity education
D. Awschalom	Physics	Nanoscale science and engineering; science/society

Affiliates

R. Ackland	Economics	Web crawling tools for social research
M. O'Neil	Computer science	Web crawling tools for social research
T. Rogers-Hayden	Environmental risk	Public deliberation and engagement (as of Oct 07)
S. Stonich	Anthropology	Public participation; environment & development
E. Gwinn	Physics	Nanoscale science and engineering; grad education

2 Postdoctoral Associates and 11 Students

Post-doctoral researchers: Philip McCarty, Tee Rogers-Hayden (International; female) (through Sept 07)

Graduate students: Social science: Karl Bryant (through Aug 07), Joe Conti, David Weaver

Nanoscience: Joseph Summers, Alexis Ostrowski (female), Tyronne Martin, Erica Lively (female)

International: Christian Beaudrie (UBC Doctoral student)

Undergraduate students: Stacy Chirchick (female), Jason Cannon, Nicole Tyler (female)

IRG-3: Risk Perception Group, [Barbara Herr Harthorn](#), Co-PI and **Group Leader**. Team members: [D. Awschalom](#), Joseph Conti, Tyronne Martin, Alexis Ostrowski, [Susan Stonich](#), [Karl Bryant](#) (formerly UCSB, now SUNY-New Paltz), Joe Summers (formerly UCSB, now Mount Holyoke), Christian Beaudrie (University of British Columbia), [Milind Kandlikar](#) (University of British Columbia), [Nick Pidgeon](#), **Group Co-Leader** (Cardiff), [Tee Rogers-Hayden](#) (University of East Anglia, UK), [Terre Satterfield](#), **Group Co-Leader** (University of British Columbia)

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—nanoscale scientists and engineers, nano risk assessment experts, regulators, industry, NGOs or other social action groups, and members of the public who differ by gender, race/ethnicity, class, occupation, education, and age. In the past year, researchers in this IRG-3 performed work in the main areas detailed below.

IRG-3: Risk Perception. Expert Judgments about Nanotechnologies' Benefits and Risks
Harthorn (Harthorn, Satterfield, Bryant, Pidgeon, Beaudrie, Martin, Ostrowski, Summers)

Study 1: Nanoscale scientists and engineers

After extensive interview protocol development and pretesting in 2006, the UCSB team has completed and transcribed 15 90-minute expert interviews in California, and is currently working to complete an additional 5. Over the same period, the UBC team has completed 7 comparable interviews in Canada,

and will complete another 3 shortly. This will result in an overall sample of 30 scientists, 20 US (Calif) and 10 Canadian. 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. Preliminary findings indicate that nomenclature and definitional issues are pervasive. Our data strongly indicate that 'nanoscience' and 'nanotechnology' are contested domains for the majority of scientists and engineers we interviewed. These issues are particularly evident in scientists' and engineers' assessments of nanoscience/nanotechnology as *new/not new* and *risky/not risky* in both the present and in projected future contexts. In addition, there seem to be several different forms of expert risk attenuation in evidence, although the upstream context and scientific uncertainty of near-term hazards make assessment complex but potentially crucial. Preliminary analysis indicates that there is likely a pattern of risk attribution outside one's own discipline. We presented 2 papers ([Harthorn](#) and [Bryant](#), [Satterfield](#) and [Kandlikar](#)) at an invited panel on nanotechnology risk perception co-chaired by [Pidgeon](#) and [Harthorn](#) at the Society for Risk Analysis-Europe in The Hague in June 2007. We presented an additional paper on possible expert attenuation ([Harthorn](#), [Bryant](#), & [Satterfield](#)) at a CNS panel co-chaired by [McCray](#) and [Harthorn](#) at the 4S meetings in Montreal in October 2007. When the sample is complete, we will vet our preliminary analyses to our UCSB participants prior to submission for publication. We hope to have articles in preparation for submission by summer 2008.

The UBC team is also preparing a web survey to extend (and validate) the interview data; they have recruited a new PhD student whose work this will be, and we hope to complete this survey in Spring, 2008 as well.

Study 2: Nanotoxicologists

We are also conducting a similar study, using a modified protocol, with experts whose work focuses on possible toxicities of nano materials. So far, the UCSB team has completed 2 interviews in California. In concert with the UBC team, we anticipate completing another 10-13 faculty interviews, focusing on the West Coast and Texas by mid-2008. We will be training our nanoscience fellows (chemists Alexis Ostrowski and Tyronne Martin) in interview processes and hope to have them conduct a number of interviews with toxicology postdocs in the UC during 2008. We expect to find significant differences between toxicologists and other lab scientists in their views of the nano conceptual domain, nanomaterials' characteristics, and knowledge and ideas about nano benefits and risks. Preliminary nanotoxicologist interviews indicate likely sharp demarcation from those engaged in basic and applied science and engineering, for instance in views about nanomaterials and risk. This work builds on the foundational work of [Satterfield's](#) collaborator, Paul Slovic, on toxicological assumptions of experts and 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 have been working on developing suitable search terms and characterizing the extant English literature on nanotoxicology, using SciFinder and other web resources. They have documented a large array of publication sources (500+) for the 2000+ articles on toxic properties of nano materials through Dec 2007. They plan to characterize the publications according to specific attention to several key issues (type of nano materials under study, in vivo/in vitro analysis methods, exposure pathways under study, etc.). We plan to submit these findings as a short letter or comment to a nano materials journal in 2008.

The on-campus group meets weekly; the international team confers weekly by e-mail and every few weeks by teleconference. Face-to-face meetings were held quarterly throughout 2007 and more

frequently in early 2008. The West Coast location of the principals and co-involvement on other IRG-3 projects facilitates more regular contact.

Co-funding: The main proposed research component of the pending UC CEIN proposal to NSF is to extend our research on nanotoxicologists, nanotoxicology, and public response to the EHS issues, and to add to the team the expertise of UCSB risk perception scholar, William Freudenburg and internationally renowned scholar Paul Slovic and his colleague Robin Gregory, both at Decision Research, Eugene, OR.

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

The comparative deliberations in California and the UK were completed in February 2007, transcriptions by April 2007, and analysis in NVivo conducted in the last 6-8 months of 2007. The analyses have focused on: a) the cross-national US-UK comparison, particularly in light of the extensive history of public deliberation efforts in the UK; b) the health and energy cross-application comparison; c) a cross-health group comparison focused on group composition effects as a means of addressing the importance of participant characteristics in driving discussion and debate (younger, more homogeneous vs. more representative sample); and d) methodologies 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 health and enhancement applications regarded with greater ambivalence. Our deliberation 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 may affect elicited views. This has implications for public participation mechanisms and science policy in the US and abroad. We expect data analysis, report writing, and paper preparation to continue through 2008 with a number of articles in risk, STS, and nano journals.

The group confers every few weeks by teleconference, and we've met three times in the past year, twice in 2007 (in The Hague in June 2007 at the SRA-E meetings, and in Montreal in October 2007) and once in 2008 in conjunction with the Research Summit. Preliminary presentations of analyses were made at the SRA-E and 4S meetings in 2007; additional presentations are planned for the World Risk Congress in June in Guadalajara, Mexico.

Co-Funding [NEW PROJECT]: Harthorn and Bryant developed and submitted a proposal to NSF in February 2008 for additional funds to extend this study. We proposed to use the same protocol and approach for a set of 6 deliberative workshops in California in January 2009, focused again on health and energy applications, and varying group composition by gender (a 2x3 design with mixed, all women, and all men groups). This will allow us to leverage the year-long development of the deliberation workshop protocol, provide more comparative data with the original groups to track change over time, and enable a concerted focus on gender as a between group difference and ethnicity as a within group difference in technological risk perception. In addition to funding Bryant's summer salary, the pending proposal requested funding for a postdoc and an additional graduate fellow for this next phase of the research. Discussion is underway for possible additional UK comparative workshops in conjunction with this new study.

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

We are in active development of a new protocol for a national survey of public perceptions of nanotech benefits and risks in the US that we plan to put in the field in May-June 2008. It will be primarily phone survey with a representative sample; and a smaller web-based survey with a targeted sample as well, particularly to pilot more experimental aspects of the survey such as a set of questions designed to assess the effects on emerging perception of exposure to visual materials on nanotechnologies, and a decision pathway survey component. Because there have been a series of public surveys of public opinion on nano to date, we have worked hard to ensure that our research will contribute something new. We will do this in part by drawing extensively on validated question sets from other well documented technological risk perception studies, so that we will have good comparative data. We also are using a number of techniques to ask particularly how perceptions emerge in the course of survey exposure to limited knowledge, since 70-90% of the US public continue to have little or no awareness of nanotechnology. Related question sets we draw from include general views on science and technology, views on other (past and present) technologies, political ideologies or “cultural values,” issues of equity and access to resources, trust in government and industry, and other issues. We are drawing extensively on the qualitative data from the deliberation research to develop the protocol; we plan to focus on some of the same examples and to follow that research in looking primarily at nanotech health/enhancement and energy/environment applications.

In addition to conventional phone survey methods, we plan to pilot in web survey with special interest groups a new method for tracking the decision pathways of respondents as they form judgments about nanotechnology ‘objects’, among other more novel approaches, responses to visual, as opposed to verbal stimuli about nano risk objects . Depending on success, we will later pursue an additional full survey using some or all of these methods.

As a part of this work, we have compiled a database on all extant nano surveys, have procured protocols for key national surveys to date, and have done extensive bibliographic research on risk perception and values research on issues related to trust, uncertainty, ambivalence, affect, emergent perceptions, science and technology, and a wider array of issues. We have had face-to-face planning meetings with Satterfield, and teleconference meetings with the full team approximately every 3 weeks. Conti and Harthorn traveled to UBC at the end of January to work intensively with Satterfield and her team on the protocol; the entire group met extensively in March in Santa Barbara in conjunction with the Research Summit. Under our general direction, sociology doctoral student Joe Conti has developed vignettes, amassed question sets from numerous other relevant surveys, and is providing essential coordination as the protocol takes shape. We expect the new protocol to provide a solid means for studying how perceptions emerge progressively in response to particular frames of benefits, contexts, technical information, and risks, and how that might lead us to predict particular responses for nanotechnology/ies as a (set of) risk object(s).

Harthorn conferred with leading nano survey researchers Steve Currall and Dan Kahan in Boston at AAAS in February 2008; she also met with national opinion poll expert, Dietram Scheufele, there in February; and then with the larger team again at UCSB later in February 2008 to talk in much more detail about the expert and public surveying they (Wisconsin, under ASU funding) have conducted and plan in the future. They have shared their protocols with us, and there is a good collaborative conversation underway, including discussion of future comparative surveys in China, and elsewhere (with IRG-2’s global team). Surveying is expensive, and none of us can do it annually as would be ideal, so collaboration within the network is highly strategic.

Co-funding: At the Research Summit in March 2008, we decided that Pidgeon will seek additional funding in the UK to conduct a comparative UK survey using the protocol we have developed for US application. Future survey research will require additional fund seeking, as the costs have become prohibitive for the methodologically most rigorous approaches using phone survey methods.

Leverage:

1) Harthorn (NSF), pending, “Deliberating Nanotechnologies in the US: Gendered Beliefs about Benefits and Risks as Factors in Emerging Public Perception and Participation,” 2008-2010 (with Bryant)

2) Nel, Andre et al. (NSF), pending “Center for Environmental Implications of Nanotechnology,” Harthorn is proposed IRG 7 leader, member CEIN Research Executive Committee, 2008-2013, Satterfield is proposed IRG 7 senior personnel.

IRG-3: Nano in the Public Sphere Group, Bruce Bimber, Co-PI, Group Leader. John Mohr, Phil McCarty, David Weaver, Erica Lively, Robert Ackland (Australian National University), Mathieu O’Neil (ANU)

The Nano in the Public Sphere team in IRG-3 aims at understanding the processes by which nanotechnologies come to be recognized as an object of politics and societal relevance, and by which the democratic system responds to novel developments and policy problems. Specifically, we aim to collect data about how the media, NGO’s, and government institutions frame ideas about nano, and to use these data to explore and develop new models of media framing, agenda-building, and public sphere dynamics. Aside from the value deriving from intrinsic interest in nanotechnologies, we suspect that the emergence of nano into the public sphere at present and in the immediate future will provide unusual opportunities for observation of the dynamics of public issues at the pre-contestation stage of politics.

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, government agencies, and NGOs 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.

IRG-3: Nano in the Public Sphere. Study 1: 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. We have reported these results in an article manuscript now in revise & resubmit status at a journal.

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: Nano in the Public Sphere. Study 2: 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. In early 2008, Ackland met with other members of IRG-3's public sphere group, and we are currently exploring possibilities for applying the web crawling techniques to the analysis of framing of nano.

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

Following the preliminary analysis of framing in Study 1 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 nanotechnologies? Are these frames characteristic of particular actors or institutions – e.g. regulatory agencies, R&D agencies, NGO's and public interest organizations, Congress, the presidency? What are the origins of frames reaching the public via the media? At present, we have identified four large frames, which we call 1) the corporate responsibility frame, 2) the progress frame, 3) the conflict frame, and 4) the authority frame. For example, statements adopting the corporate responsibility frame involve variations on the following message: Corporations are putting the public at risk and the government is not acting. The progress frame involves the message that science is unfolding in a natural way, promising many good things, but potential harmful side-effects of progress should be anticipated by experts and minimized.

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. Our first approach to analysis employs a traditional technique of reading and hand-coding for the presence or absence of the set the frames in a sample of the documents. In the second, we employ automated full-text searching of our entire population of documents, along with multi-dimensional scaling analysis to identify frames via clustering of terms.

A significant methodological 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. If we are successful at this milestone by the end of summer 2008, we will then apply our techniques to show how framing of nano in news coverage has changed over time and been influenced by various institutional and organizational actors.

IRG-3: Nano in the Public Sphere. Study 4: Framing Theory. (Bimber, Mohr, McCarty, Weaver, Lively)

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 established frames and categories yet dominate how the media report on nano (an assertion we explore empirically in study 3). Politically, nano is in a stage of pre-contestation and proto-framing. We expect that this condition will end eventually, as discourse about nano in the public sphere coalesces around particular frames and issues that become customary in reporting and therefore in public opinion. In this study, we hope to exploit the current political stage of nano to develop the theory of framing further. We note that at least three major theoretical traditions about framing exist: these are issue framing, valence or equivalency framing, and thematic vs. episodic framing. All of these involve specific predictions that have been verified empirically to varying degrees. However little work has been done to integrate the predictions of these theories or to synthesize across them. We plan to attempt that development theoretically, and to test and validate our theory using the empirical techniques we are developing in study 3.

IRG-3: Nano in the Public Sphere: Tentative Study 5: Comparing Nano and Non-Nano (Bimber, Weaver, new Graduate Fellow)

An underlying theme in most of the research of this group is the question of whether nano is in fact novel as an object of politics, and if so what attributes establish its novelty with respect to democratic processes. We are exploring approaches to a comparative study of framing of issues that would involve collecting and analyzing data about media coverage of issues such as GMO's and biotechnology, and selected non-scientific issues. Theoretically we observe that it is possible that insofar as media coverage and public opinion is concerned that: 1) at least some nanotechnologies have special attributes when compared to other scientific or technological issues (e.g. technical novelty leads to political novelty); 2) nanotechnologies are entirely comparable to other scientific and technological issues (e.g. science politics is different from non-science, but nano is not novel politically); or 3) nano, other scientific and technological issues, and "non-science" issues such as immigration, health, economy, or war all exhibit variation on some underlying dimensions such as uncertainty, threat, and reliance on authority, and that these account for the major dynamics of media coverage. We are weighing alternatives to a study that would explore these possibilities.

IRG-3: Publications

- Rogers-Hayden, T. & Pidgeon, N. (2007) "Moving Engagement 'Upstream'? Nanotechnologies & the Royal Society and Royal Academy of Engineering's Inquiry", *Public Understanding of Science*. 16, 345–364. ISSN 0963-6625; IF 0.193
- Pidgeon, Nick, & Rogers-Hayden, Tee. "Opening up Nanotechnology Dialogue with the Publics: Moving Beyond Risk Debates to 'Upstream Engagement.'" In A. Anderson, A. Petersen, S. Allan and C Wilkinson (eds.). *Health, Risk & Society, Special Issue 9, 2* (2007): 191-210. ISSN 1369-8575; IF 1.634
- Rogers-Hayden, Tee, Pidgeon, Nick, Mohr, A. (Eds). "Engaging with Nanotechnologies-Engaging Differently?" *Nanoethics, Special Issue 1(2)* (2007):123-176.
- Daniel Neuman, Alexis D. Ostrowski, Ryan O. Absalonson, Geoffery F. Strouse, and Peter C. Ford, "Photosensitized NO Release from Water Soluble Nanoparticle Assemblies," *Journal of the American Chemical Society*, 2007 (129) 4146-4147.
- Rogers-Hayden, Tee, & Pidgeon, Nick. "Developments in Public Participation in Nanotechnology: towards Sustainability." In H Kastenholtz and A Helland (eds.) *Nanotechnology Development in Light of Sustainability. Journal of Cleaner Production, Special Issue*, 16, (2008) 1010-1013.
- Joseph A. Conti, 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*. 10.1021/es702158q (April)
<http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/asap/abs/es702158q.html>
- Rogers-Hayden, T. & Pidgeon, N. *Invited*. "Nanotechnologies & the Royal Society and Royal Academy of Engineering's Inquiry." *Science and Public Affairs*. (Submitted April 2008)
- Pidgeon, N.F. 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.*, pp. 349-361 (London, Earthscan, 2008).
- Rogers-Hayden, T. and Pidgeon, N.F. Developments in nanotechnology public engagement in the UK: 'upstream' towards sustainability? *Journal of Cleaner Production*, 2008, 16, 1010-1013.
- "Quantum Dot Fluorescence Quenching Pathways with Cr(III) Complexes. Photosensitized Daniel Neuman, Alexis D. Ostrowski, Alexander A. Mikhailovsky, Ryan O. Absalonson, Geoffery F. Strouse, and Peter C. Ford, NO Production from trans-Cr(cyclam)(ONO)₂⁺," *Journal of the American Chemical Society*, 2008 (130) 168-175.
- Pidgeon, Nick, Barbara Herr Harthorn, Karl Bryant, & Tee Rogers-Hayden. "Context matters: Deliberating risks of nanotechnologies for energy and health in the US and UK." Under review, *Nature Nanotechnology*, April, 2008.
- David Weaver and Bruce Bimber, "Measuring News Events: A Comparison of Searches Using Lexis-Nexis and Google News," under review, 2008
- Bryant, Karl, and Barbara Herr Harthorn. "Differences that Matter in Public Participation: Group Composition in Debating Nanotech Health Applications' Impacts in the US." In preparation for submission summer 2008.
- 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 June 2008.
- Bruce Bimber and David Weaver "Proto-framing and Issue Novelty," In preparation.

IRG-3: Conferences, Panels and Presentations

- Harthorn, Barbara Herr. "Nanotechnology, Risk, and Societal Response," Nano Roundtable, Goldman School of Public Policy, University of California, Berkeley, California. May 4, 2007.
- Conti, Joseph, Killpack, K., Gerritzen, G., Huang, L., Mircheva, Delmas, Harthorn, B.H., Appelbaum, R.P. and Patricia Holden. "Health and Safety Practices in the Nanotechnology Workplace: Results from an International Survey." Invited presentation at the Society for Advanced Materials and Process Engineering (SAMPE) Conference on the panel "Nanomaterials Health/Safety/Toxicity 2." June 6, 2007. Baltimore, MD.
- Pidgeon, N. & Harthorn, B.H. Co-Chairs, Co-Organizers, "Nanotechnologies: Emerging Risks and Societal Responses I & II," double panel at the Society for Risk Analysis-Europe, The Hague, Netherlands, Jun 18-19, 2007
- Harthorn, Barbara Herr, & Bryant, Karl. "Understanding Nanoscale Scientists' Attenuation Under Uncertainty," paper presented in "Nanotechnologies: Emerging Risks and Societal Responses" panel at the Society for Risk Analysis-Europe, The Hague, Netherlands. June 17-19, 2007
- Satterfield, Terre, and Kandlikar, Miland. "Expert Judgments of Public Perceptions: How Well Do They Know Their Audience?" Paper presented in Nanotechnologies: Emerging Risks and Societal Responses, panel at the Society for Risk Analysis-Europe, Building Bridges: Issues for future risk research, The Hague, Netherlands. June 17-19 2007.
- Rogers-Hayden, T. and Pidgeon, N. Opening up Nanotechnology Dialogue with the Publics: Risk Communication or 'Upstream Engagement'? Building Bridges: Issues for future risk research, The Hague, Netherlands, June 17-19 2007
- Alexis Ostrowski, "Photosensitized NO Release from Water Soluble Nanoparticle Assemblies," 17th International Symposium on the Photochemistry and Photophysics of Coordination Compounds; Trinity College, Dublin, Ireland, June 2007
- McCray, Patrick, & Harthorn, Barbara Herr. Co-Chairs/Co-Organizers. "Studying the Nano-Enterprise," 4S meetings, Montreal, Canada. October 11-13, 2007.
- Satterfield, Terre, Harthorn, Barbara Herr, & Kandlikar, Miland. "Research and Development in an Age of Upstreaming," paper to be presented at the "Studying the Nano-Enterprise" panel for 4S meetings, Montreal. October 11-13, 2007.
- Rogers-Hayden, Tee, & Bryant, Karl. "Deliberating Nanotechnology Risks: UK and US Perspectives," paper to be presented at the "Studying the Nano-Enterprise" panel for 4S meetings, Montreal, Canada. October 11-13, 2007.
- Harthorn, Barbara Herr, 3 presentations at the NSF NSEC PI meeting, Dec 5-6, 2007.
- Harthorn, Barbara Herr. "Human Subjects in the CNS" Presentation in the CNS Fellows Seminar, Feb 5, 2008.
- Alexis Ostrowski, "Quantum Dots for Photochemical Nitric Oxide Delivery," Spring 2008 Meeting, Materials Research Society; San Francisco, CA, March 2008
- Harthorn and Pidgeon, Co-Chairs, "Risks, Perceptions, and Governance of Emerging Nanotechnologies," 2nd World Risk Congress 2008, Guadalajara, Mexico, Jun 8-11, 2008
- Nick Pidgeon (Cardiff University, Wales, UK) "Nanotechnology Risks: Perceptions, Communication and Public Engagement," 2nd World Risk Congress 2008, Guadalajara, Mexico, Jun 8-11, 2008
- Tee Rogers-Hayden (Univ of East Anglia, UK) and Karl Bryant (State Univ of New York—New Paltz, USA) "Public Deliberations on Nanotechnology Risks and Governance: A UK – US comparative study," 2nd World Risk Congress 2008, Guadalajara, Mexico, Jun 8-11, 2008
- Barbara Herr Harthorn (Univ of Calif Santa Barbara, USA) and Terre Satterfield (University of British Columbia, Canada) "Nano Experts' Views of the Nano Enterprise and Its Risks," 2nd World Risk Congress 2008, Guadalajara, Mexico, Jun 8-11, 2008

- Joseph Conti and Patricia Holden (University of California, Santa Barbara, USA) “Risk Beliefs and Safety Practices in the Nanomaterials Workplace: Results from an International Survey,” 2nd World Risk Congress 2008, Guadalajara, Mexico, Jun 8-11, 2008

Meetings Attended/Hosted

- Harthorn, Barbara Herr, & McCray, Patrick, Co-hosts. Annual Meeting of the CNS National Advisory Board, Santa Barbara, California. April 23-24, 2007.
- Harthorn, Barbara Herr, & McCray, Patrick, Co-hosts. NSF External Site Review, CNS-UCSB, Santa Barbara, California. April 24-26, 2007.
- On 15 May, 2007, Dr Rogers Hayden attended a conference in London run by the Institute of Nanotechnology: Nanotechnologies—Products and processes for Environmental Benefit.
- Through 2007-8 Nick Pidgeon has been a full member of the UK Royal Society / Nanotechnology Industries Association working group developing a code of practice for responsible development of nanotechnologies. Launch of this major international code is scheduled for June 2008.
- Dr Rogers-Hayden and Professor Pidgeon attended a meeting and report launch in London of ‘Demos; NanoDialogues: Four Experiments in Engagement’ and the final report of the ‘Nanotechnologies Engagement Group’, at the Institute of Physics in London, 26 June 2007.
- Barbara Herr Harthorn attended the Nanotoxicology workshop of the UC Toxics Substance Research Program as an invited guest, CNSI-UCLA, UCLA, Sept 10-11, 2007
- Barbara Herr Harthorn and Dave Guston (CNS-ASU) attended a meeting with Counsel Joel Shapiro, Senator Joseph Wyden’s office, US Senate, re: reauthorization of the National Nanotechnology R&D act
- Barbara Herr Harthorn hosted a meeting with Counsel Shapiro at UCSB, Dec 28, 2007.
- In Winter, 2008, Nick Pidgeon attended further meetings of the UK Royal Society / Nanotechnology Industries Association working group who are developing a code of practice for responsible development of nanotechnologies, which is now due to be published in the Spring of 2008.
- In January, 2008, Prof. Pidgeon represented the UK Royal Society in a meeting with delegates (including its Director-General of Environmental Health) from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, to discuss international nanotechnologies regulation.
- In February, 2008, Dr. 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.
- In February, 2008, Dr. Harthorn attended AAAS, was inducted as a Fellow in Section X, and attended meetings with nano risk perception researchers, Feb 14-17, 2008.
- Harthorn, Barbara Herr, organizer and host, CNS-UCSB Research Summit, Upham Hotel, Santa Barbara, CA Mar 14-15, 2008
- Harthorn, BH, monthly phone meetings throughout the period w/ the co-leaders of the nano in society network, Dave Guston (ASU), Davis Baird (USC) and Lynne Zucker (UCLA, for Richard Freeman, Harvard)

Outreach

- Pidgeon, N. “Risk Perception and Communication Related to Nanotechnologies”. NNI/RVO/IMEC NanotechOutreach Workshop, Leuven, Belgium. May 7-8 2007.
- Harthorn, Barbara Herr. “Interdisciplinary Social Science-STEM Graduate Education at the CNS-UCSB,” UC DIGSSS/AGEP Conference, Santa Barbara, California. May 25, 2007.
- Pidgeon, N. “Risk Perception and Communication Related to Nanotechnologies”. European Science Foundation 1st Summer School on Nanomedicine, University of Cardiff. June 10-15, 2007.

- Harthorn, Barbara Herr. "CNS-UCSB: Overview of Research, Education, and Engagement Programs," presentation in CNS program for incoming summer interns. June 25, 2007.
- Harthorn, Barbara Herr. "NanoCafe: Nano-Medicines and Societal Issues," Santa Barbara, July 18, 2007.
- Harthorn, Barbara Herr. Speaker at book signing, local science fiction author Josh Conviser, Borders, Goleta Dec 13, 2007.
- Harthorn, Barbara Herr. "Nanotechnology" Keynote address at the annual meeting of the Conference Board's Center for Corporate Citizenship & Sustainability, Westlake Village, Feb 22, 2008 (Industry Outreach)
- Pidgeon, Nick. 'Risk and Perception of Nanotechnology' at the 2nd American Society of Mechanical Engineers/Institute of Mechanical Engineers Nano-training Summer School on Nanotechnologies, London, 30 June-3 July 2008

Awards to IRG-3 Researchers

- Harthorn, B.H. Fellow, American Association for the Advancement of Science, 2007
- Martin, T. AGEF Fellow, 2007-08.
- Bimber, B. Outstanding Article Award, International Communication Association, for "Reconceptualizing Collective Action in the Contemporary Media Environment." With Andrew Flanagin and Cynthia Stohl. Published in *Communication Theory* 15(4), 2005. May 2007.
- Bimber, B. Fellow, Center for Advanced Study in the Behavioral Sciences at Stanford, 2006-2007.
- Bimber, B. Top Paper Award, Organizational Communication Division, International Communication Association, for "Modeling the Structure of Collective Action." With Andrew Flanagin and Cynthia Stohl. 2006.
- Ostrowski, A. MRS Spring Meeting Graduate Student Silver Award, March 2008
- Conti, J., 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.

Table 2: NSEC Program Support

(Table Withdrawn)

8. CENTER DIVERSITY—PROGRESS AND PLANS

As is indicated in the data for the past year (see below), CNS recruiting strategies have increased the number of underrepresented graduate students in the Fellows cohort. The strategy of collaborating with other NSF supported graduate programs such as the UC-DIGSS program (Diversity Internships for Graduate Study in the Social Sciences) to support UC recruitment of minority students in the social sciences) and the AGEF (Alliance for Graduate Education in the Professoriate) has increased the breadth of educational background and disciplinary experience in the pool of applicants for the CNS 2008-09 Graduate Fellowships. In Fall 2007, this allowed us to successfully recruit a new incoming Latina sociology student who has worked with us in throughout the 2007-2008 year as a graduate intern, will receive summer support to participate in CNS research in summer 2008, and has just competed successfully for a CNS graduate fellowship in Spring 08.

CNS also works closely with the Women in Science and Engineering (WISE) program at UC Santa Barbara. That group addresses a wide variety of interests within the graduate community and CNS research that focuses on environmental and social impacts has resonated with WISE members. In addition, CNS Director Harthorn is a co-investigator on a pending 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.

We have also focused on creating a diverse community of undergraduate research scholars by making personal contacts with local community colleges and with the local undergraduate chapters of professional organizations such as the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS). Future plans to create a network of faculty from the social science departments of community colleges in California are aimed at increasing the pool of applicants for summer research opportunities at CNS, integrated with INSET (Interns in Nanoscience, Engineering and Technology) an NSF REU project hosted by CNSI.

We are following up with our plan to select the venues for dissemination of the new 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 will join CNSI in co-hosting an Educators Workshop in the coming year on the topic of “Designing Undergraduate Courses that Integrate Nanotechnology and Society.” Building on contacts provided by Willie Pearson, one of the CNS Advisory Board members, we have advertised our Educator Workshop to take place on September 10-12, 2008 widely in appropriate sites to attract diverse participants. The workshop invites undergraduate educators, especially those at local and regional community colleges, many of which serve underserved populations, to attend and learn about recent research developments, innovative courses, as well as develop new ideas, course curricula and formats that offer integration and balance across disciplines.

In addition, UCSB hosted the national NSF SBES AGEF meeting last Spring (May 25, 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 AGEP program leaders and seems likely to become a model for others.

9. 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 CNS Associate Director Dr. Fiona Goodchild. She was assisted from January 2006 through May 2007 by Dr. Meredith Murr, former CNS Education Coordinator. In June 2007, Education Graduate student Emily Kang, partially replaced Dr. Murr (who is pursuing career advancement opportunities) and coordinated the CNS undergraduate intern program for the summer, 2007. Our new Education Coordinator, Julie Dilleuth (ABD, Geography) was recruited in Fall 2007 and joined the CNS in November 2007. She provides the day-to-day coordination of all CNS educational and engagement activities, working in close collaboration with Dr. Goodchild whose dual roles as CNS and CNSI education director enables a high level of integration of CNS efforts with nanoscience education on campus.

CNS Education Program Objectives

1. To create fellowship research opportunities for graduate students in both social sciences and science and engineering
2. To create summer undergraduate internships that focus on the research of the CNS IRGs
3. To recruit a diverse cohort of graduates and undergraduates, with special emphasis on under-represented and first generation students.
4. To organize a regular seminar that creates an integrated community of scholars across the social sciences and science and engineering
5. To engage the graduate fellows in public outreach events that improve their ability to communicate with a wider audience
6. To create new curriculum in the field of nanotechnology and society at the graduate level.
7. To develop new curriculum at the introductory (general education) level and to disseminate to undergraduate and community college faculty

Student Training Opportunities

The CNS offers opportunities for students – both graduate and undergraduate– to take lead roles in the Center’s research and education initiatives. Graduate research fellows and interns work with CNS researchers and other faculty at UCSB, and their research seminars are an important part of

fostering interdisciplinary collaboration at the Center. The CNS recruits its student fellows from the humanities, social sciences, and physical sciences and engineering.

Graduate Student Fellowships:

The Center for Nanotechnology in Society at the University of California, Santa Barbara (CNS-UCSB) awards fellowships to outstanding graduate students pursuing research in the social sciences and humanities and science and engineering. The CNS-UCSB seeks to produce and encourage excellent and innovative scholarship that addresses the intersection of nanotechnologies with society. CNS-UCSB researchers are engaged in several areas of inquiry including: the historical context of nanotechnologies; innovation, intellectual property and globalization; and risk perception and issue framing of emerging nanotechnologies. Graduate research fellows 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.

Fellows meet weekly, year-round in a seminar with faculty researchers, visiting scholars, and other interested members of the campus community. The weekly seminars address a wide range of issues including social science and NSE research methods, safeguarding human subjects, science and technology studies, professionalism, and substantive research within the IRGs. Students meet monthly in camera without faculty researchers to discuss and plan initiatives. The aim of the meetings is to develop an interdisciplinary community of scholars with special expertise and the ability to communicate effectively across significant disciplinary boundaries in addressing issues of emerging nanotechnologies and society.

Ten fellowships were awarded for June 2007 - June 2008, five each to graduate students in social sciences and in science and engineering (listed in table below). Three social science Fellows and one science and engineering Fellow were continuing with a second year of funding. An additional grad student was affiliated as part of a UC-DIGSSS recruitment in Sociology. 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 work directly with a faculty mentor in one of the IRGs, and each IRG research stream has between one and three Graduate Fellows.

CNS Graduate Fellows for 2007/2008

Fellow	Department	Affiliation
Kasim Alimahomed	Communication	IRG-2
Joe Conti	Sociology	IRG-3
Scott Ferguson	Mechanical Engineering	IRG-2
Summer Gray	Sociology	Associate
Mary Ingram	Sociology	IRG-1
Erica Lively	Electrical & Computer Engineering	IRG-3
Jerry Macala	Chemistry	IRG-2
Tyronne Martin	Chemistry	IRG-3
Alexis Ostrowski	Chemistry	IRG-3
Rachel Parker	Sociology	IRG-2
David Weaver	Political Science	IRG-3

Summary demographic information (out of 11 total):

5 Female
 1 African-American
 1 Latina
 1 S. Asian (Indian)
 2 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 eleven includes 5 women and Fellows who are African-American, Asian, and Latina. Two are the first in their family to graduate college, and 6 will be the first in their family to receive a graduate degree.

Undergraduate Summer Internships:

The NSF Center for Nanotechnology in Society (CNS) at the University of California Santa Barbara 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 to recruit community college students to an 8-week summer research experience on the UCSB campus. Interns gain first-hand experience investigating the societal issues relating to nanotechnology in a dynamic, collaborative research environment. The students are matched individually with faculty and graduate student mentors in social science, humanities, or science and engineering. CNS provides intake training in societal implications research as well as ongoing mentoring, IRG participation, and interaction. Interns frequently request to continue involvement in the CNS after completion of their internships.

In addition to research, the interns attend weekly fellows seminars and participate in group meetings to develop oral presentation skills so that they can present their results both in talks and at an end-of-summer poster session.

Summer 2007 CNS Summer Interns

Intern	University	Grad Mentor	PI	IRG
Lamar Bush	SBCC	Kasim Alimahomed	Chris Newfield	2
Jason Cannon	Alan Hancock	David Weaver	Bruce Bimber	3
Stacy Chirchick	SBCC	Joe Conti	Barbara Herr Harthorn	3
Josie Garong	Oxnard College	Mary Ingram	Patrick McCray	1
Nicole Tyler	UCSB	David Weaver	Bruce Bimber	3
Guanglei Zhang	UCSB	Rachel Parker	Rich Appelbaum	2

Summary demographic information (out of 6 total):

4 Community College
 3 Female
 2 First in family to graduate from College
 2 Asian

1 Physically Disabled

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 was run for the first time in Spring 2007 and focused on the technology of surveillance. Community colleges have expressed strong interest in adapting this course model for their undergraduate students, and we will be working closely with them to implement the transfer. CNS faculty and education leaders are involved in all aspects of the course.

In Fall 2007, Professor Harthorn developed and offered a new upper division undergraduate course, Gender, Science and New Technologies, in the Women's Studies program (WS 186) that included significant attention to nanotechnology. She actively recruited students in the nanoscale sciences and engineering along with social science students and women's studies majors. This has now been given an explicit new course number (WS 132) and will be offered annually.

In Winter 2008, CNS Graduate Fellows led a class in the Practice of Science course (Phys 121a/ECE 194r), engaging upper-level undergraduates in a discussion of their research concerning the impacts of nanotechnology on society. The Practice of Science course, sponsored by CNSI, addresses the culture and practice of experimental science and engineering, and its importance in a scientific career, and engages undergraduates in research projects in UCSB nanoscience laboratories

Graduate Curriculum:

In Fall 2007, Professor McCray, in collaboration with other CNS faculty, offered a new graduate seminar in History to provide background science and technology scholarly education for the CNS Graduate Fellows and other interested graduate students. The course was designed to accommodate students from the full range of disciplines represented by the CNS Graduate Research Fellows program.

Students in the CNS have the opportunity to participate in a new 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 requires coursework in the areas of culture and history and society and behavior, and a dissertation on a topic concerning technology and society.

In September 2008, CNS plans a new workshop providing intensive instruction for incoming and continuing fellows. The planned workshop will run for the week preceding the beginning of classes and will engage 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. We hope this new program will facilitate the development of common language, shared goals, and social integration

among all the fellows and researchers. We will use evaluation measures to assess the effectiveness of the first iteration of the program

CNS Education Program Evaluation

CNS education and public outreach 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 above.

With respect to the Fellowship program, we have already collected 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 in February 2007 and informal interviews in December 2007, identified particular strengths as well as areas for improvement in the Fellowship Program. The strong positive feedback indicates a highly successful program. Graduate Fellows reported excellent mentoring and support from their CNS faculty advisors, significant learning from each other's disciplines, and expressed excitement about CNS research. They identified specific value from participating in interdisciplinary research: access to new methods and literature, an appreciation of different academic cultures, broadened ideas and understanding, a wider professional network, and developed communication and collaboration skills.

The evaluation also revealed needs and areas on which we should focus attention. One ongoing challenge is communication among Fellows, both across disciplines and across IRGs. To address the challenge of cross-disciplinary communication and understanding, not only between the social scientists and scientists/engineers but among the social scientists from different disciplines, we have had broad-level discussions about research methodology and approaches. A supportive atmosphere built on mutual respect and trust facilitates open discussion in which students are not afraid to ask questions about unfamiliar territory. In addition, a second year of fellowship support allows continued development of interdisciplinary communication skills. With respect to communication across IRGs, we have implemented bi-quarterly fellows-only meetings, as a chance for the fellows to meet and discuss their research, broader issues, and collaborations. In addition, an end-of-quarter seminar is devoted to research updates from each of the Fellows, and we received immediate feedback that this has improved Fellows' understanding of research across CNS as a whole.

We plan to initiate the use of an online survey in summer 2008 so that we can collect information from all former graduate fellows and interns once they are no longer being funded by CNS. Important questions that we want to be able to address are:

- What are the fellows' perceptions of the challenges and benefits of interaction with graduate peers in a range of disciplines across the social sciences and science and engineering?
- How does participation in CNS make a difference to the selection of a research area and the way that research will be conducted?
- How does completion of a CNS research fellowship influence future career directions?

- How does completion of a CNS research fellowship enhance professional skills that will serve to enhance career opportunities?

Reports to the National Advisory Board

CNS faculty and staff will 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 will be discussed with a view to identifying problems and devising appropriate corrections.

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 will serve as an archive for all significant documents that are created by the Center faculty, staff and students. The web site will also serve to inform that public about highlights in the field and to advertise future events that the center has hosted.

Table 3: Education Program Participants

Table 3: Education Program Participants																	
		Citizenship Status															
		U.S. Citizen or permanent resident															
		Gender		Race					Mixed incl		Mixed						
Student Type	Total	Male	Female	NA	PI	AA	C	A	NA	PI	AA	C	A	Not Provided	Other non-US	Ethnicity Hispanic	Disabled
Enrolled in full degree programs																	
Undergraduates	6	3	3				4	2									1
Masters	0																
Doctoral	15	9	6			1	12	1								1	
Enrolled in NSEC Degree Minors																	
Undergraduates	0																
Masters	n/a																
Doctoral	1		1													1	
Enrolled in NSEC Certificate Programs																	
Undergraduates	n/a																
Masters	n/a																
Doctoral	n/a																
Practitioners taking courses																	
K-12 (Pre-college) Education																	
Teachers	0																
Students	0																
Total	18																
The CITS Emphasis is counted here as a Degree Minor, rather than a certificate																	

10. OUTREACH & KNOWLEDGE TRANSFER

The CNS-UCSB began its formal media and communication program January 2007 with the hiring of Valerie Walston. The position began as a .50 FTE and then in June 2007 was increased to full-time in response to Spring 2007 Advisory Board and NSF site review panel suggestions that we intensify our media and public communication programs to increase the CNS-UCSB profile.

Public Engagement Objectives

1. 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.
2. To create a series of events that engage members of the general public in the societal implications of nanotechnologies.
3. To maintain a Web presence that informs about the above objectives and serves to update the public and special interest groups such as industry and NGOs about significant research and policy findings.
4. To disseminate policy-relevant research findings and recommendations about nanotechnologies' development and societal interactions to appropriate local, state, national, and international policy makers.

Plans developed in Spring 2007 for accomplishing these goals included the following:

- Tailor CNS mission statement to easily digested and disseminated form
- Enhance the CNS Web site to: 1) profile our Graduate Research Fellows (9-10 per year); 2) upgrade the logo and appearance of the splash page; 3) develop Web links to increase profile; 4) promote the CNS-UCSB informal blog to invite more extramural participation; 5) create an on-line pressroom
- Enhance our public information functions by creating an image library for internal use and CNS promotion
- Further academic relations via: 1) disseminate information from our internal weekly seminar; 2) expand Weekly Clips contacts
- Foster community relationship through: 1) NanoCafé/ now Nano-Meeter; 2) explore possible annual collaborative event with the CNSI to draw attention to California nanotech R&D and its social analysis; 3) explore initiation of a book club to read science fiction with nano-relevant themes
- Enhance media relations through: 1) a bi-annual or quarterly newsletter; 2) systematic production of op-eds as CNS research allows; 3) podcasting; and 4) development of an annual CNS-UCSB event of interest to media

CNS has made significant progress in virtually all areas of media and engagement. At the recent meeting of the National Advisory Board (April 11-12, 2008), the Board strongly endorsed the progress made by the CNS in the past year in this area and encouraged us to continue with these efforts.

Nano-Meeter:

CNS and CNSI continued the informal nanoscale science discussion forum, the NanoMeeter (formerly called NanoCafé). NanoMeeters are held in the community in coffee shops or other publicly accessible sites; audiences range in size from approximately 25-50. The first topic (Spring 2007) was a lively discussion on what nanotechnology is and how it might impact our lives, while subsequent events explored medical nanotechnologies (July 2007), and China's role in nanotechnology innovation (November 2007). NanoMeeters are planned on a quarterly basis, with joint facilitation by CNS and CNSI principals, and staffed by CNS.

Speakers series:

The CNS hosts quarterly or more frequent visiting speakers who present to the Fellows Seminar and wider campus and public audiences on a range of topics: examples from 2007-2008 include Colin Milburn (Assistant Professor, English, UC Davis and author of the 2008 book *Nanovision: Engineering the Future*); Sheila Jasanoff (Pforzheimer Professor of Science and Technology Studies, Harvard University Kennedy School); Dietram Scheufele (Professor of Life Sciences Communication, Univ. of Wisconsin and PI at CNS-ASU); Xue Lan (China Institute for Science and Technology Policy, Tsinghua University), Cynthia Cannady (Director, Intellectual Property Policies and New Technologies, World Intellectual Property Organization); and Arie Rip (Professor of Philosophy of Science and Technology, University of Twente).

Public Presentations:

CNS researchers and graduate students also make public presentations to campus, local, regional, and wider audiences about the work of the CNS-UCSB. Some of these presentations include: presentation to the Goleta Valley Chamber of Commerce (Graduate Fellow Macala) in June 2007 and Laguna Blanca High School (Graduate Fellows Stoltzfus and Lively) September 2007.

Weekly Clips:

Another continuing effort is the CNS-UCSB Weekly Clips. A list of major breaking news stories on nanotechnology and societal issues are tracked and circulated electronically. We disseminate to a growing list of nearly 500 interested colleagues, students, government and policy people, industry contacts, NGO leaders and members of the general public.

Biannual Newsletter:

CNS-UCSB has plans to distribute an electronic newsletter on a biannual basis, including research items, education program highlights, past event recaps, upcoming event teasers, and a student spotlight. Distribution includes interested colleagues, students, government leaders and policy makers, industry contacts, nongovernmental organizations and members of the general public. The first newsletter was produced in Summer, 2007; a 2nd is in production currently.

Conference:

A major international conference on Nanotechnology Occupational Health and Safety was held November 15-17, 2007 at UCSB. The conference was the results of collaborative planning, co-sponsorship and co-funding from Nano in Society network partners, Harvard University (Richard Freeman, John Trumpbour) and UCLA (John Froines, Lynne Zucker). CNS-UCSB principals Rich Appelbaum and Barbara Herr Harthorn were the co-hosts of the conference. The conference

was the first such meeting to include labor representatives as a key stakeholder group; other participants among the 38 speakers came from academic social science, environmental science, nanoscale science and engineering, industry, local, state, and national governmental agencies, and community-based organizations. Additional large scale events are in the planning stages. CNS is among the lead actors in the convening of a nano-in-society network meeting in May 2008 and another at NSF in July 2008.

NanoDays:

On Saturday, April 5th, 2008, CNS and CNSI co-hosted a “NanoDays” event for ages 8 and up, featuring the Too Small to See 2 interactive museum exhibition on nanoscience currently on display at CNSI-UCSB, and several activities designed to engage and promote understanding of the nanoscale and nanotechnology. CNS Graduate Fellows led the activities and presented research posters for this event that was part of a national education effort of the Nanoscale Informal Science Education (NISE) Network. Over 85 people of all ages and from throughout the local community attended. Follow-up events are under discussion.

Web Site:

Through the CNS-UCSB Web site, 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.

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. Web design and implementation was an ongoing priority in Year 1 (2006); in 2007-2008 we have moved into processes for continual updating.

The Web site is mounted on our host server in the UC Santa Barbara Institution 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 seamlessly incorporate new functionalities and information so far, and we have achieved significant economics 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.

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 bi-annual newsletter that is distributed electronically to a widespread audience.

CNS New Media Plans 2008-2009

Now approaching the halfway mark (July 2008) of its first five years, CNS-UCSB is continuing to expand its research, products, and services. In order to continue raising awareness on campus, in the community, regionally, nationally, and on the international research stage, CNS-UCSB aims to communicate its mission, objectives, research and activities. The main steps we plan in the coming year to enhance public, community, media, and academic awareness and participation:

- CNS-UCSB's Web traffic has increased since inclusion of podcasts and additional press releases, events listings, and other online resources. Continual updates of these listings and increasing the number of these resources will ensure that traffic will continue to grow still. Web traffic is often driven by third parties links. The CNS is currently conducting a comprehensive audit of relevant organization Web sites to reveal where CNS should be represented but currently is not; we will follow with communication with these organizations to advocate active linkage to the CNS Web site.
- Blog promotion requires even more linking. An audit of like-minded blogs – and subsequent requests for a CNS Blog link – will be conducted to reveal where the CNS Blog may be better promoted. CNS will also begin strategic postings to a select set of nationally important blogs, a strategy suggested by our National Advisory Board in our annual meeting April 2008.
- The CNS will identify opportunities in regional and national markets by continual monitoring of nanotechnology-related news. Seizing upon these opportunities, the CNS will craft original op-eds and strategically place them among mainstream and trade news outlets.
- Having already identified key nanotechnology leaders on Capitol Hill and the White House, the CNS will work to disseminate strategic policy advice to state and national policy makers. Additionally, the CNS will maintain open communication with these leaders to serve as a resource for research and education.
- Industry representatives on the CNS NAB include John Seely Brown and Martin Moskovits, and in the coming year we hope to extend this. CNS researchers Harthorn, Appelbaum and Grad Fellow Conti were co-investigators on a major international study of industry safe handling perceptions and practices (see Conti et al. 2008 and CNS Research Highlight), that had generated interest from a number of industry contacts. And the Nanotech Occupational Health and Safety drew on participants from insurance and nanotech manufacturing industries as both presenters and audience. Following this, in February 2008, Director Harthorn gave a keynote presentation at a meeting of the Center for Corporate Responsibility and Sustainability of the Conference Board to an elite group of corporate leaders at their annual meeting at Dole Food headquarters in Thousand Oaks, California. Strategies to enhance industry outreach will be pursued in year 3 once the new Assistant Director is in situ. Plans include identifying key contacts within varying organizations and initiating communication to serve as an educational and research resource.

CNS Engagement with Nanoscientists and Engineers 2007-2008

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 the mutual benefit of both; 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 the pursued the following means for fulfilling this mission.

Executive Committee

We include active direct participation in the management of the CNS-UCSB by members of the nanoscience community at UCSB. The Executive Committee of the CNS-UCSB is the main decision making body of the Center in matters of research direction, education, and outreach. All seven members are full participants in now monthly (previously more frequent) meetings and numerous e-mails and direct consultation between meetings. All members fully participate in discussion, planning, assessing and reporting on the CNS activities. Two of the seven members are from the nanoscience community – Evelyn Hu, our Associate Director for Nanoscience, is a physicist and member of Electrical Engineering and Materials departments, as well as Director of the California Nanosystems Institute (CNSI) at UCSB, and Fiona Goodchild, our Associate Director for Education, is a science education and outreach expert and Director of Education at the CNSI. Both bring far reaching connections and insight into the campus, regional, and national nanoscience communities, and their involvement in our decision making ensures both that we account for their interests in our plan making and that they understand the rationales and actions of this social science center.

National Advisory Board (NAB)

The NAB is designed to serve both as a sounding board and an informal evaluation role for the CNS as it develops over the first 5 years of funding. As such, it was designed to draw from the major communities for engagement of the CNS, and nanoscientist involvement in the board has been essential. The NAB of the CNS-UCSB is currently chaired by Tom Kalil, Science Policy Advisor to the UC Berkeley Chancellor, and leader of UCB nanoscience development initiatives. In addition, the NAB 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 who is former Dean of Mathematical, Physical and Life Sciences at UCSB and currently working in industry with API Nanotronics. In addition to Kalil, the CNS Board also has another leading science policy advisor, engineer Susan Hackwood, Director of the California Council on Science and Technology Policy. Finally, Board member John Seely Brown is extensively involved in nanotech start ups and global nanotech development. Thus over half of the 11-member board is made up of science and science policy advisors.

Location and Spatial Proximity

The CNSI has provided the CNS-UCSB with 3 ocean view offices in its new, state-funded building on campus. Our education program is now physically based in the new building, adjacent to the CNSI's very active education and outreach team, so we will be engaging with them on a day-to-day basis. CNS-UCSB researchers occupy the other offices, facilitating daily interaction between CNS personnel and CNSI personnel. The CNSI also provides formal and informal

meeting contexts for CNS and CNSI researchers, students, and staff, e.g., conferencing space, access to the Allosphere (a new multi-story 3-D lab for visualization of scientific data, run by the discipline-spanning Media Arts and Technology Program), a café, informal lounges, and spaces for public engagement as well. Our first NanoCafé was held in the lobby of the CNSI in April 2007, Nano Days was held there in April 2008, and CNS weekly seminars are held in the CNSI conference room when outside visitors are involved. Increasingly, public events held by the CNS are shifting to the CNSI, which is facilitating drop-in participation by campus scientists and engineers. Plan for the coming year are to intensify CNS activity in the CNSI.

Research Program

All three IRGs of the CNS involve plans for fine grained social science research with nanoscientists and engineers, both at UCSB and elsewhere. In addition to Evelyn Hu's commitment of CNSI involvement with the CNS-UCSB, all 3 IRGs have established collaborations with and commitments for involvement from a number of leading nanoscale scientists and engineers (IRG-1—leader Patrick McCray himself holds an advanced degree in Material Science and has many contacts in the NSE community on campus; IRG-2: Daniel Blumenthal, Tim Cheng, Brad Chmelka, Glenn Fredrickson, Arthur Gossard; IRG-3: Kevin Almeroth, David Awschalom, Elisabeth Gwinn). We are in regular communication as well with a number of other leading campus nanoscale researchers (e.g., Craig Hawker, Director, Materials Research Lab and MRSEC; Matt Tirrell, Dean, Engineering). 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 nanoscience community at UCSB and elsewhere 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. The CNS is grateful for this support and interest. In the coming year, plans for extending interaction between CNS and the NSE community include exploration of possible joint activities around issues of global social and distributive justice with student organizations.

Education Program

Our recruitment and summer internship programs are closely coordinated with the 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), 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 a program of CNS Science and Engineering (S&E) Graduate Research Fellowships that involves 3-5 science and engineering graduate students per year (5 in 07-08) directly in CNS IRG research programs each year, working alongside and in close contact with CNS Social Science Graduate Research Fellows and faculty researchers. The S&E students participate fully in the weekly fellows meetings, IRG meetings, and are taking an active role in the research. 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.

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 'real nanoscience' (including labs) with historical and social context. INSCITES (Insights on Science and Technology for Society) funding is provided through an NSF Distinguished Teaching Scholar award to CNSI Director and CNS Associate Director for Nanoscience, Evelyn Hu. CNS Co-PI Patrick McCray has been co-teaching the INSCITES course, and others in the CNS are increasingly involved.

Campus outreach and programming

CNS and CNSI are partnering on a number of fronts, most evidently in our NanoCafé/NanoMeeter, an informal public discussion event which is co-led by CNSI and CNS researchers. Nano Days, held in April 2008, was another highly successful joint CNS/CNSI event that brought over 80 visitors to campus from the community and involved CNS social science and nanoscience fellows in joint public engagement activities.

Research collaborations between CNS and nanoscientists and engineers

In 2006-07, the CNS-UCSB received co-funding for a collaborative research project with a nanotoxicologist (microbiologist Patricia Holden, Bren School for Environmental Science and Management) that resulted in a nationally visible report, now a new publication on nanomaterials safe handling, with lead authorship by a CNS grad fellow (Conti et al. 2008). We have submitted other significant proposals in the past year and a half in partnership with nanoscale science and engineering research and education initiatives. Most significant is the pending Center for Environmental Implications of Nanotechnology proposal by UCLA/UCSB (Nel et al.) in which CNS plays a significant role in both research for effective risk communication and education. CNS involvement in this proposal is a direct outgrowth of the collaboration with Holden. More intersections of funding effort are under discussion on the research, education, public outreach, and media program and communication fronts, and CNS leaders are committing significant time and effort in this direction on a regular basis. In addition, CNS Director Harthorn has been approached to participate in emerging discussions with campus EH&S personnel about campus implementation of nanomaterials safe handling guidelines.

CNS Nanotechnology in Society Network Activities

Since the formal start of CNS-UCSB, we have engaged the other national center at ASU and other nano-projects in a number of different ways. Face to face meetings are very important, although they are not a part of our NSF budget. Harthorn regularly participates as CNS-UCSB PI in Nanotechnology in Society Network (NSN) conference calls on the first Wednesday of each month, initiated since the February 2006 network meeting. The other participants typically include the Principal Investigators from each of the network centers/projects, Dave Guston (CNS-ASU), Davis Baird (USC), and Richard Freeman or Lynne Zucker (Harvard/UCLA). To date, discussions have focused on strategic topics such as clearinghouse issues, joint conference planning and calendaring, as well as how to best leverage the research and education efforts of the other groups in the NSN. Collaborative research and education conferences are currently advancing in

discussion, and this conference call mechanism is providing a useful method for informing one another about activities. In addition, Harthorn and Guston exchange frequent communication in their roles as PIs of the two NSEC:CNS entities, and this has been very helpful. The network has decided, under the leadership of Davis Baird, USC, to initiate plans for a new professional organization devoted to nanotechnology in society. The first meeting will take place May 29-20 2008 at USC. Harthorn and Guston will play leading roles facilitating the discussion.

In addition, CNS-UCSB has been the administrative unit for the 2007 network PI meeting at NSF (March 2007), and has been asked by NSF to serve that role again for the 2008 meeting planned for late July 2008. Director Harthorn has also been asked by NSF to co-chair a joint France-US NSF meeting in July 2008 that will bring together 60 “young scientists” to discuss nanotechnologies. Harthorn will chair the session in the 3-day workshop on societal dimensions/impacts. The network is a key means of communicating about such opportunities and recruiting suitable participants.

A number of conversations, collaborative activities and joint ventures have emerged from these network meetings. A non-exhaustive list for the past year includes:

- IRG-2 research Newfield has been in frequent discussion with ASU’s partners, Phil Shapira and Alan Porter at Georgia Tech on substantive bibliometric matters
- Co-PI McCray is a member of the Advisory Board for Univ. of S. Carolina’s Nano research center and in frequent contact with researchers there
- Director Harthorn has organized 3 nano risk panels at national and international conferences (SRA-E 2007, The Hague; AAAS 2008, Boston; SRA 2008, in development) that have included or been co-organized with Harvard/UCLA partner Sharon Friedman, Lehigh University
- MSU’s NIRT leader Larry Busch is networking with IRG-2 Rich Appelbaum to pursue research in China
- CNS-UCSB was the lead site for a conference in November 2007 on nano occupational health and safety, developed from initial plans by Harvard’s Richard Freeman and IRG-2’s Rich Appelbaum with collaboration by Harthorn, Zucker (UCLA), Froines (UCLA), and Trumbour (Harvard)
- CNS-UCSB and Dietram Scheufele’s at Wisconsin (ASU partner) group are in on-going discussion about future collaborative risk perception and public opinion research
- Harthorn will be a panel discussant at the Gordon Conference 2008, co-chaired by Guston of CNS-ASU; 4 CNS poster submissions were accepted and will be presented
- The 4 network partners are jointly leading an initiative to found a new scholarly organization of nanotechnology in society researchers
- Network density increases over time, e.g., traveling of visitors across the network sites—students, visiting scholars, collaborator; in the past year, visitors and exchanges with CNS-ASU—Jasanoff, Laurent, Ingram, Porter

Outreach Presentations 2007-2008

- Goodchild, F., Macala J., and Stoltzfus, K. "Ethics and Nonotechnology" Annual NINN REU Convocation, UCSB, August 2007.
- Pidgeon, N. “Risk Perception and Communication Related to Nanotechnologies”. NNI/RVO/IMEC NanotechOutreach Workshop, Leuven, Belgium. May 7-8 2007.

- Harthorn, Barbara Herr. “Interdisciplinary Social Science-STEM Graduate Education at the CNS-UCSB,” UC DIGSSS/AGEP Conference, Santa Barbara, California. May 25, 2007.
- Pidgeon, N. “Risk Perception and Communication Related to Nanotechnologies”. European Science Foundation 1st Summer School on Nanomedicine, University of Cardiff. June 10-15, 2007.
- Harthorn, Barbara Herr. “CNS-UCSB: Overview of Research, Education, and Engagement Programs,” presentation in CNS program for incoming summer interns. June 25, 2007.
- Harthorn, Barbara Herr. “NanoCafe: Nano-Medicines and Societal Issues,” Santa Barbara, July 18, 2007.
- Harthorn, Barbara Herr. Speaker at book signing, local science fiction author Josh Conviser, Borders, Goleta Dec 13, 2007.
- Harthorn, Barbara Herr. “Nanotechnology” Keynote address at the annual meeting of the Conference Board’s Center for Corporate Citizenship & Sustainability, Westlake Village, Feb 22, 2008 (Industry Outreach)
- Pidgeon, Nick. 'Risk and Perception of Nanotechnology' at the 2nd American Society of Mechanical Engineers/Institute of Mechanical Engineers Nano-training Summer School on Nanotechnologies, London, 30 June-3 July 2008

11. PERSONNEL

Management of the CNS-UCSB occurs at three interrelated levels; the organization chart below illustrates the Center's management and organizational structure. The CNS is led by Director, Barbara Herr Harthorn. 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.

Through June, 2007, CNS was led by co-directors Barbara Herr Harthorn and Patrick McCray, who jointly oversaw the day-to-day operation of the Center in conjunction with full and part-time CNS staff members and the CNS Executive Committee. Having two Co-Directors was of enormous value to the CNS-UCSB in its first 18 months of operation (and the exceedingly demanding 6 months prior to the start date). Once the Center was fully up and running, initial staff recruitments completed, and the first external site review successfully concluded, the Executive Committee of the CNS agreed with the Co-Directors that one Director should be adequate to meet the on-going leadership needs of the CNS, given the very active, engaged, and proximate Executive Committee. Therefore, as of July 1, 2007, Co-Director Patrick McCray stepped down, and Co-Director Harthorn assumed the sole Directorship of the CNS. Dr. McCray has continued full participation as Co-PI, Executive Committee member, and as the leader of IRG-1. This change has been relatively seamless.

The CNS Executive Committee includes all IRG leaders/co-leaders and meets on a regular basis and addresses longer-term strategic planning for the Center in consultation with the Director. The membership of the Executive Committee consists of the Director, the leaders/co-leaders of the 3 IRGs, and the Associate Director for Education, and the Associate Director for Nanoscience.

CNS Executive Committee, 2007-2008

Richard P. Appelbaum, Sociology and Global & International Studies, Co-PI

Bruce Bimber, Political Science and Communication, Co-PI

Fiona Goodchild, California NanoSystems Institute (CNSI), CNS Associate Director for Education

Barbara Herr Harthorn, Women's Studies and Anthropology, PI & Director

Evelyn Hu, CNSI and Materials, Electrical and Computer Engineering (ECE), CNS Associate Director for Nanoscience

Patrick McCray, History, Co-PI

Christopher Newfield, English, Co-PI

Executive Committee meetings cover all issues of CNS operation, including staffing, budget, research activities, collaborations, education initiatives and personnel, internal and public events and programs, network activities, website monitoring, agency oversight and reporting activities, annual board meetings, and other matters as they arise. Meetings occur on a monthly basis, with

more frequent intervals during times of intensive work preparation; members who are not physically present on campus are dialed in by conference phone. Electronic correspondence within the Executive Committee takes place on a near-daily basis. Meeting agendas and supporting documents are on file in the CNS administration. CNS staff participate in all Executive Committee meetings as well.

In Fall quarter 2007, the 5 IRG leaders and co-leaders, and IRG-3 seed project leader Mohr, along with Education Coordinator Dillemath replaced occasional meetings with a regular meeting every 3-4 weeks for an informal brown bag lunch and discussion of research activities in the CNS. Discussion time is set aside for brainstorming ideas for the CNS strategic research plan and the upcoming renewal. This non-administrative time for the research heads to meet and talk has been extremely useful thus far and will be even moreso in the run up to the renewal process.

NSF resources continue to be leveraged well with existing university support and administrative services. CNS staff draw regularly on the expertise of the staff of CNS 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. The close working relationship with ISBER has enabled CNS to achieve efficiencies in a number of areas, and the capable ISBER staff provides backup to CNS' smaller, more specialized staff. In addition, the CNS is achieving savings through the sharing of computer technology staffing with ISBER and others of its research centers. This gives the CNS access to versatile skills when needed, without having to commit full-time salary expenditures.

The main shortfall in CNS infrastructure over the past reporting period has been the absence of an advanced lead staff person to assist the Director and oversee daily operations of the CNS. Both the CNS Board and the External Site Review panel in spring 2007 endorsed the need for more support, and NSF has recommended funding of a supplement request to support this position for 2008-2010—the award is expected any day. The budget documents submitted here reflect this anticipated award. We are nearing completion of the hiring process at this time and expect to have the new Assistant Director/Business Manager of the CNS in place within the next month.

Management Activities 2007-08

Senior Personnel: Managers

Marisol Cedillo Dougherty, CNS Analyst, Acting Business Manager

Meredith Murr, PhD, CNS Education Coordinator (through Jun 2007)

Julie Dillemath, ABD, Geography, CNS Education Coordinator (Nov 2007 on)

Public Outreach Personnel

Valerie Walston, Communication and Events Coordinator

Technical personnel

Eric Davila (through Jul 2007)

Michelle Olofson

Justin Dodds (through Aug 2007)

Jaquelyn Bernuy

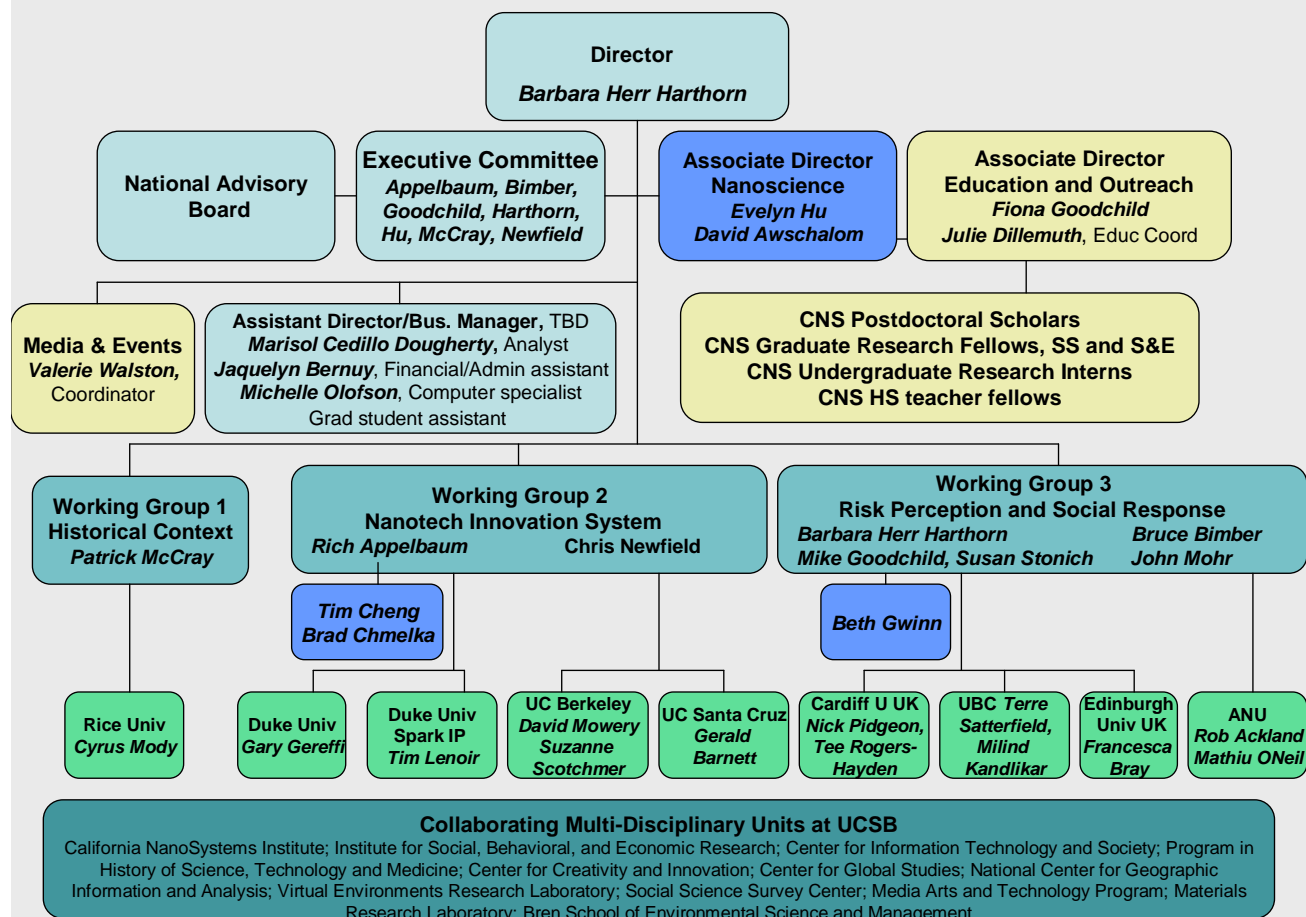
Moira O'Neil (ABD, Sociology; Grad Assistant)

Randall Ehren (consultant)

Emily Kang (education assistant, summer 2007)

Staffing. Given the difficulty of recruitment of highly skilled computer network technicians for part-time positions and the absence of anyone within the CNS to supervise such personnel, sharing a position with ISBER has been a cost effective and practical solution to our CNS computing needs. There has been some turnover, as Eric Davila left to pursue graduate education in summer 2007; his replacement, Michelle Olofson, is working well with the CNS, and Randall Ehren continues to provide consulting and service on a range of services. Specific web design

CNS-UCSB Organizational Structure - April 2008



and other services are contracted out on a short-term basis as needed. The CNS's Administrative Assistant, Justin Dodds, also left in Aug 2007 to begin graduate training in CNS IRG-2 leader, Rich Appelbaum's, graduate program in Global and International Studies. Jaquelyn Bernuy is thereplacement staff. The CNS Education Coordinator from startup through Jun 07, Meredith Murr, decided to return to the sciences (she is a PhD'd biologist); Julie Dillemath, ABD Geography, replaced her in November 2007, with Emily Kang serving as the interim coordinator during the summer internship program. All of this flux was made easier by close working

relationships with the education staff in the CNSI, and CNS Education Associate Director Fiona Goodchild, the CNSI's Education Director.

In January 2007, we hired a new staff person, Valerie Walston, to serve as the Communication Coordinator for the CNS. In its initial configuration, this was a split position with the CNSI. After the initial three months of experimenting with this arrangement, the CNSI and we agreed that the position would work more effectively as a full-time position in one of the two units. Our April Board meeting and NSF External Site Review both identified media outreach as an urgently needed gap in our effort, so the CNS has moved Valerie, an experienced public information officer, into full-time employment for us. In addition to media outreach tasks, the position in its full-time configuration also provides CNS events coordination and much needed in-house Web site updating for the CNS. This system seems to be working well for all involved. Partly as a result of this change, the CNS web page (www.cns.ucsb.edu) has been continually updated with news items as well as material describing the activities of the Center. In addition, the Clearinghouse functions are being augmented as the media component develops significant resources to share with the public (e.g., the CNS-UCSB Weekly Clips). Research materials are mounted to the site as they are completed.

CNS-UCSB co-hosted with the NSF the Nano in Society PIs meeting in Arlington, Mar 15-16, 2007 and has been asked to co-host the next meeting in Jul 28-29, 2008 (supplement pending). 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 30 participants in the 2007 meeting and the anticipated more than 40 attendees of the coming 2008 meeting.

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.

National Advisory Board

The 2nd annual meeting of the NAB was held in Santa Barbara on April 23-24, 2007, immediately preceding the CNS's first external site review (April 24-26, 2007). The meeting was attended by Board Chair, Kalil, and member Seely Brown, Colvin, Cowan, Hackwood, Moore, Moskovits, and Pearson. Member Calhoun had to decline at the last minute because of urgent SSRC business in New York. NSF Program Officers Priscilla Regan and Rita Teutonico from SBE also attended the entire meeting. The board was extremely enthusiastic about the extent and quality of the work completed by the CNS-UCSB and offered a number of specific means to assist us in the coming year. The only significant cautionary concerns were work overload for Director Harthorn and the need for a significantly enhanced media program to better publicize the excellent work we are doing. Both of these concerns are being addressed.

The 3rd annual meeting of the NAB was held on April 11-12, 2008 and will be reported on in the next reporting cycle. The Board continues enthusiastic and supportive about the work of the CNS-UCSB, and has offered instrumental assistance to the CNS in many forms.

B. Evaluation plan for CNS-UCSB

The evaluation plan for the CNS-UCSB is to evaluate performance against our goals in the main functional areas--research, education and public outreach, network with other nanotechnology in society programs, international collaboration, and clearinghouse.

More specifically, we continue the following plans for evaluating the CNS and its work against the goals we have set. The goals are laid out in the original proposal, as modified by the revised statement of work submitted in August 2005. We will 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 quarterly? Progress reports by the working group project leaders that are circulated to the full CNS executive committee. Monthly face-to-face meetings of the Executive Committee have already 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 is also providing monthly updates, meeting weekly with all graduate fellows, and will be providing 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(s) maintain oversight of this process. The National Advisory Board (NAB) members are available for consultation on an as needed basis as well, and we confer with them when additional advice is needed. There is a high level of intercommunication among the principals of the CNS, and a very significant circulation of scholarly and practical advice, references, articles, and other knowledge sources among the Executive Committee members, staff, and students, primarily by electronic media. We are using on-line methods to facilitate this process, and we will be conducting ongoing analysis of their effectiveness.

The CNS staff members are involved in the monthly Executive Committee meetings and managed on a day-to-day basis by the Director(s). Education program staff are supervised by the Associate Director of Education. 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, 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 manager and director(s) are in near daily consultation about budget matters, and, as needed, with all personnel, subcontractors, and service providers.

Quarterly reporting is required from all CNS research teams, UCSB and extramural subcontractors. This is a requirement in conjunction with invoicing for subcontractor payments, and these documents are circulated to all CNS principals. The Education program also reports quarterly on accomplishments and any issues of concern. These written records provide detail that our face-to-face meetings cannot cover, and serve to inform everyone about ongoing work of the CNS.

Achieve aims

This kind of summative evaluation takes place primarily on an annual basis. The main mechanisms for achieving this are: annual reporting (for the CNS and for the NSF) and annual meetings with the NAB. Annual reporting will be required for all components of the CNS, and such cumulative records will be the subject of focused meeting and discussion. The NAB, in addition, will meet annually in Santa Barbara and will be requested to provide detailed commentary, advice, and criticism both in person and in a written report. A key part of the NAB process will be 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 visitors will be invited to attend these meetings as observers, and, if the NAB is willing, will be free to provide commentary.

NSF annual reviews provide an opportunity for summative evaluation. Annual retreats of the CNS Executive Committee and staff are planned, following the NSF site review process. In 2007, the CNS held a day-long retreat on May 18 to discuss the external site review panel's comments and the Board suggestions in view of needed changes.

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.

In addition we plan a formal larger scale evaluation exercise in the latter part of year 3, in order to assess the future course and funding needs of the CNS.

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, WG 3 is planning to track media uptake of nano and society, emerging social group formation and action, and fluctuations in public perceptions. These data will 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. Another is provided by plans for visiting scholars and CNS programming.

Table 4: NSEC Personnel																
		Citizenship Status														
		U.S. Citizen or permanent resident														
		Gender			Race				Mixed incl				Mixed			
Personnel Type	Total	Male	Female	NA	PI	AA	C	A	NA	PI	AA	C	A	Not Provided	Other non-US	Ethnicity Hispanic
																% NSEC Dollars
Director (s)	2	1	1					2								100%
IRG Leaders	5	4	3					5								100%
Exec	2		2					1						1		86%
Research Staff	3	1	2					2	1							100%
Administrative Director and Support Staff	11	3	8					8						1		100%
Collaborators/Partners	20	16	4											20		50%
Research																
Post Docs	1	1														0%
Doctoral Students	15	9	6				1	10					1	1	1	100%
Master Students																
Undergraduate Students	2	1	1					1							1	100%
Curriculum Development and Outreach																
Senior Faculty*	5	3	3					5								100%
Post Docs*	1	1						1								0%
Doctoral Students*	15	9	6				1	10					1	1	1	100%
Masters Students																
Undergraduate Students (interns)	2	1	1					1	1							
REU Student, if applicable																
NSF REU Program (interns)	4	2	2					3	1							50%
NSF/NSEC Program REU																
NSEC's Own REU																
Other Visiting College Students																
Pre-college (K-12) Students																
Teachers - RET																
Teachers - non-RET																
Total	65	38	30				1	30	4				1	22	1	4

12. PUBLICATIONS 2007-2008

IRG-1

W. Patrick McCray, “MBE Deserves a Place in the History Books,” *Nature Nanotechnology*, 2007, 2, 5: 2-4.

W. Patrick McCray, Cyrus Mody, and Jody Roberts, “Letter to the Editor Regarding Nanoethics,” *The New Atlantis*, Summer 2007

Cyrus Mody. Forthcoming. “Why History Matters in Understanding the Social Issues of Nanotechnology and Other Converging Technologies.” *Nanoethics*.

Cyrus Mody (with David Kaiser). “Scientific Training and the Creation of Scientific Knowledge.” In *Handbook of Science and Technology Studies*, ed. Edward J. Hackett, Olga Amsterdamska, Michael Lynch, and Judy Wajcman, 3rd edition, pp. 377-402. Cambridge, Mass.: MIT Press.

Hyungsub Choi and **Cyrus C.M. Mody**. Forthcoming. The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology,” *Social Studies of Science*, 2008.

Cyrus C.M. Mody. “Nanoethics,” 4500 word invited article for *Physics Today*,

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

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

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). April 2008.

IRG-2

Lenoir, Timothy. “The Emergence and Diffusion of DNA Microarray Technology,” *Journal of Biomedical Discovery and Collaboration*, Vol. 1 (no. 10): August, 2006.

Erkal, Nisvan and **Suzanne Scotchmer**, “Scarcity of Ideas and Options to Invest in R&D,” *Institute of Business and Economic Research*, Paper E07-348 (2007).

David C. Mowery. “The “Non-Globalization” of Innovation in the Semiconductor Industry” (with A. DeMinin and J. Macher), *California Management Review*, 2007.

Newfield, Christopher, “Passé et passif de l’enseignement supérieur américain,” *Le Monde Diplomatique* September 2007.

Appelbaum, Richard P. and Parker, Rachel. “China’s Bid to Become a Global Nanotech Leader: Advancing Nanotechnology Through State-Led Programs and International Collaborations,” forthcoming, June 2008 *Science and Public Policy*.

David C. Mowery. “What does economic theory tell us about mission-oriented R&D?,” presented at the EPFL “Technology Policy” conference, Monte Verita, Switzerland, June 18 – 21, 2007; forthcoming in conference volume (title and publisher TBA).

David C. Mowery. “Introduction: Running Faster to Keep Up” (with J. Macher), in D. Mowery and J. Macher, eds., *Running Faster to Keep Up: Globalization of R&D and U.S. Economic Welfare* (National Academies Press, 2008).

David C. Mowery. “The “Non-Globalization” of Innovation in the Semiconductor Industry” (with A. DeMinin and J. Macher), in D. Mowery and J. Macher, eds., *Running Faster to Keep Up: Globalization of R&D and U.S. Economic Welfare* (National Academies Press, 2008).

David C. Mowery. “Introduction: The Norwegian Innovation Paradox” (with J. Fagerberg and B. Verspagen), forthcoming in J. Fagerberg, D.C. Mowery, and B. Verspagen, eds., *Norway’s Innovation System* (Oxford University Press, 2008).

Christopher Newfield. *Unmaking the Public University: The 40-Year Assault on the Middle Class* (Cambridge: Harvard University Press, 2008).

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

IRG-3

Rogers-Hayden, T. & Pidgeon, N. (2007) “Moving Engagement ‘Upstream’? Nanotechnologies & the Royal Society and Royal Academy of Engineering’s Inquiry”, *Public Understanding of Science*. 16, 345–364. ISSN 0963-6625; IF 0.193

Pidgeon, Nick, & Rogers-Hayden, Tee. “Opening up Nanotechnology Dialogue with the Publics: Moving Beyond Risk Debates to ‘Upstream Engagement.’” In A. Anderson, A. Petersen, S. Allan and C Wilkinson (eds.). *Health, Risk & Society, Special Issue 9, 2* (2007): 191-210. ISSN 1369-8575; IF 1.634

Rogers-Hayden, Tee, Pidgeon, Nick, Mohr, A. (Eds). “Engaging with Nanotechnologies-Engaging Differently?” *Nanoethics, Special Issue 1(2)* (2007):123-176.

Daniel Neuman, **Alexis D. Ostrowski**, Ryan O. Absalonson, Geoffery F. Strouse, and Peter C. Ford, “Photosensitized NO Release from Water Soluble Nanoparticle Assemblies,” *Journal of the American Chemical Society*, 2007 (129) 4146-4147.

Rogers-Hayden, Tee, & Pidgeon, Nick. “Developments in Public Participation in Nanotechnology: towards Sustainability.” In H Kastenholz and A Helland (eds.) *Nanotechnology Development in Light of Sustainability. Journal of Cleaner Production, Special Issue*, 16, (2008) 1010-1013.

Joseph A. Conti, 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*. 10.1021/es702158q (April)

<http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/asap/abs/es702158q.html>

Pidgeon, N.F. 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.*, pp. 349-361 (London, Earthscan, 2008).

Rogers-Hayden, T. & Pidgeon, N. *Invited.* “Nanotechnologies & the Royal Society and Royal Academy of Engineering’s Inquiry.” *Science and Public Affairs*. (Submitted April 2008)

Daniel Neuman, **Alexis D. Ostrowski**, Alexander A. Mikhailovsky, Ryan O. Absalonson, Geoffery F. Strouse, and Peter C. Ford. “Quantum Dot Fluorescence Quenching Pathways with Cr(III) Complexes. Photosensitized, NO Production from trans-Cr(cyclam)(ONO)₂⁺,” *Journal of the American Chemical Society*, 2008 (130) 168-175.

Pidgeon, Nick, Barbara Herr Harthorn, Karl Bryant, & Tee Rogers-Hayden. “Context matters: Deliberating risks of nanotechnologies for energy and health in the US and UK.” Under review, *Nature Nanotechnology*, April, 2008.

David Weaver and **Bruce Bimber**, “Measuring News Events: A Comparison of Searches Using Lexis-Nexis and Google News,” under review, 2008

Bryant, Karl, and Barbara Herr Harthorn. “Differences that Matter in Public Participation: Group Composition in Debating Nanotech Health Applications’ Impacts in the US.” In preparation for submission summer 2008.

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 June 2008.

Bruce Bimber and **David Weaver** “Proto-framing and Issue Novelty,” In preparation.

13. BIOGRAPHICAL INFORMATION, New Senior Personnel**John W. Mohr (April, 2008)**

Associate Professor, Sociology
University of California
Santa Barbara, CA 93106-2150

phone: (805) 893-7169
fax: (805) 893-3324
e-mail: mohr@soc.ucsb.edu

(i) Professional Preparation

UC Irvine	Philosophy	BA, 1978
UC Irvine	Comparative Culture	MA, 1979
Yale University	Sociology	MA, 1983, PhD 1992

(ii) Appointments

2005-2007	PI & Director NSF SBE/AGEP Program (UC-DIGSSS – UC Diversity Initiative in Graduate Study in the Social Sciences) UC, Santa Barbara
2000-2006	Director NSF AGEP Graduate Diversity Initiative UC, Santa Barbara.
2000-2005	Associate Dean, Graduate Division, UC, Santa Barbara.
1997-Present	Associate Professor, University of California, Santa Barbara.
1991-1997	Assistant Professor, University of California, Santa Barbara.

(iii) Publications (a) 5 publications most closely related to proposed project

Mohr, JW and Harrison C. White. f.2008. "How to Measure an Institution." *Theory & Society*
Breiger, Ronald L. and Mohr, JW 2004. "Institutional Logics from the Aggregation of Organizational Networks: Operational Procedures for the Analysis of Counted Data." *Computational and Mathematical Organization Theory*, 10: 17-43.
Ventresca, Marc and Mohr, JW. 2002. "Archival Research Methods." Pages 805-828 in *The Blackwell Companion to Organizations*, edited by Joel A. C. Baum. Oxford, U.K.
Mohr, JW. and Helene K. Lee. 2000. "From Affirmative Action to Outreach: Discourse Shifts at the University of California." *Poetics*. 28/1:47-71.
Mohr, JW. 1998. "Measuring Meaning Structures." *Annual Review of Sociology*, 24:345-70.

(b) Other significant publications

Roger Friedland and Mohr, JW. (eds.), 2004. *Matters of Culture: Cultural Sociology in Practice*. Cambridge University Press.
Mohr, JW and Vincent Duquenne. 1997. "The Duality of Culture and Practice: Poverty Relief in New York City, 1888-1917." *Theory and Society*, 26: 305-356.
DiMaggio, Paul J. and Mohr, JW. 1985. "Cultural Capital, Educational Attainment and Marital Selection." *American Journal of Sociology*, 90:1231-1261.

(iv) Synergistic activities

1) Graduate Advisor in Sociology, 2) Advisory Comm. Institute for Social, Behavioral and Economic Research, UCSB, 3) Member UC President's Postdoctoral Fellowship Advisory Comm.

(v) (a) Co-authors, co-editors, and collaborators in past 5 years

Michel Bourgeois, UCSB; Ronald L. Breiger, Soc, U Arizona; Joseph Castro, UCSF; Vincent Duquenne, CNRS, Paris; Sarah Fenstermaker, UCSB; Roger Friedland, UCSB; Brooke Neely, UCSB; Marc Ventresca, Said BS, Oxford U.; Harrison C. White, Soc. Columbia U.

(b) Graduate and Postdoctoral Advisors Charles Perrow, Yale U (Emeritus, Doctoral Chair); Paul DiMaggio, Princeton U. (Doctoral Advisor); Stephen Brint, UC Riverside (Doctoral Advisor).

(c) Graduate Committees in past 5 years. (All in Sociology, UCSB)

Michael Bourgeois, Joan Budesca, Joe Conti, Patricia Drew, Neil Dryden, Marta Gaffney, Paolo Gardanali, Amelia George, Hazel Hull, Sarah Jones, Katrina Kimport, Helene Lee, Erik Love, Phil McCarty, Brooke Neely, Bob Ngo, Rachel Parker, Craig Rawlings, Emily Tumpson, Angel Valdivia,

(c-ii) Postdoctoral Scholars mentored in past 5 years. Phillip McCarty

14. HONORS AND AWARDS

Bimber, B. Outstanding Article Award, International Communication Association, for "Reconceptualizing Collective Action in the Contemporary Media Environment." With Andrew Flanagin and Cynthia Stohl. Published in *Communication Theory* 15(4), 2005. May 2007.

Bimber, B. Fellow, Center for Advanced Study in the Behavioral Sciences at Stanford, 2006-2007.

Bimber, B. Top Paper Award, Organizational Communication Division, International Communication Association, for "Modeling the Structure of Collective Action." With Andrew Flanagin and Cynthia Stohl. 2006.

Conti, J., 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.

Ferguson, B.S. Center for Nanoscience Innovation for Defense Fellowship (CNID), Summer 2007

Ferguson B. S., Co-inventor: Microfluidic Megnetophoretic Device and Methods for Using the Same. U.S. Patent Application No.: 11/583,989.

Harthorn, B.H. Fellow, American Association for the Advancement of Science, 2007

Ingram-Waters, M. "Spaceflight, frostbite, and Foresight: Exploring the connections between the pro-space, cryonics, and nano social movements." Best Poster Award at the Wharton-Chemical Heritage Foundation Joint Symposium on the Social Studies of Nanotechnology, June 7, 2007.

Martin, T. AGEP Fellow, 2007-08.

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

Parker, R. 2007, National Science Foundation East Asia and Pacific Summer Institute (EAPSI) Fellowship for study in Beijing during the summer of 2007.

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

Stolzfus, Kim. UCSB Dean's Fellowship, 2007-2008

15 (a) STATEMENT OF UNOBLIGATED FUNDS

(Withdrawn)

(b) Budget Summary

(Withdrawn)

16. COST SHARING

(Withdrawn)

17. LEVERAGE

(Withdrawn)

TABLE 5: OTHER SUPPORT

(Table Withdrawn)

Table 6: Partnering Institutions									
Center for Nanotechnology in Society									2007/08
	Name of Institution	Receives Financial Support from center	Contributes Financial support to the Center	Minority Serving Institution Partner	Female Serving Institution Partner	National Lab/other govt Partner	Industry Partner	Museum Partner	International Partner
1. Academic Partnering Institutions	Allan Hancock			x					
	Arizona State University								
	Australia National University								x
	Cal Poly San Luis Obispo								
	Cardiff University	x							x
	Cornell University							x	
	Cuesta Community College								
	Duke University	x							
	Harvard University		x						
	Howard University								
	Jackson State University			x					
	Michigan State University								
	Nanoscale Informal Science Education (NISE) network							x	
	Oxnard Community College			x					
	Santa Barbara City College								
	SUNY Levin Institute	x							
	SUNY New Paltz	x							
	University of British Columbia, Vancouver, Canada	x							x
	University of California, Berkeley	x							
	University of California, Los Angeles		x						
	University of California, Santa Cruz	x							
	University of East Anglia, Norwich, UK								x
	University of Edinburgh, UK								x
	University of South Carolina								
	University of Southern Florida								
	Ventura College								
Total Number Academic Partners	26	7	2	3	0	0	0	2	5
2. Non-Academic Institutions	American Institute of Physics Incorporated								
	Environmental Defense Fund								
	Woodrow Wilson International Center								
	International Risk Governance Council (Switzerland)								
	International Council on Nanotechnology (ICON), Rice								
	Chemical Heritage Foundation	x					x		
	Cynthia Cannady Legal Services								
Total Number Non-Academic Partners	7	1	0	0	0	0	1	0	0

18. CURRENT AND PENDING SUPPORT

(Withdrawn)