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Center for Nanotechnology in Society

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NSEC: CENTER FOR NANOTECHNOLOGY IN SOCIETY
UNIVERSITY OF CALIFORNIA AT SANTA BARBARA

Principal Investigator
Barbara Herr Harthorn

Co-Directors
Barbara Herr Harthorn
W. Patrick McCray, *Co-PI*

Executive Committee (UCSB)
Richard P. Appelbaum
Bruce Bimber, *Co-PI*
Fiona Goodchild
Barbara Herr Harthorn
Evelyn Hu, *Co-PI*
W. Patrick McCray
Christopher Newfield, *Co-PI*

Staff
Marisol Cedillo Dougherty
Meredith Murr
Justin Dodds
Computing consultant:
Randall Ehren, ISBER
Web design consultant:
Steve Brown, Learning Resources

Teams
Historical Context
Innovation and Globalization
Risk Perception and Social Response
Education and Outreach

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CNS-Arizona State University
Harvard/UC Los Angeles
University of South Carolina

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NSEC: CNS-UCSB Annual Report
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I. Introduction to the CNS-UCSB

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 on innovation processes and global diffusion of nanotech, and on risk perception and social response to nanotechnologies. It also develops methods for public participation in setting the agenda for nanotechnology's future. The Center's three interdisciplinary working groups combine expertise in many fields: technology, culture, health, spatial analysis, and science and engineering. They address a linked set of social and ethical issues regarding the domestic US and global creation, development, commercialization, production, and consumption, and control of specific kinds of nanoscale technologies. The work of the CNS-UCSB is intended to include diverse communities in the analysis of nanotechnology in society and to engage in outreach and education programs that include students and teachers and that extend to industry, community and environmental organizations, policymakers, and the public.

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 renowned nanoscale researchers at the California NanoSystems Institute and with social science research centers at UCSB focused on relations among technology, culture, and society is enhanced by social science collaborators at UC Santa Cruz and UC Berkeley, Cardiff University in the UK, Duke University, University of British Columbia, University of Edinburgh, and the Chemical Heritage Foundation.

The CNS-UCSB began its operations in January 2006 and spent the first six months laying the foundation for its programs and initiating research, education, and outreach activities that will begin to be fully realized before the end of Year 1. CNS-UCSB acknowledges the support from NSF under SES-0531184 and requests the second increment of funding for the project for the period 1 January 2007 through 31 December 2007.

II. Research Activities

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 Working Groups: Working Group 1 -- Historical Context of Nanotechnologies, seeks to develop a rich understanding of the past and current landscape of the nano-enterprise; Working Group 2 -- Innovation, Diffusion, and Globalization of Nanotechnology, will develop a comprehensive

understanding of the processes of innovation, global diffusion, and commercialization of nanotechnology; and Working Group 3 -- Risk Perception and Social Response to Nanotechnologies, focuses on public perception and social intelligence about nanotechnologies, social amplification and attenuation of risk, methods for deliberation, and collective action in response to nanotechnologies. Important features of our collective approach are an integrated, participatory relationship with nanoscientists; a focus on specific nanotechnologies such as nanoelectronics, nanoparticles, 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 July, 2006, which is our six-month mark, all 3 Working Groups are well underway with research, and we anticipate having made substantial progress by the end of Year 1 (Dec 2006). Following is a summary of the activities of each Working Group.

Working Group 1--Historical Context of the Nano-Enterprise

Understanding the historical context of US nanotechnology research and development is essential for social science researchers and policy makers.

A recent review in *Nature* said that nanotechnology is a "subject with an existential crisis." As a vast, sprawling multi-disciplinary endeavor, the author asked, what holds it together? Is it simply materials science in a new package or, as cynics suggest, a way to secure funding? Or is the central theme of nanotechnology sociological rather than scientific?

Understanding the future societal and ethical implications of nanotechnology is predicated on a clear, coherent, and comprehensive understanding of its historical and social context. Examining the history of the nano-enterprise's practitioners, instruments, institutions, policies, promoters (and detractors) will help us better address questions such as these and afford an understanding of nanotechnology in the overall context of other emerging technologies. To see nanotechnology less as a revolutionary break with the past and instead as part of an effort to develop technological solutions to social and economic problems will depend on understanding its history at multiple levels of analysis – research fields, instrumentation, individual contributions, national and state policy, and nanotechnology as an example of "techno-futurist" movements.

Toward this end, Working Group 1 has research in five areas underway, under the direction of WG 1 Leader Patrick McCray

WG 1, Area 1: "Over the Horizon" Technologies: The Case of Nanoelectronics
Led by: W. Patrick McCray
Team members: William Bausman, Timothy Lenoir (Duke University), Eric Gianella (Duke University)
For the first two years of CNS research activity, we will explore the history of nanoelectronics with a special focus on the field of research known as spintronics.

Spintronics, or "spin-based electronics," is an emergent technology which exploits the quantum propensity of electrons to spin as well as making use of their charge state.

We are interviewing scientists and engineers who are active in the spintronics field. McCray is especially interested in the role of industry labs and military agencies in fostering the growth of this field. An on-going international conference on spintronics at UCSB has facilitated the interviewing process. To date, McCray has interviewed about a dozen people for, on average, two hours each. Note that these interviews are being processed by the Center for History of Physics, American Institute of Physics. This is an example of successful leveraging of CNS research efforts with contributions from other sources.

WG 1, Area 2: Mapping Spintronics Research
Led by: Tim Lenoir
Team Members: Eric Giannella and W. Patrick McCray
One long-term goal of our project is to chart the history and development of the entire field of spintronics by identifying the key scientific papers, the field of scientific contributors, and the evolution of groups of scientists and engineers in academe and industry. We want to explore the composition of those groups over time, their linkages and mergers with other groups as well as the formation of new groups in the spintronics field. In order to better link our work with the oral history interviews being conducted by other Group One members, Patrick McCray and Cyrus Mody, we focused initially on a group of key spintronics researchers who work at the UCSB Nanosystems Institute and others who participated in a UCSB and Kavli Institute for Theoretical Physics-sponsored spintronics conference in March 2006. Our goal was to map the relationships between their work and the rest of the field. In addition to providing a test-run experience for mapping the larger field, the study would provide indicators of the key people our colleagues might want to focus on for oral histories.

Since the start of our project in November 2005, we have been developing methods for depicting the structure of nanotech generally, its relation to other research areas, and generating helpful and meaningful visualizations of the historical dynamics of subfields of nanotech in relation to other fields. For mapping spintronics we utilized a data mining tool, called SOMA (for Semantic Object Mapping Application) that we have developed for another project (not supported by NSEC). SOMA is a search engine that implements the "resource description framework" of the semantic web to crawl patents, scientific/engineering articles in Web of Science, Google Scholar, MedLine, and other databases. The tool can extract "backward" and "forward" citations, collect profiles on authors and inventors, trace collaborations on patents, articles and federally funded grants, and identify place of employment. We are planning other features for next versions of the tool.

Using the SOMA search engine we focused on the Harvard-Smithsonian astrophysics and physics database available at http://adsabs.harvard.edu/physics_service.html. This database is dedicated to physics research, and has a number of features that makes it particularly well-suited to our mapping effort for spintronics. We identified 51 researchers through the UCSB spintronics conference and associated 6,300 articles with them. We did citation and co-authorship analysis on this set to produce a network of key researchers and important centers

of activity in the spintronics field—at least the view of spintronics represented at UCSB and the Kavli Institute for Theoretical Physics. The cluster data was output to a program called VxInsight, developed at Sandia National Laboratory, which provides a 3D navigable visualization of this data space. Patrick McCray and Cyrus Mody are testing it for accuracy of fit with spintronics scientists' perceptions of important work and sites of activity in the field. We are exploring using a web-based and improved version of this output as an interface for linking to the documents and other materials of the field.

In addition to continuing this work on spintronics, following decisions made at the launch meeting of the Center for Nanotechnology and Society in May, it has been decided that we will explore the broader area of "nanotechnology and computing." By the end of 2006, we will have completed our mapping activities. This provides a valuable proof of concept for these tools which will be used by other CNS-UCSB researchers to explore other areas of the nano-enterprise.

WG 1, Area 3: Nanotechnology Oral History Project
Led by: Cyrus Mody (Chemical Heritage Foundation)
Team Member: W. Patrick McCray
The nanotechnology oral history project attempts to map the constituent communities of nanotechnology, to understand how those communities developed and how they became part of nanotechnology, to offer policy insights based on the commonalities or differences in the histories of those communities, and to demonstrate how qualitative and historical data can complement the quantitative (or spatial) and/or contemporary findings generated by other CNS projects. By "constituent community" we mean those groups of scientists and engineers, usually spread across multiple organizations and disciplines, that arose in the 1970s and 1980s in order to better understand some aspect of nanoscale phenomena and which, in the late 1980s and through the 1990s, came to recognize their commonalities with other communities engaged in nanoscale work. These communities are often porous and ill-bounded, but their members recognized each other as sharing some common orientation, as participating in a common enterprise, and as working on the same or similar techniques – a mutual recognition which allows us to define who were their members (and leaders).

Thus far, Mody and McCray have identified several communities that are small and bounded enough to allow profiles to be developed quickly, and important (or representative) enough in the development of nanotechnology to offer useful insights on the field as a whole. Three of these are scientific or technological subfield, all broadly related to the microelectronics industry: the molecular electronics community, the microfabrication community, and the spintronics community. Two are local, academic nanotechnology communities: at Cornell University (with special reference to the history of the Cornell Nanofabrication Facility) and at UC Santa Barbara. One is a bureaucratic, meta-community: the group of federal grant officers and policymakers who oversaw the growth of other constituent communities and which, in the 1990s, began to coordinate their funding of nanoscale research and form the basis for the NNI.

Our research combines in-depth oral history interviews with a small set of individuals; shorter, more focused interviews with a wider group of participants; and archival research

and document collection. Shorter interviews and archival research are designed to give a representative cross-section of the community. Oral history candidates are those who have pioneered the techniques or ideas central to a constituent community; preference is given to those individuals who span more than one community of interest. Since the start of the working group in 2006, Mody has conducted four full oral histories, plus partially completed another four; these will be concluded in the following 6-8 months depending on the availability of the interviewees. Over the next six months, Mody will also begin another two to three new oral histories.

This project coordinates with the other CNS efforts in mapping variability across the nanotechnology domain, and in examining the institutional linkages that allow that variability to be governed. In the latter half of 2006 and into 2007, Mody will shift his interviewing priorities to the grant officers who oversaw funding of these communities, and to the policymakers in the Clinton administration who approved formation of the NNI.

In 2007, as interviews in the molecular electronics, spintronics, and microfabrication areas wind down, Mody and McCray will begin writing articles on those topics (Mody and Hyungsub Choi have already submitted an article on molecular electronics to *Social Studies of Science*), as well as presenting papers and organizing conference panels. One such projected activity is a jointly authored paper on the history of nanoelectronics that considers the place of spintronics and molecular electronics in industry planning.

WG 1, Area 4: Nanotechnology and Futurism
Led by: Mary C. Ingram
Team member: W. Patrick McCray
The primary goal of the Nanotechnology and Futurism group is to explore the role of futurist social groups in cultivating an environment of technological optimism within which political and social acceptance of new (and sometimes "fringe") technologies may flourish. To accomplish this goal, we have been studying the contemporary history of futurist groups, most of which were devoted to aspects of promoting the space frontier in the 1970s, and their pro-technology activism. These groups, a loose social movement in and of themselves, provide links between pro-space activism and other more current pro-technology activism around a range of nanotechnology-enabled innovations, such as the space elevator, solar sails, space colonies, and cryonics.

Studying social movements involves looking at the interactions between people, organizations, and technologies. Thus, our current activities revolve around making connections between people, the organizations with which they are/were affiliated, and technologies they promoted. To do this, we have first decided to pursue the link between space-activism and nano-activism. This decision has followed from inductive reasoning after we realized that numerous current nano-advocates had histories of pro-technology, specifically pro-space, activism. Specifically, by making connections we mean constructing a social influence network that tracks influence between persons, organizations, and technologies over time.

We are also pursuing an investigation of the role of futurist groups on the advancement of nanotechnology by developing the concept of *bridging technologies*. These are technologies which literally bridge established technologies and unrealized technologies. We are assembling a collection of primary documents (including published documents, speeches, newsletters, group and individual blogs, and websites) from futurist organizations for the purpose of tracing shifts in technological optimism and activism.

However, over the next ten months, we will continue to build our influence network of futurists and to collect primary sources from futurist organizations. We will also supplement both of these efforts by interviewing key actors within the futurist social movement. We hope to be able to answer historical and sociological questions about futurist social movements, technological optimism, and the development and acceptance of novel technologies, especially nanotechnologies. We intend to present our findings for publication in social science journals and at social science conferences.

WG 1, Area 5: Exploring Nanotechnology's Prehistory
Led by: W. Patrick McCray
Team member: William Bausman
An important historical question concerns the creation and validation of nanotechnology's creation story – the "standard model" begins with Richard Feynman's 1959 speech, moves to the apostolic role of K. Eric Drexler, to the instrumental capabilities demonstrated by Binnig and Rohrer and their development of the scanning tunneling microscope, and culminates with the passage of the NNI. Already scholars have begun to debunk this narrative by pointing out the limited effect that Feynman's speech had in galvanizing nanoscience research. There is a continued need to move away from the limitations of this basic story toward a more complex and nuanced understanding of nanotechnology's past and current context. Surely there are other "hidden" histories of nanotechnology. What are they and why have they not been visible?

To help address these questions, McCray has begun to explore the history of proto-nano by investigating the development of molecular beam epitaxy (MBE). The study may be juxtaposed with previous studies looking at the role of instrumentation in scientific research and discovery as well as the specific role that MBE played in enabling the rational design of new materials which is central to many facets of nanotechnology.

This research is being done at UCSB by McCray with extensive input from William Bausman. Bausman will be a CNS Summer Intern in 2006 and will focus part of his research activities on developing a list of key publications relevant to the history of scientific instruments, their role in fomenting scientific discovery, as well as the technical literature associated with the development of MBE. This work will build on prior studies done by Cyrus Mody on the history and sociology of probe microscopy which will provide a useful comparative case. Bausman will likely use the research as a summer intern for a future project in his graduate studies. Furthermore, Bausman's research will form the basis for investigations of the role of instrumentation in nanoscience research. This will include, in 2007, consideration of the importance of techniques like molecular beam epitaxy as enablers of nanoscience research.

Working Group 2--Innovation, Diffusion, and Globalization

One of the central goals of the CNS-UCSB is to develop a comprehensive understanding of the processes of innovation, diffusion, and commercialization of nanotechnology. To do so, our research team addresses the following questions and issues:

- What are the strengths and weaknesses of the American intellectual property and technology transfer systems for nanoscale research?
- Nanoscale R&D involves cross-institutional collaborations of increasing complexity. What institutional arrangements best facilitate nanoscale innovation?
- What are the most significant institutional, and socio-cultural variations among the United States, China, and other countries with significant involvement in nanoscience R&D?
- How does nanotechnology spread and emerge globally, and what are the implications of this process for social and economic development?

Toward these questions, Working Group 2 has research in two areas underway, under the direction of WG co-leaders Chris Newfield and Rich Appelbaum.

In spite of indicators that the U.S. retains a leading position in nanotechnological innovation, as in other areas, reports and studies released in the past year suggested reasons for concern. The legislative and executive branches have responded with the National Innovation Act (NIA) (S.2109, the Protect America's Competitive Edge (PACE) bills (S.2197, S.2198, S.2199), and the Bush Administration's American Competitiveness Initiative). These measures share an emphasis on major increases in federal research money, industry tax credits, visa reform for employment- and education-based categories, and improvements in science and technology education. Granting that more funding for instruction and research will help expand the innovation system and reduce bottlenecks, the public discussion focuses on quantity, and does not address the quality and function of the innovation system and its standard practices.

The Innovation Group seeks to add to scholarly knowledge and public discussion by examining several structural features and core design elements of the nanoscale innovation system. We concentrate on two major domains: the *university-industry interface*, and the *laboratory group*. In the former, we examine the institutional mechanics by which technology is transferred from the university to industry; the effects of intellectual property rights in the context of new and emerging hybrids of ownership, conditional use, and open access; and the research communities that emerge (or fail to emerge) across a range of different institutions. In the second domain, we example a range of variables that determine the outcome of the creative process in laboratory groups. Our goal is to improve the effective and equitable operation of the nanoscale innovation system for any given level of funding and training. A secondary goal is to bridge the gap between technological and socio-cultural requirements (see Newfield 2006, listed below).

The Innovation Group's research falls into two principal streams.

WG 2, Area 1: Nanoscale Transfer, Intellectual Property, and Partnership Policies
Led by: Chris Newfield
Team members: Gerald Barnett (UC Santa Cruz), David Mowery (UC Berkeley), Suzanne Scotchmer (UC Berkeley)

Activities to Date. This stream focuses on a central feature of the American innovation system: the institutional, legal, financial, and intellectual relationships between university laboratories, their "technology transfer" infrastructure, and their industry clients and partners. We are particularly interested in two features of this system: (a) the role of intellectual property in shaping research, disclosure, and industry uptake; and (b) cross-institutional collaborative infrastructures.

In this six-month period we have broken the general research topic down into key components that can be addressed discretely. We have focused our efforts this far on this initial question: What are the most commonly mentioned strengths and weaknesses of the technology transfer system for nanoscale research? Our goal is to determine the major problems identified by participants in the nanoscale TT process, and to compare them issues to the issues faced by "background" technologies. This question is also rooted in the full range of technologies that are involved in technology transfer in the United States. We are using aggregate tech transfer data as a baseline for further specification of nanotechnological problems.

We have decided to concentrate our nanoscale subset of TT data on nanoelectronics as it emerges from information technology and computer science-related transfer. In addition we have; begun our review of financial data submitted to centralized technology management offices and analyzed by the Association of University Technology Managers (AUTM); begun a comprehensive review of the assessment literature of technology transfer program; impacts on technological development, including previously collected interviews with principal investigators and licensing officers; started to disaggregate nano-related technology transfer data, which poses complex categorization problems; chosen our primary geographical regions and university centers; completed our protocol of semi-structured interview questions; and completed our list of first-round interview subjects (n=40), which includes scientists, licensing officers, and industry representatives on both sides of the flexible nano-line.

Our initial work on this research area has generated three additional questions:

- What are the research "roadmaps" that shape the major research questions in nano fields?
- How might investment (government or private) be made to augment diffusion?
- How might we track the benefits arising from this diffusion?

We will begin to pose these questions in the first round of interviews described above, and will spend the balance of 2007 answering them. We will deploy the same methodology described above. We will supplement this with two additional techniques: an econometric analysis of a range of ways of determining the future value of a particular line of research (Scotchmer); and an analysis of established industry-university research communities (e.g.

MediaX at Stanford, the California Institutes for Science and Innovation at the University of California; we are exploring a partnership with The Bay Area Science and Innovation Consortium (BASIC), and with Science Commons. (BASIC has led a two-year effort to explore new ways for universities, industry, and government to collaborate to advance basic research while managing their intellectual property.

WG 2, Area 2: Group Creativity in Nanoscale Research
Led by: David Seibold (Communication, UCSB)
Team members: Chris Newfield; Kim Stolzfus (Communication graduate student, UCSB); Aaron Rowe (Chemistry graduate student, UCSB).

This stream focuses on the creative process within the innovation system. Its primary focus is on the interaction of individuals, groups, institutions, and larger cultures in shaping the nanoscale innovation process. We have a special interest in two complementary features of group creativity: (a) the breakthrough moment in which conceptual brick walls are broken through; (b) "normal science," in which originality and routine are juxtaposed, and originality emerges from routine.

Activities to Date: Seibold and Stolzfus established a team of graduate and undergraduate researchers who undertook the following activities:

- a comprehensive review of the communication literature on group creativity (n = 170);
- comprehensive bibliography development of non-communication group creativity literature (n = 400);
- a search for studies of group creativity in nanotechnological research (final n = 0);
- full annotation and coding of (1) and (2);
- construction of a matrix of creativity variables from (4) (n = 60); and
- hierarchicalization of variables specific to nano-related R&D contexts (with a particular emphasis on IT and electronics).

Future Research Activities. In the remainder of 2006, this team plans to do the following: complete two reports on the reviews of the group creativity literature. The subject of the first report is group creativity in the communication literature. The subject of the second is, more broadly, group creativity in science R&D environments. These reports will be completed by the end of the summer, and will serve as a baseline for the empirical study of the nanotechnology labs planned for 2007; correlation of the above lit review results with nanotechnology case studies from the STS literature; establish a scheme for coding the interactional and non-interactional determinants identified; finalize interview protocols on the basis of completed findings; establish relationships and negotiate entry into the laboratories; identify protocols and design procedures for the empirical observation; and conduct interviews and empirical observations in 3 selected laboratories (as described in previous reports).

WG 2, Area 3: Global Diffusion of Nanotechnologies
Led by: Richard Appelbaum
Team members: Richard Appelbaum, Tim Cheng, Brad Chmelka, Rachel Parker, Yiping Cao, Gary Gereffi (Duke University), Stacey Frederick (Duke University)

Principal activities during the first six months consisted of planning activities oriented towards conducting major international research during summer 2006, along with some initial interviewing and efforts to integrate the Duke subcontract into long-term research plans.

UCSB Component: Appelbaum is in the process of identifying collaborations between CNSI (and other UCSB) nanoscientists and their Chinese counterparts. Rachel Parker, a graduate student in Sociology, was awarded a CNS Social Science Graduate Fellowship. She has begun to interview department chairs in the College of Engineering, Physics, and Chemistry, in order to generate a list of nanoscientists and engineers engaged in collaborative research with China. A matrix of collaborations is being developed to guide interviewing during the coming year. Preliminary research on Chinese nanotechnology has been conducted, to chronicle the history of nanotechnology in China, and identify the key figures and institutions involved in research, development, and commercialization. An inventory of possible research sites has been developed, to guide research during the summer of 2006 (see below). Yiping Cao, a Ph.D. student at the Bren School and native of China, was awarded a CNS Science and Engineering Graduate Fellowship to survey Chinese-language websites and assist with interviewing in China.

Duke Subcontract: Richard Appelbaum met with Gary Gereffi to plan strategy in Princeton (they were at the same conference) on 3/9-10. Plans were made to jointly conduct research in China during late July through early August, 2006. Gereffi will initially focus on nanotechnology in textiles and apparel at NCSU, and has identified a graduate student (Stacey Frederick) who will provide a list of nanotech-oriented textile companies in North Carolina, aimed at developing a North Carolina project in this area in conjunction with Gereffi's Center on Globalization and Competitiveness. Frederick has co-authored a presentation analyzing the Textile cluster in North Carolina at a detailed firm and plant location level (the presentation was given May 25, 2006 at a NCSU College of Textiles / North Carolina Department of Commerce Steering Committee meeting).

Future plans. The focus of this group is on two primary technology areas – computer chip design as it relates to nanoscale architecture and textile manufacturing incorporating nanomaterials. As this work is still underway or just in the planning stages, the following outlines the areas of research this team will focus on in the second half of 2006 and into 2007 along with the major research questions to be examined.

During the summer of 2006, Appelbaum and Gereffi will be joined by their graduate students (Ong, Parker, and Cao) in a research visit to Hong Kong and China. Interviews will be conducted with key scientists and engineers to determine such things as career trajectories, institutional and governmental support for R&D and training, entrepreneurial involvement and prospects for commercialization, and potential impacts for economic development. Expected results include data sharing to the CNS Clearinghouse and a preliminary report at year's end. Interviewing is planned at the Chinese Academy of Sciences, the National Center for Nanoscience and Technology, and at several universities, research parks, and commercial ventures in Hong Kong, Guangdong Province, Beijing, Shanghai, and possibly Tianjin (the latter are the three centers of nanotechnology research and commercialization in China).

Members of the research team will observe and interview at the Nanotechnology Center, Institute of Textiles and Clothing, Hong Kong Polytechnic University; the International Mesostructured Materials Association meeting (August 5-7, Shanghai); and the International Center on Design for Nanotechnologies (IC-DFN) meeting (August 15-16, Shanghai). (Brad Chmelka is providing the contacts for the IMMA meeting, and Tim Cheng for the IC-DFN meeting). Initial plans are to focus on research in the area of nanoporous materials (Chmelka's specialty), advanced chip design (the subject of the IC-DFN meeting), and nanofabrics (Gereffi's research focus).

Appelbaum and Gereffi will be presenting a paper, "From Cheap Labor to High-Tech Leadership: Will China's Investment in Nanotechnology Pay Off?" at the 2006 conference of the Society for the Advancement of Socioeconomics in Trier, Germany (June 30-July 2).

Appelbaum plans to participate in the Commercialization of Micro and Nano Systems Conference (COMS), held by the Micro and Nanotechnology Commercialization Education Foundation (MANCEF) in St. Petersburg, Florida (August 27-31), presenting the work of the CNS. He will use the occasion to meet with Wit Ostrenko, President of the Museum of Science and Industry (MOSI) in Tampa, Florida, to discuss the possibility of having MOSI host an exhibit on the social impacts of nanotechnology, based on the work of the CNS.

At least one additional visit to Asia is planned for the academic year, to follow up on leads developed during the summer visit. This would likely include a research visit to Taiwan, to interview Jyuo-Min Shyu, Executive Vice President, Industrial Technology Research Institute (ITRI), where he is Executive Director of the National Nanotechnology Program. ITRI is the state-sponsored organization responsible for technology development in Taiwan.

In an integration of CNS Working Group efforts, we will adopt Lenoir's text-mining software to inventory western and Chinese journals concerned with nano-technology, with the objective being to determine where China is investing heavily in nano (as indicated by the relative percentage of publications in particular fields compared to other nations), where Chinese scientists are having greatest impact in nano (which could easily differ from the areas of heavy investment), and where Chinese nanoscience and technology is heavily linked to or isolated from research occurring in other nations.

Gereffi's principal focus is on nanotechnology in the regional economy of North Carolina. As noted above, he is working with graduate student Stacey Frederick, who is conducting research at NCSU's College of Textiles, where work is being done on nanofabrics. Gereffi will draw on this research to include nanotechnology as a key industrial focus for Center on North Carolina in the Global Economy. The goal is to develop the counterpart high-tech textiles value chain in North Carolina that is related to nanotechnology. The format and database already being utilized in the NCSU study will then be adapted to show what North Carolina's footprint is in the nanotech portion of high-tech textiles in terms of different segments of that value chain within the state, as well as North Carolina in the broader national and global contexts.

Gereffi is working with Lenoir and Eric Giannella (Research Associate in the Jenkins Collaboratory) to conduct a parallel text-mining and mapping exercise involving nano-related research and in North Carolina, intended to map nano-related R&D and commercialization onto a value chains framework. In order to understand the relationships between nano-research conducted in North Carolina and the rest of the world, we plan to map scientific articles, patents, and government grants using Google Earth. We hope to understand a few important aspects of nano-science in North Carolina:

- What areas of nanotechnology are being heavily funded by state and federal agencies and where in North Carolina is that funding going?
- Are industry and academic specialties localized to particular cities or parts of NC?
- How do these regions within NC fit into research within the entirety of that area of inquiry (around the world)?
- In which areas of nano-science is North Carolina especially prolific?
- In what areas of nanotechnology is North Carolina relatively strong compared to other states and countries?
- How connected are particular regions of NC to other states and nations in terms of collaborations and co-authorships? Are these due to technical differences in regional specialties, which may demand outside collaboration, or differences in pre-existing human networks?
- In the case of multinational companies who are involved with nanotechnology with offices in NC, do they conduct any nano-research within this state?
- Examination of all these issues will lead to further qualitative investigation of critical infrastructure for nano in NC (e.g. particular university programs or nano-research centers for small businesses), and what parts of nano might be useful to invest in to support North Carolina's array of nano-activities.

In order to address these questions we will draw upon several data sources and tools. For federal funding information, we will use the RaDIUS database provided by the Rand Corporation, which contains data on all federal grants, including SBIR (e.g. title, amount per year, location, PI) from 1993 to the present. For state funding we will work with John Hardin and use data from the North Carolina government. While some of the grants may be difficult to automatically classify in terms of area of nano-science, it will be easy to aggregate funding to a city and indicate the total on a map using a 3D bar graph. Eventually we will be able to match the funding with articles or PIs and their area of nanotechnology research. These sources contain rich bibliographic information that allows us to map whom NC authors collaborate with (e.g. out of state colleagues), what the citation networks look like between regions of NC and the rest of the world. This will help us explore the within state networks of nanotechnology and nano-science and pinpoint the network hubs (highly connected individuals or organizations) that bridge work in NC to the rest of the world.

While we have already developed programs to read and parse article data, patent, and grant data for use in analyses of the recent history of modern technologies, we still have not completed our work on exporting this data in a format for Google Earth. It should be at least a few months before we are able to assemble all the necessary data for this type of analysis and develop the export software for Google Earth. Once completed, we hope to be able to

show the level of federal funding going to each city in North Carolina, the co-authorships between different areas of North Carolina and the rest of the world, and the citation networks between North Carolina patents and articles and those whose authors are outside the state.

Working Group 3--Risk Perceptions and Social Response to Emerging Nanotechnologies

Our research aims to understand nano-experts views of their work and the public and to understand diverse publics' views of and responses to nanoscience and emerging nanotechnologies. We address the following interrelated questions:

- How do experts view the social and ethical issues of particular nanotechnologies and the prospects for engagement with the public?
- What are emergent risk perceptions, beliefs, and values among US and comparative publics about different types of nanotechnologies? How do risk attenuation and amplification processes impact risk response to nanotechnologies as risk objects?
- How do global media take up and frame nanotechnology issues?
- What forms of collective social action are emerging in response to nanotechnologies, and what kinds of public groups are likely to be most influential in shaping public policy?
- What kinds of public involvement in nanotech deliberation are likely to be most effective in the US?

Under the direction of Working Group leader Barbara Herr Harthorn, WG 3 has research underway in three areas.

WG 3 is particularly focused on the spatial patterning of risk perception and collective action. In Summer 2006 we will begin building the GIS systems we will need to explore the spatial dimensions of a wide array of nanotech and public response data. Mike Goodchild, founding Director of the NSF National Center for Geographic Information and Analysis (NCGIA) at UCSB, has committed time to the working group to advise us as we move to develop this component of the research, and we anticipate recruiting an ARC-GIS expert geography graduate student to help us with this work. The infrastructure established for WG 3 spatial data visualization, exploratory and statistical spatial data pattern analysis, and development of a multi-layered, time series GIS will be generalized to the entire CNS as we extend this capacity among the working groups. We hope to make GIS maps available to other researchers and the public via the CNS Clearinghouse; we anticipate providing significant resource base to the NSF Nanotechnology in Society Network in future years if this work proceeds as anticipated.

The leaders of the WG 3 Risk Perception and Public Deliberation teams have been in frequent contact since Oct 2005. We have held face-to-face research planning meetings in London (Harthorn, Satterfield, Pidgeon, Rogers-Hayden--October 2005), Washington DC (Harthorn, Satterfield—December 2005), Santa Barbara (Harthorn, Satterfield--February 2006; Harthorn, Satterfield, Rogers-Hayden, and Pidgeon (remote), May 2006), and Vancouver (Satterfield, Kandlikar, Harthorn--March 2006). We hold audio conference calls on a monthly or more frequent basis, and there is weekly or even more frequent exchange of research materials, journal articles, and strategic planning documents by e-mail. The leaders

and students of the WG 3 Risk Perception and Nano-Networks components are also meeting regularly, exchanging preliminary data, having scholarly discussions about social processes, and exchanging references and other materials.

WG3, Area 1: Multiple Party Risk Perceptions
Led by: Barbara Herr Harthorn (UCSB), Terre Satterfield (UBC), Nick Pidgeon (Cardiff U)
Team members: Tee Rogers-Hayden (Postdoctoral Researcher, Cardiff U), Milind Kandlikar (UBC), Hillary Haldane (CNS SS Grad Fellow), Karl Bryant (CNS SS Grad Fellow), Joe Summers (CNS SE Grad Fellow), David Awschalom (UCSB), Elisabeth Gwinn (UCSB), Mike Goodchild (UCSB).

In this area, we aim to address two main questions. First, how do experts such as nanoscientists and engineers, nanotoxicologists and other risk assessors, and regulators in the U.S. (and Canada and the UK) view the social and ethical issues of particular nanotechnologies and the prospects for engagement with the public? Second, what will be the trajectories for emergent risk perceptions, beliefs, and values among US and comparative publics about different types of nanotechnologies? Low awareness of nanotechnology is widespread, but we anticipate that increased awareness and social amplification and attenuation of risk are likely to unfold in response to nano risk events, media uptake and framing of those events, risk communication from government and industry, social action in response, and specific cultural and historical contexts that predispose how particular communities assess and respond to risks.

A fundamental premise of our work is that two-way communication between experts and the public is essential to successful risk outcomes. We also posit multiple party perceptions (among both experts and the publics) to be likely and important to consider in following (or predicting) risk controversies. Therefore, systematically understanding (and problematizing) scientists' and the publics' views of one another and of emerging nanotechnologies is our main aim.

Expert study. We are initiating the CNS risk perception research with a study of experts because of the problem low awareness constitutes for broader population surveys and because we wish to enhance our nanoscience literacy before attempting public assessment or engagement.

In 2006 and into early 2007 we will conduct both interview and web-based survey approaches to understand how experts conceptualize and classify their fields of research, how they characterize the benefits and risks of nanotechnologies, specifically in their daily practices and more generally in society, and their views of the public. We plan to interview the following samples:

- Nanoscientists and engineers in academia (n=20, plus 10 postdocs), most from UCSB, oversampling women
- Nanoscientists and engineers in private sector/industry (n=20); we have begun to seek referrals from UCSB colleagues, will network using NSEC and NIRT partners where possible, and will seek participants particularly in Calif., Pacific NW and possibly Research Triangle Park area.

- Nanotoxicologists (and other risk assessors) (n=20); will network from UCSB and through other sources. Same locale strategy as (ii). We may include a small number of UK respondents for reference
- Regulators (*n*=20); Satterfield/UBC subcontract will take the lead on identifying an appropriate sample and will lead most of these interviews; may include Canada as well as US, because we expect large differences between the two in the area of regulation

We plan to construct purposive samples that as closely as possible reflect the range of positions and views in the different frames; our aim is to construct samples that are as diverse as possible in terms of disciplinary training and employment, rank, type of nanomaterials worked with, gender, and ethnicity/nationality.

We have spent significant time in meetings and conference calls since Oct 2005 through June 2006 developing the interview protocol for the expert study. We received IRB approval in Winter 2006, and have now completed several stages of pretesting. In June 2006, we are completing the free listing tasks of nanoscience conceptual terms with a sample of advanced UCSB nanoscience graduate students from diverse disciplines that is the first step for cultural consensus analysis of nanotechnology, a form of cognitive science research that will allow us to assess the degree to which experts of different disciplines share the same conceptual frameworks for classifying and attaching meaning to nanotechnology and nanoscience terms. We have done initial field testing of the protocol.

We have created a detailed directory of the full sample frame of nanoscientists on the UCSB campus, and our engineering fellow has helped create accessible descriptions of the nanoscience work each does. This valuable tool is shared with all CNS researchers. We are in the process of drawing the nanoscience sample from it and expect to conduct the 30 interviews in Summer and Fall 2006. In Summer and Fall 2006, we will also begin research for the industry nanoscientist respondent pool.

Concomitantly, we have used the directory generated by the Woodrow Wilson's project on emerging nanotechnologies to start defining the sample frame for the nanotoxicologist study. UCSB nanotoxicologist Trish Holden has offered assistance. We anticipate conducting the nanotoxicologist interviews in Fall 2006/Winter 2007. The UBC group led by Terre Satterfield will take the lead on creating the regulator sample and conducting the majority of those interviews. We expect all expert interviews to be completed by the end of 2006, and we anticipate preliminary analysis of the academic nanoscientist interviews to be completed by then as well.

We are discussing adding a web-survey for four larger samples (*n*~120 each) of each of these expert categories on a smaller subset of questions, to address representativeness issues. The sample frame research we're doing now will allow us to do so relatively easily. We will assess the resource base. We expect this work to carry through Fall 2006 and into 2007. Harthorn and Rogers-Hayden proposed a WG 3 risk focused panel for the 4S meetings in Vancouver in November in which the full team (including graduate students) plans to present preliminary research results. We anticipate that the expert study will result in a series of

presentations, working papers, publications, and possibly an edited collection. See Appendix B for the full list of presentations by group members on this work.

Risk Perception Survey. Consistent with our mixed methods approach, once we have completed the qualitative and quantitative expert risk perception studies and conducted preliminary qualitative deliberation discussions with small subsets of the publics (see below), we plan to conduct a national survey of public risk perception in the US late in 2007 or early 2008 (and, we hope, again in 2010). The research task of surveying under low awareness conditions is particularly challenging, and we are using the ramp up time to prepare adequately for this risk perception study. The survey will be conducted with a representative national US sample (provisional *n* estimation of approx. 1200-1500, with some oversampling by geospatial location, gender, and ethnicity). In anticipation of this work we have compiled and are continuing to update a shared database of all surveys of public opinion and public risk perception from around the globe to date, including some for analogous technologies. We are beginning to collect and analyze instruments used in specific surveys and are beginning discussion about our specific approach and plans. We will move toward instrument development in 2007, informed by both the expert study and the public deliberation study, as well as other studies. The phone (and possibly web-based) survey will be conducted for us by the UCSB Social Science Survey Center. Spatial analysis of the risk perception survey data will be of particular importance to us, as will analysis of sociodemographic factors in attenuated or amplified risk perception. We will begin more concerted work on the survey in early 2007 when we have the results of the expert and deliberation studies in hand as well as survey results from other researchers who are focused more broadly on 'public opinion' about nanotechnologies.

WG 3, Area 2: Public Engagement Component
Led by: Nick Pidgeon and Tee Rogers-Hayden
Team members: Barbara Herr Harthorn, Terre Satterfield, Hillary Haldane, Karl Bryant, Joe Summers, Susan Stonich

Our work focuses on nanotechnology deliberative efforts. Pidgeon and Rogers-Hayden bring to the group experience in the UK on surveys and analyzing previous public forums and deliberative efforts on GM and nanotechnologies. We will draw on their insights from two studies in particular, the Royal Society and Royal Academy of Engineering's inquiry into nanotechnologies and the evaluation of Nano Jury UK, in our CNS-UCSB work during 2006. Pidgeon's experience in independent evaluation of the GM Nation? national deliberation project in the UK is also of great use to us as we move forward to assess and pilot formats for successful public deliberation of nanotechnologies in the US.

From October 2005 through June 2006, the team has maintained regular telephone conferencing and e-mail communications,and gained ethics approval for our research affiliated to the CNS-UCSB through the Psychology Department at Cardiff University and completed the UCSB/NSF requirements for ethical approval. Our activities have included on-going engagement with networking groups, publications and planning forthcoming activities (see below). Presentations/conference papers are listed in Appendix B.

In Fall 2006 and Winter 2007, our team is planning deliberative efforts with members of the publics on nanotechnologies in Vancouver and Santa Barbara for October/November this year. We are organizing reconvened groups specifically on human health/enhancement and energy futures.The timing for the pilot projects is designed to synchronize with the 4S meetings in Vancouver. We currently plan to run the 3 sites concurrently in early 2007. Each session will involve two groups, with two meetings each. Criteria for selection of the human health/enhancement and energy future foci include range of likely public responses and framing of risks, time to realization in the marketplace, so that public deliberation can potentially contribute to policy decision making, and expertise within our nanoscientist consulting group.

In preparation for these sessions, we have begun developing materials for presentation in deliberation, are developing detailed execution plans for both North American sites, and are meeting regularly by telephone conference to advance our plans. We have also compiled a detailed database of nanotech deliberation and public participation efforts to date. This effort will provide a blend of UK and US approaches, under comparative conditions, with strong outcome evaluation measures. In addition to contributing to the public engagement goals of the CNS-UCSB, we anticipate that when complete this work will result in a number of scholarly presentations, reports, and publications, provision of useful learning and teaching tools via the CNS Clearinghouse, and provide a basis for future public participation efforts at the CNS and elsewhere.

Pidgeon and Rogers-Hayden are engaged in active public engagement research and assessment that will contribute invaluable insight to the CNS-UCSB deliberation analysis. These efforts include:

- Pidgeon and Rogers-Hayden, Nanotechnology Stakeholder government advisory group members, Coordinated by the UK Department for Environment, Food and Rural Affairs (Defra) this group facilitates discussion/learning among a wide variety of stakeholders on the issues around nanotechnology for government.
- Pidgeon and Rogers-Hayden, members of Nanotechnology Engagement Group. Run by 'Involve', this group has been funded by the UK Office of Science and Technology (OST), through 'Sciencewise', to co-ordinate learning on public engagement on nanotechnology and operate as an advisory group at 'arms length' from government.
- Pidgeon and Rogers-Hayden, UK-Japan Nanotechnology and Society Network group members. A network group of academics from the UK and Japan.
- Pidgeon and Rogers-Hayden (plus Harthorn, Newfield, Satterfield, and other CNS researchers) International Nanotechnology and Society Network (INSN) members. This group comprises research centers and individual academics focusing on social & political aspects on nanotechnology; with members from countries such as the UK, Japan, Brazil and the US.
- Rogers-Hayden, T. Co-organiser, with Dr Ben Anderson, Dr Matthew Kearnes and Dr Rob Doubleday, 'Nanotechnologies and Other Emerging Technologies' one day workshop,10 February 2006. Durham University.

WG3, Area 3: Media Framing and Collective Action

Led by: Bruce Bimber
Team Members: David Weaver (UCSB Social Science Graduate Fellow), Jerry Macala (UCSB Science and Engineering Graduate Fellow), Robert Ackland (Australian National University), Mathieu O'Neil (ANU)

The Media Framing and Collective Action area of WG 3's research examines "elite" reaction to nanotechnology in the global civil society, by focusing on media framing and the activities of networks of activists, advocacy organizations, and other non-governmental organizations. This focus reflects WG3's three-element model of public response to nanotechnology risk, namely individual-level risk dynamics, media stations as influences in risk amplification and attenuation processes, and group-level framing, agenda-setting, and mobilization processes.

We have formed a research partnership with Australian National University (ANU), under the working title Virtual Observatory for the Study of Online Networks (VOSON). VOSON is 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. The VOSON collaboration is based at ANU at the Center for Social Research, Research School of Social Sciences, and has recently been funded by the Australian Research Council (ARC) for the purpose of developing tools for examining online networks addressing nanotechnology. Bimber is a co-PI on that grant, which funds collaboration between the ANU group and the CNS-UCSB group. Under the ARC grant, Ackland visited CNS for two days in Spring, and Bimber will visit ANU in August for research meetings and to give a plenary address on nano and society issues.

CNS awarded a 12- month graduate fellowship to David Weaver, PhD student in the department of political science, to work on the Media Framing and Collective Action study.

The focus of our research efforts this year has been empirical, guided by the main theoretical questions we outlined in the proposal. We have prioritized efforts to begin collecting data that will feed our statistical analyses down the road, which in turn are aimed at testing various hypotheses about how media and advocacy groups are responding to nanotechnology. A good deal of additional theoretical lies ahead, but we have chiefly deferred those activities until we have developed our techniques for developing datasets, because we are very much interested in tracking changes in response to nanotechnology over time, and we believe that events are unfolding rapidly, especially in the media.

We conducted a preliminary mapping of global environmental groups' engagement with nano technology issues. This work demonstrates the capacity to identify cluster of groups interested in nano issues, as well as key bridging groups that link various kinds of frames and political perspectives. With our collaborators, we reported our method and preliminary findings respectively in two conference papers:

- "New Methods for Studying Online Environmental-Activist Networks," Robert Ackland, Mathieu O'Neil, Bruce Bimber, Rachel Gibson, Stephen Ward, presented at the

International Sunbelt Social Networks Conference, Vancouver, British Columbia, 21 April, 2006.

- "The Structural Role of Nanotechnology-Opposition in Online Environmental-Activist Networks," Mathieu O'Neil & Robert Ackland, presented at the International Sunbelt Social Networks Conference, Vancouver, British Columbia, 21 April, 2006.

Beginning in February, 2006, we began an exhaustive tracking of media coverage of nano-in-society issues. Our database now includes some 600 such articles. We have prototyped simple techniques for graphing media risk events, such as the coverage of the Magic Nano recall, and for characterizing what kinds of terms media use when describing nano, along with how such terms cluster together.

We will begin reporting on findings when the dataset contains ninth months of dataa. Between the present time and the nine month mark at the end of October, we will develop two new techniques: i) software scripts for automating part of our data collection, which is at present entirely manual, and ii) selection and adoption of content analysis software for analyzing content of the news articles we are collecting.

WG 3 co-funding

Harthorn (with Appelbaum) is Co-PI on a project led by UCSB nanotoxicologist, Patricia Holden in the Bren School of Environmental Science and Management that has received funding from the International Council on Nanotechnology (ICON) at Rice University to conduct a research project that will survey EH&S officers in nanotech industries about safety practices in the US, Europe, and East Asia. The project was funded in February 2006 and will be completed in Fall 2006. Bimber is Co-PI on a grant with the ANU collaborators on the VOSON project, and Harthorn is in discussion w/ the VOSON principal at ANU about VOSON/CNS-UCSB collaboration in additional fund seeking. We are also discussing additional funding needs for comparative survey data collection.

III. Research Findings

At the six-month mark, when this report is written, the research areas within the Working Groups are at various stages of advance toward reporting research findings. Some areas are still preparing for empirical work, some have data or evidence collected but not yet analyzed, and a few have preliminary findings to report.

Working Group 1 – Historical Context of Nanotechnologies

Area 1: "Over the Horizon" Technologies: The Case of Nanoelectronics

Already, we see thus far is an important role for both the military (DARPA) and the electronics industry in fostering this research. While it is to early to report concrete findings, we see important value in asking: What were the major instrumental and material hurdles to overcome? What is the relative role and importance of theory vs. experiment? How have industry and military actors supported research?

Area 2: Mapping Spintronics Research
We have demonstrated the capability of our semantic web search engine, and in the process, discovered ways to improve it for future work on mapping the structure and history of nanotechnology. Using these tools in relation to mapping the field of spintronics, we have demonstrated links between both experimentalists and theoreticians from the United States, Europe, and Japan. We have also used this to highlight connections between researchers at academic institutions and corporate laboratories. The tools allow for mapping relations using both co-publication and co-patenting information and can project these networks geospatially as well as show changing relations over time (1990-2005 was used as the baseline in five year increments). Finally, the refinement of these tools will enable them to be applied to mapping aspects of the nanoenterprise that are important for other CNS-UCSB research groups.

Area 3: Nanotechnology Oral History Project
We identified several key "constituent communities" that are critical to understanding the history and contemporary context of nanotechnology. These include instrument builders, federal grants officers, and the local/institutional environments that exist around national centers for nanoscience research. This has given rise to a series of questions that bear further consideration in future interviews and analysis of documentary materials.

Area 4: Nanotechnology and Futurism
This project only recently started (May 2006) and, consequently, there is little to report in the way of findings. However, we have already identified several key people who have played central roles in both the space as well as nano-futurist movements. In addition, key technologies such as carbon nanotubes have been embraced by both communities while certain "artifacts" occupy a liminal space between fiction and fact as it pertains to the exploration of the space and nano frontiers.

Area 5: Exploring Nanotechnology's Prehistory
The research done under this project directly connects with projects examining nanoelectronics as well as the data mapping and visualization of the spintronics field. As with the previous project, research on this topic began recently (June 2006) and it is too soon to report findings.

Working Group 2: Innovation, Creativity and Globalization

WG 2, Area 1: Nanoscale Transfer, Intellectual Property, and Partnership Policies
- In this area we have not yet collected primary data so there are no empirical findings to report; we have conducted a review of literature to prepare for field research. Our guiding propositions and hypotheses at this stage In this area we have not yet collected primary data so there are no empirical findings to report; we have conducted a review of literature to prepare for field research.

Our initial findings encourage us to pay special attention to the mechanics of the funding and construction of research communities in nanotechnology, and to identify the forms of IPR

and/or the "open innovation model" (Committee for Economic Development) that would fund and construct these most effectively.

WG 2, Area 2: Group Creativity in Nanoscale Research
In this area we have not yet collected primary data so there are no empirical findings to report; we have conducted a review of literature and a theory-development exercise to prepare for field research. Our guiding propositions at this stage are as follows:

WG 2, Area 3: Global Diffusion of Nanotechnologies
The Globalization area has devoted the first six months of 2006 primarily to planning and making arrangements for the complex international research to be conducted in Summer, 2006. Preliminary interviews conducted by leader Appelbaum at the NSF China-US Nanotechnology conference were primarily directed at laying the foundation for that research rather than generating empirical findings. Gereffi and Appelbaum are presenting a paper on China's nanotechnology development at the 2006 conference of the Society for the Advancement of Socioeconomics in Trier, Germany (see Appendix B).

Working Group 3 – Risk Perception and Social Response

WG 3, Area 1: Multiple Party Risk Perceptions
In the expert risk perception study, we are just beginning data collection, so there are no findings yet to report. Preliminary interviews indicate likely strong disciplinary differences in conceptualization of the nanoscience and nanotechnology fields; if these are borne out in the full range of interviews, these differences are anticipated to be predictive of differences in expert judgments about the benefits and risks of emerging nanotechnologies and about likely public response. We will be presenting preliminary data on the academic nanoscientist views at the Social Science Studies of Science (4S) meetings in Vancouver in November 2006.

WG 3, Area 2: Public Engagement
The public engagement area draws on numerous publications by Pidgeon, Pidgeon and Rogers-Hayden, and others. In particular, Pidgeon, Poortinga, Rowe et al. (2005) *Risk Analysis*, 25(2):467-480 examine the differences in views of GM risks and benefits in the GM Nation? project between self-selected participants and participants in a representative sample—the latter showed strong positive and negative assessments of the technology, the self-selected participants displayed strongly univalent negative views. Pidgeon's co-authorship of *Nanoscience and Nanotechnologies: Opportunities and Uncertainties* Royal Society / Royal Acad. Eng, 2004, London particularly informs our approach to low public awareness and high scientific uncertainty as issues for engagement processes. With regard to nanotechnology's risks Rogers-Hayden and Pidgeon's Sept 2006 article in *Nanotechnology Law and Business*, "Reflecting upon the UK's Citizens' Jury on Nanotechnologies: *Nano Jury UK"* examines the public jury model of engagement. These UK experiences have uncertain predictive value for engagement in the US, and the pilot comparative work we plan is essential to address this issue.

WG 3, Area 3: Media Framing and Collective Action

In the Media Framing and Collective Action area, the team has conducted a preliminary mapping of global environmental groups' engagement with nano technology issues, and has reported its methods and preliminary findings respectively in two conference papers (see Appendix B, Ackland et al. 21 April 2006). WG 3 Leader Harthorn presented these data as well at the NNCO conference in May 2006 on public participation in nanotechnology. This work demonstrates the capacity to identify cluster of groups interested in nano issues, as well as key bridging groups that link various kinds of frames and political perspectives. The team has also collected six months of data on media framing, but has not yet analyzed these data formally for reporting as a research finding.

IV. Education, Human Resources, and Engagement

The goal of education and public engagement activities at the Center for Nanotechnology in Society is to nurture an interdisciplinary community of researchers, students, educators, and the general public who collaboratively engage in the study of nanotechnology and society.

Education Program Activities

The CNS-UCSB hired Meredith Murr (PhD, 2006) to serve as its Education Coordinator. She works with Fiona Goodchild, Associate Director for Education, to coordinate the creation of fellowships and research internships for undergraduate and graduate students interested in exploring the societal issues relating to nanotechnology. To date, the CNS has offered five undergraduate summer internships, designed for three students from four-year colleges and two students from community colleges in California. These internship programs are administered jointly with existing summer internship programs administered by the California NanoSystems Institute (CNSI) and the Materials Research Laboratory (MRL) at UCSB. Interns attend meetings and seminars alongside peers who are working in nanotechnology projects in UCSB laboratories in science and engineering.

CNS recruited the first full cohort of nine CNS-UCSB Graduate Research Fellows in Winter 2006 from the UCSB campus. They will begin their research in Summer 2006. This group includes five, year-long fellows in social sciences who work with the Working Groups and four part-time graduate student fellows in science and technology who are interested in participating in the research of the Working Groups. These two groups will jointly attend seminars specially designed to address current issues and to integrate research perspectives across CNS, as well as participate in monthly Graduate Fellows Meetings. Because of the mid-year start date of the CNS, the Center recruited five fellows in January 2006 for variable commitments in Winter and Spring 2006; we initiated Graduate Fellows Meetings with them in March 2006. The Graduate Fellows work together in shared research spaces, and there is significant cross-working group interaction among them. Summer 2006 will see the first full research team participation of CNS graduate fellows in both social sciences and nanosciences, along with the first cohort of undergraduate interns.

With respect to curriculum development, the CNS has been working closely with CNSI to develop a series of undergraduate courses as part of the Insights on Science and Technology for Society (INSCITES) series that will be offered for the first time in Winter 2007. CNSI

Director Hu, et al. have begun to recruit the first graduate teaching fellows who will be trained in Fall 2006 to instruct undergraduate science/engineering majors in innovative general education courses. These will focus on the science, economics, sociology, and history of new technologies, starting initially with nanotechnologies. In addition, the new interdisciplinary Ph.D. emphasis in Technology and Society coordinated by the UCSB Center for Information Technology and Society (directed by CNS Co-PI Bruce Bimber) will offer opportunities for CNS faculty to develop and institutionalize new graduate courses on nanotechnology and society. Discussion is underway as well to add a LEAPS (Let's Explore Applied Physical Sciences) course offering on nanotechnology and risk, and to implement new graduate and undergraduate curricula on gender and science and technology that would span social sciences and physical and life sciences.

Our programs for education focus now on graduate professional development and undergraduate curriculum design, with some public information programming focused on nanotechnology. We have reduced our K-12 programs in response to direction from the NSF. While more modest in scale, we continue to view education programs as important activities for integrating activities of the Center. We retain an emphasis on coordinating closely with the California NanoSystems Institute, which has a portfolio of education and outreach programs.

In May 2006, CNS Graduate Research Fellow Hillary Haldane conducted a self-directed informal survey of the Winter and Spring 2006 CNS fellows in preparation for her presentation to the CNS National Advisory Board on May 5, 2006. They collectively identified the following roles for fellows in the CNS:

- Research Development and Implementation. Active participation in developing incremental stages of the research for each WG, being treated as an equal member of the WG in exchange of ideas, methods, direction, etc. Carry out aspects of the research such as interviewing, observations, drafting protocols, necessary consent forms, research description for dissemination, and full participation in the analysis of data collected.
- Peer Support. Fellows are encouraged to work with other fellows on a daily and informal basis. Part of this is achieved through the sharing of office space-fellows become intimately familiar with the tasks of other fellows. This is also achieved via Monthly WG Colloquium. The peer dialogue helps fellows stay informed of the activities across WGs and importantly helps to identify areas of duplication or sample saturation.
- Mentorship. The undergraduates joining CNS in the Summer 2006 will give CNS fellows an opportunity to hone their mentoring skills and participate in a meaningful information exchange and educational opportunity with a student at a very different academic stage from his or her own.
- Administrative. Provide administrative support to the research efforts of the WG Faculty and Staff members. This includes photocopying and printing of materials, interlibrary loan requests and book/article management, bibliography maintenance (some WGs have annotated bibliographies), research information management including database creation and maintenance, literature searches, literature reviews, and filing of resources.

Haldane and the Fellows also identified the following benefits of the CNS Graduate Research Fellowships:

- Professionalism. First hand experience with a multi-disciplinary approach to research. As more and more research in the future will require this cross-disciplinary knowledge, Fellows are at an advantage in seeing how a multi-disciplinary approach is implemented and how possible challenges are worked through and turned into successful opportunities. Fellows are given co-authorship and co-presentation opportunities as well, and are included in decision making meetings to develop skills that will be useful in a competitive academic job market.
- Mentorship. CNS gives fellows the opportunity to work closely with a highly trained and skilled senior academic. Students in the Social Sciences rarely have an opportunity to work as a research partner with advanced researchers—CNS gives fellows a unique opportunity to closely observe and learn from senior scholars in their fields. It also allows students to engage with scholars from different disciplinary backgrounds, something not commonly found in social science departments.
- New Methodologies/New Vocabularies. Working closely with scholars from a variety of departments, Fellows are exposed to a wide range of research methodologies and even disciplinary specific vocabularies. This introduction to new ways of constructing research tasks, asking questions, and forming hypotheses allows the Fellows to think in ways beyond their disciplinary specific training and prepares them for a job market that seems to reward those who are conversant beyond their discipline.
- Dissertation Research. CNS Fellows (at the junior level) are able to simultaneously support the research goals of the CNS while using their fellowship opportunity as a launching pad for their own dissertation research. More senior Fellows will be able to use the CNS opportunity to think about what sort of post-doctoral training or experience will enhance the skills obtained during their time at CNS.
- Recruitment. The CNS will allow UCSB to recruit highly qualified, top tier prospective graduate students to our campus. UCSB departments affiliated with the CNS would benefit from selling the CNS as a potential opportunity to prospective students as a way to attract some of the best and brightest.

Human Resources and Diversity

Undergraduate Recruitment

The partnership that the CNS has with the California NanoSystems Institute (CNSI) will enable it to continue to recruit students from underrepresented groups; these students will be drawn from community colleges, state universities and research universities. As a result of establishing partnerships and connections with all three types of institutions in California, CNSI advertises widely and recruits a diverse group of students from across the state who take part in INSET (Interns in Nanoscience, Engineering and Technology) and EPSEM (Expanding Pathways for Science, Engineering and Mathematics), both NSF funded projects. CNS will use these same connections to recruit undergraduate interns. This will entail preparing new information and making sure that it reaches social science as well as STEM students. For example, in the summer of 2006, one of the community college interns and one of the UCSB undergraduates (both will be summer interns) are from underrepresented groups in science and engineering.

The introduction of the INSCITES courses at UCSB in 2007, will create a new opportunity for undergraduate students. The first course, entitled "Understanding Today's Technology," will recruit students who want to take a general education course. Approximately 25% of the UCSB undergraduate population is composed of students from Latina/o backgrounds, so more students from underrepresented groups are likely to learn about the research focus and educational opportunities created by CNS.

In addition, plans are under discussion to collaborate with our sister CNS at ASU in developing a national conference series for undergraduate involvement in research that will recruit extensively from Latina/o, African American, and Native American students.

Recruiting Graduate Fellows

CNS will collaborate with the Director of Recruitment and Retention, Monique Limon, and Kofi Taha, Diversity Coordinator for Science and Engineering and Social Sciences, to engage in program events and to advertise opportunities through both the UCSB AGEP (Alliance for Graduate Education in the professoriate) and other nodes in the AGEP network across the US. The overall recruiting strategy will be expanded in the upcoming year through increased contact with relevant professional societies, such as SACNAS (Society for the Advancement of Chicano and Native Americans in Science).

Researcher Participation

We plan to pursue faculty researcher participation in the CNS with AGEP partner institutions (Howard University and Jackson State University) and have a meeting planned with the UCSB leader of the program to initiate discussion. We will also discuss pursuing additional funding to further enable the CNS to reach out to California community college teachers with large underserved student populations. Faculty from both kinds of institutions would be included directly as participants in the research groups.

In addition, CNS research focuses substantively in several respects on equity issues associated with technological change. WG 2 is concerned with shifting global social and economic equity that may accompany nanotechnologies development and emergence; WG 3 will be investigating gender, ethnicity, and nationality effects on nanoscientists' and publics' views of nanotechnologies' risks as well as considering the ways that history of racialization and technological hazard exposure affect nanotechnology risk perception. CNS PI Harthorn is an established cultural anthropology researcher of Latina/o health equity and participatory research.These ties will be drawn upon to further the direct involvement in the CNS of students, faculty, and community members of diverse backgrounds, cultural heritage, and experience.

Public Engagement

In order to ensure that all groups in the Santa Barbara area are aware of CNS activities, we will make full use of the above contacts to reach and represent the interests of the wide range of diverse groups in the population in Southern California. In particular, we will recruit public deliberation participants in panels that reproduce the socio-demographic diversity of the communities in which we will conduct them (Santa Barbara, Vancouver, and Cardiff, UK).

CNS organization

At all junctures in its development, the CNS has recruited staff and participants with attention to diversity of ethnicity, gender, and experience. The PI, who is also a Co-Director, is a woman, and the Executive Committee has excellent gender balance and some ethnic diversity. This process is also reflected in the composition of our center staff. Our lead CNS staff manager is a 1st generation Latina of Mexican origin, and our education coordinator is a woman with an advanced degree in biology. We will continue to attend to these issues in subsequent recruitments.

The CNS National Advisory Board was recruited with attention to diversity by gender, ethnicity, and interest in the equity issues that are likely to accompany emerging nanotechnologies. Initial board appointments were for 2 years, and we will continue to pursue diversity goals in recruitment for these future roles.

Outreach and Engagement Plans

The CNS involves K-12 teachers, community college students, industrial, and general public participants on the UCSB campus at both the CNS center and the new CNSI building and off campus in multiple sites. CNS will participate in UCSB's Alliances for Graduate Education and the Professoriate Program (AGEP), with partners Jackson State and Howard University. We will also begin development of programs for the California Alliance for Minority Participation (CAMP), and will partner with the CNSI project called Expanding Pathways in Science, Engineering and Mathematics (EPSEM) to integrate community college students from Latino backgrounds.

CNS knowledge sharing with academic and practitioner communities is already extensive and growing (see Appendix B, presentations and meetings attended). We are active to the limits of our budget in attending conferences, leading sessions and workshops, and pursuing network opportunities around the globe. We hope to seek additional funds to allow graduate and even undergraduate participants to attend conferences with senior personnel. We are planning in Summer 2006 to begin a 'Nano and Society' reading group which will meet weekly initially and read at least one article per week on the societal issues surrounding nanotechnologies. We hope to involve students and faculty researchers from a range of disciplines in such scholarly and practical discussions.

CNS leaders have held or been lead participants in programming for the general public in 2006, and more events will be planned as we shift into the 2nd half of our initial year of operation. Most notable among these events, we staged our public launch of the CNS on May 4, 2006. This involved a pair of large public events that drew several hundred participants from campus and the local Santa Barbara area. The main event included a public forum with speakers from the CNS (Harthorn, Newfield, Hu) and invited speaker NPR Science Correspondence, Richard Harris. In conjunction, we also sponsored and hosted the first public presentation of the "Allosphere," a dramatic multi-media scientific data visualization tool developed by the UCSB Media Arts and Technology Program that will be used to

visualize nanoscience data and findings in a form accessible and intriguing to the general public (see Appendix D).

Additional public outreach by the CNS has included numerous public presentations to the UCSB campus and local community, for example Student Affairs staff retreat (Harthorn), the UCSB Chancellor's Community Breakfast Program (Harthorn and McCray), the LEAPS (Let's Explore Applied Physical Science) program (Harthorn and Haldane), EPSEM (Expanding Pathways to Science, Engineering, and Mathematics) Summer Institute (McCray), and the RISE program (Research Internships in Science and Engineering through the UCSB MRL) (Harthorn). We anticipate that such presentations will increase as the CNS becomes better established and more programs are aware of our interests and expertise.

We are also pursuing possible exhibitions on nanotechnology and society topics. Appelbaum plans to participate in the Commercialization of Micro and Nano Systems Conference (COMS), held by the Micro and Nanotechnology Commercialization Education Foundation (MANCEF) in St. Petersburg, Florida (August 27-31), presenting the work of the CNS. He will use the occasion to meet with Wit Ostrenko, President of the Museum of Science and Industry (MOSI) in Tampa, Florida, to discuss the possibility of having MOSI host an exhibit on the social impacts of nanotechnology, based on the work of the CNS.

The CNS (via Co-Director McCray) is collaborating with Center for Chemical Bonding at UCSB as they develop a proposal for Phase II funding from the National Science Foundation. Collaboration, if proposal is funded, would entail development of a web-based exhibit exploring the history, societal issues, and science associated with the design of new materials via computational chemistry and instrumentation giving scientists the ability to precisely fabricate new materials at the nanoscale.

Media outreach has included numerous media interviews by CNS leaders and resultant media coverage (dozens of articles between Oct 2005 and June 2006). As we fill our Media and Outreach Communication specialist position in the next several months, we anticipate significant ramp up in this area. We also are strengthening collaborative ties with other campus research centers and institutes in the sciences to pursue funding for our intended Science Writer program that was eliminated in the budget cut at start up. We are in fruitful discussion on this and hope to be able to implement in year 2 or 3 of the CNS.

Website and Clearinghouse

Through the CNS *Clearinghouse*, we aim to share the tools and resources generated for our own research, education, and public outreach programs to a wider audience. Such resources will include: identification and links to other researchers and their interests; sharing of emergent publications and bibliographies in annotated and/or classified format; clipping service re: public media coverage; all CNS reports and products; and educational resources from UCSB and elsewhere, with necessary permissions, such as syllabi of nano-society courses. The CNS website (cns.ucsb.edu) was mounted in late Fall 2005 in anticipation of the January 2006 start date and will serve as the main portal for information dissemination to and contact with the various constituencies the CNS aims to serve. Web design and

implementation has been an ongoing priority in year 1, and we hope by the end of this year to have implemented most of the desired capabilities for internal and external communication, data storage and access, and learning tools support.

The Website is currently mounted on our host server in the UCSB Institute for Social, Behavioral, and Economic Research (ISBER), which provides a secure and stable backbone for maintenance of our system. We are in discussion now about migrating this to a dedicated server in the next year to plan for anticipated future demand. Computer and network support from ISBER and UCSB Learning Resources has enabled us to seamlessly incorporate new functionalities and information so far, and we have achieved significant economies and efficiencies through this partnership. As data collection increases and collaborations become more extensive around the globe, the need will increase for the CNS to serve as a "collaboratory.," We will continue to review and modify the formats, functionalities and capacities of the website to meet its Clearinghouse mandates. In the future we anticipate the CNS-UCSB website will become a site for public interaction about nano and society issues, through such methods as participatory mapping, opinion collecting, and dialogue.

Engagement with Nanoscientists and Engineers

Engagement with nanoscientists and engineers is a central and distinctive aim of the CNS-UCSB. To that end, we have the following plans 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 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 Martin Moskovits, Dean of Mathematical, Physical and Life Sciences at UCSB, who is himself a leading nanoscience chemist. In addition, the NAB includes: Nobel Laureate Alan Heeger, UCSB Professor of Physics, Harvard nanoscientist and NSEC director, Robert Westervelt and Rice

University nanochemist and national center (CBEN) leader, Vicki Colvin. In addition, two leading science policy advisors, Tom Kalil, Science Policy Advisor to the UC Berkeley Chancellor, and engineer Susan Hackwood, Director of the California Council on Science and Technology Policy bring added voice. Thus almost half of the 13-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 newly opening building on campus. Our education program is now physically based in the new building, adjacent to the CNSI's large education and outreach team, so we will be engaging with them on a day-to-day basis. One of the CNS-UCSB Co-Directors (Harthorn) will maintain a research office in the CNSI to facilitate daily interaction between CNS personnel and CNSI personnel at the highest level. When fully open (expected January 2007), the CNSI will provide 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.

Research Program

All three Working Groups (WGs) 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, WG 2 and WG 3 have established collaborations with and commitments for involvement from a number of leading nanoscientists (WG2: Daniel Blumenthal, Tim Cheng, Brad Chmelka, Glenn Fredrickson, Arthur Gossard; WG3: Kevin Almeroth, David Awschalom, Elisabeth Gwinn). We are in regular communication as well with a number of other leading campus nanoscientists (e.g., Craig Hawker, Director, Materials Research Lab and MRSEC). During preparation of the center proposal, we convened two open meetings with interested nanoscientists, and interest and participation has been consistently high.

More specifically, WG 1 is engaged in depth interviewing of UCSB and extramural scientists involved in the development of spintronics research, as well as oral histories with several leading campus researchers. A number of interviews have already been completed, and more are in planning. The willingness of researchers to commit to this interview process is one index of engagement with the CNS. In addition WG 1 is mapping the networks and historical interconnections among nanoscience spintronics researchers.

WG 2 has two main projects, the first looking at innovation processes, the second at globalization. The innovation studies have involved a number of face to face research planning meetings with the collaborators, and will in years 1 and 2 involved systematic interviewing of nanoscientists and their students and postdocs across different kinds of laboratory and institutional settings. The globalization research has similarly involved extensive planning meetings, interviewing of China and US nanoscientists at an NSF meeting, and will involve interviewing of UCSB, Duke, and East Asian nanoscientists. The team plans a research trip to China and Taiwan in August 2006, and extensive planning is underway, along with commitments to participate.

WG 3 similarly has two projects, one of which will involve nanoscientist engagement. The project on risk perception and public participation is planning to interview a sample of UCSB and extramural nanoscientists, nanotoxicologists, and regulators about nanotechnologies' risks and benefits. This work will be conducted in summer and fall 2006 and is seen as a necessary prelude to interviewing or surveying the public about their risk perceptions. As well, in Fall 2006, this group is planning a comparative mini deliberation session in the US, Canada, and the UK and will be drawing on nanoscience expertise for the technical material presented in the workshops, as well as for possible involvement.

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.

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 implemented a program of CNS Nanoscience Graduate Research Fellowships that will involves at least 4 science and engineering graduate students directly in CNS Working Group research programs each year, working alongside and in close contact with CNS Social Science Graduate Research Fellows and faculty researchers. The science students participate in the monthly fellows meetings, and are taking an active interest in the research. We hope that through their students, faculty nanoscientists will gain insight into our work, appreciation for our social scientific methods, and enhanced interest in engaging with us. There is some evidence that this is already taking place.

CNS is also involved with CNSI in the development of an innovative education program that will give 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 Co-PI Evelyn Hu.

Campus outreach and programming

The Campus Launch events involved nanoscientist engagement in a number of respects, and many individual faculty members and students attended the public events and reception following. The tandem launch of the Allosphere organized by the CNS also drew several hundred eager participants. CNS researchers are actively involved in making invited presentations to colloquia and other series that involve nanoscientist faculty and students. These will be detailed in our Annual Report. Our plan is to gain visibility initially through

such existing venues, to initiate joint programming, and to begin a speakers series in Year 2 that will encourage participation by nanoscientists as well as social scientists, humanities and fine arts scholars. Joint programming under discussion with the CNSI includes a California technology development and policy conference, and a speakers series. In addition, CNS and CNSI will co-fund and jointly hire a media specialist to assist in coordinated, effective communications of nanoscience and nanotechnology research to the public.

New collaborations between CNS and nanoscientists and engineers
Since opening our doors in January 2006, the CNS-UCSB has already received co-funding for a collaborative research project with a nanotoxicologist (microbiologist Patricia Holden, Bren School for Environmental Science and Management). We are also discussing a potential partnership with the Chemical Bonding Center on a range of research and education programs if they receive funding. Finally, we have consulted on a campus nanoscience NUE proposal and additional activities of this sort will develop over time. More intersections of 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.

Network for Nanotechnology in Society

Since the formal start of CNS, 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. So far, we conducted a preliminary meeting at UCSB with ASU principals Dave Guston and Dan Sarewitz in Nov, 2005 to discuss shared national center duties. We also participated as a team (Harthorn, McCray, Appelbaum, and Newfield) in a day-long network meeting held February 8, 2006 at the National Science Foundation.

Harthorn also 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 network meeting. The other participants typically include the Principal Investigators from each of the network groups, Dave Guston (CNS-ASU), Davis Baird (USC), and Richard Freeman (Harvard/UCLA). To date, discussions have focused primarily 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 entitites, and this has been very helpful. Harthorn was an invited guest at the January launch of the CNS-ASU, and ASU sent an invited guest to the May launch of the CNS-UCSB.

A number of intersections have emerged through the network in the research area as well. For example, Appelbaum (UCSB) and Freeman (Harvard) are in discussion about a joint conference in 2007; Appelbaum was an invited participant in a conference on nanotechnology in China in February 2006 that emerged from contact with a LeHigh scholar in the Harvard/UCLA network; ASU partner Shapira and Newfield (UCSB) have developed

shared interests and joint conference invitations; Rogers-Hayden and Pidgeon (UCSB/Cardiff) and Guston (ASU) are co-editing a collection of publications; Harthorn (UCSB) and Rogers-Hayden (UCSB/Cardiff) are co-chairs of a 4S panel in Nov 2006 that includes Harvard/UCLA LeHigh scholar Friedman. McCray (UCSB) has been an invited guest at ASU conferences and is in discussion with USC scholar Johnson about possible collaborations. We expect these intersections to grow and develop over time and will be tracking them.

Representatives of the CNS also attended meetings and made presentations to the International Nanotechnology and Society Network (INSN), and the CNS–UCSB is on the executive committee of the INSN. The CNS-UCSB has significant research interest and expertise in international and global research, and we expect to be active participants in the coming years. We attended the October 2005 meeting in London (Harthorn, Newfield, Satterfield, Pidgeon, Rogers-Hayden in attendance) in conjunction with a Working Group meeting; we also were represented at the March 2006 meeting (Newfield, Rogers-Hayden) in Oxford.

We are in communication with other potential network members such at the NIRT at MSU on agricultural and food standards, and we will be working to strengthen these ties in the coming year.

V. Contributions

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 (digital) technology; environment; and our extraordinary capacity for interdisciplinarity. In terms of its broader vision, the CNS seeks to update the organizations that have produced many of the intellectual breakthroughs that have been most valuable to society. No single model has worked in every circumstance: stubborn independence helped the medieval university keep advanced learning alive, while self-organized improvisation enabled groups of great scientists and inventors such as the "Lunar Men" to create the clubs, workshops and factories that sustained discovery and application when the 18th century university was hostile to experimental method. The modern research university arose to serve both economic and human development and is now a hybrid and multivalent network of semi-autonomous units that struggles to adapt to the changing requirements of discovery and dissemination. With this history in mind, the CNS recognizes that its research, education, and outreach efforts will prompt continued structural redesign. The CNS aims to create a genuine learning community of diverse participants that can pool its knowledge for the simultaneous benefit of society and technology. In so doing, the CNS may serve as a model for reconfiguring knowledge institutions to remain timely, accurate, and relevant in a period of rapid change.

The research mission of the CNS – to provide a systems-level analysis of nanoscale research and development, the global diffusion of nanotechnologies, and responses to nanotechnologies as they emerge – is an ambitious multi-year plan. Because nanotechnology spans such an enormous range of possible applications and implications, it will not be

sufficient simply to mount a series of independent projects studying one or another technology in isolation. It is clear that the entirety of the nano-enterprise must be kept in view, so that funding decisions, policies, and regulations do not advance piecemeal. This poses a research challenge that is largely unprecedented. Compared with the decisions associated with the advance of information technology, for instance, nanotechnology presents a qualitatively larger and more complex challenge. Traditionally, scholars studying science and technology have been successful at examining one or two areas of impact; those studying nanotechnology must simultaneously confront a broad range of implications and, ideally, integrate and combine their research findings into results that inform other scholars, policy makers, and the various public communities the CNS serves.

The CNS has the potential to make significant contributions to and between 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 other STS scholars. The tools and methodologies developed and used by CNS researchers may provide an example for documenting the development of other contemporary emerging technologies that, like nanotechnology, will be important in the 21st century.

- WG2's research on the innovation and diffusion of technology in multiple contexts – from the individual laboratory to the academic-corporate nexus to the global setting – will combine contributions from the social science and humanities to better understand how new technologies are created and transmitted.

- WG3 is poised to contribute to both the scholarly and practical understanding of risk through collection of vital baseline data about different communities' risk perceptions and beliefs, tracking of ongoing media framing (and reframing) of these new emerging technologies, and following unfolding social response at the level of the individual and of collective action.

- The CNS is fundamentally an interdisciplinary undertaking. The CNS employs a set of integrative activities that help synthesize the WGs and involve its non-academic collaborators. Most simply and practically, the WG's share research results on an ongoing basis through regular face-to-face meetings, seminars, and consultations within the Center. The CNS will combine depth with integration by allowing each WG to pursue its research independently, while providing mechanisms for continuously synthesizing research results and sharing educational, outreach, and collaborative activities.

- 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 outreach programs will be leveraged with other education programs at UCSB including those of the California NanoSystems Institute. Innovative new courses and programs such as INSCITES will offer students the opportunity to gain a more comprehensive understanding of key technologies in the societal contexts. In addition, more than 15 graduate and undergraduate students have been given the opportunity to participate 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 outreach builds on a strong set of institutional ties with regional California community colleges that serve Latina/o students, an AGEP program with Howard University and Jackson State University, 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 will draw on their expertise in developing this part of our program.

VI. Management and Oversight

Management and Governance

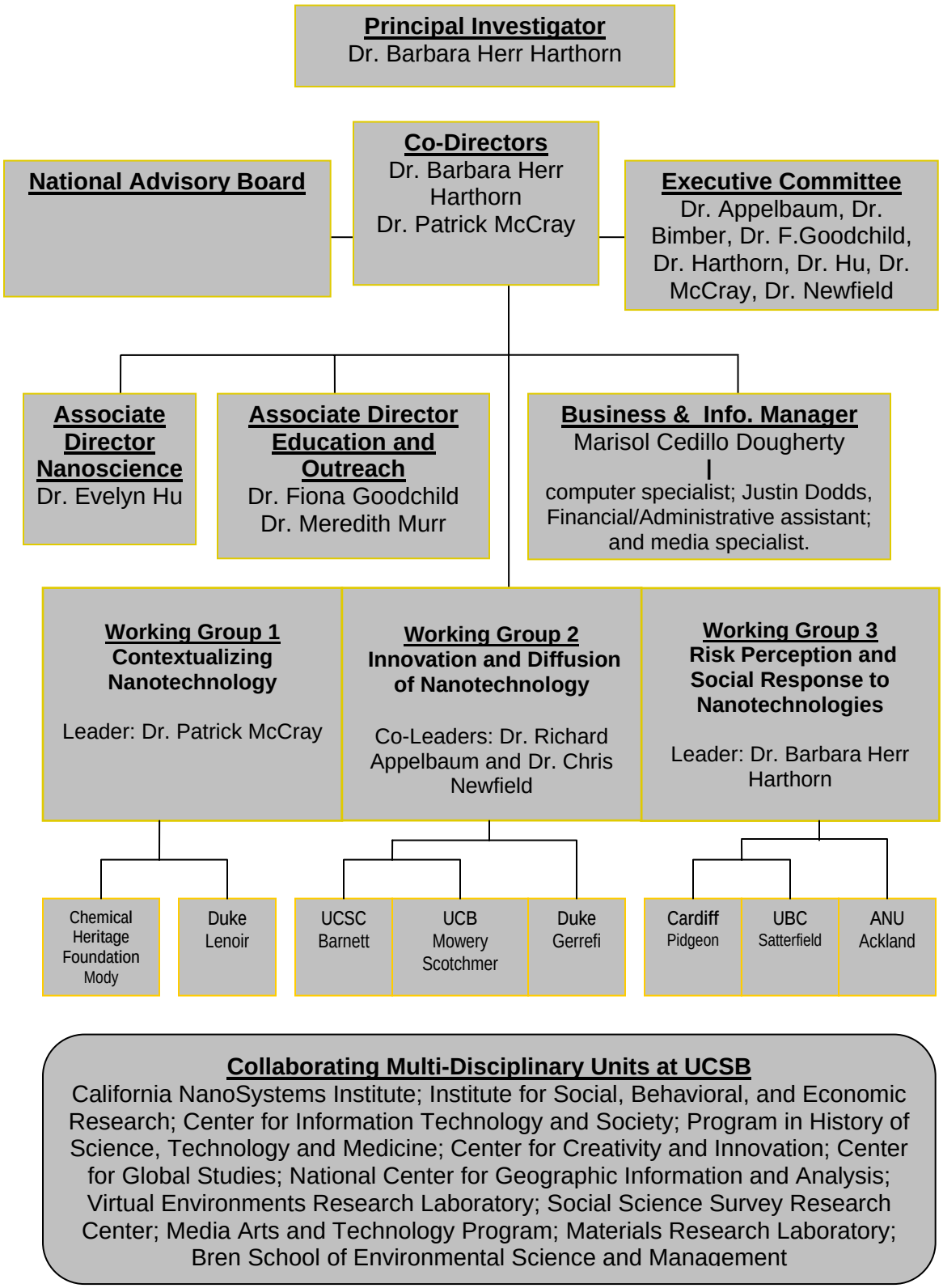
Management of the CNS-UCSB occurs at three interrelated levels; the organization chart below illustrates the Center's management and organizational structure. The CNS is led by Principal Investigator, Barbara Herr Harthorn. Dr. Harthorn is responsible for all official agency contact with the CNS-UCSB, 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 interaction. CNS co-directors Barbara Herr Harthorn and Patrick McCray jointly oversee the day-to-day operation

of the Center in conjunction with full and part-time CNS staff members and the CNS Executive Committee. The Co-Directors are frequently called upon to represent the CNS in presentations to campus, local community, national and international academic and activist communities, and in interaction with the press.

The CNS Executive Committee meets on a regular basis and addresses longer-term strategic planning for the Center in consultation with the Co-Directors. The membership of the Executive Committee is the PI and Co-Directors, the leaders/co-leaders of the 3 working groups, and the Director and Educational Director of CNS nanoscience partner organization, the California NanoSystems Institute. Members include: Richard Appelbaum, Bruce Bimber, Fiona Goodchild, Evelyn Hu, Barbara Herr Harthorn, Patrick McCray, and Christopher Newfield. Typical topics of recent discussion include the selection of our first round of graduate student fellows and undergraduate interns, integrative working group activities, public event programming, and leveraging our interaction with other Nanotechnology and Society groups in the U.S. and overseas. Since March 2006, meetings have occurred on a monthly basis; any members who are not physically present 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. Additional meetings, for example among the working group leaders, take place as needed to address particular research issues that arise.

NSF resources are being leveraged well with existing university support and administrative services. CNS staff can draw on the expertise of the staff of the Institute for Social, Behavioral, and Economic Research for assistance in all aspects of extramural award administration, accounts management, personnel action, travel accounting, purchasing, and computer network administration. The close working relationship with ISBER has enabled CNS to move quickly and efficiently in a number of areas, and the capable ISBER staff provides backup to CNS' much smaller 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.

CNS-UCSB Structure



Year One Management Activities

In *the pre-award period*, we secured and furnished space for the Center on campus; hired core personnel, including CNS manager Marisol Cedillo Dougherty; designed and mounted a dedicated website and clearinghouse portal (cns.ucsb.edu); recruited and announced a National Advisory Board composed of national leaders in policy, research, and industry; initiated media relations and outreach; recruited CNS graduate fellows for the balance of the 2005-06 academic year; reaffirmed contacts with the nanoscience community on campus; initiated participation in US and international networks of nano and society researchers; gained blanket IRB approval for Human Subjects; and engaged in an array of preliminary research activities. All research working groups held face-to-face research planning meetings in the pre-award period as well as numerous conference calls, e-mail consultations and circulation of preliminary planning documents, research instruments in development, news and publications of mutual interest. Led by Co-Directors Harthorn and McCray, the Executive Committee met an average of twice a month throughout the initial ramp-up period and conferred electronically or by phone on a near-daily basis about these many activities and initiatives. Meetings of the Executive Committee were held every 2-3 weeks.

As of the opening date of the CNS in January 2006, Barbara Herr Harthorn became lead Principal Investigator of the Center, and former PI Bruce Bimber stepped back into Co-PI and Executive Committee member position. Harthorn and McCray have shared Director duties since the award was announced in Fall 2005. This leadership transition has been effected smoothly, and the CNS enjoys the strong support of UCSB administration in its efforts.

Since the start date, we have continued organizational efforts on several fronts. We continued to fill open staff positions: In March 2006, we hired Justin Dodds to serve as our part-time Administrative Assistant. Mr. Dodds has since begun to work effectively with Marisol Cedillo Dougherty, our center manager, on the daily administration of the CNS. These activities include purchasing, event planning, and center finances. In the next few weeks, we anticipate hiring a half-time computer and network technician who will assume responsibility for, among other things, the Center's web page and web-hosted data base management. The recruitment for the shared computer network specialist (with our host Organized Research Unit, the Institute for Social, Behavioral, and Economic Research-ISBER) is proceeding; competition is keen on campus for the limited number of available personnel, and we are currently reclassifying the position to enhance our position. We expect to have it filled by mid-summer. We have also reached an agreement w/ the CNSI to share a media and public communication position, thus leveraging our CNS funding to get a full-time professional employee at a level well beyond what we would recruit with a lower level half time position. We hope to have this person in place by early Fall 2006.

Office space for CNS-UCSB researchers, staff, and students has progressed. As of June 2006, our office space in North Hall was nearly fully furnished and occupied. We have created a new area for CNS meetings in our main Center space, North Hall 2216. In addition, we have completed furnishing and equipping the three CNS offices in the CNSI building and they are being occupied as enabled by building completion. When the CNSI is fully completed and furnished, the CNS will have access to shared conferencing and other spaces

there as well as its current facilities in ISBER in North Hall. We have recently been notified of the need to relocate core staff offices from one floor to another in North Hall to accommodate the new Nobel laureate in Economics. We will complete this move over the summer and be fully ensconced in comparable space by early Fall 2006. All CNS space has been outfitted and networked by ISBER computer network administrator, Randall Ehren, and his staff. The CNS is receiving excellent desktop and web support services from ISBER and the campus, and this has enabled our speedy move to full operation.

Harthorn and McCray have continued to promote the CNS through press releases and media interviews. In addition, the CNS web page (cns.ucsb.edu) has been continually updated with news items as well as material describing the activities of the Center. In the next few months, we anticipate beginning to develop web based repositories for CNS research results and references.

Finally, on May 4-5, 2006, the CNS-UCSB held its public launch event. This coincided with the first meeting of our National Advisory Board. Tremendous effort on the part of all CNS faculty and staff went into planning this event which featured Richard Harris (science correspondent for National Public Radio) as the guest speaker. Representatives from the NSF attended both the launch and the board meeting (see attached flyers in Appendix D).

Communication

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.

National Advisory Board

A crucial part of the CNS' plan for engagement with different constituencies and for evaluation of its efforts by them involves the creation and involvement of a National Advisory Board. The purpose of the board is to meet annually, to review all aspects of the CNS-UCSB operation, and to provide suggestions and advice about our work, our approach to the work, recommended changes in approach, and planning for the post-initial-funding period of the CNS-UCSB. Senior SBE Directorate officials will be invited to attend NAB meetings as observers and, at the invitation of the board, as participants. The Chair of the NAB will be asked to generate a report summarizing the Board's actions at each year's meeting. The timing of the Board meetings is dictated by the NSF plans to conduct annual site visits of the CNS in the summer. We plan to hold the board meetings in Santa Barbara in advance of the preparation of our Annual Report and annual Site Visit.

In late 2005, the CNS-UCSB recruited members for a National Advisory Board. The Board's members meet annually and are all national leaders in policy, research, and/or industry. Membership of the Board as of June 2006 is:

- Ann Bostrom, Associate Professor in School of Public Policy at 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
- Alan Heeger, Professor of Physics and 2000 Nobel Laureate in Chemistry, UCSB
- Thomas Kalil, UC Berkeley and former Deputy Assistant to the White House for Technology and Economic Policy
- Bruce Lewenstein, Associate Professor in the Science and Technology Studies Department, Cornell University
- Julia Moore, Deputy Director of Foresight and Governance Project at the Woodrow Wilson International Center for Scholars
- Martin Moskovits, Dean of Science and Professor of Physical Chemistry, UCSB
- Willie Pearson, Jr., Chair of History, Technology and Society at Georgia Tech
- Robert Westervelt, Director of the Nanoscale Science and Engineering Center-NSEC at Harvard University

The first meeting of the Board on May 5, 2006 was scheduled in anticipation of a planned NSF site visit in July 2006 (now deferred) and associated annual reporting activities and in conjunction with the launch event on May 4, 2006. The necessarily short notice for this meeting greatly reduced participation this year, but we are now on a schedule for long lead times of notification and planning. This year's meeting was a half-day event held at the Upham Hotel in Santa Barbara and attended by the CNS Executive Committee, visiting Working Group collaborators, CNS graduate fellows, CNS staff, and NAB members Bostrom, Moskovits, Kalil and Pearson, along with NSF SBE visitors David Lightfoot and Mark Weiss. The discussion focused primarily on the rationale for and approach to focusing on emerging nanotechnologies as well as specifics on how best to meet NSF expectations for education, diversity, clearinghouse, and network activities. The date will be set shortly for the next meeting in Spring 2007 and we will move to facilitate the Board's selection of an external Chair. Many Board members have also indicated their willingness to serve as informal consultants to the CNS throughout the year, and we will certainly be taking advantage of this offer. In addition, Board member John Seeley Brown was unable to attend the Board meeting, but he was at UCSB a week earlier for the Board meeting of the Center for Information Technology and Society. PI Harthorn was able to meet and discuss CNS business with him at that time.

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 propose 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 regular 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 valuable 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 engagement program is also providing monthly reports, meeting monthly with all graduate fellows, and will be providing extensive programmatic support to undergraduate interns.

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 Co-Directors maintain oversight of this process. The National Advisory Board (NAB) members are available for consultation on an as needed basis as well, and we will confer with them when additional advice is needed.

There is 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 developing 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 PI and Co-Directors. 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 PI are in near daily consultation about budget matters, and, as needed, with all personnel, subcontractors, and service providers.

Achieve aims

This kind of summative evaluation we plan 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. Senior NSF visitors will be invited to attend these meetings as observers, and, if the NAB is willing, will be free to provide commentary.

Additional summative measures will be drawn at any natural junctures, for example, the completion of a particular research program, or the completion of a round of fellows. Exit interviews will be conducted with all graduate fellows as they complete their fellowships, and follow up of all fellows will be pursued on an annual basis to track effects of their involvement in the CNS program.

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.

CNS-UCSB 2006 Annual Report—Appendix A
2006 Participants

Principal Investigator
Barbara Herr Harthorn, Institute for Social, Behavioral, and Economic Research (ISBER)

Project Directors
Barbara Herr Harthorn, ISBER
Patrick McCray, History

CNS Executive Committee
Richard P. Appelbaum, Sociology and Global & International Studies
Bruce Bimber, Political Science and Communication, Co-PI
Fiona Goodchild, California NanoSystems Institute (CNSI), CNS Associate Director for Education
Barbara Herr Harthorn, ISBER, PI
Evelyn Hu, CNSI and Materials, Electrical and Computer Engineering (ECE), CNS Associate Director for Nanoscience, Co-PI
Patrick McCray, History, Co-PI
Christopher Newfield, English, Co-PI

Senior Personnel: Managers
Marisol Cedillo Dougherty, CNS manager
Meredith Murr, CNS Education Coordinator

Senior Personnel: Social Science and Nanoscience(UCSB unless noted)
Richard P. Appelbaum, Sociology and Global and International Studies
Kevin C. Almeroth, Computer Science
David W. Awschalom, Physics and California Nanosystems Institute
Gerald Barnett, Office for Management of Intellectual Property, UC Santa Cruz
Bruce Bimber, Political Science and Communication
Daniel Blumenthal, Electrical and Computer Engineering
Francesca Bray, Social Anthropology, Edinburgh University, UK
Kwang-Ting (Tim) Cheng, Electrical and Computer Engineering
Bradley F. Chmelka, Chemical Engineering
David Clarke, Professor of Materials
Gary Gereffi, Sociology, Duke University
Fiona Goodchild, CNS and CNSI
Michael F. Goodchild, Geography
Arthur C. Gossard, Materials, Electrical and Computer Engineering
Anita Guerrini, History and Environmental Studies
Elizabeth Gwinn, Physics
Barbara Herr Harthorn, CNS and ISBER
Evelyn Hu, CNSI and Materials, ECE

Milind Kandlikar, Institute for Resources, Environment and Sustainability, University of British Columbia
JoAnn Kuchera-Morin, Media Arts and Technology Program
Timothy Lenoir, Duke University
W. Patrick McCray, History
Umesh Mishra, Electrical and Computer Engineering
Cyrus Mody, Chemical Heritage Foundation
David Mowery, Haas Business and Public Policy, UC Berkeley
Christopher Newfield, American Culture
Laury Oaks, Women's Studies, Anthropology, and Sociology
Michael Osborne, History and Environmental Studies
Nicholas Pidgeon, Social Psychology, Cardiff University, Wales, UK
Tee Rogers-Hayden, Social Psychology, Cardiff University, Wales, UK
Theresa A. Satterfield, Institute for Resources, the Environment, and Sustainability, University of British Columbia
Suzanne Scotchmer, Economics and Public Policy, UC Berkeley
David Seibold, Communication
Ram Seshadri, Materials
Hyongsok (Tom) Soh, Mechanical and Environmental Engineering
Susan C. Stonich, Anthropology, Environmental Studies, Geography, and Interdisciplinary Marine Sciences
Matthew Tirrell, Chemical Engineering and Materials
Wim van Dam, Computer Science

Other Collaborators (UCSB unless noted)
James Blascovich, Social Psychology and Virtual Environments Research Lab
Patricia Holden, Bren School of Environmental Science and Management
Magali Delmas, Bren School of Environmental Science and Management
Nicola Spaldin, Chemistry
Craig Hawker, Materials Research Laboratory and MRSEC
Jim Reichman, NSF Center for Ecological Synthesis and Analysis
John Mohr, UC-AGEP

National Advisory Board members:
Ann Bostrom, Georgia Tech
John Seely Brown, University of Southern California
Craig Calhoun, New York University
Vicki Colvin, Rice University
Ruth Schwartz Cowan, University of Pennsylvania
Susan Hackwood, California Council on Science and Technology
Alan Heeger, University of California, Santa Barbara
Thomas Kalil, University of California, Berkeley
Bruce Lewenstein, Cornell University
Julia Moore, Woodrow Wilson International
Martin Moskovits, University of California, Santa Barbara
Willie Pearson, Jr., University of California, Santa Barbara

Robert Westervelt, Harvard University

Nanotechnology in Society Network:
David Guston, CNS-ASU
Dan Sarewitz, CNS-ASU
Davis Baird, Univ. of South Carolina
Richard Freeman, Harvard Univ. and NBER

Technical personnel
Justin Dodds
Randall Ehren (consultant)
Steve Brown (consultant)

Public Outreach Personnel
Media and communication manager (to be named)

Graduate Research Fellows and Associates (Social Science & NanoScience)
Karl Bryant, Sociology
Yiping Cao, Environmental Science
Hilary Haldane, Anthropology
Mary Ingram, Sociology
Jerry Macala, Chemistry
Rachel Parker, Sociology
Aaron Rowe, Chemistry
Kim Stoltzfus, Communication
Joseph Summers, Electrical and Computer Engineering
David Weaver, Political Science
GIS specialist (to be named)

Other Grads
Ryan Ong, Duke University

Undergraduate Interns
William Bausman, University of California, Santa Barbara
Eric Gianella, Duke University
Gary L. Haddow, University of California, Santa Barbara
Carlos Perez, University of California, Santa Barbara

Community College Interns
Jon Lo Kim Lin
Sarah Schultz

Partner Organizations
Australia National University
Cardiff University (UK)
Chemical Heritage Foundation

Duke University
University of British Columbia
University of California, Berkeley
University of California, Santa Cruz
University of Edinburgh (UK)

Network Institutions
Arizona State University
University of South Carolina
Harvard University/University of California, Los Angeles
Michigan State University
American Institute of Physics
Cornell University/National Nanotechnology Infrastructure Network
International Council on Nanotechnology (ICON)-Rice University
Environmental Defense
Nanoscale Informal Science Education (NISE) network
Woodrow Wilson International Center, Project on Emerging Nanotechnologies
International Risk Governance Council (Switzerland)

Educational Institutions
Santa Barbara City College
Jackson State University
Howard University
University of Southern Florida

Community Partners
In development

CNS-UCSB 2006 Annual Report—Appendix B
CNS-UCSB Network Activities and Presentations (Oct 2005 – Nov 2006)

Even before the CNS-UCSB officially started its activities in January 2006, researchers associated with it have participated in an array of activities that have presented the Center's work – research as well as education and public outreach – to a wider audience. These meetings, presentations, and publications have also served as a means to build the Nanotechnology in Society Network that the National Science Foundation wishes to create.

Research Presentations, Network Meetings, and Conferences Attended (or pending)

Harthorn, Barbara Herr & Newfield, Christopher. "CNS-UCSB," Presentation and participants at the meeting of the International Nanotechnology and Society Network, London, October 17, 2005. (Also attended by Pidgeon, Nick, Satterfield, T., & Rogers-Hayden, T.)

Mody, Cyrus. "Commercializing Probe Microscopy," National Bureau of Economic Research Science & Engineering Workforce Project Workshop, Cambridge, MA. October 20, 2005.

Mody, Cyrus. "Nanotechnology and the Modern University," Society for Social Studies of Science annual meeting, Pasadena, CA. October 21, 2005.

McCray, W. Patrick, attendee, Society for Social Studies of Science annual meeting, Pasadena, CA. October 21, 2005.

Mody, Cyrus. "Commercializing Probe Microscopy," Anthropology colloquium, MIT. October 24, 2005.

Hu, Evelyn. "The Power of the Very Small: Nanoscience Innovation at the CNSI," 2005 Taiwan-American Aeronautics & Space Technology Conference. Oct. 29, 2005.

Mody, Cyrus. "Test Objects and the Materials of Community," Society for the History of Technology annual meeting, Minneapolis, MN. November 4, 2005.

Harthorn, Barbara Herr, McCray, W. Patrick, Appelbaum, Richard, Bimber, Bruce, & Hu, Evelyn; CNS-UCSB and CNS-ASU network meeting, UCSB. Nov. 20, 2005.

Hu, Evelyn. **"**Composing a Life in Nanoscience: A Journey of Discovery**,"** Dec. 14, 2005, Santa Barbara chapter meeting of the AAUW.

Newfield, Christopher. "The University in an Age of Commercial Research: Where will the Bologna Process Take Europe's Universities?," Instituts für Nordamerikastudien, Albert-Ludwig Universität, Freiburg, Berlin, Germany. January 2006.

McCray, W. Patrick. "Forbidding Science? Balancing Freedom, Security, Innovation, and Precaution," Invited panelist for international conference hosted by the Center for the Study of Law, Science, and Technology, Arizona State University. January 12-13, 2006.

Mowery, David. Attendee, Canada-California Strategic Partnership summit, Cross-border research partnerships, including a focus on nanotechnology, Los Angeles, CA. January 12, 2006.

Harthorn, Barbara Herr. "Center for Nanotechnology in Society-UCSB," CNS-ASU launch event, Tempe, AZ. January 30, 2006.

Seibold, David. "Quantitative Measures of Group and Organizational Communication," Presented at the Annual Meeting of the Western States Communication Association. Palm Springs, CA. February 2006.

Appelbaum, Richard, Harthorn, Barbara Herr, McCray, W. Patrick & Newfield, Christopher. "CNS at UC Santa Barbara," presentation to National Science Foundation. February 8, 2006.

Rogers-Hayden, T. Co-organiser, with Dr Ben Anderson, Dr Matthew Kearnes and Dr Rob Doubleday, "Nanotechnologies and Other Emerging Technologies," one day workshop, Durham University. February 10, 2006.

Rogers-Hayden, T. & Pidgeon, N. "Enlarging the Nano Public Engagement Terrain," Nanotechnologies and Other Emerging Technologies Workshop, Durham University. February 10, 2006.

McCray, W. Patrick & Harthorn, Barbara Herr. "The Center for Nanotechnology in Society at UCSB," "Social Science Engages Nanotechnology" panel, American Association for the Advancement of Science, St. Louis, MO. February 17, 2006.

Hu, Evelyn. "Basketballs, Avian Flu and a Flattened World: The Promise of Nanotechnology," Santa Barbara Rotary Club, February 17, 2006.

Harthorn, Barbara Herr & McCray, W. Patrick. "CNS-UCSB," presenters to the College of Letters and Science (Chairs meeting), UCSB. February 23, 2006.

Harthorn, Barbara Herr & Haldane, Hillary. Presenters in Let's Explore Applied Physical Science (LEAPS) seminar, UCSB. February 24, 2006.

Mody, Cyrus. "Constituent Communities and the Creation of Nanotechnology," Invited talk, MIT. February 27, 2006.

Harthorn, Barbara Herr. "What's a Medical Anthropologist Doing Leading a Nanoscale Science and Engineering Center?" Anthropology Department, UCSB. February 28, 2006.

Newfield, Christopher. "Governance and Creativity in Nanoscale Research," Tomorrow's People Conference, Said Business School, University of Oxford. March 2006.

Newfield, Christopher. Meeting with Daniel Sarewitz, CNS-ASU, Said Business School, University of Oxford. March 2006.

Newfield, Christopher. "What is American Business Culture?," Institut de l'études européens, Université de Paris – VIII. March 2006.

Mowery, David. "Academic Patents and Material Transfer Agreements: Complements or Substitutes?" (with A. Ziedonis), presented at the meetings of the Association of University Technology Managers, Orlando, FL. March 2, 2006.

Mowery, David. "Proposition 71 and the 'Bayh-Dole Model,'" presented at the Berkeley Center for Law & Economics conference on Proposition 71, Boalt Hall Law School, UC Berkeley. March 3, 2006.

Hu, Evelyn. "Impossibly Small (?): The Wonders of Nanotechnology," Science and Technology/MESA Day, UC Santa Barbara, March 4, 2006**.**

Mowery, David. "Lessons from the history of federal R&D policy for an 'Energy ARPA,'" written testimony prepared for "Should Congress Establish 'ARPA – E,' the Advanced Research Projects Agency – Energy?" Science Committee, U.S. House of Representatives. March 9, 2006.

Pidgeon, N. "Risk and Uncertainty," Schering-British Council Meeting, British Embassy. March 9, 2006.

Newfield, Christopher. Participant and presenter at "Tomorrow's People," international conference hosted by Oxford University. March 14-17, 2006.

Appelbaum, Richard. "Overview of the proposed work of the Center for Nanotechnology in Society (CNS) at the University of California, Santa Barbara," The US-China Nanotechnology Workshop, NSF, Arlington, VA. March 23-24, 2006.

Barnett, Gerald. "Metrics and Leading Indicators for Collaborative Structures," Bay Area Science and Innovation Consortium, IP Working Group, San Francisco, CA. March 23, 2006.

Harthorn, Barbara Herr. "Understanding Nanotechnology and Societal Change," Professional Development Workshop, Student Affairs Retreat, UCSB. March 23, 2006.

Mowery, David. "University-Industry Research Collaboration and Technology Transfer in the United States since 1980," presented at the SSRC – World Bank symposium on "University-Industry Linkages," Paris. March 27, 2006.

Harthorn, Barbara Herr & Satterfield, Terre. Presentation on Risk Research at the CNS-UCSB, panel on Risk Studies in Applied Anthropology, Society for Applied Anthropology/Society for Medical Anthropology, Vancouver. March 29, 2006.

Goodchild, Fiona. Participant, "DEMOS meeting on Governing at the Nanoscale," meeting at Lancaster University. April 2006.

Seibold, David. "Temporality and Creativity in Groups: Research Program and Prospects," Presented to the Department of Communication, Purdue University, West Lafayette, IN. April 2006.

Rogers-Hayden, T. & Pidgeon, N. "'Upstream' Public Engagement on Nanotechnologies, a new turn in Technology Governance in the UK," Department of Political Science, Life-Science-Governance Research Platform, University of Vienna. April 6, 2006.

Harthorn, Barbara Herr. Presentation on the CNS-UCSB at UCSB Center for Information Technology and Society board meeting, Santa Barbara, CA. April 9, 2006.

Ackland, Robert, O'Neil, Mathieu, Bimber, Bruce, Gibson, Rachel & Ward, Stephen. "New Methods for Studying Online Environmental-Activist Networks," International Sunbelt Social Networks Conference, Vancouver, British Columbia. April 21, 2006.

O'Neil, Mathieu & Ackland, Robert. "The Structural Role of Nanotechnology-Opposition in Online Environmental-Activist Networks," International Sunbelt Social Networks Conference, Vancouver, British Columbia. April 21, 2006.

Mowery, David. "'Nonglobalization' of Innovation? The Semiconductor Industry" (with J. Macher and A. deMinin), presented at the National Academy of Sciences STEP Board conference on Globalization of Innovation, Washington, D.C. April 21, 2006.

Newfield, Christopher. "Intellectual Property and the Creative Process," Atlanta Science and Technology Conference, Georgia Institute of Technology. May 2006.

Newfield, Christopher. Meeting with Arie Rip, University of Twente, Nanodistrict project, Atlanta Science and Technology Conference. May 2006

Newfield, Christopher. Meeting with Phillipe Larédo, l'Ecole des Mines, Paris, Atlanta Science and Technology Conference, May 2006.

Newfield, Christopher. "Creativity and US Business Culture," Institut de l'études européens, Université de Paris – VIII. May 2006.

Newfield, Christopher. "A Game the West Can Win? Innovation, the University, and the High-Tech Economy," Institut de l'études européens, Université de Paris – VIII. May 2006.

Harthorn, Barbara Herr. "CNS-UCSB Overview," Center for Nanotechnology in Society, Public Launch event, UCSB. May 4, 2006

Newfield, Christopher. "Where's My Flying Car?" Center for Nanotechnology in Society, Public Launch event, UCSB. May 4, 2006.

Hu, Evelyn. "'The World is Flat' Nano-Style: Avian Flu, Silver Band-Aids and the Promises of Nanotechnology for Society," Center for Nanotechnology in Society, Public Launch event, UCSB, May 4, 2006.

Harthorn, Barbara Herr, McCray, W. Patrick, Murr, Meredith, Haldane, Hillary & Summers, Joe. "CNS-UCSB," CNS National Advisory Board Meeting, presentations, Upham Hotel, Santa Barbara. May 5, 2006.

Mowery, David. "The Bayh-Dole Act and High-Technology Entrepreneurship in the United States during the 1980s and 1990s," presented at the Kauffman Foundation – Max Planck Gesellschaft conference on Entrepreneurship and Economic Growth, Munich, Germany. May 8–9, 2006.

Pidgeon, N. "The British Nanotechnologies Report and the Case for Upstream Societal Dialogue," VALDOR-2006, Stockholm. May 15-18, 2006.

McCray, W. Patrick. Panelist for Conference on Trading Zones, Interactional Expertise and Interdisciplinary Collaboration, NSF-funded international conference hosted by Arizona State University. May 21-25, 2006.

Harthorn, Barbara Herr. "How Do We Identify the Publics to be Engaged in Nanotechnology?" Plenary presentation, National Nanotechnology Coordinating Office, Public Participation workshop, Arlington, VA. May 30-31, 2006.

Hu, Evelyn. "Frontiers of Nanotechnology," American Institute of Physics 75th Anniversary, Diverse Frontiers of Science Symposium**,** June 3, 2006.

Newfield, Christopher. Meeting with Alfred Nordmann, Technische Universität Darmstadt, Cité des Science et de l'Industrie, Paris. June 2006.

Newfield, Christopher. Meetings with Philip Shapira and Thomas Heinze, Georgia Tech and the Fraunhofer ISI, Karlsruhe, Germany. June 2006.

Harthorn, Barbara Herr. "Studying Nanotechnology and Society at UCSB," Chancellor's Community Breakfast, Cabrillo Arts Center, Santa Barbara. June 9, 2006.

McCray, W. Patrick. "Much Ado About Next to Nothing? Making Policies for our Nano-Future," Chancellor's Community Breakfast, Cabrillo Arts Center, Santa Barbara. June 9, 2006.

Barnett, Gerald. "Information and Invention," AUTM Software and Digital Media Course, Pittsburgh, PA. June 23, 2006.

Rogers-Hayden, T. & Pidgeon, N. "Nano Jury UK: the 'Evaluators' Perspective," Guest workshop participant, Citizen Participation in Science and Technology: How to Design and Organize Deliberation, Citizen Participation in Science and Technology (CIPAST) Dresden. June 26-28, 2006.

Barnett, Gerald. "Tech Transfer: New Models in University Innovation," panelist, The Venture Forum 2006, San Jose, CA. June 28, 2006,

Appelbaum, Richard & Gereffi, Gary. "From Cheap Labor to High-Tech Leadership: Will China's Investment in Nanotechnology Pay Off?," conference of the Society for the Advancement of Socioeconomics, Trier, Germany. June 30-July 2, 2006.

Pidgeon, Nick. Participant, International Risk Governance Council, conference on Nanotechnology Risk Governance, Zurich, Switzerland. July 6-7, 2006.

McCray, W. Patrick. “Impact of Nanotechnology in Society,” UCSB EPSEM seminar. July 19, 2006.

Harthorn, Barbara Herr. “Nanotechnology and Society,” UCSB RISE program. August 1, 2006.

Seibold, David. "Structuration and Group Communication," conference of the International Network for Group Research, Pittsburgh, PA. July 2006.

Bimber, Bruce. “Nanotechnology and Social Movements,” Plenary Address, Societal Impacts of Nanotechnology Conference, Australian National University, Canberra, Australia. Aug 3-4, 2006.

Bimber, Bruce. “Nanotechnology and Public Policy: Reports from the Field,” Roundtable Panelist, Annual Meeting of the American Political Science Association, Philadelphia, Aug. 31, 2006.

McCray, W. Patrick. Participant, Gordon Conference, Big Sky, Montana. Aug 13-18, 2006.

Rogers-Hayden, T. & Pidgeon, N. “Reflecting upon the First Citizens’ Jury on Nanotechnology, *Nano Jury UK*” Reviewing Humanness: Bodies, Technologies and Spaces, European Association for the Study of Science and Technology (EASST) Conference, University of Lausanne. August 23-26, 2006.

Rogers-Hayden, T. & Pidgeon, N. “Creating the Future through Public Engagement on Nanotechnologies,” Future Matters: Futures Known, Created and Minded, Cardiff University. September 4-6, 2006.

Harthorn, Barbara Herr & Rogers-Hayden, T. Co-Chairs/Co-Organizers, Risk Perceptions and Social Responses to Emerging Nanotechnologies, session at the Society for Social Studies of Science (4 S), Vancouver. November 2-4, 2006 (pending).

Bimber, Bruce & Weaver, David A. “Framing Nano in the News,” Annual Meeting of Society for Social Studies of Science (4 S), Vancouver. November 2-4, 2006 (pending).

Harthorn, Barbara Herr & Haldane, Hillary. “Risk and Responsibility: How Nanoscientists and Engineers View the Nano-enterprise,” Society for Social Studies of Science (4S), Vancouver. Nov 2-4, 2006 (pending).

Rogers-Hayden, T. & Pidgeon, N. “Deliberating Emerging Nanotechnologies in the UK and Beyond,” Society for Social Studies of Science (4 S), Vancouver. November 2-4, 2006 (pending).

Satterfield, Terre, and Kandlikar, Milind. “Expert Judgments of Public Perceptions: How Well Do They Know their Audience?” Society for Social Studies of Science (4S), Vancouver. Nov 2-4, 2006 (pending).

Harthorn, Barbara Herr. Discussant, CNS-ASU panel at American Association for the Advancement of Society meetings, San Francisco, Feb 15-19, 2007 (pending).

CNS-UCSB 2006 Annual Report—Appendix C
Publications and Reports by CNS Researchers (Fall 2005 - Jun 2006)

McCray, W. Patrick. "Will Small Be Beautiful? Making Policies for Our Nanotech Future." *History and Technology* 21, 2 (2005): 177-203.

Rogers-Hayden, T. & Pidgeon N. Reflecting on the First Citizens' Jury on Nanotechnology: Nano Jury UK. *Small Times* December (2005).

Harthorn, Barbara Herr, McCray, Patrick & Satterfield, Terre. "Anthropological Research at the UCSB Center for Nanotechnology in Society," *Practicing Anthropology* (special issue on nanotechnology) 28, 2 (2006): 38-40.

Mody, Cyrus C.M. "Corporations, Universities, and Instrumental Communities: Commercializing Probe Microscopy, 1981-1996." *Technology and Culture* 47, 1 (2006): 56-80.

Mody, Cyrus C.M. "Nanotechnology and the Modern University." *Practicing Anthropology* (special issue on nanotechnology) 28 (2006): 23-27.

Mowery, David "Defense-Related R&D and the Growth of the Postwar Information Technology Industrial Complex in the United States" (with K. Fabrizio), *Revue Economique Industrielle*, 2006.

Newfield, Christopher. "Nano-Punk for Tomorrow's People," Commentary on the Tomorrow's People Conference, James Martin Institute, Said Business School, Oxford University March 2006; on line at http://www.cns.ucsb.edu/filestore/Newfield%20Nano-punk%20report.pdf

Rogers-Hayden, T. & Pidgeon, N. "Reflecting upon the UK's Citizens' Jury on Nanotechnologies: *Nano Jury UK*." *Nanotechnology Law and Business* 2, 3 (2006):167-178.

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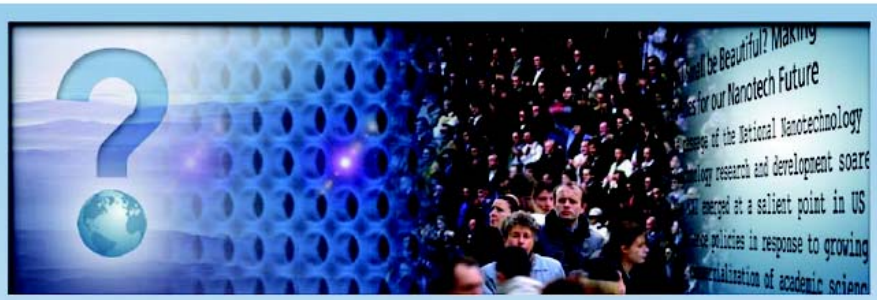


You Are Invited to Attend the Public Launch Event for the

UCSB

Center for Nanotechnology in Society

May 4, 2006
4:00 – 5:30 PM
Engineering Science Building, Room 1001

Chancellor Henry T. Yang
Welcome and Introduction

Dr. Barbara Herr Harthorn
CNS Principal Investigator and Co-Director
Overview of CNS and Acknowledgments

Dr. Christopher J. Newfield
Professor, English Department and CNS Co-PI
Where's My Flying Car?

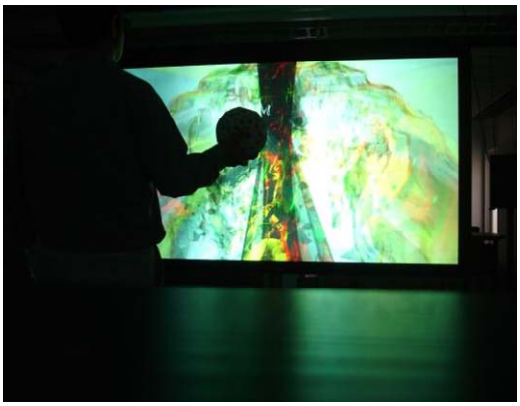
Dr. Evelyn Hu
Director, California NanoSystems Institute
'The World is Flat' Nano-style: Avian Flu, Silver Band-Aids and the Promises of Nanotechnology for Society

Featured Speaker
RICHARD HARRIS
Science Correspondent, National Public Radio
Nanotechnology: More than Just a Buzzword?

Public reception immediately following

In conjunction with the launch of the UCSB Center for Nanotechnology in Society

A Virtual Immersive Model of the Nano World: Scientific Data Visualization Demonstration



Thursday, May 4, 2006
3:00 - 4:00 PM and 5:30 - 6:45 PM
Engineering Science Building, Room 2001

Professors JoAnn Kuchera-Morin and Xavier Amatriain
Director and Co-Director, Media Arts and Technology Initiatives
and
Professor Marcos Novak, Media Arts and Technology

In this demonstration MAT faculty and students will preview he experience in the UCSB California NanoSystems Institute's "Allosphere," a 3-story high multi-user immersive laboratory still under construction. In this demonstration, multi-channel audio, stereoscopic projection, and wireless interactive controllers are used to allow visualization of scientific data, including brain scan images and nanoscale materials.

Graduate Research Fellowships in Science and Engineering

Center for Nanotechnology in Society
University of California, Santa Barbara

2006-2007

Do you ever wonder how nanotechnologies might change society?

The Center for Nanotechnology in Society at the University of California, Santa Barbara (CNS-UCSB) announces several fellowship opportunities for outstanding graduate students pursuing research in science and engineering who have interest in examining the societal issues relating to nanotechnology. CNS-UCSB researchers are engaged in several areas of inquiry including:

- the historical context of nanotechnologies;
- innovation, intellectual property and globalization;
- risk perception, political activism, and public communication.

These graduate fellowships are intended for science and engineering graduate students currently enrolled at UCSB. The fellows will be funded half-time (25%) and will pursue research with CNS faculty to examine the societal issues of nanotechnology concurrently with their science and engineering research. All CNS Fellows will engage in research methodologies and educational opportunities that will further their professional development. All graduate fellows will be sponsored by a faculty member who is affiliated with the Center. The fellowship will provide up to $12,500 for a 6-12 month appointment.

Please visit our website for complete information and application materials
http://www.cns.ucsb.edu/education.html
Or e-mail Meredith Murr, CNS Academic Coordinator at murr@cns.ucsb.edu

Application Deadline is March 1st, 2006

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Graduate Research Fellowships in
Social Sciences and Humanities

Center for Nanotechnology in Society
University of California, Santa Barbara

2006-2007

Do you ever wonder how nanotechnologies might change society?

The Center for Nanotechnology in Society at the University of California, Santa Barbara (CNS-UCSB) announces several fellowship opportunities for outstanding graduate students pursuing research in the social sciences and humanities. CNS researchers are engaged in several areas of inquiry including:

- the historical context of nanotechnologies;
- innovation, intellectual property and globalization;
- risk perception, political activism, and public communication.

Graduate fellows will be in residence at UCSB and expected to interact with faculty, researchers, and other students at the CNS-UCSB. CNS Graduate Fellows will be sponsored by a faculty member who is affiliated with the Center. All Fellows will engage in research methodologies and educational opportunities that will further their own professional development. The fellowship will provide up to $25,000 for a 6-12 month period of residence at the CNS-UCSB.

Please visit our website for complete information and application materials
http://www.cns.ucsb.edu/education.html
Or e-mail Meredith Murr, CNS Academic Coordinator at murr@cns.ucsb.edu

Application Deadline is March 1st, 2006

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Undergraduate Summer Research Internships

Center for Nanotechnology in Society
University of California, Santa Barbara

Program Dates: June 26- August 18, 2006

Have you ever wondered how nanotechnologies might change society?

The Undergraduate Summer Research Internships in the Center for Nanotechnology in Society (CNS) bring science, engineering, and social science majors to UCSB for a summer research experience. Interns are individually matched with a mentor and gain first-hand experience investigating the societal impacts of nanotechnology with top researchers in the country. Interns also attend weekly meetings, special seminars and develop presentation skills.

- **Internships will be awarded in the areas of nanotechnology and social science to current UCSB undergraduates**
- **The stipend for undergraduate interns is $2,800 total for 8 weeks**
- **We will provide up to $800 for housing expenses**

Please visit our website for complete information and application materials
http://cns.ucsb.edu/education.html
Or e-mail Meredith Murr, CNS Academic Coordinator at murr@cns.ucsb.edu

Application Deadline is March 31st, 2006

NSF | CNS UC SANTA BARBARA | NATIONAL NANOTECHNOLOGY INITIATIVE | UCSB UC SANTA BARBARA