The Center for Nanotechnology in Society
ARIZONA STATE UNIVERSITY

The Center for Nanotechnology in Society at Arizona State University

NSF #0531194

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Annual Report for the Period
October 1, 2009 to September 30, 2010

This report includes work conducted at nine collaborating universities of NSEC/CNS-ASU: Arizona State University, Georgia Institute of Technology, North Carolina State University, Rutgers, The State University of New Jersey, University of California-Berkeley, University of Colorado-Boulder; University of Georgia, University of New Hampshire, and the University of Wisconsin-Madison.

2. Table of Contents

3. Project Summary

The Nanoscale Science and Engineering Center/Center for Nanotechnology in Society at Arizona State University (NSEC/CNS-ASU) combines research, training, and engagement to develop a new approach to governing emerging nanotechnologies. CNS-ASU uses the research methods of "real-time technology assessment" to enable anticipatory governance through enhanced foresight capabilities, engagement with lay publics, and integration of social science and humanistic work with nanoscale science and engineering research and education.

CNS-ASU has two types of integrated research programs, as well as educational and outreach activities (that are themselves integrated with research). Its real-time technology assessment programs are: RTTA 1, Research and Innovation Systems Assessment, which uses bibliometric and patent analyses to understand the evolving dynamics of the NSE enterprise; RTTA 2, Public Opinion and Values, which uses surveys and quasi-experimental media studies to understand changing public and scientists' perspectives on NSE; RTTA 3, Anticipation and Deliberation, which uses scenario development and other techniques to foster deliberation on plausible NSE applications; and RTTA 4, Reflexivity and Integration, which uses participant-observation and other techniques to assess the Center's influence on reflexivity among NSE collaborators. Second, the thematic research clusters (TRCs), which pursue fundamental knowledge and create linkages across the RTTAs, are: TRC 1, Equity and Responsibility; and TRC 2, Human Identity, Enhancement, and Biology.

The Center's major conceptual-level achievement has been validating anticipatory governance as a richly generative strategic vision. Its three major operations-level achievements are: 1) completing the "end-to-end" assessment for TRC 2 by linking multiple RTTA capacities to create novel insights in a study of nanotechnology and the brain; 2) deepening the integration of NSE researchers into CNS-ASU; and 3) building collaborations for informal science education (ISE) on the societal aspects of NSE. Programmatic achievements include: establishing an internationally adopted definition of nanotechnology to assemble and mine bibliographic and patent databases; conducting two national public opinion polls and a poll of leading nano-scientists; conducting the first National Citizens' Technology Forum on nanotechnologies for human enhancement; demonstrating that interactions between NSE researchers and social scientists can generate more reflexive decisions; sustaining an international research program on NSE and equity; exploring views and capacities of human nanotechnologies; and laying the foundations for a new research program in urban design, materials and the built environment.

The Center's principal **intellectual merit** derives from the large-scale, interdisciplinary ensemble that underpins it. The ability to embrace and facilitate interactions among disparate approaches to understanding nanotechnologies, and build complementary capacities to tap that knowledge for governance, is the critical intellectual contribution to which CNS-ASU aspires. Both in terms of publications and citations, the Center's work has a substantial impact on scholarship. For **broader impact**, the Center has coupled research, education, and outreach activities exceptionally well by training significant numbers of new scholars from the social sciences and NSE, incorporating forefront research in new courses and ISE opportunities, and returning lessons learned and techniques developed for outreach back to the classroom. The Center has broadened the participation of under-represented groups by cultivating junior scholarship and raising issues of equity, gender, and disability as objects of programmatic study. The Center has enhanced the infrastructure for research and education by organizing community-defining conferences, producing community-defining sources of knowledge, serving as an international hub for dozens of scholars, sharing data and instruments widely, and disseminating its results aggressively to its academic peers as well as to public, scientific, industry, and policy audiences.

4. List of Center Participants, Advisory Boards, and Participating Institutions

4. (a) LIST OF CENTER PARTICIPANTS

Participants receiving Center support:

ASU

Braden Allenby	**Professor**	**Civil & Environmental Engineering**
Daniel Barben	**Assistant Research Professor**	**Consort. for Science, Policy, & Outcomes**
George Basile	**Executive Director**	**Decision Theatre for a Desert City**
Ira Bennett	**Assistant Research Professor**	**Consort. for Science, Policy & Outcomes**
Philip Bernick	Assistant Professor	English
Prasad Boradkar	**Associate Professor**	**Industrial Design**
Heather Canary	Associate Professor	Humanities & Arts
Marilyn P. Carlson	**Professor**	**Mathematics & Statistics**
Nalini Chhetri	**Lecturer**	**Letters & Sciences**
Netra Chhetri	**Assistant Professor**	**Consort. for Science, Policy, & Outcomes**
David Conz	**Assistant Research Professor**	**Interdisciplinary Studies**
Elizabeth Corley	**Associate Professor**	**Public Affairs**
Kevin Corley	Assistant Professor	Management
Rodolfo Diaz	Professor	Electrical Engineering
Chris Diehnelt	Professor	Biodesign Institute
Gary Dirks	**Director**	**LightWorks**
Thomas Duening	Director	Entrepreneurial Programs
Karin Ellison	Associate Director	Biology & Society
Scott Endsley	Vice President	System Design for Quality Improvement
Sandy Epstein	**Sr. Mgr. Strategic Bus. Dev.**	**Decision Theatre**
Timothy Eschrich	**Process Engrg. Manager**	**Ctr. for Solid State Electronics Research**
Mahmud Farooque	**Associate Director**	**Consort. for Science, Policy, & Outcomes**
Tricia Farwell	Professor	Journalism & Mass Communication
Adelheid Fischer	**Staff**	**Innovation Space**
Erik Fisher	**Assistant Professor**	**Political Science**
Matthew Fraser	**Associate Professor**	**Sustainability**
Joel Garreau	**Lincoln Professor of Law**	**Law**
Jay Golden	**Assistant Professor**	**Sustainability**
Stephen Goodnick	**Professor**	**Electrical Engineering**
Devens Gust	**Professor**	**Chemistry & Biochemistry**
David H. Guston	**Professor**	**Political Science**
Ed Hackett	**Professor**	**Human Evolution & Social Change**
Jiping He	Professor	Bioengineering
Renata Hejduk	Assistant Professor	Architecture & Landscape Architecture
Stephen Helms Tillery	Assistant Professor	Bioengineering
Mark Henderson	Professor	Engineering
Joseph Herkert	**Associate Professor**	**Humanities & Arts**
James Hershauer	Professor	Management
Mary Ingram-Water	Lecturer	Barrett Honors College
Paul Johnson	**Executive Dean**	**Engineering**
Stephen Johnston	Professor	Biodesign Institute
Kamil Kaloush	**Associate Professor**	**Sustainable Engrg. & Built Environment**
Sayfe Kiaie	**Associate Dean**	**Engineering**
Anatoli Korkin	Director	Research & Economic Affairs

Joe Kullman	**Media Relations Officer**	**Marketing & Public Affairs**
Timothy Lant	**Assistant Research Professor**	**Decision Theatre for a Desert City**
Nancy Levinson	Director	College of Design
Stuart Lindsay	**Regents Professor**	**Biodesign Institute**
Jose Lobo	**Associate Professor**	**Sustainability**
Farzad Mahootian	**Lecturer**	**Letters & Sciences**
George Maracas	**Research Professor**	**Electrical Engineering & Sustainability**
Gary Marchant	**Professor**	**Law**
Joan McGregor	Professor	Philosophy
Chad McAllister	Staff	Chemistry & Biochemistry
Clark A. Miller	**Associate Professor**	**Political Science**
Tom Moore	**Professor**	**Chemistry & Biochemistry**
Torin Monahan	Assistant Professor	Justice & Social Inquiry
Robert Pahle	**Assistant Research Professor**	**Decision Theatre for a Desert City**
Mookesh Patel	Associate Professor	Visual Communication Design
Patrick Phelan	Professor	Engineering
S. Thomas Picraux	Professor	Materials Research
Jonathan Posner	**Assistant Professor**	**Mechanical & Aerospace Engineering**
George Poste	Chief Scientist	Complex Adaptive Systems Initiative
Paul Privateer	Associate Professor	Film & Media Studies
B. Ramakrishna	Associate Professor	Materials
Wellington Reiter	Dean	College of Design
Barry Ritchie	Professor	Physics
Bruce Rittman	**Regents Professor**	**Chemical Engineering**
Jason S. Robert	**Associate Professor**	**Life Sciences**
Daniel R. Sarewitz	**Professor**	**Science & Society**
Anne Schneider	Professor	Justice & Social Inquiry
Dawn Schwenke	**Research Professor**	**Health Management & Policy**
Cynthia Selin	**Assistant Research Professor**	**Consort. for Science, Policy, & Outcomes**
RF (Rick) Shangraw	**Vice President**	**Research & Economic Affairs**
Trevor Thornton	**Professor**	**Electrical, Computer, & Energy Engineering**
Michael Tracy	Director	Center for Cancer Research
Wim Vermass	**Professor**	**School of Life Sciences**
Qiangbin Wang	Professor	Biodesign Institute
Paul Westerhoff	Professor	Civil, Environmental, Sustainable Engrg.
Jameson M. Wetmore	**Assistant Professor**	**Human Evolution & Social Change**
Roxanne Wheelock	**Staff**	**International Letters & Cultures**
Philip White	**Professor**	**Industrial Design**
Arnim Wiek	**Assistant Professor**	**Sustainability**
Joann Williams	Professor	Chemistry & Biochemistry
Neal Woodbury	**Professor**	**Chemistry & Biochemistry**
Frederick Zenhausern	Professor	Biodesign Institute

Collaborators

Roger Angel	**Univ. of AZ, Regents Prof.**	**Astronomy**
Peter Asaro	Rutgers, Assistant Professor	Philosophy
Ardeth Barnhart	**Univ. of AZ, Co-Director**	**AZ Research Institute for Solar Energy**
Deborah Bassett	**Univ. of WA, Dir Social Stud.**	**Workforce Development**
Larry Bell	**Director**	**Museum of Science**
Marianne Boenink	**Univ. of Twente, Lecturer**	**Philosophy**
Line Bonneau	**Said Bus. School, Res. Fellow**	**Science, Innovation and Society**

Jason Borenstein	Georgia Tech, Professor	Philosophy, Science & Technology
Barry Bozeman	**Georgia, Professor**	**Public Administration & Policy**
Donald Braman	George Washington, Prof.	Law
Dominique Brossard	Wisconsin, Asst. Professor	Journalism & Mass Communication
Thomas Chermack	**Colorado, Asst. Professor**	**Organizational Performance & Change**
Michael Chorost	Author	
Jennifer Cleary	**Rutgers, Sr. Project Mgr.**	**Planning & Public Policy**
Michael D. Cobb	**NCSU, Associate Professor**	**Political Science**
Christopher Coenen	**Offc. Technology Assessment**	**German Parliament**
Napier Collyns	**Co-Founder**	**Global Business Network**
Joseph Conti	American Bar Foundation	Law
Susan Cozzens	**Georgia Tech, Professor**	**Public Policy**
Wendy C. Crone	Wisconsin, Professor	Engineering Physics
Marian Deblonde	**Antwerp, Researcher**	**Environment & Sustainable Development**
Bruna De Marchi	Mass Emergencies Programme	Inst. of International Sociology of Gorizia
Peter deLeon	Colorado, Denver, Professor	Public Affairs
Terry Devitt	Wisconsin, Science Writer	Science & Technology
Fanie Duvenghuge	Manager	Microchip
Sharon Dunwoody	**Wisconsin, Professor**	**Journalism & Mass Communication**
Shirin Elahi	**Scenario Architect**	**Complex Global Risks**
Kevin Elliott	**South Carolina, Assoc. Prof.**	**Philosophy**
Elizabeth Farrell	New Hampshire, Coord.	Culture & Sustainability, Food & Society
James Faubion	**Rice, Professor**	**Anthropology**
A. Fernandez-Ribas	**Georgia Tech**	**Public Policy**
Aaron Fichtner	**Rutgers, Director**	**Research & Evaluation**
Ulrich Fiedeler	**Austrian Academy of Science**	**Institute of Technology Assessment**
Guillermo Foladori	Universidad de Zacatecas	Nanotechnology
Silvio Funtowicz	**European Commission**	**Protection & Security of the Citizen**
Joan Fujimura	Wisconsin, Professor	Sociology
Hans Glimell	**Gothenburg, Professor**	**Sociology**
Lieve Goorden	**Antwerpen, Professor**	**Millieu & Technologieman**
Michael Gorman	**Virginia, Professor**	**Science, Technology and Society**
Stuart Graham	Georgia Tech, Professor	Management
David Grimshaw	Head of International Prog.	Practical Action
Patrick Hamlett	NCSU, Associate Professor	Science, Technology & Society
Keishiro Hara	**Osaka, Assoc. Professor**	**Research Inst. For Sustainability Science**
Barbara Harthorn	California, Santa Barbara	Director, CNS-UCSB
Brad Herring	**Mus. of Life Science, Director**	**Nanoscale Informal Science Education**
Linda Hogle	Wisconsin, Associate Professor	Medical History & Bioethics
Rachelle Hollander	Executive Director	National Academy of Engrg.
Maja Horst	**Copenhagen Business School**	**Politics & Philosophy**
Leigha Horton	**Performer**	**Science Museum of Minnesota**
Maurizio Iacopetta	Georgia Tech, Assistant Prof.	Economics
Helen Ingram	California-Irvine, Professor	Planning, Policy, and Design
Noela Invernizzi	Federal University of Parana	Development Studies
Alan Irwin	**Copenhagen Business School**	**Research**
Deborah Johnson	Virginia, Professor	Science, Technology & Society
Dan M. Kahan	Yale, Professor	Law
Thomas Kelly	New Hampshire, Professor	Office of Sustainability
Eun-sung Kim	**Wisconsin, Asst. Professor**	**Science & Technology**
Kamilla Kjolberg	**Bergen, Research Fellow**	**Study of the Sciences and Humanity**

Daniel Kleinman	Wisconsin, Professor	Rural Sociology
Mark Knell	Norwegian Institute	Chemistry
Margaret Kosal	**GA Tech, Asst. Professor**	**International Strategy, Technology & Policy**
Lotte Krabbenborg	**Groningen, Faculty**	**Science and Society**
Kristen Kulinowki	Executive Director	Rice University
Frank Kusiak	**California-Berkeley**	**Science**
Jennifer Kuzma	**Minnesota, Assoc. Professor**	**Public Affairs**
Frank Laird	Colorado, Professor	International Studies
Stephanie Long	**Mgr., Public Prog. & Science**	**Science Museum of Minnesota**
Michael Lynch	Cornell, Professor	Science & Technology
Roop Mahajan	Virginia Tech, Director	Critical Technology & Applied Science
Jim Malone	Physician	Private Practice
Catherine McCarthy	**Project Leader**	**Science Museum of Minn.**
Sheila McNamee	New Hampshire, Professor	Communication
Evan Michelson	Senior Research Associate	Rockefeller Foundation
Laurence Miller	Physician	Mayo Clinic – Scottsdale
Robert J. Milligan	Physician	Physician Services Group
Bastien Miorin	**Grenoble**	**Institut d'Etudes Politiques**
Carl Mitcham	**CO School of Mines, Prof.**	**Liberal Arts & International Studies**
Julia A. Moore	Deputy Director	Woodrow Wilson Center
Webb Myers	**STIP Associate**	**Intelligent Info. Services Group**
Alan Nelson	**Director**	**Biodesign Institute**
Nils Newman	**STIP Associate**	**Intelligent Info. Services Group**
Dean Nieusma	Rensselaer Poly. Inst., Prof.	Science & Technology Studies
Rune Nydal	**Norwegian Univ. Associate**	**Science & Technology**
Rae Ostman	**National Collab., Director**	**Sciencenter**
Krsto Pandza	Leeds Univ., Senior Lecturer	Business
Shobita Parthasarathy	Michigan, Assistant Professor	Public Policy
Alice Pawley	Assistant Professor	Purdue University
Angela G. Pereira	**Eur. Comm., Scientific Offc.**	**Joint Research Centre**
Sarah Pfatteicher	Assistant Dean	Wisconsin, Madison
Mark Philbrick	California-Berkeley	Public Policy
Roger Pielke, Jr.	Colorado, Professor	Environmental Studies
Kenneth Pimple	Indiana, Professor	Religious Studies
Alan Porter	**Georgia Tech, Professor**	**ISYE & Public Policy**
R. Queralto Moreno	Univ. of Seville, Professor	Ethics & Political Philosophy
Paul Rabinow	California, Berkeley, Prof.	Social Cultural Anthropology
Khan Rahi	Loka Institute, Staff	Community Research Network
Jerome Ravetz	**Said Bus. Sch., Assoc. Fellow**	**Science, Innovation & Society**
Christine Reich	Assistant Director	Museum of Science
David Rejeski	Director	Woodrow Wilson Center
Arie Rip	Univ. of Twente, Professor	Science & Technology Studies
H. Rodriguez Zabaleta	**Univ. del Pais Vasco**	**Automatic Control & Systems Engineering**
Juan Rogers	**Georgia Tech, Assoc. Prof.**	**Public Policy**
Dale Rothman	**Denver, Assoc. Prof.**	**International Futures**
Alan Rubel	Greenwall Fellow	Georgetown Univ. Law Ctr.
Dietram Scheufele	**Wisconsin, Professor**	**Life Sciences Communication**
Jennifer Schneider	CO Schl. of Mines, Asst. Prof.	Liberal Arts & International Studies
John Selsky	**Univ. South Fl., Assoc. Prof.**	**Management**
Philip Shapira	**Georgia Tech, Professor**	**Public Policy**
Laurel Smith-Doerr	Program Director	National Science Foundation

Joe Spencer	Production Manager	ALD NanoSolutions
Nicholas Steneck	Professor	University of Michigan
Karl Stephan	Associate Professor	Texas State University
Roger Strand	**Bergen, Professor**	**Science Theory**
Michael Sullivan	Director	Hispanic Research Center
Tsjalling Swiersta	**Twente, Professor**	**Philosophy**
Albert Teich	Director	AAAS
Julia Trosman	Director	Center for Business Models
Rinie van Est	Coordinator	Rathenau Institute
Carl Van Horn	**Rutgers, Professor**	**Planning & Public Policy**
Jue Wang	Florida Intl., Asst. Prof.	Religious Studies
Fern Wickson	**Bergen, Associate Professor**	**Study of Science & Humanity**
Matthias Wienroth	**Durham, Research Assoc.**	**Geography**
David Winickoff	California, Berkeley, Prof.	Bioethics & Society
Gregor Wolbring	**Univ. of Calgary, Asst. Prof.**	**Bioethics, Culture, and Disabilities**
Edward Woodhouse	Rensselaer Poly. Inst., Prof.	Science & Technology Studies
John Wooding	Massachusetts, Lowell, Prof.	Economic & Social Development
Charyl Yarbrough	Rutgers, Project Director	Workforce Development
Jan Youtie	**Georgia Tech, Sr. Research.**	**Enterprise Innovation Institute**
G. Zenner Petersen	**Wisconsin-Madison, Dir. Ed.**	**Materials Research Science & Engineering**

ASU
Post-Doctoral Scholars

Troy Benn	**Post-doctoral Fellow**	**Civil & Environmental Engineering**
Doe Daughtrey	Post-doctoral Fellow	Religious Studies
Matthew Harsh	**Post-doctoral Fellow**	**Consort. for Science, Policy, & Outcomes**
Sean Hays	**Post-doctoral Fellow**	**Political Science**
Anastasios Panaretos	Post-doctoral Fellow	Electrical Engineering
Cathy Slade	**Post-doctoral Fellow**	**Public Policy**
Berea Williams	**Post-doctoral Fellow**	**Chemistry & Biochemistry**

ASU
Graduate Researchers

Judd Anderman		**Science & Technology Policy**
Parul Agrawal		Materials Science & Engineering
Rebecca Allen		**Biodesign Institute**
Derrick Anderson		**Public Policy**
Ceyhan Beckham		**Electrical Engineering**
Monamie Bhadra		**Human & Social Dimensions of S & T**
Shreya Bhattacharyya		**Chemistry**
Bradley Brennan		**Chemistry & Biochemistry**
Antonio Calleja-Lopez	**University of Seville**	**Political Science**
Shannon Conley		**Political Science**
Jessica Corman		**Biology**
Shannon DiNapoli		Life Sciences
Ajit Dhamdhere		**Nanoscience**
Ariana Fox		**Biology**
Jinglin Fu		**Chemistry & Biochemistry**
Aixa Garcia-Mont		Education
Manuel Garay Valenzuela		**Education Leadership & Policy Studies**
Sandeep Kaur Gill		**Nanoscience**

Cesar Gonzalez Esquer		**SOLS Graduate Programs**
Kelly Hale		**Anthropology**
Dongran Han		**Chemistry**
Keivon Hobeheidar		**Biological Sciences**
Qian Hu		**Public Affairs**
Nate Hisamura		Mathematics
Taylor Jackson		Biology & Society
Lijing Jiang		Chemistry & Biochemistry
Craig Jolley		Biophysics
Punarvasu Joshi		**Electrical Engineering**
Tomasz Kalinowski		**Biological Design**
Risto Karinen		Political Science
Ashley Kibel		Physics
Byoungyoon Kim	**Rensselaer Poly. Institute**	**Science & Technology**
Phani K. Kondapani		**Nanoscience**
Jason Lappe		Chemistry and Biochemistry
Jonathan Lappen		**Geography**
William Lepkowski		**Chemistry & Biochemistry**
Shannon Lidberg		**Human & Social Dimensions of S & T**
Beate-Josefine Luber	University of Bielefeld	Graduate Student
Yi Lai Christine Luk		**Human & Social Dimensions of S & T**
Christopher Madden		**Chemistry & Biochemistry**
Sharlissa Moore		**Human & Social Dimensions of S & T**
Vicki Moore		**Chemistry & Biochemistry**
Romarie Morales		**Applied Mathematics**
Tracy Niday		**Chemistry**
Christina Nulle		Global Technology Development
Azra Panjwani		Mathematics
John Parsi		Political Science
Alicia Rodgers		**Science & Technology Policy**
Jennifer Rogers	California, Santa Barbara	Graduate Student
Kehinde Salau		**Mathmatics & Statistics**
Daan Schuurbiers	**Delft Technical University**	**Biology & Society**
Cyndy Schwartz		**Human & Social Dimensions of S & T**
Jaswinder Scharma		Biomedicine
Nisha Sherma		**Chemistry**
Quinn Spadola		Physics
Francois Thoreau	**University of Liege**	**Political Science**
Justin Tosi		Political Science
Brenda Trinidad		**Human & Social Dimensions of S & T**
Yusuf Tufail		**SOLS Graduate Programs**
Walter Valdivia		**Public Administration**
Oriol Vidal Aparicio		Political Science
Jennifer Watkins		**Chemistry & Biochemistry**
Jinglei Zhang		**Chemistry & Biochemistry**

Affiliated
Post-Doctoral Scholars

Sarah Davies	**Durham University**	**Geography**
Jason Delborne	Wisconsin	Rural Sociology
Sonia Gatchair	**Georgia Tech**	**Public Policy**

Eun Syung Kim	**Wisconsin**	**Sociology**
Padraig Murphy	**Dublin City University**	**Communication**
Debasmita Patra	**Cornell**	**Communication**
Ramya Rajagopalan	Wisconsin	Sociology
Elena Simakova	**Cornell**	**Science & Technology Studies**
Jue Wang	**Georgia Tech**	**Public Policy**

Affiliated Graduate Researchers

Ashley Anderson	**Wisconsin**	**Biomedical Engineering**
Ravtosh Bal	Georgia Tech, Georgia State	Public Policy
Javiera Barandiaran	California, Berkeley	Environmental Sciences
Amy Barr	New Hampshire	Sociology
Noel Benedetti	**Wisconsin**	**Life Sciences Communication**
Gaymon Bennett	California, Berkeley	Systematic Theology
Ajay Bhaskarabhatla	Georgia Tech	Public Policy
Stephen Carley	**Georgia Tech**	**Public Policy**
Kajsa Dalrymple	**Wisconsin**	**Public Policy**
Julie Dillemuth	California, Santa Barbara	Geography
Anthony Dudo	**Wisconsin**	**Journalism & Mass Communication**
Paul Ellwood	**Leeds Univ. Business School**	**Business**
A. Fernandes-Ribas	Georgia Tech	Public Policy
Jason Gallo	Northwestern	Media, Technology & Society
Reynold Galope	**Georgia Tech**	**Public Policy**
Harmeet Ghandi	**Georgia Tech**	**Quantitative & Computational Finance**
John Garner	**Georgia Tech**	**Computing**
Ying Guo	**Beijing Institute of Tech.**	**Political Science**
Birgitte Hansen	**Copenhagen Business School**	**Management, Politics, & Philosophy**
Leela Hebbar	Rutgers	Public Policy
Elliott Hillback	**Wisconsin**	**Journalism & Mass Communication**
Shirley Ho	Wisconsin	Journalism & Mass Communication
Can Huang	Georgia Tech	Industrial Management
Lu Huang	**Beijing Institute of Tech.**	**Political Science**
Jennifer Jensch	Wisconsin	Public Policy
Ronak Kamdar	Georgia Tech	Quantitative Finance & ISYE
Luciano Kay	**Georgia Tech**	**Public Policy**
Enukyung Kim	Wisconsin	Journalism & Mass Communication
Sojung Kim	Wisconsin	Journalism & Mass Communication
Ashley Kirby	Georgia Tech	Public Policy
Erin Lamos	Georgia Tech	Public Policy
Brice Laurent	Ecole des Mines	Public Policy
Ricky Leung	Wisconsin	Sociology
Chien-Chun Liu	Georgia Tech	Management
Federica Lucivero	**University of Twente**	**Philosophy**
Pratik Mehta	Georgia Tech	Industrial & Systems Engineering
Patrick E.T. McKeon	Georgia Tech	Public Policy
Yu Meng	**Georgia Tech**	**Public Policy**
Mary Moore	Wisconsin	Computer Science
Hari Narayanan	Georgia Tech	Quantitative Finance & ISYE
Christina Ndoh	NCSU	Public Administration
Tanner Osman	Georgia Tech	Public Policy
Krishna Parthasaathi	**Georgia Tech**	**Industrial & Systems Engineering**

Jayesh Patil	Georgia Tech	Computing
Ruimin Pei	**Beijing Institute of Tech.**	**Political Science**
Robin Phelps	**Colorado, Denver**	**Public Affairs**
Mark Philbrick	California, Berkeley	Environment & Management
Sofia Randhawa	Georgia Tech	Quantitative Finance & ISYE
Vanessa Schweizer	**Carnegie Mellon**	**Engineering & Public Policy**
Lea Shanley	Wisconsin	Environment & Resources
Tsung-Jen Shih	Wisconsin	Journalism & Mass Communication
Harmeet Singh	Georgia Tech	Quantitative Finance & ISYE
John Slanina	Georgia Tech	Public Policy
Diran Soumonni	**Georgia Tech**	**Public Policy**
Anthony Stavrianakis	**California, Berkeley**	**Anthropology**
Alexa Stephens	Georgia Tech	Public Policy & City & Regional Planning
Vrishali Subramanian	**Georgia Tech**	**Public Policy**
Li Tang	**Georgia Tech**	**Public Policy**
Dhanaraj Thakur	**Georgia Tech**	**Public Policy**
Juin-Yi Tsai	Wisconsin	Journalism
Rutger van Merkerk	University of Twente	Innovation & Environmental Sciences
M. Van Oudheusden	Antwerp University	Political & Social Sciences
Charles Walsh	Georgia Tech	Public Policy
Jue Wang	Georgia Tech	Public Policy
Rosalyna Wijaya	Wisconsin	Journalism & Mass Communication
John Willingham	North Carolina State	International Studies
Thomas Woodson	**Georgia Tech**	**Public Policy**
Xuanting Ye	**Beijing Institute of Tech.**	**Political Science**
Heming Zhang	Nankai Univ./Georgia Tech	Public Policy
Shuliang Zhang	**Beijing Institute of Tech.**	**Political Science**
Qin Zhu	**Dalian University of Tech.**	**Philosophy**

ASU

Undergrad Interns & Researchers

Kalil Abdullah	Molecular Biotechnology
Nidhi Bhalla	Political Science
Shreya Battacharyya	Chemistry
David Calderon	**Molecular Bioscience & Biotechnology**
Rahul Chhabra	Chemistry
Josh Choi	Biomedical Engineering & Economics
Kelley Conley	**Psychology**
Rob Davis	Biology
Travis Doom	Bioengineering
David Edwards	English & Creative Writing
Tara Egnatios	Public Policy
Andrew Gaddis	**Industrial Engineering**
Rebecca Hudson	Business
Benjamin Lowenstein	**Sociology**
Rachel Lowenstein	Business
Alexander MacLean	**Honors**
Keith Martin	**Film**
Colin McDonald-Smith	**Computer Science**
Tobie Milford	Biology & Society
Christina Nulle	Global Technology Development

Sidra Omer	Journalism & Mass Communication
Mark Petersen	Economics
Zachary Pirtle	Mechanical Engineering
Jaron Reed	**Political Science**
David Renolds	Chemical Engineering
Lucas Rogers	Engineering
Dusana Schnell-Vivas	**Marketing**
Rachel Smith	Biology & Society
Daryl Traylor	**Microbiology**
Julia Weakley	Global Studies
Brian Young	Biology & Society
Ke Wu	Biology & Society

Affiliated Undergrad Interns & Researchers

Annie Bidgood	**Georgia Tech**	**ISYE**
Audrey Campbell	Georgia Tech	Industrial Systems & Engineering
Brescia Cassellius	Wisconsin	Journalism & Mass Communication
Gordon Cutler	Georgia Tech	Computing
Sharyn Finney	Georgia Tech	Public Policy & Economics
Brian Lynch	Georgia Tech	Public Policy
John Garner	Georgia Tech	Public Policy
Clay Karwisch	Georgia Tech	History, Technology & Society
Charles Luke McCloud	Georgia Tech	Public Policy
Dave Schoeneck	Georgia Tech	Physics
Charles Walsh	Wisconsin	School of Business

CNS-ASU Staff

Melissa Cornish	Biodesign Institute Liaison
Corrine Dillon	Program Manager
Gretchen Gano	**Education & Outreach Coordinator**
Michelle Iafrat	**Administrative Associate**
Regina Sanborn	**Program Manager**
Joy Trottier	Administrative Associate

Participants affiliated, not receiving CNS-ASU support:

ASU

Ariel Anbar	**Earth & Space Exploration**	**Professor**
Derrick Anderson	**CSPO**	**Management Intern**
Catherine Arnold	**CSPO**	**Communications Coordinator**
Rachel Bowditch	**Theatre & Film**	**Assistant Professor**
Nicholas Broderick	**Theatre & Film**	**Student**
Michael Crow	Arizona State University	President
Lauren Dykes	**Theatre & Film**	**Graduate Teaching Assistant**
Mark Edwards	Business	Professor
Alfinio Flores	Curriculum & Instruction	Professor
Antonio Garcia	Hispanic Research Center	Associate Director
Joel Greene	Public Policy	Professor
Stuart Hadley	Public Affairs & Foreign Rel.	Vice President
Josh Katzker	**Theatre & Film**	**Graduate Teaching Assistant**
Rachel Levinson	Research & Economic Affairs	Government Relations Liaison

George Maracas	**School of Sustainability**	**Professor**
Deirdre Meldrum	**Fulton School of Engineering**	**Dean**
George Moakley	**Theatre & Film**	**Student**
Alan Nelson	**Director**	**Biodesign Institute**
Patrick Phelan	School of Engineering	Professor
Vincent Pizziconi	Bioengineering	Professor
Jamie Sandomire	**Theatre & Film**	**Student**
Sara Schwabe	**Theatre & Film**	**Graduate Teaching Assistant**
Michael E. Smith	**Evolution & Social Change**	**Professor**
Milton Sommerfield	**Life Sciences**	**Professor**
Michael Thompson	**Theatre & Film**	**Student**
Matt Watkins	**Theatre & Film**	**Student**
Eric Wheeler	**Theatre & Film**	**Student**
Dave White	**Community Res. & Develop.**	**Associate Professor**

Affiliated

Ida Andersen	Danish Board of Technology	Director
Timothy Apenzeller	National Geographic	Editor
David Attis	Policy Studies	Senior Director
David Beck	NISEnet	Staff
Roberta M. Berry	Georgia Institute of Technology	Professor
Rosalyn Berne	University of Virginia	Professor
Gary Bild	Nanotech. Industry Liaison	Member
Larry Bock	Board of Visitors	Member
Christopher Bosso	Northeastern University	Professor
Garrett Brown	National Geographic	Editor
Sebastien Brunet	**University of Liege**	**Professor**
Rick Canady	Food & Drug Administration	Staff
Amy Carroll	House Committee	Staff
Lorenzo Cena	University of Iowa	Graduate Student
Jan Cerveny	Department of Energy	Staff
Joshua Chamot	Legislative & Public Affairs	Staff
William Clark	Harvard University	Professor
James Collins	National Science Foundation	Head of Biological Sciences
William Cyrs	University of Iowa	Graduate Student
Michael Dennis	Society & Technology	Staff
Heather Douglas	University of Tennessee	Professor
Kate Duckworth	NISEnet	Staff
Ellen Feigal	TGen	Staff
Elizabeth Farrell	University of New Hampshire	Staff
Monica Gaughan	University of Georgia	Professor
Stephen Godwin	National Research Council	Director
David Goldston	Harvard University	Professor
Douglas Goodman	Nanotech. Industry Liaison	Member
Michael Gorman	University of Virginia	Professor
Herb Goronkin	Nanotech. Industry Liaison	Member
Richard Gullickson	Lawrence Livermore Lab	Staff
Diana Hicks	Georgia Institute of Tech.	Public Policy
Stephen Hilgartner	Cornell University	Science & Technology Studies
Michael Holland	House Science Committee	Staff
John Hughes	Nanotech. Industry Liaison	Member

Kent Hughes	Teach America	Director
Anil Jain	Michigan State University	Computer Science & Engineering
Sheila Jasanoff	Harvard University	Science & Technologies Studies
Donna Kent	Televerde	Global Studies
Matt Kim	Nanotech. Industry Liaison	Member
Fred Kronz	University of Texas	Philosophy
Ray Kurzweil	Board of Visitors	Member
Dirk Libaers	Georgia Institute of Tech.	Public Policy
Troy Livingston	NISEnet	Staff
Uttam Malani	Georgia Institute of Technology	Public Policy
Benjamin M. Mann	Defense Science Office	Program Manager
Robin Marks	NISEnet	Staff
John McGarity	Nanotech. Industry Liaison	Member
Maxwell J. Mehlman	Case Western Reserve Univ.	Professor
Celia Merzbacher	Office of Naval Research	Staff
Daniel Metlay	Nuclear Waste Review Board	Staff
Michael Moffitt	University of Michigan	Associate Professor
Jeff Morris	Environ. Protection Agency	Staff
Daniel Morrison	Vanderbilt University	Professor
Sean Murdock	Nanotech. Industry Liaison	Member
Richard Nelson	Board of Visitors	Member
Susan Norton	National Geographic	Editor
James Paul	House Committee	Staff
Priscilla Regan	Social, Behavioral & Econ.	Professor
Mihael Roco	National Science Foundation	Senior Advisor
Marc Rothenberg	Legislative & Public Affairs	Staff
Tind Shepper Ryen	House Committee on Science	Staff
Laura Schiavo	National Building Museum	Curator
Mark Shapiro	Board of Visitors	Member
Gregory Simonson	Science, Tech. & Military	Professor
Mitchell Small	Carnegie Mellon University	Professor
Alexa Stephens	Georgia Tech	Public Policy
Joanne Tornow	National Science Foundation	Program Manager
Anna Waldron	Cornell University	Professor
Fred Weber	Nanotech. Industry Liaison	Member
James Wilsdon	The Royal Society	Director
Carly Wobig	University of Illinois	Graduate Student

Nanotechnology in Society Network PIs:

Davis Baird	University of South Carolina
Richard Freedman	Harvard University
Barbara Harthorn	UCSB
Lynne Zucker	UCLA

Expert and Oversight Panel for National Citizens' Technology Forum

Roberta M. Berry	Georgia Tech	Professor
Stephen Helms Tillery	ASU	Professor
Maxwell J. Mehlman	Case Western Reserve	Professor
Kristen Kulinowski	Rice	Executive Director
Jason S. Robert	ASU	Assistant Professor
Ida Andersen	Danish Board of Technology	Staff

David Rejeski	Woodrow Wilson Center	Director

4. (b) LIST OF ADVISORY BOARDS

i. Executive Committee

Braden Allenby, Professor, ASU Department of Civil & Environmental Engineering
Elizabeth Corley, Associate Professor, ASU Department of Public Affairs
David H. Guston, Professor, ASU School of Government, Politics, & Global Studies
Deirdre Meldrum, Dean, ASU Fulton School of Engineering
Clark A. Miller, Associate Professor, ASU School of Government, Politics, & Global Studies
Alan Nelson, Director, ASU Biodesign Institute
Daniel R. Sarewitz, Director, Consortium for Science, Policy, & Outcomes

ii. Board of Visitors

Larry Bock, Chairman, Luxe Ventures
Diana Hicks, Professor, Department of Public Policy, Georgia Institute of Technology
Stephen Hilgartner, Professor, Department of Science & Technology Studies, Cornell University
Sheila Jasanoff, Professor, Science & Technologies Studies, Harvard University
Ray Kurzweil, Author
Rachel Levinson, Industrial & Government Relations Liaison, ASU Research & Economic Affairs
Richard Nelson, Professor, Department of Economics, Columbia University
David Rejeski, Director, Woodrow Wilson Center
RF (Rick) Shangraw, Vice President, ASU Research & Economic Affairs
Mark Shapiro, Center for Investigative Journalism
Mitchell Small, Professor, Department of Public Policy, Carnegie Mellon University
Albert Teich, Director, Science & Policy Programs, American Association for the Advancement of Science
James Wilsdon, Director, The Royal Society

iii. Nanotechnology Industry Liaison Committee

Gary Bild
Larry Bock, Chairman, Luxe Ventures
Ellen Feigal, Director of Medical Devices and Imaging, TGen
Douglas Goodman
Herb Goronkin
John Hughes
Anil Jain, Professor, Department of Computer Science & Engineering, Michigan State University
Donna Kent, Senior Vice President of Global Studies, Televerde
Anatoli Korkin, Director, ASU Office of Research and Economic Affairs
John McGarity
Michael Moffitt, Professor, Department of Computer Science and Engineering, University of Michigan
Sean Murdock, Nanotechnology Industry Association
Fred Weber

iv. Expert and Oversight Panel for National Citizens' Technology Forum

Roberta M. Berry, Associate Professor of Public Policy; Director, Law, Science & Technology Program, Georgia Institute of Technology
Stephen Helms Tillery, Assistant Professor, Harrington Department of Bioengineering; Assistant Professor of Kinesiology, Arizona State University

Kristen Kulinowski, Executive Director, Center for Biological & Environmental Nanotechnology, Rice University
Maxwell J. Mehlman, Arthur E. Petersilge Professor of Law; Professor of Bioethics, School of Medicine; Director of the Law-Medicine Center, Case Western Reserve University
Jason S. Robert, Associate Professor, Department of Basic Medical Sciences, The University of Arizona College of Medicine; Associate Professor, School of Life Sciences, Arizona State University
Ida Andersen, Danish Board of Technology
David Rejeski, Director, Project on Emerging Nanotechnologies, Woodrow Wilson International Center for Scholars

4. (c) LIST OF PARTICIPATING INSTITUTIONS

i. ASU Academic Participating Institutions

Barrett, The Honors College
Biodesign Institute
Center for Research on Education in Science, Mathematics, Engineering, & Technology (CRESMET)
Center for the Study of Religion & Conflict
College of Liberal Arts & Sciences
College of Public Programs
Complex Adaptive Systems Initiative
Consortium for Science, Policy, & Outcomes
Decision Theater for a Desert City
Global Institute of Sustainability
Graduate College
Herberger Institute for Design & the Arts
Hispanic Research Center
Ira A. Fulton School of Engineering
LightWorks
Mary Lou Fulton College of Education
Responsible Conduct of Research Program, School of Life Sciences
Sandra Day O'Connor School of Law
School of Earth & Space Exploration
School of Government, Politics, & Global Studies
School of Human Evolution & Social Change
School of International Letters & Cultures
School of Letters & Sciences
School of Life Sciences
School of Mathematical & Statistical Sciences
School of Sustainability
Science Policy Assessment & Research on Climate (SPARC)
W.P. Carey School of Business
Walter Cronkite School of Journalism & Mass Communication

ii. Academic Participating Institutions Other than at ASU

Austrian Academy of Science
Beijing Institute of Technology, China
Carnegie Mellon University
Case Western Reserve University
Center for Nanotechnology in Society at University of California, Santa Barbara
Colorado School of Mines
Columbia University
Copenhagen Business School, Denmark
Cornell University
Dalian University of Technology, China
Delft Technical University, the Netherlands
Dublin City University
Durham University, United Kingdom
Ecole des Mines, France
European Commission

Federal University of Parana, Brazil
Florida International University
George Washington University
Georgetown University
Georgia Institute of Technology
Harvard University
Illinois Institute of Technology
Indiana University
Institute of International Sociology of Gorizia
Institut d'Etudes Politiques de Grenoble, France
James Martin Institute for Science & Civilization, Oxford University, UK
Lancaster University, UK
Leeds University Business School, UK
Mesa Biotech Academy
Mesa High School
Michigan State University
North Carolina State University
Northeastern University
Northwestern University
Norwegian University of Science & Technology, Norway
NSEC/CNS-University of California, Santa Barbara (UCSB)
Osaka University, Japan
Purdue University
Rensselaer Polytechnic Institute
Rice University
Rice University/ICON
Rutgers, The State University of New Jersey
Said Business School, Oxford
Texas State University, San Marcos
The Center for International Development, Harvard University
UCLA/Harvard/NBER: Collaborative Research; Personnel Exchanges
Universidad de Zacatecas, Mexico
Universidad del Pais Vasco, Spain
University of Antwerp, Belgium
University of Arizona
University of Bergen, Norway
University of Bielefeld, Germany
University of Calgary, Canada
University of California, Berkeley
University of California, Irvine
University of California, Los Angeles
University of California, Santa Barbara
University of Colorado, Boulder
University of Colorado, Denver
University of Denver
University of Georgia
University of Gothenburg, Sweden
University of Groningen, Netherlands
University of Illinois, Chicago
University of Iowa
University of Liege, Belgium

University of Massachusetts, Amherst
University of Michigan
University of Minnesota
University of New Hampshire
University of Seville, Spain
University of South Carolina
University of South Florida
University of Tennessee, Knoxville
University of Texas
University of Twente, the Netherlands
University of Virginia
University of Washington
University of Wisconsin, Madison
Vanderbilt University
Virginia Tech University
Yale University

4. (d) Non-Academic Participating Institutions

ALD Nano Solutions
American Association for the Advancement of Science (AAAS)
American Bar Foundation
Arizona Nanotechnology Cluster
Arizona Bioindustry Organization
Arizona Science Center
Arizona Technology Council
Bioindustry Organization of Southern Arizona
Carnegie Mellon
Cell Publishing
Center for Business Models in Health Care
Center for Responsible Nanotechnology
Complex Global Risks
Danish Board of Technology
Department of Energy (DOE)
Ecological Society of America
Exploratorium, San Francisco
Environmental Protection Agency (EPA)
European Commission
Food and Drug Administration (FDA)
German Parliament
Global Business Network
Gordon Research Conferences
Greenwall Foundation
Intelligent Information Group Services
International Nanotechnology in Society Network (INSN)
Jennings, Strouss, & Salmon PLC
Lawrence Livermore Lab
Loka Institute
Luxe Ventures
Mayo Clinic – Scottsdale
Microchip
Museum of Life & Science, North Carolina
Museum of Science, Boston
Nanoscale Informal Science Education Network (NISEnet)
National Academy of Engineering
National Business Museum
National Geographic Society
National Nanotechnology Coordinating Office
National Nanotechnology Infrastructure Network
National Research Council
National Science Foundation
Nature Publishing Group
Norwegian Institute
Nuclear Waste Review Board
Office of Naval Research
Practical Action
Physician Services Group
Rathenau Institute

Rockefeller Foundation
Sandia National Laboratory
Sciencenter, New York
Science Museum of Minnesota
Spirit of the Senses Salon
Springer Publishing
Targeted Genetics Corporation (TGen)
Teach America
Tempe Festival of the Arts (Fall and Spring)
Televerde
The Foresight Institute
The Royal Society
The Washington Post
U.S. DOE/Center for Integrated Nanotechnology (CINT)
Woodrow Wilson International Center

Table 1: Quantifiable Outputs						
	Reporting Year-1	Reporting Year-2	Reporting Year-3	Reporting Year-4	Reporting Year 5	Total
Outputs	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	
Publications resulted from NSEC Support						
in Peer Reviewed Journal	10	7	4	8	27	56
in Peer Reviewed Conference Proceedings	0	0	0	0	0	0
in Peer Reviewed Book Chapters	1	7	7	2	4	21
Technical Reports	6	2	2	4	7	21
Working Papers	1	1	3	12	11	28
Books	0	0	2	0	0	2
Theses	1	6	11	9	8	35
in Trade Journals	0	2	2	2	3	9
Other Journal Publications	0	3	1	1	2	7
Internet	0	2	0	0	8	10
with Multiple Authors	10	9	11	16	46	92
co-authored with NSEC faculty	10	9	11	16	42	88
NSEC Technology Transfer						
Inventions Disclosed	0	3	3	3	0	9
Patents Filed	0	0	0	0	0	0
Patents Awarded	0	0	0	0	0	0
Software Licensed	0	0	0	0	0	0
Spin-off Companies Started	0	0	0	0	0	0
Degrees to NSEC Students						
Bachelors Degrees Granted	3	8	1	11	3	26
Masters Degrees Granted	2	4	1	4	6	17
Doctoral Degrees Granted	1	1	3	5	5	15
NSEC Graduates Hired by						
Industry	0	1	0	2	3	6
NSEC participating Firms	0	0	0	0	0	0
Other US Firms	0	1	0	0	0	1
Government	0	1	0	1	0	2
Academic Institutions	2	5	3	2	10	22
Other	0	1	0	3	1	5
Unknown	4	4	1	11	0	20
NSEC Influence on Curriculum						
New Courses Based on NSEC Research	3	5	2	3	4	17
Courses Modified to Include NSEC Research	2	3	2	3	1	11
New Textbooks Based on NSEC Research	0	0	1	0	1	2
Free-standing Course Modules or Instructional CDs	0	0	0	0	0	0
New Full Degree Programs	0	0	1	1	1	3
New Certificate	0	0	0	0	0	0
Information Dissemation/Educational Outreach						
Workshops, Short Courses to Industry	0	0	0	2	0	2
Workshops, Short Courses to Others	2	3	2	0	7	14
Seminars, Colloquia, etc.	73	88	38	66	116	381
World Wide Web courses	0	0	0	0	0	0
Academic Presentations	49	60	21	37	107	274
Industry Presentations	9	10	1	5	8	33
Science Cafes	6	8	4	7	10	35
Visiting Speakers	8	9	12	8	15	52
Community Speaking Engagements	1	1	0	2	11	15
Newsletters	5	4	3	3	0	15

6. Mission, Significant Advances, and Broader Impacts

The Center's mission is to: 1) *research* the societal dimensions of nanoscale science and engineering (NSE); 2) *train* a community of scholars with new insight into these dimensions; 3) *engage* various publics and NSE researchers in dialogues about the goals and implications of NSE; and 4) *partner* with the NSE enterprise to generate greater *reflexiveness* in research, development, education and policy. Using the methods of real-time technology assessment (RTTA; Guston and Sarewitz 2002), CNS-ASU weaves these activities together to support a broad-based societal capacity for the *anticipatory governance* of emerging technologies.

Overall, the Center has made significant strides in accomplishing this mission. In particular, the Center's core methods of real-time technology assessment and its vision of anticipatory governance have been recognized in important scholarly venues, e.g., the field-defining *Handbook of Science and Technology Studies*, which includes Barben et al.'s (2008) chapter, and the series on innovation policy in *Nature*, which published Guston's (2008) commentary. The Center's work also includes a more detailed genealogy of anticipatory governance (Karinen and Guston 2010). Beyond such publications, a number of programs and scholars have begun to adopt it and scrutinize it for their own purposes, from the incorporation of anticipatory governance into the programmatic agenda of the Nano-scale Informal Science Education Network's (NISE Net) public forums (see **Outreach** section), to the work of a cadre of international scholars (mostly graduate students) who have visited CNS-ASU to imbibe its perspective (see **International Collaborations** section), to sessions at the annual 2009 (May) AAAS Science and Technology Policy Forum, the inaugural 2009 (Sep) meeting of the Society for the Study of Nanoscience and Emerging Technologies and the 2009 (Oct) meeting of the Society for Social Studies of Science of Science dedicated to anticipatory governance.

CNS-ASU research is now having a substantial influence on the scholarly literature. The *Yearbook of Nanotechnology in Society* series (Springer; Guston, series editor) has one volume published (Fisher, Selin and Wetmore 2008), a second in production (Cozzens and Wetmore forthcoming 2010), after some delays a third almost ready for review (Robert, Miller and Bennett in preparation 2011), and a fourth in the planning stage (Miller and Barben in preparation 2012). *The Encyclopedia of Nanoscience and Society* (Sage; Guston, editor) is in press, with an anticipated publication date of Nov 10. Both of these publications serve community-forging purposes. The *Yearbook* helps create a community of scholars around a narrow topic and then provides them with relatively high visibility.[1] The *Encyclopedia* has brought together a larger community of scholars – who were pleased to know such an effort was in the works – in its production and will help introduce a younger scholarly audience – high school and undergraduate students – to topics in nanotechnology in society. In total, Center researchers have 8 books published, under review or under contract, six of which are primary CNS publications.

The Center's researchers have published, had accepted or submitted for review 79 peer-reviewed journal articles (60 of which are primary CNS-supported publications), covering a range of outlets including:

- broad-based audiences in science and technology studies (e.g., *Science, Technology & Human Values*; *Science as Culture*; *Minerva*),
- policy and innovation studies (e.g., *Science and Public Policy*; *Research Policy*; *Journal of Technology Transfer, Technological Forecasting & Social Change*),
- law and ethics (*Science and Engineering Ethics*; *Journal of Law, Medicine, and Ethics*),

[1] There had been some concern about the high price of the first volume early on, but Springer has inaugurated a new print-on-demand paperback version, which will be available for $25 to people at universities that subscribe to Springer Online. This program does not assist scholars at less well-off institutions, or persons not connected to academic or other research institutions, however. CNS will maintain its bulk purchase of the Yearbook and will provide copies free of charge to people who are so-situated.

- communication (*Science Communication*; *Journal of Mass Communication Quarterly*; *Public Understanding of Science*), and
- specific, NSE-related audiences for
    - scientists (*Journal of Nanotechnology Research*; *Nature Nanotechnology*),
    - social scientists and humanists (*NanoEthics*) and
    - educators (*Journal of Nanotechnology Education*).

The Center has 9 non-peer-reviewed publications in trade journals and other journals, including commentaries by Guston in *Nature* (2008) and in *People & Science* (2009), and by Wetmore and Posner in *NanoToday*. Center researchers have further published or have forthcoming 38 book chapters, including three contributions to the field-defining *Handbook of Science and Technology Studies*, many contributions to the *Yearbooks* and other new nano-in-society anthologies, and major new works on interdisciplinarity and on innovation policy and assessment. The *Encyclopedia of Nanoscience and Society* also drew on the expertise of Center-affiliated researchers for 59 entries, or about 12% of the total number.

Although citations are a somewhat crude measure of scholarly impact, this body of published work is already garnering an impressive number – more than 500 citations as documented in Google Scholar (as of Apr 10), up from 188 citations one year ago, with an H-index for Center publications equal to 12 (indicating 12 publications with 12 or more citations each, up from H=9 last year). (This total does not include the roughly 60% of the 131 Google Scholar citations to the original RTTA article by Guston and Sarewitz [2002] that have occurred since CNS-ASU was founded and which represent the visibility of the Center and its core intellectual ideas as well. It also excludes some recent *Nature Nanotechnology* publications, which do not appear accessible on Google Scholar.)

As evidence of its impact on education, the Center has contributed to the completion of 36 student theses, including 14 completed doctoral theses, 3 master's theses, and 19 undergraduate honors theses, across a variety of disciplines. CNS-Biodesign fellows and others have completed three doctoral theses with the PhD+. These numbers do not yet include five domestic and five international graduate students whose doctoral research is being guided by the STIR project.

Data and instruments produced by CNS-ASU are sought by and shared with an increasing number of researchers across the globe. For example, the searchable definition of nanotechnology produced by RTTA 1 has been adopted by the European Nano Observatory. The public opinion survey instrument developed by RTTA 2 was not only developed in coordination with EuroBarometer but also has been shared with researchers in Singapore, Ireland, France, and Poland. Survey data has also been provided to policy officials, including the National Nanotechnology Communication Office. NCTF data have been used not only by the distributed groups of scholars who hosted local citizens' technology forums, but data have also been provided at the request of researchers at NYU and in France.

Center activities have also helped generate additional research projects, including more than $1.1M of subsidiary and spin-off awards at ASU and roughly $1.8M at the collaborating universities. At ASU, these awards include:

- Boradkar, et al., National Collegiate Inventors and Innovators Alliance, $30K, Sep 07 – May 08 (this award supported one year of InnovationSpace on CNS agenda);
- Sarewitz and Bozeman, NSF SciSIP, $203K, Oct 07 – Sep 10, Public Value Mapping: Developing a Non-Economic Model of the Social Value of Science and Innovation Policy (this award included collaborations with TRC 1 and RTTA 4);
- Herkert, Wetmore, et al., NSF Ethics Education in Science and Engineering, $300K, Jan 08 – Dec 10 (this award tests a number of macro-ethics education interventions, several initially piloted by CNS-ASU);

- Guston, NSF Conference Award for the Gordon Research Conference, $60K, Aug 08 (this award supported the GRC on "Governing Emerging Technologies");
- Guston, Greenwall Foundation Conference Award for the Gordon Research Conference, $10K, Aug 08 (this award supported the GRC on "Governing Emerging Technologies");
- Fisher and Guston, NSF Socio-Technical Integration and Research, $540K, Apr 09-Mar 12 (this award extends the RTTA 4 agenda to create an international team of doctoral students doing interventionist-oriented comparative laboratory ethnographies); and
- Fisher, National Nanotechnology Infrastructure Network, 09-10, $5,300 (this award documents the Integration of Social and Ethical Considerations into a number of NSEC and NNIN sites).

At GA Tech, these awards include:

- Porter, NSF National Partnership for Managing Upstream Innovation, $45K, Nov 04 – present;
- Shapira, Youtie, Rogers, NSF Measurement and Analysis of Highly Creative Research, $340K, Jan 08 – Dec 10;
- Porter et al., NSF Measuring and Tracking Research Knowledge Integration $393K, Sep 08 – Aug 11;
- Porter et al., NSF NER: Representations of Active Nanostructures Across Scientific, Popular, and Policy Realms of Discourse, $85K, Jan 07 – Aug 09;
- Porter et al., UK Royal Commission, $20K, Jan 08 – Apr 08;
- Porter, Youtie and Meyers, Euronano, $21K, Jul 07 – Jan 08;
- Fernandez-Ribas, Kauffman and GA Research Alliance, Small Businesses International Nano Patent Strategies, $16K, Jun 08 – May 09; and
- Ruddles, Shapira, et al. National Research Council of Canada, UK Nanoclusters, $40K, Jan 09 – Apr 09.
- Rogers, Youtie, Porter, Shapira, NSF Assessment of Nanoscale Science and Engineering Systems, $200K, Oct 09 – Sep 10.
- Shapira, Tang, Meng. Chemical Heritage Foundation, The Development of Advanced Materials in China: Case Studies of Nanotechnology Materials Innovations, $10K, Sep 09 – Aug 11.

At Wisconsin, these awards include:

- Scheufele, University of Wisconsin—Madison Graduate School, Science and Social Responsibility: Tapping Values and Perceptions among Researchers in Nanotechnology, $9,029, Sp 07;
- Scheufele, NSF, Media, Talk, and Trust: The Social Amplification of Risk during Site Selection for a Bio-research Facility, $400K, 08-10;
- Scheufele (co-PI with PI Berube at NCSU), NIRT: Intuitive Toxicology and Public Engagement, $1.4M ($150K at UW), 08-10; and
- Scheufele, (consultant with PI Hallman at Rutgers), USDA CSREES National Research Initiative (NRI) Food Nanotechnology: Understanding the Parameters of Consumer Acceptance, $200K, 08-10.

CNS-ASU has been a force for institutional change at ASU and its collaborating universities. In addition to having created a number of new undergraduate and graduate courses and its PhD+, CNS-ASU has:

- collaborated with ASU's Biodesign Institute to require integrated societal training of the doctoral students in its new Biological Design PhD program;
- collaborated with ASU's new Professional Science Master's program in Nanoscience to offer a societal training course in the new curriculum;
- collaborated with ASU's new NNIN node to develop a training program in the societal dimensions of nanotechnology and in informal science education for its users;
- helped instigate the pursuit of a PhD+ program at GA Tech;

- provided leverage for a proposal by Scheufele at Wisconsin for a "Science and Culture" cluster hire to add personnel to the infrastructure that CNS has supported there;
- began to collaborate with the Ira Fulton Schools of Engineering at ASU to include societal components in a planned school of synthetic biology; and
- collaborated with a number of NSF (STC, ERC, IGERT and NUE), DOE (ARPA-E and Hub) and NIH proposals emerging from ASU containing programs that CNS pioneered. NSE awards at ASU with CNS-ASU partnerships and activities include:
  - Lindsay, NSF NIRT for organic photo-voltaics, $1.1M (Sep 06 – Aug 10)
  - Posner, NSF CBER, Interaction of Engineered Nanomaterials with Artificial Cell Membranes, $313K, Sep 09 – Aug 12.
  - Posner, NSF CBER, Collaborative Research: Rational Design of Enhanced Catalytic Nanomotors, $600K, Mar 09 – Feb 12.

CNS-ASU has engaged with the NSE community more broadly than just with researchers at its own institutions. For example, CNS-ASU researchers created societal training activities for staff and visiting researchers at the Department of Energy's Center for Integrated Nanotechnologies, and we have collaborated with the NNIN to produce a training video for all NNIN users that reached roughly 1000 NNIN users in the previous year. While the training video is still available on www.nnin.org, NNIN is moving away from its use and we are in ongoing communication about additional training activities (see **Outreach** section for more detailed discussion). Through its spin-off STIR project, CNS researchers are conducting integrated studies in 20 laboratories world-wide, and the directors and other members of those laboratories have also become involved in publications and other collaborative activities. A measure of the external demand for such activities is CNS-ASU's DC Summer Session, which currently has 19 paid subscribers registered for 2010 from universities including not only ASU but also Cal Tech, City College of New York, Colorado School of Mines, Delaware, Florida, Princeton, and RPI.

The following section briefly summarizes the most significant advances of the Center over the last year in terms of fundamental knowledge and technology (here conceived as applied and/or reflexive knowledge, processes, and capacities, often but not exclusively for internal use).

Fundamental knowledge. Each research program, and most individual research projects, contributed significant advances in fundamental knowledge of the societal aspects of nanotechnology in the last year. This section provides the highlights of all major and some minor projects.

- RTTA 1 Research Program Analysis: Analyzing extensive global databases of Science Citation Index records, other publication databases, and patent databases (MicroPatents, PatStat), CNS-ASU researchers have found:
  - NSE exhibits characteristics of multi-disciplinarity based on cognitive integration of disciplinary-diverse knowledge sources in cited references (Porter and Youtie 2009);
  - Inventor locations of nano patents indicate that US multinational enterprises are not widely decentralizing nanotechnology R&D (Fernandez-Ribas and Shapira 2009);
  - While most of the leading nano-districts are found in locations that were prominent in previous rounds of emerging technologies, new geographic concentrations of nanotechnology research have also surfaced.
  - Nano EHS research is growing rapidly although it is orders of magnitude smaller than the broader nano S&T domain. Nano EHS work is moderately multidisciplinary, but gaps in biomedical nano EHS's connections with environmental nano EHS are apparent (Youtie et al, 2009)
  - There is a sharp rise in active nanostructure publications in 2006, which is maintained in subsequent years, suggesting a shift in research from passive to active nanostructures. (Subramanian et al, 2010).

- RTTA 1/2 Public Value Mapping: Conducting case studies in public value mapping of nanotechnologies, CNS-ASU researchers have found:
    - Nano-based cancer therapies seem poorly situated to contribute much if anything to decreasing health disparities (Slade under review).
    - Nano-based water treatments are an ambivalent source of public value (Leech).
    - Quantitative analysis of value statements can provide credible and robust basis for policy analysis (Fisher et al. forthcoming).
- RTTA 1/3 Workforce Assessment: Completing studies of the need for NSE-related skills in the NJ bio-pharma industry (Van Horn et al. 2009a) and of post-secondary nano degree programs in the US (Van Horn et al. 2009b), CNS-ASU researchers found:
    - Companies are uncertain of their hiring plans for employees with NSE skills;
    - Employment outlook is uncertain because of macro-economic factors but also because of regulatory issues (time to approval for drugs) and public perception of nano.
    - Some need exists for NSE knowledge across job areas, e.g., safety for lab workers but regulatory concerns for marketing professionals.
    - Associate's degrees to be the most common, followed by PhDs;
    - Most degrees at the bachelor's or higher level are at high research-performing institutions;
    - Course content and employer involvement is highly variable among programs.
    - There is modest connection at best between the geography of degree creation and the geography of nano R&D.
- RTTA 2/1 Public Opinion Polling: Based on a national public opinion survey (dual frame RDD and listed households CATI survey, N=1015, conduct May-Jul 07), CNS-ASU researchers found:
    - that when members of the public associates nanotechnology with specific application areas, they are more likely to take risk perceptions into account when forming attitudes about the technology (Cacciatore et al. forthcoming);
    - Respondents in the US are significantly less likely to agree that "nanotechnology is morally acceptable" than respondents in many European countries, and that there is a tight, negative correlation between the perception of nanotechnology as moral and standard measures of religiosity in these countries (Scheufele et al. 2009);
    - that despite increasing nanotechnology outreach efforts over the past decade, there is a widening nanotech knowledge gap among members of the public with the least and most formal education levels (Scheufele and Corley 2010).
- RTTA 2/3 Scientists' Survey: Based on a survey of leading US nano-scientists (mail survey, N=363, conducted May-Jul 07), CNS-ASU researchers found:
    - that in addition to risk perceptions, nano-scientists use their economic and social values to make decisions about nanotech regulation, and that surveillance/privacy, human enhancement, medicine, and the environment are the application areas in which nano-scientists see the greatest need for new nanotechnology regulations (Brossard et al. 2009);
- RTTA 3/1 Scenario Development
    - NanoFutures Solar to Fuels deliberations yielded clarity around the timing of energy systems development versus the political will and pacing of policy; the entrance of water and land use as key issues in the public understanding of new energy technologies; the potential exacerbation of existing inequities by new technologies (Davies and Selin 2010)
    - The Energy Futures research crystallized the challenges of designing engagements to investigate nanotechnology, energy and potential futures- three topics that are appear 'invisible' yet may give rise to novel and unpredictable social dilemmas (Davies and Selin under development);
    - Plausibility was revealed to be a rich and compelling concept useful in future-oriented research and practice as an assessment tool (Selin et al under development);

  - Dual utility of plausibility in the practice of generating scenarios: on the production side, implausibility is helpful to disestablish conventional thinking and open up dialogue; on the consumption side, plausibility is useful to persuasively communicate scenarios (Selin and Wiek, under development); and
  - Anticipatory governance can blend with sustainability principles in the context of urban planning by highlighting capacity building, deliberative engagements and foresight (Wiek and Selin, under development).
- RTTA 3/4 National Citizens' Technology Forum: Based on reports from citizens' participating in the NCTF, pre- and post-tests from the event, and transcripts and other data, CNS-ASU researchers have found:
  - that ordinary citizens place a great deal of importance on issues of equality (Bal in press 2010);
  - that lay-citizens can and do produce policy-relevant recommendations in highly technical areas (Philbrick and Barandiaran 2009);
  - that citizens prefer face-to-face deliberations, and keyboard-to-keyboard deliberations raise substantial challenges (Delborne et al. 2009); and
  - that participation challenges citizens and strong incentives to participate in intensive deliberative activities are necessary (Kleinman et al. 2009).
- RTTA 4/2: Through a set of integrative research and educational activities with NSE researchers, CNS-ASU researchers have found:
  - that integrative research tends to increase reflexive awareness among researchers, can introduce changes in practice, and often has longer-lasting residual effects (various STIR reports and manuscripts in preparation);
  - significant support for the midstream modulation proposition that the acknowledgement of social and ethical dimensions of their work by scientists and engineers can constitute a prerequisite for an increased capacity on their part to effectively take such broader dimensions of their work into account; and
  - that in-lab interventions as well as both integrated and stand-alone courses can significantly increase the ethical awareness of science and engineering graduate students (EESE report).
- RTTA 4/3: Through Integration Policy Studies, CNS-ASU researchers have found:
  - in confirmation of earlier findings of Fisher and Mahajan (2006) that NSE policy makers and practitioners consistently invoke potentially contradictory values in making NSE policy statements (Fisher et al. forthcoming); and
  - evidence of few integrative research activities among the vast array of activities conducted by NSECs and listed on their websites (Garay and Fisher).
- TRC 1: The collected expertise embodied in the forthcoming *Yearbook of Nanotechnology in Society: Nanotechnology, Equity, and Equality* suggests that many of the promises for and challenges to equity and equality that have been generated by previous technologies are in the process of being reproduced by nanotechnology.
- TRC 2: Through the "end-to-end" process in which issues in Human Identity, Enhancement, and Biology are systematically connected with RTTA activities, CNS-ASU researchers have found:
  - From RTTA 1 bibliometric analysis (Nulle, Miller, Harmeet, and Porter, in prep):
    - There is a substantial literature on nano and the brain, with a large plurality of the work being conducted in the US;
    - NSE research is widely distributed across subfields and domains of neuroscience;
    - NSE research is contributing fundamentally to the ability to understand, repair, interface technologically with, and possibly enhance the human brain.
  - From RTTA 2 National Survey data (Miller, Cobb, and Hays, in prep):

        - The US public is relatively uninformed about human enhancement technologies, even in comparison to nanotechnologies more generally.
        - The US public differentiates between the use of nanotechnologies for improving health outcomes (therapies) and the use of nanotechnologies for non-health related (enhancement) purposes.
        - While perceptions of risks and benefits are relatively balanced, most respondents believed that nanotechnological enhancements would be available only to the wealthiest Americans and that the government, rather than the market, should set the terms for access to them.
        - Women are significantly less likely to support human enhancement using nanotechnologies.
    - From ethnographic work in nanobiology, nanotechnologies are not just the output of research but are themselves important tools in the conduct of the research.
    - From historical research on cochlear implants (Anderson, in prep), the development, adoption, regulation and commercialization of nano-neural interface technologies is likely to be extremely complex and influenced by a variety of variables, including economics, policy, and culture.
    - From a focus group on nanotechnology and religion (Milford, in prep), focusing public engagement activities on specific communities can enhance deliberation about emerging technology by incorporating identity-specific ethical reflections.

<u>Technology (in this case, mostly applied and/or reflexive knowledge, processes, methods and capacities; often these are developed in one part of CNS-ASU and used in another, thus forming the intellectual core of "ensemble-ization")</u>.

- RTTA 1 RISA:
    - RTTA 1 searchable definition of nanotechnology adopted by European Nano Observatory, and 14 programs and dictionaries to enable usage of this information.
    - Several targeted bibliometric studies supported ongoing CNS-ASU work.
- RTTA 2 POV:
    - Data from the National Survey was critical for TRC 2/E2E project.
    - The public opinion survey instrument was shared with researchers in Singapore, Ireland, and Poland.
    - Creation of media database, tapped by other programs.
- RTTA 3 DP:
    - RTTA 3/1 designed an online survey to assess the technical plausibility of potential energy applications using nanotechnology.
    - Operationalization of anticipatory governance in urban planning, city government setting.
    - Scenes developed for a variety of formal and information educational activities, outreach and stakeholder engagement.
    - RTTA 3/4 NCTF data requested by researchers at NYU, Ecole des Mines de Paris, and Dublin City University.
- RTTA 4 RAE:
    - RTTA 4/2 Midstream modulation protocol is at the root of the multi-national STIR collaboration and other new and planned research.
    - RTTA 4/3 researchers created a large database that has been used for additional projects by other RTTA researchers.

<u>Education and Training:</u>

- At the post-doctoral level, CNS-ASU continues to train high-quality post-doctoral associates and place them into faculty positions, most recently Daniel Barben at Aachen University, Germany, and Catherine Slade at Augusta State University, GA.
- At the graduate level, CNS-ASU has involved some three dozen graduate students in its YR 5 activities. The Center introduced a new training activity for graduate students in design and a new studio course in the School of Sustainability preliminary to its new research theme commencing in Fa 10. The Center's third PhD+ student graduated in Dec 09, along with one supported social science PhD, and several more CNS-related doctoral and master's students are expected to graduate by August. The Center has added additional PhD+ students, and we will conduct two iterations of our DC Summer Session in Su 10 with paying subscribers. We taught students in the Professional Science Master's Program in Nanoscience and in the Biological Design PhD program, and we continued other new courses including "Science Policy for Scientists and Engineers," "Energy," and "Governing Emerging Technologies" at the graduate level. The Center continues to play an integral role in the Human and Social Dimensions of Science and Technology graduate program, with about half of two cohorts of students funded by or participating deeply in CNS-ASU activities.
- At the undergraduate level, CNS-ASU introduced and continued to teach classes influeced by the Center, including "Global Environmental Politics," "Science and Democracy," and "Human Enhancement and Democracy." Undergraduate research interns continue to make important contributions.
- In informal science education, CNS-ASU continued participating in NanoDays in Mar 10 by having students staff a booth at the Tempe Festival of the Arts and at the AZ Science Science, and it also continued Science Café program with the AZ Science Center. More importantly, it expanded its collaboration with NISE Net through a set of meetings, leading to substantive partnerships around NanoDays materials, tabletop displays, and planned exhibits, among other things.
- In training for scientists and engineers, CNS-ASU is revamping its relationship with NNIN through the new local node at ASU. It also continued to work with DOE's Center for Integrated Nanotechnology and the NNIN node at GA Tech.

Industrial collaborations. The most significant private-sector relations that CNS-ASU has established in the past year are:

- completion of the workforce assessment study for the New Jersey region;
- the disclosure of InnovationSpace inventions to AZTE and other private sector contact through ISpace;
- the collaboration with the Center for Genetics and Society in the webinar briefing of the Consultative Group on Biodiversity;
- the completion of a STIR lab study with a private sector laboratory and follow-on publications in development.

The following section briefly describes the current and potential impacts of CNS-ASU on teaching, training, and learning; outreach to pre-college institutions; broadening the participation of underrepresented groups; enhancement of infrastructure of research and education; dissemination to scientific and technological communities; and benefits to society.

Teaching, training and learning. At any given time, CNS-ASU, including its constituent universities, is training in various capacities approximately one-half dozen junior research faculty and post-doctoral fellows, more than two dozen graduate students, and one dozen undergraduate students in nanotechnology in society. At the constituent universities, most of this training consists of working on CNS-related research projects under the subcontracts to those universities. At Wisconsin, however, the community of

trainees is much larger than that of funded student researchers because the data developed by RTTA 2/1 Public Opinion Poll are too extensive to be analyzed entirely within the project. While CNS-ASU's constituent universities have not yet engaged in unique course development around nanotechnology in society, the CNS-related research they are producing is being incorporated into a number of classroom modules and activities. At ASU, CNS has engaged in extensive training and curriculum development and innovation. In this reporting year, CNS-ASU has continued to influence undergraduate courses in disciplinary areas, expanded its graduate training with new coursework and research opportunities for both social scientists and NSE students, and collaborated with NISE Net to expand the inclusion nano-in-society ideas in informal science education. CNS has also cultivated a cohort of interdisciplinary junior scholars, two more of whom have received tenure track appointments.

Outreach to pre-college institutions. CNS-ASU has arranged for continuing education credit for in-service teachers for attending its Science Cafes. In previous years we have reported on the development and teaching of what we believe to be the nation's only graduate-level course for in-service high school teachers in nanotechnology and society, and on our inability to find an appropriate financial model for attracting enrollment to the course. In the current year, we modified for the course for inclusion in the PSM in Nanoscience degree program, and two teachers, one in-service and one retired, took it. CNS is therefore actively seeking ways to fund credit-hours on campus, as well as ways to market the syllabus to other training programs. The *Encyclopedia of Nanoscience and Society*, on which work commenced in YR 4, has high school and college libraries as its target market.

Broadening participation of under-represented groups. CNS-ASU, including its constituent universities, has developed a strong record of including women in key research and leadership positions and recruiting members of under-represented groups into graduate and undergraduate research positions. In most measurement categories, CNS-ASU equals or exceeds national averages. We have also focused activity on disability communities as an under-represented population through the activities of TRC 1 Equity and Responsibility and TRC 2 Human Identity, Enhancement, and Biology. In the previous year, we replaced the symposium for under-represented students with a training activity more akin to the DC Summer Session and other training activities that CNS-ASU has made successful, but targeted for under-represented students. Held for the first time in Sp 09 for two dozen graduate students from under-represented communities, the seven-week course was quite successful and will be repeated in Fa 10. CNS-ASU submitted an REU supplement proposal focused on under-represented students but it was rejected; we plan to revise and resubmit the REU in the coming year.

Enhancement of infrastructure for research and education. CNS-ASU maintains a web site (http://cns.asu.edu) that provides information about its research, education and outreach programs to a general audience. In particular, CNS-ASU has most of its monthly seminars and occasional speakers' presentations available on the web site in audio, video, and PPT versions – including new video formats on YouTube. The website has several functional areas, including:

- The NanoFutures site (http://cns.asu.edu/nanofutures), which invites various lay-public and expert groups to help construct and comment on nanotechnological scenarios that CNS-ASU has seeded. This site will continue to expand as users visit and develop new content themselves;
- An educational clearinghouse (http://cns.asu.edu/educate), which offers the syllabi of all nano-related courses and some co-curricular activities that CNS has developed, as well as some documents from other sources. This site will continue to expand as CNS-ASU develops additional curricular and co-curricular material and gathers material from elsewhere; and
- The STIR project website (http://cns.asu.edu/stir/) and Facebook site, which provides general information about the project and a password protected site for collaborative work among the far-flung international STIR network.

CNS-ASU spear-headed the creation of the International Nanotechnology and Society Network (INSN; www.nanoandsociety.org), founded at ASU in January 2005 and currently including more than one

hundred members from more than a dozen nations. At the Sep 09 inaugural meeting of the Society for the Study of Nanoscience and Emerging Technologies (S.NET; Guston is a founding member of the board and a member of the first and second program committees), we have decided to re-purpose INSN to deal specifically with issues of nanotechnologies, equity and development. CNS-ASU has also created a number of research tools and instruments, e.g., the searchable definition of nanotechnology and the databases derived with it, survey protocols and opinion data, and the NCTF reports, internet transcripts and video data that have been sought by and provided to other scholars. CNS-ASU has also been the site of literally scores of visiting students, scholars and practitioners seeking a vibrant intellectual community and training in the Center's methods.

Dissemination to scientific and technological communities. CNS-ASU has engaged in extensive dissemination activities, both to its social science and humanities colleagues, but also to the community of NSE researchers with whom it also interacts. Of its 79 published, forthcoming or under review journal articles, 14 are in journals like *Nature Nanotechnology*, *Journal of NanoParticle Research*, *EMBO Reports*, and others that are generally oriented toward science and engineering researchers. We have also published in trade and professional journals that target scientists, e.g., *Materials Today* and *Nano Today*, and have published an invited commentary in *Nature* and letters in *Science* and *Nature*. CNS-ASU researchers have given more than 380 presentations, roughly 60% of which were presented to their social science colleagues and roughly one-third of the remainder to targeted audiences of scientists and engineers. Our dissemination activities have also included supported and unsupported invitations to our All Hands meeting, extended to roughly 10 individuals, including students, each year, and the workshops we conducted in YR 5 – including events on plausibility and STIR and policy and innovation with GA Tech in Manchester, UK.

Benefits to society. In its July 2007 memorandum, NSF describes a set of questions (sub-criteria) related to its broader impacts criterion. Here we articulate the contributions of CNS-ASU for each of these sub-criteria:

- *"How well does the activity advance discovery and understanding while promoting teaching, training, and learning?"* The integration of research, education, and outreach is a particular focus and strength of CNS-ASU, and many of its programs are designed toward this goal from the outset.
    - CNS-ASU has teaching, training, and learning projects at all levels from the pre-college education to post-doctoral training, as well as informal science education projects and training for scientists and engineers.
    - Most of these teaching, training, and learning projects integrate research, education, and outreach, e.g.:
        - students in the Sp 10 "Science Policy for Scientists and Engineers" and in the "Energy" class participated in the NISE Net-sponsored NanoDays by staffing a booth of nano-demonstrations at a local arts festival;
        - undergraduate research, e.g., as represented in the third *Yearbook*, is well-integrated with research programs;
        - graduate course development, e.g., the new "Future Scenarios, Anticipatory Governance, and Sustainability" (Sp 10) is driven by research interests; and
        - CNS-ASU research activities become case studies for concurrent educational activities, e.g., Guston's "Governing Emerging Technologies" graduate seminar was thoroughly integrated into the Social Challenges of the Future workshops.
    - CNS-ASU partnerships with NSE researchers have enriched its Science Cafes, which local teachers may use for credit;
    - CNS-ASU trains a small number of CNS-Biodesign Fellows and other PhD+ students to conduct societal implications research or perform outreach projects around their NSE research, and this program is expanding to GA Tech;

  - Student authors are included on approximately 40% of CNS manuscripts;
  - Students are first or sole-author on roughly one-sixth of the roughly 380 CNS presentations, and they have presented their CNS-related work in a variety of venues;
  - CNS-ASU has created and will continue to develop a section of its website to serve as a clearinghouse for nano-in-society curricular activities.
- *"How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?"* For CNS-ASU, diversity is not just a matter of inclusion of a diverse research population but making aspects of diversity explicit parts of the research agenda.
  - CNS-ASU fosters research topics that explicitly address issues of underrepresented groups, e.g.:
    - A RTTA 1/1 Innovations Systems Assessment project investigates female involvement in nanotechnology patenting;
    - A RTTA 1/2 Public Value Mapping project that includes attention to the differential impacts of minority participation in clinical trials for potential nano-therapeutics; and
    - An entire research program area on Equity, Equality and Responsibility, which in part addresses ethnic and geographic issues in the distribution of benefits and risks from nanotechnologies.
  - CNS-ASU collaborates with the Hispanic Research Center on science policy training for its two dozen graduate-level fellows from underrepresented groups;
  - CNS-ASU exposes students to under-represented perspectives in classrooms and co-curricular activities, e.g., inviting mobility-disabled bioethicist Wolbring to the InnovationSpace classes.
- *"To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships?"* CNS-ASU envisions itself as a national and international leader in promoting research, education, and outreach in nano-in-society topics and in integrating those topics into NSE research and education settings.
  - CNS-ASU exists as the largest node of the NSF-instigated nano-in-society network and has taken leadership in the generation of the following networks and collaborations (outside ASU):
    - CNS has hosted more than 50 international visitors, including 20 visitors from 11 different countries in YR 5 alone;
    - A Memorandum of Understanding with NISE Net for collaborations centered on enhancing informal science education with expertise from the societal aspects of NSE has led to numerous, ongoing, and increasingly substantive collaborations;
    - Hosting a free, full-day workshop on anticipatory governance and real-time technology assessment prior for 27 registrants prior to the inaugural S.NET meeting;
    - Leading the ASU-created International Nanotechnology and Society Network, currently consisting of more than 100 researchers in more than a dozen nations;
    - Partnering with the second US-India Nano-science and Engineering Institute to add a societal implications component, led by Bennettt, to its program and nano-in-society personnel to its mission.
    - STIR continues to cultivate, deepen, and expand an international network of graduate students and laboratories.
  - Within ASU, CNS-ASU is a hub for transdisciplinary research and teaching, with specific activities including:
    - CNS curricular offerings currently enhance graduate education in the Biodesign Institute, the Ira A. Fulton Schools of Engineering, the Department of Physics and the Department of Chemistry and Biochemistry;

        - CNS supports InnovationSpace, which bridges the schools of design, engineering, and business;
        - CNS graduate coursework helps link the Schools of Politics and Global Studies, Human Evolution and Social Change, Life Sciences, and the Human and Social Dimensions of Science and Technology doctoral program;
    - CNS-ASU partners with the Arizona Science Center for the production of monthly Science Cafes during the academic year;
    - CNS-ASU has made NanoFutures available in response to queries about its use in pre-college teaching and training activities;
- *"Will results be disseminated broadly to enhance scientific and technological understanding?"* CNS-ASU aims to reach a variety of audiences – scholarly, professional, and public – with its research, education, and outreach activities.
    - CNS-ASU's e-mail distribution list reaches nearly 1400 individuals;
    - CNS-ASU researchers have given more than 380 talks across all audiences since the inception of the Center, more than 100 in YR 5 alone;
    - CNS-ASU targets networks and user facilities for the distribution of nano-in-society training material, e.g.:
        - NISE Net has disseminated the CNS-ASU report on concepts in nano-in-society for education and outreach (Miller et al. 2007) to approximately 300 museums and other participants in NanoDays;
        - NNIN continues to disseminate the CNS-ASU led PPT training module to its network of user facilities on its website;
        - CNS continues a loose collaboration with DOE's CINT user facility to train its users and students; and
        - Miller has started a blog in collaboration with NISE Net.
    - CNS-ASU conducts monthly Science Cafes – many directly involving CNS personnel – during the academic year, averaging approximately 50 persons in attendance at the Arizona Science Center in the recent year;
    - CNS-ASU has a contract with Springer to produce the first five volumes of the *Yearkbook of Nanotechnology in Society* (Guston, series editor), the first of which is published (Fisher, Selin and Wetmore 2008), the second of which is in press, and third of which is almost ready for review;
    - CNS-ASU Director Guston has completed reviewing entries for a two-volume *Encyclopedia of Nanoscience and Society* (Sage, forthcoming 2010) that will transmit detailed concepts in nano-in-society to high school and college students;
- *"What may be the concrete and demonstrable benefits of the proposed activity to society?"* The concept of anticipatory governance – comprising foresight, engagement, and integration – provides the intellectual framework for the broader benefits to society that CNS-ASU seeks to generate.
    - Foresight activities, particularly the scenes of plausible nanotechnological products that CNS-ASU has developed and vetted, create through the NanoFutures interactive website an opportunity for diverse publics to encounter, explore, and evaluate nanotechnologies prior to the actual emergence of these technologies;
        - NanoFutures continues to attract interest from educators for classroom use, e.g., recent request from University of Antwerp.
    - Engagement activities, including the small-scale intensive Science Cafes as well as informal science education activities informed by CNS perspectives, create more informed citizens on important topics in nano-in-society;
    - CNS researchers are involved in three ongoing video projects, including two major documentaries;

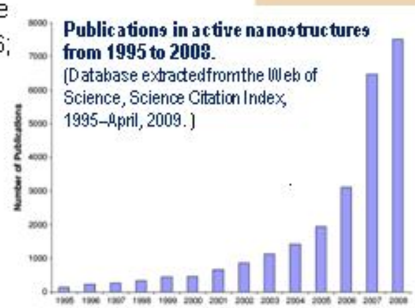
- Interaction with NSE researchers, including courses, training activities, workshops, laboratory collaborations, and interventions resulted in identifiable changes in knowledge, identity, and practice;
- CNS-ASU has had other informational and educational exchanges with decision makers, including:
  - Guston testified to the National Nanotechnology Advisory Panel, a working group of the President's Council of Advisors for Science and Technology, as part of its biennial review of the National Nanotechnology Initiative in Feb 10;
  - Sarewitz is part of the bipartisan National Commission on Energy Policy task force on geoengineering, announced Mar 10;
  - Guston, Shapira, and Selin participated in the International Study of the Long-term Impacts and Future Opportunities for Nanoscale Science and Engineering in Mar 10;
  - Fisher advised the Norwegian Research Council on designing solicitations for integrative research projects in Feb 10; and
  - Ga Tech RTTA 1/1 research on a variety of topics has been disseminated to many public offices, including:
    - Shapira, Youtie, and Kay on "Corporate Entry into Nanotechnology through Patents and Publications: 1990 to 2008" to the NNCO and NSF nanotechnology offices in Dec 09 (revised, February 2010);
    - Shapira and Kay on corporate entry by sector for the US Trade Commission in Mar 10.
    - Youtie and Porter on nano EHS research to EPA in Dec 09.

The Center for
Nanotechnology in Society
ARIZONA STATE UNIVERSITY

From passive to active nanostructures: Signs that a major transition is beginning

A critical transition in nanotechnology's developmental trajectory is the anticipated* shift from passive to active nanostructures. Passive nanotechnologies (such as nanocoatings, nanoparticles, and nanostructured materials) are already available. Second generation active nanostructures (for example, nanoelectro-mechanical systems, nanomachines, self-healing materials, and targeted drugs) can evolve their properties, structure and/or state during their operation. This could increase nanotechnology's impacts and require new approaches for risk assessment.

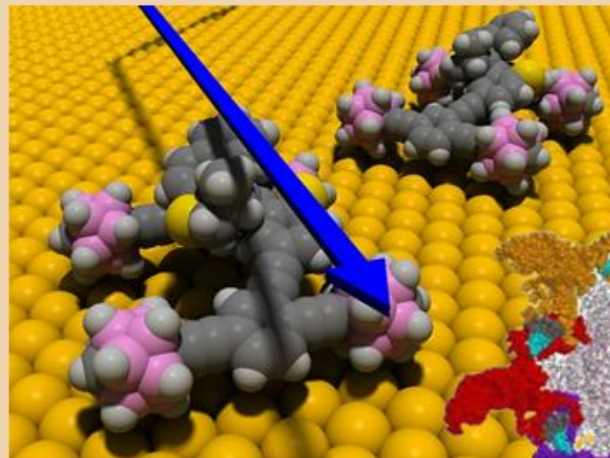
A new CNS-ASU analysis (*Journal of Nanoparticle Research*, January 2010) of global nanotechnology publications verifies that the anticipated shift to active nanostructures is underway. A sharp rise in publications focusing on active nanostructures begins in 2006; this rise accelerates in 2007 and 2008.

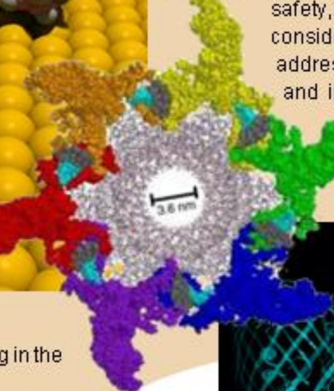


Publications in active nanostructures from 1995 to 2008.
(Database extracted from the Web of Science, Science Citation Index, 1995–April, 2009.)

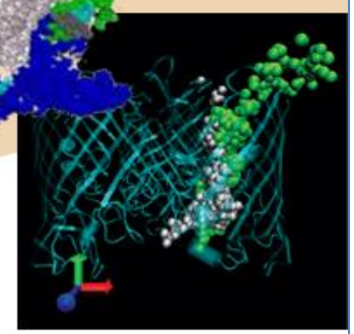
Access the entire article at http://bit.ly/activenano

*A shift to active nanostructures is hypothesized by M.C. Roco (2004); see also Tour (2007) (citations in article)





Active nanostructures are likely to have a different and increased profile of impacts (including benefits as well as potential risks) compared with passive nanotechnologies. The implications for societal, health and safety, and environmental considerations need to be addressed in other studies and in policy and governance processes.



We suggest the following categories of active nanostructures are emerging in the research literature:

- *Remote actuated active nanostructures*, such as light-actuated embedded sensors;
- *Environmentally responsive active nanostructures*, such as responsive drug delivery;
- *Miniaturized active nanostructures*, such as synthetic molecular motors and molecular machines;
- *Hybrid active nanostructures*, or uncommon combinations of materials, such as silicon-organic;
- *Transforming active nanostructures*, such as self-healing materials.

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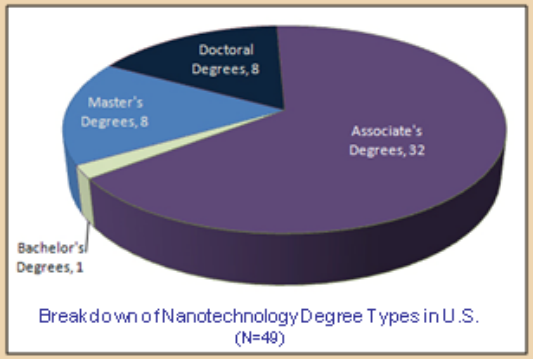
Research, education and outreach activities at the Center for Nanotechnology in Society at Arizona State University are supported by the National Science Foundation under cooperative agreement #0531194.

The Center for Nanotechnology in Society
ARIZONA STATE UNIVERSITY

A Snapshot Profile of Nanotechnology Degree Programs in the U.S.

One way post-secondary institutions respond to labor needs for emerging technologies is by creating new degree programs. CNS-ASU recently collaborated with the Heldrich Center for Workforce Development at Rutgers University to profile U.S. degree programs created in response to nanotechnology. The study defined nanotechnology degree programs as associate's, bachelor's, master's and doctoral programs that use the term "nano" in the formal degree title. This definition excluded certificates, minors, tracks, informal education and concentrations in nanotechnology. Sources used to identify nanotechnology degree programs included national databases, structured Web searches, a review of scholarly literature on nanotechnology education, and expert referrals.

Although there is no consensus yet on the best way to educate future nanotechnology workers, many scientists, employers and educators agree that the field requires interdisciplinary skills and knowledge across multiple science and engineering disciplines. The study therefore broadly examined how institutions approached the issue of *interdisciplinarity* within their degree programs.



Breakdown of Nanotechnology Degree Types in U.S. (N=49)

The total number of formal nanotechnology degree programs is small, with 49 programs identified at 38 post-secondary institutions. These institutions are not concentrated in areas of high nanotechnology publication and patent activity, but rather are clustered in response to state and federal investments. For example, the NSF-supported *Nano-Link* involves a set of six associate's degree programs linked across five Midwestern states, and Pennsylvania's Nanofabrication Manufacturing Technology Network links 18 degrees across 16 institutions. Both programs require a capstone semester at a four-year college to complete an associate's degree program from a two-year school, thus partnering two- and four-year colleges.

The motivation behind degree program development varied by degree type. For associate's degrees, workforce and economic development were key motivators. Direct employer involvement in associate's programs was common, as nearly all were designed to train nanotechnology technicians. On the other hand, student attraction and faculty motivation to establish interdisciplinary education in nanotechnology were common themes in program development at the graduate level. Employer involvement at higher levels of education was less common, the major exception being the *College of Nanoscale Science and Engineering in New York*, where six graduate degree programs involve high levels of industry partnership.

Approaches to the interdisciplinary aspects of nanotechnology varied among programs. At all program levels, students are required to take courses from a variety of traditional core disciplines. Several institutions feature more intensive faculty collaboration across departments/schools, to create—and sometimes co-teach— nanotechnology-specific courses and lab work. Many faculty members stressed the importance of students maintaining a strong link to a core, traditional discipline. These faculty expressed concern about "diluting" the rigor of core disciplines. Not surprisingly, then, many degree requirements continue to be related to traditional disciplines.

College of Nanoscale Science & Engineering
University at Albany State University of New York

Nano-Link
Midwest Regional Center for Nanotechnology Education

Finally, at this time little is known about the employment outcomes of nanotechnology degree program graduates.

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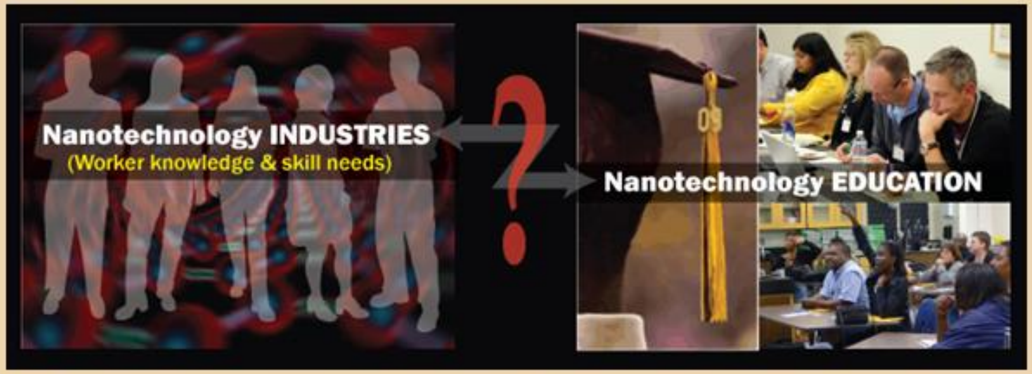
Nanotechnology Workforce Needs of Pharmaceutical Companies Still Evolving



How do companies hire employees with appropriate skill sets for *emergent technologies* that are so new that little experience exists to identify what new skill sets are appropriate? That has been the riddle encountered by CNS-ASU's collaboration with the Heldrich Center for Workforce Development at Rutgers University to study workforce implications of nanotechnology. The centers' recent case study research with two pharmaceutical firms—Merck and Schering- Plough—reinforces earlier survey findings in other industries: the need for specifically "nanotechnology-trained" workers is still limited, and employers continue to hire workers with degrees in traditional scientific disciplines. However, both companies are planning more comprehensive nanotechnology training for incumbent workers, and both reported the need for workers to have greater interdisciplinary knowledge. Moreover, this study found that nanotechnology presents different skill and knowledge needs for different classes of workers, including those in non-technical positions.

Both pharmaceutical companies reported needing very few senior-level nano-technology workers, even in their nanotechnology-enabled R&D divisions. They did note a need for workers to have greater interdisciplinary skills that cross chemistry, biology, physics and engineering. The two firms also want employees to understand health and safety issues, flow characteristics, and be skilled in characterization (i.e., observing, measuring, or analyzing the internal structure of materials to understand how they will react with other elements). The primary area where new knowledge and skills are needed is in biology, such as in how nano-chemical formulations interact with living biological systems. One employer noted that non-technical workers in marketing, sales, legal and general management need to become better educated on both the basic science behind nano-technology as well as the social, legal, ethical, health and safety concerns associated with its use.

Much has been speculated about the extent to which the need for skilled nanotechnology workers will grow. At some point, education systems may need to change radically to allow nanotechnology to reach its full social and scientific potential. However, this research suggests that employers have not yet embraced such a paradigm shift. As nanotechnology matures, policy-makers should track how hiring trends and skill and education requirements continue to change, to better align workforce education with evolving employer needs.

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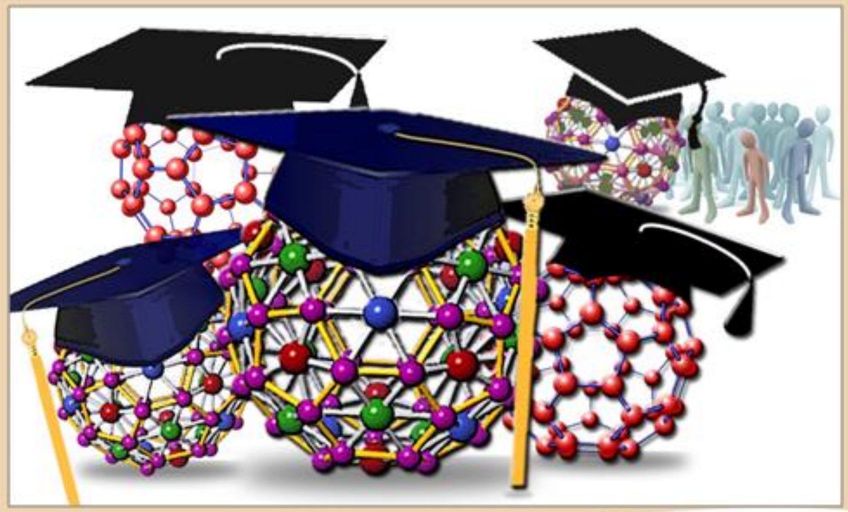
Nanotechnology Info Gap Widening: Is Outreach Getting to the Right Audiences?



The gap in nanotechnology knowledge between the least educated and the most educated citizens has widened over the past five years. According to a CNS-ASU study of national survey data published in the January, 2010 *The Scientist* magazine of the life sciences, Americans with at least a college degree have shown an increased understanding of the new technology since 2004. On the other hand, for those with education levels of less than a high school diploma, knowledge about nanotechnology has declined significantly. These results raise concerns that the group most in need of knowledge and information – those with the lowest levels of formal education – are not being reached by current outreach and education efforts.

Every day that researchers spend not addressing these emerging gaps will create a larger disconnect between scientifically literate audiences and the information poor. There is therefore a real urgency to find ways of communicating effectively with all groups in society. Fortunately, the study also found that the Internet is one of the most effective methods for informing the less educated about nanotechnology. The number of days a week that respondents spent online was significantly related to nanotech knowledge levels. In other words, the Internet may finally live up to its hype as a tool for creating a more informed citizenry by serving as a "leveler" of knowledge gaps about nanotech. The CNS-ASU study offers a clear mandate to researchers to explore the potential of nontraditional ways of connecting with lay audiences.

Read the full article at http://www.the-scientist.com/2010/1/1/22/1.

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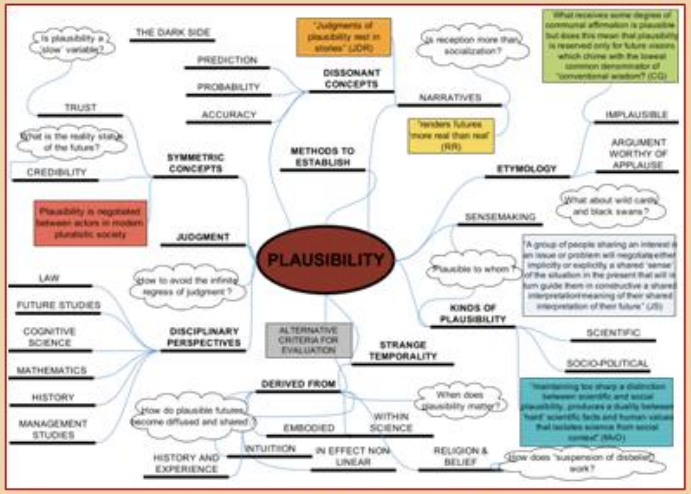
Crafting Research Agendas in Plausibility:
The Plausibility Project Workshop at Arizona State University

There are no future facts yet.

At the same time, there is a need to think ahead, to consider consequences, risks, implications of actions, and desirability in the face of uncertainty and indeterminacy.

This predicament gives rise to a question: How do we assess the quality of *anticipatory* knowledge?

Our normal ways of managing risk and thinking about the future are unsatisfying. Our normal ways of assessing knowledge quality in terms of accuracy, reliability, precision and consistency are problematic. *Plausibility* arises as a viable— though under-theorized and illusive—concept that moves beyond the search for a "factual" encounter with the future.



In November 2009, the Center for Nanotechnology in Society, in collaboration with the Consortium for Science, Policy and Outcomes (Arizona State University) and the Institute for Science, Policy and Innovation (University of Oxford), joined forces with an interdisciplinary group of scenario practitioners, science and society scholars, philosophers and historians to explore the conceptual and methodological underpinnings of *plausibility*: what is it, why does it matter, where is it evaluated and for whom is it a central value.

Three outcomes emerged:

- Identification of the "state of the art" (concepts, empirical studies) regarding plausibility;
- An accounting for research and knowledge gaps surrounding plausibility;
- Development of a coordinated research agenda.

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Responsible Innovation: Integrating the Social and Natural Sciences in Laboratories around the World

Dr. Erik Fisher, Assistant Professor
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Around the world, science polices are calling for "integration" to address broader societal dimensions of science research in ways that have the potential to influence both the process and the products of such research. Despite such calls, neither the capacity of laboratories to respond to them nor the role that "socio-technical" collaborations may play in enhancing such responsiveness is well understood.

STIR – International Laboratory Engagement Study – SocioTechnical Integration Research

Accordingly, the STIR (Socio-Technical Integration Research) project embeds social and human scientists in 20 labs across ten nations on three continents to investigate these questions. Social researchers learn the theory and observe the methods of their laboratory counterparts, but they also introduce a protocol that unpacks social and ethical dimensions of the lab science itself in a real-time, hands-on collaborative manner.

The methods and inquiries of the social scientists become embedded in the laboratory during each engagement study. This process is more fully described at http://cns.asu.edu/stir/.

Integrative activities can trigger changes in laboratory practices, whether by expanding the values and questions researchers consider or by informing material practices themselves.

For example, reflections on responsible innovation generated novel ideas for antenna structures and nanoparticle synthesis for researchers at Arizona State University's Center for Single Molecule Biophysics. Moreover, such inquiries often advance deliberation on public values.

For laboratory scientists, thinking and talking about the broader dimensions of their work in an integrated way need not entail a sacrifice in productivity. Rather, efforts to enhance both scientific creativity *and* societal responsiveness can be mutually reinforcing.

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The Yearbook of Nanotechnology in Society, Volume II: Nanotechnology & the Challenges of Equity, Equality & Development

For at least the past decade, nanotechnology has been touted as the Next Big Thing in technology, the successor to information and biotechnologies. Scientists and policymakers both contend that investments in nanoscale science and engineering will create revolutions in areas as diverse as materials, drug delivery, cancer treatment, and space travel. While new technologies often do provide solutions to pressing issues, the outcomes are not always distributed equally. Nanotechnology will likely prove to be no different. Nanotechnologies could alter distributional dynamics and raise important issues about fairness. They could greatly aid the economies and public health of poor countries, or they could increase the gulf between poor and rich ones. Simply put, nanotechnology will give rise to new risks and benefits, and different areas, peoples, and groups will get different amounts of each.

The second volume of *The Yearbook of Nanotechnology in Society* begins to develop a better understanding of how those changes might play out and what we should be aware of as new nanotechnologies and industries are created.

The yearbook brings together social scientists, engineers, natural scientists, policymakers, NGOs and corporate perspectives from six continents. They present a wide variety of approaches to and methods by which to address nanotechnology, equity, equality, and development. The bulk of the text is made up of academic articles written specifically for the volume. These articles represent the latest work being done in the area. It also includes a number of chapters – including a press release, an advertisement, and reports – that give the reader an idea of how major political players are dealing with and discussing equity issues in nanotechnology today.

Finally, the volume closes with lessons for the future. It includes three articles written by active participants in the policy realm that offer practical advice to both scholars hoping to develop a research plan for better understanding nanotechnology and equity and policy decision makers who want to work for more equitable outcomes.

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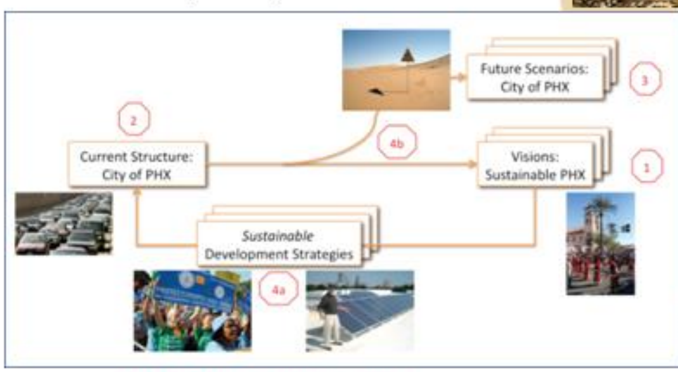
Sustainable Anticipatory Governance: A New Governance Model for Urban Development

Cities across North American face persistent and interdependent sustainability challenges, including loss of economic opportunities, increasing infrastructure requirements, issues of resource scarcity, climate change impacts, poverty and violence. Emerging technologies, such as nanotechnology, have the potential to remake cities from the bottom up, but come with their own risks. Add in demographic shifts and a lagging U.S. economy, and it is clear that urban "planning as usual" is likely to fail to address such complex issues. Phoenix, Arizona faces all of these large-scale systemic challenges to planning for a sustainable future.

The Center for Nanotechnology in Society at Arizona State University is partnering with ASU's School of Sustainability to collaborate with the City of Phoenix in the development of a new governance model for the city's long-term development. *Sustainable anticipatory governance* integrates ideas of sustainability governance with anticipatory governance. Sustainability governance is a guiding principle for actions that balance socio-economic demands with maintaining a critical quantity and quality of natural resources and ecosystem services. The community is designed in such a way that its material and social structures do not interfere with nature's ability to sustain life. Anticipatory governance maintains that addressing sociotechnical dilemmas early on affords greater opportunities for creating positive societal outcomes. The process is informed by a future-oriented capacity for deliberation. Together, *sustainable anticipatory governance* embraces more democratic and transparent decision and policy-making, so that risk is dealt with proactively, with creative anticipation.



The overall objective of this project is to develop sustainable development strategies for the city of Phoenix. Four research questions will be addressed: (1) What is a coherent sustainability vision for Phoenix? (2) What is the current state of the city? (3) What are potential future pathways of the city over the next 25 years? What are anticipated path dependencies, and what critical sustainability challenges might emerge? (4) What would be the critical coordinated steps to transition to the future vision? This project kicked off in Spring, 2010 with a workshop course co-taught by the PIs on "Future Scenarios, Anticipatory Governance, and Sustainability – Urban Development in Phoenix."

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Lessons of Engagement: How Scientists Can Learn from Policy-Makers and the Public

Scientists are often called to present their work to the public in a way that those with no science background can understand. The argument often is made that if the public could only understand what scientists do, there would be undying support for research. The Center for Nanotechnology in Society at Arizona State University challenges this unidirectional notion of influence. While the ability to explain scientific information in simple terms is an important aspect of public communication, it is not a one-way street. Science as a whole will benefit greatly if it regards its relationship with the public as a *two-way conversation.*

Some of the world's most influential scientists gained their status because they listened to and engaged with those outside of science. There are scientists in academia, industry, and government who are able to understand the questions and concerns of both the public and science. These individuals have served as important ambassadors between the two realms – scientists and non-scientists – that are increasingly codependent.

At the American Association for the Advancement of Science Annual Meeting in February, 2010, CNS-ASU hosted a panel discussion with three young scholars who had all participated in engagement projects with policy-makers and/or the general public. They explained not only why they undertook such projects and what they learned through the process, but moreover, how their experiences subsequently shaped their careers and how their scientific work changed as a result.

Troy Benn is a PhD candidate in the School of Sustainable Engineering and the Built Environment at Arizona State University. Troy has partnered with CNS-ASU on several projects, including presenting, at the Arizona Science Center, his research on the release into wastewater of nanosilver in consumer products. The experiences have helped him contextualize, communicate, and grapple with the social and political implications of his research, as he has received much attention from policy, regulatory and industrial professionals.

Naveen Sinha, a PhD candidate in Harvard's School of Engineering and Applied Sciences, participated in a program at the Museum of Science, Boston. By developing analogies and visual aids to explain his research to a general audience, he better understood what fundamental questions remain unanswered in his field. He also discovered that much science today is so interdisciplinary that he has to be able to explain his own field simply, even for other scientists in other disciplines to understand.

The final panel member was Lekelia Jenkins, a PhD and AAAS Science and Technology Policy Fellow working for the National Marine Fisheries Services. Lekelia has learned how to bridge the gap between academic and government scientists in order to address today's increasingly complex science and conservation management challenges.

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Should Corporations Contribute to Nano-Regulation?

What is the best way to regulate nanotechnology? Various groups have participated in the debate, including the U.S. Food and Drug Administration, the Environmental Protection Agency, environmental organizations, and other national and local governing bodies. Surprisingly, even nano-related industries have contributed to the discussion, such as the 2005 DuPont-Environmental Defense Fund partnership to create a "Framework for Responsible Nanotechnology."

In a June 2009 opinion published in *NanoToday**, authors Wetmore and Posner identify some of the benefits and drawbacks to extensive corporate involvement in the development of nano-regulations. Traditionally, industry is supposed to resist regulation, but many companies believe that the right regulations can provide enormous benefits. After all, it is significantly easier for companies to plan for the future when they know what the rules will be.

*doi:10.1016/j.nantod.2009.03.002
http://dx.doi.org/10.1016/j.nantod.2009.03.002

Furthermore, when regulatory guidelines exist for how companies should behave in a certain area, it becomes significantly more difficult to bring suit against them. Regulations thus limit litigation.

A number of environmental and labor organizations, however, have argued that allowing corporations to create a regulatory framework is a conflict of interest that could undermine the federal government's authority. Most companies serve their shareholders' interests over those of the general public; therefore, self-serving regulations that bring short-term profits are an ongoing temptation. Corporate control of policymaking would also likely mean that issues that could slow the product development process, like equity, would be even more marginalized.

Nevertheless, a number of corporate engineers and scientists understand some of the technical aspects of nanotechnology better than anyone else, and such information is vital to the development of sound nano-regulations. Corporations should be encouraged to actively participate in the discussion while remembering that they must ultimately look out for the well-being of the general public.

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S.NET Workshop Teaches Others About CNS-ASU Research Methods

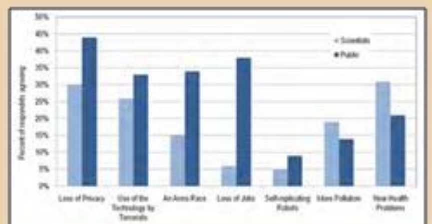
Dr. David H. Guston, Professor of Political Science;
Director, The Center for Nanotechnology in Society at Arizona State University;
Associate Director, Consortium for Science, Policy & Outcomes, Arizona State University

In the five years since being established as a Nanoscale Science and Engineering Center under the National Science Foundation, the Center for Nanotechnology in Society at Arizona State University has pioneered the concept of ***anticipatory governance*** to guide its research methods of ***real-time technology assessment (RTTA)***. But what, exactly, are those research methods? What does anticipatory governance and RTTA look like as implemented by social scientists?

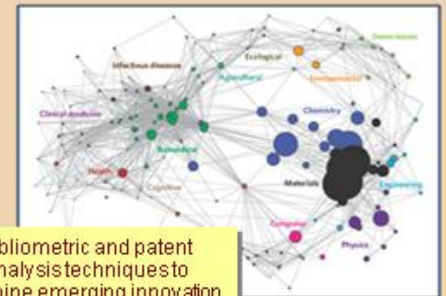
To answer those questions, and to begin the process of establishing forums through which to teach and transfer its methodologies to other scholars, last fall CNS-ASU conducted a workshop at the inaugural meeting of the Society for the Study of Nanoscience and Emerging Technologies (S.NET). The workshop was a prototype for an extended methods course CNS-ASU is planning for winter, 2011. In the half-day S.NET workshop, different CNS-ASU principal investigators presented short sessions describing the quantitative and qualitative techniques they use to conduct real-time technology assessment, shaped by the guiding principal of anticipatory governance.

The CNS-ASU research techniques presented at the workshop included:

Techniques to develop plausible scenarios of technological futures



Public opinion surveys to gauge attitudes towards and understanding of nanotechnology



Bibliometric and patent analysis techniques to examine emerging innovation systems.

The configuration and evaluation of public deliberative exercises on emerging technologies

Participant feedback regarding the prototype workshop was very positive. Attendees valued the professional networking, the overview and diversity of approaches presented, learning what social and natural scientists consider to be societal issues, and the high-quality supporting materials.

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8. Strategic Research Plan

The long-term research goals of CNS-ASU are to demonstrate and refine the ability to perform RTTA and, in doing so, cultivate reflexivity and build the capacity for anticipatory governance in the NSE enterprise broadly conceived. By "reflexivity" we mean a capacity for social learning – by individuals, groups, institutions, and publics – in the NSE enterprise narrowly and society more broadly that expands the domain of and informs the available choices in decision making about nanotechnologies. By "anticipatory governance" we mean a broad-based capacity that extends through-out society that can collect, analyze, synthesize and interpret a wide range of information to manage emerging knowledge-based technologies while such management is still possible (Barben et al. 2008; Guston 2008; Karinen and Guston 2010).

In the first five years of the Center, we have demonstrated the ability to perform RTTA through the individually successful programs, the synergies among them, and the successful completion of the "end-to-end" activity related to TRC 2, Human Identity, Enhancement and Biology (Robert et al. forthcoming 2011), which integrates those programs, as well as that related to TRC 1, Equity, Equality and Responsibility. The ability to extend and refine RTTA required developing two related strengths: the connection among, or "ensemble-ization" of, the Center's programs, and the guiding role provided by the strategic vision of anticipatory governance – and its component capacities of foresight, engagement, and integration – for the research programs.

In the previous year, we embarked on empirical projects we aimed at the Center's activities – in a reflexive mode of turning our methods on ourselves – to gather strategic intelligence for these two crucial tasks and further develop these strengths. As described in the YR 4 annual report, to improve "ensemble-ization," post-doctoral fellow Matt Harsh studied TRC 2's end-to-end process and conveyed his findings to TRC 1.

Harsh continued with CNS in AY 09-10, and in partial response to his findings, TRC 1 was able to achieve significant E2E integration across CNS programs in the production of its forthcoming *Yearbook* (Cozzens and Wetmore forthcoming 2010). The concept of E2E involves collaboration across the research programs of CNS (RTTAs and TRCs). The process involves bringing the expertise and methods of the research programs to bear on one specific area of nanotechnology and connected social dimensions of nanotechnology with the goals of generating novel insights and eventually influencing the innovation trajectory by collaborating with scientists and other decision makers. While the forthcoming *Yearbook* on "Nanotechnology, Equity and Equality" does not focus explicitly on one nanotechnology application (the proposed work of TRC 1 in the renewal will focus on nanotechnologies related to energy and water), it approximates an E2E process. The *Yearbook* draws out new insights about the equity and equality implications of nanotechnology from across the work of CNS researchers in collaboration with relevant decision-making communities and international development practitioners. The links between RTTA 1 and TRC 1 were particularly notable in the development of the *Yearbook*, and several RTTA 1 scholars introduced questions of equity into their work for the first time.

Moreover, changes in team leadership have emphasized substantive connections among research programs, e.g., renewal RTTA 1 co-leader Jose Lobo, an urban economist, and renewal RTTA 3 co-leader Merlyna Lim, with training in architecture, bring substantive connections to interactions with the renewal TRC 2 on urban design, materials, and the built environment.

Also as described in the YR 4 annual report, to strengthen the guiding role of anticipatory governance as the Center's strategic vision, we held a visioning workshop (Selin 2008). As we complete YR 5 of the Center and move into the renewal period, anticipatory governance has enhanced the plans of Center's research programs in ways exemplified below:

Foresight. RTTA 1's creation of a panel of nano-industrial firms will provide further insight into the commercial plausibility of emerging nanotechnologies. RTTA 2 will be conducting surveys, including its YR 5 National Survey, with more quasi-experimental designs to elicit information from respondents that is more oriented toward future expectations. TRC 2 will ground multi-stakeholder discussions of "nano and the city" in a next generation of "scenaric devices" – not just narratives but models, prototypes, and other tools.

Engagement. RTTA 1's industry panel will serve both quantitative and qualitative research goals in an ongoing basis. Data from these firms will be of significant interest to private and public sector decision makers, and gathering and presenting them will increase the Center's profile among both communities. RTTA 3's planned deliberation activity, while not as intensive as the NCTF conducted in YR 3, is potentially much more extensive and even self-perpetuating. TRC 1's research plan on distributional technology assessment is oriented toward engaging with researchers, both for- and not-for profit private sector groups, and public sector entities in the countries it will study.

Integration. The Center is expanding integrative activities by replicating most components of its extensive partnership with the Biodesign Institute in a new relationship with the Ira A. Fulton Schools of Engineering and by conducting the STIR project, which reproduces RTTA 4/2's midstream modulation protocol in 10 different comparative, international integration studies. RTTA 2 will perform another extensive nano-scientists' survey, the results of which will feed freely into the other programs. TRC 2 will conduct integrative workshops, similar to the IPNS workshop CNS-ASU conducted in YR 2, in two of its countries of study.

The visioning workshop identified a number of "bumper-sticker" themes for the ongoing development of anticipatory governance. Here we describe how each theme reflects developing and planned programs at CNS-ASU.

1. Train, baby, train. As suggested in part by the number of student theses produced, the Center has created a strong research training program for undergraduates, graduate students, and post-doctoral researchers. It has also created a set of innovative courses for undergraduates and graduates and informal education experiences for learners of all ages. Nevertheless, the number of trainees at any level that can be supported directly through CNS-ASU is limited. A major training initiative in the renewal proposal is thus to host a Winter School in the Anticipatory Governance of Emerging Technologies, which will allow us to reach an additional 20 graduate students and post-docs from around the world each year. The renewal also commits the Center to "modularize" its classroom innovations for broader distribution, and we have hired in Aug 09 Gretchen Gano as an education and outreach coordinator (75%) to assist in this task.

2. Demonstrate and translate. CNS-ASU expertise and analysis has influenced a variety of audiences. Its searchable definition of nanotechnology has been adopted by a major European effort to understand and promote NSE innovation. It has organized a standing-room-only briefing to the Congressional Nanotechnology Caucus on public understanding of and engagement with nanotechnology. It has collaborated with NISE Net to communicate ideas of the societal aspects of NSE alongside of the technical aspects at science museums. And it has had a significant influence on the scholarly literature. While we have hired an education and outreach coordinator, our plan to hire a coordinator for private sector engagement (funded by supplement) has been delayed for reasons already discussed with NSF, CNS-ASU has, however, begun to develop more systematic and provocative ways of engaging specific audiences, particularly by

producing videos of some Center activities for dissemination on the web site. Other ideas, e.g., translating core concepts and activities into vernaculars of target audiences, e.g., an issue brief series for policy makers, a narrative series for lay publics, etc., are in the planning stages. In particular, CNS-ASU's parent center, the Consortium for Science, Policy and Outcomes, is planning a series of "handbooks" – targeted to professional-level students and practitioners – on the new science and technology policy tools that it is developing. Both RTTA and anticipatory governance will be represented in this series.

3. Reach out: Disseminate, explore, sell. While CNS-ASU has involved a variety of stakeholders and publics in its activities – from the broad lay public in its NCTF, to health policy experts and practitioners in its Future of Medical Diagnostics Workshop, and from private sector interests and public officials in a pair of Mar 09 briefings to in-service high school teachers in a specifically designed course – the Center can still be more pro-active in reaching out to such audiences. In the renewal period, CNS-ASU will more directly explore the interests of government, business, and other stakeholders in the kinds of work it does and can do. Activities under development include the Center's close participation in the development of "Future Tense," a documentary on the societal aspects of emerging technologies planned for public television. More importantly, the new TRC 2 – "Urban Design, Materials, and the Built Infrastructure" – planned in the renewal period is directed at public and private sector decision makers in an urban context, and the Center has a variety of concrete plans in place to foster the necessary collaborations with them. Preliminary to the official launch of this research program, CNS-ASU has supported a new studio-style class in ASU's School of Sustainability, taught be renewal TRC 2 co-leader Wiek and renewal RTTA 3 co-leader and assistant director for outreach Selin. This class has already developed substantial networks in the city of Phoenix around the topics of sustainability and anticipatory governance. And while CNS-ASU was not an official sponsor, its role in collaborating with ASU's Phoenix Urban Research Laboratory (PURL) in planning the renewal TRC 2 led to an exceptionally successful panel at the recent AAAS annual meeting on Urban Design and Energy Demand, organized by former PURL director Levinson, who was to be a senior investigator in the renewal but has since left ASU.

4. Research differently. Although the Center's four-fold mission in research, training, engagement and partnership is not unique among NSF-sponsored academic centers, CNS-ASU strives to take a different approach in creating close synergies within and among these activities, e.g.: the "End-to-End" research activities that allow the RTTA 1 bibliometric and patent databases and the RTTA 2 surveys to be resources for RTTA 3 deliberations and TRC analyses; the interweaving of education and outreach through training students to conduct NanoDays and other informal educational programs; and the integration of research and training in studio courses like InnovationSpace and in courses like the undergraduate Learning Community and the graduate "Governing Emerging Technologies" that draw their pedagogy directly from the research experience. CNS-ASU continues to research differently by expanding its perspective in a more global direction and by contemplating the role of RTTA and anticipatory governance in the context of the broader innovation system. To bring a more global perspective to the renewal, CNS-ASU includes at least one explicit international partner for each major program activity, and the budget explicitly includes funds to host international visits (although we were unable to fund any of the planned international subcontracts with the budget award received). The Center will also situate its work in the broader innovation system, for example, through interactions between RTTA 1's study of the geographic aspects of NSE innovation and enterprise formation, TRC 1's international research related to equity and

development, and TRC 2's focus on the role of NSE in the city. Indeed, TRC 2 allows us to ask questions about nano and the city that are not delimited to the US national context, and the leaders of the primary activities involved (TRC 2 co-leaders Wiek and van der Leeuw; RTTA 3 co-leaders Selin and Lim) all have PhDs from non-US institutions and extensive, active international connections and collaborations. In the current year, both Selin and Lim are engaged in preliminary activities in Northern Europe and Southeast Asia, respectively.

5. Grow. CNS-ASU began as a network, led by ASU, among research groups from five other universities (Wisconsin, GA Tech, Colorado, Rutgers, and NC State). The Center has since added researchers at UC Berkeley, Georgia, University of New Hampshire, and CO School of Mines and has served as a hub for literally dozens of short- and medium-term international visitors to learn about RTTA and the anticipatory governance of nanotechnologies. We have reached scores of graduate-level scientists and engineers through courses, seminars, co-curricular training activities, workshops, research collaborations, and we have influenced the curriculum of two new nano-related degree programs at ASU. Whereas, the first annual report included about 90 affiliated individuals; in this annual report we include more than two hundred individuals who have interacted substantively with the Center by drawing on its resources or data and providing it services and expertise. We plan to continue extending our reach by retaining relationships with our collaborators at ASU's Biodesign Institute while expanding programs that we pioneered there to the Ira A. Fulton Schools of Engineering (embodied by Deirdre Meldrum, Dean of Engineering, as a co-PI in the renewal). But TRC 2 represents a significant commitment to expanding contacts beyond engineering and materials through the fields of architecture, design, public affairs, sustainability and urban planning. Our leadership team for the renewal includes four people not previously affiliated with the Center (and the new networks they bring).

6. Play well with scientists and engineers. CNS-ASU has developed an exceptional track record in collaborating with NSE researchers. While ASU leadership has sought to cultivate an environment of collaboration and interdisciplinarity, CNS has taken advantage of this environment to develop and implement a clear vision of what such collaborations can be, exemplified by a dedication to working toward mutual research and educational outcomes, and experience in designing appropriate protocols and curricula that embody these approaches. Indeed, the Center's two largest spin-off awards, STIR and its EESE award, exemplify these qualities in research and education, respectively. While the transition from collaborating with Biodesign to collaborating with Engineering may be challenging, the Center has already developed inroads into the latter through collaborations with professors Paul Westerhoff (and his recently graduated doctoral student Troy Benn), Jonathan Posner (who has included CNS activities on his sponsored projects), and Trevor Thornton, leader of the Arizona Institute for Nano-Electronics and the new NNIN node at ASU. The Center will attempt to expand its playing field of collaborative scientists and engineers by working in the renewal with such groups at ASU as the National Center of Excellence in SMART Materials, which emphasizes engineering solutions to sustainability problems, and internationally through STIR and integrative activities in TRC 2.

9. Research Program, Accomplishments, and Plans

As described briefly above, CSN-ASU research programs are divided into two types: the Real-Time Technology Assessment programs with a more use-inspired agenda, and the cross-cutting Thematic Research Clusters with a more curiosity-driven agenda. Key to the success of the Center is not only their individual productivity, but also the interaction among them and their accord with the strategic research plan. While key contributions in foresight, engagement and integration are evident from other areas in this Report, we continue to offer descriptions of "ensemble-ization" at the conclusion of each section.

RTTA 1: Research and Innovation Systems Analysis (RISA)

Personnel – faculty and senior participants

Philip Shapira, RTTA 1/1 leader (Georgia Tech, professor, Public Policy) (GT PI)

Barry Bozeman (University of Georgia, professor, Public Affairs)
Aaron Fichtner (Rutgers, director of research, Bloustein School of Planning and Public Policy and Heldrich Center for Workforce Development)
Erik Fisher (ASU, assistant professor, School of Politics and Global Studies and CSPO)
Nils Newman (Intelligent Information Services Corporation, Atlanta)
Alan Porter (Georgia Tech, professor emeritus, ISYE and Public Policy) (GT Co-PI)
Juan Rogers (Georgia Tech, associate professor, Public Policy)
Daniel Sarewitz (ASU, professor, CSPO and School of Life Sciences)
Carl Van Horn (Rutgers, professor, Bloustein School of Planning and Public Policy and Heldrich Center for Workforce Development)
Jan Youtie (Georgia Tech, senior researcher, Enterprise Innovation Institute and adjunct associate professor of Public Policy) (GT Co-PI)

Other Personnel – graduate students (8), undergraduate students (3), visiting scholars (5), post-docs (1)

Goals. The overarching goal of RTTA 1/RISA is to characterize the technical scope and dynamics of the NSE enterprise and the linkages between it and a variety of public values and outcomes. The major research theme – RTTA 1/1: Research Program Assessment – characterizes the NSE enterprise and its dynamics through data-mining techniques such as bibliometric and patent analysis, as well as through text-mining, interviews, and other methods. The strategic areas of emphasis are: the organization, structure and trajectories of emerging nanoscience and nanotechnology enterprise and application.

Research Accomplishments and Plans, RTTA 1/1.

RTTA 1/1 Research Program Assessment originally constructed a large-scale set of global databases of nanotechnology research publication records comprised of 1.1 million articles including 406,000 from the Web of Science's Science Citation Index (SCI) and others from INSPEC and Compendex, covering the period 1990-2006 (mid). In addition to the publication database, we also have developed a patent database that includes 54,000 nanotechnology patents (from 70 patent offices worldwide, including USPTO, EPO, WIPO, and the Chinese State Patent Office) covering the 1990-2006 (mid) time period.

The database originates out of a two-stage bibliometric search method that was developed and published in Porter et al. (2008). This method is emerging as a public tool that other research groups are using or adapting. The article describing the database has attracted 52 citations in Google Scholar (as of April 2, 2010) and 12 citations in the Web of Science, despite its recent publication date. Researchers associated with the Euro Nano Observatory compared six search approaches in preparation for its research

monitoring activities and found that five of the six, including our approach, converge on a similar definition (Huang et al. 2008). As a result, the Euro Nano Observatory (a Framework Programme 7 project involving 16 partners from 10 European nations; see http://www.observatory-nano.eu/project/) is following our search approach as its benchmark for monitoring nanotechnology R&D.

In Year 5, a major effort was successfully completed to update the database to capture publications in the 2006-2009 time period, which resulted in a total of 1.6 million articles including 740,000 in SCI for the period 1990-2009. In YR 5, we undertook pilot work to develop a new updated patent database using PatStat. This database includes more than 88,000 records from more than 90 countries. Additional databases of leading US nanotechnology-based firms and patent citations have been developed. The datasets are being exploited to assess nanotechnology research and innovation implications, resulting in 30 publications and working papers in the current reporting period.

Selected findings from this research include:

- Nanoscience exhibits characteristics of multidisciplinarity based on cognitive integration of disciplinary-diverse knowledge sources in cited references (Porter and Youtie 2009). This finding is part of an effort to address the interdisciplinary characteristics of nanotechnology. The study uses science overlay mapping techniques and reference citation analysis of subsamples of the aforementioned database of 508,000 nanotechnology publications extracted from SCI. The results show that nanotechnology exhibits a high degree of disciplinary diversity and nanotechnology publications cite, and therefore draw knowledge from, work from a wide range of disciplines. These findings emphasize the importance of assisting nano-researchers' ability to source knowledge from disparate areas will be a potential foundation for the future development of nanotechnology.

- Inventor locations of nano patents indicate that US multinational enterprises are not widely decentralizing nanotechnology R&D (Fernandez-Ribas and Shapira 2009). This conclusion stems from an examination of globalization of R&D in nanotechnology developed through a patent analysis of the US and international inventor locations of the 25 leading nano patenting US multinational corporations (MNCs). Econometric modeling of the data finds that the location of US MNC inventive activity internationally in nanotechnology is a function of host country technological breadth, science and technology capabilities, and market factors. Yet, while host country capabilities are important in the globalization of nanotechnology R&D, an even greater share of MNC inventive activities in nanotechnology occurs within the US.

- While most of the leading nanodistricts are found in locations that were prominent in previous rounds of emerging technologies, new geographic concentrations of nanotechnology research have also surfaced (Shapira, Youtie and Carley 2009). This finding is based on an examination of nanotechnology research and commercialization at a regional level. Leading US and European prototype "nanodistricts" or metropolitan areas active in nanotechnology research are identified based on publication characteristics over the 1990-2006 timeframe. The factors underlying the emergence of these metropolitan areas are probed through exploratory cluster analysis. Total publications and corporate publications are most consistently and positively associated with nano patenting in US nanodistricts.

- Nano environmental health and safety (EHS) research is growing rapidly, although it is orders of magnitude smaller than the broader nano S&T domain. Nano EHS work is moderately multidisciplinary, but gaps in biomedical nano EHS's connections with environmental nano EHS are apparent (Youtie et al. 2009)

- There is a sharp rise in active nanostructure publications in 2006 that is maintained in subsequent years, suggesting a shift in research from passive to active nanostructures. This work presents five active nanotechnology prototypes and suggests societal implications of this shift. (Subramanian et al. 2010)

- US companies remain the largest producers of corporate publications and patents worldwide. US corporate activities in nanotechnology have grown in absolute terms in the 1990s and 2000s. However, as engagement in nanotechnology has developed internationally, the relative worldwide share of US companies has declined as corporations based in other countries have expanded their entry into nanotechnology and increased their publication and patent outputs. (Shapira et al. 2010)

- The engagement of social science with nanotechnology (Shapira, Youtie, Porter forthcoming). Based on the development of a publication database of more than 300 social science articles that address the topic of nanotechnology, the study finds multiple dimensions of cited literature and an increase in social science citations of other social scientists' works since 2005.

Several new research papers are in the pipeline, including:

- The cognitive geography of nanotechnologies and knowledge flows (Porter and colleagues). This strand of research seeks to use overlay maps, citation analysis, and case studies to examine the flow of knowledge across disciplines in nanotechnology.

- Research centers as a policy tool in the US National Nanotechnology Initiative (Rogers). Using a database that compares nanotechnology research centers to other research centers and unaffiliated researchers, this study suggests that commercially-oriented activity is greater among the nanotechnology centers.

- A significant shift has occurred in recent years in the orientation of corporate nanotechnology activities, from research discovery to patented applications (Shapira and colleagues).We find that the character and structure of corporate nanotechnology activity by country is influenced by national innovation system characteristics and prior public research funding patterns, confirming that public policies and processes at the national level remain vitally important in establishing frameworks for nanotechnology commercialization.

- The role of women in nanotechnology patenting (Meng) draws on gender-assignment of inventors associated with 27,000 nanotechnology patents from 2002-2006 and a comparison of characteristics such as team size, assignee type, and subject classification.

- Research and commercialization of nanotechnology in China (Shapira, Wang). China has the second highest number of SCI publications, but ranks much lower in terms of commercial patenting. This research draws on case studies and bibliometric analysis to uncover the factors associated with the research-commercialization gap.

- Nanotechnology and US-China knowledge moderation (Tang, Shapira). To uncover factors underlying the rise of Chinese-authored publications, this research focuses on US-China co-authored papers and the role of the knowledge moderator in the flow of knowledge between the two countries.

In YR 5, RTTA 1 researchers significantly enhanced the corporate patenting side of the Georgia Tech global nanotechnology database. Initial aspects of creating a panel of large and small companies actively involved in nanotechnology-enabled product and materials development were implemented.

In Year 6, RTTA 1 proposes to continue to update and refine its research with real-time assessment and policy work along two themes:

1. To deepen probes, through new analyses and methodological approaches, of developments in the organization, structure and trajectories of emerging nanoscience. In this area, we will continue to mine its global datasets and develop collaborations inside and outside of CNS-ASU. Subsequent work will focus on the influence of nanoscale science and engineering centers on the nanotechnology R&D domain, highly creative research, and trajectories of likely emerging nanotechnologies technologies warranting impact assessment.
2. To develop a new stream of research on nanotechnology enterprise and applications. This theme will develop real-time strategic intelligence about nanotechnology commercialization in the US and globally. The primary new research thrust will be to create a corporate nanotechnology panel comprised of 250 US and 250 international large and small enterprises involved in nanotechnology. This panel will be used to address research questions such as (1) what kinds of linkages do these companies have with universities and other research institutions? (2) how is strategy for introduction of nanotechnology-enabled products and materials construed in the face of uncertainty? (3) where do these companies and their products fit in the global supply chain and where is inventive activity geographically located? (4) what international boundaries are these supply chains crossing and what role do consumer values and demand play? (5) what kinds of employment and training needs and issues do these companies face? and (6) how does nanotechnology-related governance and regulation affect the plans and practices of these companies?

Research Program, Accomplishments, and Plans, RTTA 1/2

RTTA 1/2 Public Value Mapping explores the connections between claims of contributions to public values made on behalf of a research activity like nanotechnology and empirically identifiable outcomes associated with those values. Based on a model articulated by Bozeman and others (Bozeman 2002; Bozeman 2007; Bozeman and Sarewitz 2005), RTTA 1/2 is collaborating with an associated but separately funded project (NSF SBE-0738203; Sarewitz, PI; Bozeman, co-PI) to elaborate PVM across a number of case studies, four of which involve nanotechnologies. PVM provides a model of innovation and major intellectual advances based on widely shared and non-economic, i.e., public, values. As there are potential market failures, there are likewise potential public values failures, including: interest articulation or aggregation, imperfect monopolies, benefit hoarding, scarcity of providers, short time horizon, conservation of resources, and threats to human dignity and subsistence.

The nano-related cases under development include:

- Cancer health disparities, developed by Catherine Slade, post-doctoral research associate, investigating the extent to which novel nano-based therapies for cancer might or might not contribute to exacerbating health disparities;
- The use of nanotechnologies to improve water quality, being developed by Beth-Anne Leech, a doctoral student at University of Georgia;
- Technology transfer and nanotechnologies, being developed by CNS-ASU doctoral student Walter Valdivia; and
- The use of the PVM framework for analyzing energy nanotechnologies, under development by ASU researcher Fisher and in conjunction with graduate student Derrick Anderson.

The project has formulated a standard approach for each of the cases, involving narrative descriptions of the social problems and stakes involved in the case, the imputed public values and policy statements

articulated, the case content, the state of the knowledge value and user communities, an assessment of the public values failures involved, an assessment of the market values involved, an analysis of the values chain that links articulated public values to outcomes, and recommendations.

Work to date by Slade on nanotechnologies and cancer health disparities begins with the following observations about the social problems and stakes involved. Racial disparities in cancer survival continue to grow. For nanomedicine to be the new nemesis of cancer that it is supposed, potential therapies must be identified through clinical trials. Yet, minority participation in clinical trials continues to decline, and so how can it be ensured that minorities benefit from nanomedicine advances?

Slade has completed a PVM case study using qualitative and quantitative analysis to assess the public value failures in the nanomedicine case as follows:

- Interest articulation or aggregation: NIH requirements for minority participation in sponsored research dating back to 1993 have been largely ineffective in increasing proportion of minorities in trials.
- Imperfect monopolies: Minorities, especially low income persons in minority groups, tend to receive their health care in private community settings least likely to have physicians with access to or an interest in participation in clinical trials.
- Benefit hoarding: Lack of diversity in potential study populations (those with access to participating physicians or centers) results in inequitable distribution of clinical trials (often life-saving) resources. Most trials limit co-morbid conditions that are more prevalent in minority populations.
- Scarcity of providers: There is a lack of minority physicians in general, and only 3 to 4% of board-certified minority physicians participate in clinical trials (compared to several times that for white physicians).
- Short time horizon: Healthy People 2010 and 2020 short term goals for cures for cancer and elimination of health disparities are inconsistent with timeframes for nanomedicine development.
- Conservation of resources: There is no replacement for cultural diversity, yet health policies often ignore the benefits and treat minority populations as expendable.
- Threats to human dignity and subsistence: Results of clinical trials often have limited generalizability to the population as a whole, with even less generalizability to minority groups that may experience different biological responses to drugs and devices than most study participants. The result could be greater risk to minorities of the "unintended consequences" of nanotechnology.

Slade's case study report is currently under review for inclusion in volume 2 of the *Yearbook of Nanotechnology and Society* (Cozzens and Wetmore in press 2010). A paper using the same data is under review in *Minerva* (see below). A manuscript referencing the case study is under review by the *American Journal of Public Health* and Slade has submitted aspects of the study for the *Encyclopedia of Nanoscience and Society* (Guston in press 2010). The study was referenced in a recently accepted article concerning policy values articulation in *Scientometrics* (Fisher et al.) and in an invited article on equitable distribution of science in *Policy Sciences* (Bozeman, Slade and Hirsch et al). The data from the study will also be used for a book chapter entitled *Lessons from Developed Countries* (Bozeman, Slade and Boardman) in *Making it to the Forefront: Nanotechnology – A Developing Country Perspective* (Duda, editor).

Similarly, the work by Leech on nanotechnologies and water quality begins with the following observations about the social problems and stakes involved: First, clean drinking water is essential to human survival, and there is an increasing demand for clean water especially in developed countries.

Nanotechnologies can, and have been touted as being able to, address several water quality problems including remediation and desalination. Nanotechnologies have also been implicated in potential environmental health and safety concerns. Do the short term benefits of nanotechnologies for water purification outweigh the long-term hazards of potential nanoparticle contamination?

Leech assessed public value failures of nanotechnology and water quality as follows:

- Interest articulation or aggregation: The public generally takes clean drinking water for granted until there is a problem. Prior problems have been of relatively small scale or duration. This produces complacency.
- Imperfect monopolies: This failure is less relevant for this study. Most water systems are public, although some systems have more political and economic clout than others.
- Benefit hoarding: Water distribution systems allow negotiation between providers that could result in inequitable access to cleaner water. More affluent communities could have earlier and greater access to new technologies.
- Scarcity of providers: Local water agencies have scarce access to technical expertise in nanotechnology. The high cost of new water quality systems, coupled with an existing, aging infrastructure predicts the maldistribution of new systems.
- Short time horizon: The long-term effects of nano-particles as water contaminants are unknown. Less is known about the combination of new nanotechnology and aging water quality infrastructure (most tests in laboratory settings).
- Conservation of resources: There is no substitute to water – once contaminated it is often too late to recover without significant cost. Once water systems are retrofitted for nano, alternatives would be few and costly in the case of failure.
- Threats to human dignity and subsistence: Clean water is necessary for survival.

Leech continues to use the data collection thus far for her course work and dissertation for her PhD degree in Public Administration and Policy at the University of Georgia. Slade and Leech have developed a research plan to collect survey data from water works managers in Georgia to assess their readiness for investments in nanotechnology to address decrepit water and sewage systems. The journal for submission has not been determined as of yet

ASU graduate student Valdivia – who also works with TRC 1 – has developed an augmented model of policy evaluation (or AMPE) for PVM, which he is applying to technology transfer policy. This new model expands policy evaluation to consider the public values that motivated the policy. In the case of technology transfer, the application of AMPE led Valdivia to understand that while some outcomes are desirable (e.g., increase in university patenting activity) certain others are less desirable (e.g., monopolistic pricing) when these outcomes are assessed against a set of basic requirements of democratic policymaking (Bozeman's public value failure criteria). This type of analysis favors a deeper understanding of the trade-offs presented in every policy domain. It becomes evident from the case technology transfer that the necessity of using profit incentives needs to be balanced against social demands for broad distribution of the benefits of nanotechnology. AMPE is also more consistent with the tenets of anticipatory governance because it does not rely, as many policy analytic perspectives, on the presumption that policy planners and implementers can predict outcomes.

As a result of feedback and findings from the RTTA 4/2 Photon workshop, Fisher, graduate student Anderson and undergraduate Renolds created a database of policy documents in order to map public values across science policy authorization and implementation processes. The database consists of over 1,000 documents with over 100,000 pages from major contributors to the NSE policy discourse including Congressional reports, NSF program solicitations, and NSF funded award summaries. This database has

in turn provided CNS-ASU with an empirical basis for understanding the public values content embedded in the policy context of NSE laboratories. In a forthcoming publication in *Scientometrics*, Fisher, Slade, Anderson and Bozeman demonstrate that quantitative analysis of value statements can provide a credible and robust basis for policy analysis. In a significant contribution to the growing field of PVM, they reveal a multifactor structure of public values that has been consistently cited by a range of actors across the NSE research policy network. RTTA 4/3 researchers also plan to track and map sequential changes in values across time and across multiple levels of the science policy implementation process. They will also collaborate with RTTA 2 researcher Corley to conduct a policy content analysis in parallel to the media content analysis of nanotechnology that RTTA 2/2 researchers have conducted. This project thus simultaneously advances the goals of three RTTA programs.

A special issue of the journal *Minerva* devoted to PVM is now under review. Submitted articles include nanotechnology PVM case studies by Slade (cancer applications) and Valdivia (technology transfer), along with three other cases, and an introductory article on theory and method by co-PI Sarewitz and Bozeman. This will represent the completion of RTTA 1/2 Public Value Mapping unless additional funds are raised.

Research Program, Accomplishments, and Plans, RTTA 1/3

RTTA 1/3 Workforce Assessment, based at Rutgers, The State University of New Jersey, completed work on two projects in YR 5: first, case study research on the demand for workers with NSE skills in the biotechnology and pharmaceutical industries in the New Jersey area (Van Horn et al. 2009a); and second, a study identifying and describing the development of NSE degree programs at US post-secondary institutions (Van Horn et al. 2009b).

In the first project, the team analyzed data on NSE patents generated by RTTA 1/1, as well as information on nanotechnology stocks, to identify companies in the selected region engaged in NSE research. The team worked with industry organizations in New Jersey to gain access to scientists, senior managers, and others at identified companies, completing case studies with two large pharmaceutical firms. The number of interviews was limited by the low number of workers involved in NSE-related work at each company. In addition, biotech/pharma companies engaged in NSE R&D or product development seemed somewhat reluctant to discuss such work due to perceived public concern over the use of nanotechnologies in personal care and other products.

Findings from the case studies suggest that the current demand for workers who have specific NSE skills is limited in New Jersey's biotech/pharma companies. Even among two companies that have generated significant patents in NSE (according to data collected through RTTA1/1), few workers required in-depth, NSE-specific skills. As the team found in its previous study of the Arizona region (Van Horn and Fichtner 2008), companies are also uncertain of their future hiring needs. In the biotech/pharma industry, uncertainties about future hiring are exacerbated by industry-wide employment volatility worsened by the current recession, the lengthy time horizon for drug approvals, as well as what interviewees suggest is the growing public concerns over the use of nanotechnologies in products that come in contact with the body. Researchers also found that, while a company may be based in New Jersey, NSE-related work is not necessarily performed in-state due to the national and international footprint many pharmaceutical companies have developed. Because of the specialized and limited nature of NSE R&D and manufacturing processes, this work is performed in a limited number of locations spread throughout the US and the world.

According to the case studies, it appears that lead scientists involved in product development and formulation need the highest level of NSE-related skills. In addition, some senior workers in the manufacturing division need knowledge of NSE to design and monitor technologies that handles

nanoparticles. Similar to the Arizona findings, employers generally hire workers with degrees from traditional disciplines, but they stressed a need for interdisciplinary knowledge and skills in core areas associated with NSE such as characterization techniques and concepts from quantum mechanics. Generally, employers report that NSE-relevant knowledge is developed on the job through mentoring with senior professionals. Other workers need a lesser degree of knowledge associated with nanotechnology. For example, lab workers need to understand safety principles for working with particular types of nanoparticles, and marketing professionals need an overview of NSE and the health and safety implications of using nanoparticles in consumer health products and drugs.

In the second project, RTTA 1/3 has identified and characterized post-secondary degree programs across the US focused specifically on NSE. Given the difficulty and costs associated with surveying postsecondary institutions, this study compiled existing, partial inventories of degree programs, such as those maintained by the National Center for Learning and Teaching Nanoscale Science and Engineering (NCLT), the National Nanotechnology Initiative, the Woodrow Wilson International Center for Scholars, and *Small Times*, a nanotechnology industry trade magazine. In addition, researchers conducted structured Internet searches and utilized snowball sampling techniques to identify existing programs. Researchers attempted to circulate a Web-based survey through major, national postsecondary school associations, including the American Association of Community Colleges, the Association of American Universities, the Council of Graduate Schools, and others, but their cooperation in this effort was not forthcoming.

Using these techniques, researchers identified 49 programs that fit the criteria of being post-secondary, degree-offering, and referring specifically to nano in their titles. They then conducted structured interviews with program administrators and reviewed web sites and documents related to degree and course data to identify program characteristics. Researchers also used secondary data sources, such as the Integrated Postsecondary Education Data System (IPEDS), to identify institutional characteristics of the colleges and universities offering these programs. The research had seven specific findings:

1. The total number of programs is small, with associates' degrees being most common, followed by doctoral degrees.
2. Degree programs are not concentrated in areas of high publication activity but rather in response to federal and state investments.
3. Workforce and economic development are key motivators for the creation of associate's degrees, while the rationales for other degrees are more diverse.
4. Employer involvement with degree programs is inconsistent.
5. A shortage of qualified faculty, limited consensus on learning goals, and other factors contribute to varied approaches to the interdisciplinary aspects of programs.
6. Partnerships among related programs, including those across institutions in the same region, are common.
7. Little is known about employment outcomes of program graduates.

The report concludes that the development of nanotechnology degree programs reflects the emerging nature of the technology itself, and that the value of such degree programs for meeting the needs of employers is not clear. The authors recommend:

- continued support for experimental approaches to nanotechnology education until proven models appear;
- encouragement for the involvement of employers in curriculum development and the creation of more transdisciplinary content and institutional partnerships; and
- additional support for further research on post-secondary degree programs and learning and employment outcomes.

This work represents the completion of the RTTA 1/3 Workforce Assessment research agenda.

Contributions to "ensemble-ization" or other center-wide activities.

RTTA 1/1's presentation at the 2009 S.NET Conference workshop led to a publication on environmental, health, and safety in nanotechnology which is co-authored with a CNS-ASU PhD+ graduate. This publication would have never been possible without access through CNS-ASU to the CNS-ASU graduate student who is a scientist in the nanotechnology environmental, health, and safety area.

In addition, there are several other activities to which RTTA 1/1 has contributed:

- RTTA 1/1's organization of the EU-US Transatlantic Workshop on Nanotechnology Research and Innovation Policy included two researchers from CNS-ASU, including one from RTTA 3.
- RTTA 1/1 provided bibliometric analyses for newly created RTTA 3/1 energy scenes;
- RTTA 1/1 provided metropolitan-level data to RTTA 1/3 Workforce Assessment in nano-bio/pharma.
- RTTA 1/1 researchers contributed 3 chapters to TRC 1-led *Yearbook*.

RTTA 2: Public Opinion and Values

Personnel: Faculty and senior participants

Dietram Scheufele, RTTA 2 co-leader (Wisconsin, Professor, School of Journalism and Mass Communication)
Elizabeth Corley, RTTA 2 co-leader (ASU, Associate Professor, School of Public Affairs)

Dominique Brossard (Wisconsin, Assistant Professor, School of Journalism and Mass Communication)
Sharon Dunwoody (Wisconsin, Professor, School of Journalism and Mass Communication)

Other Personnel – post-docs (0), graduate students (9), undergraduate students (0)

Goals. The overall goal of RTTA 2 POV is to monitor, among both the public and scientists, the understanding of and values relating to NSE and its potential societal outcomes, track these variables over time, and examine the role of the media in reflecting and influencing them. POV comprises a set of inter-related research themes around the public, NSE researchers, and the media. RTTA 2/1 Public Opinion Polling is the major project, conducting nation-wide public opinion polls to understand at an aggregate level the public's knowledge of and values regarding nanotechnologies. RTTA 2/2 Media Influence is a research theme that tracks media stories of nanotechnologies and, using a quasi-experimental design, attempts to understand how various media frames for nanotechnology stories can influence the knowledge and opinions of the public. RTTA 2/3 Scientists' Opinion is a research theme that conducts polls of NSE researchers to understand their values regarding nanotechnologies.

Research Accomplishments and Plans, RTTA 2/1

RTTA 2/1 completed its last general, full-scale public opinion data collection in Jul 07. No new survey data collections are scheduled until the renewal period. The 2007 survey was a CATI survey with a combined RDD and listed household sample conducted May – Jul 07 (N=1015; AAPOR RR-3 30.6%; margin of error, +/- 3%). Questions in the survey were specifically designed or chosen to enable comparisons with a 2004 US nanotechnology survey as a baseline and with the 2006 Eurobarometer for international comparative data (the 2008 pre- and post-test surveys for the National Citizens' Technology Forum were crafted to correspond with this survey as well). The survey's content included questions about communication and information environment, strategies for processing scientific information, attitudes and values, nano literacy, perceptions of scientists, policy makers and the need for regulation, and perceptions of the risks and benefits and future developments of nanotechnologies.

RTTA 2 also continued experimental data collections to provide more granular insights into how different groups form risk perceptions about nanotechnology. This directly expands on YR 5 research by RTTA 2 that showed how audiences draw different attitudinal conclusions from risk perceptions on various nano applications, and how these perceptions differ across demographic groups. Finally, RTTA 2 began to refine the media content analyses to explore specific application areas (e.g., food) in greater detail, examining specific themes of coverage related to these application areas.

During Year 5, Scheufele and Corley presented results from these data at national policy and communication conferences and published the results from all three data sources in peer-reviewed journals. Specific findings include:

- Anderson, Brossard and Scheufele (forthcoming) is a partnership with the NSEC research group at Wisconsin. It draws from CNS-ASU data and NSEC data and explores how science audiences

are increasingly using online sources for information about nanotechnology, and what information they are likely to encounter from the most prominent online sources.

- Cacciatore, Scheufele and Corley (forthcoming) explores how the public's associations of nanotechnology with certain application areas (e.g., medical field, military, etc) moderate the influences of risk and benefit perceptions on attitudes about nanotech. The study concludes that when the public associates nanotechnology with application areas, they are more likely to take risk perceptions into account when forming attitudes about the technology.
- Corley, Scheufele, and Hu (2009) explores the way that leading U.S. nano-scientists develop policy stances about nanotechnology. The study concludes that in addition to risk perceptions, nano-scientists also use their economic and social values to make decisions about nanotech regulation. The authors also find that surveillance/privacy, human enhancement, medicine, and the environment are the application areas in which scientists see the greatest need for new nanotechnology regulations.
- Brossard, Scheufele, Kim and Lewenstein (2009) examines how religiosity and other personal values serve as a perceptual filter for audiences when they process information about nanotechnology. In particular, it shows that the same piece of information may be interpreted very differently by audiences, depending on the values and personal predisposition they bring to the table, raising issues – once more – with one-size-fits-all approaches to science outreach.
- Scheufele, Corley, Shih, Dalrymple, and Ho (2009) explores the role of "religious filters" as a heuristic that the public uses for developing attitudes about nanotechnology. This study combines U.S. public opinion data with Eurobarometer data to conclude that respondents in the U.S. are less likely to agree that nanotechnology is morally acceptable than many of the respondents in European countries. In particular, the authors find that these moral attitudes are correlated with levels of religiosity in the countries, even after including control variables for science performance and national research productivity.
- Corley and Scheufele (2010) concludes that despite increasing nanotechnology outreach efforts over the past decade, there is a widening nanotech knowledge gap among members of the public with the least and most formal education levels. The authors conclude that the internet might be one tool that could serve as a "leveler" of these knowledge gaps.

In YR 6, RTTA 2, will focus on the first of two large-scale experimental national studies, conducted by Knowledge Networks. These data will combine the advantages of fairly representative national samples with the internal validity of experimental studies, since they allow RTTA 2/1 scholars to randomly assign respondents to conditions and test their reactions to visual stimuli, educational materials, etc. that could be provided by other RTTAs or other parts of RTTA 2, but also by partners of CNS-ASU (e.g., NISE Net) who would like to explore innovative ways of reaching broad cross-sections of the public with tools for informal science education. The large sample size for this first study will also allow RTTA 2/1 scholars to examine different subpopulations, including those that have been traditionally underserved by science communication efforts (defined by gender, age, ethnicity, or other factors). This will expand on some of this year's analyses that showed widening gaps among highly-educated and traditionally underserved populations.

We will also continue to track media content as part of RTTA 2/2, branching out increasingly into the most prominent application areas, including nano food and nano medicine. In YR 6, RTTA 2 will also continue to utilize the infrastructure we have built for lab experimental research and explore how different populations form attitudes and build knowledge about nanotechnology. Graduate students in Life Sciences Communication and Journalism & Mass Communication will continue to use RTTA 2 from Years 1-5 for dissertations, conference papers, and journal articles.

Contributions to "ensemble-ization" or other center-wide activities.

RTTA 2 is collaborating with RTTA 4/2 over the latter's policy document's database and its ability to inform the former's understanding of the public's and scientists' understandings of NSE.

RTTA 2 provided support and coordination for the extension of work conducted by RTTA 3/4 in follow-up to the NCTF.

RTTA 2 provided expertise in support of the RTTA 3/1 NanoFutures vetting survey.

RTTA 3: Deliberation and Participation

Personnel: Faculty and senior participants

Daniel Sarewitz, RTTA 3 co-leader (ASU, Life Sciences and CSPO)
Patrick Hamlett, RTTA 3 co-leader (NCSU, political science)

Ira Bennett (ASU, assistant research professor, CSPO)
Prasad Boradkar (ASU, associate professor, Design)
Michael Cobb (NCSU, associate professor, political science)
Jason Delborne (Colorado School of Mines, assistant professor, Science, Technology, Society and Policy)
David H. Guston (ASU, professor, political science and CSPO)
Daniel Lee Kleinman (Wisconsin, professor, Rural Sociology)
Cynthia Selin (ASU, assistant research professor, CSPO)
Dosun Shin (ASU, assistant professor, School of Design Innovation)
Arnim Wiek (ASU, assistant Professor, School of Sustainability)

Other Personnel: Post-docs (1); grad students (6); undergraduates (2); visiting scholars (2)

Goals. The central goals of RTTA 3 are to develop multiple, plausible visions of nanotechnology-enabled futures, elucidate public preferences for various alternatives and, using such preferences, help further refine future visions and enhance contextual awareness. RTTA 3 consists of four tightly integrated themes that cover research, education, and outreach. RTTA 3/1 Scenario Development creates, vets, and disseminates plausible nanotechnological "scenes" for further development and deliberation by a variety of stakeholders. RTTA 3/2 InnovationSpace is a collaborative undergraduate design course among ASU's Schools of Design, Engineering, and Business in which transdisciplinary teams of students create product designs, marketing plans, and engineering models of potential products within a framework of responsible innovation. RTTA 3/3 CriticalCorps uses the methods of cultural studies and design to elaborate on the socio-cultural significance of the scenes developed and products imagined by the other RTTA 3 programs. RTTA 3/4 National Citizens' Technology Forum is the first-of-its-kind, independent and joint deliberation of six groups of locally representative lay citizens from across the US on issues in human nanotechnologies and enhancement.

RTTA 3/1 Scenario Development

This section describes two major activities, NanoFutures and Plausibility, in some detail as published findings are not yet available.

NanoFutures: Energy, Equity and Society
NanoFutures creates examples of future nano-enabled energy applications to stimulate and facilitate deliberation about the potential societal implication of nanotechnologies. NanoFutures is not an attempt to get the future "right" by predicting the most likely applications. Instead, CNS is exploring the idea that scenaric thinking can help build a broader social capacity for anticipation. This exercise in anticipatory governance provokes reflection of values, the role of technology in society, and some of the stubborn problems—and solutions—proposed by new technologies.

YR 5 activities consisted of initiating and executing the next round of NanoFutures focused on Energy and Equity which is tied to TRC 1 Equity and Responsibility. This next iteration of NanoFutures follows the same well-functioning structure of activities developed at CNS over the last few years (for background, see the NanoFutures v.1 on human enhancement: http://cns.asu.edu/nanofutures/):

I. *Scene Development:* construct short vignettes of possible nanotechnological futures (which we call "scenes") relevant to CNS-ASU activities.
II. *Vetting:* establish the technical plausibility of the scenes through multi-method investigations in collaboration with NSE researchers in Biodesign, the Fulton School of Engineering, and Georgia Tech, as well as with the TRCs and their contacts;
III. *Evaluation and Elaboration:* create opportunities for dialogue on vetted scenes with targeted audiences and consequently elaborate them into scenarios; and
IV. *Outreach and Broader Use:* use the vetted scenes and elaborated scenarios in other CNS-ASU activities, e.g., InnovationSpace, deliberative engagements, NISE Net, etc.

***I. Scene Development*:**
The Energy, Equity and Nanotechnology theme follows TRC 1 and corresponds to the thematic focus of year 4's InnovationSpace program. The scenes have been developed primarily by Bennett and CNS-Biodesign fellow Kalinowski and were selected and informed by a thorough review of the (rather limited) literature on NSE and the energy sector. The technical scenes have been carefully chosen to fall across a range of 1) applications including generation, transmission and distribution; 2) long and short time horizons; 3) fuel sources (e.g., solar, wind, coal, nuclear, and bio). CNS-ASU is also particularly interested in those technological systems that raise some societal dilemmas. Like NanoFutures v. 1, this program seeks to explore the values informing technological priority setting and choice.

The NanoFutures scenes related to energy and nanotechnology are:

> **What if we could use bacteria to make renewable gasoline?** In this scene, photosynthetic microbes are genetically modified into nanoscale solar-powered factories that turn carbon dioxide into renewable fuels.
>
> The Potential Technology: Solar Conversion to Biodiesel
>
> By 2025, algae-like microbes called cyanobacteria have been genetically engineered to have high oil content. These cyanobacteria are grown in huge outdoor photobioreactors (PBRs), which are arrays of glass tubes filled with water and bubbled with carbon dioxide. The PBRs are very large, covering at least a square kilometer with arrays of tubes holding millions of liters of genetically modified cyanobacteria. The PBRs are located in sunny regions to maximize productivity, and can be installed on land not suitable for agriculture. In order for microbe-derived gasoline to be affordable, the PBRs must be located next to a coal-fired power plant or other economical supply of concentrated carbon dioxide. The PBRs are surrounded by collection troughs to prevent accidental release of genetically-modified cyanobacteria into the environment, should the glass tubes break or leak.
>
> Cyanobacteria are harvested from the PBRs by filtration, and the leftover water is recycled. The concentrated biomass is then treated to break open the cells and extract the oil. This 'green crude' is piped to the same petrochemical refineries that are used to process traditional fossil fuels, where it is converted to renewable gasoline or other fuels. The leftover (non-oil) biomass can be composted or used as feed for livestock.
>
> *Questions for Discussion:*
>
> - How will countries without sunny climates become energy independent?
> - Would you put gasoline from genetically modified organisms in your car?
>
> **What if microbes could produce electricity while cleaning wastewater?** In this scene, bacterial nanowires are used to create electricity from organic waste.
>
> The Potential Technology: Microbial Fuel Cells
>
> Traditional wastewater relies on naturally occurring bacteria to clean the water by using the contaminants as food. Bacteria eat the contaminants in a process that transfers

electrons from one chemical to another. However, some bacteria (such as Geobacter sulfurreducens) can transfer electrons directly to the anode (battery terminal) of an electric circuit. The discovery in 2005 that some bacteria naturally produce nanowires to attach themselves to anodes suggests a new mechanism for direct electron transfer in MFCs, though the details are still being studied. By 2025, it's possible that by putting wastewater and bacteria in a microbial fuel cell (MFC), the electrons from Geobacter and other bacteria can generate electricity and clean the wastewater simultaneously. Improvements in MFCs have included the development of cheap ultra-thin membranes to increase efficiency, and photobiocatalysts to boost power by tapping solar energy. Water treatment plants already power themselves by using MFCs, and generate electricity for the grid as well. Farms use animal and agricultural waste (compost) to power their medium-scale MFCs. In the home, MFCs can be integrated into two square meter units which are connected to the sewer line. They have become popular with those who aren't connected to the electricity grid – and those who simply want to save some money.

Questions for Discussion:

- What might happen to rural areas if it becomes easier to live off-the-grid?
- How will the ownership of energy transform if individuals are able to produce their own power?
- How would you feel about installing and managing your own MFC system?

What if electrical power became ultra-portable? In this scene, new kinds of nanotube-based ultra-capacitors have become increasingly powerful and have virtually unlimited life spans.

The Potential Technology: Ultracapacitors

Batteries can be used to store electricity. Charging and discharging them is slow, and they have a limited life cycle, meaning that they can only be recharged a finite number of times. Capacitors provide the same function as batteries: they store electrical energy, and are typically used to power anything from a digital watch to an electric car. However, since capacitors don't rely on chemical energy (as traditional batteries do), they charge faster and have virtually unlimited life spans.

Capacitors store a charge on electric plates separated by an insulator, which means that the more surface area the plates have, the more energy a capacitor can store. Next-generation ultracapacitors in 2025 may allow us to store more energy than has been possible before by replacing plates with carbon nanotubes packed densely together to provide a high total surface area. These new kinds of ultracapacitors have all sorts of applications – for example storing solar energy for night time use, enabling the widespread use of electric cars and new ways of powering public transport, and in consumer electronics.

Questions for Discussion:

- Will better ultrapacitors in our electronic goods make us more energy hungry?
- Where do you think ultracapacitors are likely to be first applied? (Public transport? Consumer products? Solar energy storage?)
- How do electronics containing nanotechnology compare with today's products terms of recycling/disposal?

What if electricity went wireless? In this scene, wireless magnetic resonant energy transfer enables cable-free transmission of electricity throughout homes, offices, and outdoor spaces.

The Potential Technology: Wireless Electricity Transmission

Wireless magnetic resonant energy transfer is based on the phenomenon of resonance. Just as one vibrating tuning fork will cause another to vibrate in sympathy with it, energy can be transferred through magnetic resonance. In 2025, wireless technologies use a transmitter – a copper coil that acts like an electromagnetic resonator – and a receiver, which consists of a similar sized copper coil. The transmitter sends a magnetic field and the receiver resonates in that field. Transmitters can be plugged into a standard household socket to power any electronic device capable of wireless power within range (roughly 15 feet). They might be used, for example, to wirelessly power stereos or TVs, or to charge laptops and cell phones in urban areas. However, this convenience comes at a cost: about 30% more energy is used to power something wirelessly than through an outlet.
Questions for Discussion:

- How would you feel about your home having wireless electricity?
- Do you think the convenience of wireless electricity is worth the loss of energy efficiency it entails?

What if nuclear power became cost competitive with coal? In this scene, nanofluid coolants have increased nuclear reactor energy production by 20%.

The Potential Technology: Nanofluid Coolants for Nuclear Power

As demand for energy grows and concerns over climate change increase, nuclear energy – which currently produces a fifth of US electricity – is increasingly promoted as a carbon-neutral path to energy independence. However, it would take decades to approve and build a nuclear reactor. Nanotechnology may allow engineers to increase electricity generation of nuclear power plants that are in operation today.
Most nuclear reactors in the U.S. are pressurized water reactors. This type of reactor creates electricity by using pressurized water to transfer heat between the hot nuclear rods and a steam engine that makes electricity. Usually, the pressurized water will start to form bubbles at the rod surface. If too many bubbles form, they begin to insulate rather than cool the rod, thereby limiting the efficiency of these types of reactors. By coating the reactor rods with alumina nanoparticles, bubbles form and are pushed away from the rods more easily, preventing them from accumulating and insulating the rod surface. So by simply adding a small amount (0.1% total volume) of alumina nanoparticles, the heat-removal limit of the pressurized water is increased 70%. This improved ability to transfer heat from the rods results in higher energy production by the nuclear reactor.
Questions for discussion:

- Do we want to accept the myriad trade-offs associate with nuclear power?
- Do you see this as a short or long term solution?

What if buildings were made out of solar panels? In this scene, new kinds of nanotechnology-enabled solar cells mean that solar power is integrated with building materials on a large scale.

The Potential Technology: Thin Film Solar Cells

Solar panels (photovoltaics) have been popular for decades for generating clean, renewable energy. In a typical solar panel, there are two types of silicon-based semi-conductors. The first type converts photons to electrons, and the second type provides a target for the electrons to reach. The electrons that travel between the two semiconductors are wired in a circuit with a fan, a light, or whatever device needs electricity to run. However, communities have rallied against solar panels on grounds of aesthetics, land use and threats to the environment. New photovoltaic technology works the same way as traditional solar panels, but instead of silicon, it uses titanium dioxide nanoparticles

coated with photosensitive dye. The dye captures photons and generates electrons, and the nanoparticles act as the electron target.
By 2025, new homes might be built with tiles coated with thin layers of photovoltaic materials, enabling energy generation to become more distributed. These nanoparticles can even be painted onto surfaces, turning a normal wall into an electricity source. In fact, almost any surface that will receive sunlight can be coated with the photovoltaic material: roads, sidewalks, buildings, cars, or children's playgrounds.
Questions for Discussion:

- Who should own energy from the sun?
- If there is a network of solar electricity generation around houses, streets and cars, who will maintain it?

II. Vetting:

These six scenes, refined from nine, are the final products of an extensive vetting procedure that involved tracking publications and identifying experts through bibliometric studies and running a survey with relevant nano-scale scientists and engineers to assess the scenes' plausibility. Vetting for NanoFutures v.2 evolved from v.1 by supporting both more targeted and more diverse participation. Additionally, the vetting protocol was improved through a more systematic inquiry into plausibility and a better capturing of data through the use of an online survey.

Vetting began with identifying keywords and phrases to capture the unique technological trajectory associated with the scene. For instance, for the Solar Conversion to Biofuel scene, we used "cyanobacteria," "systems engineering," "biofuel," "carbon sequestration," and "algal biofuels." These keywords were sent to our collaborators at Georgia Tech, who performed a bibliometric analysis of the Web of Science database (filtered for nanotechnology-specific publications) to produce lists of authors of peer-reviewed publications who have focused on each technical area. The main goal was to identify such experts to query more specifically in the survey, the bibliometric analysis revealed the number of publications in 2007 and 2008, which helped to assign relevance and prominence to the technological trajectory. For ultracapacitors, e.g., keywords yielded the 126 publications: battery/batteries and variations (~80); multi-walled carbon nanotubes (~10); lithium ion (~15); nanoparticles (~2); electrode membranes (~2); nano-membranes (~2).

Authors of these papers were contacted for the next stage of vetting of the scenes, the online survey. A survey was developed for each scene, asking both closed- and open-ended questions about the scene's technical plausibility, how it could be composed more accurately, whether it captured the key issues at stake, and what its social implications might be. There were also 3 questions focused specifically on the plausibility of the scene (see Plausibility Project below).

Invitations to participate in the surveys were sent to several hundred scientists in total. The response rate was relatively low, with between one and 26 individuals responding to each survey. Based on the comments we received, we altered the scenes to better reflect the direction of current research and the likelihood of particular developments. Where response rates were low or responses to particular questions were inconsistent, we sought advice from individuals working in relevant areas of research at ASU. Full details of the vetting of each scene and the changes made are available in a vetting report created by a CNS-ASU Biodesign Fellow.

The results of the vetting procedures in relation to plausibility will be analyzed in a paper (Selin under development) and presented at the Society for Social Studies of Science annual meeting in Tokyo in Aug 10.

III. Evaluation and Elaboration:

The central deliberative activity centered on an interdisciplinary workshop held in Mar 10. This workshop, "Exploring Solar to Fuels**"** considered emerging energy technologies, their implications for broader society, and the resource, social, environmental and political barriers to their implementation. The Solar to Fuels workshop brought together natural scientists with scholars of technology and society, history, political science, and sociology to envision Solar to Fuels technologies and explore the societal issues at stake. It sprang not only the NanoFutures project at CSN but also ongoing conversations with Steve Goodnick, Director of ASU's Arizona Institute for Renewable Energy (AIRE) and with Gary Dirks, leader of ASU's Lightworks project and of Light*Speed*Solutions, a proposed research project for the Department of Energy's hub competition to create fungible fuels from sunlight.

The workshop's central query was: What are the critical societal and policy issues involved in creating fuel from sunlight? The discussion had a number of aims:

- To articulate and clarify current directions and trends in research, in societal issues, and in policy on this technology;
- To map key insights around future visions of this technology and the critical carriers and barriers that will help and hinder its development;
- To generate material for a social science research article on the societal implications of energy technologies and interdisciplinary collaboration on these.

Selin and Davies led the half-day workshop, which was jointly funded by CNS, AIRE, and LightWorks. They also carried out extensive interviews of the principals prior to the workshop. Central themes for visions of Solar to Fuel technology in 2025 and issues seen as critical to the technology's development were:

- **Barriers and carriers: Key dynamics around the technology's development**

The interviews and workshop explored a range of broader issues seen as critical to how such technologies will develop, including the public and policy context of new energy systems, decisions between centralized and distributed energy systems, and the sense of urgency created by global climate change. These broader dynamics are detailed below.

New energy systems - not just technologies: New energy technologies will require new ways of thinking about science, technology, and society. Not only are new, interdisciplinary forms of working required, but the technologies need to be understood "end to end," i.e., within a context of policy, usage, and technological life cycles. This means that targeted, science-only calls and proposals are no longer effective means of development. New ways of developing human capital - to create a body of workers who are able to integrate different natural and social science perspectives into their thinking - are required to deal with the business, public and policy contexts of energy systems. Similarly, research on and implementation of policy innovation is required. Regulatory and incentive schemes need to develop in ways that keep pace with new technological development but which also manage the timing of this development in ways that acknowledge the urgent need for change in US energy use. Understanding scaling up is also essential: building new power plants and factories can take decades and relies on complex sets of supply chains. If solar to fuels technology is to be rolled out on a large scale, the ability to meet this production capacity - in terms of, for example, materials for mirrors or human capital in the form of engineers - needs to be planned in advance. Research therefore needs to understand not just how a technology might work, but what the industrial ecosystem around it might look like.

The public as a problem? The public is often seen as a challenge to change in energy systems: people are perceived as energy-hungry, energy-inefficient, and unwilling to change their behavior. "Solar has

always had to address some kind of public perception of a problem." Negative or overly pessimistic public perceptions of emerging energy technologies do exist. But to emphasize this is perhaps to take an overly simplistic view: while education programs are certainly necessary, public responses to technology are informed by a wide variety of concerns and experiences as well as an appreciation of scientific facts. Indeed, public understandings of energy technologies are likely to vary widely. More research is needed on the ways in which different public groups will consume, perceive, and make choices about emerging energy technologies such as Solar to Fuel. What kinds of behaviors - from having to go to the gas station to paying more for fair trade or organic food - are likely to be carried over from existing experience, and in what ways will radical new ways of using energy come about? Workshop participants thus felt that more humility in meeting people where they are at is required in order to enable the co-evolution of energy transitions between producers and consumers. Public engagement with new energy technologies needs to be seen as an opportunity, not a problem, and participation should be built into scientific research on these areas. Diverse public groups - legislators, activists, 'NIMBY'ers - should be brought together with those involved in developing new energy technologies in order to understand the ways that these technologies will be used - or not - in practice.

Finding political (and corporate) will: Workshop participants agreed that there is a profound urgency around the development of new energy systems. Climate change is real and will have significant impacts: indeed, the time for action to mitigate its worst effects is probably over. Dealing with these effects would necessitate putting the world's production systems on a "wartime footing" - converting all automobile production plants, for example, into wind turbine factories. Such a conversion will simply not happen, however, given that public and political will is not committed to this sense of urgency. Our current systems have a limited capacity to deal with these unprecedented challenges, and changing this may require major shifts in governing and regulating energy. But we cannot fully predict the ways that Solar to Fuel technology will be taken up by publics or the ways that it will shape global energy use and sale: "Will there be a 'curse in the success'?" Are there challenges around equity, democracy and resource use that are being left unresolved by focusing on CO_2 emissions and climate change? How might individuals have new kinds of relationships with energy and with each other? These kinds of questions should now be considered as part of the process of research and development, in which social and natural science expertise are used in tandem to deal with the complexity of energy transitions. We should also, however, not expect research to give us all the answers. These will be understood in full only as the technology unfolds into everyday experience.

The questions and the themes raised in the workshop call for further research - and for a continuation of interdisciplinary forms of collaboration and discussion. Towards that end, CNS and CSPO were asked to submit a Policy and Society research and education program attached to the Light*Speed*Solution grant proposal to the DOE. An analysis of the pre-workshop interviews and workshop discussions will be described in a paper (Davies and Selin, under development) that looks at the key barriers to future-oriented dialogue about nanotechnology, energy and society.

IV. Outreach and Broader Impacts:

One of the unexpected surprises gleaned from the first iteration of NanoFutures on human enhancement was the value of the scenes in educational contexts. Used in the classroom to stimulate discussion, as a focus of a Science Café in a local museum, or as a center piece for professional lectures, the scenes temper nanotechnology writ large into discrete points of departure for broader explorations of ethics, trade-offs and societal implications. Therefore in YR 5, the scenes are being specially prepared for educational purposes, including informal education by developing "Questions for Discussion" and "For

Further Reading" sections. This effort will ultimately involve packaging, publicizing and distributing the scenes to Center faculty and other educational institutions through CNS's increased capacity in dissemination and targeting, e.g., nanotechnology education programs identified by Van Horn et al. (2009). CNS has also hosted several Science Café's in YR 5 focused on energy to connect to RTTA 3/1 and to gear up for renewal activities related to the built environment.

Plausibility

A second significant activity within RTTA 3/1 in YR 5 involved basic research into future-oriented theory and practice. The Plausibility Project seeks to better understand the meaning and significance of plausibility through questioning the ways individuals and communities know, explore, assess and shape futures across time, cultures and professional practices. In Nov 09, the CNS-ASU in collaboration with the Consortium for Science, Policy and Outcomes and the Institute for Science, Policy and Innovation (University of Oxford) joined forces with an interdisciplinary group of scenario practitioners, science and society scholars, philosophers and historians to explore the conceptual and methodological underpinnings of plausibility; an appreciation of what it is, why it matters, where its evaluated and for whom it occurs a central value.

The outcomes of the workshop were threefold:

1. Identification of "state of the art" concepts and empirical studies regarding plausibility;
2. Accounting for research and knowledge gaps about plausibility;
3. Developing a coordinated research agenda.

Prior to the workshop, invitees were asked: "From your perspective, what is intriguing about plausibility?" Participants' essays in response can be found at: http://www.cspo.org/projects/plausibility/portraits.htm.

The workshop was a dynamic conversation space that incorporated plenary discussions with small group discussion and activities. Discussions were rich and sweeping and contained an unusual adventure, as the concept of plausibility seems to spark deep intellectual curiosity and practical challenges (e.g., in scenario planning methods) in unsettling ways. The results of the workshop are summarized in CNS-ASU report (Selin 2010). An extended reflection on plausibility and the pathologies of probability is under preparation by workshop participants (visiting scholar Angela Pereira from the European Commission is taking the lead). A high level, 2000 word article that charts out the conceptual and methodological status of plausibility is being developed by CNS-ASU faculty with University of Oxford faculty Wilkinson and Ramirez. Selin is also preparing a NSF STS proposal to develop a virtual library on plausibility which will help to establish the budding body of literature on the subject. The Plausibility Project is also serving as a site to develop CNS-ASU's multi-media capacities by prototyping a variety of outputs and dissemination products (blog post to documentary) on the project.

The **Social Challenge of the Future Series** was connected to the Plausibility workshop, through which the visiting scholars shared their latest work with the broader ASU community of faculty and students. There were four seminars in Nov 09 hosted by CNS-ASU and further supported by ASU's College of Liberal Arts and Sciences:

- "New Current in Post-Normal Science" with Silvio Funtowicz, Angela Pereira, and Jerry Ravetz;
- "Radical Evolution: the Promise and Peril of Enhancing our Minds, Our Bodies – and What it Means to be Human" with Joel Garreau;
- "Symposium on Scenarios" with Thomas Chermack, Vanessa Schweizer and Shirin Elahi; and
- "Emerging Technologies: the Past, Present and Future" with Luis Campos.

RTTA 3/2 InnovationSpace

InnovationSpace is an entrepreneurial joint venture among the College of Design, Ira A. Fulton Schools of Engineering, and W.P. Carey School of Business at Arizona State University. The goal of this transdisciplinary education and research lab is to teach students how to develop products that create market value while serving real societal needs and minimizing impacts on the environment. The two-semester InnovationSpace course satisfies the studio, capstone and thesis requirements for senior majors in each unit. In addition, many of the students are Barrett Honors College students and write their honors theses about their InnovationSpace work. In the course, cross-functional teams of students drawn from industrial design, visual communication design, business and engineering use a product-development model known as Integrated Innovation to research, develop, test and refine real-world product concepts for paying sponsors including, in recent years, CNS, Intel, Herman Miller

Since 2006, CNS-ASU has supported the work of three transdisciplinary teams annually (total of 12 students). In YR 5 CNS-ASU has partnered with InnovationSpace to fund two students from the School of Design Innovation, Qian Yang and Luke Morey have been working on nanotechnology-related projects. Both students have taken ideas developed by undergraduate students in InnovationSpace and are developing those further. They are doing user research, technology research and environmental impact research under the guidance of Boradkar. Ms. Yang is working on her Master of Science in Design degree and her concentration is New Product Innovation. She is working on the product Explore developed in InnovationSpace in Spring 2008, which is a hand-held device for individuals who are blind. It scans and converts text into audio as well as Braille on a haptic screen. Research has shown that individuals who can read Braille have a much higher chance of employment. *Explore* has a refreshable full-page refreshable Braille screen that relies on electroactive polymers. Mr. Morey is also a Master of Science in Design student and his concentration is Arts, Media and Engineering. His project is called Tangent, and it is a personal mobility device for young adults. Current research with Tangent involves exploring all the potential that new nanomaterials offer for the product. Having conducted research with potential purchasers, the team is now examining how biomimicry could help them develop new and innovative solutions. Both students are exploring the potential of nanotechnology in the design of these devices.

RTTA 3/3 CriticalCorps

RTTA 3/3 CriticalCorps uses the methods of cultural studies and design to elaborate on the socio-cultural significance of the scenes developed and products imagined by the other RTTA 3 programs. RTTA 3/3 CriticalCorps developed a “toolbox” for designers to use to improve the societal implications of their designs. This activity drew on RTTA 3/2 InnovationSpace designs for CNS-ASU from YR 2 as case examples. It is presented in a master’s thesis that was completed this year (Lidberg 2008). No new activity in YR 5.

RTTA 3/4: National Citizens’ Technology Forum (NCTF)

In Mar 08, CNS-ASU held its National Citizens’ Technology Forum on nanotechnology and human enhancement technologies. As the NCTF was conducted in YR 3, last year’s annual report provides substantial intellectual and procedural background for it, as well as details of preliminary findings (most of which are available in Hamlett, Cobb and Guston [2008]). In this section, we discuss additional findings and follow-on activities that have occurred in YR 5.

Because the NCTF was a collaborative effort across six institutions and coordinated through CNS-ASU not only by Guston centrally but also by Hamlett and Cobb at NCSU, a broad set of scholars have contributed to data analysis and publication:

In a chapter for the *Yearbook of Nanotechnology in Society, Volume II: Nanotechnology, Equity and Equality*, GA Tech doctoral student Ravtosh Bal (in press 2010) uses a qualitative analysis of the deliberations of the Atlanta CTF, transcripts of the internet sessions, and a comparison of the final reports from the six sites to argue that ordinary citizens placed considerable weight on equity – meaning concern about access but also widening social divisions – as an ethical issue underlying policy formulation in nanotechnology for human enhancement. She finds that equity and fairness were important issues across all sites.

- In an article published in *Science and Public Policy*, Berkeley graduate students Philbrick and Barandiaran (2009) compare the six NCTF site reports with the language of S. 3274, which would re-authorize the National Nanotechnology Initiative, from 2008. They produce evidence that lay citizens can and do produce policy-relevant recommendations in highly technical arenas, and they highlight further opportunities for integrating public input into the policy-making process.

- In a paper published in *Public Understanding of Science*, Delborne et al. (2009) draw on a mix of qualitative data from the earlier Madison CTF and quantitative data from the nationwide NCTF survey to explore the relationship between face-to-face and keyboard-to-keyboard deliberations. They find that participants preferred to interact face-to-face rather than in the online environment, and they identify a mix of technological and facilitation challenges that must be carefully considered for future efforts to bring democratic deliberation into a virtual environment.

- In a second paper in *Public Understanding of Science*, Kleinman et al. (2009) perform a comparative analysis of the 2005 nanotechnology consensus conference in Madison, WI and the 2008 NCTF Madison site. They draw primarily on interviews with the participants, but also on the NCTF pre- and post-test data. Among their central conclusions are that in an era in which the barriers to civic engagement—most especially time—are large for many citizens, significant incentives are likely to affect participation.

- Wisconsin researcher Powell and colleagues have prepared two working papers (Powell et al. 2009a; b).

    - The first explores various conceptualizations of ideal participants for engagement exercises such as the NCTF. Authors use both quantitative and qualitative data (national survey data and interviews with Madison participants) to examine NCTF participants' demographics, knowledge, interests, feelings, and risk perceptions before and after the process, with a more in-depth qualitative focus on Madison participants.
    - The second draws primarily on qualitative data (interviews with Madison NCTF site participants) to explore citizens' experiences in the NCTF process. Citizens were very reflective about the goals, structures, and facilitation of the exercise and their roles and capacities within these structures and processes. Their reflections on these issues shaped their deliberations, opinions, and emotions during and after the process, as well as their sense of internal and external political efficacy regarding NBIC technologies.

- NCTF coordinators at NCSU have three book chapters underway.
    - One (Cobb, Wickson and Hamlett in preparation) describes the NCTF to a European audience interested in different forms of public engagement with science. It provides an overview of the process of running a national consensus conference and presents a brief summary of some of the opinion shifts of panelists that took place after deliberation.

- A second book chapter (Cobb and Hamlett in preparation) highlights the few negative and more plentiful positive outcomes of having lay people deliberate about nanotechnologies. It introduces researchers in specialized science fields doing public engagement with the more critical assessments of deliberation found in other disciplines.
- The third book chapter (Cobb, Miller and Hays in preparation) provides an overview of the 2008 nationally representative survey about human enhancement technologies. This chapter is valuable in disseminating findings from the first and only nationally representative survey specifically about human enhancement technologies.

In addition to these publishing efforts, Cobb has used residual funds for follow-up activities to the NCTF. Cobb recently completed data collection for a follow-up survey to the NCTF. This study surveyed both NCTF participants and applicants who were not selected to participate in the NCTF about their feelings on a wide array of nanotechnology-related topics and about their participation in politics and science. A central question was whether participation in the NCTF stimulate greater involvement with science or political behaviors. This study is unique because it is believed to be the first one to collect longitudinal data to evaluate the potential long-term effects of a consensus conference-style deliberation event. Data analysis is just beginning, with the goal of generating a manuscript to submit to a peer-reviewed journal like *Public Understanding of Science*.

Cobb and ASU colleagues Miller and Hays have designed, pre-tested, and recently (5 Apr 10) launched a nationally representative survey about human enhancement technologies. This survey includes questions designed to help explain some of the findings from a similar 2008 national survey, questions to allow further comparison with NCTF panelists' opinions about the same topics, and a visual framing experiment intended to explore how using art to simplify how nanotechnology might work can affect nascent opinions about it. This research also supports work by Hays, a recent Ph.D at ASU, on issues of fairness and equity in using human enhancement technologies to compete in sport or for jobs.

Cobb and fellow NCSU faculty member Jesse Hur recently collaborated on a study about how experts on nanotechnology evaluate human enhancement technologies and how these experts are affected by the visual framing of nanotechnology. The data from this effort will be used to conduct comparisons with the data collected using the same image in the 2010 nationally representative survey, in which most survey respondents will have only a passing familiarity with the subject matter. The data was collected at the North Carolina Nanotechnology Commercialization Conference in Greensboro, NC, 31 Mar – 1 Apr 10.

Contribution to "ensemble-ization" or other center-wide activities.

RTTA 3/1 worked with TRC 1 to develop consistent understandings of equity for the NanoFutures scenes dealing with energy and nanotechnology.

RTTA 3/1 is involved in the preliminary activities of the renewal TRC 2, including the current graduate studio course on sustainability and anticipatory governance.

RTTA 3 enrolled faculty from RTTA 4 and TRC 1 into the Solar to Fuels project.

RTTA 3/4 worked with TRC 2 and the E2E project to incorporate questions into the pre-test and post-test for the NCTF regarding the application of NSE research to neuroscience and brain research and to analyze the resulting data for inclusion into the E2E project.

RTTA 4: Reflexivity and Integration

Personnel – faculty and senior participants

Erik Fisher, RTTA 4 leader (ASU, assistant professor, Political Science and CSPO)
Elizabeth Corley, RTTA 4 co-leader (ASU, associate professor, Public Affairs)

Ira Bennett (ASU, assistant research professor, CSPO)
Dave Conz (ASU, assistant research professor and lecturer, CSPO and Bachelor of Interdisciplinary Studies)
David H. Guston (ASU, professor, School of Politics and Global Studies, CSPO)
Farzad Mahootian (ASU, lecturer, School of Letters & Sciences)
Cynthia Selin (ASU, assistant research professor, CSPO)
Jameson Wetmore (ASU, assistant professor, School of Human Evolution and Social Change and CSPO)

Other Personnel – graduate students (18), undergraduate students (1), post-docs (2)

Goals. RTTA 4/1 documents the influence of CNS-ASU research and engagement activities on the knowledge, values, and choices of NSE researchers and others. RTTA 4/2 implements the integrative agenda of anticipatory governance through field research and other work that CNS-ASU performs with NSE researchers. RTTA 4/3 studies the meaning and implementation of integration and reflexivity in the sphere of science policy. Projects under the RTTA 4 rubric include: annual interviews with collaborating NSE researchers; laboratory studies and engagements, including the (separately funded) STIR project, the Tubes in the Desert project and the (separately funded) Ethics in the Lab project; co-curricular activities including the DC Summer Session; and various projects that characterize, map and assess the integration of societal dimensions into NSE research and policy.

Research Accomplishments and Plans.

RTTA 4/1: Annual Interviews

In order to document and assess the influence of the Center's activities on the NSE researchers with whom we collaborate, we implement an interview protocol annually each spring/summer. This protocol has focused on the knowledge, identity, and practices of our collaborating scientists, particularly around their understanding of the societal aspects of their work. We conducted baseline research in Sp 06 and subsequent rounds in Sp 07, Sp 08, and Sp 09. The Sp 10 interviews are currently being scheduled.

The Sp 09 annual interviews expanded the sample frame beyond the Biodesign Institute to include the School of Life Sciences, the College of Engineering, the School of Design, and other academic units on two ASU campuses. A total of 18 natural scientists, engineers, and non-STEM respondents were interviewed the Sp 09 annual interviews. Findings produced (both solicited and unsolicited) recommendations for modes of public engagement and outreach, including that natural scientists should be included in engagement activities that integrative activities should be easy for natural scientists to understand. One (STEM) respondent objected to popular stereotypes of natural scientists while another (non-STEM) expressed an uneasiness with integrative goals that might come at the expense of pure research.

RTTA 4/1 has in the past also engaged in tracking the nature of STEM participation in CNS-ASU over time. Last year we reported on the results of using dynamic network analysis to represent STEM

participation across multiple CNS-ASU activity areas and to track recruitment and retention. The dynamic nets project encountered bugs in the software program, however, which Visone has since pulled from its website. The project is currently on hold until more reliable software is released or identified.

RTTA 4/2: Laboratory Engagement Studies

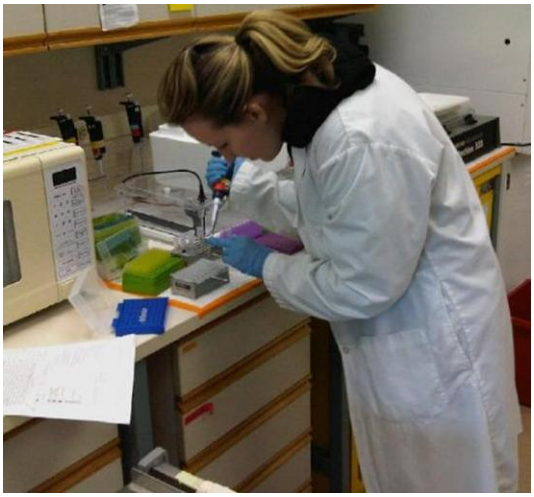
CNS-ASU has created a set of laboratory studies and engagements. These studies are not traditional laboratory ethnographies with a focus on observation and explication, but rather efforts to integrate social science and humanities with NSE research. In previous years, we reported on efforts of Wetmore and McGregor in the Woodbury lab and of Fisher in the Center for Integrated Nanotechnologies (CINT) in the Department of Energy's Sandia and Los Alamos National Laboratories. In the current year, we report on the following integrative laboratory studies and engagements, which CNS-ASU continues to conduct from the previous year and which continue to serve as the basis for interaction with NSE scientists and engineers: STIR, Ethics in the Lab, and Tubes in the Desert. We also report on some of the continued outcomes of past integrative work of Fisher with the Lindsay lab and of Selin with the Johnston lab.

The STIR Project
Fisher is PI and Guston Co-PI on the "Socio-Technical Integration in Research" (STIR) project. It coordinates a set of twenty comparative, international, intervention-oriented ethnographies in North America, Western Europe, and East Asia. The project trains a group of ten doctoral students ("STIRers") in Fisher's midstream modulation framework and techniques in order both to conduct socio-technical collaborations and to assess the policy relevance of their outcomes. In the last year, STIR laboratory engagement studies have commenced in the Westerhoff lab and have been completed in the Lindsay, Vermass, and Seo laboratories at ASU. Beyond ASU, STIR engagement studies have commenced or been completed in 15 other laboratories around the world. For Yr 6, STIR studies are planned in the Johnston lab at ASU and in at least four more locations elsewhere around the globe.

Table RTTA 4-1: STIR at a glance. Each row indicates one student investigator. Gray fill indicates completed study, light gray fill indicates study in progress.

	Social Science	**Site 1**	**Site 2**	**Physical Science**
US-based investigators	HSD	Tempe	Hong Kong	BioPhysics
	Political Science	British Columbia	Oxford	Fertility
	Public Affairs	Denver	Belfast	Materials
	Anthropology	Berkeley	Basel	Synthetic Biology
	STS	Tempe	Seoul	Chemistry & Bio
EU & Asia-based investigators	Philosophy	Tempe	Madrid	Physics
	Business	Leeds	York	Manufacturing
	Philosophy	Golden	Dalian	Fuel Cells
	Political Science	Walloon	Flanders	Nano/bio
	Biotech & Society	Delft	Tempe	Microbiology

Typical project findings include strong indications of both the possibility and the utility of socio-technical collaborations, including the following integration capacity-building outcomes:



- *Reflexive awareness*: "Researchers [realized] that there are inconsistencies in their views about the role of science in society."
- *Changes in practice*: Critical questions from a STIRer "sparked a hefty debate in the group" with the result that "several people in the lab had now started wearing lab coats again."
- *Residual effects*: "Three of four participants…returned to contact [a STIRer] several times with further observations and requests in relation to the broader aspects of research."

STIR activities have been both research and educationally intensive. In Jan 09, a 3-day initial training and kickoff workshop held at ASU brought together 16 faculty members (5 international, 3 STEM), 14 doctoral students (6 international, 1 STEM), and one private sector research manager. In Jul 09, a second workshop in Norway spanned 4 days, during which 12 doctoral students (7 international) presented and developed their initial findings under the guidance of 2 faculty members. In addition to the two international workshops, PI Fisher has conducted: regular lab meetings with doctoral investigators; regular mentoring sessions (face-to-face and via skype) with all project investigators; and 10 research site visits in 6 countries (Belgium, Canada, the Netherlands, Switzerland, the UK, and the US), not including ASU sites. He has also made a number of public and professional presentations on the project. Fisher has further collaborated with several project participants on the development of multi-authored publications (Schuurbiers, Calleja, Ellwood, Zhu, Phelps), mentored several others for single- and multi-authored publications (Conley, Schuurbiers, Calleja, Luk, Kim), and collaborated and/or mentored project participants regarding numerous presentations. He serves on the dissertation or masters thesis committees of several STIR graduate investigators (Conley, Calleja, Phelps); has worked on several single and multi-authored publications involving non-investigator participants (Guston, Miller, Biggs, Lindsay, Jie) and non-project participants (Mitcham, Mahajan, Lightner) on work relevant to the project; has proposed several conference panels on STIR (for APSA, 4S and SNET); has sought both additional and supplementary funding to support project activities; and is currently planning a third project comparative case study workshop in Japan.

The STIR project is co-funded for 3 years at $540,000 through several NSF programs: Science, Technology and Society; Biology and Society; Mathematical and Physical Sciences and Society; Science of Science and Innovation Policy; and Office of International Science and Engineering. Additionally, through a national and international network that PI Fisher has cultivated since joining CNS-ASU in Aug 06, STIR project funded and unfunded collaborators have contributed approximately $450,000 to support and continue the non-NSF funded aspects of the project and will likely contribute more, bringing the total project funding to approximately $1M.

Tubes in the Desert

The "Tubes" cyanobacterial biodiesel project changed dramatically during 09 due to the unexpected non-renewal by British Petroleum of the project phase that was to commence in Su 09. In Nov 09, ASU announced it was awarded two bioenergy ARPA-E grants totaling $14M. One of the awards is funding the restructured Cyanobacterial Biodiesel project, no longer officially referred to by its old name. Under a new PI, the new goal of the project is to maximize lipid production and secretion - along with the production of other valuable co-products such as food and dyes - by a particular genetically-modified strain of cyanobacteria, *Synechocystis* 6803. The goal of the former project was photobioreactor development and industrial-scale biodiesel production. CNS-ASU continues to collaborate with the new

project, having added one of the new team's biology doctoral student researchers, Allen, as a CNS-ASU fellow. CNS-ASU's role is co-funding Conz to observe the project, interact with project members on relevant societal aspects, and perform research on other aspects of the project such as how the story of the new transition is being told by its participants. To date, Conz has successfully embedded himself in the project and presented his work at several conferences including two organized by a Phoenix community-based non-profit, Desert Biofuels Initiative, which aims to bring together actors from industry, academia, regulatory agencies, and other publics. In addition, the comparative case analysis of a similar algae biofuel project at ASU's Polytechnic campus is underway. In Jan 10, Conz participated with two principals from the Polytechnic project at the CNS-ASU Science Cafe.

Ethics in the Lab

An NSF-funded EESE grant has worked closely with CNS to develop and evaluate four different models for ethics education at the graduate student level. Three of these models that were originally developed by CNS are already being offered on a regular basis. The stand-alone course model has been offered every semester since F 08 and has spawned two additional versions focused on specific topics like energy and developing countries. The embedded course model was offered in F 08 and F 09 and will be offered next year as well. Wetmore and McGregor conducted an Ethics in the Lab project that builds on their early work done at CNS. From Fa 09 to Sp 10 they worked with the Helms-Tillery's neurobiology lab to explore the ethics and broader implications of neural implants and working with laboratory animals. They met five times with the lab group during its normal meetings and discussed the ethical concerns that emerged from the lab group, which dwelt most significantly about the ethical treatment of their animal research subjects – most of whom are primates. These interactions are currently being evaluated by EESE personnel to see whether the intervention was able to shift the discussion and outlook of the lab members. Next year they plan to work with the lab run by Professor of Bioengineering and Associate Director of the Hispanic Research Center Garcia.

In addition to the EESE project, RTTA 4/2 is involved in the development of co-curricular activities meant to integrate societal aspects of nanotechnology into the education of NSE research students. The principal activity in the past and present reporting years was the DC Summer Session "Science Outside the Lab: A Policy Dis-Orientation," reported on in the **Education** section.

RTTA 4/3 conducts a number of "integration policy studies" that characterize, map and assess the integration of societal dimensions into nanotechnology policy and R&D processes in the US and Europe. RTTA 4/3 projects currently include:

- Research by Garay, under the supervision of Fisher, on the nature of societal aspects of nanotechnology research and integration at the Nano-scale Science and Engineering Centers (NSECs). This project led to a poster at the 08 Gordon Research Conference on Science and Technology Policy. In May 09 Fisher received an award from the NNIN SEI that funds Garay to conduct fieldwork at a number of co-located NSEC and NNIN sites. He is currently conducting interviews to learn how program leaders and others understand, practice and experience socio-technical integration as mandated in US federal legislation;
- Using an RTTA 4/2 database of over 1,000 documents from Congress, the NSF, and NSF funded NSE laboratories, Fisher, Slade, Anderson and Bozeman identified and analyzed a wide range of public value statements. Their analysis revealed a multifactor structure of public values that has been consistently cited by a range of actors in an NSE research policy network, demonstrating that quantitative analysis of value statements can provide a credible and robust basis for policy analysis. Their results, which represented a connection to RTTA 1, will be published in *Scientometrics* under the title, "The Public Value of Nanotechnology?"
- Rodriguez, in collaboration with Fisher and Schuurbiers, has undertaken a large scale, systematic and interpretive analysis of hundreds of STEM research calls in European framework programs

(FPs 5, 6 and 7) to track the pervasiveness of socio-technical integration in the European R&D system. They identify a variety of modalities in which integration of the humanities and social sciences can occur, and initially find an increase in integrated projects that may correspond with the rise of nanotechnology as a research policy focus.

- Laurent and Fisher are revising a paper on "Integration Discourses" that presents the results of a research project that analyzed US federal nanotechnology policy documents from 2001-2006. In seeking to understand how various actors define and justify socio-technical integration, they identify three distinct visions of science and society that underlie prescribed roles for social scientists and members of the public in the US nanotechnology enterprise.

Continuing Integrative Outcomes

CNS-ASU's research collaboration with Lindsay's Center for Single Molecule Biophysics (SMB) began in Dec 07 with the Photon project, whose framing derived both from Fisher's RTTA 4/2 midstream modulation framework and from RTTA 1/2 Public Value Mapping (PVM). Previously, we reported that the Photon project led to Fisher becoming an honorary SMB research affiliate and that, as a result of an Apr 08 workshop that Fisher organized to explore the relation of public values to the group's research, participating NSE faculty experienced "breakthrough" and "useful" research ideas, Since then, several additional offshoots have continued to grow out of the Photon project:

- The Photon workshop led Fisher, Anderson and Renolds to create in Su 08 a large database of policy documents in order to map public values across science policy prescription and implementation processes as expressed by major contributors to the NSE policy discourse. Fisher, Slade, Anderson and Bozeman consequently used this database to conduct PVM of nanotechnology policy authorizations and allocations using quantitative analysis during Su 09. The results of their research will appear in a paper forthcoming in *Scientometrics*.
- CNS-ASU researchers plan use the Fisher, Anderson and Renolds database in three additional planned projects: an RTTA 1/2 PVM project led by Sarewitz that will include the participation of doctoral student Schwartz; a collaboration with Corley, who spans RTTAs 2 and 4, on content analysis methods in parallel to RTTA 2's media content analysis of nanotechnology; and an RTTA 4/3 qualitative study that follows up on the results of Fisher, Slade, Anderson and Bozeman (this research started in Fa 09).
- In another set of developments, doctoral student Luk took a class on quantum mechanics from Lindsay and, under Fisher's direction, completed a laboratory engagement study with another SMB project, for one of her two STIR case studies; and, in Feb 09, Fisher introduced graduate student Calleja to the Photon project team as the participant-observer attached to the project. Calleja since went on to complete a 12-week laboratory engagement study involving members of the Photon project as one of his paired studies for the STIR project, which he (with Fisher) has presented on in two international academic conferences.

CNS-ASU collaborated with Johnston in the Nov 07 Medical Diagnostics project, also affiliated with RTTA 3/1, and run by Selin. Previously, we reported on outcomes from this scenario development workshop that included a report (Selin 2008), a change in one participating graduate student's research, and a request by a former staffer of the President's Council of Advisors on Science and Technology (PCAST) to share the full report with then current PCAST members. Since then, an additional offshoot has grown out of the Medical Diagnostics project:

- Lucivero received an invitation from Johnston to join his laboratory in order to conduct the second of her two STIR studies.

Contribution to "ensemble-ization" or other center-wide activities.

RTTA 4 continues to work with RTTA 1, 2 and 3 in several projects, including the utilization of multi-level PVM findings both to understand and to justify the scope and nature of integration activities at the micro-level; plans to interview and broadcast a handful of research policy experts who have experience with integration from a combined PVM/STIR framework; the planned utilization of the RTTA 4/2 database to provide a policy dimension to existing RTTA 2 studies of public and natural scientist views of NSE; and the planned incorporation of midstream modulation activities into a lab that previously participated in scenario development and into the Nano and the City TRC.

TRC 1: Equity, Equality and Responsibility

Personnel – faculty and senior participants
Susan Cozzens, TRC 1 co-leader (GA Tech, Public Policy)
Jameson Wetmore, TRC 1 co-leader (ASU, Human Evolution and Social Change, CSPO)

Personnel – graduate students (5), undergraduate students (1), post-docs (2)

Goals. The goals of TRC 1 Equity, Equality and Responsibility are to study ways that NSE reflects social and economic inequalities and contributes to increasing or decreasing them in different national contexts; to identify how the concepts of equity and responsibility are being applied in the development of NSE; and to explore ways to ensure that NSE can contribute to equity and responsibility as public values. These goals include concerns about equity in the distribution of the conduct of NSE research as well as in the distribution of risks and benefits from consequent innovations, both domestically and internationally. Activities include developing options for NSE researchers to act responsibly toward such concerns.

Research Accomplishments and Plans

During the last year the Thematic Research Cluster (TRC 1) on Equity, Equality and Responsibility has largely been focused on completing Volume II of the *Yearbook of Nanotechnology in Society*.

In Nov 08, TRC 1 leaders Wetmore and Cozzens organized and hosted a Workshop on Nanotechnology, Equity, and Equality. The workshop, co-sponsored by Project Resultar at the Technology Policy and Assessment Center (Georgia Tech), brought together over 30 participants from around the world to discuss the equity implications of nanotechnology. Some of the participants involved have done extensive work in nanotechnology and society, but had not yet broached equity issues explicitly. Some were very knowledgeable about equity and technology, but had not yet examined nanotechnology specifically. Some had already worked on linking nanotechnology and equity. The workshop also included several scientists and engineers developing cutting edge technologies. Over the course of the three days the participants presented their research, learned about the areas they were less familiar with, and offered advice to their new colleagues.

After the workshop, the participants turned their nascent ideas into full fledged research papers. Cozzens and Wetmore coordinated this effort, serving as editors for the *Yearbook in Nanotechnology in Society, Volume II*, titled "Nanotechnology, and the Challenges of Equity, Equality and Development." The *Yearbook* includes 17 articles originally developed for the workshop and reworked into academic papers (the majority of which have been individually peer reviewed), three other articles commissioned specifically for the *Yearbook*, and a handful of republished articles and reports created independently of the *Yearbook* that are important recent contributions to the study of nanotechnology and equity. Several *Yearbook* chapters were written by graduate students or postdoctoral scholars, of whom some were supported at some time by CNS-ASU (graduate students Bal, Kay, and Meng; postdoctoral fellow Slade).

Graduate student Valdivia, advised by Guston, made progress on his doctoral research motivated by questions of equity that are central to TRC 1. The research offers a critical analysis of several fundamental premises that have driven innovation policy in the US. Of particular interest to TRC1 is the premise that economic growth induced by innovation trickles down to all sectors and is, in general, widely distributed. Two studies take issue with this premise. One is a critical review of economic growth models to show that the single attention on growth comes at the neglect of distribution, while both processes take place at the same time. This study puts attention to an explanation of wage disparities that emerge due to asynchronous actions on the public and private sectors, as research funding lags behind the adoption cycles of a new technology. This is of interest to the governance of nanotechnology considering

that these technologies are at the early stages of the adoption cycles. The second study discusses distributional consequences of technology transfer policy showing that the safeguards implemented to balance the profit incentive with the public interest have gradually lost grip resulting in business practices that inordinately concentrate social benefits of innovation. Valdivia expects to complete his dissertation in Su 10.

Doctoral student Bal, advised by Cozzens and supported in previous years by TRC 1, reported results of the equity theme in the National Citizens Technology Forum in the *Yearbook*. Public participation can lead to science and technology policies that are not only legitimate but also fair for they involve the citizens who will be affected by the outcomes of the policies. The NCTF data is used to examine how the issues of fairness and equity were dealt with in the deliberations and recommendations of the participants. These citizen views can provide a basis for the formulation of policy that addresses the needs of the public in terms of equity and fairness. Initial analysis of the data reveals that ordinary citizens place considerable weight on the issues of equity and therefore, participatory processes in science and technology policy are more likely to consider equity as compared with expert dominated policy making. Bal's dissertation will analyze the influences of societal inequality on the power dimension of interaction with a citizen panel, using NCTF data.

Doctoral student Thomas Woodson joined the Georgia Tech TRC 1 team last summer, helping to gather information on nano water and energy programs in Brazil and India. He will turn the India work into a book chapter this year, collaboratively with Vrishali Subramanian of the RTTA 1 Georgia Tech team.

Cozzens and Wetmore submitted a grant proposal to NSF for work related to TRC 1, to study pro-poor nanotechnology efforts. Democracies with significant S&T capability are the most likely sites for strong pro-poor science-based programs to occur. If the TRC1 group receives funding, it will study pro-poor technology efforts in three countries, India, Brazil, and South Africa, focusing on the water and energy sectors. They will study the appearance of emerging technologies in these programs, the particular issues they raise, and the conditions under which they have been used successfully to achieve sustainable social inclusion goals, pursuing nanotechnology cases where they are available. Working with local collaborators, they will study the relevant actors, policies, products, and programs in the three countries; produce case study descriptions of a selection of technologies; and work with local stakeholders to apply the lessons learned to design of their projects, products and programs.

Contribution to E2E, "ensemble-ization" or other center-wide activities.

Drawing on his earlier investigation of the end-to-end process with TRC 2, Harsh assisted the TRC 1 team in using the second *Yearbook* as a way to broadly coordinate with other CNS members and groups. As described below, the Yearbook includes contributions from across CNS research activities.

Yearbook 2 Description

The second volume of the *Yearbook of Nanotechnology in Society* was edited by TRC 1 team leaders Cozzens and Wetmore and is focused on the ways in which nanotechnology may exacerbate or help to reduce inequalities and inequities in societies around the world. A full manuscript was submitted to Springer in Feb 10 and is due to be published in Su 10. The volume brings together social scientists, engineers, natural scientists, policymakers, NGOs and corporate perspectives from six continents. They present a wide variety of approaches to and methods by which to address nanotechnology, equity, equality, and development. The bulk of the text is made up of academic articles written specifically for the volume. These articles represent the latest work being done in the area. It also includes a number of

chapters – including a press release, an advertisement, and reports – that give the reader an idea of how major political players are dealing with and discussing equity issues in nanotechnology today.

The Yearbook of Nanotechnology in Society, Volume II
Nanotechnology and the Challenges of Equity, Equality, and Development
(Springer, 2010)
Edited by Susan Cozzens and Jameson M. Wetmore

Scholars of science and technology policy have been increasingly interested in the ways in which new technologies change the relationships between the "haves" and the "have nots."[2] There is much hope that technologies can help us to build a more equitable world. And yet in most cases, new technologies do the opposite. Sometimes this is simply the result of the privileged having first access to the newest advances. But studies have also shown that even when technologies are specifically designed for the disadvantaged they can still hinder their development. Technologies can have a significant impact on a variety of equity issues. This yearbook examines these issues as they relate to nanotechnology from a number of different perspectives.

The yearbook is largely made up of commissioned articles fleshed out initially for the November 2008 "Workshop on Nanotechnology, Equity, and Equality" sponsored by CNS. In addition to those 17 articles the editors have commissioned an additional three articles to fill in some of the gaps left by the original participants. Finally the yearbook includes a handful of republished articles and "artifacts" that help to convey the major events and scholarly work done in the area of nanotechnology and equity between 2007 and 2009.

The yearbook is divided into five parts. The **first part** looks at "Dimensions of Nano Fairness." This covers basic questions about the advantages (or disadvantages) and risks that nanotechnology will or may in the future generate for culturally-defined groups, including those identified by gender, ethnicity, and ability. **Laurel Smith-Doerr** (National Science Foundation) begins by applying what we know about women in other STEM fields, particularly biotechnology, to project what might happen in nanotechnology settings. **Sonia Gatchair** (Georgia Tech) provides an analysis of the opportunities that may be created for minorities in the high tech workforce that will be needed to bring new nano-enabled devices to market. **Yu Meng** (Georgia Tech) looks to better understand the role that women play in nanotechnology by analyzing the RTTA1 patent database. And **Catherine Slade** (ASU) examines the question of whether nanotechnologies developed to help diagnose cancer will lead to greater racial disparities. **Gregor Wolbring** (University of Calgary) makes a plea for the lessons of equity to be applied to abilities and not simply gender, race, and class. The final chapter in the first part is an advertisement for a golf club that promises to give its owners a competitive advantage that is decidedly unequitable.

Part two of the yearbook examines the "uneven structures" that contribute to further inequities. It opens with an article by Georgia Miller and Gyorgy Scrinis of Friends of the Earth, Australia that argues that if we do nothing, the traditionally powerful will direct nanotechnology to their own ends as they always have. **Mark Knell** (Norwegian Institute for Studies in Innovation, Research and Education) connects the development of nanotechnology with economic theories of long waves of innovation, to project the results of the diffusion of nanotechnologies for various parts of the global economy. **Walter Valdivia** (ASU) follows this by taking a more specific example – that of the hypothesized General Purpose Technology – to see if in the realm of nanotechnologies it can have a positive impact on income inequality in the United States. **Jan Youtie** and **Philip Shapira** (Georgia Tech) present and analyze data on inequalities between regions in concentrations of nanotechnology development activity, based on RTTA1 datasets.

[2] See: "Special Issue on Science, Policy & Social Inequities", *Science and Public Policy*, March 2007.

One group that has traditionally been especially concerned about the equity of structures and processes are labor unions. **Guillermo Foladori** (Zacatecas University) looks at the recent attempts by worker's movements to promote governance of nanotechnology. This topic is not just an academic endeavor. In 2008 the **European Trade Union Confederation** released a resolution on nanotechnology and nanomaterials that we include to show some of the latest political movements to protect workers from potentially harmful effects of nanotechnology.

The **third part** of the yearbook focuses on the idea that equity issues are not simply limited to outcomes. In order to create a more equitable world we must also focus on structures and processes. **Dean Niesuma** (RPI) opens the part with an analysis of how ideas of equity can be integrated into the design process to lead to a more equal distribution of benefits and burdens. **Ravtosh Bal** (Georgia Tech) follows this up with an analysis of the ways the public brought up equity issues in one of CNS-ASU's public outreach and engagement programs.

The third part concludes with two articles about Africa. **Matthew Harsh** (ASU) looks at the debates over who was allowed access to decisionmaking about biotechnology in Kenya and the lessons that can be learned as nanotechnology is introduced into the country and other developing nations. We have also republished an article by Kikonyogo Ngatya about the issues that Uganda is having in developing a capacity to respond to the threat and promise of nanotechnology.

While a few of the articles in the first few sections will address countries other than the US, inequities across continents and between developed and developing countries is an important site for studies of the impact of nanotechnology on equity. **Part four** is dedicated to nanotechnology and the world system. It opens with a republished article by Todd Barker and others at the **Meridian Institute** that outlines the opportunities and risks of using nanotechnology to benefit the poor in developing countries. **Noela Invernizzi** (Federal University of Parana) then looks at government policy in Brazil that specifically addresses equity issues and assesses the successes and failures it has had. **Luciano Kay** and **Phil Shapira** (Georgia Tech) compare the academic and patent output by a number of countries in Latin America. In the next chapter **Dhanaraj Thakur** (Georgia Tech) looks for ways of spreading out the benefits of nanotechnologies in developing countries using lessons learned from open source software. Next are two articles about nanotech in South America. We then republish an article by David Grimshaw (Practical Action, UK) and his colleagues that describes a case study in Zimbabwe of dialogues connected the needs of poor people with scientists who are in the process of developing new applications of nanotechnologies to produce clean drinking water. Part four ends with an article by Profs. **Sharan** and **Mohapatra** (IIT Jaipur and IIT Kanpur) and **Jameson Wetmore** (ASU) on the state of high tech education in India, some of the mismatches between this education and the needs of a developing country, and steps that can be taken to remedy the disconnect.

Finally we believe that it is important that equity and nanotechnology not be simply an academic exercise. To help broaden the impact of this volume and studies in the field in general the **final part** will be focused on lessons for action. **Rini van Est** who has worked with the EU and the Rathenau Institute provides a chapter on the lessons learned in parliamentary technology assessment. **Evan Michelson** (Rockefeller Institute) formerly of the Wilson Center's Project on Emerging Nanotechnologies, reflects on his experiences there and on ways in which equity and equality can be advanced in NGOs and governments. **Susan Cozzens** concludes the yearbook by summarizing lessons from the existing research on distributional consequences of emerging technologies in the form of steps an innovation policymaker could take to orient a nanotechnology initiative towards equity and equality outcomes. Several kinds of program designs can be incorporated in the initiative to help it produce benefits for everyone.

TRC 2: Human Identity, Enhancement, and Biology

Personnel – faculty and senior participants

Jason Robert, TRC 2 co-leader (ASU, associate professor, School of Life Sciences, CSPO)
Joan Fujimura, TRC 2 co-leader (Wisconsin, professor, Sociology)

Ira Bennett (ASU, assistant research professor, CSPO)
Clark Miller (ASU, associate professor, Political Science, CSPO)

Personnel – graduate students (5), undergraduate students (4), post-docs (1)

Goals. The goal of TRC 2 Human Identity, Enhancement and Biology is to investigate the historical, philosophical, cultural, and political dimensions of the interactions between human biology and human values in the context of new nanotechnologies.

Research Accomplishments and Plans.

In May 07, under the leadership of Robert, co-leader of TRC2, and co-PI Miller, CNS-ASU launched its first Center-wide "End-to-End" (E2E) initiative, focused on the application of NSE to neuroscience and the human brain. The objective of the E2E initiative has been to pilot the full scope of RTTA activities as a research tool for the anticipatory governance of emerging nanotechnologies. E2E involves research and researchers from all aspects of the Center, including all four RTTA projects and both TRCs.

The E2E project addresses core questions of human identity, enhancement, and biology central to TRC 2, using data and analyses produced by each of the Center's RTTA projects. The work proceeds from the prior interest of Robert in neural prosthetics research, where advances in micro-scale devices allow for signal exchange and neuron stimulation between mechanical-electrical prosthetics and brain function. This emphasis offers a number of unique advantages for the E2E project:

- NSE is increasingly emphasized as a potential research tool to create advanced neural prosthetics.
- NSE also has potential applications to the further advance of neuroscience in brain imaging, neural functioning, and mental health therapies.
- The relatively early stage of NSE applications in neuroscience permits the development of RTTA capabilities in parallel with the emergence of new research directions – a key element of anticipatory governance.
- Perhaps most importantly, NSE applications to the human brain – leading to treatments for debilitating diseases or to cognitive enhancement – has a high probability of significant, long-term moral, ethical, and societal implications that call for substantive social science and humanities research.

During prior reporting years, E2E project made substantial progress, including:

- With RTTA 1, the creation and analysis of a database of over 10,000 nano-neural research publications in the period 1990-2008, providing full coverage of NSE publications involving work related to neural or brain structures and functions;
- With RTTA 2, the creation and preliminary analysis of a database of 850 news and media articles in the period 1990-2007 from Lexis/Nexis, including potentially valuable press releases that offer earlier indications of research trends than publication data.
- In addition, with RTTA 2, RTTA 3, and TRC 1, the conduct and analysis of a national representative, random digit dialed telephone survey (N=556) to explore public attitudes about

the use of nanotechnologies for human enhancement, in complement to the NCTF on the same topic.
- With RTTA 3, two substantive deliberative exercises – the National Citizens Technology Forum and the Dialogue on Nanotechnology and Religion, as well as integrative activities around vetting scenes for a variety of uses.
- The creation of a database of NSF research grants on NSE applications in neuroscience and brain research.

In YR 5, the E2E project began to wind down in anticipation of the end of its activities and the transition of TRC 2 to work on the Nano and the City project funded in the renewal period. The primary focus of the project has been on progress toward the publication of the third volume of the *Yearbook*, which will constitute the final product of the E2E project and present a wide range of important findings. This work has gone more slowly than initially anticipated but is now approaching completion.

Major E2E activities in Yr 5 focused on finalizing student projects that are contributing to chapters in the *Yearbook*:

- Graduate student Milleson finalized her chapter for the *Yearbook* surveying the full range of moral issues comprising the terrain of "nanoethics" and assessing the place of nano-neuro research within that terrain. Milleson used standard social science and natural science and engineering scholarly indices to create a comprehensive database of nano-ethics publications and then cross-referenced this database with the database created through RTTA 1/1.
- Graduate student Nulle completed her chapter for the *Yearbook* providing a systematic analysis of the expanded database created through RTTA 1/1, identifying and describing major categories of research and, with Miller, developing a detailed review of all research carried out in several key categories represented in the database. The most important finding of this work is that NSE is being widely applied to the study of the brain, neurosciences, and neuro-technologies; approximately 1600 distinct articles were published in these fields in each 07 and 08. This finding runs counter to a commonly expressed perspective that applications of NSE to brain research and neuroscience are years if not a decade or more in the future (e.g., Zonneveld et al. 2008). Roughly 40% of this work occurs in the United States, with additional research in Germany, Japan, the UK, and France accounting for another 30% of world publications in this field.
- In collaboration with RTTA 3 and 4, graduate student Conley finalized her chapter for the *Yearbook* analyzing a developing, real-world case of anticipatory governance taking place in the city of Cambridge, MA. Advised by Miller, Fisher and Guston, this project followed the work of the Cambridge Public Health Department as it conducted, in collaboration with the Museum of Science, Boston, a series of public engagement exercises focused on the health and safety risks of nanoparticles, including their impact on the central nervous system and brain. Subsequently, the Public Health Department issued guidelines for nanoparticles in the workplace in Cambridge and seeks to institutionalize an annual public engagement activity to continue to ensure public input into these decisions. Conley's work analyzes how well this process conforms to the model of anticipatory governance developed by CNS-ASU and seeks to offer guidance for how future policy processes might more effectively adopt the model.
- Graduate student Anderson finalized his chapter for the *Yearbook*, which provides a historical analysis of the development of cochlear implant technologies and the ethical, legal, and societal implications that have accompanied their use to cure deafness – as well as a detailed analysis of NSE research applied to cochlear research.
- Graduate student (now post-doctoral fellow) Hays finalized his chapter for the Yearbook, which connects TRC 2 survey data to broader political theoretical analysis of emerging debate

surrounding human cognitive enhancement and the socio-economic and political implications it has for democratic societies (see paragraph below for greater details of the study).

- Undergraduate bioengineering student Naufel – continuing her work with philosophy doctoral student Milleson and E2E co-director Robert – completed her *Yearbook* chapter on the ethics of NSE-enabled neural prosthetics. The chapter explores the ways in which NSE may influence self- and other-directed perceptions of moral status, focusing on the invasiveness and permanence of nano-neural prosthetics. Naufel's work intersects with work underway by her honors co-advisors, Robert and bioengineering professor Helms-Tillery, on the ethics and politics of translational research related to neural prosthetics. Robert and Helms-Tillery are in the process of drafting two articles – one comprising a survey of the ethical and political landscape for translational neuroengineering research and the other assessing agenda-setting and resource allocation for such research.

In addition to the *Yearbook*, TRC/E2E work significantly influenced several additional projects that continued in Yr 5.

TRC 2 faculty Robert and Miller, as well as CNS faculty Corley and Guston, are helping to establish and participating in a new Consortium on Emerging Technologies, Military Operations, and National Security (CETMONS), which focuses on the ethics of nanotechnology, synthetic biology, neuroscience, human enhancement and other areas of S&T and their implications for the military, national security, and civil-military relationships in democratic societies. CETMONS is a partnership of ASU, Case Western Reserve, Georgia Tech, and the US Naval Academy and has conducted three preliminary research workshops designed to link academic researchers with potential partners in the US military.

In addition to finalizing the *Yearbook*, Robert undertook research with neuroscience / neuroprosthetics collaborators at ASU, and continued to work on his monograph tentatively titled *Chimeras, Cyborgs, and the Moral Limits of Science*, (Robert under contract). The monograph focuses on a suite of emerging and enabling technologies, including NSE, generating interesting normative questions about the limits, if any, of scientific inquiry. Additionally, Robert worked with the Center for Law, Science, and Innovation and the Lincoln Center for Applied Ethics, both at ASU, on NSE-related projects, including the *Future Tense* project.

Cobb, in collaboration with Miller and Hays, has developed a follow-up survey instrument on public perceptions of nanotechnology-based human enhancements was fielded by Knowledge Networks in Apr 10. This instrument will further test three sets of results from the prior survey: public perceptions of risks (via a novel visual framing experiment), views of the relationship between theories of human intelligence and human enhancement, and values regarding human enhancement.

ASU doctoral student Hays, advised by Guston, completed his dissertation, which mobilizes some of the survey's findings. The dissertation introduces political theory in a robust way to the science studies and science policy communities and to challenge the way historical analysis is used in both theoretical and empirical assessments of science and technology policy. The subject of the dissertation is the emerging debate surrounding human cognitive enhancement and the socio-economic and political implications it has for democratic societies. Its theoretical focus is particularly on contemporary democratic theories of popular participation, in opposition to older more hierarchical theories of political decision-making, and how these can be brought to bear on how best to make decisions about policy through the political process. Hays included questions about human enhancement's impact on competition in the US into both the NCTF pre- and post-tests and the national survey and is now contributing to a follow-up survey now being developed by Cobb and Miller. His dissertation also makes use of data gathered in other questions on all three of those instruments. The survey data will form the basis of an empirical chapter aimed at substantiating the theoretical claims Hays is making about the need for more context-sensitive analysis

and policy with regard to human enhancement, as opposed to the often naive historical analogies normally employed. Hays is adapting on of his dissertation chapters for publication in the next volume of the *Yearbook*. He will explore the role of unitary and distributed theories of intelligence in shaping American's response to cognitive enhancement technologies from both theoretical and a historical perspectives.

In a separately organized TRC 2 project, Wisconsin postdoctoral associate Rajagopalan and co-leader Fujimura have been involved in an ongoing study of the activities of nanobiology researchers. The construction of a new institute for biomedical research, scheduled to open at the end of 2010, has already had a significant impact on campus biology research priorities. One of the themes of the new institute is systems biology. Fujimura and Rajagopalan have been investigating the development, uses and deployments of nanobiotechnologies in and as a result of systems biology and synthetic biology research on the Wisconsin campus. Using ethnographic methods, including interview-based and participant-observation approaches, they are engaging with scientists in key laboratories at Wisconsin engaged in developing and using nanotechnology tools and approaches to, for example, engineer tailor-made viruses, or explore structural mechanisms of DNA packaging and epigenetic modification in cells. Fujimura and Rajagopalan are tracing how fields that span the sciences and engineering, such as systems biology, develop, by examining the roles played in these fields by emerging nano- and biotechnologies and associated knowledge and theory production. They are also investigating how the use and customization of such technologies spreads, by looking at how collaboration and interdisciplinarity develop in everyday interaction among scientists working across the life sciences, physical sciences and computer sciences. In the new institute, these laboratories will be working alongside privately funded product development laboratories, and Fujimura and Rajagopalan are examining the interactions and technological/methodological exchanges between public and private research sites that are already starting to take place. In preliminary work, they have found that these scientists engage in different ways with social, cultural, ethical, and policy concerns as they construct research programs, technologies, materials, and methods. Fujimura and Rajagopalan will continue to track the movements of nano-scale technologies as they mediate collaborations across disciplines and push the field of NSE, as well as other disciplines, in new directions. This work has resulted in several recent and forthcoming publications.

Contribution to E2E, "ensemble-ization" or other center-wide activities.

The E2E project has served as a principal instrument of "ensemble-ization" of CNS-ASU activities across a broad range of Center activities. Arguably, it is the first and largest center-wide activity undertaken to date and will serve as a model for additional E2E projects in the future. Post-doctoral fellow Harsh undertook a study of E2E processes and activities to develop a generalized framework for future E2E activities in the Center, and his findings are reported in part in the Strategic Plan section.

Yearbook 3 Description

TRC 2 co-leader Robert, along with Miller and Bennett, have taken responsibility for the third volume of the Yearbook. Below is the Table of Contents.

The Yearbook of Nanotechnology in Society, Volume III
Anticipatory Governance: Nanotechnology, the Brain, and the Future
Edited by Jason Scott Robert, Clark A. Miller, and Ira Bennett

Volume III of *The Yearbook of Nanotechnology in Society* represents a chronicle of social science and humanities research activities in relation to nanotechnology, the brain, and the future. The volume focuses on brain repair, brain enhancement, and brain damage, as viewed through the lens of the Center for

Nanotechnology in Society's real-time technology assessment activities applied to the intersection of nanotechnology and neuroscience.

I. Introduction and key resources

1. Nanotechnology, the brain, and the future: Anticipatory governance via end-to-end real-time technology assessment (Jason Scott Robert, Ira Bennett, and Clark A. Miller)
2. Nanoscience, nanoscientists, and controversy (Jason Scott Robert – **REPRINT**)
3. Analysis of bibliometric data for research at the intersection of nanotechnology and neuroscience (Christina Nulle, Clark A. Miller, Harmeet Singh, and Alan Porter)
4. Public attitudes toward nanotechnology-enabled human enhancement in the United States (Clark A. Miller, Michael Cobb, and Sean Hays)
5. Nanoethics and the brain (Valerye Milleson)
6. Nanotechnology and religion: A dialogue (Tobie Milford)

II. Brain repair

7. The age of neuroelectronics (Adam Keiper – **REPRINT**)
8. Cochlear implants and Deaf culture (Derrick Anderson)
9. Healing the blind: Attitudes of blind people toward technologies to cure blindness (Arielle Silverman)
10. Ethical, legal and social aspects of brain-implants using nano-scale materials and techniques (Francois Berger et al. – **REPRINT**)
11. Nanotechnology, the brain, and personal identity (Stephanie Naufel)

III. Brain enhancement

12. Technologically facilitated competition in liberal democracy (Sean Hays)
13. Towards responsible use of cognitive-enhancing drugs by the healthy (Henry T. Greeley et al. – **REPRINT**)
14. The opposite of human enhancement: Nanotechnology and the blind chicken debate (Paul B. Thompson – **REPRINT**)
15. Anticipatory governance of human enhancement: The National Citizens' Technology Forum (Patrick Hamlett, Michael Cobb, and David Guston)
    a. Arizona site report
    b. California site report
    c. Colorado site report
    d. Georgia site report
    e. New Hampshire site report
    f. Wisconsin site report

IV. Brain damage

16. Cytotoxicity of nanoparticles (Nastassja Lewinske, Vicki Colvin, and Rebekah Drezek – **REPRINT**)
17. Recommendations for a municipal health and safety policy for nanomaterials: A Report to the City of Cambridge City Manager (Sam Lipson – **REPRINT)**
18. Museum of Science Nanotechnology Forum lets participants be the judge (Mark Griffin – **REPRINT**)
19. Nanotechnology policy and citizen engagement in Cambridge, Massachusetts: Local reflexive governance (Shannon Conley)

Renewal TRC 2: Urban Design, Materials, and the Built Environment ("Nano and the City")

Personnel – faculty and senior participants

Arnim Wiek, TRC 2 co-leader (ASU, assistant professor, School of Sustainability)
Sander van der Leeuw, TRC 2 co-leader (ASU, professor and Director, School of Human Evolution and Social Change)

Cynthia Selin (ASU, assistant research professor, CSPO)

Personnel – graduate students (1)

Goals. The goal of TRC 2 Urban Design, Materials, and the Built Environment is to investigate the nano-enabled city of the future, addressing the links among NSE, the built environment, social structures, and sustainability. TRC 2 will map out the diversity in problem perceptions, future visions, value-laden sustainability appraisals, and related implementation strategies across various stakeholder groups. We will engage in deliberative research with various urban communities, including public policy makers, business people, engineers, interest groups representatives, and citizens from the Phoenix Metropolitan Area. The goal of our research is to use the deliberative and visioning approaches provided by RTTA 3 to identify points of consensus as well as contest that might foster or hamper progress towards a sustainable co-evolution of NSE, the built environment, and societal needs.

Research Accomplishments and Plans.

Although the renewal TRC 2 does not formally begin until Oct 10, the TRC 2 team is engaged in three preliminary activities to assure a smooth and rapid transition.

The first, The Future of Phoenix – Crafting Sustainable Development Strategies for Phoenix, is a research and educational program that explores the intersections of sustainability and anticipatory governance in urban settings. The work is organized in collaboration with the City of Phoenix and as a graduate course/workshop. This use-inspired, action research project is embedded in the local governance of the City while simultaneously directed towards developing theory and methods relevant to the research programs and educational goals of CNS-ASU and the School of Sustainability at ASU. It is thus an interdisciplinary research project that is not only relevant today but also seeks to establish a long standing platform of collaboration between urban-focused research at ASU and the decision makers who have a stake in such research. This graduate workshop/course is a highly coordinated, intensive, real-world educational program that supports student learning of urban dynamics, sustainability principles in practice, foresight and contemporary modes of planning. Co-instructors Wiek and Selin structured the course to enable students to learn theory and methods in a dynamic and integrated fashion and have supported their skills development through concentrations on facilitation, engagement, teamwork, project management and communication. Wiek and Selin see this course/workshop as a potentially valuable model for a Nano and the City Studio that draws students into practical, community-based projects in such a way to enrich their scholarly training with empirical work. More about the course is reported in the **Education** section.

The second project is the creation of a database on Nano-Enhanced Materials and the Urban Environment (NEMUE). The database compiles basic information and digital sources – from images to conference proceedings to blogs – about the real and imaged ways in which nanotechnologies can impact the built environment and urban life. The systematic sorting of this information can help provide a more comprehensive view of the ways in which nanotechnologies are becoming embedded in various urban systems. This collated information will form an initial basis for TRC 2 research. The NEMUE database

will also aid future scenario workshops by helping participants to understand and imagine how nanotechnology could be used in the city, and it may ultimately become an interesting tool for a variety of users, akin to the consumer products database compiled by the Woodrow Wilson International Center's Project on Emerging Nanotechnologies.

The third project is the writing of a "primer" article describing in some preliminary way the various urban issues as intersected by nanotechnologies (water, energy, health, etc.). The visions surrounding the use of nanotechnologies in design, materials and the built environment suggest that nanotechnologies could be critically important for solving urban energy, water, and other demanding problems. Yet, these visions do not critically account for adverse side effects, path dependencies of infrastructure, and the systemic character of sustainability. More importantly, the multiple agents – city officials, civil engineers, NGOs, and citizens – who participate in urban development and governance rarely have the chance to deliberate on the opportunities and risks of these applications before they become real. The article provides extensive background for the issue, outlines the sets of promises and provocations related to such use of nanotechnologies, and sets out an agenda for engaged research. The article is intended to be a "covering" paper on "Nano and the City" that would serve as a legitimating, stake-claiming, and visibility reference for the TRC 2 research activities.

Plans for the upcoming year are consistent with those described in the **Renewal Proposal** last year.

TABLE 2: NSEC PROGRAM SUPPORT

Projects	**(1)current year 10/01/09-09/30/10 Budget (NSF)**	**(2)current year 10/01/09-09/30/10 Budget (Cost-Share)**	**(3)current year 10/01/09-09/30/10 Budget (Other Support)**	**(4)Sum 1-5 Current year Total Budget**	**(5)Next year 10/01/10-09/30/11 Proposed NSF Budget***
RTTA 1	$86,603	$0	$0	$86,603	$0
RTTA 2	$173,643	$0	$0	$173,643	$0
RTTA 3	$93,478	$3,403	$43,975	$140,856	$0
RTTA 4	$80,860	$8,113	$46,560	$135,533	$0
TRC 1	$21,694	$0	$39,600	$61,295	$0
TRC 2	$15,604	$0	$0	$15,604	$0
Seed Projects*	$0	$0	$0	$0	$0
Total Projects	**$471,882**	**$11,516**	**$130,135**	**$613,534**	**$0**
Education	$28,168	$6,846	$48,750	$83,764	$0
Administration	$279,230	$0	$10,496	$289,726	$0
Equipment	$12,483	$0	$0	$12,483	$0
Knowledge Transfer	$52,228	$8,000	$0	$60,228	$0
Indirect Costs	$361,009	$0	$93,744	$454,753	$0
Subtotals	**$1,205,000**	**$26,362**	**$283,125**	**$1,514,488**	**$0**
Total Budget	**$1,205,000**	**$26,362**	**$283,125**	**$1,514,488**	**$0**
Uncommitted	**$0**	**$0**	**$0**	**$0**	**$0**

Please note:

1. Seed Projects have been included in the individual research program to which they are relevant.
2. This is Year 5 of the CNS-ASU grant (#0531194). The renewal grant budget for 2010-2015
   will be issued under a new award number.

10. NSEC Diversity Progress and Plans

Progress Toward Enhancing Diversity

Since its founding, the Center has worked to enhance the diversity of its leadership, faculty, postdoctoral, graduate, and undergraduate researchers. The Center has put significant effort into recruiting women and individuals from underrepresented groups. These efforts have included working with the ASU Hispanic Research Center to conduct workshops and courses oriented toward graduate and undergraduate students from underrepresented groups, as well as efforts to ensure appropriate advancement of faculty and postdoctoral researchers through promotion and increasing involvement in Center leadership.

The Center's efforts have worked especially well in recruiting women into the Center's activities at all levels. NSECs are expected to be model programs and to meet or exceed national percentages for the inclusion of women and underrepresented groups in science and engineering. At all levels except undergraduate, the current percentage of women in the Center exceeds the relevant national equivalent percentage. In terms of Center leadership and faculty involvement, the Center also exceeds the national percentage for Hispanic teachers in colleges and universities. The percentage of graduate students from underrepresented groups also exceeds the percentage of doctoral degrees awarded nationally to students from under-represented groups. See Tables 4A and 4B for an overview of Center personnel.

As directed by the NSEC diversity reporting requirements, we compare our data below with data from national science and engineering statistics, as provided by the National Science Foundation. For comparison, we have used data from NSF's *Women, Minorities, and Persons with Disabilities in Science and Engineering* (http://www.nsf.gov/statistics/wmpd/start.htm) updated January 2009. The data available from this report is not symmetrical with respect to women and minorities nor the social sciences and science and engineering more broadly. We have therefore used the statistics available. Thus, our comparison categories vary somewhat.

Leadership: The Center's leadership is in transition from its first phase (Yrs 1-5) to its renewal phase (Yrs 6-10). The Center's leadership initially included two women of six principal investigators (Carlson, Schneider) and three women of eleven leaders of the six RTTA and TRC research programs (Corley, Hogle, Schneider), for a total of five of seventeen (29%). At the time of the Yr 5 review, Meldrum and Corley are co-PIs and Corley, Cozzens, Youtie, and Fujimura are team leaders, for a total of 5 of 15 (33%). For the renewal period, there will be three women among the six renewal PIs (Corley, Meldrum, Youtie) and five women of eleven among the RTTA and TRC research program leaders (Corley, Cozzens, Lim, Selin, Youtie), for a total of eight of seventeen (47%). Of these individuals: Corley began as an assistant professor and faculty researcher and is now an associate professor, research program leader, and co-PI; Cozzens began as a faculty researcher and is now a research leader; Selin began as a postdoctoral researcher and is now an assistant research professor, research program leader, and assistant director for outreach; Youtie began as a faculty researcher and is now a research program leader and co-PI. Lim is joining the Center as an assistant professor and research program leader. Meldrum is joining the Center as co-PI.

The planned research program leaders for the renewal also include one Hispanic (Lobo) and one Asian American (Lim), for a total of two of seventeen (12%) – an improvement over the lack of any members of underrepresented racial or ethnic groups among the original leadership team.

The percentage of women in Center leadership roles is currently on par with the percentage of women in tenured or tenure-track faculty positions in science and engineering nationally (26%, data from 2006; no information available on women faculty in the social sciences separately from other science and engineering fields). The Center's Hispanic leadership for the renewal period exceeds the percentage of

Hispanic teachers in colleges and universities nationally (4%, data from 2007; the percentage for science and engineering doctorate holders in teaching and research faculty positions is also 4%; no data available on the social sciences separately from other science and engineering fields).

Faculty: Since its inception, the Center has increased the number (and percentage) of women faculty involved in Center research (non-leadership) from an initial seven (7 of 31, 23%) to thirty-three (33 of 124, 26%) active faculty and collaborators.

The Center has also increased the ethnic diversity of faculty involved in Center research (non-leadership). The Center faculty initially included five Asian American faculty (5 of 31, 16%) and zero from underrepresented groups (0 of 31, 0%). The Center faculty at the end of year five include five Asian American faculty (5 of 124, 5%), three Hispanic faculty (3 of 124, 3%), and one disabled faculty member (1 of 124, 1%).

The percentage of women faculty in the Center exceeds the percentage of women in tenured or tenure-track faculty positions in science and engineering nationally (26%, see notes under faculty leadership). The percentage of Hispanic faculty in the Center exceeds the percentage of Hispanic teachers in colleges and universities nationally (4%, see notes under faculty leadership).

Postdoctoral Researchers: Since its inception, the Center has also increased the diversity of women in postdoctoral research positions. Initially, the Center had one woman postdoctoral researcher (Selin) out of four (25%), who has subsequently been promoted to assistant research professor and has become a research program leader. At the end of Yr 5, the Center has seven active women postdoctoral researchers out of twelve (58%).

Center progress in enhancing the racial and ethnic diversity of its postdoctoral researchers has been less satisfactory. The Center has also increased the number of Asian and Asian American postdoctoral researchers involved in the Center, from one in its initial year (1 of 4, 25%) to three in Yr 5 (3 of 7, 43%). Unfortunately, the Center has not increased the number of Hispanic, African-American, Native American, or Pacific Islander postdoctoral researchers from its initial zero.

The percentage of women postdoctoral researchers in the Center exceeds the percentage of women in postdoctoral positions in the social sciences nationally (46%; data from 2006; this percentage is higher than for any other field than psychology; among all science and engineering fields, the percentage is 33%).

Graduate Students: The Center has seen significant progress since its inception in improving the gender, racial, and ethnic diversity of its graduate students. At its inception, the Center had eight women graduate students (8 of 28, 29%) and eight Asian or Asian American graduate students (8 of 28, 29%). At the close of Yr 5, the Center has thirty-seven women (31 of 74, 42%), twenty-four Asian or Asian American (27 of 74, 30%), one Native American (1 of 74, 1%), one African American (1 of 74, 1%), and nine Hispanic (6 of 74, 8%) active graduate students.

The percentage of women graduate students involved in Center research is comparable to the national number of science and engineering PhD degrees awarded to women nationally (45%; data from 2006; no data available for the social sciences separately from other science and engineering fields). The overall percentage of Native American, African American, and Hispanic graduate students involved in the Center, collectively, is comparable to the percentage of doctoral degrees awarded to students from under-represented groups nationally (10%, data from 2006; no data available for the social sciences separately from other science and engineering fields).

Undergraduates: The Center has made little progress in improving the diversity of its undergraduate researchers. At its inception, the Center had two women undergraduate students (2 of 8, 25%) and three Asian or Asian American undergraduates (3 of 8, 38%). At the end of Yr 5, the Center has four women undergraduate students (4 of 11, 36%) and one Hispanic undergraduate student (1 of 11, 9%).

Plans Going Forward

While the Center has performed strongly on diversity during its first four years, meeting and, in some cases, exceeding relevant national percentages, we are not yet satisfied. We have therefore established a strategic plan for the renewal period on diversity that aims to further improve the Center's diversity profile.

Overall Objectives: The Center's overall objective with respect to diversity is to be a model for incorporating diversity among Center participants. To achieve this, we propose to pursue the following specific goals:

1. To maintain and continue to advance high levels of Center diversity in those areas documented above where Center diversity currently exceeds appropriate national levels;
2. To seek opportunities to recruit new Center participants, where appropriate, who will enhance the diversity of the Center in those areas where the Center is currently lower than appropriate national levels; and
3. To significantly enhance graduate and undergraduate participation among students from underrepresented racial and ethnic groups.

Center Leadership and Faculty: As noted above, the Center has strong performance in terms of gender and ethnic (Hispanic) diversity among Center leadership and faculty. The Center has had relatively little success, by contrast, in recruiting faculty participation from other underrepresented racial groups.

Our objectives for the renewal period for faculty diversity are to maintain and ideally improve our high levels of diversity in those areas where we have been successful and to seek out opportunities for increasing participation of faculty from underrepresented racial groups.

Enhancing faculty diversity is difficult. Our plan for increasing participation of faculty from underrepresented racial groups includes three elements:

1. Arizona State University has recently hired a new Hispanic faculty member in the School of Politics and Global Studies (Ramirez) whose work focuses on public attitudes about science, technology, and the environment. We will approach him to become involved in CNS. In addition, ASU has announced a new competition for targeted Hispanic faculty hires to enhance diversity, and CSPO will submit a proposal.
2. Arizona State University has a faculty member who works in the area of science, technology, and the law (Tsosie) who is Native American. Through TRC 1, "Equity and Responsibility," the Center will approach Prof. Tsosie to consider the possibility of engaging questions of nanotechnology and equity vis-à-vis the Native American communities of Arizona.
3. The Center will actively seek other opportunities to involve faculty from underrepresented groups in its activities.

Postdoctoral Researchers: As among faculty, the Center has had strong success in improving the gender diversity of its postdoctoral researchers but has had considerably less success with ethnic and racial

diversity. Also as among faculty, the small number of individuals working in the field of nanotechnology and society from underrepresented backgrounds limits the potential for success in this arena.

Our objectives for the renewal period are to continue to have high levels of involvement in the Center among women and to seek to improve on our prior inability to hire postdoctoral researchers from diverse racial or ethnic backgrounds.

Our plan to enhance postdoctoral diversity will focus on efforts to attract appropriate candidates from underrepresented ethnic and racial backgrounds into our candidate pools for open postdoctoral positions. To achieve this goal, we will use the networks that we are building for recruiting undergraduate and graduate students from underrepresented backgrounds (see section below on *Networking for Diversity*) to disseminate position advertisements.

Graduate Students: The Center anticipates several efforts to enhance the diversity of graduate students participating in its research. Our objectives are to maintain the high level of gender diversity and to increase the diversity of students from underrepresented backgrounds in the Center. We will accomplish the latter via a three-pronged effort.

1. The Center has an established a relationship with the Hispanic Research Center (HRC) at Arizona State University, through which the Center has built a growing number of contacts with students from African American and Hispanic backgrounds. In the most recent year, for example, CNS taught a 7-week course on nanotechnology in society (described in the **Outreach** section) to 24 ASU graduate students in the sciences and engineering from underrepresented backgrounds. The course was very successful, with several of the students expressing a desire to be involved in future CNS activities and three of the students participating the CNS Su 09 DC Summer Session. In addition, two HRC students will participate in the Su 10 DC Summer Session, and the course will be offered for a second time in Fa 10. For the renewal period, we plan to continue to engage this group of students and any new students who join the Hispanic Research Center.
2. To date, the focus of diversity planning at CNS at the graduate student level has been primarily at ASU. For the renewal period, we plan to expand our efforts to other CNS campuses and, especially, to Georgia Tech.
3. Finally, we hope that our significant expansion of diversity in the Center leadership for the renewal period (Corley, Youtie, Lim, Selin, Meldrum, Lobo, Cozzens) will help us recruit and retain graduate students from diverse backgrounds.

Undergraduate Students: The Center has, to date, involved a relatively small number of undergraduate researchers as paid research interns at ASU and, occasionally, via honors thesis research. We have had some success with diversity among this group, especially among women and Hispanic students. We hope to enhance the number of undergraduate students from diverse backgrounds involved in CNS activities through an REU program, which we will resubmit as a supplementary grant. For the REU program, especially, CNS will focus specifically on recruiting students from a broad diversity of gender, racial, and ethnic backgrounds to become involved with CNS research. In Fa 10, CNS will be hiring as a GRA an Hispanic woman who is a specialist in diversity training in STEM; she will help develop and coordinate the REU resubmission and implementation.

During the renewal period, our plan is to use the REU program to help us: (1) to identify and recruit undergraduate students from underrepresented groups who are interested in CNS research topics; (2) to introduce students to the excitement and importance of CNS research; (3) to help prepare students with the skills they will need to be successful in applying to and getting in to graduate school; and (4) to encourage students to apply to graduate programs in which they can continue to pursue CNS research. This program is built on a model developed and highly successfully run by the ASU mathematics

department, in conjunction with the Hispanic Research Center. Our hope is that, following this model, we can begin to provide a foundation for enhancing the diversity of not only CNS students but also, more broadly, the field of research on nanotechnology in society.

Networking for Diversity: As part of its efforts during its first five years, the Center has begun to develop significant networks of potential partners for enhancing Center diversity. We will use these networks for a variety of recruiting purposes. We have developed connections with the following programs:

- The Hispanic Research Center, Arizona State University
- The Engineering Education Outreach program, Georgia Tech
- The Humanitarian Engineering program, Colorado School of Mines
- The "Ethics of the Nanoscale" Nanotechnology Undergraduate Education program, Auburn University and Tuskegee University

In addition, through Gregor Wolbring, a CNS consultant, we have made initial contact with several disability studies programs that may offer potential sites for recruiting students with disabilities.

- The Rehabilitation Counseling Program, California State University, Fresno
- Department of Rehabilitation Counseling, Virginia Commonwealth University
- The "Ohio's STEM Ability Alliance: STEM Degrees and Careers for Ohioans with Disabilities" Project, Ohio State University

11. Education

CNS-ASU is involved in extensive formal and informal educational activities from graduate student and post-doctoral training and mentoring to science and engineering practitioner training to collaborations with science museums. Many of these activities are tightly integrated with research and outreach activities, and most maintain as their central focus the building of broader societal capacity for anticipatory governance. Thanks to the myriad programs that CNS-ASU has developed, it is beginning to be seen as a national leader in educating science and engineering graduate students in the social implications of their work.

Post-doctoral training and junior research scholars. CNS-ASU has put significant effort into building a cohort of talented junior scholars who are developing not only research skills but collaborative and leadership skills as well. These researchers – Barben (Political Science & Sociology), Bennett (Chemistry), Conz (Sociology), Fisher (Environmental Studies), Harsh (Science and Technology Studies), Selin (Knowledge & Management), Wetmore (STS) – were all initially hired at the post-doctoral level at ASU. Another postdoctoral researcher, Rodriguez-Zabaleta (Philosophy & Risk Assessment), joined ASU through an award from the Basque Government and has collaborated in Center research with Fisher. The Center has also provided training to post-doctoral fellows at the University of Georgia (Slade, under the direction of Bozeman on RTTA 1/2), Georgia Tech (Wang, under the direction of Shapira on RTTA 1/1 and Gatchair, under the direction of Cozzens on TRC 1), and Wisconsin (Delborne, under the direction of Kleinman on RTTA 3/4 and Rajagopalan, under the direction of Fujimura on TRC 2).

These scholars have made significant advances professionally and have taken core leadership roles this past year in CNS initiatives:

- This year (Apr 10), Barben begins a professorship at Aachen University of Technology in Political Science, funded by the Association of German Engineers, focusing on studies of the future of emerging sciences and technologies. His work on reflexive and anticipatory governance of emerging technologies is a core element of his new position.
- Five others have obtained tenure-track assistant professor positions: Wetmore at ASU in the School of Human Evolution and Social Change, Fisher at ASU in Political Science, Delborne at Colorado School of Mines in Science, Technology, Society and Policy, Wang at Florida International University in Public Administration, and most recently Slade at the Hull College of Business at Augusta State University with an affiliation with the Medical College of Georgia.
- Three others have been promoted into research faculty positions at ASU, all in the Consortium for Science, Policy and Outcomes (CSPO, the parent center of CNS-ASU): Bennett, Conz, and Selin.
- Three have taken on formal leadership roles in the Center: Wetmore is currently a co-leader of TRC 1 and assistant director for education, Fisher is currently a co-leader of RTTA 4 and assistant director for international activities, and Selin is a co-leader of RTTA3 and TRC2 and assistant director for outreach. Others have led particular projects: Conz leads the CNS research project in RTTA 4 in collaboration with the Biodesign Institute's Tubes in the Desert Project, and Harsh has played an important role in TRC 1.
- Two have obtained additional external support for CNS-related activities: Fisher is PI on the $540K socio-technical integration research (STIR) award, which extends the Center's integration agenda that Fisher pioneered as a CNS-funded doctoral student at Colorado. Fisher is also PI on a National Nanotechnology Infrastructure (NNIN) award that seeks to "Document Integration" at several NSEC and NNIN sites. Wetmore is co-PI on a $300K NSF award from the Ethics Education in Science and Engineering program that develops, teaches, and assesses several models of micro- and macro-ethics instructional activities for graduate students. Many of the activities encompassed by all four of these grants have roots in the Center's program.

- Fisher and Selin are both collaborators on an $820,000 award from the Research Council of Norway to Norwegian researcher Roger Strand that incorporates intellectual approaches in integration and foresight that they, respectively, have pioneered.
- Several have been involved in the Center's *Yearbook of Nanotechnology in Society*: Fisher, Selin and Wetmore (2008) edited the first volume. Wetmore edited and submitted a full manuscript with Cozzens of the second volume. Bennett is editing with Robert and Miller the third volume, and Barben is editing with Miller the fourth volume. Rodriguez-Zabaleta is contributing a chapter for the fourth volume.

Graduate Education and Training. CNS-ASU organizes a variety of graduate education and training activities, aimed at several audiences. The first audience is the graduate students involved in the Center's core research activities. Many of these students have drawn on CNS research to develop their theses. In the reporting year, the Center has been training:

- At ASU, eleven doctoral students (Conley [Politics and Global Affairs], Valdivia [Public Affairs], Milleson [Philosophy], Garay [Education], Lidberg, Bhadra, Gano, Schwartz, Trinidad, Luk, and Moore [Human and Social Dimensions of Science and Technology]) and five master's students (Anderson [Public Affairs], Calleja-Lopez [Politics and Global Affairs], Nulle [Global Technology and Development], and Wheelock [Liberal Studies]) are currently involved in CNS projects. Panjwani (2007) completed her master's thesis in the Mathematics and Statistics Department two years ago and a manuscript related to her thesis is currently under review (Greenwood, Wang, Selin, and Panjwani under review). Pirtle [mechanical Engineering] graduated in May 09 and did a Fulbright Fellowship in Mexico with Guilermo Foladori on the responsibilities of nanoscientists. Hays completed his PhD and is now serving as a post-doctoral fellow with Center and teaching with the School of Politics and Global Affairs.

- At Wisconsin, six doctoral students (Dudo, Ho, Dalrymple, Shih, Hu, and Hillback, in Life Sciences Communication and Journalism and Mass Communication) have been working with RTTA 2 data. One of their papers won the 2009 Emerging Nanoscale Materials Specialty Group Student Merit Award at the 2009 annual convention of the Society for Risk Analysis. Ho graduated recently (2008) with a PhD in Journalism and Mass Communication and is now a tenure-track assistant professor at Nayang Technological University in Singapore. Leung completed his PhD in Sociology (2008) using CNS data and is now a postdoctoral researcher at the University of Minnesota. Another student previously funded by CNS as a visiting researcher at Wisconsin, Gallo, graduated with a PhD from Northwestern and is now employed at the Science and Technology Policy Institute, a privately-operated FFRDC, in Washington, DC. Noel Benedetti just defended her M.S. degree using RTTA 2 data and will work as a technology consultant. Researchers and graduate students at Wisconsin also regularly participate in informal science outreach efforts, including Wednesday Nite at the Lab and the Wisconsin Literacy speaker series. Several students also contributed entries to the *Encyclopedia for Nanoscience and Society*.

- At Georgia Tech, seven doctoral students (Carley, Galope, Kay, Subramanian, Tang, Meng, Woodson), five visiting doctoral students (Guo, Wang, Ye, Beijing Institute of Technology; Pei and Zhang, Chinese Academy of Science), two master's students (Narayanan, and Gandhi), and three undergraduates (Bidgood, Campbell, Garner) work with RTTA 1 and TRC 1 all using CNS-ASU data and analyses, many toward their theses. Two students (Narayanan, Gandhi) graduated this year with an MS in Quantitative and Computational Finance and another (Garner) graduated with a BS in Computing. GA Tech has previously graduated one doctoral student (Wang) and one master's student (Mehta), both of whose research was on CNS-related data and topics. Wang is now an assistant professor at Florida International University. Meng has been awarded a one-year visiting research placement at the Fraunhofer

Institute for Systems and Innovations Research, Germany. Tang and Meng also received a Robert W. Gore award ($10,000) from the Chemical Heritage Foundation to undertake case studies of nanomaterials innovation in China in 2009-2010. Based on their RTTA 1 research, Carley, Kay, Subramanian, Tang and Meng each authored or co-authored one or more journal submissions, journal papers or book chapters this year.

- Other graduate students at University of New Hampshire (Barr, Sociology), North Carolina State University (Ndoh and Willingham, Public Administration), and University of California, Berkeley (Barandiaran and Philbrick, Environmental Sciences) were all involved in the organization, conduct and analysis of the National Citizens' Technology Forum. Philbrick and Barandiaran (2009) have published on their activities and have contributed multiple entries to the *Encyclopedia of Nanoscience and Society*.
- The STIR project, through a variety of workshops, group meetings, regular one-on-one sessions, and site visits by PI Fisher, trains and mentors thirteen doctoral students (Calleja-Lopez, Conley, Ellwood, Hansen, Kim, Lucivero, Luk, Phelps, Schuurbiers, Stavrianakis, Thoreau, Van Oudheusden, Zhu) and one master's student (Miorin).

At ASU, the second graduate student audience has been NSE researchers themselves. For these students, CNS-ASU created the CNS-Biodesign Fellows program, in which CNS pays one-third of their support. These students then participate in CNS-related curricular and co-curricular activities and perform what we call the PhD+, adding societal implications material to their doctoral research. Last year, the Center graduated its third PhD+, Troy Benn (Environmental Engineering). Benn's research on the fate of nanosilver embedded in clothing achieved national recognition. Previous PhD+ students were Jason Lappe (Chemistry and Biochemistry; Woodbury lab) and Quinn Spadola (Physics; Lindsay lab). This year CNS is sponsoring three Biodesign Fellows: Tomasz Kalinowski (Biodesign; Halden lab) has been working to develop informal science education videos on nanotechnology. Jennifer Watkins (Chemistry and Biochemistry; Wachter lab) has been helping to run the Science Café program. Rebecca Allen (Biodesign; Curtis lab) is working with RTTA 3 to develop energy scenarios.

CNS-ASU has also attracted additional PhD+ students, not affiliated with the CNS-Biodesign Fellows program, including two additional students, Rebecca Allen and Sreekar Krishna (Center for Cognitive Ubiquitous Computing) have begun research on their PhD+.

The success of the PhD+ has generated a great deal of interest beyond CNS-ASU. CNS researchers Guston, Miller, Bennett, and Wetmore, have been invited to participate on a number of technical grant proposals over the past year and support for future PhD+ students was written into several of these proposals. In addition, the CNS researchers at Georgia Tech have had preliminary discussions with the science and engineering faculty there and plan to implement their own program in years 6-10.

A number of the education activities originally developed by CNS to help graduate student scientist and engineers understand the social and ethical implications of their work were rolled into the Ethics in Engineering and Science Education grant on which Wetmore is a co-PI. The EESE grant just received its first evaluation data and the results are quite impressive. Four models were evaluated – the embedded course (Bennett in Biodesign), stand-alone course (Posner, Wetmore and Bennett 1-credit), laboratory engagement (Wetmore and MacGregor in Helms-Tillery), and a hybrid course (Ellison and Herkert). Pre- and post- tests were given to all students involved. All four models were found to have a statistically significant and positive effect in helping students be more ethically sensitive, have more knowledge of relevant standards, and have better ethical judgment. These results are not typical for traditional responsible conduct of research courses and demonstrate the valuable contributions of these education approaches.

In association with the EESE grant, Bennett participated for a second year in the new Biological Design Graduate Program's core course Fundamentals of Biological Design. The nine-credit course which meets for 10 hours a week introduces the students to the technical aspects of directed evolution, synthetic biology, and immunology to name a few. In total there were more than 50 faculty presenters to the class. Bennett attended every class and used the presenter's remarks as entry points into discussions of social, ethical or political aspects of research with the class and presenter. The response by the presenters ranged from hesitant to fully embracing the conversation. From these interactions with presenting faculty several potential collaborations have developed. The interactions with the students in the course have resulted in two new Biodesign Fellows, Kalinowski and Allen. In addition to embedding Bennett in the Biodesign intro course and the Science Policy for Scientists and Engineers courses, CNS has also collaborated with ASU's EESE grant on a laboratory engagement program. During F 09 and Sp 10, Wetmore and McGregor worked with Steven Helms-Tillery's neuroscience lab. They worked with the lab participants to reflect on the social and ethical implications of their research including the potential military uses and issues surrounding primate research.

In Su 09, CNS-ASU conducted a second CNS-sponsored session of "Science Outside the Lab: A Policy Dis-Orientation" for NSE doctoral students, reflecting a rapidly growing interest among NSE students and faculty. This program built on the success of an earlier version conducted by CNS in Jun 07 for NSE doctoral students in the Biodesign Institute and the Fulton School of Engineering at ASU. Developed and taught by Wetmore and Bennett and held in Washington, DC, the course offers graduate NSE students a chance to leave the lab for two weeks to explore the relationships among science, policy and societal outcomes. Students meet government officials, lobbyists, staffers, regulators, journalists, academics, museum curators, and others who fund, regulate, shape, critique and study science, and they engage in hands-on policy learning through tours and exercises like a mock congressional hearing where students present their ideas for new policies to congressional staffers in the House Science Committee's hearing room. After participating in CNS immersion projects, taking multiple courses, and being mentored by Bennett and Wetmore, NSE graduate student Berea Williams gained the skills, knowledge, and enthusiasm about the social and political implications of nanotechnology to serve as a student leader on the trip.

In Su 10, CNS-ASU will conduct two separate sessions of "Science Outside the Lab: A Policy Dis-Orientation" for NSE doctoral students, reflecting a rapidly growing interest among NSE students and faculty. The new model for the program relies on students and their advisors to secure the funding that will cover the expenses of the program. We have successfully secured enough students with funding to run two two-week sessions – including students not only from ASU but from half a dozen universities across the country. After participating in CNS immersion projects, taking multiple courses, and being mentored by Bennett and Wetmore, NSE graduate student Punarvasu Joshi and recent PhD Troy Benn have gained the skills, knowledge, and enthusiasm about the social and political implications of nanotechnology to serve as student leaders in the two 10 DC Summer Sessions. The success of the DC program has inspired a number of faculty to include funding for students to participate in it in their ERC, IGERT and education grant proposals.

In F 09, CNS researchers Wetmore, Bennett, Gano, and Harsh began to collaborate with Trevor Thornton and the ASU node of the National Nanotechnology Infrastructure Network in an Informal Science Education Training program for graduate students. The program provides several hours of training for students in how to communicate with the general public about science and engineering and then gives them the opportunity to gain important practical experience by presenting their work on the floor of the Arizona Science Center. The basic idea behind the program is to help young scientists develop valuable communication skills. The added bonuses are that the public gets to know about the cutting edge research being done at ASU and the students are asked difficult questions about the social and ethical implications

of their work that they must develop good answers to. The program began in Mar 10 and students are sent to the museum to present once a week.

Two years ago, CNS-ASU also developed a partnership with a new degree program the Professional Science Masters in Nanoscience, led by the Department of Physics and the Department of Chemistry and Biochemistry, to offer a 2-credit graduate course in the societal aspects of nanotechnology. This course is currently being taught by Bennett as a required course in the degree program.

The third graduate student audience at CNS-ASU consists of those students in traditional departments and schools, as well as those in interdisciplinary programs, who are interested in CNS-related coursework. CNS-ASU has established nine graduate courses at ASU, including three that are new in this reporting year:

- "Science, Technology and Developing Areas," a one-credit course offered through the Department of Chemistry and Biochemistry and the School of Human Evolution and Social Change, was developed in F 09 by Harsh and Wetmore to work through TRC 1 topics with graduate students. The course attracted graduate students from the social sciences, natural sciences, and engineering and explored the myriad issues that must be addressed for technical assistance to truly benefit the disenfranchised.
- Wetmore created a new course in Sp 10 entitled: "Introduction to Analyzing Sociotechnical Systems," offered in the School of Human Evolution and Social Change. Not only were a number of nanotechnology topics covered, but students were also assigned a research project to develop a demonstration for NanoDays 2010. This class also fulfills a core requirement of the Professional Science Master's Degree program in Science and Technology Policy offered by CSPO.
- In AY 09-10, Boradkar developed a training program akin to InnovationSpace but for graduate students. Two students under his direction have performed additional research, design and development on nanotechnologies previously conceived by the undergraduate InnovationSpace students. (See **RTTA 3/2** for additional details.)
- "Science Policy for Scientists and Engineers," taught by Bennett, Posner, and Wetmore in F 09 and S 10, is a 1-credit seminar for NSE scientists and engineers to explore questions and issues of science and technology policy in society that are relevant to their own research. Again this year the course was filled to capacity. These courses are being evaluated under the EESE grant to determine how well they help young scientists and engineers understand the micro- and macro-ethical aspects of their work.
- "Energy," taught by Bennett in Sp 09, is a 1-credit seminar for PhD students in chemistry that explores the dynamic interplay between scientific research, technological innovation, policy development, and cultural change surrounding large-scale energy system change in the 21st century.
- "Governing Emerging Technologies," taught in F 08 and F 09 through the School of Politics and Global Studies by Guston, explores the Center's core concept of anticipatory governance and synthesizes many of the Center's findings. Students in the course were tightly integrated into the Center's activities, e.g., participating in the Oct 08 Visioning Workshop and the Nov 09 Equity Workshop. Several other CNS-ASU faculty have participated in the course including Conz, Corley, Fisher and Selin. This class also fulfills a core requirement of the Professional Science Master's Degree program in Science and Technology Policy offered by CSPO.
- "Nanotechnology, the Brain, and the Future," taught in the School of Life Sciences and the School of Politics and Global Studies, is a variable-credit course offered by Miller and Robert (F 07, S 08, F 08) as part of the E2E project. Students and faculty used it to prepare research projects for E2E and the CNS All-Hands meeting.

- "Science, Technology & Societal Outcomes," taught in the School of Life Sciences and the School of Human Evolution and Social Change by Wetmore and Bennett was offered in Sp 06 and Sp 07 but not in the current reporting year;
- "Nanotechnology: Law and Regulation," was taught by Marchant in the Sandra Day O'Connor School of Law. Several other CNS-ASU faculty participated in the course, including Guston, Robert, and Selin. As a major project the students explored potential regulatory and liability issues in the scenes developed by NanoFutures. The course was offered in prior and current reporting years.

Although the new TRC 2 "Nano and the City" does not formally begin until Oct 10, Center staff have initiated teaching activities that provide a favorable starting position for it. Renewal TRC 2 co-leader Wiek and renewal RTTA 3 co-leader Selin are currently teaching a graduate course on "Future Scenarios, Anticipatory Governance, and Sustainability – Urban Development in Phoenix." The course engages 22 students from five ASU graduate programs in systematically crafting visions of sustainability for Phoenix and developing governance strategies for transformative change. The course also integrates the theme of urban socio-technical systems and emerging technologies. As the course is embedded in a collaborative research project with the City of Phoenix to inform the adaptation of the General Plan, the course facilitates research in teams and involves faculty across ASU as well as stakeholder groups across the city. The course builds capacity in anticipatory governance and attracts students to engage in subsequent research. Moreover, it creates a network among stakeholders, professionals, and decision makers in Phoenix interested in "Nano and the City." The course will be continued with a focus on the role of nanotechnology in urban development.

The Center has also been an integral part of the development of a new doctoral program at ASU, the Human and Social Dimensions of Science and Technology (HSD), which was approved by the Arizona Board of Regents in Dec 07 and admitted its first class in Aug 08. CNS Associate Director Miller directs the HSD PhD program, and Guston, Robert, Sarewitz, Corley, and Wetmore serve on its Executive Committee. Other CNS faculty, including Fisher, Selin, and Barben, serve as members of its Graduate Faculty. CNS-ASU is funding one member of the first cohort of students, Lidberg, who is working on design policy and innovation, especially with regard to the preparation of the new TRC 2 for the renewal proposal. A second student, Bhadra, was funded two years ago by the Biodesign Institute as part of a collaborative relationship with CNS, helped conduct focus groups and surveys for the Tubes in the Desert project and contributed to RTTA 4 annual interviews. A third student, Luk, has planned her second-year research project (an HSD degree requirement) in collaboration with STIR and has carried out an engagement study in the Lindsay laboratory. Three others participated in a scenario-based workshop on solar-to-fuels energy production led by Selin. In Fa 09, CNS continued to fund Lidberg who is pursuing preliminary research for the Nano in the City project, creating an inventory of imagery and documents describing the application of nanotechnology to urban materials and infrastructures. CNS created the 75% education and communication coordinator position for Gano, who is part of the second cohort of students in the HSD program. In Fa 10, CNS expects to fund Trinidad, a continuing HSD student, in a position jointly funded among CNS, the NNIN node at ASU, and the Ira A. Fulton Schools of Engineering. CNS has also made an offer to Frey, a newly admitted HSD student, to work with Corley in RTTA 2 activities. The Center is also currently looking for a student in the School of Sustainability to work with the new TRC 1.

Undergraduate Education and Training. CNS organizes a variety of undergraduate education and research training experiences. In previous years, numerous undergraduates have written honors theses with CNS faculty and undergraduates – mostly from the Carey School of Business – also complete honors theses in conjunction with their InnovationSpace coursework. We have none to report this year.

Last year, Pirtle held a Fulbright Scholarship, "Nanotechnology in Mexico: Scenarios, Outcomes, and Democratized Science Policy," which he pursued in Mexico with Foladori. For his project he conducted a general overview of the nanotechnology research being done in Mexico and the societal problems it relates to, describing how the Mexican research funding agency, CONACYT, works and how it conceives of the societal impact of different research proposals. Pirtle also interviewed key members of the nanotechnology community about how they try to connect their research to societal problems; wrote a research paper on how real-time technology assessment can best benefit Mexico; and attended and presented at key Mexican nanotechnology meetings, including being an invited speaker at "La nanotecnología en México: la evaluación de tecnología y los impactos sociales. Fourth Congress on Nanotechnology." University of Guadalajara, Lagos de Moreno. July 2009. He is currently working on a draft paper with Foladori that examines the explicitly stated research goals in the Mexican Law on Science and National Development Plan, arguing that there is no way to assess whether research in nanotechnology will attain the legislatively desired societal outcomes. Upon his completion of the program he became a Mirzayan Science & Technology Policy Graduate Fellow at the National Research Council.

Other prior honors students are also publishing their thesis research in CNS publications:

- Arielle Silverman, whose undergraduate thesis in Biology and Society surveyed a population with visual impairments about their attitudes toward nano-enabled therapies and enhancements in conjunction with TRC 2, will publish her work in the third volume of the *Yearbook of Nanotechnology in Society*;
- Tobie Milford, whose undergraduate thesis in Religious Studies reviewed public participation in science literatures and analyzed TRC 1's Nanotechnology and Religion workshop, will publish his work in the third volume of the *Yearbook of Nanotechnology in Society* and has written several entries for the *Encyclopedia of Nanoscience and Society*.

CNS also trains undergraduate interns, who work on research or other projects in collaboration with CNS faculty. CNS has sponsored seven undergraduate interns this year: Alexander MacLean (RTTA 4 / RTTA 2 public value of research policy project), David Calderon (Science Cafés), David Edwards (CNS Library and Website), Travis Doom (media coverage of nanotechnology and the brain, equity issues in nanotechnology), Andrew Gaddis (CNS Website), Ben Lowenstein (anticipatory governance concepts), Keith Martin (outreach support, e.g., videography and editing), Colin McDonald-Smith (Energy workshop), Mark Peterson (Spanish translation of NanoFutures scenarios), Jaron Reed (RTTA 3/1 plausibility project, Benn's nano-silver outreach activities, TRC 1 *Yearbook*, and web development), Dusana Schnell-Vivas (NanoFutures), and Daryl Traylor (Encyclopedia, nano legislation, evaluation of S.NET workshop). Two additional undergraduate students, Kelley Conley and Stephanie Naufel, are working with Robert, Miller, and Bennett on research for the TRC 2 E2E project.

In addition to the numerous courses developed in the first four years of CNS, including "Perspectives on Nanotechnology," "Justice and the Future," "Learning Community: Nanotechnology in Society," and "Human Enhancement and Democracy," nanotechnology and society issues were newly integrated into two other undergraduate courses. "Global Environmental Politics," developed by Fisher, was taught by him in F 09 and Sp 10 and devotes one week to global political environmental issues related to nanotechnology. "Science and Democracy" (originally developed by Miller) was taught in Sp 09 by post-doctoral associate Harsh and included a discussion of nanotechnology regulation and several student presentations on nanotechnology. Harsh revised the course for W 09 as a 3-credit online course with interactive and video-enhanced oral exam modules. Wetmore's "Technology and Society" course (taught in F 07, F 08, and F 09) included a week's worth of discussion that explored the regulatory history of nanotechnology as well as the equity issues raised by it.

CNS-ASU's long standing relationship with InnovationSpace continued this year, but in a slightly different format. InnovationSpace is a two-semester long, transdisciplinary course collaborative among the ASU Schools of Design, Engineering, and Business. It satisfies the design or project requirements for senior majors in each school by creating cross-functional teams who use an Integrated Innovation model to research, develop and refine real-world product concepts for paying sponsors. This year CNS supported the shooting of a mini-documentary based on one of last year's successful student led projects on nanotechnologies that improve energy equity (08-09) (See **RTTA 3/2** for further explanation). And, as mentioned above, CNS sponsored two graduate students to perform additional research, design, and development on earlier projects.

K-12 Education. In a previous reporting year, CNS-ASU described the development of a graduate course that provides in-service K-12 teachers with research experiences and also helps them develop curricular materials for their own K-12 classrooms on societal aspects of nanotechnologies. CNS did not offer a version of the course in the current reporting year. Two teachers participated in the course in Sp 09, one in-service and one who is in the nano-science professional masters degree program and does not currently teach. The value of the course is demonstrated by continuing follow-ups by in-service teachers with Bennett, who has consulted with some of those in the course about the development of curricular materials and visited classrooms at Mesa High School and its Biotech Academy. In one of these classes the in-service high school teacher from Bennett's Nanoscience in Society course had her students choose specific technologies and analyze the social, political, and cultural aspects of that technology and then promote a policy position through an oral presentation to their class and prepare a letter to a congressional representative.

CNS-ASU has also arranged for its Science Cafes, held monthly in conjunction with the Arizona Science Center (see below) to provide in-service teachers with continuing education credit. In addition, CNS co-director Miller served as a primary consultant to two chapters (4 and 13) in *The Big Ideas of Nanoscale Science and Engineering* (Stevens et al. 2009) published by NSTA Press for K-12 science teachers. These chapters are based, in part, on a guide to nanotechnology in society education produced by CNS (Miller et al. 2007).

The relatively small scale of engagement to date is causing us to reconsider our strategy for K-12 education, and we have made contact with leaders in teacher training for K-12 formal science education at the Museum of Science, Boston, and the San Francisco Exploratorium, to help us develop a more ambitious effort. Much of the work done with NISE Net and the Arizona Science Center (See sections above and below) reaches K-12 audiences. It is also the case that one of the target audiences for the *Encyclopedia for Nanoscience and Society* (Guston in press 2010) is high school students and teachers.

Informal Science Education. CNS-ASU has begun to have a significant impact on informal science education nationally through its partnership with the Nanotechnology Informal Science Education Network (NISE Net) to incorporate research on the ethical and societal implications of nanotechnology into museum programs and exhibits around the country. Two years ago, CNS produced a guide to this topic (Miller et al. 2007) that NISE Net distributes as part of its Forums Guide and NanoDays Kit. This guide has also been distributed widely to science museums at NISE Net meetings and is available on the CNS website for download. In addition, NISE Net Director Larry Bell, who has attended all four annual CNS All-Hands Meetings held to date, has identified anticipatory governance as a central theme for future NISE Net programming and, more broadly, as the basis for a new model for the role of science museums in informal science education (Bell 2008).

This year the CNS – NISE Net collaboration ramped up considerably. In Sep 09 the two organizations held two sets of joint presentations. Benn, Wetmore, Bennett, and Carlos Perez presented table top demonstrations of nanosilver in clothing and nanowires in conjunction with Rae Ostman and NISE Net organizers both at the Pacific Science Center and the opening reception of the first annual meeting of S-

NET. Since that first joint demonstration, CNS scholars and NISE Net organizers have met a half dozen times at conferences like the AAAS, the CNS all hands meeting, and other organized meetings. (See **Outreach** for additional details.)

The major short term product of these collaborative efforts has been a series of posters and brochures designed to spark conversations among the public about social and political issues associated with nanotechnology. The genesis of these products was a list of social and ethical implication questions that NISE Net museum employees were commonly asked, but did not have the resources to adequately answer. CNS researchers including Wetmore and Gano developed short responses to these questions which were further refined for broader audiences by NISE Net. Ultimately the questions and answers became the basis for the posters and brochures. These products were deployed on a small scale during NanoDays 2010. They are currently being evaluated in anticipation that they can be distributed to the 300 plus institutions participating in NanoDays next year.

CNS sponsors a monthly Science Café during the academic year at the Arizona Science Center, which typically attracts an audience of 40-50. CNS has pioneered a new format in which two ASU experts – usually one from the natural sciences or engineering and one from the social sciences or humanities – begin the dialogue. We have found this format more engaging than a single speaker, and it helps break down the implicit barrier of expertise that divides one lecturer from his or her audience. CNS-ASU has held a total of 32 Science Cafes to date (one in Spanish), and the Center will continue these in the coming academic year. This year, we developed an online events list of Science Cafes in the Phoenix area in conjunction with the Arizona Science Center's Biotech talks series and the **ASU Sigma Xi Science Café**, described in more detail below. The CNS Science Café is now listed on a web site dedicated to them, created by WGBH television in Boston (http://www.sciencecafes.org/).

Analysis of data and publications resulting from the National Citizens' Technology Forum – not only a pilot deliberative project but an exercise in intensive informal science education that occurred in Sp 08 – continued in the present reporting year, as did a follow-up survey of NCTF participants and a control group of applicants (see **RTTA 3/4** for details).

Practitioner Training. The Center has developed and piloted training modules in the ethical and societal implications of nanotechnology for scientists and engineers working in user facilities at the DOE Center for Integrated Nanotechnologies (CINT) and the National Nanotechnology Infrastructure Network (NNIN).

Last year, NNIN user facilities were strongly encouraged to use the video (created by Guston and others) and a survey was conducted to evaluate their experience. Respondents at 9 of the 11 user facility sites in the NNIN indicated that they were already using the video, and an additional site indicated that it would be doing so from this point forward. Four sites indicated that the video had been presented at a total of 117 training sessions, with the other sites indicating that users watched the video individually, with no formal records being kept. The sites indicated that approximately 1000 NSE researchers in total had watched the video. The actual use of the video varied. Some sites merely made the video URL link available. Other sites asked users to verify via a signature that they had viewed the video. Others required users to watch the video in groups. One group indicated that questions and comments sometimes follow, and one group indicated that they always follow the video with group discussion.

While the video remains on the NNIN website for use at some sites, after much deliberation NNIN has decided that face-to-face discussions of SEI issues would better engage the researchers at its user facilities. Wetmore attended a workshop in Jan 10 at Cornell University to discuss ways of doing this. Wetmore and Bennett are currently working with Trevor Thornton (leader of the ASU NNIN node) to develop a thirty-minute module to be presented in conjunction with the health and safety training that all

users of the ASU NNIN facility must successfully pass. The current plan is to introduce researchers to the practical implications and applications of CNS research and findings, while also making them aware of the support CNS can offer to young scholars in the form of PhD+ opportunities and coursework.

This past year Susan Cozzens worked with the NNIN node at Georgia Tech to provide its summer REU students with basic instruction in the social implications of nanotechnology.

Disseminating the CNS education models

CNS is increasingly being seen as a leader in educating scientists and engineers in the social implications of their work. CNS scholars and educators are increasingly being asked to present the education activities sponsored by CNS so that others can learn from and sometimes emulate them. In addition to the NNIN meeting attended by Wetmore, he was also invited to the MRSEC education directors meeting at MIT in Nov 09, the National Institute for Nano-Engineering Summer Student Program at Sandia National Labs in July 09, and the Centers, Universities, and the Scientific Innovation Ecology Workshop at the NSF in Sp 09. Bennett and Wetmore have also had a number of conversations with Christine S. Jones, Assistant Director of the Center for Science, Mathematics and Technology Education at Colorado State University about their teacher education programs and Bennett will participate in one of their teacher training workshops this summer

Scholars have also been visiting CNS-ASU to meet with its faculty to learn more about ASU's education programs. For instance, CNS held a mini-retreat in Nov 09 with Heather Douglas (UT Knoxville), Janet Kourany (University of Notre Dame), Norton Wise (UCLA), Joe Herkert (ASU), Karin Ellison (ASU), Bennett, and Wetmore. During this informal half-day program, CNS scholars presented the visitors with the wide array of education programs and discussed the philosophy and pedagogy behind them. The response to this retreat has been very positive. Kournay, for instance, relates that our programs are functioning as a model for similar programs being developed at the University of Notre Dame, and that the sophistication of the CNS models has caused them to reevaluate what they propose.

Table 3A: Education Program Participants, Irrespective of Citizenship

		Gender		Race					Mixed-incl.	Mixed-				
Student Type	Total	Male	Female	NA	PI	AA	C	A	NA,PI,AA	C,A	Not Provided	Other Non-US	*Ethnicity Hispanic	Disabled
Enrolled in full degree programs														
Undergraduate														
Masters	9	5	4				4	5					0	
Doctoral	10	3	7				8	2					1	
Enrolled in NSEC Degree Minors														
Undergraduate														
Masters														
Doctoral														
Enrolled in NSEC Certificate Programs														
Undergraduate														
Masters	2	1	1					2					0	
Doctoral	31	17	14			1	25	5					5	
Practitioners taking courses														
Enrolled in NSEC Programs														
Undergraduate														
Masters														
Doctoral														
Practitioners taking courses														
K-12 (Pre-college) Education														
Teachers														
Students														
Total	52	26	26	0	0	1	37	14	0	0	0	0	6	0

Table 3B: Education Program Participants, U.S. Citizens or Permanent Residents

		Gender		Race					Mixed-incl.Mixed-					
Student Type	Total	Male	Female	NA	PI	AA	C	A	NA,PI,AA	C,A	Not Provided	Other Non-US	*Ethnicity Hispanic	Disabled
Enrolled in full degree programs														
Undergraduate														
Masters	4	2	2				4							
Doctoral	9	3	6				8	1					1	
Enrolled in NSEC Degree Minors														
Undergraduate														
Masters														
Doctoral														
Enrolled in NSEC Certificate Programs														
Undergraduate														
Masters														
Doctoral														
Practitioners taking courses														
Enrolled in NSEC Programs														
Undergraduate														
Masters	2	1	1					2						
Doctoral	24	12	12			1	21	2					4	
K-12 (Pre-college) Education														
Teachers														
Students														
Total	39	18	21	0	0	1	33	5	0	0	0	0	5	0

12. Outreach and Knowledge Transfer

12. Outreach and Knowledge Transfer

The outreach activities at CNS-ASU are, on one hand, tightly integrated with research and education and, on the other, governed by a strategy that aims at developing broad-based capacities among both NSE researchers and various publics. As described in the strategic research plan, CNS-ASU pursues an agenda of foresight, engagement and integration in order to advance its strategic goal of building capacities for reflexivity and anticipatory governance in the NSE enterprise in particular and in society more broadly. CNS-ASU thus has a dual-tracked outreach strategy that includes, in one track, outreach to various lay-publics (**engagement**) and, in the other track, outreach to scientists and engineers (**integration**). In addition, CNS has more traditional outreach and knowledge transfer to professional colleagues via workshops and presentations, as well as a modest technology transfer program associated with InnovationSpace.

In the current year, CNS-ASU hired Gretchen Gano as Outreach and Education Coordinator at 75% time. Gano organizes activities for CNS-ASU to reach the community and K-12 educators, designs materials and programs based on CNS research activities for both formal and informal education, and builds scholarly communication and archiving capabilities. Gano is also a new student in the Human and Social Dimensions of Science and Technology program. She has previous professional degrees in public policy and in communication, information and library science.

Derived from priorities established in YR 4's Visioning Workshop (Selin 2008), in YR 5, Gano and Assistant Director of Outreach Selin have launched a new media initiative, focused efforts on developing collaborations with NISE Net, and supported the development of new programs across the Center to bring anticipatory governance to new audiences.

Collaborations with the Nanoscale Informal Science Education Network (NISE Net)

Laying the foundation for an expanded relationship and collaboration with NISE Net in the renewal period, CNS-ASU and NISE Net partners held a series of planning and working meetings, conducted joint demonstrations, and co-created materials to enhance the presence of social science research in NISE Net activities. The collaboration explores the role that science museums should play in anticipatory governance by positioning NISE Network partners to engage with questions about social, legal, ethical implications of developing nanotechnology. These activities broaden and deepen capacity of science museums to shape and contextualize broad public knowledge about the role of science and emerging technologies in society. These collaborative activities represent initial steps in constructing an in-depth initiative in anticipatory governance education to enhance key ideas and skill in both formal and pre-college education and informal science education. Further, closer collaboration with NISE Net expands upon CNS-ASU's concept of ensemblization.

NISE Net Annual Meeting 2009

Bennett, Wetmore, Miller, and Gano attended the NISE Net annual meeting in Sep 09 that included a number of breakout sessions to discuss network projects around regional nodes. One function of the meeting was to update core partner institutions on the leading edge of nanoscale science. As a part of these updates, Miller led a breakout group entitled "Themes in Nanotechnology in Society Research" based on CNS-ASU recent research. In addition to participating in the meeting and joining regional planning groups, CNS-ASU attendees met with NISE Net core working groups for Education and Content

development to begin discussions about planning for activities during renewal period years 6-10. While at the S.NET meeting in Seattle, WA, Bennett and Wetmore gave CNS-developed demonstrations at the Pacific Science Center on nanosilver and nanowires and received feedback from PSC science communication staff.

NISE net involvement in CNS-ASU All Hands Meeting

NISE Net organizers reciprocally attended the Jan 10 CNS-ASU All Hands meeting. On the second evening, NISE representatives hosted a plenary session: Leigha Horton and Stephanie Long gave a dramatic reading of a skit situated around the benefits and risks associated with the potential use of nanomaterials for drug delivery in cancer treatment. Skits like this one are being developed as a part of the NISE Net nano forums strand as instruments to spark public discussion around social implications of novel uses of these technologies. The plenary generated robust discussion around participation and engagement opportunities in informal science settings as well is in decision-making and policy realms. This discussion continued in a day three breakout session led by NISE participants around integrating social dimensions into participatory activities including forums, science cafes and other programming.

NISE Net/CNS Collaboration Planning Workhop

Selin of CNS-ASU and Ostman of ScienceCenter organized an intensive 1-day planning meeting Jan 10. CNS-ASU participants included Bennett, Gano, Guston, Miller, Selin, Wetmore and visiting scholar, Sarah Davies. NISE Net representatives were Larry Bell, Brad Herring, Leigha Horton, Frank Kusiak, Stephanie Long, Catherine McCarthy, Rae Ostman, and Greta Zenner Petersen. The objective of the meeting was to explore and define opportunities for CNS and NISE Net to work together, including identifying ways for NISE Net to make use of CNS research and expertise on the social, political and ethical implications of nanotechnology. CNS goals for the meeting included: investigating research opportunities with dual applications in the public sphere; learning more about the NISE Net evaluation process for public products; and learning more about trends for informal science communication on nano and emerging technologies in the broader museum community. The central NISE Net goal was to investigate ways for CNS-ASU researchers to review existing and planned programs, products, and initiatives to modify and plan for ways to introduce social dimensions to situate and contextualize factual information about NSE.

The group reviewed existing evaluation data about how the public responds to NanoDays kit materials, public programs such as the Science Museum of Boston Forums programming, and Science Cafes. While there is evidence that visitors come away with a better understanding of core ideas and future directions for NSE, they may not know how to attach this information to applications and outcomes in their own lives, the dynamics of their communities, or global impacts to nations, economies, and the environment. Participants agreed to look squarely at the "so what" factor and to use this question as a challenge for approaching each proposed project. Participants discussed many existing examples of exhibitry and programming in museum settings that meets this challenge effectively. One exemplary exhibit is the recent *Race: Are We So Different?* developed at the Science Museum of Minnesota, which initially was difficult to develop and its appeal uncertain given the cutting-edge nature of its materials and approach, however now it is one of the most requested traveling exhibits available in the museum community.

Given the shared goals and challenges, the group turned in earnest to talk about applied ways to realize these goals. The meeting resulted in four working groups for generating concrete projects or museum exhibit materials: 1) augment, or "hack" existing NanoDays activities and prototype new ones; 2) Develop educational products to promote visitor reflection and questions related to societal and ethical implications of nanotechnology; 3) make professional development products to support educator

interactions and; 4) embed social and ethical implications perspectives into product and content development within NanoDays planning for years 6-10.

These four working groups spawned the list of near, medium, and long-term projects, a selection of which are discussed below. Teamwork, scheduling, and exchange of materials in various stages of development has continued into the spring. The next group meeting is planned for May 15 when a similar NISE Net group will attend a ½ day meeting to discuss content and product development for years 6-10 of the network's grant and discuss plans for a Sp 11 workshop in extending the Anticipatory Governance framework into museums and other information science education settings. The outcomes from the meeting will feed directly into the content development group planning session at the NISE Net subawardees meeting set for Jun 10 at the Science Museum of Minnesota. NISE visitors will also attend CSPO's *The Rightful Place of Science?* conference during the week of May 16-19 and have proposed a salon session for the conference on this topic.

A portion of the Planning meeting was devoted to a focused discussion about additional joint funding opportunities to support a novel traveling exhibit on the emerging technological futures, or to add a technology futures component to existing planned exhibits of network partners, dubbed *Making Futures Real*. Larry Bell and Rae Ostman from NISE, Miller, Guston, Selin, and Gano from CNS-ASU discussed opportunities for developing an NSF Informal Science Education proposal together to plan exhibition materials. Bell referred CNS to Paul Martin at the Science Museum of Minnesota to develop this aspect of the collaboration and to identify areas for strategic fundraising. This outgrowth of the CNS/NISE discussions involves expanding upon the lessons learned in the context of nanotechnology and establishing mechanisms for CNS to collaborate on museum projects grappling with how to construct socially contextualized representations and understanding around emerging technologies more broadly and the futures these usher in. The meeting with SMM representatives is described in the next item.

Designing ISE for Emerging Scientific and Technological Futures in the Public Square–
Making Futures Real – Planning Meeting

CNS-ASU leadership along with Paul Martin and Pat Hamilton from the Science Museum of Minnesota and Rae Ostman from NISE held a smaller meeting during the AAAS conference in San Diego, Feb 10, as a result of the initial NISE/CNS planning meeting. NISE Coordinator, Rae Ostman and Gano co-developed an agenda to review projects and share information, define areas for potential collaboration, discuss funding opportunities to include NSF and other agencies and identify next steps. SMM representatives outlined four potential projects (described below per SMM online materials) that could integrate CNS research and open opportunities for Making Futures Real components:

- Once and Future Earth, a major exhibit in progress based on the premise that humans have set in motion global changes that will unfold for millennia. The exhibit features ideas about making a better Earth through human-implemented technical political, economic and social solutions. This new exhibition will open in 18 months.
- Brighter Futures, learning for ages 0-5, a project targeting young audiences. Brighter Futures will engage public audiences, policymakers, and children's caregivers in deliberations around the latest research on early childhood development. The goal of the project is to help everyone understand child development, how environment and experiences affect child development, and how we as a society can best support our youngest citizens.
- Science and Social Change is a project in the proposal stage at NSF. It would be an interdisciplinary programmatic initiative that seeks to engage new and existing audiences in dialogue about the role and impact of science in our communities and our world. The exhibit will involve small experimental spaces of 1000 square feet or less. The concept is to allow museums

to try out edgier topics (gender, incarceration, mental illness) and to work quickly to prototype ideas for larger installations.

- National Anthropocene Education Network proposal to NSF: National network of museums partnered with research centers. NAEN exhibits and programs will inform large audiences while also encouraging the creation of long-term, mutually beneficial relationships between science centers and environmental institutions by providing both parties something that each values: For museums—novel ISE experiences for their audiences and access to cutting-edge research; for environmental institutes—resources to reach audiences currently outside their spheres of influence. Together the partners will be able to accomplish something challenging for each to realize on their own—attract and interact with audiences of decision makers.

Miller and Gano plan a follow up visit to the Science Museum of Minnesota in Apr 10 to visit exhibit design staff and to discuss funding options for developing a collaboration on one of the above four projects.

Museum and Educational Materials and Program Development

In YR 4, initial collaborations between CNS and NISE Net originated led to the development of a narrative to mirror a National Science Teachers Association (NSTA) publication on the Big Ideas of Nanoscale Science and Engineering with "10 big ideas" in nanotechnology and society. The basic principles set out in the whitepaper, "Nanotechnology & Society: Ideas for Education and Engagement" (Miller et al. 2007), established a blueprint for future development and instrumentation that the co-development of applied materials and programs has followed in year five. This year, Miller formalized aspects of this original whitepaper in an NSTA publication *The Big Ideas of Nanoscale Science and Engineering: A guidebook for Secondary Teachers* consulting on content for chapter 13: Science, Technology and Society.

Preliminary observations on impact of the NISE/CNS materials during NanoDays at the Tempe Festival for the Arts:

When I revealed the information on the backside of the flyer, then [visitors] "got it", could appreciate it, and took the flyers with them for future reference. Some suggested maybe placing the key words on the front of the flyer - Privacy, Risk vs Benefits, Is it Healthy and/or safe? - those words would have drawn them to the poster "faster" and made them want to pick it up and read.

We also had some comments… about how they could "get involved" with the Nanotechnology education/ advocacy efforts at ASU.

-Brenda Trinidad, PhD student, Human and Social Dimensions of Science and Technology

In YR 5, CNS-ASU and NISE Net have completed or are have work underway on the following materials and programs:

Questions about the Societal Implications of Nanotechnology
Building on the key themes outlined in Miller et al. (2007) as benchmarks for effective consideration of science and society issues around emerging technologies, CNS/NISE contacts began thinking about how to develop capacity among museum educators/facilitators to answer the "so what" questions they receive when working with visitors using NISE network materials. NISE partners aggregated "social implications" questions from staff at network institutions.

During Fa 09, CNS-ASU researchers developed narrative answers and examples for a set of 15-20 questions. This working document became the basis for a set of six prototype posters and 2-sided handouts, with details appropriate for public dissemination and for informing museum staff, that were tested and evaluated during NanoDays 2010 by several partner institutions. Themes included:

- Does nanotechnology belong in toys?
- Will nanotechnology improve living conditions around the world?
- Would you use a dangerous technology?
- What's hidden in your sunblock?

- Are you being tracked?

Once these materials are evaluated, the set will be included in the 2011 NanoDays kits.


Does nanotechnology belong in toys?
Nanosilver is found in many consumer products.
Silver is naturally antibacterial, and tiny nanosized silver particles are especially effective at killing germs. Nanosilver is used in bandages, cutting boards and washing machines—and at one time was even found in a toy bear.
Exposure to nanosilver products probably won't harm you, but widespread use of nanosilver could contaminate water supplies, kill fish or lead to highly resistant "superbugs."
Any technology has risks and benefits. When one person or group benefits, others may be put at risk. Who should make decisions about whether to use nanotechnologies? Does it make sense to use nanosilver catheters to prevent infections in hospitals? What about using a nanosilver washing machine at home?

Regulatory Issues

Samsung's Silvercare washing machine "eliminates" bacteria

WHO WATCHES OUT FOR POTENTIAL RISKS POSED BY NANOTECHNOLOGY?

There is no one regulatory agency that oversees nanotechnology, but the U.S. government's Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) are currently developing ways to monitor the effects of nanotechnology. Because nanotechnology is so difficult to identify, and is still an emerging science, we don't really know yet how safe or dangerous it is—for people or things. So far, the government hasn't regulated anything specifically because it was enhanced by nanotechnology, but it has weighed in on its use in some products.

Samsung's "SilverCare" washing machine, for instance, claimed that its product used silver ions to "kill" 99.9% of bacteria in clothes. This claim caught the attention of the EPA, which argued that because Samsung advertised that its washing machine "killed" bacteria, the product should be regulated under the Federal Insecticide Fungicide and Rodenticide Act (or FIFRA). The EPA required Samsung to substantiate the safety precautions the company had taken with SilverCare. Instead, Samsung decided simply to change its advertising to claim that the washer "eliminates" bacteria, which the EPA has chosen not to regulate.

WHO ELSE COULD HELP REGULATE NANOTECHNOLOGY?

Another major group that could regulate nanotechnology is you—the public. Recently, a company called Pure Plushy sold a teddy bear that was embedded with silver nanoparticles to prevent dust mites, bacteria and mold from growing on it. By eliminating these organisms, the bear—known as Benny the Bear—could be enjoyed by children with severe asthma and allergies. Benny became famous when Andrew Maynard of the Woodrow Wilson International Center asked publicly whether it was safe for a child to chew on a bear that had nanosilver embedded in it, which the company assured that it was.

Scientists know that nanosilver can be very dangerous for fish and other aquatic life, but there haven't been any studies showing that nanosilver can be bad for people. In fact, people have been using colloidal silver as an antibiotic treatment for many illnesses and infections for centuries. Pure Plushy took this to mean that its product was safe. But as Maynard and others wrote more articles questioning whether enough research had been done to be confident in its safety, Pure Plushy realized that their position on Benny's safety didn't matter as much as the public's perception. Without specific studies to support their claim, Pure Plushy decided to change their marketing to avoid potential lawsuits as well as public backlash against nanotechnology.

LEARN MORE

The NISE Network	Nanotechnology-based consumer products	nano & me: Nanotechnology in our lives
www.whatisnano.org	*www.nanotechproject.org/inventories/consumer*	*www.nanoandme.org/regulation*

This information was created jointly by the Nanoscale Informal Science Education Network and the Center for Nanotechnology in Society at Arizona State University. Any opinions, findings, and conclusions or recommendations expressed in this program are those of the author and do not necessarily reflect the views of the National Science Foundation.

This project was supported by the National Science Foundation under Grant Nos. ESI-0532536 and 0531194.

"Real World Nano" Blog
In Jan 10, Miller became a NISE Net blogger on the NISE Network website [http://www.nisenet.org/blogs/real-world-nano]. The *Real World Nano* blog is a new space to explore what happens when nanotechnology leaves the laboratory and makes its way into the rest of society. RWN is a partnership between NISE Net and CNS-ASU. The goal is to launch a conversation about how the meaning, importance, and application of nanotechnology in society can be conveyed through informal science education. A link through from the CNS-ASU website to the NISE Net blog space is a planned addition to the CNS online presence.

Tabletop Demonstrations for Museums
CNS-ASU is gearing up to consult in the design of new nano-themed table-top demonstrations being planned by the NISE content group. Ideas under development are "Nano Then, Nano Now and Nano When," a sliding puzzle with different nano application areas with past uses, present manifestations and future visions associated with them (e.g., nano and glass). The poster and handout development group will take the lead in conceptualizing futures-oriented tabletops from the NanoFutures scenes. Other ideas are in process with prototypes ready for internal evaluation at the June NISE subawardee meeting.

Other Engagement Programs

NanoDays 2010

As in previous years, CNS-ASU participated in NanoDays by adding the societal "so what?" twist on the information and materials provided by NISE Net. In coordination with the NanoDays national program, CNS-ASU sponsored three days of demonstrations about phenomena at the nano-scale. Twenty-four students from graduate and undergraduate classes taught by Bennett and by Wetmore and Thornton, as well as students newly active in the new Informal Science Communication Program participated in public displays at the Tempe Festival of the Arts, a street art fair that attracted upwards of 200,000 visitors and in the official NanoDays event hosted at the Arizona Science Center. The demonstrations covered many aspects of NSE, including how size affects a material's properties using quantum dots, how to visualize things at the nano-scale, and how to suit up to enter a nanomaterials clean room. While a fun, educational experience for the children and adults that visited the demonstrations, it was likely most useful for the students who had to (often for the first time) distill complicated technical information down to its simplest explanation. The prototype NISE/CNS posters and handouts were also exhibited at both sites.

Science Cafes

As also described under informal education, CNS-ASU continued to produce its successful Science Café series, hosted one Friday each month during the academic year by the Arizona Science Center in downtown Phoenix. The series continued to maintain attendance on average of 40-50 people, and continued to use its format innovation – pairing a social scientist or humanist with a natural scientist or engineer – to good effect. Cafés are now coordinated by the Outreach Coordinator and moderated by CNS-Biodesign Fellow, Jennifer Watkins. In past years, CNS-ASU curated events during the fall and spring semester. There are new plans to extend the series into the summer months beginning Jun 10 and to collaborate with additional ASU schools and departments interested in organizing speakers, including the School of Earth and Space Exploration through Dr. Ariel Anbar.

This year, plans for integrated promotion of Science Café events in the Phoenix metro area were realized through the creation and recent launch of a new online events list and associated subscription listserv. The site advertises Science Cafes in the Phoenix area in conjunction with the Arizona Science Center's Biotech talks series and the ASU Sigma Xi Science Café, held in Tempe. The web-based events list also

features short video clips from recent CNS-ASU Science Cafés: **http://phoenixsciencecafe.wordpress.com/**. The site also serves as a digital archive of the digital version of CNS-ASU café fliers generated for each evening. This new web presence for the café series augments the existing visibility we receive on the WGBH Science Café web site (www.sciencecafes.org). Both the expanded schedule and the shared online announcement vehicle reflect the CNS-ASU strategy to embed the Science Café events into the larger informal science education and cultural community in the Phoenix metro area.

Speaker highlights of the recent year included two evenings dealing with nanotechnology and energy in Phoenix, anticipating the new thematic research area (TRC) on nanotechnology and the city beginning in year six. "Bugs for Fuel? Microbes in Our Energy Future," with speaker Conz, dealt with biological alternatives to fossil fuel and "Good to the Last Drop? The Water-Energy Connection" with speaker Goodnick, addressed the challenges of managing water use and energy consumption in the Phoenix metro area. In the current year, CNS faculty Ellison, Conz, and Goodnick have all contributed to the series, and Allenby will conduct one in Apr 10. In addition to outreach and informal education opportunities, the Science Cafes operated by CNS-ASU provide continuing education credits to in-service teachers.

Informal Science Communication Program

During Sp 10, CNS-ASU and ASU's node of the National Nanotechnology Infrastructure Network initiated a program in informal science communication in cooperation with the Arizona Science Center. Graduate students interested in working with the public to promote a broader understanding of science and technology receive training in methods and techniques to engage with diverse audiences. These "Science Liaisons" then work on the floor of the Arizona Science Center once or twice a month during the semester. Students of all disciplines were invited to apply. To date, organizers have conducted two four-hour training sessions for new program initiates to introduce participants to social and ethical dimensions of informal science communication and to assist them in developing several practical demonstrations that are appropriate for working with all age groups at the Arizona Science Center. Beginning in Mar 10 and coinciding with a physical renovation of the main lobby area, ASU students and program organizers spend one session a week from 10AM to 2PM at the Science Center interacting with visitors. Faculty leads Thornton, Wetmore, Bennett, Harsh, Gano, and student leaders, Joshi and Trinidad provide ongoing support and mentorship through informal monthly group meetings and an online organizational space in the university's courseware system, Blackboard. A set of informal and formal science educational resources, training materials, and a collaboratively-edited Google calendar schedule are accessible through the community site. Participants receive reimbursement for transportation and lunch. Thirty-five students are now members of the online group and receive regular announcements about program activities; ten students have completed the training and are active volunteers. We have received lots of positive feedback from museum program organizers and visitors in the opening weeks of this program and have plans to continue it into the coming year. The collaborations with the Arizona Science Center, including the Science Cafes, have been quite productive. Laura Martin, director of Science Interpretation at the Science Center has recently asked CNS to collaborate on the application of a grant from NOVA to develop museum presentations and displays on material science.

Future Scenarios, Anticipatory Governance, and Sustainability – Urban Development in Phoenix SOS 594 (23178)

In Mar 10 at Phoenix City Hall, students in the Future Scenarios, Anticipatory Governance, and Sustainability – Urban Development in Phoenix SOS 594 (23178) class led by Wiek and Selin, conducted a half-day stakeholder engagement activity in partnership with the Planning Department of the City of Phoenix. Preceding it were several community meetings to gather public sentiments and inform an update to the Phoenix General Plan concerning a 2050 vision to guide city planning. At these earlier meetings,

citizens from various villages were asked 1) what they like about the city of Phoenix and 2) what their visions for an ideal city would include in the year 2050. Using information from these visioning exercises grouped in four sectors (economy, environment, infrastructure, and community), students designed an activity to allow 115 community stakeholders to investigate further into vision items that could involve trade-offs between one or more desired components in the city to bring that part of the vision to fruition. Based on the concept of anticipatory governance, the goal of this activity is to assist the City Planning department in crafting a vision statement for the General Plan that moves beyond a laundry list of disconnected features to one that accounts for interdependencies, trade-offs, and sustainable principles and is therefore a richer portrait of community visions. This visioning activity sets the stage and establishes strategic contacts for the new TRC 2: Nano and the City theme that will be active in years 6-10.

Nano2

Selin, Guston and Shapira participated in the International Study of the Long-term Impacts and Future Opportunities for Nanoscale Science and Engineering Workshop in Evanston, IL in Mar 10. This second workshop, following one held a decade ago, meant to take stock of the progress that NSE research has made over the past ten years and begin to set an agenda and expectations for the next decade of research and education. Guston presented plenary remarks on "Broader Societal Implications" and Selin and Shapira presented prepared remarks in a breakout session on "Innovative and Responsible Governance," where Shapira also served as a rapporteur. All three also participated in the breakout session on "Preparation of People and Infrastructure." Output from the workshop will include a multi-authored book derived from the plenary and breakout statements and will include the results of similar workshops to be held in Hamburg, Tokyo, and Singapore.

PCAST

In Jan 10, Guston testified before the National Nanotechnology Advisory Panel (NNAP), a working group of the President's Council of Advisors for Science and Technology (PCAST) charged with making a biennial review of the National Nanotechnology Initiative (NNI). In addition to making his five-minute statement, Guston submitted twenty pages of written testimony and two pages of follow-up. His testimony focused on four areas: 1) general progress in societal research on nanotechnology, which has made significant strides under NNI sponsorship; 2) size and composition of the societal research portfolio, which is inadequate to the size, diversity and dynamism of the NSE community; 3) integration of societal research in NSE activities, which shows promise but has not been implemented as broadly as it should be; and 4) public engagement with nanotechnology, which likewise shows promise but has not been pursued with sufficient purpose. He also concluded with a discussion about the societal challenges of nanotechnology and offered some recommendations for NNI regarding research, training and outreach on societal issues in nanotechnology.

National Commission on Energy Policy Task Force on Geoengineering
Sarewitz has been appointed to the bipartisan task force created by the National Commission on Energy Policy to examine research and policy issues associated with geoengineering – modifying the environment on a large scale to change the Earth's atmosphere. The task force, which encompasses experts in science, technology, national security, ethics and other fields, met for the first time March 10. The task force aims to make recommendations to Congress and the Obama administration this summer. As an emerging technology and on that implicates nanotechnologies in many of its imagined schemes, geoengineering is an apt site for the application of the vision of anticipatory governance.

Documentary and video/media projects:

New Media Initiative

Recognizing that interdisciplinary and integrated communications about the social, ethical, political and legal dimensions of developing nanotechnology requires a diverse outreach strategy, CNS-ASU embarked on a new media project to build the infrastructure, workflows, and capacities. The goal of the project is to expand the reach of the Center's regular research and engagements through a variety of mediums. This initiative launched with a study of CNS-ASU current products and target audiences to determine how to maximize existing efforts and prioritize the development new skills and resources.

Nano-Vods

Gano has made progress extending the Occasional Speaker and Science Café Series by producing and syndicating digital video captured at live events. A format, graphics and workflow for producing video features ranging from two to ten minutes in length, called Nano-vods, were produced and developed over the fall semester. Prototype Nano-vods previewed at the January All Hands meeting, and premiered in April as a part of a new video playlist embedded on the CNS-ASU homepage and available through YouTube. The Science Café Nano-Vods also appear in a playlist associated with the new Science Café online events list (http://phoenixsciencecafe.wordpress.com/). In the coming year, CNS-ASU plans to make archived, full-length versions of its Occasional Speaker Series videos available for asynchronous viewing. The Center may also experiment with live streaming and blogging for these events as well; a prototype of this process will be tested in May 10 at The Rightful Place of Science conference held by CNS-ASU's parent Consortium for Science Policy and Outcomes. A link from the CNS-ASU website to the NISE Net blog space to feature the newly launched Real World Nano blog by Miller is also planned.

CNS Project Documentaries

In addition to capturing regular live events, CNS-ASU plans to produce occasional thematically-based video pieces to communicate research ideas generated at the Center in multiple media formats. One such piece, linked to the Fa 09 Plausibility workshop, will be added to the project site and the CNS-ASU homepage in May. Another piece featuring interviews with the authors contributing to the second volume of the *Yearbook* will premiere during Su 10. As with the CNS-ASU website content, the digital video pieces will be discoverable through Google and other web search engines; they will also be available through YouTube.

"Future Tense" Documentary Project

CNS-ASU personnel have been intimately involved in the development of a media project, "Future Tense," that explores the ethical, legal and social challenges inherent in emerging GRINN technologies (genetics, robotics, informatics, nanotechnology, and neuroscience). The centerpiece of the project is a planned 3-part, prime-time PBS series that will also involve a mass of new media and web-based ancillaries, along with education and community engagement materials. This public television event thus incorporates a documentary series, an interactive online presence and a multi-year educational and public outreach program that investigates the potential benefits of GRINN technologies, the serious ethical, social and legal dilemmas posed by their use, and the search for possible strategies and solutions to address these dilemmas. These outreach activities aim to encourage a national dialogue about the issues raised by "Future Tense" and are well aligned with the strategy and research agendas of CNS-ASU. The series is being developed by Emmy-award winning producer/director Leo Eaton, in conjunction with MacNeil Lehrer Productions and local PBS station KAET Phoenix. Members of the advisory group for the project include Allenby, Guston, Herkert, Poste, Robert, Selin and Sylvester, and Marchant is a principal organizer. Many of CNS-ASU's research, education and outreach projects are being mined and adapted in the planning of the project. The project in YR 5 is largely on hold due to financing issues, although ASU has just announced a "Future Tense" partnership with New America Foundation and Slate that may have a positive impact on the documentary project.

STIR Documentary: Lab Life

Frank Theys, a Belgian filmmaker based in Holland, is planning a documentary that would film life, work, and probing discussions about new emerging technologies in laboratories around the world. After learning about the STIR project through numerous sources in Europe, Theys contacted Fisher and then traveled to CNS-ASU in Nov 09 to meet with Fisher and Vermaas. He has since been invited by Johnston and several other STIR collaborators to film in their laboratories. *Lab-Life* is meant for a broad audience. The background idea is that public discussions about technology often entail a hostile attitude towards the scientific world, fed by fear of the unknown. The aim of this documentary is to provide a more realistic view of scientific research of today, which will allow the audience to better appreciate the actual kinds of technical challenges and questions scientists deal with. For this purpose the filmmaker follows a few laboratories where at the same time an 'embedded humanist' from the STIR project is at work, since this provides the extra opportunity to follow the reflections that are happening within the scientific world, show a collaboration between the humanities and the natural sciences at work on the floor of the laboratory itself, and in doing so, create so to speak a portrait of the integrated socio-scientific world. 'Lab-Life' is produced by Savage Films (Belgium) and Cobos Films (The Netherlands) in a coproduction with the public broadcaster ZDF/ARTE (Germany/France), supported by the Flemish and the Dutch Film Funds, the European MEDIA program and the CERA Art Foundation. The film will have a cinema release (90 min.) and a 60 min. or series version for television and will be distributed by Autlook Films (Austria). Filming is currently anticipated to begin in Su or Fa 10.

InnovationSpace Everwell Video
In YR 5 CNS-ASU has nearly completed production of a short documentary featuring the product innovations and educational experiences occurring in the InnovationSpace program. The film, directed by KAET-TV executive producer Melody Cavanary, highlights a CNS-ASU InnovationSpace project from YR 4, Everwell. Everwell is a nano-enabled condensation device that extracts water from air potentially enabling a clean, convenient, off-the-grid solution designed for Arizona's Native American communities. The production team has completed shooting, interviewing and background research and is in the editing phase.

Presentations to Public Audiences

CNS-ASU researchers have made numerous presentations to public audiences, including some 39 cumulatively to specifically policy audiences and 40 to lay audiences. Beyond those mentioned above, highlights in YR 5 include:

- Wetmore, Bennett, and Ostman (Sep 09) presented CNS / NISE Net Joint Museum Demonstrations on Nanotechnology and Society, Pacific Science Center, Seattle.
- Conz (May 09) presented Tubes in the Desert to Greenfield Country Day School. Tucson, AZ.
- Sommerfield, Edwards, Conz (Jan 10). "Bugs for Fuels: Microbes in our Energy Future." CNS-ASU Science Café, Arizona Science Center.
- Wetmore (Nov 09) "Technology and the City," at *On the Cutting Edge… Today's Jewish Women Symposium*, Scottsdale, AZ.

Presentations to Policy and Professional Audiences

- Youtie and Porter (Dec 09) provided an analysis of research in the environmental, health, and safety of nanotechnology and briefing to Environmental Protection Agency.
- Guston (April 09) gave a video plenary lecture for the Ministry of Research, Science and Technology of Wellington, New Zealand on "Anticipatory Governance of Emerging Technologies."

- Kay (May 09) presented on "Nanotechnology R & D Collaborations in Brazil" at the Workshop of International R & D Cooperation with Latin America in Madrid.
- Miller (Mar 10) presented "Systems Integration: The Human and Social Dimensions of Energy Systems Transformation" at the Advisory meeting for the Directorate of Mathematical and Physical Sciences, National Science Foundation, Washington, DC.

INTEGRATION

Solar to Fuels Workshop

Selin and Davies organized and conducted an interdisciplinary workshop held Mar 10. This Energy Futures, Policy and Society workshop on "Exploring Solar to Fuels" considered emerging energy technologies, their implications for broader society, and the resource, social, environmental and political barriers to their implementation. The complex and dynamic challenges lie at the interface of energy technologies and society: they require new combinations of expertise in dealing with them. The Solar to Fuels workshop brought together natural scientists with scholars of technology and society, history, political science, and sociology to envision Solar to Fuels technologies and explore the societal issues at stake. The central query was: What are the critical societal and policy issues involved in creating fuel from sunlight?

National Nanotechnology Infrastructure Network

In addition to the Informal Science Education Training program for graduate students mentioned previously, the CNS-ASU continues broader discussions about integrating SEI issues in the NNIN. After much deliberation NNIN has decided that face-to-face discussions of SEI issues would better engage the researchers at its user facilities. Wetmore attended a workshop in Jan 10 at Cornell University to discuss ways of doing this. Wetmore and Bennett are currently working with Trevor Thornton (leader of the ASU NNIN node) to develop a thirty-minute module to be presented in conjunction with the health and safety training that all users of the ASU NNIN facility must successfully pass. The current plan is to introduce researchers to the practical implications and applications of CNS research and findings, while also making them aware of the support CNS can offer to young scholars in the form of PhD+ opportunities and coursework.

Hispanic Research Center

In Sp 09 CNS partnership and the Hispanic Research Center (HRC launched a 7-week short course entitled "Introduction to Making STEM Research Socially Relevant." This course will be reiterated in Fa 10. Students involved in the first version of the course went on to take part in the Su 09 DC Summer Session and continue to work with faculty sponsors Wetmore and Bennett, and additional students from HRC will participate in the Su 10 iteration. A Fa 10 lab engagement activity is being planned with Antonio Garcia, Associate Director of the Hispanic Research Center and Professor of Bioengineering in the Ira A. Fulton Schools of Engineering.

Identifying Promising Innovation Pathways for Nanostructure-enhanced Solar Cells & Nano-biosensors

In Fa 09 Porter and graduate students Guo and Huam hosted two foresight workshops on nanostructure-enhanced solar cells and nano-biosensors at Georgia Tech. These efforts gathered technical experts to profile R&D and commercialization opportunities and forecast promising innovation pathways. The work was based on GT's technology forecasting approach which involved: identifying Georgia Tech

researchers, based on bibliometrics and collegial contacts; one-on-one meetings with lead scientists to assess needs; and the production of a variety of models and profiles developed in RTTA 1. These models include mining science, technology and innovation information (Science, Citation Index, Derwent Patents, Factiva Business and Popular Press); mapping collaborations between companies and universities; linking technologies to plausible applications; and commercialization signals. The workshop provided an opportunity to assess such work and to collectively array promising innovation pathways for nanostructure-enhanced solar cell applications. The workshop provided a forum to articulate alternative futures and explore the timing and outcomes of plausible innovation pathways.

NanoFutures Project

The NanoFutures scenes of plausible products of nanotechnology have proved helpful in structuring dialogues about the societal implications of nanotechnology with a variety of professional, student and public audiences. In Jan 10, Selin conducted an online survey that queried natural scientists perspectives on emerging energy technologies.

Indian Institute of Technology, Bombay winter school

In Dec 09, Bennett served as a faculty member for the National Nanotechnology Infrastructure Network's International Winter School for Graduate Students (IWGN) in the same capacity as Wetmore had in Dec 08. The Winter School, organized by NNIN Director Sandip Tiwari, brought together 10 American and 10 Indian natural science and engineering graduate students at the Indian Institute of Technology Bombay, for a week's worth of classroom sessions on semiconductor materials science and engineering. Bennett taught a classroom session on the social implications of nanotechnologies and on Indian and US systems for governing publicly funded science. The second part of the Winter School involved a six day trip into the Indian state of Madhya Pradesh, where the group visited a variety of different types of primary education settings ranging from upscale private schools to tribal school that are run by lamp light at night because the children spend the day herding goats and cattle. Bennett ran evening discussion sessions with the students to further explore what the students had seen and experienced during the day, particular attention was paid to how and when technological interventions were appropriate for the villages.

American Association for the Advancement of Science

In Feb 10, CNS organized a panel at the annual meeting of the American Association for the Advancement of Science. The panel entitled "Lessons of Engagement: Learning from Policymakers and the Public" brought together three science and engineering graduate students who have been involved in projects that bring scientists and the public together. Troy Benn (ASU) represented much of the work of CNS as he has participated in the DC Summer Session, coursework, museum programs, and CNS sponsored a trip for him to explore the policy relevance of his dissertation at the EPA, FDA, and Woodrow Wilson Center. Kiki Jenkins (University of Washington) described her work as a AAAS Policy Fellow, and Naveen Sinha (Harvard) described his work at the Museum of Science, Boston. The panel drew an audience that was largely made up of interested students and faculty who had developed similar engagement programs and served to promote both the CNS education program and other programs for graduate student scientists and engineers to develop skills outside of the laboratory.

Research Integration Presentations

CNS-ASU researchers have made a cumulative 47 presentations to audiences with a specifically technical orientation. Beyond those mentioned above, highlights in YR 5 include:

- Guston (Mar 10) "The Anticipatory Governance of Emerging Technologies." Plenary remarks. INEW 2010: the Second International Nanomaterials Ethics Workshop, Korea Institute of Science and Technology, Seoul, Korea.
- Shapira (Jun 09) "Anticipating Nanotechnology: Applying Real-Time Technology Assessment to Develop Strategic Insights for Nanotechnology Research and Integration" for the Centre for Self Organising Molecular Systems at the University of Leeds, UK.
- Wetmore (Dec 09) "Best Practices of NSECs and MRSECs for Advancing NSE Education – Diversity Aspects" at the 2009 NSF Nanoscale Science and Engineering Grantees Conference, Arlington, VA.
- Fisher (Jun 09) presented "Science and Society in the Laboratory? Reflections of an Embedded Humanist" Colorado Fuel Cell Center. Colorado School of Mines, Golden, CO.

Collaborations with Academic Colleagues

Society for the Study of Nanoscience and Emerging Technologies (S.NET) Preconference Workshop

In Sep 09, CNS faculty conducted a half-day pre-conference workshop on CNS research methods as a part of the inaugural meeting of the Society for the Study of Nanoscience and Emerging Technologies (S.NET) in Seattle, WA. The workshop featured sessions on the spectrum of quantitative and qualitative techniques used to support methods of RTTA and facets of CNS's guiding concept of anticipatory governance: foresight, engagement, and integration. The workshop was a prototype for a 2-week annual Winter School in the Anticipatory Governance for Emerging Technologies planned to begin in W 11-12 for 20-25 students. Workshop presentations included Youtie and Porter sharing a technique for using bibliometric and patent analysis to examine emerging innovation systems. Corley described survey design to gauge public opinion and understanding around nanotechnology. Selin discussed and demonstrated techniques for developing plausible scenarios of technological futures. Guston described the configuration and evaluation of public deliberative exercises on emerging technologies based on the recent multi-site NCTF on human enhancement. Cozzens addressed assessment techniques for examining issues of equity and equality around the development of emerging technologies both nationally and internationally. Wetmore focused on pedagogical components of training science and engineering students about the societal aspects of their research.

The workshop received twenty-seven formal registrants, twenty of whom returned evaluation forms providing comments about the format and content included. The evaluation asked six questions about the balance of content covered, valuable aspects, areas for improvement, reflections on future workshop fees, and additional comments. Responses in the context of this short session will allow us to make adjustments as we extend the workshop format into a multi-day winter school. Participants characterized the following aspects of the workshop as most valuable: Broad overview/diversity of approaches presented, esp. RTTA; High Quality, clear presentations; Providing supporting materials (CDs) as a take-away; Educational ideas; Learning what social & natural scientists think are societal issues; Great to include museum people as attendees; Length was ideal; Interactive question time; Practice examples; and Networking.

Outcome: Anticipatory Governance workshop with NISE Net Partners
NISE Net and CNS-ASU partners will hold a joint workshop in 2011 on extending and situating CNS's guiding research concept of Anticipatory Governance firmly into informal science communication around nanotechnology and other emerging technologies.

Plausibility Project

In Nov 09, renewal RTTA 3 co-leader Selin and renewal TRC 2 lead Wiek joined forces with the Institute for Science, Policy and Innovation (University of Oxford) and an interdisciplinary group of scenario practitioners, science and society scholars, philosophers and historians to explore the conceptual and methodological underpinnings of plausibility – an appreciation of what it is, why it matters, where its evaluated and for whom it occurs a central value. The Plausibility Project seeks to better understand the meaning and significance of plausibility through questioning the ways individuals and communities know, explore, assess and shape futures across time, cultures and professional practices. Three outcomes emerged: Participants identified "state of the art" (concepts, empirical studies) regarding plausibility; accounted for research and knowledge gaps surrounding plausibility; and developed a coordinated research agenda with preliminary indications of who would be interested in addressing which gap. Selin plans to seek separate funding for a virtual library on plausibility and use the project report (Selin 2010) to help seed a short publication for an outlet like the commentaries in *Nature*.

Social Challenge of the Future

Social Challenge of the Future was a series of speakers connected to the Plausibility workshop. With additional funds from ASU's College of Liberal Arts and Sciences, Social Science division, the Center shared several of the scholars visiting for the workshop with the broader ASU community of faculty and students. There were four well-attended symposiums in Nov 09: on Scenarios, on History of Emerging Technologies, on Human Enhancement, and on Post Normal Science where top-ranked scholars and practitioners involved in scenario planning, science studies, risk management, and foresight shared their latest work.

Transatlantic Workshop on Nanotechnology Research and Innovation Policy

Shapira and Youtie have collaborated with the European Union Center of Excellence at Georgia Tech to hold the EU-US Transatlantic Workshop on Nanotechnology Research and Innovation Policy in Mar 10. Managers at the Georgia Tech Marcus Nanotechnology Center are were actively involved with RTTA 1/1 researchers in the planning of this workshop, the director was a keynote speaker, three nanotechnology companies of the center's equipment were featured speakers, as was the Vice Consul for Science and Innovation of the British Consulate-General. Participants from eight North American and European countries took part, including 14 early career scholars. Sponsors and partners included the European Union Center of Excellence (EUCE) at Georgia Tech, CNS-ASU, Consulate General of Canada in Atlanta, Georgia Tech School of Public Policy, Georgia Tech Program in Science, Technology and Innovation Policy, and Manchester Institute of Innovation Research, University of Manchester.

Presentations to academic and professional audiences

CNS-ASU researchers have made a 236 cumulative presentations to collegial academic and professional audiences. Beyond those mentioned above, highlights in YR 5 include:

- Dudo et al. (Aug 09) presented "Science on Television in the 21st Century: Recent Trends in Portrayals and Their Contributions to Public Attitudes toward Science" at the Annual Conference of the Association for Education in Journalism and Mass Communication, Boston, MA.
- Barben and Guston (Oct 09) organized two sessions with 10 scholars on "Reflexive and Anticipatory Governance of Science and Technology: What's New in Assessing and Shaping Innovation-Based Futures" at the Annual meeting of the Society for the Social Studies of Science. The sessions included presentations from CNS-ASU scholars Guston, Barben, Calleja-Lopez, Fisher, Selin and will lead to the production of a special issue in *Social Studies of Science*.

- Bennett (Mar 10) "Visions for Future Innovations and Implications" at the Atlantic Transatlantic Workshop on Nanotechnology Innovation and Policy Georgia Institute of Technology, Atlanta, GA.
- Youtie, J. (Aug 09) "Understanding and Stimulating Highly Creative Research: Measurement and Analysis- U.S. and Europe." American Sociological Association Annual Meeting in San Francisco, CA.

Collaborations/Interactions with Industry and Other Sectors

InnovationSpace

CSN-ASU has a modest technology transfer program through its support of InnovationSpace (ISpace). One important output of ISpace is an invention disclosure by each of the cross-functional undergraduate teams. ISpace teams working with CNS have disclosed 9 inventions to ASU's technology transfer arm, Arizona Technology Enterprises (AZTE). These disclosures have generally been the endpoint of technology development from ISpace, as it is not a specific goal of the class, nor especially of CNS-ASU, to have a commercialized product as an outcome. Nevertheless, and particularly in conjunction with some potential private sector partners, further intellectual development of the products would be desirable and could lead to commercially valued outcomes. ISpace thus, in conjunction with CNS-ASU, submitted an internal proposal to the Promoting Entrepreneurship Grant program – sponsored at ASU by the Kauffman Foundation – to add graduate level expertise to develop some of the ISpace product ideas. Although the Kauffman Foundation declined to fund the proposal, CNS opted to fund the graduate students in YR 5 rather than the undergraduate ISpace activity as in previous years (see **RTTA 3/2** for details). The mini-documentary, supported by CNS and being produced for ISpace for completion in Sp 10, will also be used to support industrial outreach.

Consultative Group on Biodiversity

In Su 09, the Center for Genetics and Society (www.geneticsandsociety.org) – a private not-for-profit public affairs group focused on responsible uses and responsible governance of human genetic and reproductive technologies – invited Guston to collaborate in a "webinar" (telephone and PPT) on the environmental and social justice aspects of emerging technologies. In Oct 09, Guston and Marcy Darnovsky of CGS made two, hour-long presentations to the Consultative Group on Biodiversity (www.cgbd.org), a forum of 56 private philanthropies of varying sizes committed to working on environmental policy, sustainability, and biodiversity issues. Guston introduced the concept of anticipatory governance to the group and provided overviews of the relationship between concerns for the environment and social justice and such emerging technologies as nanotechnologies and synthetic biology. As a follow-up to this collaboration, Guston has been invited to and will attend the First Tarrytown Meeting, organized by CGS, to discuss with roughly one hundred other academic, policy and NGO representatives governance issues of emerging technologies.

Private Sector Engagement Committee (PSEC) and Post-Doctoral Researcher

While CNS-ASU has had a successful outreach and engagement program – particularly to the general public on the one hand and academic NSE researchers on the other – it has not yet succeeded in creating sustained interactions with the private sector beyond ISpace and ad hoc contacts such as these. The problem, we have come to recognize, is one of insufficient human resources. CNS-ASU therefore submitted a supplement request to NSF in Mar 09 for a post-doctoral researcher whose primary duty will be to build the Center's private sector contacts and coordinate its outreach to and engagement with them. A principal goal of the post-doctoral coordinator for private sector outreach and engagement will be to

reconceive the role of the Nano-Industry Liaison Committee (NILC) and, in the course of a variety of tasks supporting private sector engagement across the Center's activities, recruit a new, more active and more effective Private Sector Engagement Committee (PSEC).

CNS-ASU was awarded (#0936064) supplement support a post-doctoral level coordinator for private sector engagement to bolster its relationship with private sector and industrial interests. This appointment has been delayed due to obstacles with obtaining a work visa for the candidate identified. The Center must now hold a third search to fill the position.

We expect that the post-doc will enable other CNS-ASU programs to collaborate more closely with the private sector, e.g., to allow workshops from across the Center to more effectively recruit private sector participants and interact with private sector laboratories included in the Socio-Technical Integration Research (STIR) laboratory engagement study. In addition to ICON, the post-doc will also coordinate with groups like the NanoBusiness Alliance in the US and the Arizona NanoCluster locally, and the Nanotechnologies Industry Association and the Business and Industry Advisory Committee (BIAC 2009) to the OECD in Europe to ensure that CNS-ASU perspectives are represented to private sector audiences. Finally, we envision that the post-doc will identify and develop at least one research project on his or her own related to the role, e.g., a study of private sector analogues to anticipatory governance and a formulation of CNS-ASU's vision of its relation to the private sector. Should the supplement be fully funded, the post-doc will have a modest travel budget and an undergraduate intern to assist in these tasks.

Presentations to private sector/industrial audiences

CNS-ASU researchers have made a cumulative 19 presentations to audiences with a specifically private sector/industrial orientation. Beyond those mentioned above, highlights in YR 5 include:

- STIR student Phelps completed her study of ALD Nanosolutions and intends to produce a co-authored paper with personnel from the firm.
- Selin (May 10) presented on "The Future of Organizing Scenarios" at the Organizational Design Forum annual meeting, Denver, CO.
- Guston (Oct 10) conducted a webinar on "Emerging Technologies and Sustainability" for the Consultative group on Biodiversity with the Center for Genetics and Society.
- Porter (Aug 09) delivered "Locating Nanotechnology among the Disciplines" at the Nano@Tech seminar series, Georgia Tech.

13. Shared and other Experimental Facilities

While CNS-ASU has no physical science or engineering experimental facilities as such, it has created a nexus of exciting, cutting-edge inquiry that has drawn large numbers of scholars, many of them international, to visit and collaborate with us in a variety of capacities. The Center has a physically coherent space – integral with its parent center, the Consortium for Science, Policy and Outcomes – and sufficient capacity and flexibility to host visitors. Since beginning operation in Oct 05, and using rigorous selection criteria, CNS-ASU has hosted numerous visitors including some 50 international scholars, students, and policy practitioners from 18 countries. This section reports on the interactions that CNS-ASU has generated, which in turn point to the Center's value as a destination for visiting international scholars and its role as the central node in a widening international network.

To provide meaningful structure for our reporting on these visits, we limit our account here to include only a subset of these interactions based on three rigorous selection criteria. First, we only report on visitors who come from outside the US. Second, we only report on visitors who have no formal positions within US institutions, whether at ASU or elsewhere. We thus do not count international students such as Calleja (Spain), who has a Fulbright scholarship to attend ASU and work with CSPO and CNS; Bal, Gatchair and Kay, who receive some form of support from Georgia Tech); Kim (Korea), Luk (Hong Kong), Stavrianakis (UK) and Zhu (China), who have appointments either at ASU or another US institution; or international post-doctoral scholars such as Davies (UK) or Rodriguez (Basque Country) who have an appointments at ASU. Third, we only count one member of each group of between two and four visitors from the same institution or country (except in cases where members engaged in separate Center interactions that did not involve the group as such). We thus count Hosono (Japan), but not the other three scholar-practitioners from the same Japanese delegation.

In Years 1-4, CNS-ASU was visited by twenty-nine international visitors who fit these criteria. Visits from these people varied in length of stay, ranging from a few days to several months, but in nearly each case the visitor provided a lecture or seminar on his or her work related to nanotechnology in society and met intensively with CNS-ASU researchers. These visitors included faculty, students, and policy practitioners.

In year 5, twenty visitors who fit the three criteria specified visited CNS-ASU, including:

1. Line Bonneau - James Martin Research Fellow in Futures, University of Oxford, England
2. Shirin Elahi - Director, Scenarios Architecture, ltd., England
3. Ulrich Fiedeler – Institute for Technology Assessment, Austria
4. Silvio Funtowicz - European Commission, Italy
5. Maja Horst - Copenhagen Business School, Denmark
6. Keishiro Hara, Associate Professor, Osaka University, Japan
7. Alan Irwin - Dean of Research, Copenhagen Business School, Denmark
8. Federica Lucivero - University of Twente, the Netherlands
9. Bastien Miorin - Institut d'Etudes Politiques de Grenoble, France
10. Rohan Nelson - CSIRO Sustainable Ecosystems, Australia
11. Angela Guimaraea Pereira - European Commission, Italy
12. Jerome Ravetz - University of Oxford, England
13. Roger Strand - University of Bergen, Norway
14. Frank Theys - VOTNIK cvba, Belgium
15. Matthias Wienroth – Durham University, England

Additionally, in Year 5, Georgia Tech has hosted five visiting scholars from two institutions in China:

16. Lu Huang
17. Ying Guo
18. Ruimin Pei
19. Xuanting Ye
20. Shuliang Zhang

CNS-ASU visitors consist of faculty, students, policy practitioners and private sector practitioners who come from eleven countries. At least six Year 5 visitors have published articles or have articles accepted that cite Center published research or otherwise grew out of their interactions with the Center. Three have returned for follow-up visits, two have participated in Center activities organized elsewhere in the world, and at least four have hosted Center researchers who were visiting them in their native countries. Five are collaborators on the separately-funded STIR project.

Nearly ten Year 5 visitors are faculty from academic institutions. From a survey conducted in 09, we learn from faculty visitors that CNS-ASU has "a clear presence and high reputation in Europe," that it and that conducts "theoretically ground-breaking work," the Center is seen as a major hub for international networking. One visiting faculty member reports that "in the many conferences, seminars and meetings we have had in several Latin American Countries, CNS-ASU appears as a key reference and is seen as our US principal center for studying recommendations, pursuing academic endeavors, and making intellectual contacts." When a delegation of US, Japanese researchers "had a chance to visit the their CNS-ASU was certainly the place to visit" (on stated so-called "not-to-miss" list). These visitors have that collaborating with CNS-ASU "is considered strategic" for their institutions and is viewed as "of critical importance to our research projects."


The Center for Nanotechnology in Society
ARIZONA STATE UNIVERSITY

Occasional Speaker Presentation

Strategic Science:
Research Intermediaries and the Governance of Innovation

Wednesday, August 26, 2009
11:30 - 1:00 pm
Biodesign Auditorium

Note location change

Please RSVP your attendance to Michelle Iafrat, 480-727-8190 no later than August 24.

Dr. Matthias Wienroth
Research Associate, Department of Geography
Durham University, United Kingdom

Strategic Science - Research Intermediaries and the Governance of Innovation is a two-year project funded by the Economic and Social Research Council and hosted by the Institute of Hazard and Risk Research at Durham University in the UK. The project aims to explore how the development of new technologies is influenced by government policy—principally mechanisms for researching funding, knowledge transfer and public deliberation. In comparing recent approaches to nanotechnology with current developments in synthetic biology, the project examines the institutional and governmental dynamics that shape the emergence of such technologies. The project also asks how the strategic support for, and coordination of, research activities might be improved through processes of public and democratic accountability. It examines ways in which the development of new technologies is both shaped and governed by national science and innovation policies and research support mechanisms.

Dr. Matthias Wienroth, who previously worked as a freelance journalist, has studied political science, intercultural communication and history. He received an MA in Political Science and Adult Education from the University of Leipzig in Germany. Dr. Wienroth received his Ph.D. in 2008 at the Policy, Ethics and Life Sciences Research Centre at Newcastle University in the UK. His research interests focus on the debates, practices and institutionalizations of emerging science and technologies such as nanoscale research and developments in the life sciences.

The Center for Nanotechnology in Society at Arizona State University is affiliated with the Consortium for Science, Policy & Outcomes (CSPO), in the College of Liberal Arts and Sciences. CNS-ASU research, education and outreach activities are supported by the National Science Foundation under cooperative agreement #0531194.

Several of our 09 visitors were students. Two are involved in the STIR project, and one has made plans for a second visit. In general, all visiting graduate students receive mentorship from CNS-ASU researchers and have opportunities to publish. From their accounts given in 09, we learn that CNS-ASU has provided students with formative experiences and opportunities for development. One student writes that "the rewarding nature" of CNS-ASU's "gratifying and productive" research environment led to gains "both professionally and personally." Another reports that the STIR workshop "influenced my thinking regarding my own research interests in the management of emerging technologies." Another states that CNS-ASU is considered to be the "best place in US for someone who is interested in innovative TA concepts, both in my view as well as in the view of people from the German TA community."

Four of the international visitors to the Center in Year 5 were policy practitioners: one works for a publicly funded technology assessment institution, two hold positions in the European Commission, and one is with Australia's national science agency. At least one has hosted Center faculty within his home country and has returned for a follow-up visit. From the 09 accounts of policy practitioner visitors we learn that CNS-ASU is seen around the world as offering value in the public sphere. One practitioner writes that "CNS-ASU is well known in the Netherlands for being one of the most important institutes in America for studying the relationship between nanotechnology and society." Another reports that interactions with CNS-ASU "have provided a knowledge and theory base which dramatically increases

the rigor of environmental science-policy research emerging in Australia." A third states that "we will benefit from a closer, less informal, collaboration given the competence and experience accumulated by the CNS-ASU."

Sample publications or publishing activity in Year 5 by recent international visitors to the Center, at both its ASU and Georgia Tech locations, and that stemmed from or were shaped by their interactions with CNS-ASU include:

1. Guo, Y., Huang, L., and Porter, A.L. 2010. Research Profiling: Nano-enhanced, Thin-film Solar Cells. *R&D Management*, 40 (2), 195-208.
2. Guo, Y., Xu, C., Huang, L, and Porter, A.L. 2009. Composing a technology delivery system for an emerging energy technology: The case of dye-sensitized solar cells, *Journal of Technology Transfer*. Under review.
3. Horst, M. (2010, forthcoming). Taking Our Own Medicine: On an Experiment in Science Communication. *Science and Engineering Ethics.*
4. Huang, L., Guo, Y., and Porter, A.L. 2010. Identifying the emerging roles of nanoparticles in biosensors, *Journal of Business Chemistry*, Vol. 7 (1).
5. Huang, L., Peng Z., Guo, Y., and Porter, A.L., Characterizing a Technology Development at the Stage of Early Emerging Applications: Nanomaterial-enhanced Biosensors, *Technology Analysis & Strategic Management*. Forthcoming.
6. Laurent, B. (2010, forthcoming). Scholarly intervention in public engagement: The example of nanotechnology policy in France. *Science and Engineering Ethics.*
7. Porter, A.L., Guo, Y., and Chiavetta, D. 2010. Tech Mining: Text mining and visualization tools, as applied to nano-enhanced solar cells. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*. Under review.
8. Schuurbiers, D. (2009, March). In Amerika. A tryptic on daily life at ASU for *TU Delta*, the weekly magazine of Delft University of Technology.
9. Schuurbiers, Daan and Erik Fisher. 2009. "Lab-scale intervention." *EMBO Reports*, 10(5): 424-427.
10. Schuurbiers, D., Osseweijer, P. and Kinderlerer, J. (2009). Implementing the Netherlands Code of Conduct for Scientific Practice—A Case Study. *Science and Engineering Ethics*.
11. Smits, R.; van Merkerk, R.; Guston, D.H.; and Sarewitz, D. (2010, in Press). "Strategic Intelligence: The Role of TA in Systemic Innovation Policy" in *The International Handbook of Innovation Policy*. Northampton, MA: Edward Elgar.
12. te Kulve, H. and Rip, A. (2010, forthcoming). Constructing Productive Engagement: Pre-engagement Tools for Emerging Technologies. *Science and Engineering Ethics.*
13. van Oudheusden, M. and Evers, J. (2010, forthcoming). Questioning "Participation": A Critical Appraisal of its Construction in a Flemish Participatory Technology Assessment. *Science and Engineering Ethics.*

Year 5 visits also led to or coincided with several instances of knowledge transfer, dissemination, and application. These include the co-hosting by Roger Strand from the University of Bergen of the second STIR workshop in Vatnahalsen, Norway. Strand's visit allowed him to present the plans for his recently

funded project on *Reflexive Systems Biology*, which incorporates integration and foresight methods developed by the CNS-ASU, and in which both Fisher and Selin participate as senior collaborators. Theys is planning a documentary that would film several STIR doctoral students at work in laboratories around the world. 'Lab-Life' is a documentary directed by Frank Theys and produced by Savage Films (Belgium) and Cobos Films (The Netherlands) in a coproduction with the public broadcaster ZDF/ARTE (Germany/France), supported by the Flemish and the Dutch Film Funds, the European MEDIA program and the CERA Art Foundation. The film will have a cinema release (90 min.) and a 60 min. or series version for television and will be distributed by Autlook Films (Austria).

Additionally, these activities and capacities have enabled CNS-ASU to become increasingly involved in arranging and participating in international events that take place outside of our physical space proper and that extend the reach and vibrancy of our network of partners and collaborators. For its second workshop, the STIR project supported the attendance of 14 participants, including twelve doctoral students from eight countries. For the second year in a row, CNS-ASU faculty (Bennett) helped the NNIN to coordinate and conduct an extended trip to India for an international exchange. Center faculty have also in Year 5 provided expert advice to the Research Council of Norway (Fisher), a keynote address for an international workshop on technology assessment in the Flemish Parliament building (Fisher), and plenary remarks for an International Nanomaterials Ethics Workshop in South Korea (Guston).

Plans for future visits and international events hosted by CNS-ASU are underway. We have a number of new and returning international visitors currently planning multiple month visits including, including Rune Nydal (Norwegian University of Science and Technology, Norway),
Simon Pfersdorf (Institut für Technikfolgenabschätzung und Systemanalyse, Germany), Federica Lucivero (University of Twente, the Netherlands), Jeong-yim Seo (Ewha Women's University, Korea), and at least one doctoral student from the Copenhagen Business School in Denmark. The STIR project is making plans to hold its third workshop later this year in Tokyo, Japan.

14. Personnel

CNS-ASU has experienced some modest personnel changes that are being implemented with this annual report. Additional changes will be made once the renewal becomes effective in Oct 10.

The Center is managed by a Director (Guston), two Associate Directors (Sarewitz and Miller, who focuses on education and outreach) and an Executive Committee composed of the center's PIs. In the reporting year, we have changed the slate of PIs to represent changes both at ASU and with the Center's priorities. Guston, Sarewitz, Miller, and Corley still represent the societal dimensions research interests, but Alan Nelson, who has succeeded George Poste as director of the Biodesign Institute, has replaced him as co-PI. Deirdre Meldrum, Dean of the Ira A. Fulton Schools of Engineering, has also replaced Marilyn Carlson as co-PI to acknowledge our shifting agenda to include greater collaboration with engineering faculty. For the renewal, the Center's PI list will change modestly again. Dietram Scheufele (Wisconsin) and Jan Youtie (GA Tech) will be added to recognize the deep partnership with those subcontracting institutions, and Sarewitz and Nelson will be removed.

In the reporting year, Director Guston designated three assistant directors: Fisher (who focuses on international activities), Selin (who focuses on outreach), and Wetmore (who focuses on education).

CNS-ASU has two full-time staff: Regina Sanborn, Program Manager, who reports to the Director, and Michelle Iafrat, Administrative Associate, who reports to the Program Manager. In Aug 09, the Center hired doctoral student, Gretchen Gano, on a 75% staff line as its Education and Outreach Coordinator.

CNS-ASU has a set of team leaders for each of its major RTTA and TRC research programs. These leaders are spread across CNS-ASU participating institutions and in some instances overlap with institutional leaders (see below). The team leaders currently are:

RTTA 1: Philip Shapira, GA Tech
RTTA 2: Elizabeth Corley, ASU; Dietram Scheufele, Wisconsin
RTTA 3: Daniel Sarewitz, ASU; Patrick Hamlett, North Carolina State.
RTTA 4: Erik Fisher, ASU; Elizabeth Corley, ASU

TRC 1: Jameson Wetmore, ASU; Susan Cozzens, GA Tech
TRC 2: Jason Robert, ASU; Joan Fujimura, Wisconsin

Changes in team leadership will occur for the renewal period. The new array will be:

RTTA 1: Jan Youtie, GA Tech; Jose Lobo, ASU
RTTA 2: Elizabeth Corley, ASU; Dietram Scheufele, Wisconsin
RTTA 3: Cynthia Selin, ASU; Merlyna Lim, ASU
RTTA 4: Erik Fisher, ASU; Elizabeth Corley, ASU

TRC 1: Jameson Wetmore, ASU; Susan Cozzens, GA Tech
TRC 2: Arnim Wiek, ASU; Sander van der Leeuw, ASU

Given these changes and the rigor of establishing a new TRC, Guston will reinstitute regular monthly telephone communications among the leadership in Fa 10. CNS-ASU also communicates internally through a regular lab meeting, held every other week, for personnel at ASU, and regular lab meetings held at similar intervals among the Wisconsin and GA Tech groups. A listserv dedicated to CNS-ASU affiliated personnel at all its institutions also facilitates communication.

Much of the interaction among CNS personnel is driven by both the preparation for and the consequences of the All-Hands meeting. The first All-Hands meeting, held 19-21 April 2007, involved more than fifty faculty and student researchers from the several universities involved in CNS-ASU, plus about one dozen specially selected nano-in-society scholars from outside of CNS. CNS-ASU held its second All-Hands meeting 23-25 Apr 08.

CNS-ASU held a Visioning Workshop in Oct 08 to engage in reflexive scrutiny of our future visions of anticipatory governance and RTTA. It included CNS-ASU research, education, and outreach leadership, as well as a few select outsiders and several of our NSE research collaborators. The meeting helped feed into the Center's strategic planning process and prepared for the All Hands meeting. CNS held its third All-Hands meeting on 14-16 Jan 09, the major focus of which was preparing for the renewal effort. Seventy individuals were in attendance representing ASU (researchers, students and staff), CNS-affiliated universities (researchers and students), and others in the nano-in-society field. Our fourth All-Hands meeting was held 11-13 Jan 10, with sixty-four in attendance representing ASU (researchers, students and staff), CNS-affiliated universities (researchers and students), and several representatives from NISE Net.

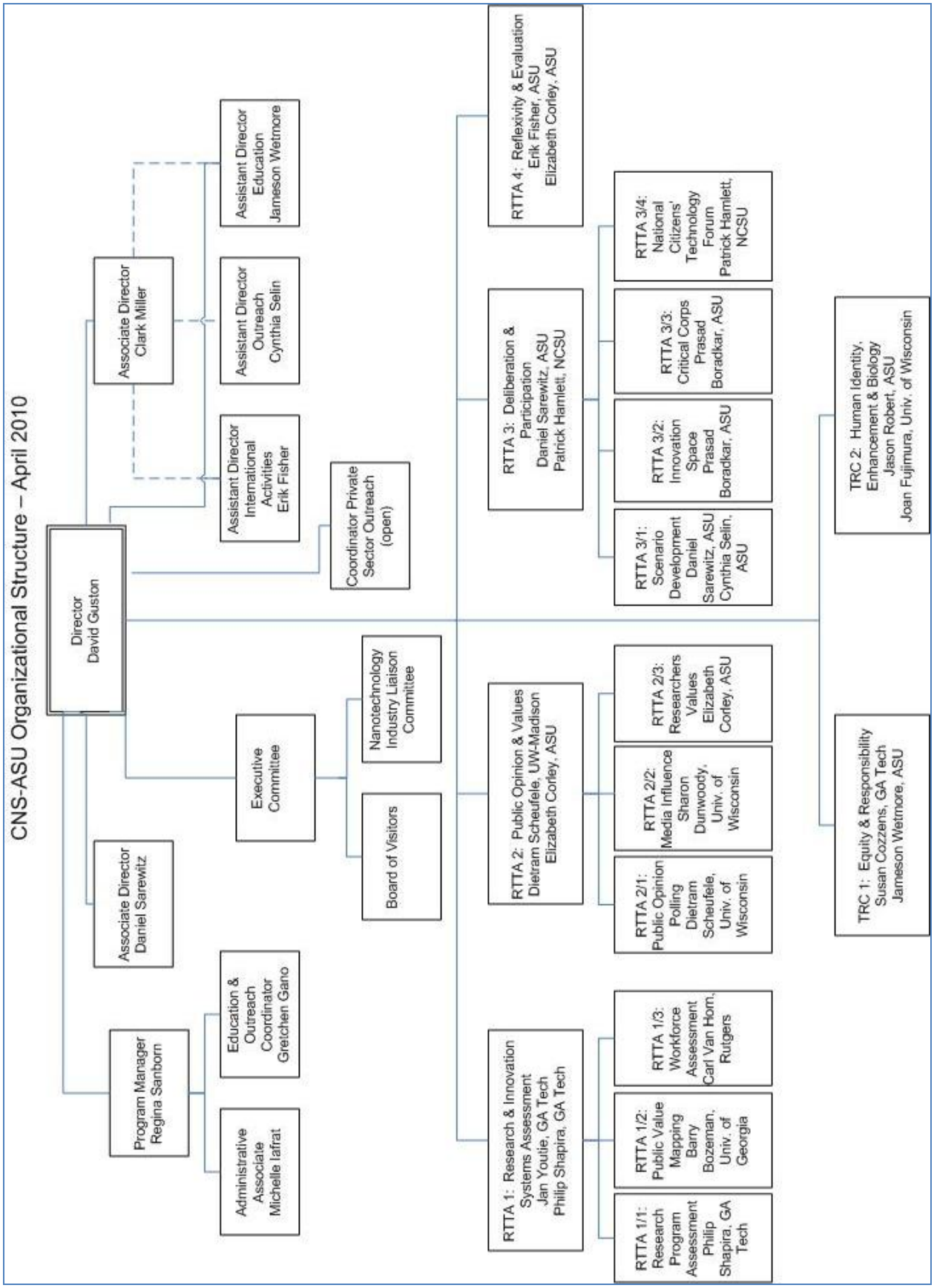

CNS-ASU Organizational Structure – April 2010
Director
David Guston
Associate Director
Clark Miller
Assistant Director
Education
Jameson Wetmore
Assistant Director
Outreach
Cynthia Selin
Assistant Director
International
Activities
Erik Fisher
Coordinator Private
Sector Outreach
(open)
Associate Director
Daniel Sarewitz
Program Manager
Regina Sanborn
Education &
Outreach
Coordinator
Gretchen Gano
Administrative
Associate
Michelle Iafrat
Executive
Committee
Board of Visitors
Nanotechnology
Industry Liaison
Committee
RTTA 1: Research & Innovation
Systems Assessment
Jan Youtie, GA Tech
Philip Shapira, GA Tech
RTTA 1/1:
Research
Program
Assessment
Philip
Shapira, GA
Tech
RTTA 1/2:
Public Value
Mapping
Barry
Bozeman,
Univ. of
Georgia
RTTA 1/3:
Workforce
Assessment
Carl Van Horn,
Rutgers
RTTA 2: Public Opinion & Values
Dietram Scheufele, UW-Madison
Elizabeth Corley, ASU
RTTA 2/1:
Public Opinion
Polling
Dietram
Scheufele,
Univ. of
Wisconsin
RTTA 2/2:
Media Influence
Sharon
Dunwoody,
Univ. of
Wisconsin
RTTA 2/3:
Researchers
Values
Elizabeth
Corley, ASU
RTTA 3: Deliberation &
Participation
Daniel Sarewitz, ASU
Patrick Hamlett, NCSU
RTTA 3/1:
Scenario
Development
Daniel
Sarewitz, ASU
Cynthia Selin,
ASU
RTTA 3/2:
Innovation
Space
Prasad
Boradkar, ASU
RTTA 3/3:
Critical Corps
Prasad
Boradkar, ASU
RTTA 3/4:
National
Citizens'
Technology
Forum
Patrick Hamlett,
NCSU
RTTA 4: Reflexivity & Evaluation
Erik Fisher, ASU
Elizabeth Corley, ASU
TRC 1: Equity & Responsibility
Susan Cozzens, GA Tech
Jameson Wetmore, ASU
TRC 2: Human Identity,
Enhancement & Biology
Jason Robert, ASU
Joan Fujimura, Univ. of Wisconsin

Table 4A: NSEC Personnel, Irrespective of Citizenship

							Citizenship Status											
							U.S. Citizen or Permanent Resident											
					Gender		Race					Mixed-inc	Mixed					
Personnel Type				**Total**	**Male**	**Female**	**NA**	**PI**	**AA**	**C**	**A**	**NA,PI,AA**	**C,A**	**Not Provided**	**Other Non-US**	***Ethnicity Hispanic**	**Disabled**	**% NSEC Dollars**
Director				1	1	0	0	0	0	1	0					0	0	0
Asc. Dir.				2	2	0	0	0	0	2	0					0	0	0
Team Leaders				14	9	5	0	0	0	13	1					0	0	50%
Staff				3	0	3	0	0	0	3	0					0	0	100%
Collaborators				117	87	33	1	0	0	108	8					5	1	0%
Research																		
	Post Docs			11	3	8	0	0	1	7	3					0	0	100%
	Doc/Mas. Students			72	42	32	0	0	0	48	26					10	0	100%
	Undergraduate Students			11	7	4	0	0	1	10	0					1	0	100%
Curriculum Development and Outreach																		
	Senior Faculty																	
	Junior Faculty																	
	Research Staff																	
	Visiting Faculty																	
	Industry Researchers																	
	Post Docs																	
	Doctoral Students																	
	Masters Students																	
	Undergraduate Students																	
REU Student, if applicable																		
	NSF REU Program																	
	NSF/NSEC Program REU																	
	NSEC's Own REU																	
Other Visiting College Students																		
Pre-college (K-12)																		
	Students																	
	Teachers - RET																	
	Teachers - non-RET																	
TOTALS				**233**	**148**	**85**	**1**	**0**	**2**	**192**	**38**					**16**		

Table 4B: NSEC Personnel, U.S. Citizen or Permanent Resident

					Gender		Race					Mixed-inc	Mixed					
Personnel Type				**Total**	**Male**	**Female**	**NA**	**PI**	**AA**	**C**	**A**	**NA,PI,AA**	**C,A**	**Not Provided**	**Other Non-US**	***Ethnicity Hispanic**	**Disabled**	**% NSEC Dollars**
Director				1	1	0	0	0	0	1	0				0	0	0	0%
Asc. Dir.				2	2	0	0	0	0	2	0				0	0	0	0%
Team Leaders				14	9	5	0	0	0	13	1				0	0	0	50%
Staff				3	0	3	0	0	0	3	0				0	0	0	100%
Collaborators				117	87	33	0	0	1	88	8				38	0	1	0%
Research																		
	Post Docs			11	3	8	1	0	0	7	3				4	0	0	100%
	Doc/Mas. Students			72	42	32	0	0	0	48	26				41	10	0	100%
	Undergraduate Students			11	7	4	0	0	1	10	0				0	1	0	100%
Curriculum Development and Outreach																		
	Senior Faculty																	
	Junior Faculty																	
	Research Staff																	
	Visiting Faculty																	
	Industry Researchers																	
	Post Docs																	
	Doctoral Students																	
	Masters Students																	
	Undergraduate Students																	
REU Student, if applicable																		
	NSF REU Program																	
	NSF/NSEC Program REU																	
	NSEC's Own REU																	
Other Visiting College Students																		
Pre-college (K-12)																		
	Students																	
	Teachers - RET																	
	Teachers - non-RET																	
Totals				**233**	**148**	**85**	**1**	**0**	**2**	**192**	**38**				**83**	**11**	1	

15. Publications, Patents and Press

Primary NSEC support indicated by (‡) *symbol. Partial NSEC support for all others.*

Books

1. ‡**Cozzens, Susan** and **Jameson Wetmore** (eds.). In press, 2010. *Yearbook of Nanotechnology in Society, Volume II: The Challenges of Equity, Equality, and Development*. New York, NY: Springer.

2. ‡**Fisher, Erik, Cynthia Selin** and **Jameson Wetmore** (eds.). 2008. *Yearbook of Nanotechnology in Society, Volume I: Presenting Futures*. New York, NY: Springer.

3. ‡**Guston, David H.** (ed.). In press, 2010. *Encyclopedia of Nano-science and Society (two volumes)*. Thousand Oaks, CA: Sage Publications.

4. ‡**Miller, Clark A.** and **Daniel Barben** (eds.). In preparation, 2012. *Yearbook of Nanotechnology in Society, Volume IV: Nanotechnology and Democracy*. New York, NY: Springer.

5. **Robert, Jason S.** Under review. *Chimeras, Cyborgs, and the Moral Limits of Science*. Prescott, AZ: One World Press.

6. ‡**Robert, Jason S.**, **Clark A. Miller** and **Ira Bennett** (ed.). In preparation, 2011. *Yearbook of Nanotechnology in Society, Volume III: Nanotechnology, the Brain and the Future*. New York, NY: Springer.

7. **Wetmore, Jameson** and Deborah G. Johnson (eds.). 2009. *Technology and Society: Building our Sociotechnical Future*. Cambridge, MA: MIT Press.

Book Chapters

1. ‡**Bal, Ravtosh**. In press, 2010. "Public Perceptions of Fairness in NBIC Technologies." *Yearbook of Nanotechnology in Society, Volume II: Challenges of Equity, Equality, and Development*, eds. **Susan Cozzens** and **Jameson Wetmore**. New York, NY: Springer.

2. ‡**Barben, Daniel**, **Erik Fisher**, **Cynthia Selin** and **David H. Guston**. 2008. "Anticipatory Governance of Nanotechnology: Foresight, Engagement, and Integration." *The Handbook of Science and Technology Studies, Third Edition*, eds. Edward J. Hackett, Olga Amsterdamska, Michael Lynch and Judy Wajcman, 979-1000. Cambridge, MA: MIT Press.

3. ‡**Bennett, Ira.** 2008. "Developing Plausible Nano-Enabled Products." *Yearbook of Nanotechnology in Society, Volume 1*, eds. **Erik Fisher**, **Cynthia Selin** and **Jameson Wetmore**, 149-156. New York, NY: Springer.

4. ‡**Cozzens, Susan**. In press, 2010. "Building Equity and Equality into Nanotechnology." *Yearbook of Nanotechnology in Society, Volume II: Challenges of Equity, Equality, and Development*, eds. **Susan Cozzens** and **Jameson Wetmore**. New York, NY: Springer.

5. ‡**Cozzens, Susan** and **Jameson Wetmore** (eds.). In press, 2010. Introduction to the book, introductions to all 26 chapters, *The Yearbook of Nanotechnology in Society, Vol. II: Challenges of Equity, Equality, and Development*, New York, NY: Springer.

6. ‡**Fisher, Erik.** 2009. "Legislative and Regulatory Framework." *Nanotechnology and FDA-Regulated Products: The Essential Guide*. Washington, DC: Food and Drug Law Library.

7. ‡**Fisher, Erik.** 2007. "The Convergence of Nanotechnology, Policy, and Ethics." *Advances in Computers 71: Nanotechnology*, ed. M. Zelkowitz, 274-296. London, England: Academic Press (Elsevier).

8. ‡**Fisher, Erik** and **Clark A. Miller**. 2009. "Contextualizing the Engineering Laboratory." *Engineering in Context*, eds. S.H. Christensen, M. Meganck and B. Delahousse, 369-381. Palo Alto, CA: Academica Press.

9. ‡**Fisher, Erik** and **Roop L. Mahajan**. Accepted. "Embedding the Humanities in Engineering: Art, Dialogue, and a Laboratory." *Creating New Kinds of Collaboration: Trading Zones and Interactional Expertise*, eds. M.E. Gorman and R. Evans. Cambridge, MA: MIT Press.

10. ‡**Fujimura, Joan H.** 2010. "Technobiological Imaginaries: How Do We Know Nature?" The Politics of Divergent (Interdisciplinary) Framings of Nature and Evolving Ecologies. Mara Goldman, Matthew Turner, and Paul Nadasdy (eds.). Duke University Press.

11. ‡**Gallo, Jason**. 2009. "Doing Archival Research: How to Find a Needle in a Haystack." *Research Confidential: Solutions to Problems Most Social Scientists Pretend They Never Have*, ed. E. Hargittai, 262-286. Ann Arbor, MI: University of Michigan Press.

12. ‡**Gatchair, Sonia**. In press, 2010. "Potential Implications for Equity in the Nanotechnology Workforce in the U.S." *Yearbook of Nanotechnology in Society, Volume II: Challenges of Equity, Equality, and Development*, eds. **Susan Cozzens** and **Jameson Wetmore**. New York, NY: Springer.

13. ‡**Guston, David H.** 2007. "The Center for Nanotechnology in Society at Arizona State University and the Prospects for Anticipatory Governance." *Nanoscale: Issues and Perspectives for the Nano Century*, eds. N. Cameron and M.E. Mitchell, 377-92. New York, NY: John Wiley and Sons.

14. **Guston, David H.** 2007. "Toward Centres for Responsible Innovation in the Commercialized University." *Public Science in Liberal Democracy: The Challenge to Science and Democracy*, eds. P.W.B. Phillips and J. Porter, 295-312. Toronto, Canada: University of Toronto Press.

15. ‡**Guston, David H.**, **John Parsi** and Justin Tosi. 2007. "Anticipating the Political and Ethical Challenges of Human Nanotechnologies." *Nanoethics: The Ethical and Social Implications of Nanotechnology*, eds. Fritz Allhoff, Patrick Lin, James Moor and John Weckert, 185-97. New York, NY: John Wiley and Sons.

16. ‡**Harsh, Matthew**. In press, 2010. "Equity and Participation in Decisions: What can Nanotechnology Learn from Biotechnology in Kenya?" *Yearbook of Nanotechnology in Society, Volume II: Challenges of Equity, Equality, and Development*, eds. **Susan Cozzens** and **Jameson Wetmore**. New York, NY: Springer.

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2. **Anderson, Ashley A.**, **Dietram A. Scheufele** and **Dominique E. Brossard**. 2010. "Trust in Scientists: The Role of Media in Establishing Trust in Sources of Information about Nanotechnology." Presentation. Annual Convention of the World Association for Public Opinion Research, Chicago, IL.

3. **Barben, Daniel**. July 18, 2009. "Was ist "neu" an neuen Technologien? Die vergangene und gegenwaertige Zukunft der Biotechnologie in soziologischer Perspektive." Talk. Deutsches Museum, Neue Technologien im Spannungsfeld von Wissenschaft, Politik, Oeffentlichkeit und Wirtschaft, Munich, Germany.

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5. **Barben, Daniel**. May 23, 2009. "Antizipatorische Governance von Zukunftstechnologien: Kapazitaetsbildung im Spannungsfeld von Technikgestaltung und Akzeptanzpolitik." Talk. German Political Science Association (DVPW), Section on Politics und Technology, Berlin University of Technology: Governance von Zukunftstechnologien, Berlin, Germany.

6. **Barben, Daniel**. June 16, 2008. "Biotechnologieregime im Gesellschaftsvergleich. Zur Soziologie neuer Wissenschaft und Technik." Guest lecture. Institute for Science and Technology Studies, University of Bielefeld, Bielefeld, Germany.

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28. **Cobb, Michael**. March, 2009. "Public Engagement: National Citizens Technology Forum." Presentation. Nanotechnology and Public: Data for Decision Makers briefing to the U.S. Congressional Nanotechnology Caucus, Washington, DC.

29. **Cobb, Michael**. January, 2009. "U.S. Public Opinion about Nanotechnologies used for Human Enhancements: Consensus Conferences, Deliberation and Framing Effects on Risk Perceptions." Communicating Emerging Technologies II: Risks and Uncertainties, University of Nevada, Las Vegas, NV.

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32. **Conley, Shannon**. November, 2008. "Regulating Life: The Regulation of Assisted Reproduction in Canada and the UK." Center for the Study of Institutional Diversity Weekly Seminar Series, Arizona State University, Tempe, AZ.

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34. **Corley, Elizabeth A.** 2009. "Public and Nano-Scientist Perceptions about Nanotechnology. Workshop on Emerging Technologies, Military Operations and National Security." Presentation. Case Western University, Cleveland, OH.

35. **Corley, Elizabeth A.** 2009. "Eliciting Public Understanding of and Values toward Emerging Technologies through Opinion Polls." Presentation. Society for the Study of Nanoscience and Emerging Technologies, Seattle, WA.

36. **Corley, Elizabeth A.** July, 2008. "Societal Dimensions of Nanotechnology: An Exploration of Public and Scientist Perceptions." Invited presentation. Young Scientists Nanotechnology Workshop, French Embassy, Washington, DC.

37. **Corley, Elizabeth A.** April, 2008. "Scientists and the Public: Comparing Views on Nanotechnology Risks and Regulations." Talk. CSPO Enlightening Lunch, Arizona State University, Tempe, AZ.

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42. **Corley, Elizabeth A.**, **Dietram A. Scheufele**, **Sharon Dunwoody**, **Elliott D. Hillback**, **Tsung-Jen Shih** and **David H. Guston**. October, 2007. "Nanotechnology Attitudes among Scientists and the Public." Presentation. Annual Meeting, Society for Social Studies of Science, Montreal, Canada.

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44. **Dalrymple, Kajsa E**., Amy B. Becker, **Dominique E. Brossard**, **Dietram A. Scheufele** and Al C. Gunther. August, 2009. "Getting Citizens Involved: How Controversial Science Policy Debates Stimulates Issue Participation during a Political Campaign." Presentation. Annual Convention of the Association for Education in Journalism and Mass Communication, Boston, MA.

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46. **Dudo, Anthony D.**, **Dominique E. Brossard**, James Shanahan, **Dietram A. Scheufele**, Michael Morgan and Nancy Signorelli. August, 2009. "Science on Television in the 21st Century: Recent Trends in Portrayals and their Contributions to Public Attitudes Toward Science." Presentation. Annual Conference of the Association for Education in Journalism and Mass Communication, Boston, MA.

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51. **Fichtner, Aaron**. 2007. "Preliminary Results: The Workforce Needs of Companies Using Nanotechnology in Arizona." Presentation. Nanotechnology 2007 Conference, San Jose, CA.

52. **Fisher, Erik**. 2010. "What is Midstream Modulation?" Reflexive Systems Biology Kick-Off Meeting University of Bergen. Bergen, Norway. February 27.

53. **Fisher, Erik.** 2010. "TA-Trends in the USA." Keynote lecture. TA Workshop: Keeping Pace with TA. Instituut Samenleving & Technologie. Flemish Parliament. Brussels, Belgium. February 26.

54. **Fisher, Erik**. September, 2009. "Integration and Reflexivity: Integrating Social Science and Humanistic Work with Laboratory Research in Emerging Science and Technology." S.NET Pre-Conference Workshop: Real-time Technology Assessment and Anticipatory Governance, University of Washington, September 8.

55. **Fisher, Erik**. July, 2009. "Inquiry as Intervention." *STIR Workshop 2: Inquiry as Intervention*. Vatnahalsen, Norway. 4-7 July.

56. **Fisher, Erik**. June, 2009. "Laboratory Engagement. STIR: Initial Project Results." TA NanoNed Annual Meeting. Utrecht, the Netherlands.

57. **Fisher, Erik.** June, 2009. "The 'Two Cultures' in Science Policy." Center for Science and Technology Policy Research. University of Colorado at Boulder. Boulder, Colorado.

58. **Fisher, Erik**. June, 2009. "Science and Society in the Laboratory? Reflections of an Embedded Humanist." Colorado Fuel Cell Center. Colorado School of Mines. Golden, Colorado.

59. **Fisher, Erik.** June, 2009. "Integrating Science and Society in Nanotechnology Laboratories." *The Nano Renewable Energy Summit*. Denver, Colorado.

60. **Fisher, Erik**. June, 2009. "Integrating Ethics and Engineering in the Laboratory: Reflections of an Embedded Humanist." Graduate Interdisciplinary Liberal Engineering Ethics Workshop on *Integrating Ethics and Societal Issues into a Graduate Curriculum*. Virginia Tech. Blacksburg, Virginia.

61. **Fisher, Erik.** May, 2009. "Inquiry and Nanotechnology." *Human Practices Workshop*. University of California at Berkeley. Berkeley, California. 18 May 2009.

62. **Fisher, Erik.** May, 2009. "The 'Two Cultures' in Science Policy Today." University of Colorado-Denver, School of Public Affairs. Denver, Colorado.

63. **Fisher, Erik**. March, 2009. "Socio-Technical Integration Research." Presentation. Research Funding and the Good Life, University of Twente, the Netherlands.

64. **Fisher, Erik**. January, 2009. "STIR Project Overview." *STIR Workshop 1: Constructing Foundations*. Arizona State University. Tempe, Arizona. January 17-19.

65. **Fisher, Erik**. November, 2008. "Deliberation on the Implementation of a Code of Conduct and fostering International Dialogue and Collaboration." Expert participant. European Commission, Brussels, Belgium.

66. **Fisher, Erik**. November, 2008. "Nanotechnology: Environment, Health and Safety." Presentation. Environmental Professionals of Arizona / Academy of Certified Hazardous Materials Managers, Tempe, AZ.

67. **Fisher, Erik**. October, 2008. "Laboratory Engagements: Risky Discourse and Research Decisions." Presentation. Networks, Risk and Knowledge Sharing, University of Massachusetts, Amherst, MA.

68. **Fisher, Erik**. July, 2008. "Collaborations for Financial Success: Universities Collaborating with Government and the Private Sector." Panelist. The Nano Renewable Energy Summit, Denver, CO.

69. **Fisher, Erik**. July, 2008. "Midstream Modulation: Embedding the Humanities in Engineering Practice and Education." Presentation. Kluyver Colloquium, Delft Technical University, Delft, The Netherlands.

70. **Fisher, Erik**. April, 2008. "Embedded Humanists." Presentation. Engineering in Context, Colorado School of Mines, Golden, CO.

71. **Fisher, Erik**. March, 2008. "Midstream Modulation and the Politics of Engagement." Presentation. STS in Action, Claremont, CA.

72. **Fisher, Erik**. December, 2007. "Inventing the Socially Conscious Laboratory." Presentation. Consortium for Science, Policy & Outcomes, Arizona State University, Tempe, AZ.

73. **Fisher, Erik**. September, 2007. "Integrating Social Considerations into Nanotechnology Research." Presentation. 1st Rocky Mountain Nanotechnology Showcase, Denver, CO.

74. **Fisher, Erik**. August, 2007. "Broader Impacts and the Embedded Humanist." Presentation. Making Sense of the Broader Impacts of Science and Technology, Golden, CO.

75. **Fisher, Erik**. July, 2007. "Integrating Societal Considerations and Nanotechnology in the Four Corners Region." Presentation. Colorado Nanotechnology Alliance, Denver, CO.

76. **Fisher, Erik**. June 27, 2007. "Integrating Science and Society in the Laboratory." Presentation. Center for Integrated Nanotechnologies, Los Alamos National Laboratory, Los Alamos, NM.

77. **Fisher, Erik**. June, 2007. "Drilling Down on U.S. Ethics Policy for Nanotechnology." Presentation. Center for Interdisciplinary Research (ZiF), Bielefeld University, Bielefeld, Germany.

78. **Fisher, Erik**. June, 2007. "Socio-technical Integration and the Nanotechnology Laboratory." Presentation. Visions about Nanoscience and Technology Workshop, Leuven, Belgium.

79. **Fisher, Erik**. June, 2007. "Investigating the Implementation of U.S. Ethics Policy for Nanotechnology." Presentation. Institute for Technology Assessment and Systems Analysis, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Karlsruhe, Germany.

80. **Fisher, Erik**. June, 2007. "Engaging the Reflexive Capacity of Nanotechnology Researchers." Presentation. Nanotechnology, Ethics & Sustainability; NANOMAT Conference, Bergen, Norway.

81. **Fisher, Erik**. June, 2007. "Socio-technical Integration at Macro and Micro Levels." Presentation. Rathenau Institute, Den Haag, The Netherlands.

82. **Fisher, Erik**. January, 2007. "Social and Policy Issues in Nanotechnology." Presentation. 5th CINT Users Workshop, Center for Integrated Nanotechnologies, Albuquerque, NM.

83. **Fisher, Erik**. November 20, 2006. "Current Societal Considerations in Nanotechnology." Presentation. Center for Integrated Nanotechnologies, Los Alamos National Laboratory, Los Alamos, NM.

84. **Fisher, Erik**. November, 2006. "Reflecting on the Shape of Nanotechnology Research from Within." Presentation. 4S Conference (Society for Social Studies of Science), Vancouver, Canada.

85. **Fisher, Erik**. September, 2006. "Socratic Engagement of Nanotechnology: A Case Study in Ethics Policy." Presentation. University of North Texas, Department of Philosophy and Religion Studies, Denton, TX.

86. **Fisher, Erik**. August, 2006. "From Upstream Engagement to Midstream Modulation: Shaping Technology from Within." Poster presentation. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

87. **Fisher, Erik**. July, 2006. "Midstream Modulation: U.S. Federal Nanotechnology Policy Implementation." Presentation. TA NanoNed Day, Utrecht University, The Netherlands.

88. **Fisher, Erik**. May, 2006. "Midstream Modulation of Technological Trajectories." Trading Zones and Interactional Expertise Workshop, Arizona State University, Tempe, AZ.

89. **Fisher, Erik**. And Antonio Calleja López. October, 2009. "Reflexive modulation of laboratory practices for the governance of science and technology." *Society for the Social Studies of Science, Annual Meeting.* Washington DC, October 28-31.

90. **Fisher. Erik** and **Derrick Anderson**. December, 2009. "From Lab to Legislature: Public Value Mapping of Nanotechnology Science and Innovation Policy Making." *The Dupont Summit on Science and Technology Policy, "The New Administrations Challenges on Science & Technology: Staying the Course in Times of Crisis."* Policy Studies Organization, Carnegie Institution for Science, Washington DC, December 4.

91. **Fisher, Erik**, **Derrick Anderson** and **David Renolds**. August, 2008. "Mapping and Modulating the Public Value of Academic Research." Poster presentation. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

92. **Fisher, Erik** and **Roop L. Mahajan**. November, 2006. "Midstream Modulation." Presentation. International Mechanical Engineering Conference, Chicago, IL.

93. **Gallo, Jason**. October 19, 2007. "The National Science Foundation and the Creation of a Standing Army for Science." Paper presentation. Annual Meeting of the Society for the History of Technology, Washington, DC.

94. **Gallo, Jason**. April, 2007. "The National Science Foundation and the Control of Information." Department of Life Sciences Communication colloquium series, University of Wisconsin, Madison, WI.

95. **Garay, Manuel** and **Erik Fisher**. August, 2008. "NSECs and the Integration of Societal Concerns into R&D." Poster presentation. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

96. **Garcia, Antonio** and **Joan McGregor**. October 17, 2008. "Will Genetic Discrimination Replace Racial Discrimination?" Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

97. Gordon, Claire and **Ira Bennett**. February 16, 2007. "Why Things (Still) Don't Fit: Human Variation and Ergonomics in the 21st Century." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

98. Guo, Ying, **Alan L. Porter** and Lu Huang. October, 2009. "Comparing and Probing National Research Strategies for Nanotechnology Thin-film Solar Cells." Presentation. 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, GA.

99. Guo, Ying, **Alan L. Porter** and Lu Huang. April 09, 2009. "Nano-enhanced Thin-film Solar Cells: Global Activity and Forecast." Paper presentation. IAMOT 2009, 18th International Conference on Management of Technology, Management of Green Technology, International Association for Management of Technology, Orlando, FL.

100. Guo, Ying, Lu Huang and **Alan L. Porter**. October, 2009. "Profiling Research Patterns for a New and Emerging Science and Technology: Dye-sensitized Solar Cells." Presentation. 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, GA.

101. **Guston, David H.** March, 2010. "Broader Societal Implications." Plenary remarks. Nano2: International Study of the Long-term Impacts and Future Opportunities for Nanoscale Science and Engineering, Evanston, IL.

102. **Guston, David H.** March, 2010. "The Anticipatory Governance of Emerging Technologies." Plenary remarks. INEW 2010: The Second International Nanomaterials Ethics Workshop. Korea Institute of Science and Technology, Seoul, Korea.

103. **Guston, David H.** March, 2010. "The Center for Nanotechnology at Arizona State University." Lecture. Program in the History and Philosophy of Science, Seoul National University, Seoul, Korea.

104. **Guston, David H.** February, 2010. "Bridging Nanoscience and Society: The Center for Nanotechnology in Society at ASU." Presentation. Annual Meeting of the American Association for the Advancement of Science, San Diego, CA.

105. **Guston, David H.** December, 2009. "Anticipatory Governance at the Center for Nanotechnology in Society." Lecture. ESRC Critical Public Engagement Seminar. Durham University, Durham, UK.

106. **Guston, David H.** December, 2009. "Public Engagement at CNS-ASU: The National Citizens Technology Forum and Other Modes." Lecture. Institute for Hazard Risk Research. Durham University, Durham, UK.

107. **Guston, David H.** October, 2009. "Genealogies of Anticipatory Governance." Presentation. Annual Meeting of the Society for Social Studies of Science, Washington, DC.

108. **Guston, David H.** October, 2009. "STS and Policy in the Academy." Chairs Plenary Panel. Annual Meeting of the Society for Social Studies of Science, Washington, DC.

109. **Guston, David H.** October, 2009. "Emerging Technologies and Sustainability: Parts I and II." Webinar briefing. Consultative Group on Biodiversity with the Center for Genetics and Society, San Francisco, CA.

110. **Guston, David H.** September 09, 2009. "The Roots, Branches and First Fruits of Anticipatory Governance." Presentation. Nanoethics Graduate Education Symposium, University of Washington, Seattle, WA.

111. **Guston, David H.** June, 2009. "Anticipatory Governance of Emerging Technologies." Presentation. NINE Summer Students Program. Sandia National Laboratory, Sandia, NM.

112. **Guston, David H.** June, 2009. "From the Lab to the Legislature: Locating Technology Assessment." Lecture on Science and Values. The Politicisation of Science. University of Bielefeld, Bielefeld, Germany.

113. **Guston, David H.** April, 2009. "Anticipatory Governance of Emerging Nanotechnologies at CNS-ASU." Video Plenary Lecture. Nanotechnology: Here and Now Meeting. Ministry of Research, Science and Technology, Wellington, New Zealand.

114. **Guston, David H.**, et al. March 09, 2009. "Nanotechnology and the Public: Data for Decision Makers." Briefing. U.S. Congressional Nanotechnology Caucus, Washington, DC.

115. **Guston, David H.** March, 2009. "Nano, Human Enhancement, and Public Engagement." Presentation. Faculty seminar on transhumanism, Center for the Study of Religion and Conflict, Arizona State University, Tempe, AZ.

116. **Guston, David H.** March, 2009. "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Presentation. Center for the Study of Institutional Diversity brown bag, Arizona State University, Tempe, AZ.

117. **Guston, David H.** March, 2009. "Public Engagement: National Citizens' Technology Forum." Presentation. Nanotechnology and the Public: Data for Decision Makers briefing before the U.S. Congressional Nanotechnology Caucus, Washington, DC.

118. **Guston, David H.** March, 2009. "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Presentation. Department of Political Science brown bag, Arizona State University, Tempe, AZ.

119. **Guston, David H.** March, 2009. "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Video lecture. Graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.

120. **Guston, David H.** September 10, 2008. "CNS-ASU and Nano-in-Society in the USA." Presentation by video. Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.

121. **Guston, David H.** July, 2008. "Reflections on CNS-ASU and Nano in Society in the U.." Keynote talk. Dutch NanoNed Flagship TA and Societal Aspects of Nanotechnology meeting, Utrecht, The Netherlands.

122. **Guston, David H.** June, 2008. "The Center for Nanotechnology in Society at ASU and the Anticipatory Governance of Emerging Technologies." Presentation. Institute for Science and Technology Studies, Bielefeld University, Bielefeld, Germany.

123. **Guston, David H**. June, 2008. "Anticipatory governance of Nanotechnologies: The Center for Nanotechnology in Society at ASU." Special talk. Visiting Japanese technology assessment delegation, Arizona State University, Tempe, AZ.

124. **Guston, David H.** April 04, 2008. "Governing Emerging Technologies." Presentation. Arizona Institute of Nanoelectronics opening ceremonies, Tempe, AZ.

125. **Guston, David H.** February, 2008. "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Video lecture. Graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.

126. **Guston, David H.** November, 2007. "Toward Anticipatory Governance of Emerging Technologies." Presentation. Special Series on Science and Public Policy, Brown University, Providence, RI.

127. **Guston, David H.** November, 2007. "Governing Emerging Technologies." Presentation. Spirit of the Senses Salon, Phoenix, AZ.

128. **Guston, David H.** June 14, 2007. "Anticipatory governance and reflexivity: A means for realtime technology assessment." Talk. The Future of Nanotechnology: A Celebration of the 30th Anniversary of the Cornell NanoScale Science & Technology Facility, Cornell University, Ithaca, NY.

129. **Guston, David H.** December, 2006. "Anticipatory Governance of Emerging Technologies." Presentation. Monthly meeting of the Arizona Nanotechnology Cluster, Tempe, AZ.

130. **Guston, David H.** October, 2006. "Anticipatory Governance of Emerging Technologies: The Center for Nanotechnology in Society at ASU." Presentation. Stanford University Seminar in Science, Technology and Society, Stanford, CA.

131. **Guston, David H.** August, 2006. "Anticipatory Governance of Emerging Technologies." Presentation. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

132. **Guston, David H.** May, 2006. "CNS-ASU: Interdisciplinary Programs in a Self-Styled Boundary Organization." Presentation. Conference of Trading Zones, Interactional Expertise, and Interdisciplinary Collaboration, Arizona State University, Tempe, AZ.

133. **Guston, David H.** May, 2006. "What Do We Want to Learn from Public Participation in Nanotechnology?" Presentation. NNI Public Participation in Nanotechnology Workshop, Arlington, VA.

134. **Guston, David H.** April, 2006. "Social Science Engages Nanotechnology." Invited talk. Virginia Tech, Blacksburg, VA.

135. **Guston, David H.** February 17, 2006. "The Center for Nanotechnology in Society at ASU." Nanotechnology Seminar: Social Science Engages Nanotechnology, AAAS Annual Meeting 2006, St. Louis, MO.

136. **Guston, David H.** February, 2006. "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Video lecture. Graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.

137. **Guston, David H.** February, 2006. "Societal Implications of Nanotechnology." Lecture. Discovery Lecture Series 2006, Transforming Society Through Emerging Technologies: The National Nanotechnology Initiative at Five Years, Purdue University, West Lafayette, IN.

138. **Hamlett, Patrick.** March, 2008. "Public Deliberations About Science and Technology: Should the Public Have a Say on the Future of Nanotechnology." Presentation. NSF Science and Technology Center Program, Center for Environmentally Responsible Solvents and Processes Innovation Seminar Series, North Carolina State University, Raleigh, NC.

139. **Hamlett, Patrick** and **Michael Cobb**. August, 2008. "Reporting the Results of the first National Citizens Technology Forum." Presentation. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

140. **Hamlett, Patrick** and **Michael Cobb**. July, 2008. "The First National Citizens Technology Forum on Human Enhancement: Results and Prospects." Paper presentation. VIPSI-2008 (Information Processing Society, International) Conference: Knowledge Engineering, Tutorials, & Brainstorming, Pisa, Italy.

141. **Hamlett, Patrick** and **Michael Cobb**. May, 2008. "The First National Citizens Technology Forum on Nanotechnology - First Results." Presentation. University & Industry Consortium, Spring 2008 Meeting, Lansing, MI.

142. **Hays, Sean**. July, 2009. "Nietzsche and the Philosophical Underpinnings of Human Enhancement." Presentation. SPT 2009: Converging Technologies, Changing Societies. Society for Philosophy and Technology, University of Twente, the Netherlands.

143. **Hays, Sean**. March, 2009. "Transhumanism, Anti-humanism, and Nietzsche's Overman." Presentation. Human Enhancement & Nanotechnology, Western Michigan University, Kalamazoo, MI.

144. **He, Jiping** and **Jason S. Robert**. June 04, 2006. "Wiring Brains to Machines: Science Fiction or Science Fact." Talk. CNS-ASU Science Cafe, Mills End Coffee Shop, Tempe, AZ.

145. **Hibner Koblitz, Ann**, **Priscilla Greenwood** and Jennifer McNeill Bekki. March 21, 2008. "Women in Science: Various Issues and Viewpoints." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

146. **Hillback, Elliott D.**, **Anthony D. Dudo**, **Jiun-Yi Tsai**, **Sharon Dunwoody**, **Dominique E. Brossard** and **Dietram A. Scheufele**. December, 2009. "Tracking Online Behavior After Exposure to News of a Local Nanotechnology Risk: A Risk Information Seeking and Processing (RISP) Model Approach." Presentation. Annual Convention of the Society for Risk Analysis (Emerging Nanoscale Materials Specialty Group Student Merit Award), Baltimore, MD.

147. **Ho, Shirley S.**, **Dietram A. Scheufele** and **Elizabeth A. Corley**. June, 2010. "Integrating Models of Mass-Interpersonal Communication: Testing Moderation and Mediation Effects of Elaborative Processing and Interpersonal Discussion on Scientific Knowledge and Public Attitudes Tow." Presentation. Annual Convention of the International Communication Association, Singapore.

148. **Ho, Shirley S.**, **Dietram A. Scheufele** and **Elizabeth A. Corley**. August, 2009. "Value Predispositions, Mass Media, and Attitudes toward Nanotechnology: The Interplay of Public and Experts." Presentation. Annual Convention of the Association for Education in Journalism and Mass Communication, Boston, MA.

149. **Ho, Shirley S.**, **Dietram A. Scheufele** and **Elizabeth A. Corley**. May, 2009. "Making Sense of Policy Choices: A Closer Look at the Mediating Roles of Elaborative Processing and Interpersonal Discussion on Public Perceptions of Nanotechnology." Paper presentation. Annual convention of the International Communication Association, Chicago, IL.

150. **Ho, Shirley S.**, **Dietram A. Scheufele** and **Elizabeth A. Corley**. August, 2008. "Influences of Mass Media, Interpersonal Communication, and Cognitive Processing on Risks Versus Benefits Perception of Nanotechnology." Paper presentation. Annual convention of the Association for Education in Journalism and Mass Communication, Chicago, IL.

151. **Hogle, Linda F.** March, 2007. "Stem Cells as a Study in Transience: A Future History." Paper presentation. Max Planck Institute for the History of Science, Berlin, Germany.

152. **Holbert, Keith** and **Clark A. Miller**. January 18, 2008. "Why Not Nuclear Power? The Science and Politics behind Nuclear Energy." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

153. Huang, Lu, **Alan L. Porter** and Ying Guo. April 06, 2009. "Identifying the Role of Emerging Nanoparticles in Biosensors." Paper presentation. IAMOT 2009, 18th International Conference on Management of Technology, Management of Green Technology, International Association of Management of Technology, Orlando, FL.

154. Huang, Lu, Ying Guo and **Alan L. Porter**. October, 2009. "A Systematic Technology Forecasting Approach for New and Emerging Science and Technology: Case Study of Nano-enhanced Biosensors." Presentation. 2009 Atlanta Conference on Science and Innovation Policy. The Paper won the Best Graduate Student Paper Award at the 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, GA.

155. Huang, Wan-Ling, Eric Welch and **Elizabeth A. Corley**. 2009. "Public Sector Voluntary Initiatives: The Adoption of the Environmental Management System for Biosolids by Public Waste Water Treatment Facilities in the United States." Paper Presentation. Midwest Political Science Association Conference.

156. Jimenez, Benedict, Eric Welch and **Elizabeth A. Corley**. 2009. "Explaining Differences in the Quality and Effectiveness of Environmental Management Systems in Public Organizations: The Experience of Public Sewage and Wastewater Treatment Facility Operators in the." Paper Presentation. Midwest Political Science Association Conference.

157. **Johnston, Stephen** and **Joan McGregor**. September, 2006. "Predicting Your Medical Future (Doc-in-a-Box)." CNS-ASU Science Cafe, Changing Hands Bookstore, Tempe, AZ.

158. Jung, Ranu and **Jason S. Robert**. January, 2007. "Adaptive Technologies for the Central Nervous System: Are We Changing What It Means to be Human." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

159. **Kambhampati, Subbarao** and David Calverley. November, 2007. "Do Robots Need a Bill of Rights? Implications of Artificial Intelligence." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

160. **Kay, Luciano**. October, 2009. "The Emergence of Nanotechnology Enterprise in Brazil." Presentation. 2nd Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.

161. **Kay, Luciano**. October, 2009. "Nanotecnologia en America Latina. Brasil y la Emergencia de Nano-empresas." Presentation. VI Seminario Internacional Nanotecnologia, Sociedade e Meio Ambiente - VI Seminanosoma, Manaus, Brazil.

162. **Kay, Luciano**. May, 2009. "Developing Nanotechnology in Latin America." Poster presentation. NSF Site Visit for CNS Renewal, Tempe, AZ.

163. **Kay, Luciano**. May, 2009. "Nanotechnology R and D Collaboration with Brazil. Managing Challenges and Opportunities in an Emerging Networked Technology." Presentation. Workshop of International R and D Cooperation with Latin America, Madrid, Spain.

164. **Kay, Luciano**. January, 2009. "Nanotechnology Research Networks in Brazil." Poster presentation. CNS All Hands Meeting, Tempe, AZ.

165. **Kay, Luciano**. January, 2008. "Nanotechnology in Latin America." Paper presentation. DRUID-DIME Academy Winter 2008 Ph.D. Conference on Economics and Management of Innovation and Organizational Change, Rebild, Denmark.

166. **Kay, Luciano**, **Noela Invernizzi** and **Philip Shapira**. October, 2009. "The Role of Brazilian Firms in Nanotechnology Development." Presentation. 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, GA.

167. **Kim, Matt** and **Prasad Boradkar**. September, 2007. "Designing Things: Balancing Beauty, Utility and Sustainability in Products." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

168. **Laurent, Brice** and **Erik Fisher**. August, 2007. "The Integration of Public Input into the American Nanotechnology Federal Program: Meanings and Contradictions." Presentation. Third Living Knowledge conference, Ecoles des Mines, Paris, France.

169. Libaers, Dirk. September, 2006. "The Role and Contribution of Foreign-born Scientists and Engineers to the U.S. Nano Science and Technology Research Enterprise." Presentation. 2006 Technology Transfer Society Conference, Atlanta, GA.

170. **Lidberg, Shannon**. November, 2008. "Who Benefits? India's National Design Policy and the Setting of Designers' Priorities." Presentation. CNS-ASU Workshop on Nanotechnology, Equity and Equality, Tempe, AZ.

171. **Lidberg, Shannon**. August, 2008. "Design Policy Around the Globe: How Developed and Emerging Markets are Using Design for Economic Competitiveness." Poster presentation. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

172. **Lidberg, Shannon**. March, 2008. "Examining Potential Futures: A Designer's Toolbox for Identifying Potential Social and Cultural Implications." Presentation. ST Global Conference, Washington, DC.

173. **Lindsay, Stuart**. March 23, 2006. "Humankind's Future On the Head of a Pin: Nanotechnology - What it is, What it can do." Talk. CNS-ASU Science Cafe, Mills End Coffee Shop, Tempe, AZ.

174. **Lindsay, Stuart**, **Roy Curtiss** and **David H. Guston**. May 18, 2007. "Forbidding Science: Are There Things We Just Shouldn't Know." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

175. **Lynch, John** and **Norbert Samuelson**. February 20, 2009. "Evolution and Faith Revisited: Can the Two be Reconciled." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

176. **Maracas, George**, **Patrick Phelan** and **Braden Allenby**. September 19, 2008. "Is Nanotechnology Good for Sustainability or Not." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

177. **Marchant, Gary E.** July, 2006. "Nanotechnology Regulation: The United States Approach." Presentation. Conference on New Global Regulatory Frontiers: Evaluating what will work for Nanotechnology, Monash University, Melbourne, Australia.

178. Maricle, Genevieve. January, 2008. "The State of Policy and Socio-Economic Research." Presentation. American Meteorological Society Annual Meeting, New Orleans, LA.

179. Maricle, Genevieve. December, 2007. "Shaping Science: Turning Science Studies into Science Action." Presentation. Center for Science and Technology Policy Research Noontime Seminar Series, Boulder, CO.

180. Maricle, Genevieve. October, 2007. "Wrestling with Engagement: Tools for Iterating Intervention in STS." Presentation. Society for the Social Studies of Science Annual Meeting, Montreal, Canada.

181. **McGregor, Joan** and **Jameson Wetmore**. August, 2008. "Researching and Teaching the Ethics and Social Implications of Emerging Technologies." Poster presentation. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

182. McKeon, Patrick. September 23, 2008. "State-Level Nanotechnology Policy Initiatives and Implications for Georgia." Presentation. Nano@Tech, Georgia Institute of Technology, Atlanta, GA.

183. McKeon, Patrick. 2008. "State-Level Nanotechnology Policy Initiatives and Implications for Georgia." Presentation. Fresh Perspectives on Economic Development, Atlanta, GA.

184. **Meldrum, Deirdre** and **Jameson Wetmore**. October 19, 2007. "Less is More Technology: Is Smaller and Cheaper Always Better." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

185. Meng, Yu. April, 2009. "Female Involvement in Nanotechnology Patenting: Does it Make a Difference." Presentation. Workshop on Original Policy Research, School of Public Policy, Georgia Institute of Technology, Atlanta, GA.

186. Merkerk, Rutger van, **David H. Guston** and Ruud Smits. November, 2006. "An International Comparison of Recent Technology Assessment Approaches: Bypassing Collingridge." Presentation. 4S Conference (Society for Social Studies of Science), Vancouver, British Columbia, Canada.

187. **Miller, Clark A.** March, 2010. "Systems Integration: The Human and Social Dimensions of Energy System Transformation." Talk. Advisory Meeting, Directorate of Mathematical and Physical Sciences, National Science Foundation, Washington, DC.

188. **Miller, Clark A**. 2010. "Innovation: Thoughts on Science, Technology, Transformation, and Valuation." Talk. Manifolds-A Social Innovation Symposium, Fergus, Canada.

189. **Miller, Clark A.** March, 2009. "Imagining the Future: Can Science Fiction Help Us Govern Technology." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

190. **Miller, Clark A.** 2009. "Themes in Nanotechnology in Society Research." Talk. Nanoscale Informal Science Education Annual Meeting, San Francisco, CA.

191. **Miller, Clark A.** 2009. "Nanotechnology: Environment, Health, and Safety." Talk. Semiconductor Environment, Safety, and Health Association, Scottsdale, AZ.

192. **Miller, Clark A.** April, 2007. "Commentary: The Law and the Future Brain." Presentation. U.S. District Court and Sandra Day OConnor College of Law, Arizona State University, Tempe, AZ.

193. **Miller, Clark A.** December 09, 2006. "Boundary Organizations: Strategies for Linking Knowledge to Action." Presentation. Workshop on Boundary Organizations, Tempe, AZ.

194. **Miller, Clark A.** November 16, 2006. "Informing Anticipatory Governance of New and Emerging Technologies through Nanotechnology in Society Research." Presentation. Nanoscale Informal Science Education Network (NISE Net).

195. **Miller, Clark A.** October, 2006. "Reflexive, Anticipatory Governance of Science and Technology." Roundtable presentation. Public Administration and Challenges of Emerging Technologies Roundtable, 2006 NASPAA Annual Conference: The Future of the Public Sector, National Association of Schools of Public Administration and A, Minneapolis, MN.

196. **Miller, Clark A.** June, 2006. "Think Differently! Strategies for Success in Nano." Presentation. Food Research Institute, University of Wisconsin-Madison, Madison, WI.

197. **Miller, Clark A.** April 19, 2006. "Nanotechnology in Society Education: Teaching the Mental Habits of Social Engineers and Critical Citizens." Presentation. Education in Nanoscience and Engineering Symposium, 2006 Spring Meeting, Materials Research Society, San Francisco, CA.

198. **Miller, Clark A.** March, 2006. "Nanotechnology in Society." Presentation. Ohio State University, Columbus, OH.

199. **Miller, Clark A.** and **Ira Bennett**. April, 2007. "Science Fiction as Technology Assessment: Some Preliminary Thoughts on Anticipatory Governance for the Rest of Us." Presentation. Cornell University, Ithaca, NY.

200. Moore, Ana. September 27, 2006. "Spanish-language Science Cafe." Talk. CNS-ASU Science Cafe, Friendly House, Phoenix, AZ.

201. Newman, Nils. November, 2006. "Nanotechnology Research Mapping and Assessment." Presentation. STI Indicators Conference, Leuven, Belgium.

202. Newman, Nils. June 07, 2006. "Where is Nano Going." Presentation. Advancing Measures of Innovation: Knowledge Flows, Business Metrics, and Measurement Strategies Workshop, National Science Foundation, Arlington, VA.

203. Pandza, Kristo, Paul Ellwood and **Erik Fisher**. October, 2009. "From Social Aspirations to Organizational Capability: Identifying Micro-Foundations and the Role of Strategizing." *Interactive Strategy Process Work-in-Progress Workshop/ SMS Pre-Conference: Advancing Strategy Process Research.* Washington D.C. October 11.

204. Philbrick, Mark. 2009. "The National Citizens' Technology Forum: Lessons for the Future" (presented at the annual meeting of the Society for the Social Studies of Science, Washington, DC, 28 October – 1 November 2009).

205. Philbrick, Mark. September, 2009. "Operationalizing Anticipatory Governance: Steering Emerging Technologies Towards Sustainability" Presented at the inaugural meeting of the Society for the Study of Nanoscale and Emerging Technologies, Seattle, WA, 8-11 September 2009.

206. **Porter, Alan L.** November, 2009. "Assessing Nanotechnology: Research Metrics and Maps." Presentation. American Evaluation Association Annual Conference, Orlando, FL.

207. **Porter, Alan L.** August, 2009. "Locating Nanotechnology among the Disciplines, Nano @ Tech."

208. **Porter, Alan L.** November 30, 2007. "Trends in Data Treatment in the United States." Keynote presentation. International Conference on Competitive Intelligence, Carlos III University of Madrid, Madrid, Spain.

209. **Porter, Alan L.** October, 2007. "Public Lecture." Institute for S&T Information, Beijing, China.

210. **Porter, Alan L.** November 15, 2006. "Mining Patents and Research Publications to Improve Technology Management: Nano Illustrations." Presentation. 2nd PATINEX Conference, Seoul, South Korea.

211. **Porter, Alan L.**, David J. Schoeneck, Ajay S. Bhaskarabhatla, **Jan Youtie** and Dirk Libaers. May, 2006. "Explorations in Research and Innovation Systems Assessment: Where Is Nano Going." Presentation. The Atlanta Conference on Science and Technology Policy 2006 US-EU Policies for Research and Innovation, Atlanta, GA.

212. **Porter, Alan L.**, David J. Schoeneck, Nils Newman, **Philip Shapira**, **Jan Youtie** and Rich Kolar. September, 2006. "Nano R&D Profiles: A Deeper Look." Presentation. International Conference on Science & Technology Indicators, Leuven, Belgium.

213. **Porter, Alan L.**, David J. Schoeneck, **Philip Shapira**, **Jan Youtie** and Rich Kolar. September, 2006. "Defining the Nanotechnology Domain in Realtime Technology Assessment." Presentation. Presented at 2006 Technology Transfer Society Conference, Atlanta, GA.

214. **Porter, Alan L.** and Ismael Rafols. 2009. "Measuring and Mapping Interdisciplinary in Six Research Fields Over Time (1975-2005)." Presentation. ISSI Conference, Rio de Janeiro.

215. **Porter, Alan L.** and Ismael Rafols. September, 2008. "Science Overlay Maps: Easy-to-use Tools to Help Visualize and Track Bodies of Research, A Deeper Look at the Visualization of Scientific Discovery in the Federal Context." Presentation. Workshop at the National Science Foundation, Arlington, VA.

216. **Porter, Alan L.**, **Jan Youtie**, **Philip Shapira**, David J. Schoeneck, **Li Tang** and Pratik Mehta. April, 2007. "Profiling Nano R&D." Presentation. Presented at Nano-Giga Challenges, Phoenix, AZ.

217. **Porter, Alan L.** and **Jayesh Patil**. March, 2007. "Where Is Nano Going?" Presentation. Nano-Giga Challenges, Phoenix, AZ.

218. **Porter, Alan L.**, Martin Meyer and **Ismael Rafols**. May, 2008. "The Cognitive Geography of Nanotechnologies: Location and Knowledge Flows of Nano-Research in the Map of Science." Presentation. Presentation at the NBER Conference on Emerging Industries: Nanotechnology and NanoIndicators, Cambridge, MA.

219. **Porter, Alan L.**, Nils Newman and **Jan Youtie**. October, 2009. "Tech Mining, VantagePoint, and Science Overlay Mapping." Presentation. Pre-conference Workshop of 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, GA.

220. **Porter, Alan L.**, **Philip Shapira** and **Jan Youtie**. October, 2008. "Nano Social Science: An Emerging Specialization." Presentation. Nanotechnology and Society: Emerging Opportunities & Challenges Networks, Risk and Knowledge Sharing, University of Massachusetts, Amherst, MA.

221. **Porter, Alan L.**, **Philip Shapira** and **Jan Youtie**. September, 2006. "Defining the Nanotechnology Domain in a Real Time Technology Assessment." Presentation. Technology Transfer Society Annual Conference, Atlanta, GA.

222. **Posner, Jonathan** and **Jameson Wetmore**. April, 2009. "Technologies of Distraction: Mobile Phones, iPods, and E-mail." Presentation. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

223. **Rafols, Ismael** and **Alan L. Porter**. October, 2009. "Interdisciplinary in Nanoscience: What is the Nano Field and how does it Share its Knowledge." Presentation. 2nd Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.

224. **Rafols, Ismael**, **Alan L. Porter**, **Jan Youtie** and **Li Tang**. September, 2008. "Nanotechnology as a Multi-polar Science." Presentation. Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.

225. **Rafols, Ismael**, **Alan L. Porter** and Loet Leydesdorff. October, 2009. "Science Overlay Maps: A New Tool for Research Evaluation." Presentation. 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, GA.

226. **Rafols, Ismael**, **Alan L. Porter** and Loet Leydesdorff. 2009. "The Use of Global Maps of Science in Management and Policy Contexts." Presentation. Accepted. ENID Indicators Conference 2010.

227. **Rafols, Ismael**, **Alan L. Porter** and Martin Meyer. September, 2009. "A Model of Interdisciplinarity in Nanotechnology: How Local Knowledge Integration Links a Globally Fragmented Field." Presentation. SNET Conference.

228. **Rafols, Ismael**, Martin Meyer, Jung-Hwan Park and **Alan L. Porter**. August, 2008. "The Cognitive Geography of Nanotechnologies: Location and Knowledge Flows of Nano-Research in the Map of Science." Presentation. Presented at Society for Social Studies of Science (4S), Rotterdam, The Netherlands.

229. **Robert, Jason S.** January, 2009. "Technology and Human Enhancement: Whats the Connection." Presentation. Midwestern University, Glendale, AZ.

230. **Robert, Jason S.** June, 2007. "Braving the Brain." Presentation. Canadian Bioethics Society, Toronto, Canada.

231. **Robert, Jason S.** May, 2007. "Cyborgs, Ratbots, and Bionic Humans: Wiring Brains to Machines." Presentation. Discovery Center, Halifax, Nova Scotia, Canada.

232. **Robert, Jason S.** May, 2007. "Neural Interface Systems: Ethical and Conceptual Issues at the Frontier of Brain Repair." Presentation. Neuroethics Program, Stanford Center for Biomedical Ethics, Palo Alto, CA.

233. **Robert, Jason S.** April, 2007. "Problematizing Enhancement." Presentation. Dartmouth College, N, Hanover, NH.

234. **Robert, Jason S.** February, 2007. "Braving the World of Neurotechnology." Presentation. Health Law Institute Seminar Series, Dalhousie University, Nova Scotia, Canada.

235. **Robert, Jason S.** October, 2006. "Brain Repair and Neural Enhancement." 4S Conference (Society for Social Studies of Science), Vancouver, Canada.

236. **Robert, Jason S.** October, 2006. "Nanotechnology, Neurotechnology, and Society." Presentation. Institute of Nanotechnology Symposium, Northwestern University, Evanston, IL.

237. **Robert, Jason S.** October, 2006. "Forbidden Science Boundaries on New Emerging Science and Technology." Presentation. Jewish Women's Symposium, Tempe, AZ.

238. **Robert, Jason S.** August, 2006. "Controversial Science, Controversial Scientist." Presentation. NABIS Conference, Chicago, IL.

239. **Rogers, Juan D.** October, 2009. "Nanotechnology Research Centers: What Value do they add? What Values do they Operate on." Presentation. 2nd Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.

240. Rogers, Robert P. Jr. June, 2008. "Research Centers as Policy Tools in Emerging Technologies: Scientific and Technical Human Capital in Nanotechnology Centers in the U.S." Presentation. Chinese Academy of Sciences, Beijing, China.

241. Rogers, Robert P. Jr. April, 2007. "The Role of Research Centers in the US Nanotechnology Initiative." Presentation. Workshop on Social Dimensions of Nanotechnology, Paris, France.

242. **Sarewitz, Daniel**. October, 2008. "Paths to Outcomes Based Innovation Policy." Presentation. National Institutes of Health Science of Science Management Meeting, Bethesda, MD.

243. **Sarewitz, Daniel**. September, 2008. "Science Policy and Innovation." Presentation. Presidential Council of Advisors on Science and Technology, Washington, DC.

244. **Sarewitz, Daniel**. November 26, 2007. "New Tools for Science Policy Making." Presentation. Harvard University, Science, Technology, and Society Circle, Cambridge, MA.

245. **Sarewitz, Daniel**. October, 2007. "Anticipatory Governance of Emerging Technologies: Competing Values, Irreducible Uncertainties, and Transformation Innovation." Presentation. University of Oviedo, Oviedo, Spain.

246. **Sarewitz, Daniel**. October, 2007. "Technology and Effectiveness in Contested Political Settings, Center for Research on Energy, Environment, and Transportation." Presentation. CIEMAT, Madrid, Spain.

247. **Sarewitz, Daniel**. April, 2007. "Political Effectiveness in Science and Technology." Presentation. Workshop on Science and Social Values, Center for Interdisciplinary Research, Bielefeld University, Bielefeld, Germany.

248. **Sarewitz, Daniel**. March, 2007. "Connecting Research to Social Outcomes." Presentation. Presentation to the University of Nebraska Board of Regents, Lincoln, NE.

249. **Sarewitz, Daniel**. January, 2007. "Ways of Knowing Novel Materials, Symposium on Environmental Effects of Novel Materials and Processes." Presentation. Royal Commission on Environmental Pollution, London, England.

250. **Sarewitz, Daniel**. August, 2006. "Policy Perspectives." Panel. Meta-Analysis: Emerging Themes in Science Policy. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

251. **Sarewitz, Daniel**. February, 2006. "Tools For Goldilocks: Rethinking the Relationships Among Research, Funding, and Progress." Presentation. AAAS Annual Meeting, Symposium on The Goldilocks Dilemma Facing Science Funding: Can it be Just Right, St. Louis, MO.

252. **Scheufele, Dietram A.** March, 2009. "Public Understanding of and Attitudes Toward Nanotechnology: An Overview." Presentation. Presented at the Nanotechnology and Public: Data for Decision Makers briefing to the Congressional Nanotechnology Caucus, Washington, DC.

253. **Scheufele, Dietram A.** February, 2008. "A Comparative Look at Markets, Media, and Emerging Attitudes About Nanotechnology." Panel. The Annual Convention of the American Association for the Advancement of Science, Boston, MA.

254. **Scheufele, Dietram A.** February, 2008. "Engaging Religious Audiences on Nanotechnology." Presentation. Annual Convention of the American Association for the Advancement of Science, Boston, MA.

255. **Scheufele, Dietram A.** May, 2007. "Public Perceptions and Understanding of Nanotechnology." Presentation. Center for Nanoscale Science and Technology (CNST) Nanotechnology Workshop, University of Illinois, Urbana-Champaign, IL.

256. **Scheufele, Dietram A.** March 16, 2007. "Public Perceptions and Understandings of Nanotechnology." Presentation. Nano and Giga Challenges in Electronics and Photonics conference, Tempe, AZ.

257. **Scheufele, Dietram A.** March 08, 2007. "Risky Business? Risk Perception & Nano Business." Panel. Symposium, Illinois Institute of Technology, Center on Nanotechnology and Society, Chicago, IL.

258. **Scheufele, Dietram A.** January 30, 2007. "How Media and Audiences Make Sense of Scientific Issues: The Case of Nanotechnology." Presentation. CMCIS Research Lecture Series, University of South Carolina, Columbia, SC.

259. **Scheufele, Dietram A.** 2007. "Understanding the Opinion and Communication Dynamics Surrounding Nanotechnology." Presentation. Symposium on the Social Studies of Nanotechnology, University of Pennsylvania, Wharton School of Business & Chemical Heritage Foundation,, Philadelphia, PA.

260. **Scheufele, Dietram A.** 2006. "Influences on Public Opinion About Nanotechnology." Presentation. Public Participation in Nanotechnology & Nanoscale Science workshop, National Nanotechnology Coordination Office, Washington, DC.

261. **Scheufele, Dietram A.** 2006. "It's Not All About Information: Exploring People's Attitudes Toward New Technologies." Lecture. Science, Democracy, and Public Policy colloquium, La Follette School of Public Affairs, University of Wisconsin, Madison, WI.

262. **Scheufele, Dietram A.** 2006. "Public Communication and Policy Making About Nanotechnology." Talk. Nano Workshop for Policy Makers, Materials Research Science and Engineering Center and Engineering Center on Nanostructured Interfaces, University of Wisconsin, Madrid, WI.

263. **Scheufele, Dietram A.** 2006. "Successful Public Communication About Nanotechnology." Talk. The Baldwin Nano Workshop for Journalists, Materials Research Science and Engineering Center and Engineering Center on Nanostructured Interfaces, University of Wisconsin, Madison, WI.

264. **Scheufele, Dietram A.** 2006. "Successful Public Communication About Nanotechnology." Talk. Integration of Societal Implications into Science workshop, U.S. Department of Energy, Washington, DC.

265. **Scheufele, Dietram A.**, **Dominique E. Brossard** and **Kajsa E. Dalrymple**. November 16, 2007. "Whose Voice Matters Most? Public Opinion about the Role of Scientists, Religious Groups, Officials, and Citizens in Public Discourse about Science." Presentation. Annual Convention of the Midwest Association for Public Opinion Research, Chicago, IL.

266. **Scheufele, Dietram A.**, **Elizabeth A. Corley**, Tsung-Jen Shih, **Kajsa E. Dalrymple** and **Shirley S. Ho**. November, 2008. "Public Opinion Dynamics Surrounding Emerging Technologies in Europe and the U.S." Presentation. Annual convention of the Midwest Association for Public Opinion Research.

267. **Scheufele, Dietram A.**, **Elizabeth A. Corley**, **Elliott D. Hillback**, Tsung-Jen Shih, **Sharon Dunwoody** and **David H. Guston**. October 13, 2007. "Nano Attitudes Among Scientists and the Public." Presentation. Annual Convention of the Society for Social Studies of Science, Montreal, Canada.

268. **Schuurbiers, Daan**. May 04, 2009. "In and out of the lab." Lab Meeting. Center for Bioenergy and Photosynthesis, Arizona State University, Tempe, AZ.

269. **Schuurbiers, Daan**. January 19, 2009. "Bugs in the Petri dish and beyond - Results from a midstream modulation study in a microbiology lab in Delft." Presentation. STIR Workshop 1: Constructing Foundations, Tempe, AZ.

270. **Schuurbiers, Daan**. January 17, 2009. "Can shadows shed light?" Presentation. STIR Workshop 1: Constructing Foundations, Tempe, AZ.

271. **Schuurbiers, Daan**. January 15, 2009. "Midstream modulation as part of a PhD on social responsibility in science." Presentation. CNS All Hands Meeting, Tempe, AZ.

272. **Schuurbiers, Daan**. September 19, 2008. "Of social responsibility and scientific practice - Midstream modulation in two microbiology laboratories." Presentation. CSG Workshop "Doing Society and Genomics", Nijmegen, The Netherlands.

273. **Selin, Cynthia**. May, 2010. “Future of Organizing Scenarios”. Organization Design Forum annual meeting. Denver, CO.

274. **Selin, Cynthia**. April, 2010. “The Future of Nanotechnology” Nanotechnology Law and Policy Course. Arizona State University. Tempe, AZ.

275. **Selin, Cynthia**. March, 2010. “Anticipation and Foresight.” International Study of the Long-term Impacts and Future Opportunities for Nanoscale Science and Engineering Workshop. Chicago.

276. **Selin, Cynthia**. March, 2010. “Envisioning Solar to Fuels.” Workshop on Energy Futures, Policy and Society. Arizona State University. Tempe, AZ.

277. **Selin, Cynthia**. November, 2009. “Plausibility.” ASU Plausibility Workshop. Tempe, AZ.

278. **Selin, Cynthia.** October, 2009. “Diagnosing Futures.” Society for the Social Studies of Science. Washington, DC.

279. **Selin, Cynthia**. September, 2009. “Deliberation and Anticipation.” Society for the Study of Nanoscience and Emerging Technologies. Seattle, WA.

280. **Selin, Cynthia.** June, 2009. “Anticipation and Deliberation on the Nano City.” Risoe National Laboratory, Denmark.

281. **Selin, Cynthia**. April, 2009. "Using Scenarios and Foresight to Manage Turbulence." Presentation. Organizational Design Forum, Tacoma, WA.

282. **Selin, Cynthia**. May, 2008. "Managing the Uncertainty of Nanotechnologies." Panel. Challenges to Law, Ethics, and Policy Making Conference at University of Padua, Padua, Italy.

283. **Selin, Cynthia**. February, 2008. "Evidencing the Future and other Dilemmas Working in the Future Tense." Presentation. Anthropology Department, Rice University, Houston, TX.

284. **Selin, Cynthia**. October 12, 2007. "Between Hope and Prudence: Experiments with Scenaric Learning." Presentation. Society for the Social Studies of Science, Annual Meeting, Montreal, Canada.

285. **Selin, Cynthia**. October, 2007. "The Future Tense: The Ways and Means of Anticipation." Presentation. CSPO Enlightening Lunch, Tempe, AZ.

286. **Selin, Cynthia**. September, 2007. "The Future of Nano & Bio Technologies." Panel. CRN conference on Challenges & Opportunities, Tucson, AZ.

287. **Selin, Cynthia**. July, 2007. "Real Time Technology Assessment: Anticipation, Integration, & Engagement." Presentation. Program on Technology Scenarios, Risoe, National Laboratory, Roskilde, Denmark.

288. **Selin, Cynthia**. April, 2007. "Hope and Prudence: Experiments in Scenaric Learning." Presentation. Futures of Life: Acquiring and Creating Anticipatory Knowledge, Cornell University, Ithaca, NY.

289. **Selin, Cynthia**. March 23, 2007. "Anticipatory Governance through Scenarios." Presentation. Workshop on Global Environmental Futures: Interrogating the Practice and Politics of Scenarios, Watson Institute for International Studies, Brown University, Providence, RI.

290. **Selin, Cynthia**. September, 2006. "The Center for Nanotechnology in Society." Presentation. NanoTX Conference, Dallas, TX.

291. **Selin, Cynthia** and Arnim Wiek. November, 2009. "Sustainability meets Anticipatory Governance in Phoenix." CSPO Enlightening Lunch, ASU.

292. **Selin, Cynthia**, Darlene Johnson, Santiago Manriquez, Terry Ryan and Lynda Zeise. November, 2008. "Democratizing Science: Should the Public Have a Voice in Science Research and Development." Presentation. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

293. Shanley, Lea A. September, 2006. "Control and Access: GIS Legal Issues for Indian Nations in the United States." Presentation. URISA 2006 Annual Conference, Chicago, IL.

294. Shanley, Lea A. June, 2006. "Privacy and Security: Internet Publication of Digital Spatial Data and Land Records in Wisconsin." Presentation. Presentation at WLIA Regional Meeting on Privacy, Copyright, Data Distribution and GIS Law, Elkhart Lake, WI.

295. Shanley, Lea A. and Steve J. Ventura. August, 2007. "Land Records and Map Services: Internet Privacy Policies in Wisconsin." for URISA 2007Annual Conference, Chicago, IL.

296. **Shapira, Philip**. March, 2010. "Nanotechnology Innovation and Commercialization." Panel on Innovative and Responsible Governance to Address Grand Challenges of Human Development, Workshop on the Long-term Impacts and Future Opportunities for Nanoscale Science and Engineering (NANO2), Chicago (Evanston), IL.

297. **Shapira, Philip**. May, 2009. "From Lab to Market: Pathways of Research Commercialization in Nanotechnology Firms in China." Presentation. Colloquium on Nanotechnology Innovation and Commercialization in China, Manchester, UK.

298. **Shapira, Philip**. June, 2009. "Anticipating Nanotechnology: Applying Real-Time Technology Assessment to Develop Strategic Insights for Nanotechnology Research and Innovation." Seminar. Centre for Self Organising Molecular Systems (SOMS), University of Leeds, UK.

299. **Shapira, Philip**. April, 2009. "State Models for Supporting Emerging Nanotechnology." Presentation. Workshop on Regional, State and Local Initiatives in Nanotechnology, National Nanotechnology Initiative, Oklahoma City, OK.

300. **Shapira, Philip**. March, 2009. "Anticipating Nanotechnology: Real-Time Technology Assessment of Research and Innovation Systems." Presentation. School of Management and Economics, Knowledge Management and Data Analysis Laboratory, Beijing Institute of Technology, Beijing, China.

301. **Shapira, Philip**. March, 2009. "Anticipating Nanotechnology: Real-Time Technology Assessment and the Center for Nanotechnology in Society." Presentation. Institute for Future Technology (IFTECH), Tokyo, Japan.

302. **Shapira, Philip**. March, 2009. "Emergence of Distributed Technology Assessment in the USA: From OTA to the Center for Nanotechnology in Society." Presentation. International Workshop on Innovation and Institutionalization of TA in Japan, I2TA, University of Tokyo, Tokyo, Japan.

303. **Shapira, Philip**. June 20, 2007. "Nanotechnology in Society: Research and Innovation Systems Program Assessment." Presentation. Beijing Institute of Economic Management, Chinese Academy of Science, June 19, 2007; and at Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China.

304. **Shapira, Philip**. February, 2007. "Societal Assessment of Nanotechnology U.S. Experience." Presentation. Symposium on Nanotechnology by the Ministry of Research, Science and Technology at the Advanced Materials and Nanotechnology (AMN-3) 2007 Conference, Wellington, New Zealand.

305. **Shapira, Philip** and **Alan L. Porter**. March 23, 2009. "Nanotechnology: Will it Drive a New Innovation Economy for the US." Presentation. Project on Emerging Nanotechnologies, Woodrow Wilson International Center for Scholars, Washington, DC.

306. **Shapira, Philip** and **Alan L. Porter**. September, 2005. "Mapping the Nanotechnology Enterprise." Presentation. American Political Science Association Annual Meeting, Washington, DC.

307. **Shapira, Philip**, **Alan L. Porter** and **Jan Youtie**. August, 2006. "Refining Search Terms for Nanotechnology." Presentation. Presented at the National Science Foundation, Arlington, VA.

308. **Shapira, Philip**, **Alan L. Porter**, **Jan Youtie** and **Li Tang**. September, 2008. "Nanotechnology Questions, Methods, Metrics and Results: CNS." Presentation. Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.

309. **Shapira, Philip** and **David H. Guston**. March, 2007. "Societal Assessment of Nanotechnology US Experience." Presentation. Ministry of Research, Science and Technology, Wellington, New Zealand.

310. **Shapira, Philip** and **Jan Youtie**. May, 2008. "Whats New About Emerging Metropolitan Nanodistricts in the United States and Europe? Characteristics of Research and Commercialization." Presentation. The NBER Conference on Emerging Industries: Nanotechnology and NanoIndicators, Cambridge, MA.

311. **Shapira, Philip**, **Jan Youtie** and **Luciano Kay**. October, 2009. "Global Developments in Nanotechnology Commercialization." Presentation. 2nd Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.

312. **Shapira, Philip** and **Jue Wang**. April, 2008. "From Lab to Market: Strategies and Issues in the Commercialization of Nanotechnology in China." Presentation. Panel on Cultures Meet Technology: New Approaches to Innovation and Economic Development in Asia and the West, Association for Asian Studies, 2008 Annual Meeting, Atlanta, GA.

313. Shih, Tsung-Jen, **Dietram A. Scheufele** and **Elizabeth A. Corley**. June, 2010. "Exploring Item Non-Response in Public Opinion Surveys about Nanotechnology: Evidence from 21 Countries." Presentation. Annual Convention of the International Communication Association, Singapore.

314. Shih, Tsung-Jen, **Dietram A. Scheufele** and **Elizabeth A. Corley**. June, 2010. "A Multilevel Model of Risk and Benefit Perception." Presentation. Annual Convention of the International Communication Association, Singapore.

315. **Slade, Catherine.** December, 2009. "Public Values in Nanomedicine." *The Dupont Summit on Science and Technology Policy, "The New Administrations Challenges on Science & Technology: Staying the Course in Times of Crisis."* Policy Studies Organization, Carnegie Institution for Science, Washington DC, December 4.

316. **Slade, Cathy**, **Derrick Anderson**, **Erik Fisher** and Barry Bozeman. August, 2009. "Public Value Mapping of Nanotechnology: A Developing Approach for Tracking Public and Social Values in Science and Innovation Policies." *Annual Meeting of the America Sociological Association*, San Francisco, California. August 7-11.

317. Sommerfield, Milton R., Mark Edwards and **David Conz.** January 15, 2010. "Bugs for Fuels: Microbes in our Energy Future." CNS-ASU Science Café, Arizona Science Center, Phoenix, AZ.

318. **Suchman, Mark C.** 2007. "The Implications of Nanotechnology for Social Science and Social Policy." Presentation. Cornell CNF Public Interest Talk Series, Ithaca, NY.

319. **Suchman, Mark C.** 2007. "Sharing is (S)caring on the Digital Frontier: The Challenges of Information Technology Governance in Health Care Organizations." Presentation. Cornell Center for the Study of Economy and Society, 2006-2007 Seminar Series on Institutions, Market Processes, and the Firm and to Brown University Department of Sociology Colloquium, Ithaca, NY.

320. **Suchman, Mark C.** 2007. "HIT or Miss? The Governance Challenges of Health Information Technology." Presentation. Cornell Law School Faculty Workshop; and to Duke Law School Faculty Workshop, Ithaca, NY.

321. **Suchman, Mark C.** 2006. "Taming the Market for Medical Information: Sharing is (S)caring on the Digital Frontier." Presentation. University of California-Irvine Critical Legalities Symposium, Irvine, CA.

322. **Tang, Li**. April, 2008. "Networks of Research Collaboration in China: Evidence from Nanotechnology Publication Activities, 1990-2006." Presentation. Invited Presentation at the University of Maastricht, The Netherlands, Maastricht, The Netherlands.

323. **Tang, Li**. February, 2008. "Nanotechnology Knowledge Networks in China." Presentation. PRIME Nanotechnology Winter School, Grenoble, France.

324. **Tang, Li**. October, 2007. "Networks of Research Collaboration in China: Evidence from nanotechnology publication activities, 1990-2006." Presentation. Atlanta Science and Technology Policy Conference, Atlanta, GA.

325. **Tang, Li**. October, 2007. "New Argonauts & Scientific Networks: Evidence from Chinas Nanotech Publication." Presentation. Atlanta Science and Technology Policy Conference, Atlanta, GA.

326. **Thoreau, Francois**. September 08, 2009. "Integrated Research and Protected Spaces: A New Role for ST." Poster presentation. Society for the Study of Nanoscience and Emerging Technologies, Seattle, WA.

327. **Thorpe, Michael** and **Manfred Laubichler**. April, 2007. "Reductionism and Emergence in Science: New versus Old Views of Nature and the Universe." Presentation. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

328. **Valdivia, Walter**. August, 2008. "Technology, Growth, and Inequality." Poster presentation. Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

329. **Valdivia, Walter**. June, 2008. "Inequality and Nanotechnology." Presentation. Workshop on Inequality and Emerging Technologies, Valleta, Malta.

330. **Valdivia, Walter**. January, 2008. "Science Policy and Inequality." Presentation. First Indo-American Institute of Nano-scale Science and Engineering, Chennai, India.

331. **Valdivia, Walter**. January, 2008. "Science Policy and Inequality: A Research Program." Presentation. NISTADS, New Delhi, India.

332. **Valdivia, Walter**. October, 2007. "Non-Cooperative Games in Science Policy." Presentation. Atlanta Conference on Science and Innovation Policy, Atlanta, GA.

333. **Valdivia, Walter**. March, 2007. "Anticipatory Governance of Emerging Technologies." Presentation. Science-Society Interface at Universite de Lausanne, Lausanne, Switzerland.

334. **Vermaas, Willem**, **Michael White** and **Barry Ritchie**. February 15, 2008. "Evolution and Faith: Room for Both." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.

335. Wang, Jue, **Elizabeth A. Corley** and Eric Welch. 2009. "Barriers and Motivators for the Adoption of Public Sector Environmental Management Systems." Paper Presentation. Western Social Science Association.

336. Wang, Jue. February, 2008. "From Lab to Market: Strategies and Issues in the Commercialization of Nanotechnology in China." Presentation. Presentation at the National Academy of Sciences, Student Forum on Science and Technology Policy, Washington, DC.

337. Wang, Jue. September, 2007. "From Lab to Market: Strategies and Issues in the Commercialization of Nanotechnology in China." Presentation. National Academy of Science, Conference on the Dragon and the Elephant: Understand the Development of Innovation Capacity in China and India, Washington, DC.

338. Wang, Jue. September, 2006. "Resource Spillover from Academia to High Tech Industry: Evidence from Nanotech Start-up Enterprises." Presentation. 2006 Technology Transfer Society Conference, Atlanta, GA.

339. **Wetmore, Jameson**. April, 2010. Nanodays – student presentations of basic science and nanotechnology applications at the Arizona Science Center, Phoenix, AZ, April 3, 2010.

340. **Wetmore, Jameson**. March, 2010. Nanodays – student presentations of basic science and nanotechnology applications at the Tempe Festival of the Arts, Tempe, AZ, March 26-28, 2010.

341. **Wetmore, Jameson**. March, 2010. "Opportunities for Engaging with the Public," the Asilomar International Conference on Climate Intervention Technologies, Pacific Grove, CA, March 25, 2010.

342. **Wetmore, Jameson**. February, 2010. "Lessons of Engagement: Learning from Policymakers and the Public," Annual Meeting of the American Association for the Advancement of Science, February 22, 2010.

343. **Wetmore, Jameson**. December, 2009. "Overview of CNS-ASU," with David H. Guston at the 2009 NSF Nanoscale Science and Engineering Grantees Conference, Arlington, VA, Dec 9, 2009.

344. **Wetmore, Jameson**. December, 2009. "Best Practices of NSECs and MRSECs for Advancing NSE Education – Diversity Aspects" at the 2009 NSF Nanoscale Science and Engineering Grantees Conference, Arlington, VA, Dec 9, 2009.

345. **Wetmore, Jameson**. November, 2009. "Technology and the City," at *On the Cutting Edge… Today's Jewish Women Symposium*, Scottsdale, Arizona, November 8, 2009.

346. **Wetmore, Jameson**. October, 2009. "Begging for Regulation: The Quest to Tame Nanotechnology," *Annual Meeting of the Society for Social Studies of Science*, Washington, DC, October 30, 2009.

347. **Wetmore, Jameson**. July, 2009. "Anticipatory Governance of Emerging Technologies," National Institute for Nano-Engineering Summer Student Program, Sandia National Labs, July 22, 2009. Invited.

348. **Wetmore, Jameson**. July, 2009. “Nanotechnology and Society,” Presentation with Troy Benn to The Arizona Science Center’s Junior Science Correspondents Program, July 8, 2009.

349. **Wetmore, Jameson**. June, 2009. “What Should Everyone Know about Technology?” Panel discussion, *American Society for Engineering Education Annual Conference,* Austin, Texas, June 16, 2009.

350. **Wetmore, Jameson**. June, 2009. “Integrating Microethics and Macroethics in Graduate Science and Engineering Education: Developing Instructional Models,” with Joe Herkert, *American Society for Engineering Education Annual Conference,* Austin, Texas, June 15, 2009.

351. **Wetmore, Jameson**. March, 2009. "Innovation and Graduate Education." Presentation. Presented at Centers, Universities, and the Science, Arlington, VA.

352. **Wetmore, Jameson**. December, 2008. "Amish Sociologists: Building Society with Technology." Presentation. National Nanotechnology Infrastructure Network, Indian Institute of Technology, Kanpur Winter School on Organic Electronics, Kanpur, India.

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Invention Disclosure

1. Scio: A Nano-enhanced, Convenient, Portable Cancer Biomarker Testing Device. (2008, April).

2. Flux: A Cast with Adjustable Rigidity that Allows for Faster Recovery. (2008, April).

3. Explore: A Mobile Haptic Text to Braille Translator. (2008, April).

4. Nome: An Energy-producing Shelter for Natural Disaster Victims. (2009, April).

5. Everwell: A Device for Rural Users that Converts Air Humidity into Potable Water. (2009, April).

6. Tangent: A Solar-powered Individualized Urban Transportation. (2009, April).

16. Biographical Information for New Investigator

Arnim Wiek, PhD., is an Assistant Professor in the ASU School of Sustainability

Educational Background

Free University Berlin, Germany, Philosophy, M.A.	1998
University of Jena, Germany, Environmental Sciences, M.Sc.	2002
Swiss Federal Institute of Technology Zurich, Switzerland, Environ. Sciences, Ph.D.	2005
Swiss Federal Institute of Technology Zurich, Post-doctoral	2005-2007

Areas of Expertise

Sustainability science; societal aspects of emerging technologies; urban/regional sustainability studies

Current and Other Positions Held

June/July 2009	Visiting Professor in Sustainability Science, Graduate School of Frontier Sciences, University of Tokyo, Japan
August 2008 to present	Assistant Professor in Sustainability Science, School of Sustainability, Arizona State University
May 2007 to July 2008	Visiting Scientist, Institute for Resources, Environment and Sustainability, University of British Columbia, Canada (Grant from Swiss NSF)
May 2005 to April 2007	Lecturer, Swiss Federal Institute of Technology Zurich, Switzerland, Environmental Sciences

Current NSF Grants

"Congruence and Gaps between Theory and Empirical Research in Sustainability Science," Principal Investigator, National Science Foundation (under review), $325K

Publications

1. Wiek, A., Gasser, L., Siegrist, M., 2009, in press. Systemic scenarios of nanotechnology – Sustainable governance of emerging technologies. *Futures*.
2. Wiek, A., Lang, D., Siegrist, M., 2008. Qualitative system analysis as a means for sustainable governance of emerging technologies – The case of nanotechnology. *Journal of Cleaner Production* 16, 988–999.
3. Helland, A., Scheringer, M., Siegrist, M., Kastenholz, H., Wiek, A., Scholz, R.W., 2008. Risk assessment of engineered nanomaterials – A survey of industrial approaches. *Environmental Science & Technology* 42, 640–646.
4. Wiek, A., Zemp, S., Siegrist, M., Walter, A., 2007. Sustainable governance of emerging technologies – Critical constellations in the agent network of nanotechnology. *Technology in Society* 29, 388–406.
5. Siegrist, M., Keller, C., Kastenholz, H., Frey, S., Wiek, A., 2007. Lay people's and experts' perception of nanotechnology hazards. *Risk Analysis* 27, 59–69.

Graduate and Postdoctoral Advisors

Claudia Binder (University of Zurich), Jouni Korhonen (University of Tampere, Finland), Roland Scholz (Swiss Federal Institute of Technology Zurich).

17. Honors and Awards

At the University of Wisconsin, Madison, six doctoral students (Dudo, Ho, Dalrymple, Shih, Hu, and Hillback) in Life Sciences Communication and Journalism and Mass Communication won the 2009 Emerging Nanoscale Materials Specialty Group Student Merit Award at the 2009 annual convention of the Society for Risk Analysis for their work on RTTA 2 data.

Huang, Lu, Ying Guo and Alan L. Porter. October 2009. "A Systematic Technology Forecasting Approach for New and Emerging Science and Technology: Case Study of Nano-enhanced Biosensors." Presentation. 2009 Atlanta Conference on Science and Innovation Policy. The Paper won the Best Graduate Student Paper Award at the 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, Georgia.

Scheufele, D., Professor at the University of Wisconsin, Madison, was selected for the John E. Ross Professorship in Science Communication in the Department of Life Sciences Communication as its inaugural chair in January 2010.

Scheufele, D., Professor at the University of Wisconsin, Madison, was appointed to a second 3-year term on the National Conference of Lawyers and Scientists (NCLS) of the American Association for the Advancement of Science (AAAS), and also was appointed co-chair of the AAAS Program on Scientific Freedom and Responsibility and Law in October 2009.

Wetmore, J., Assistant Professor at the ASU School of Human Evolution and Social Change (SHESC), was awarded SHESC's Undergraduate Teaching Award in May 2009.

Wolbring, G., Assistant Professor at University of Calgary was selected as President-Elect of the Canadian Disability Studies Association in September 2009.

At the University of Wisconsin, Madison, six doctoral students (Dudo, Ho, Dalrymple, Shih, Hu, and Hillback) in Life Sciences Communication and Journalism and Mass Communication won the 2009 Emerging Nanoscale Materials Specialty Group Student Merit Award at the 2009 annual convention of the Society for Risk Analysis for their work on RTTA 2 data.

Table 6: Partnering Institutions (cumulative)											
		Name of Institution	Receives Financial Support from Center	Contributes financial support to the center	Minority Servicing Institution Partner	Female Serving Institution Partner	National Lab/other govt. Partner	Industry Partner	Museum Partner	International Partner	Other
I.a. Academic Partnering Institutions (ASU)											
		Barrett, The Honors College									x
		Biodesign Institute	x	x							
		CRESMET									x
		Center for the Study of Religion and Conflict									x
		College of Liberal Arts and Sciences		x							
		College of Public Programs	x								
		Complex Adaptive Systems Initiative (CASI)									x
		Consortium for Science, Policy and Outcomes		x							
		Decision Theater for a Desert City									x
		Global Institute of Sustainability									x
		Graduate College	x								
		Herberger Institute for Design and the Arts	x								
		Hispanic Research Center			x						
		Ira A. Fulton School of Engineering	x	x							
		LightWorks									x
		Mary Lou Fulton School of Education	x								
		SOLS-Responsible Conduct of Research Program									x
		Sandra Day O'Connor School of Law									x
		School of Earth & Space Exploration									x
		School of Government, Politics, and Global Studies	x								
		School of Human Evolution and Social Change	x								
		School of International Letters and Cultures	x								
		School of Letters and Sciences	x								
		School of Life Sciences									x
		School of Mathematical and Statistical Sciences									x
		School of Sustainability									x
		Science Policy Assessment and Research on Climate (SPARC)									x
		W.P. Carey School of Business									x
		Walter Cronkite School of Journalism and Mass Communication									x
I.b. Academic Partnering Institutions											
		Austrian Academy of Science								x	
		Beijing Institute of Technology, China								x	
		Carnegie Mellon University									x
		Case Western Reserve University									x
		Center for International Development, Harvard University									x
		Center for Nanotechnolgy in Society, UCSB		x							
		Colorado School of Mines	x								
		Columbia University									x
		Copenhagen Business School, Denmark	x							x	
		Cornell University									x
		Dalian University of Technology, China	x							x	
		Delft Technical University, the Netherlands	x							x	
		Dublin City University								x	
		Durham University, United Kingdom								x	
		Ecoles des Mines, France								x	
		European Commission								x	
		Federal University of Parana, Brazil	x							x	
		Florida International University									x
		George Washington University									x
		Georgetown University									x
		Georgia Institute of Technology	x								
		Harvard University									x
		Illinois Institute of Technology									x
		Indiana University	x								
		Institute of International Sociology of Gorizia	x							x	
		Institut d'Estudes Politiques de Grenoble, France								x	
		James Martin Institute for Science and Civilization, Oxford, UK								x	
		Lancaster University								x	
		Leeds University Business School, UK	x							x	
		Mesa Biotech Academy									x
		Mesa High School									x
		Michigan State University									x
		North Carolina State University	x								
		Northeasten University									x
		Northwestern University									x
		Norwegian University of Science & Technology, Norway								x	
		NSEC/CNS-University of California, Santa Barbara (UCSB)									x
		Osaka University, Japan								x	
		Purdue University	x								
		Rensselaer Polytechnic Institute	x								
		Rice University									x

		Rice University/ICON		x							
		Rutgers, The State University of New Jersey	x								
		Said Business School, Oxford								x	
		Texas State University, San Marcos	x								
		UCLA/Harvard/NBER: Collaborative Research; Personnel Exchanges									x
		University de Zacatecas, Mexico	x							x	
		Universidad del Pais Vasco, Spain								x	
		University of Antwerp, Belgium								x	
		University of Arizona								x	
		University of Bergen, Norway								x	
		University of Bielefeld, Germany								x	
		University of Calgary, Canada	x							x	
		University of California, Berkeley	x								
		University of California, Irvine									x
		University of California, Los Angeles									x
		University of California, Santa Barbara									x
		University of Colorado, Boulder	x								
		University of Colorado, Denver	x								
		University of Denver									x
		University of Georgia	x								
		University of Gothenburg, Sweden								x	
		University of Groningen, the Netherlands								x	
		University of Illinois, Chicago									x
		University of Iowa									x
		University of Liege, Belgium	x							x	
		Univesity of Massachusetts, Amherst									x
		University of Michigan									x
		University of Minnesota									x
		University of New Hampshire	x								
		University of Seville, Spain	x							x	
		University of South Carolina									x
		University of South Florida									x
		University of Tennessee, Knoxville									x
		University of Texas									x
		University of Twente, the Netherlands								x	
		University of Virginia									x
		University of Washington									x
		University of Wisconsin, Madison	x								
		Vanderbilt University									x
		Virginia Tech University									x
		Yale University									x
	Total Number Academic Partners										
		111									
II. Non-academic Partnering Institutions											
		ALD Nano Solutions						x			
		American Association for the Advancement of Science (AAAS)									x
		American Bar Foundation									x
		Arizona Nanotechnology Cluster						x			
		Arizona BioIndustry Organization						x			
		Arizona Science Center							x		
		Arizona Technology Council						x			
		BioIndustry Organization of Southern Arizona						x			
		Cell Publishing		x						x	
		Center for Business Models in Health Care									x
		Center for Responsible Nanotechnology									x
		Complex Global Risks									
		Danish Board of Technology								x	
		Department of Energy (DOE)					x				
		Ecological Society of America									x
		Exploratorium, San Francisco							x		
		Environmental Protection Agency (EPA)					x				
		European Commission								x	
		Food and Drug Administration (FDA)					x				
		German Parliament								x	
		Global Business Network						x			
		Gordon Research Conferences (GRC)		x							
		Greenwall Foundation		x							
		Intelligent Information Group Services						x			
		International Nanotechnology in Society Network (INSN)								x	
		Jennings, Strouss and Salmon PLC		x							
		Lawrence Livermore Lab					x				
		Loka Institute									x
		Luxe Ventures						x			
		Mayo Clinic-Scottsdale						x			
		Microchip						x			
		Museum of Life& Science, North Carolina							x		
		Museum of Science, Boston							x		
		Nanoscale Informal Science Education Network (NISE Net)							x		
		National Academy of Engineeering	x								

		National Business Museum							x		
		National Geographic Society									x
		National Nanotechnology Coordinating Office									x
		National Nanotechnology Infrastructure Network									x
		National Research Council									x
		National Science Foundation					x				
		Nature Publishing Group		x						x	
		Norweigian Institute					x			x	
		Nuclear Waste Review Board					x				
		Office of Naval Research					x				
		Practical Action									x
		Physician Services Group									x
		Rathenau Institute								x	
		Rockefeller Foundation		x							
		Sandia National Laboratory					x				
		Sciencecener, New York						x			
		Spirit of the Senses									x
		Springer Publishing		x							
		Targeted Genetics Corporation (TGen)									x
		Teach America									x
		Tempe Festival of the Arts									x
		Televerde									x
		The Foresight Institute									x
		The Royal Society									x
		The Washington Post									x
		U.S. DOE/Center for Integrated Nanotechnology (CINT)					x				
		Woodrow Wilson International Center									x
	Total Number Non-academic Partners:										
		62									