



The Center for Nanotechnology in Society at
Arizona State University

NSF #0531194

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Annual Report for the Period

October 1, 2008 to September 30, 2009

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.

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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 its 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 achievement has been validating anticipatory governance as a richly generative strategic vision. Its two major operations-level achievements are: 1) the imminent completion of the “end-to-end” assessment for TRC 2, linking multiple RTTA capacities to create novel insights in a study of nanotechnology and the brain; and 2) the deepening integration of NSE researchers into CNS-ASU. Major programmatic achievements include: establishing an internationally recognized 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 reflexive decisions; establishing a path-breaking, international research program on NSE and equity; and exploring views and capacities of human nanotechnologies and conducting the first E2E assessment.

The Center’s principal **intellectual merit** derives from the large-scale, interdisciplinary ensemble that underpins it intellectually and operationally. The ability to embrace and facilitate interactions among disparate approaches to understanding nanotechnologies, and build complementary and reinforcing capacities to tap that knowledge for governance, is the critical intellectual contribution to which CNS-ASU aspires. Both in terms of numbers 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 both the social sciences and NSE, incorporating forefront research in new courses and informal educational 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	Asst. Research Professor	Consort. for Science, Policy, & Outcomes
Troy Benn	Graduate Teaching Associate	Civil & Environmental Engineering
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
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
Thomas Duening	Director	Entrepreneurial Programs
Karin Ellison	Associate Director	Biology & Society
Scott Endsley	Vice President	System Design for Quality Improvement
Tricia Farwell	Professor	Journalism & Mass Communication
Adelheid Fischer	Staff	Innovation Space
Erik Fisher	Assistant Research Professor	Consort. for Science, Policy, & Outcomes
Devon 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
Stephen Johnston	Professor	Biodesign Institute
Anatoli Korkin	Director	Research & Economic Affairs
Nancy Levinson	Director	College of Design
Stuart Lindsay	Regents Professor	Biodesign Institute
Farzad Mahootian	Lecturer	School of Letters and Sciences
Gary Marchant	Professor	Law
Joan McGregor	Professor	Philosophy
Chad McAllister	Staff	Chemistry & Biochemistry
Clark A. Miller	Associate Professor	Political Science
Torin Monahan	Assistant Professor	Justice & Social Inquiry
Mookesh Patel	Associate Professor	Visual Communication Design
S. Thomas Picraux	Professor	Materials Research
Jonathan Posner	Assistant Professor	Mechanical & Aerospace Engineering
George Poste	Director	Biodesign Institute
Paul Privateer	Associate Professor	Film & Media Studies

B. Ramakrishna	Associate Professor	Materials
Wellington Reiter	Dean	College of Design
Barry Ritchie	Professor	Physics
Jason S. Robert	Associate Professor	Life Sciences
Daniel R. Sarewitz	Professor	Life Sciences
Anne Schneider	Professor	Justice & Social Inquiry
Cynthia Selin	Assistant Research Professor	Consort. for Science, Policy, & Outcomes
Michael Tracy	Director	Biodesign Institute
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
Philip White	Professor	Industrial Design
Arnim Wiek	Assistant Professor	School of Sustainability
Joann Williams	Professor	Chemistry & Biochemistry
Neal Woodbury	Professor	Chemistry & Biochemistry
Frederick Zenhausern	Professor	Biodesign Institute

Collaborators

Peter Asaro	Rutgers University	Assistant Professor
Larry Bell	Director	Museum of Science
Jason Borenstein	Georgia Inst. of Technology	Professor
Barry Bozeman	Georgia, Professor	Public Administration & Policy
Donald Braman	George Washington, Prof.	Law
Dominique Brossard	Wisconsin, Asst. Professor	Journalism & Mass Communication
Michael Chorost	Author	
Jennifer Cleary	Rutgers, Sr. Project Mgr.	Planning & Public Policy
Michael D. Cobb	NCSU, Associate Professor	Political Science
Joseph Conti	American Bar Foundation	Law
Susan Cozzens	Georgia Tech, Professor	Public Policy
Wendy C. Crone	Wisconsin, Professor	Engineering Physics
Bruna De Marchi	Inst. of Int'l. Socio. of Gorizia	Head of Mass Emergencies Programme
Peter deLeon	Colorado, Denver, Professor	Public Affairs
Terry Devitt	Wisconsin, Science Writer	Science & Technology
Fanie Duvenghugue	Microchip	Manager
Sharon Dunwoody	Wisconsin, Professor	Journalism & Mass Communication
Elizabeth Farrell	New Hampshire, Coord.	Culture & Sustainability, Food & Society
Aaron Fichtner	Rutgers, Director	Research & Evaluation
Guillermo Foladori	Universidad de Zacatecas	Nanotechnology
Joan Fujimura	Wisconsin, Professor	Sociology
Joel Garreau	The Washington Post	Science & Technology
Stu Graham	Georgia Tech, Professor	Management
David Grimshaw	Practical Action	Head of International Programme
Patrick Hamlett	NCSU, Associate Professor	Science, Technology & Society
Barbara Harthorn	California, Santa Barbara	Director, CNS-UCSB
Linda Hogle	Wisconsin, Associate Professor	Medical History & Bioethics
Rachelle Hollander	National Academy of Engrg.	Executive Director
Maja Horst	Copenhagen Business School	Politics & Philosophy
Maurizio Iacopetta	Georgia Tech, Assistant Prof.	Economics
Helen Ingram	California-Irvine, Professor	Planning, Policy, and Design
Noela Invernizzi	Federal University of Parana	Development Studies

Deborah Johnson	University of Virginia	Professor
Dan M. Kahan	Yale, Professor	Law
Thomas Kelly	New Hampshire, Professor	Office of Sustainability
Eun-sung Kim	Wisconsin, Assistant Professor	Science & Technology
Daniel Kleinman	Wisconsin, Professor	Rural Sociology
Mark Knell	Norwegian Institute,	Chemistry
Kristen Kulinowki	Rice University	Executive Director
Frank Laird	Colorado, Professor	International Studies
Michael Lynch	Cornell, Professor	Science & Technology
Roop Mahajan	Virginia Tech, Director	Critical Technology & Applied Science
Jim Malone	Private Practice	Physician
Laurence Miller	Mayo Clinic – Scottsdale	Physician
Robert J. Milligan	Physician Services Group	Physician
Carl Mitcham	CO School of Mines, Prof.	Liberal Arts & International Studies
Evan Michelson	Rockefeller Foundation	Senior Research Associate
Sheila McNamee	New Hampshire, Professor	Communication
Julia A. Moore	Woodrow Wilson Center	Deputy Director
Niles Newman	Intelligent Info. Svcs. Group	STIP Associate
Dean Niesuma	Rensselaer Poly. Institute	Assistant Professor
Krsto Pandza	Leeds Univ. Business School	Senior Lecturer
Shobita Parthasarathy	Michigan, Assistant Professor	Public Policy
Alice Pawley	Purdue University	Assistant Professor
Sarah Pfatteicher	Wisconsin, Madison	Assistant Dean
Mark Philbrick	California-Berkeley	Public Policy
Roger Pielke, Jr.	Colorado, Professor	Environmental Studies
Kenneth Pimple	Indiana University	Professor
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
Christine Reich	Museum of Science	Assistant Director
David Rejeski	Woodrow Wilson Center	Director
Arie Rip	University of Twente	Professor
Juan Rogers	Georgia Tech, Assoc. Prof.	Public Policy
Alan Rubel	Georgetown Univ. Law Ctr.	Greenwall Fellow
Dietram Scheufele	Wisconsin, Professor	Life Sciences Communication
Jennifer Schneider	CO Schl. of Mines, Asst. Prof.	Liberal Arts & International Studies
Philip Shapira	Georgia Tech, Professor	Public Policy
Laurel Smith-Doerr	National Science Foundation	Program Director
Joe Spencer	ALD NanoSolutions	Production Manager
Nicholas Steneck	University of Michigan	Professor
Karl Stephan	Texas State University	Associate Professor
Michael Sullivan	Hispanic Research Center	Director
Albert Teich	AAAS	Director
Julia Trosman	Center for Business Models	Director
Rinie van Est	Rathenau Institute	Coordinator
Carl Van Horn	Rutgers, Professor	Planning & Public Policy
Jue Wang	Florida Intl., Asst. Prof.	Religious Studies
David Winickoff	California, Berkeley, Prof.	Bioethics & Society
Gregor Wolbring	University of Calgary	Assistant Professor
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

*ASU**Post-Doctoral Scholars*

Doe Daughtrey	Post-doctoral Fellow	Religious Studies
Matthew Harsh	Post-doctoral Fellow	Consort. for Science, Policy, & Outcomes
Anastasios Panaretos	Post-doctoral Fellow	Electrical Engineering
Cathy Slade	Post-doctoral Fellow	Public Policy
Brea Williams	Post-doctoral Fellow	Chemistry & Biochemistry

*ASU**Graduate Researchers*

Parul Agrawal		Materials Science & Engineering
Derrick Anderson		Public Policy
Monamie Bhadra		Human & Social Dimensions of S & T
Antonio Calleja-Lopez	University of Seville	Political Science
Shannon Conley		Political Science
Shannon DiNapoli		Life Sciences
Aixa Garcia-Mont		Education
Manuel Garay Valenzuela		Education
Sean Hays		Political Science
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
Jason Lappe		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
Sharlissa Moore		Human & Social Dimensions of S & T
Christina Nulle		Global Technology Development
Azra Panjwani		Mathematics
John Parsi		Political Science
Jennifer Rogers	California, Santa Barbara	Graduate Student
Daan Schuurbiens	Delft Technical University	Biology & Society
Cyndy Schwartz		Human & Social Dimensions of S & T
Jaswinder Scharma		Biomedicine
Quinn Spadola		Physics
Francois Thoreau	University of Liege	Political Science
Justin Tosi		Political Science
Walter Valdivia		Public Administration
Oriol Vidal Aparicio		Political Science
Roxanne Wheelock		Liberal Studies

*Affiliated**Post-Doctoral Scholars*

Jason Delborne	Wisconsin	Rural Sociology
Sonia Gatchair	Georgia Tech	Public Policy
Eun Syung Kim	Wisconsin	Sociology
Ramya Rajagopalan	Wisconsin	Sociology
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
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
John Garner	Georgia Tech	Computing
Ying Guo	Beijing Institute of Tech.	Political Science
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
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
H. Narayanan	Georgia Tech	Quantitative Finance & ISYE
Christina Nдох	NCSU	Public Administration
Tanner Osman	Georgia Tech	Public Policy
Jayesh Patil	Georgia Tech	Computing
Robin Phelps	Colorado, Denver	Public Affairs
Mark Philbrick	California, Berkeley	Environment & Management
Sofia Randhawa	Georgia Tech	Quantitative Finance & ISYE
Lea Shanley	Wisconsin	Environment & Resources

Tsung-Jen Shih	Wisconsin
Harmeet Singh	Georgia Tech
John Slanina	Georgia Tech
Anthony Stavrianakis	California, Berkeley
Alexa Stephens	Georgia Tech
Vrishali Subramanian	Georgia Tech
Li Tang	Georgia Tech
Dhanaraj Thakur	Georgia Tech
Juin-Yi Tsai	Wisconsin
Rutger van Merkerk	University of Twente
M. Van Oudheusden	Antwerp University
Charles Walsh	Georgia Tech
Rosalyna Wijaya	Wisconsin
John Willingham	North Carolina State
Heming Zhang	Nankai Univ./Georgia Tech
Qin Zhu	Dalian University of Tech.

Journalism & Mass Communication
Quantitative Finance & ISYE
 Public Policy
Anthropology
 Public Policy & City & Regional Planning
Public Policy
Public Policy
Public Policy
Journalism
 Innovation & Environmental Sciences
Political & Social Sciences
 Public Policy
 Journalism & Mass Communication
International Studies
 Public Policy
Philosophy

*ASU**Undergrad Interns & Researchers*

Kalil Abdullah
 Nidhi Bhalla
 Shreya Battacharyya
 Bradley Brennan
David Calderon
 Rahul Chhabra
 Josh Choi
Kelley Conley
 Rob Davis
Travis Doom
David Edwards
 Tara Egnatios
Andrew Gaddis
Rebecca Hudson
Benjamin Lowenstein
Rachel Lowenstein
 Tobie Milford
Christina Nulle
 Sidra Omer
Mark Petersen
 Zachary Pirtle
 David Renolds
 Lucas Rogers
Dusana Schnell-Vivas
 Rachel Smith
 Julia Weakley
 Brian Young
 Ke Wu

Molecular Biotechnology
 Political Science
 Chemistry
 Chemistry & Biochemistry
Molecular Bioscience & Biotechnology
 Chemistry
 Biomedical Engineering & Economics
Psychology
 Biology
Bioengineering
English & Creative Writing
 Public Policy
Industrial Engineering
Business
Sociology
Business
 Biology & Society
Global Technology Development
 Journalism & Mass Communication
Economics
 Mechanical Engineering
 Chemical Engineering
 Engineering
Marketing
 Biology & Society
 Global Studies
 Biology & Society
 Biology & Society

Affiliated Undergrad Interns & Researchers

Annie Bidgood	Georgia Tech
Brescia Cassellius	Wisconsin

ISYE
 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
Michelle Iafrat	Administrative Associate
Regina Sanborn	Program Manager
Joy Trottier	Administrative Associate

Participants affiliated, not receiving CNS-ASU support:*ASU*

Catherine Arnold	CSPO	Communications Coordinator
Nalini Chhetri	CSPO	Lecturer
Netra Chhetri	CSPO	Assistant Professor
Michael Crow	Arizona State University	President
Alfinio Flores	Curriculum & Instruction	Professor
Antonio Garcia	Hispanic Research Center	Associate Director
Stephen Goodnick	Electrical Engineering	Professor
Joel Greene	Public Policy	Professor
Stuart Hadley	Public Affairs & Foreign Rel.	Vice President
Rachel Levinson	Research & Economic Affairs	Government Relations Liaison
Jose Lobo	Global Institute of Sustain.	Associate Professor
George Maracas	School of Sustainability	Professor
Joan McGregor	Philosophy	Professor
Patrick Phelan	School of Engineering	Professor
Vincent Pizziconi	Bioengineering	Professor
RF (Rick) Shangraw	Research & Economic Affairs	Vice President

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
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 and Environmental Engineering
Marilyn Carlson, Professor, ASU Department of Mathematics & Statistics
Elizabeth Corley, Associate Professor, ASU Department of Public Affairs
David H. Guston, Professor, ASU Department of Political Science
Clark A. Miller, Associate Professor, ASU Department of Political Science
George Poste, Director, ASU Biodesign Institute
Daniel R. Sarewitz, Director, Consortium for Science, Policy, and 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 and Technology Studies, Cornell University
Sheila Jasanoff, Professor, Science and Technologies Studies, Harvard University
Ray Kurzweil, Author
Rachel Levinson, Industrial and 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 and Economic Affairs
Mark Shapiro, Center for Investigative Journalism
Mitchell Small, Professor, Department of Public Policy, Carnegie Mellon University
Albert Teich, Director, Science and Policy Programs, American Association for the Advancement of Science
James Wilsdon, Director, The Royal Society

iii. Nanotechnology Industry Liaison Committee (will be reconstituted in Year 5)

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 Korokin, 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 and 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, and Technology (CRESMET)
Center for the Study of Religion and Conflict
College of Design
College of Liberal Arts and Sciences
College of Public Programs
Consortium for Science, Policy, and Outcomes
Decision Theater for a Desert City
Global Institute of Sustainability
Graduate College
Hispanic Research Center
Ira A. Fulton School of Engineering
Mary Lou Fulton College of Education
Responsible Conduct of Research Program, School of Life Sciences
Sandra Day O'Connor School of Law
School of Human Evolution and Social Change
School of Letters and Sciences
School of Sustainability
Science Policy Assessment and Research on Climate (SPARC)
W.P. Carey School of Business
Walter Cronkite School of Journalism and Mass Communication

ii. Academic Participating Institutions Other than at ASU

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
Ecole des Mines, France
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
James Martin Institute for Science and 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
NSEC/CNS-University of California, Santa Barbara (UCSB)
Purdue University
Rensselaer Polytechnic Institute
Rice University
Rice University/ICON
Rutgers, The State University of New Jersey
Texas State University, San Marcos
The Center for International Development, Harvard University
UCLA/Harvard/NBER: Collaborative Research; Personnel Exchanges
Universidad de Zacatecas, Mexico
University of Antwerp, Belgium
University of Arizona
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 Georgia
University of Illinois, Chicago
University of Iowa
University of Liege, Belgium
University of Massachusetts, Amherst
University of Michigan
University of New Hampshire
University of Seville, Spain
University of South Carolina
University of Tennessee, Knoxville
University of Texas
University of Twente, the Netherlands
University of Virginia
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
Cell Publishing
Center for Business Models in Health Care
Center for Responsible Nanotechnology
Danish Board of Technology
Department of Energy (DOE)
Ecological Society of America
Exploratorium, San Francisco
Environmental Protection Agency (EPA)
Food and Drug Administration (FDA)
Gordon Research Conferences
Greenwall Foundation
Intelligent Information Group Services
International Nanotechnology in Society Network (INSN)
Jennings, Strouss, and Salmon PLC
Lawrence Livermore Lab
Loka Institute
Luxe Ventures
Mayo Clinic – Scottsdale
Microchip
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
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

5. Table 1: Quantifiable Outputs					
	Reporting	Reporting	Reporting	Reporting	
	Year-1	Year-2	Year-3	Year-4	Total
Outputs	2005-2006	2006-2007	2007-2008	2008-2009	
Publications resulted from NSEC Support					
in Peer Reviewed Journal	10	7	4	8	29
in Peer Reviewed Conference Proceedings	0	0	0	0	0
in Peer Reviewed Book Chapters	1	7	7	2	17
Technical Reports	4	1	1	4	10
Working Papers	1	1	3	12	17
Books	0	0	2	0	2
Theses	2	7	11	9	29
in Trade Journals	0	1	2	0	3
Other Journal Publications	7	1	2	2	12
with Multiple Authors	10	9	11	16	46
co-authored with NSEC faculty	10	9	11	16	46
NSEC Technology Transfer					
Inventions Disclosed	0	3	3	3	9
Patents Filed	0	0	0	0	0
Patents Awarded	0	0	0	0	0
Software Licensed	0	0	0	0	0
Spin-off Companies Started	0	0	0	0	0
Degrees to NSEC Students					
Bachelors Degrees Granted	3	8	1	11	23
Masters Degrees Granted	2	4	1	4	11
Doctoral Degrees Granted	1	1	3	5	10
NSEC Graduates Hired by					
Industry	0	1	0	2	3
NSEC participating Firms	0	0	0	0	0
Other US Firms	0	1	0	0	1
Government	0	1	0	1	2
Academic Institutions	2	5	3	2	12
Other	0	1	0	3	4
Unknown	4	4	1	11	20
NSEC Influence on Curriculum					
New Courses Based on NSEC Research	3	5	2	3	13
Courses Modified to Include NSEC Research	2	3	2	3	10
New Textbooks Based on NSEC Research	0	0	1	0	1
Free-standing Course Modules or Instructional CDs	0	0	0	0	0
New Full Degree Programs	0	0	1	1	2
New Certificate	0	0	0	0	0
Information Dissemination/Educational Outreach					
Workshops, Short Courses to Industry	0	0	0	2	2
Workshops, Short Courses to Others	2	3	2	0	7
Seminars, Colloquia, etc.	73	88	38	66	265
World Wide Web courses	0	0	0	0	0
Academic Presentations	49	60	21	37	167
Industry Presentations	9	10	1	5	25
Science Cafes	6	8	4	7	25
Visiting Speakers	8	9	12	8	37
Community Speaking Engagements	1	1	0	2	4
Newsletters	5	4	3	3	15

6. Mission 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 new volume of 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 archaeology of anticipatory governance (Karinen and Guston, forthcoming 2009). 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 a session at the annual 2009 (May) AAAS Science and Technology Policy Forum dedicated to anticipatory governance.

CNS-ASU research has begun to have a substantial influence on the scholarly literature. The *Yearbook of Nanotechnology in Society* series (Springer; Guston, series editor) has one volume published (Fisher, Celin and Wetmore 2008), a second in production (Robert, Miller and Bennett forthcoming 2009), a third almost ready for review (Cozzens and Wetmore forthcoming 2010), and a fourth in the planning stage (Miller and Barben in preparation 2011). *The Encyclopedia of Nanoscience and Society* (Sage; Guston, editor) is in preparation, with most articles due in May 09. 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. In total, Center researchers have 7 books published or under contract.

The Center's researchers have published or submitted for review 55 peer-reviewed journal articles (44 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*),
- law and ethics (*Science and Engineering Ethics*; *Journal of Law, Medicine, and Ethics*),
- 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*),

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.

- social scientists and humanists (*NanoEthics*) and
- educators (*Journal of Nanotechnology Education*).

The Center has 18 non-peer-reviewed publications in trade and other journals, including Guston's *Nature* commentary, and has further published 25 book chapters, including three contributions to the field-defining *Handbook of Science and Technology Studies*, many of the new nano-in-society anthologies, and major new works on interdisciplinarity and on innovation policy and assessment.

Although citations are a somewhat crude measure of scholarly impact, this body of published work is already garnering an impressive number – more than 188 citations to its published work as documented in Google Scholar (as of Apr 09), with an H-index for Center publications equal to 9 (indicating nine publications with nine or more citations each). (This total does not include the roughly half of the 89 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.)

As evidence of its impact on education, the Center is principally responsible for 34 completed or imminently completed (Sp or Su 09) student theses, including 4 completed doctoral theses, 4 master's theses, and 19 undergraduate honors theses, across a variety of disciplines. In addition, CNS-Biodesign fellows have completed two doctoral theses with the PhD+, and 6 other doctoral theses of domestic and international students have been influenced by interactions with CNS-ASU. These numbers do not, of course, yet include the five domestic and five international graduate students whose doctoral research will be 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 nearly one million dollars of subsidiary and spin-off awards at ASU and roughly \$1.5 million 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);
- 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"); and
- 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).

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.

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; and
- Scheufele, NSF, Media, Talk, and Trust: The Social Amplification of Risk during Site Selection for a Bio-research Facility, \$400K.

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 to offer a societal training course in the new curriculum;
- 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; and
- collaborated with a number of STC, ERC, IGERT and NUE 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 (dates)
 - 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 last year (see **Outreach** section for more detailed discussion). Through its spin-off STIR project, CNS-informed and/or affiliated researchers will conduct integrated studies in 20 laboratories world-wide.

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 1/1 Research Program Analysis: Analyzing extensive global databases of Science Citation Index records, other publication databases, and MicroPatents, 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.
- 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.
- RTTA 1/3 Workforce Assessment: Completing a study to identify post-secondary degree programs in the US focused on NSE ([Van Horn](#) et al. 2009), CNS-ASU researchers found:
 - 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:
 - Significant negative correlation between religiosity and agreement with the statement that "nanotechnology is morally acceptable" ([Brossard](#) et al. 2008);
 - 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).
- 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 ([Corley](#) et al. under review):
 - NSE researchers are more supportive of regulations when they perceive high levels of risk, and levels of support for regulation are surprisingly not influenced by perceived levels of benefits;
 - NSE researchers tend to think that new regulations are needed in areas of privacy, human enhancement, medicine, and energy and the environment;
 - Support for regulations is significantly higher among female NSE researchers and among materials researchers.
- RTTA 3/1 Scenario Development
 - NanoFutures website deliberations yielded concerns about: dual use; the metaphysical quandaries of man-machine integration; exacerbation of existing inequities by new technologies; and how systemic interactions between different enhancement technologies may give rise to novel and unpredictable social dilemmas ([Selin](#) and Hudson under review);
 - Prototypes – as tangible, user-centered scenarios – are viable pedagogic tools to support NSE researchers, business practitioners and design professionals in making concrete the ethical issues attending emerging technologies ([Selin](#), [Boradkar](#) and [Fisher](#), under review; and

- The functionality of a stochastic model of social values related to surveillance technology shows that modeling provides a useful way to bring social science knowledge (scenarios of emerging nanotechnologies) explicitly into technology assessment. (Greenwood, Wang, Selin and Panjwani under review).
- RTTA 3/4 National Citizens' Technology Forum: Based on reports from citizens' participating in the NCTF and pre- and post-tests from the event, CNS-ASU researchers have found:
 - The NCTF provided a high-quality deliberative environment that did not suffer from various problems thought to be inherent to small-group decision making and lay citizens are capable of deliberating in a thoughtful way that can contribute to public discourse and even policy decisions – with a few caveats (Hamlett, Cobb and Guston 2008);
 - Popular unease with enhancement technologies exists alongside of hope for nano-enabled therapies (Hamlett, Cobb and Guston 2008);
- RTTA 4 RAE: Through a set of integrative research and educational activities with NSE researchers, CNS-ASU researchers have found:
 - Integrative activities can have at least modest effect on NSE researchers' knowledge, identity and practice regarding the societal aspects of their work.
 - Midstream modulation of research agendas and research conduct – based on interactions with social scientists – occurs at the level of small groups as well as individual researchers, and at the level of laboratory directors as well as the level of graduate students and trainees.
 - Such interaction has not hampered the NSE research projects and has, in early indications, been found to enhance them with “breakthrough” and “useful” ideas.
 - The public is not very concerned about the use of genetically modified cyanobacteria for biofuels production, but they do not trust energy companies.
- TRC 1: The collected experts participating in the November 2008 workshop on Nanotechnology, Equity, and Equality determined that many of the promises for and challenges to equity and equality that have been generated by previous technologies are very likely to be raised 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.

Technology (in this case, 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”).

- RTTA 1 RISA:
 - RTTA 1 searchable definition of nanotechnology adopted by European Nano Observatory.
 - Several targeted bibliometric studies supported ongoing CNS-ASU work.
 - RTTA 1/1 findings on patenting in nano-districts helped RTTA 1/3 Workforce Development identify firms for inclusion in its study of New Jersey.
 - RTTA 1/2 research on nanotechnologies for clean water will provide background information for TRC 1 activities.
- 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:
 - An online survey has been designed to assess the technical plausibility of potential energy applications using nanotechnology.
 - Triangulating visualization tools to analyze the content of a blog provides insight into the range and frequency of themes raised and displays the array of perspectives. (Selin and Hudson under review)
 - RTTA 3/4 NCTF data requested by researchers at NYU and Ecole des Mines de Paris.
- RTTA 4 RAE:
 - Midstream modulation protocol is at the root of the multi-national STIR collaboration and other new and planned research.

Education and Training:

- At the undergraduate level, CNS-ASU continues with InnovationSpace, which is developing integrated innovations in “nanotechnology, energy and equity.” Five ISpace students are expected to graduate in Sp 09 having written undergraduate honors theses for their CNS-related work. Post-doctoral fellow Harsh has integrated nanotechnology issues in the existing undergraduate class, previously developed by Miller, on “Science and Democracy.” Undergraduate research interns continue to make important contributions, e.g., Travis Doom on media coverage of nano and the brain, Mark Peterson on the Spanish translation of the scenarios, Dusana Schnell-Vivas on NanoFutures, and Kelley Conley and Shephanie Naufel on TRC 2/E2E activities.
- At the graduate level, CNS-ASU has involved some three dozen graduate students in its YR 4 activities. The Center’s second PhD+ student is expected to graduate in May, and three more CNS-related doctoral students are expected to graduate over the next several months. The Center has added additional PhD+ students, and we will conduct two iterations of our DC Summer Session in Su 09. We taught students in the new Professional Science Master’s Program in Nanoscience and in the new Biological Design PhD program, and we introduced other new

courses including “Science Policy for Scientists and Engineers,” “Energy,” and “Governing Emerging Technologies” at the graduate level. The Center has also played an integral role in the new Human and Social Dimensions of Science and Technology graduate program, with six of seven students in the first year’s class either employed by or contributing to CNS-ASU activities.

- In informal science education, CNS-ASU continues its close collaborations with NISE Net, including, e.g., participating in NanoDays in Mar 09 by having graduate students set up a booth at the Tempe Festival of the Arts, by developing with NISE doctoral student Benn a demonstration on nano-silver in consumer goods that is now archived with NISE Net. CNS also continued its Science Café program with the AZ Science Center.
- In training for scientists and engineers, the video CNS-ASU developed, in collaboration with D. Kysar (Yale) and A. Viseu (York U., Toronto), has been viewed by approximately 1000 users of the National Nanotechnology Infrastructure Network (NNIN).

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

- the near-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 workshop, organized by Scheufele and hosted by Wisconsin Innovation Network, on public opinion research for the high-tech sector; and
- at least five presentations by faculty for specifically private sector audiences in the reporting year.

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 the last year, CNS-ASU has continued its fruitful collaboration with the undergraduate InnovationSpace, expanded its graduate training with new coursework for both social scientists and NISE students, and collaborated with NISE Net to include nano-in-society ideas in informal science education. CNS has also cultivated a cohort of interdisciplinary junior scholars, three of whom have now been appointed to tenure-track positions in the last year (Delborne, from Wisconsin to CO School of Mines, Ho from Wisconsin to Nanyang Technological University, and Fisher from ASU to ASU).

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 current 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. CNS-ASU is also submitting an REU supplement proposal focused on under-represented students.

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. 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/>), 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. Given the founding of the new Society for the Study of Nanoscience and Emerging Technologies (Guston is a founding member of the board and a member of the first program committee), we are currently in the preliminary stages of exploring a re-purposing of INSN to deal specifically with issues of nanotechnologies, equity and development. Another example of enhancing the research infrastructure through community-building is the 2008 Gordon Research Conference (GRC) on Science and Technology Policy, co-chaired by Guston and focused on "Governing Emerging Technologies." One-hundred and thirty scholars and practitioners – 27% from outside academia and 15% from outside the US – attended. 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.

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 55 published, forthcoming or under review journal articles, 9 are in journals like *Nature Nanotechnology*, *Journal of NanoParticle Research*, and others that are generally oriented toward NSE 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*. CNS-ASU researchers have given approximately 260 presentations, roughly half to their social science colleagues and roughly one quarter 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 4 – including (in addition to the GRC) events on equity, STIR, and ethics education at ASU, policy and innovation with GA Tech in Manchester, UK, and public opinion research for high-tech firms in Wisconsin.

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 09 “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 in the form of honors theses like Milford (2008) and Naufel (in progress) are well-integrated with research programs;
 - graduate course development, particularly “Nano, the Brain, and the Future” (Sp 08; F 08; Sp 09) is driven by research interests;
 - CNS-ASU research activities become case studies for concurrent educational activities, e.g., Guston’s “Governing Emerging Technologies” graduate seminar was thoroughly integrated into Center activities like the Oct 08 Visioning Workshop and the Nov 08 Equity Workshop; and
 - as a studio course, InnovationSpace integrates a substantial amount of research derived from CNS through faculty visits and guest lectures, among more traditional routes, into its design activities.
 - CNS-ASU partnerships with NSE researchers have enriched its Science Cafes, which local teachers may use for credit;
 - Director Guston has given video lectures for a science policy course at the University of Michigan and for the National Center for Learning and Teaching on CNS-ASU and anticipatory governance;
 - 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;
 - Student authors are included on approximately 40% of the 55 CNS manuscripts published in, forthcoming or under review in peer-reviewed journals;
 - Students are first or sole-author on roughly one-sixth of the roughly 265 CNS presentations, and they have presented their CNS-related work in a variety of venues, including at the National Academy of Sciences (Wang), the 2008 Gordon Research Conference on Science and Technology Policy on “Governing Emerging Technologies (Garay, Hays, Lidberg, Pirtle, and Valdivia), Science Cafes, and elsewhere;
 - 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, commencing this summer by GA Tech doctoral student Meng on 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 nanotherapeutics; and
 - An entire research program area on Equity 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 roughly three dozen international visitors, including 18 visitors from 12 different countries in YR 4 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 collaborations;
 - A Memorandum of Understanding with the National Nanotechnology Infrastructure Network (NNIN) for collaborations centered on training NNIN users in societal aspects of NSE has led to the training video that has reached roughly 1000 NNIN users to date;
 - Leadership in the ASU-created International Nanotechnology and Society Network, currently consisting of more than 100 researchers in more than a dozen nations;
 - Co-chairing the Gordon Research Conference on “Governing Emerging Technologies;”
 - Partnering with the first US-India Nano-science and Engineering Institute to add a societal implications component, led by Wetmore, to its program and nano-in-society personnel to its mission.
 - 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 School of Engineering, the Department of Physics and the Department of Chemistry;
 - CNS supports InnovationSpace, which bridges design, engineering, and business;

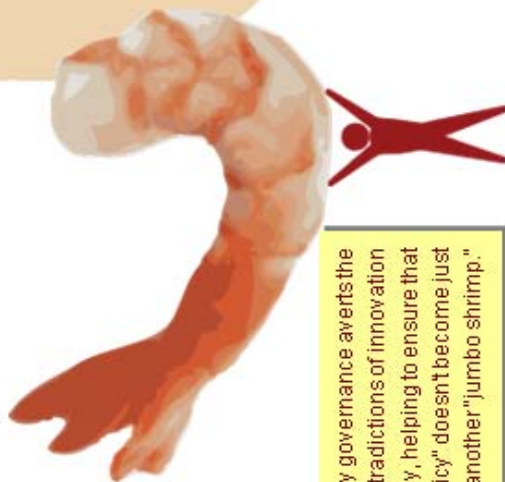
- CNS graduate coursework helps link Political Science, Human Evolution and Social Change, the School of Life Sciences, and the new Human and Social Dimensions of Science and Technology graduate programs;
 - CNS-ASU partners with the Arizona Science Center for the production of monthly Science Cafes 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 more than 1300 individuals;
 - CNS-ASU researchers have given more than 260 talks across all audiences since the inception of the Center, 69 in YR 4 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 200 museums and other participants in NanoDays;
 - NNIN has disseminated the CNS-ASU led PPT training module throughout its network of user facilities;
 - 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 *Yearbook of Nanotechnology in Society* (Guston, series editor), the first of which is published (Fisher, Selin and Wetmore 2008), the second of which is almost delivered to press, and third of which is just about complete as well;
 - CNS-ASU Director Guston has almost completed soliciting articles 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 has been translated into Spanish for distribution through a Latin American network for nanotechnology-in-society;
 - NanoFutures was featured in a CNS contribution to the AZ Science Center’s outreach project, Triple Play Days, in Jul 08.
 - Engagement activities, particularly the large scale and intensive National Citizens’ Technology Forum but also the small-scale intensive Science Cafes, create more informed citizens on important topics in nano-in-society;
 - CNS researchers have begun in YR 4 working with Emmy-award winning producer Leo Eaton as advisors for his documentary, “Future Tense,” currently in pre-production;
 - Interaction with NSE researchers, including courses, training activities, workshops, laboratory collaborations, and interventions resulted in identifiable changes in knowledge, identity, and practice. For example:

- After exposure to CNS-ASU through the DC Summer Session, environmental engineering doctoral student Troy Benn volunteered to become a PhD+ student with the Center, which supported a trip to Washington, DC to visit with Environmental Protection Agency officials to discuss how to fine-tune his ongoing research on nano-silver in the environment to EPA's potential regulatory needs.
- Assistant Professor and NSF Career Awardee Jonathan Posner (Mechanical Engineering) has been actively involved in extending his expertise and activities into the social and political aspects of nanotechnology. This past year he co-taught two courses with Bennett and Wetmore which introduce graduate student scientists and engineers to the social and political implications of science and technology, designated significant portions of his new grant proposals to educating graduate students in nanotechnology in society issues, and co-wrote (with Wetmore) an article for *NanoToday* on nanotechnology regulation.
- Troy Benn (with Bennett and Wetmore) developed a trailblazing public demonstration based on his work with nanosilver socks that not only engaged children and got them excited about science, but also sparked detailed conversations about the regulatory and environmental issues surrounding nanotechnology. This demonstration inspired a series of similar demonstrations by other graduate student scientists and engineers and was the impetus for planning a series of joint sessions and presentations with NISE Net at the September 09 S-NET conference.
- CNS-ASU has had other informational and educational exchanges with decision makers, including:
 - At the request of a former staff member of the President's Council of Advisors for Science and Technology, Selin (2008) distributed the report of the Medical Diagnostics workshop (Selin 2008) to current PCAST members;
 - Wetmore presented an overview of the Center's educational activities to an NSF workshop on "Centers, Universities, and the Scientific Innovation Ecology";
 - The organization of a briefing on Capitol Hill on nano and the public to 60+ people in collaboration with the Congressional Nanotechnology Caucus;
 - Guston and Scheufele served on the Nanotechnology Technology Advisory Group (nTAG) to the US Office of Science and Technology Policy, the White House.
 - Shapira and Porter presented a live seminar and webcast, organized by CNS-ASU in conjunction with the Woodrow Wilson International Center, on nano and innovation, to an audience of more than 70 people in DC and several hundred on the web.



Policies that predict and direct innovative research might seem to be a practical impossibility, says **David H. Guston**, but social sciences point to a solution.

In some respects, *innovation policy* can be regarded as an oxymoron, a figure of speech that combines two contradictory terms (ever take a *working vacation*?). A key tension is that policies come too late to affect the past that necessitated them, but too early to understand the future they are supposed to shape.



Anticipatory governance averts the inherent contradictions of innovation policy, helping to ensure that "innovation policy" doesn't become just another "jumbo shrimp."

Innovation Policy: Not Just a Jumbo Shrimp

In the August 21, 2008 *Nature* 454 Commentary, CNS director David Guston proposes **anticipatory governance** as the solution, an approach that retains an element of revolutionary thinking yet steers policy towards goals that are arrived at prudently and democratically.

Anticipatory governance:

- Encourages public engagement with the scientific enterprise during all stages of research and development, introducing discussions of values and ethics;
- Relies on scenario-based visions of the future for the anticipation, rather than the prediction, of socio-technological change;
- Fosters the integration of social science and humanistic scholarship with science and engineering research to raise attention to societal values in the conduct of laboratory research.

The Center for Nanotechnology in Society at Arizona State University is pioneering anticipatory governance through engagement, anticipation and integration activities with nanoscale scientists and engineers. While anticipatory governance is not widely nor uniformly practiced, it has important potential as a creative instrument of innovation policy.

(For information about how to access the entire article, visit <http://www.nature.com/nature/journal/v454/n7207/full/454940a.html>)

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





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A key notion about nanotechnology is that it is "convergent," i.e., that it brings together different sciences and technologies into a single field. This convergence has been expected to lead to an increase in *interdisciplinarity* in research at the nanoscale. Indeed, these days the commitment to interdisciplinary research is evident in science policy, education programs and training approaches.

CNS-ASU undertook to answer the question: what is the extent and nature of disciplinary diversity in nanoscale research? In a study

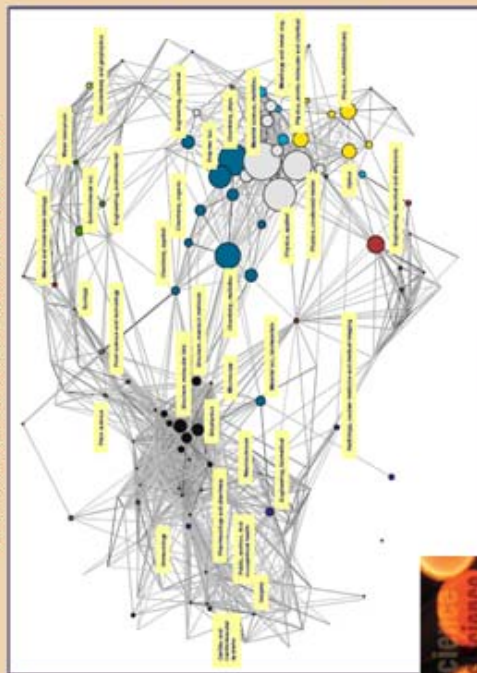
forthcoming in the *Journal of Nanoparticle Research*^{1*}, a science overlay mapping process is used to visualize

the position of nanotechnology research publications across scientific disciplines identified by using the Web of Science Subject Categories. The study also uses integration scores as another means to gauge interdisciplinarity.

*Published online 03/06/09:
<http://www.springerlink.com/ezprooxy1.lib.asu.edu/content/556n21hg4344110m?ip=14>
08a5e712134b4c9816251171e4497&pl=5

How Interdisciplinary is Nanotechnology?

"Map of Science" technique showing nano research areas active in 2005



The results suggest that nano exhibits a high degree of disciplinary diversity. Nano publications center on materials science, chemistry and physics. However, nano also significantly involves many other fields, including biomedical sciences, computer sciences, mathematics, environmental sciences, and engineering, among others. Most importantly, the study shows that nano publications cite, and therefore draw knowledge from, multiple disciplines. The preponderance of references in nano-related articles are to research outside the macro-discipline in which the article is published.

Thus, nanotechnology is, at this point in time, a multi-disciplinary collection of fields.

Although we do not know whether the component nano research fields are essentially converging, they do draw upon and integrate knowledge from a wide range of diverse fields. These findings suggest that attention should be given to facilitating the diffusion and absorption of knowledge across disparate areas. Authors and editors must assure that findings are presented to be as accessible as possible to researchers from other disciplines. Furthermore, we encourage exposure to, if not training in, "informetrics" tools and methods to better locate relevant research using leading databases.

Dr. Alan Porter, Technology Policy & Assessment Center, Georgia Institute of Technology, also Search Technology, Inc.

Dr. Jan Youtie, Manager of Policy Services, Enterprise Innovation Institute, Georgia Institute of Technology



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.



Nanotechnology Research Publication Trends, 1990 Through Mid-2008

Given the rapid growth and multidisciplinary nature of nanotechnology, the ability to map the boundaries of this emerging field is central to understanding its research paths and commercialization prospects. CNS-ASU partners at Georgia Institute of Technology's Program on Nanotechnology Research and Innovation Systems Assessment have developed a search strategy that enables them to create real-time databases of nanotechnology research activity in the U.S. and globally.

Nano research publications are identified using Science Citation Index (SCI) records from the Web of Science (WOS). Nano publications can then be represented as a percentage of overall SCI publications.

This nano research database has recently been updated to reflect nanotechnology publications from 1990 through June 2008.

Dr. Philip Shapira,
Professor of Public Policy,
Georgia Institute of Technology

Dr. Jan Youtie
Principal Research Associate, Economic Development Institute
Georgia Institute of Technology

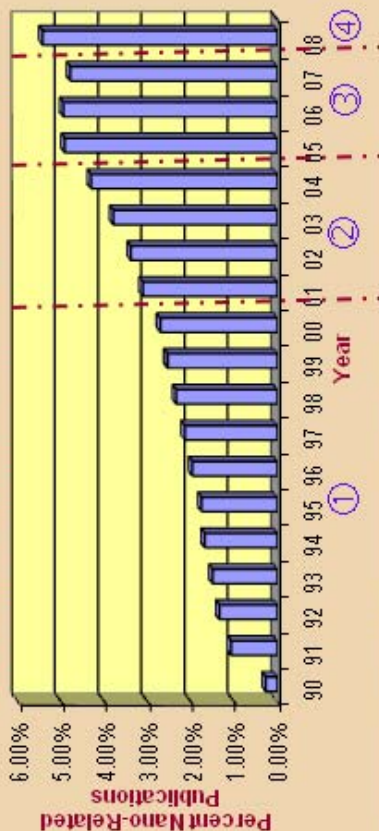
The data indicate that there has been growth in absolute annual publication numbers for every year from 1990 through mid-2008. However, there have been fluctuations in the rate of growth, with four observable periods: the first

period (1990-1996) represented a steadily increasing share of nano publications; the second period (2001-2005) saw a steep rise in share; the third period (2005-2007) showed a slight downturn in the rate of nano publication growth in 2006-2007; but the percentage is again larger in the fourth period (first half of 2008).



Similar updates to databases indicating nanotechnology publications in China show that China continues to gain on U.S. nanotechnology research and engineering activity.

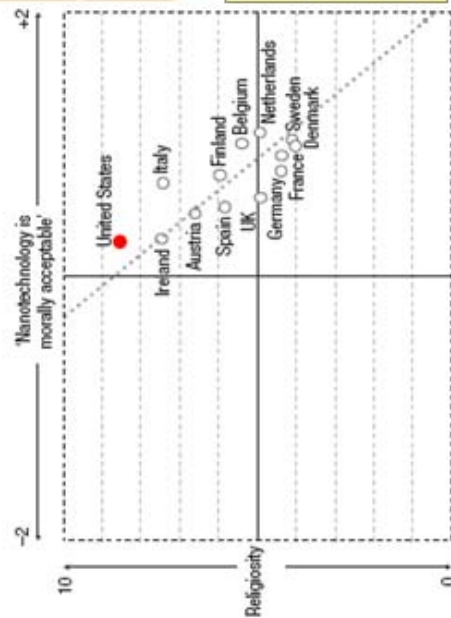
Growth of Nanotechnology Publications as a Share of All Science Citation Index Publications, 1990 Through Mid-2008





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The view that science and religion occupy separate and non-overlapping domains may be naïve when it comes to nanotechnology's capacity to alter the fundamentals of nature. According to a December 2008 CNS-ASU report published in *Nature Nanotechnology*, survey results from the U.S. and Europe show that—particularly in the U.S.—people with strong religious beliefs are significantly less likely to see nanotechnology as morally acceptable.



Dr. Elizabeth A. Corley, Associate Professor of Public Policy, Arizona State University College of Public Programs

Religious in U.S. Question the Moral Acceptability of Nanotechnology



Even after controlling for other country differences such as national research productivity, results show that religion remains one of the strongest predictors of whether or not nanotechnology is viewed as morally suspect. These results are consistent with recent research exposing broader negative public attitudes toward science when people filter their views through religion.

The findings have important implications for how scientists approach the emerging public dialogue concerning nanotechnology. Citizens are not looking only for information, but also for answers about the technology's social implications. In other words, they want to know not only what can be done, but what *should* be done. The more prepared scientists are to answer both questions, the more credible they will be perceived.

Relationship between strength of religious beliefs and moral acceptance of nanotechnology. Based on country-level data, we see a negative relationship between levels of religiosity (vertical axis) and beliefs that nanotechnology is morally acceptable (horizontal axis). More religious countries cluster together at the top end of the dotted regression line, and more secular countries at the bottom end.

More information about the article, first published online on 12.7.2008 as doi, at <http://www.nature.com/nano/journal/v09/n40/rental/shm/ano.2008.361.html>



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.

Dr. Dietram A. Scheufele, Professor of Life Sciences Communication, and Journalism & Mass Communication, University of Wisconsin, Madison



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InnovationSpace at Arizona State University is a transdisciplinary education and research lab that teaches students how to develop products that create market value while serving real societal needs and minimizing impacts on the environment. CNS-ASU sponsors three teams to visualize how futuristic nanotechnology product scenes can translate into usable products.

The *Tangent* product concept offers energy-efficient commuter transportation in congested urban environments. It is a foldable, portable personal transport device that can be plugged into any wall outlet for a quick charge. Due to its nano-photovoltaic skin, it is also solar-powered.



tangent
go on a



InnovationSpace Explores Nanotechnology for Affordable & Renewable Clean Energy

Students in the 2008-2009 program are exploring the promise of nanotechnology in solving energy problems. Teams of students from design, business and engineering are creating product concepts that use nanotechnology to improve access to affordable and renewable supplies of clean energy:



NOME

Focusing on how to assist victims of natural disaster where a significant amount of existing infrastructure and shelter has been destroyed, the *NOME* product concept offers shelter that regulates its interior temperature via solar energy. With its nano-photovoltaic exterior surface, low-weight batteries and structural material of varying flexibility, the *NOME* is air transportable and designed for simple and quick setup.





EVERWELL

The *Everwell* system improves the functions of daily life for people who live in remote rural areas. Specifically addressing the lack of clean, accessible water on the Navajo Indian reservation, where people must travel to communal wells every few days and transport water in large, heavy containers, the *Everwell* product concept can be used in the home to collect clean drinking water directly from the air. Nanotechnologies are utilized in its thermal material for water collection and temperature regulation, solar power, sensors for water level, and water filtration.



Prasad Boradkar, Associate Professor of Industrial Design,
College of Design, Arizona State University



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A new area of technological change has been emerging: the "converging technologies" of nanotechnology, biotechnology, information technologies, and cognitive science (NBIC).

Many observers believe that these new technologies could lead to radical and pervasive enhancements of human abilities. Both supporters and critics of NBIC technologies acknowledge that their continued development portends dramatic social and cultural challenges.

Stakeholders see a need for *informed citizen input* early in the process of developing such technologies. The National Citizens' Technology Forum (NCTF) was one such effort at public input on the topic of NBIC technologies used for human enhancement.



Dr. Michael D. Cobb,
Associate Professor of Political Science
North Carolina State University

Dr. Patrick Hamlett, Associate Professor of Science,
Technology & Society, and Political Science
North Carolina State University

Citizens' Report Addresses Nanotechnologies Used for Human Enhancement

The Center for Nanotechnology in Society at Arizona State University and its collaborators at North Carolina State University have released the final NCTF report (#R08-0002) discussing findings from reports of the six panels of citizens from across the nation who participated in the forum, as well as results from surveys of the participants before and after their deliberations.

The citizens' reports detail:

- concern over the effectiveness of regulations for NBIC technologies and support for developing international safety standards for them;
- desire for public information, including more public deliberative activities and K-12 education, about NBIC technologies;
- concern for the equitable distribution of NBIC technologies; and
- preference for *therapeutic* over *enhancement* research.

The surveys show:

- significant learning, and formation and changes of opinion among the participants;
- extensive hope and increased worry about new NBIC technologies; and
- opposition to a number of hypothetical enhancement technologies described in the background literature.

The report concludes that average citizens want to be involved in the technological decisions that shape their lives. After learning and deliberating about NBIC, citizens remained strongly supportive of research that could produce transformational technologies, provided they had access to reliable information about it and there was trustworthy oversight of its development. With access to accurate and varied sources of information, including experts' opinions, citizens are capable of generating thoughtful, informed and deliberative analyses that deserve the attention of decision-makers.



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.



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Dr. Jameson Wetmore, Assistant Professor,
School of Human Evolution and Social Change,
and The Center for Nanotechnology in Society,
Arizona State University

Ethics issues routinely arise in the practice of science and engineering as well as in the complex relationships among science, engineering, technology and society. To address this variety of issues and the many constituencies involved, science and engineering education must draw upon relevant instructional research and include work in practical and professional ethics.

Towards this end, the National Science Foundation has awarded a \$300K grant to Arizona State University for a three-year project to design and refine innovative instructional models that integrate microethical and macroethical issues into ethics education for graduate students in emerging areas of science and engineering.



Integrating Ethics into Graduate Science & Engineering Education

The project has four components: a Coordination Workshop; development of four instructional models for integrating micro- and macroethics in graduate science and engineering education; comprehensive project assessment; and a Results Dissemination workshop. "Microethics" refers to moral dilemmas and issues confronting individual researchers or practitioners. "Macroethics" refers to moral dilemmas and issues that collectively confront the scientific and engineering community, as well as broader societal issues in science and technology.



The grant builds upon previous CNS-ASU projects, including coursework, its summer experiential workshop in Washington D.C., and various laboratory engagements. The instructional models for the project include a standalone course on societal implications of science and technology, micro- and macroethics material embedded in a required science course, online instructional modules, and engagement of ethics in laboratory settings. The strengths and limitations of each model will be assessed for student outcomes in moral judgment, maturity and sensitivity to ethical issues, efficacy of learning, and influence of instructor-student communication on learning.

The project team includes Arizona State University faculty in ethics, science, engineering, science and technology studies, and communication, an Advisory Council of faculty from four other universities, and three consultants with national reputations in science and engineering ethics education.



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Dr. Erik Fisher, Assistant Research Professor,
The Center for Nanotechnology in Society at
Arizona State University

Policies in many nations are placing new pressures on emerging technologies to more explicitly align research and development activities with beneficial societal outcomes. However, neither the capacity of laboratories to respond to such pressures, nor the role that interdisciplinary collaborations between natural and human scientists may play in enhancing responsiveness, is well understood.

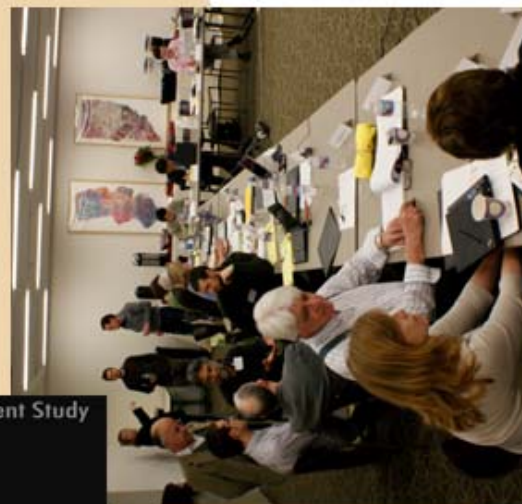
To address these limitations, the National Science Foundation has awarded CNS-ASU faculty Erik Fisher and David Guston a three-year, \$540K grant to support the **Socio-Technical Integration Research Project (STIR)**. STIR will study the extent to which collaborations between social and natural scientists working alongside one another in research laboratories may advance responsible innovation. The objectives of STIR are to:

- identify and compare external expectations for laboratories to engage in responsible innovation;
- assess and compare the responsiveness of laboratory practices to these pressures;
- investigate how interdisciplinary collaborations may assist in elucidating, enhancing or stimulating responsiveness.

NSF Grant Extends CNS-ASU Laboratory Integration Activities to Global Scale

STIR will train ten social science/humanities doctoral students—half in the United States and half in other countries—to each carry out paired laboratory studies based on a research method developed by Fisher, the project's principal investigator. These students will spend approximately four months working intimately with scientists and engineers in two laboratories, one in their home countries and one abroad. The paired studies will allow students to gain comparative understanding of the capacity of laboratories to inform and strengthen science-society linkages.

A kickoff workshop was held at Arizona State University in January, 2008. It consisted of three days of readings, exercises, and seminars by an international set of senior collaborators in order to train the interdisciplinary team of student investigators.



STIR Workshop 1:
Constructing Foundations



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.



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Dr. Jameson Wetmore, Assistant Professor,
School of Human Evolution and Social Change,
and The Center for Nanotechnology in Society,
Arizona State University

Dr. Susan Cozzens, Director,
Technology Policy and Assessment Center
Georgia Institute of Technology

On November 20-28, 2008, CNS-ASU
and the Technology Policy and
Assessment Center at Georgia Institute
of Technology co-sponsored a
workshop on **Nanotechnology, Equity
and Equality**. The goal of the workshop
was to foster a rich interchange that
would change how participants see the
ways emerging nanotechnologies are
likely to affect various groups in society
as well as the structure of societies and
economies, both national and global.

Workshop on Nanotechnology, Equity and Equality



The workshop brought together scholars and practitioners who approached the topic from several perspectives: those managing nanoscience and nanotechnology funding programs, scientists and engineers developing nanotechnologies in the laboratory or industrial settings, scholars of the social context of nanotechnology, and analysts from a variety of fields who have given thoughtful consideration to issues of equity/inequity and equality/ inequality, especially in the context of emerging technologies.

The papers that were presented at the workshop are being developed into the third installment of the *Yearbook of Nanotechnology in Society*.

Given what we currently know about nanotechnologies, what are the likely consequences for equality and fairness of the technologies on the near-term horizon? What features of nanoscience and nanotechnology enterprise are contributing to those consequences?

Given what we know about equality and fairness, what is the variety of possible consequences of nanotechnologies over the longer term? What can be done now to affect the probabilities of the various possibilities?



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.

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 forthcoming 2009).

In the first four 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 2009), which integrates those programs. The ability to extend and refine RTTA requires two related activities: improved connection among, or “ensemble-ization,” of the Center’s programs, and second, strengthen the guiding role of the strategic vision of anticipatory governance – and its component capacities of foresight, engagement, and integration – for the research programs. Below, we describe to 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.

Improving ensemble-ization. TRC 1 Equity and Responsibility and the new TRC 2, Urban Design, Materials, and Built Infrastructure will allow us to continue and improve our “end-to-end” activities through deeper and more organic integration among the research programs. We expect to improve integration in part through experience, as TRC 1 researchers have had the opportunity to commence their research activities while the rest of the Center was operating in an integration fashion, while the original (HIEB) TRC 2 began its work alongside the other research programs.

To ensure continued and improved integration, the Center hired in Oct 08 post-doctoral fellow Matthew Harsh specifically to learn, in reflexive fashion, the lessons of “end-to-end” from TRC 2 and convey them to and coordinate them for TRC 1. Harsh’s charge was to understand the E2E process – and the unique challenges and opportunities it presented – in order to facilitate institutional learning and provide tangible lessons for the TRC1 team that is starting its own E2E process. Harsh approached the task as a research project, conducting several semi-structured interviews between Oct 08 and Jan 09. As a new post-doc, Harsh was able to provide an outsider’s view of the data gathered, mostly from interviews with the two main E2E co-ordinators (Miller and Robert), but also meeting with the leaders of TRC 1 (Wetmore and Cozzens) and with the Center’s director (Guston).

Harsh found that when TRC 2 first began, it was a slightly uncoordinated “hodgepodge” of activities. The two main investigators (Robert at ASU and Hogle at Wisconsin) worked well together, but they were from different disciplines and were thus interested in different questions. Furthermore, one investigator saw the TRCs as under-resourced, in terms of researchers and students, compared to the RTTAs. The idea of carrying out an “End-to-End” (E2E) activity emerged as a way of clarifying one way that the TRCs could productively interact with the RTTAs.

TRC 1 saw the E2E process as a complete “real-time technology assessment” for a specific area of NSE. But E2E was an experiment. It asked: “Can CNS pull threads together from all its distinct research programs (i.e., the RTTAs) to tell a coherent story about some facet of emerging technologies?” The specific area of NSE that was chosen was nano-neuro science, or interactions between nanotechnologies and the brain. This choice itself was informed by research from across CNS. RTTA 1 showed a relative

explosion of research on nano-neuro technologies. RTTA 2 and 3 showed that publics were largely unaware of this research. They are also unaware of the ethical issues involved – issues that Robert was exploring as part of TRC 2.

The coordinators of E2E saw its ultimate as influencing the science, technology and innovation trajectory of the nano-neuro field. At the very least, they thought, the E2E work should feed back its findings to the relevant innovation communities. But they also identified structural difficulties in achieving these goals: CNS is funded as a research center, not an operational enterprise that carries out actual technology assessments. Nevertheless, there may be dissemination strategies that can support these goals.

The E2E team faced many challenges in its work, mostly related to a dearth of consistent labor and limited interactions with key personnel in the RTTAs. It was hard for already overcommitted researchers to find time to contribute to E2E. Holding researchers accountable was difficult because of the geographic spread of the institutions conducting the RTTAs. This challenge was partly overcome by having students work on E2E. A great deal of progress on the E2E agenda was made through a class run by Robert and Miller for three semesters at ASU where a mixed group of graduate and undergraduate students conducted research and prepared posters and papers relevant to E2E.

Interviewees felt that TRC 1 is already in a superior position for carrying out its E2E activities because the RTTAs have a substantial amount of work behind them and have already generated data relevant to TRC 1. One specific recommendation from TRC 2 for TRC 1, however, was not to run a class but instead to attract a group of two to four committed graduate students who would each focus on one sub-topic of TRC 1 and be charged with liaising with all the RTTAs to find research relevant to that sub-topic.

Harsh will continue with CNS in AY 09-10 and will thus be able to assist the new TRC 2 in its initial integrative activities as well. Moreover, changes in team leadership have emphasized substantive connections among research programs, e.g., new RTTA 1 co-leader Jose Lobo, an urban economist, and RTTA 3 co-leader Merlyna Lim, with training in architecture, bring substantive connections to interactions with the new urban TRC 2.

Strengthening the guiding role of anticipatory governance. Anticipatory governance emerged as a strategic vision from learning during the first year of the Center and thus exemplifies the application of reflexivity to the conceptual and operational evolution of CNS-ASU. Improving it requires its better articulation in the goals and practices of the research programs. Exploring anticipatory governance in greater academic and practical detail (Barben et al. 2008; Guston 2008; Karinen and Guston forthcoming 2009) has contributed to this goal, as has the Oct 08 Visioning Workshop in which participants from each RTTA and TRC convened to discuss future visions of anticipatory governance. Cross-center activities focused on anticipatory governance, e.g., a workshop proposal currently under consideration for the upcoming inaugural meeting of the Society for Studies of Nanoscience and Emerging Technologies – that includes relevant RTTA and TRC leaders as well as an explication of anticipatory governance – also contribute to this goal. The modest reconfiguring of RTTA 3 from “Deliberation and Participation” to “Anticipation and Deliberation” further signals the increased influence of the strategic vision. Arnim Wiek, the co-leader of new TRC 2, brings prior experience with and understanding of RTTA and anticipatory governance – particularly foresight, but also engagement – to his task.

(One should also note that the strategic vision cannot provide the totality of guidance for the RTTAs, which are designed to have independent research directions as well and are not, for both intellectual and management purposes, simply service research.)

As we plan for YR 5 of the Center, as well as the renewal period, anticipatory governance has enhanced the plans of 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 as a whole will expand integrative activities by replicating most components of its extensive partnership with the Biodesign Institute in a new relationship with the Ira A. Fulton School of Engineering and by implementing the STIR project, which reproduces RTTA 4'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.

As alluded to above, in Oct 08, CNS-ASU turned its methods on itself in a second example of reflexive inquiry and conducted a "visioning workshop" on the future of anticipatory governance (Selin 2008). In addition to generating provocative and entertaining scenarios of how the practice of anticipatory governance could play out in four different long-term futures, the workshop served a strategic planning function by focusing on what CNS-ASU might do to facilitate its capacity-building goals, regardless of the paths laid out by broader social forces. We asked ourselves: What actions can and should be taken to bring about the best possible manifestation of anticipatory governance? What are the implications of this workshop for our work? How can we apply this learning to work differently?

We grouped our answers to these questions under a number of "bumper-sticker" themes. Here we describe how each theme reflects previous activity and how new and evolving programs at CNS-ASU have been influenced by this thinking.

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 plan on hiring a part-time education coordinator for this among other purposes.
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. Yet CNS-ASU has not self-consciously and systematically addressed the creation of specific products for specific, and especially non-academic, audiences. Through the efforts of an education and outreach coordinator (to be hired in Aug 09) and the planned coordinator for private sector engagement (initially proposed in a supplement proposal submitted late Mar 09), CNS-ASU will develop more systematic and provocative ways of engaging specific audiences, particularly by 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.

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.
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 will continue 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 as well as a small number of international subcontracts. 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, and TRC 2’s focus on the role of NSE in the city. TRC 2 also 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.

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 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 some two hundred 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 School 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 major 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 doctoral student Troy Benn) and Jonathan Posner. The Center will attempt to expand its playing field of collaborative scientists and engineers by working with such groups at ASU as the National Center of Excellence in SMART Materials, which emphasizes engineering solutions to sustainability problems and the new NNIN node focused on the Arizona Institute for Nano-Electronics, led by Trevor Thornton, nationally through the full NNIN, 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. We thus present with the program accomplishments and plans below comments on how each program contributes to the agendas for anticipatory governance (anticipation, engagement, and integration) and “ensemble-ization,” and to education, training, and outreach. In addition to the formal research programs, this section concludes with a similarly structured discussion about CNS-ASU’s international research program and accomplishments.

RTTA 1: Research and Innovation Systems Analysis (RISA)

Personnel – faculty and senior participants

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

Barry Bozeman (Georgia, professor of public affairs)

Jennifer Cleary (Rutgers, senior project manager, Heldrich Center for Workforce Development)

Andrea Fernandez-Ribas (GA Tech, STIP research associate, Public Policy and Enterprise Innovation Institute)

Aaron Fichtner (Rutgers, research director, Heldrich Center for Workforce Development)

Erik Fisher (ASU, assistant research professor, CSPO)

Leela Hebbar (Rutgers, senior research assistant, Heldrich Center for Workforce Development)

Nils Newman (Intelligent Information Services Corporation, Atlanta)

Alan Porter (GA Tech, professor emeritus, ISYE and Public Policy) (GT Co-PI)

Juan Rogers (GA Tech, associate professor, Public Policy)

Carl Van Horn (Rutgers, professor and director, Public Policy and Heldrich Center for Workforce Development)

Jue Wang (Florida International U., assistant professor, Public Administration)

Jan Youtie (GA Tech, senior researcher, Enterprise Innovation Institute and adjunct associate professor of Public Policy)

Other Personnel – post-docs (1), graduate students (12), undergraduate students (4), visiting scholars (2)

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: characterizing nanotechnology and its drivers, nanoscience development and organization, nanotechnology enterprise, national nano developments and policy, and nano place and space. The smaller research themes are: RTTA 1/2: Public Value Mapping, which 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; and RTTA 1/3: Workforce Assessment, which identifies one such public value, an appropriately educated nano-workforce, and assesses the supply and demand characteristics for such a workforce in a regional labor market.

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 23 citations in Google Scholar (as of Mar 09) and 4 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 4, a major effort was successfully completed to update the database to capture publications in the 2006-2008 time period, which resulted in a total of 1.4 million articles including 508,000 in SCI for the period 1990-2008 (mid). In YR 4, we undertook pilot work to develop a new updated patent database using PatStat. This database is now successfully mounted and can be accessed. 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 to date in some 30 publications and working papers, including 20 in the current reporting period.

Selected findings from this research include:

- Nanoscience exhibits characteristics of multidisciplinary 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.

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 comparative database of nanotechnology research centers relative to other research centers and unaffiliated researchers, this study suggests that commercially-oriented activity is greater in nanotechnology research centers.
- The shift in nanotechnology research to active nanotechnology ([Subramanian](#), [Shapira](#) and [Youtie](#)). This study seeks to characterize active nanotechnology research publications, presents five active nanotechnology prototypes, and suggests societal implications of this shift.
- The engagement of social science with nanotechnology ([Shapira](#), [Youtie](#), [Porter](#)). 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.
- The role of women in nanotechnology patenting ([Meng](#)), draws on gender-assignment of inventors associated with 27,000 nanotechnology patents from 2002-2006 and comparison of characteristics such as team size, assignee type, and subject classification.
- Research 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 4, RTTA 1/1 researchers significantly enhanced international linkages with nanotechnology in society and research commercialization researchers at Manchester Business School (UK), Beijing Institute of Technology (China), and University of Sussex (UK) in part to prepare for YR 5 activities, which include plans to explore the initial aspects of creating a panel of large and small companies actively involved in nanotechnology-enabled product and materials development. Although panel creation will formally take place in years 6-10, RTTA 1/1 will conduct preliminary bibliometric analysis of large and small company publication and patenting activity in the 2006-2008 timeframe and put into place the protocols and organizational linkages (with European and Asian colleagues) to extend this panel globally. RTTA 1/1 will also continue to mine its global datasets and develop collaborations inside and outside of

CNS-ASU, and in new work will focus on multidisciplinary and coherence, highly creative research, knowledge transfer and commercialization, and trajectories of likely emerging nanotechnologies technologies warranting impact assessment.

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 a 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 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 3 of the *Yearbook* (Cozzens and Wetmore in preparation), and she has submitted a manuscript to *Health Affairs*.

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 has made a preliminary assessment of the public value failures involved 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.

Slade and Leech have used their data collection thus far to submit a research proposal for presentation at the 2009 American Public Health Association conference. They 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.

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 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 approximately 250 Congressional reports, 100 NSF program solicitations, and 800 corresponding NSF funded award summaries. This database will provide an empirical basis for understanding the public values content embedded in the policy context of NSE laboratories. Fisher and colleagues will thus track and map sequential changes in values across multiple levels of the science policy implementation process, and 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.

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

In YR 4, the RTTA 1/3 Workforce Assessment team performed two projects: first, case study research on the demand for workers with NSE skills in the biotechnology and pharmaceutical industries in the New Jersey area; and second, a study to identify and describe the development of NSE degree programs at US post-secondary institutions.

For 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. To date the team has completed case studies with two large pharmaceutical firms. A third case study is nearly complete. 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.

Preliminary findings from the case studies, which will be elaborated in a final report, 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 post-secondary degree programs across the US focused solely 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.

Once researchers identified degree programs, they conducted structured interviews with program administrators and reviewed 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. Preliminary results, to be elaborated in the final report ([Van Horn et al. 2009](#)), suggest that Associate's degrees are the most common degree type, followed by doctoral programs. Most degrees at the Bachelor's level and above are offered at institutions that perform high or very high levels of research according to the Carnegie classification system. Employer involvement, course content, and approach to the interdisciplinary aspects of NSE is highly variable among these programs. In addition, schools have myriad reasons for developing the programs, only some of which are tied to meeting the current and future skill needs of NSE employers.

Connection to Anticipation, Engagement, and/or Integration.

Anticipation:

- RTTA 1/1 “nano place and space” seeks to anticipate emerging clusters of nano R&D, or “nanodistricts,” in the US and has formed the basis for cluster-based prototypes and econometric modeling of research and commercialization factors.

- Porter's work in RTTA 1/1 uses publication-based connections to link through pathways of future technology development in specific application areas. One approach is to fit growth models to NSE publication trend data to project multi-path models of high potential developmental pathways. Another approach is to link basic research in the area of nano-enabled solar cells to technological developments required to achieve the market applications such as thin film cells, dye-sensitized solar cells, and flexible solar cells.
- Subramanian, Shapira and Youtie in RTTA 1/1 are attempting to explore whether forecasts of an emerging active nano-structures agenda has appeared in the literature.
- RTTA 1/3 assessment of nano-related post-secondary degree programs contributes to understanding the contours of the future nano workforce.
- A third example is our linkages with the scenarios/scenes work in RTTA 3. We have used our publication databases to help validate and provide evidence for these scenes.

Engagement:

- RTTA 1/1 researchers Shapira and Porter led the seminar, “Nanotechnology: Will it Drive a New Innovation Economy for the U.S.?” hosted by the Woodrow Wilson Center Project on Emerging Nanotechnologies and the Center for Nanotechnology in Society (CNS-ASU).
- RTTA 1/1 researchers participated in the National Nanotechnology Initiative’s (NNI) conference on Regional, State, and Local Initiatives in Nanotechnology, Mar/Apr 09 in Oklahoma City.

Integration:

- RTTA 1/1 researchers have made presentations at forums such as the Biotechnology Policy Forum at Georgia Tech.
- RTTA 1/1 researchers have held exploration meetings with individual scientists at GA Tech to explore opportunities for collaboration and for implementing a PhD+ there.

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

- RTTA 1/1 researcher Youtie and graduate students Meng and Kay participated in the TRC 1 Workshop on Nanotechnology, Equity, and Equality and are expecting to make three chapter contributions to the consequent *Yearbook*;
- RTTA 1/1 provided bibliometric analyses of publication activity for TRC 2: Human Identity, Enhancement and Biology, especially on nano and the brain;
- 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 for workforce assessment in nano-bio/pharma.
- RTTA 1/2 doctoral student Valdivia’s work is also central to TRC 1, and he is contributing a chapter to the *Yearbook*.
- RTTA 1/2 post-doc Slade’s work is important to TRC 1, and she is contributing a chapter to the *Yearbook*.
- RTTA 1/3 research on nano degree programs contributes to understandings about equity important for TRC 1.

Connection to Education, Training, and Outreach.

RTTA 1/1 training has occurred primarily through providing hands-on research opportunities to graduate and undergraduate research assistants. In addition to the core complement of students at GA Tech, RTTA 1/1 has opened up access to data to other student research at CNS. RTTA 1/2 research is conducted largely by a group of doctoral students and post-doctoral trainees led by Bozeman. Both programs are

characterized by extensive opportunities for publishing by students and trainees. RTTA 1/3 research on educational programs is being conducted significantly by Cleary, who is also a doctoral student and will turn that research into her dissertation.

RTTA 1/1 has engaged in extensive outreach activities, including presentations at:

- International Workshop on Nanotechnology, Society, and Policy, Manchester, UK, Sep 08;
- Nanotechnology and Society: Networks, Risk and Knowledge Sharing, University of Massachusetts, Amherst, Oct 08;
- OECD Working Party on Nanotechnology (WPN), Helsinki, Oct 08;
- Technology Transfer Society, Albany, NY, Oct 08;
- Workshop on Original Policy Research, Atlanta, Sep and Nov 08;
- Biotechnology and Public Policy Forum, Georgia Tech, Feb 09;
- Nano@Tech directors meeting, Feb 09;
- AAAS Annual Meeting, Chicago, Feb 09;.
- DRUID, Copenhagen, Jan 09 and Madrid, Feb 09;
- Beijing, Mar 09 and Tokyo Mar 09;
- Woodrow Wilson International Center/Project on Emerging Nanotechnologies; Washington, DC, Mar 09;
- NNI Workshop, Regional, State, and Local Initiatives in Nanotechnology, Apr 09.

RTTA 2: Public Opinion and Values (POV)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)

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

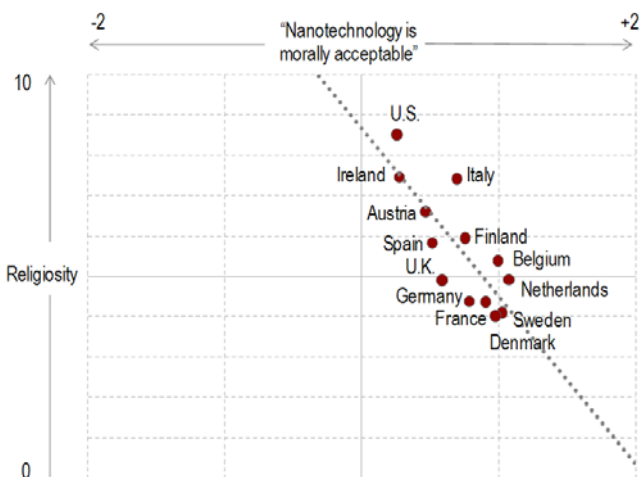
RTTA 2/1 completed its full-scale public opinion survey in July 2007. The survey was a CATI survey with a combined RDD and listed household sample conducted May – Jul 07 (N=1015; AAPOR RR-3 30.6%; margin of error, +/- 3%). Questions in the survey were specifically designed or chosen to enable comparisons 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. During YR 4, Scheufele and Corley continued to analyze and present and publish results from these data.

Scheufele and Corley worked with CNS-ASU doctoral students to examine individual-level relationships in the US between religiosity and agreement with the idea that “nanotechnology is morally acceptable.” They found a significant negative correlation between religiosity and agreement that nanotechnology is morally acceptable, and this relationship held even after even after potential mediators of the link between religious beliefs and attitudes towards nanotechnology, such as trust in scientists, knowledge about nanotechnology, or attention to science content in various media, were included as control variables.

Scheufele and Corley further explored whether this relationship was typical of western countries by comparing their US public opinion data results with Eurobarometer public opinions surveys. (The Eurobarometer 64.3 provides opinion data collected from 29 countries through face-to-face interviews of 29,193 Europeans aged 15 and above.) Specifically, they used Eurobarometer data from the twelve

countries that are the top public funders of European nanotechnology research. Respondents in the US were significantly less likely to agree that “nanotechnology is morally acceptable” than respondents in many European countries. Furthermore, at the country level, Scheufele and Corley observed a negative relationship between aggregate levels of religiosity (that is, the overall religious climate) in each country and aggregate beliefs that nanotechnology is morally acceptable (see figure below).

Correlation Between Religious Climates and Moral Support



These country-level analyses corroborate the link between religiosity and attitudes towards nanotechnology that Scheufele and Corley found in the individual-level US data. Furthermore, these results suggest that the religious climates in each country may play an important role in predicting levels of support for nanotechnology. Scheufele and Corley published the results of this analysis with several CNS-ASU graduate students (Scheufele et al. 2009).

In YR 4, RTTA 2/1 also collaborated with TRC 2/E2E to conduct a smaller-scale (N=556) national survey that explored questions of nanotechnology and human enhancement, in complement to the National Citizens’ Technology Forum on the same topic. Scheufele and Corley from RTTA 2, Miller and Hays from TRC 2, Guston and Cobb from RTTA 3, and Wetmore and Cozzens from TRC 1 were all involved in the construction of the survey, the results of which are described under TRC 2/E2E.

Early in YR 5, RTTA 2/1 will field its second large-scale national survey, and third overall. It will be akin in size to the first survey and return to questions that highlight longitudinal and comparative opportunities – particularly as they relate to public information about nanotechnology, support for regulatory scenarios, and market dynamics. Toward that end, the purposes of the survey are two-fold:

First, based insights from earlier RTTA 2 research (media analyses, previous surveys) and other RTTAs and TRCs (e.g., NCTFs, end-to-end), it will explore public attitudes toward specific nanotechnological applications rather than nanotechnologies in general. It will also include more fine-grained operationalizations of value systems and other predispositional factors that our previous CNS research has shown to influence information uptake among different publics. The survey will thus address both basic research questions surrounding attitude formation and more applied questions related to policy and regulatory proposals.

Second, the survey will set the stage for RTTA 2 work in the potential renewal period. This will include an assessment of the potentially very different public opinion dynamics that may be emerging for related

or subordinate areas of nano, such as nano-foods or synthetic biology. In this sense, the survey will also help RTTA 2 to map out the public nano landscape in a way that provides critical data as all RTTAs and TRCs go into the renewal period. RTTA 2 is also investigating, with RTTA 1/1, the possibility of obtaining a supplement to perform public opinion and scientists' opinion work in China.

Research Accomplishments and Plans, RTTA 2/2

RTTA 2/2 has conducted a variety of analyses of nanotechnologies in the media, including tracking over time broad themes of nano coverage and analyzing those themes across different strata of newspapers. Results are currently being written up and will be presented at the annual meeting of the Association for Education in Journalism & Mass Communication. RTTA 2 is also currently in the process of fielding the first of two large-scale experiments assessing media influence and attitude formation on nanotechnology. These experiments will deal with nano cleaners and the links between visual presentation of data and information processing about nanotechnology. The projects to date involve three faculty (Dunwoody, Brossard, and Scheufele) and 8 graduate students from the School of Journalism and Mass Communication at Wisconsin. One of the students is a paid participant in CNS-ASU, while the rest are working on a volunteer basis as part of the CNS nano working group at Wisconsin.

The goal of the RTTA 2/2 project is to explore the ways in which public narratives about nanotechnologies might influence lay audiences' perceptions of, the extent of learning about, and their judgment about the possible risks presented by nanotechnologies. Research focuses on Web narratives in part because of the growing salience of this channel for delivering science information. The group is conducting a series of experiments that manipulate a subset of factors that it hypothesizes may influence such dependent variables as: 1) knowledge gain; 2) personal risk judgment; and 3) the extent to which individuals choose to process information about nanotechnologies with care and effort.

Prominent among those predictive factors may be:

- Cognitive overload – the extent to which the rigors of negotiating an information channel trump learning. This is a continuing concern for the Internet, as individuals often confront novel home page designs and confusing technology.
- Interactivity – the extent to which a truly interactive message will influence learning. Much literature touts the ability of interactive messages to enhance learning; we would like to test that within a nano framework.
- Affect – the role of emotion in riveting readers' attention, getting them to invest in learning, and influencing such things as their risk judgments. "Affect" is the variable du jour for risk communication studies, in part because it has proven itself to be a powerful predictor of both knowledge gain and behavioral change. Since perception of the possible health risks of nano are barely on the radar screen among lay publics, we want to explore the extent to which narrative devices that generate emotional reactions will also influence those risk perceptions.
- Images – to what extent do visual images intended to represent nanotechnologies influence knowledge gain or, in some cases, emotional response? In contrast to their apparent power, images are a neglected area of study. Since the scale of NSE makes the employment of such images almost irresistible, we want to better understand how they convey meaning.

Research Accomplishments and Plans, RTTA 2/3

RTTA 2/3 completed its survey of the leading U.S. nano-scientists between May and June 2007. The survey was conducted by mail and it focused on collecting data from 363 leading U.S. nanotechnology scientists and engineers. The survey was administered by the University of Wisconsin Survey Center in three waves following Dillman's Tailored Design Method (Dillman, Smyth, & Christian 2008). The final response rate for the nano-scientist survey was 39.5 percent (AAPOR RR-3: 39.5%).

The sampling design was based on identifying the first authors and contact authors for the most highly cited, recent nanotechnology publications that were indexed in the ISI Web of Knowledge database. To rigorously establish which publications were actually within the multidisciplinary field of nanotechnology, Corley and Scheufele drew on RTTA 1's detailed description of its nanotechnology search terms (Porter, Youtie, Shapira, & Schoeneck, 2008). To develop the final sample for the scientist survey, RTTA 1 researchers delivered to Corley and Scheufele a database of 91,479 nanotechnology publications published between January 2005 and July 2006. Those data were filtered to remove non-U.S. affiliated scientists, graduate students, and first or contact authors who were cited fewer than five times in the publication database. This filtering process was used to ensure that the survey sample focused on the most highly-cited, most active, US-affiliated scientists in NSE. The final filtering process produced 1,022 names and this yielded 363 completed questionnaires.

The table below illustrates summary statistics of demographics, careers, and disciplines for the respondents.

Descriptive Statistics (N=363)

	Mean
<i>Demographic Variables</i>	
Age	44.94
Male (%)	85.59
<i>Career Variables</i>	
Year of Ph.D.	1991.21
Tenured (%)	46.28
Supported by Grants/Contracts (%)	80.17
<i>Field of Ph.D. Degree</i>	
Chemistry (%)	38.02
Physics (%)	22.31
Engineering (%)	16.53
Materials Science (%)	9.64
Biology (%)	6.06
Other (%)	7.44

Corley and Scheufele have continued analysis of these data since the completion of the survey. During YR 4, much of the analysis focused on exploring nano-scientists' perceptions about regulation. Even though there is a high degree of scientific uncertainty about NSE risks, many scholars have argued that policy-making cannot be placed on hold until risk assessments are complete (Faunce 2007; Kuzma 2007; O'Brien & Cummins 2008; Powell, Griffin, & Tai 2008). In the absence of risk assessment data, decision-makers may rely on scientists' input about risks and regulation to make policy decisions.

Corley and Scheufele thus used RTTA 2/3 data to explore the heuristics that the leading US nano-scientists use when they think about regulating nanotechnology. While they found that NSE researchers are more supportive of regulating nanotechnologies when they perceive higher levels of risks, they also

found – somewhat surprisingly – that NSE researchers did not change their beliefs about regulation based on perceived benefits. This finding contrasts with that of Scheufele and Lewenstein (2005), who found that the public tends to rely on perceptions of benefits, shaped by interpretive frames offered by mass media, when making nanotech policy decisions. They argued that these cognitive shortcuts are often provided by the way the media portrays the issue of nanotechnology (i.e., media framing) since media coverage of nanotechnology in the U.S. has been largely focused on the potential benefits of the field rather than the potential risks (Gaskell, Ten Eyck, Jackson, & Veltri, 2004). While Scheufele and Lewenstein (2005) found that the public relies on benefits perceptions, Corley and Scheufele found that nano-scientists rely on their risk perceptions. One possible explanation for this difference between the public’s and researchers’ perceptions about regulation is that the researchers might view regulations as protections for the public (and therefore focus on risks), while the public might think of regulations as restricting their access to nanotechnology benefits (and therefore focus on benefits).

Along with the public, nano-scientists are also members of the audience for different public discourses about emerging technologies. Iyengar (1991) showed that highly-involved audiences are often highly attentive to relevant media outlets and therefore more susceptible to heuristics and other cues provided by these news sources. This includes cues provided by elite and mass media about the how emerging technologies are being framed with respects to their risks and benefits. It could be argued, of course, that scientists have high levels of technical expertise about issues related to science and technology and are therefore less susceptible to potential media influences. In fact, in YR 4 Corley and Scheufele found that media perceptions did not impact nano-scientists’ perceptions about nanotechnology regulation even though media attention and perceptions do impact the public’s perceptions about regulation.

Corley and Scheufele also investigated for which areas of NSE application researchers thought current regulations were insufficient. The scientists were asked to report whether they believed that “current regulations were sufficient” or “new regulations were needed” (on a 5 point Likert-type scale) for eight different areas of NSE application: cosmetics, military, medicine, bioengineering, environment, computers, privacy, and other consumer products. Of these eight application areas, the scientists believed that the four for which current regulations were not sufficient were privacy, human enhancement, medicine, and the environment. On the other hand, military/defense and machines/computers were the two areas where the scientists were most likely to think that current regulations were sufficient. These differences are shown in the table below. Corley and Scheufele also found some gender and disciplinary differences among the nano-scientists. Male nano-scientists were less supportive of regulation than their female peers, and materials scientists were more supportive of regulation than scientists in other fields.

Corley and Scheufele have prepared a manuscript with doctoral student Qian Hu that summarizes these findings (Corley, Scheufele and Hu under review).

Summary Statistics for Adequacy of Existing Nanotechnology Regulations

“Thinking about applications of nanotechnology in each of the following areas, please indicate to which degree you think current regulations are sufficient or we need new regulations in order to address the new realities created by nanotechnology.”					
	<i>1= Current Regulations are Sufficient (%)</i>	<i>2 (%)</i>	<i>3 (%)</i>	<i>4 (%)</i>	<i>5=We Need New Regulations (%)</i>
Surveillance and	14.4	13.2	27.3	19.5	25.5

Privacy					
Human Enhancement	12.5	9.7	23.1	31.6	23.1
Medical Field	14.5	13.3	27.1	27.4	17.8
Environment and Energy	17.2	13.6	29.8	22.9	16.6
Military and Defense	19.1	13.7	29.5	21.6	16.1
Cosmetics	17.9	16.7	25.5	24.0	15.8
Machines and Computers	35.1	20.1	27.9	9.9	6.9

Connection to Anticipation, Engagement, and/or Integration.

Anticipation

- RTTA 2/1 activities help establish the background conditions of public understanding and values against which nanotechnologies will emerge, thus contributing to anticipation.
- RTTA 2/1 and 2/3 contribute to anticipation by exploring how the public's and scientists' perceptions of NSE might feed into the development and implementation of future regulation. This foresight function is particularly the case with the second national survey on human enhancement, which called on respondents to consider plausible future nanotechnological applications.

Engagement

- While not as intensive as other public engagement activities, the extensiveness of the public opinion survey is a contribution to engagement.
- RTTA 2/2 helps understand the influence of styles of inputs into engagement activities.

Integration

- RTTA 2/3 is a contribution to integration by providing empirical data and analyses about NSE researchers' understanding of the environment in which their research exists.

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

RTTA 2 has shared instruments and findings and has collaborated with researchers in a number of other RTTAs and TRCs.

- Working with TRC2 and the E2E project to develop a database of news media coverage of NSE research applying nanotechnology to neuroscience and a framework for analyzing this data.
- Working with TRC1, TRC2, RTTA 3, and the E2E project to develop a survey instrument for the next national survey of nanotechnology and developing the protocols for the Wisconsin Survey Center to field the survey in spring/summer 2008.
- Working with TRC 2 member Gregor Wolbring to refine a survey of disability-related organizations to understand their expectations regarding nanotechnologies.

Connection to Education, Training, and Outreach.

RTTA 2 currently has 5 doctoral students who are in the process of completing dissertations using various data sources collected with support from CNS-ASU.

RTTA 2/1 has engaged in extensive outreach activities, including presentations at:

- World Stem Cell Summit, Madison, WI;
- Rutgers University, Center for Mobile Communication Studies, New Brunswick, NJ;
- Keynote, NSF Workshop on the Future of Education in Materials, Washington, DC;
- NNI Risk Communication Workshop, Washington, DC;
- North Carolina State University, “Communicating Risks” workshop, Raleigh, NC;
- President's Symposium, Botanical Society of America, Vancouver, BC;
- Wisconsin Technology Council, La Crosse, WI;
- Thrive, Madison Region Economic Development Enterprise, Madison, WI;
- Food and Drug Law Institute, Washington, DC; and
- University of California-Santa Barbara, Center on Nanotechnology in Society, Santa Barbara, CA.

At Wisconsin, team co-leader Scheufele has also given presentations to:

- Wisconsin Alumni Association, “Wednesday Nite @ The Lab;”
- Materials Research Science and Engineering Center and Engineering Center on Nanostructured Interfaces, “Baldwin Nano Workshop for Journalists;”
- Science & Technology Studies Brown Bag Speaker Series; and
- Visualizing Science: A Research Colloquium.

CNS has also established links with other units on campus as part of the WID competition (see below) and a course on “‘Communicating Science’ for Scientists,” co taught by Dietram Scheufele and a faculty member in Bacteriology at UW. This course is currently being developed and will be taught this upcoming fall.

RTTA 2 members have also begun collaborations with members of CNS-UCSB on a potential expansion of our survey work to Asia.

Media coverage of RTTA 2 findings include: ABCnews.com, *BusinessWeek*, the *Los Angeles Times*, the *Wall Street Journal*, the *Capital Times*, *Wired*, and *SmallTimes* in the U.S. Internationally, RTTA 2 work has been covered in the *Daily Telegraph* and *The Times* (UK), *Die Welt* and *Frankfurter Allgemeine Zeitung* (Germany), *AFP* (France), and *COSMOS* magazine (Australia).

RTTA 3: Deliberation and Participation

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)

Phil Bernick (ASU, assistant professor, English)

Prasad Boradkar (ASU, associate professor, Design)

Thomas Duening (ASU, Director of Entrepreneurial Programs, School of Engineering)

Adelheid Fischer (ASU, Program Manager, College of Design)

Guillermo Foladori (University of Zacatecas, Professor)

David H. Guston (ASU, professor, political science and CSPO)

Mark Henderson (ASU, Professor of Engineering)

James Hershauer (ASU, Professor of Management, W.P. Carey School of Business)

Mookesh Patel (ASU, Associate professor of visual communication design, College of Design)

Cynthia Selin (ASU, assistant research professor, CSPO)

Philip White (ASU, Assistant Professor of Industrial Design, College of Design)

Post-docs (1); grad students (3); undergraduates (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 publics. 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 creates, vets, and disseminates plausible nanotechnological “scenes” for further development and deliberation by a variety of publics. YR 4 activities consisted of analyzing the first iteration of NanoFutures and designing and initiating the next version of NanoFutures, which will be focused on TRC 1 Equity and Responsibility.

In the last year, researchers have fully analyzed the results from the interactive website (<http://cns.asu.edu/nanofutures>), which was produced jointly by CNS and the San Francisco Exploratorium’s NISE Net project and served as both an outreach and data collection vehicle. The site was designed to enable diverse communities to investigate and discuss visions of plausible nano-enabled products related to human enhancement. These results have been documented in a manuscript ([Selin](#) and Hudson under review). Of particular concern was how new media could be employed to evoke widespread, discerning conversations about the social implications of nanotechnology. Results generated through the new media applications are presented along with a discussion of the successes and failures of the project.

Blogs, wikis, virtual worlds and interactive websites are all part of web 2.0, a transformation from the one-way communicative functionality of web 1.0. Such new media tools are designed around “an architecture of participation” (O’Reilly, 2004) and are populated and defined by user-generated content. CNS-ASU ventured into the world of web 2.0 with the NanoFutures project using a variety of new media applications in attempts to scale up public engagement activities addressing nanotechnology in a manner both interactive and transparent. CNS-ASU treats scenarios as a vehicle for articulating future-technology-in-use in an accessible narrative to allow a grounded, though imaginative, display of complex socio-technical products and systems and the social choices they present. We were interested in exploring whether and how new media applications might embed the CNS scenarios to foster broad dialogue and deliberation.

The research project began by crafting visions of nano-enabled future products, drawn from published technical and popular literature. Next, the product “scenes” were vetted for plausibility through focus groups with scientists that possessed the relevant expertise. The vetting was completed with a bibliometric analysis of key terms produced in the focus groups (Selin 2009). Plausibility is important due to the proliferation of extreme and incredible futures circulating about nanotechnology. Following Nordmann (2007, 394), we believe it prudent not to “squander” ethical concern “on incredible futures” but to focus on plausible technological products. By “plausible” we refer primarily to the technical as in: Is this product technically plausible to invent and build (Selin forthcoming)? While technical plausibility is established through the vetting process, the social, political, economic, and ethical determinants of plausibility are assessed by a broader range of stakeholders in the deliberative, online portion of the NanoFutures project.

We designed the website to entice and provoke users to respond to and interact with the scenes in a meaningful way. Participants critiqued scenes on a blog that functions as both a discussion forum (for ease of use) and a wiki application (to compare diverse intelligence from users). In this way, NanoFutures attempted to generate what we’ve called open source scenaric thinking in the mode of “extended peer review” for “post-normal science” as articulated by Funtowicz and Ravetz (1990).

Extending participation and deliberation through open source mechanisms is a significant step beyond traditional scenario methodologies. Whereas traditional scenarios are created with attention to plot, storyline and colorful actors that weave together the social and the technical, our “naïve” product descriptions are meant as scenes to set that stage. The scenes – descriptions stripped of elaborate social description – are a starting point for dialog among various stakeholders about the implications of plausible.

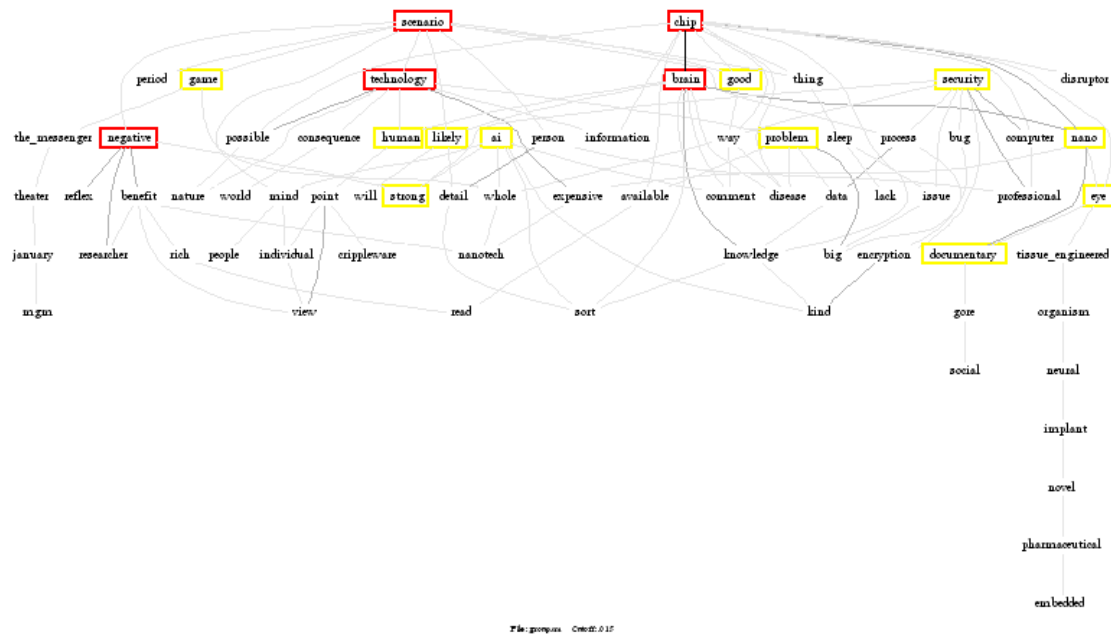
We launched the website in May 08 and retrieved the 78 comments on the RANT blog portion of the website on July 2008. As we will show, this level of participation yielded some rich initial responses and a satisfactory data base for beginning to explore novel approaches to content analysis. Nevertheless, and despite significant effort to promote the web site (including 846 targeted e-mail invitations to NSE researchers and solicitations to a variety of membership and community-based organizations reaching potentially thousands more), the number of responses was obviously disappointing with regards to our goal of creating a self-sustaining dialogue.

No standards of practice exist for analyzing blog discussions qualitatively by theme. Other researchers have developed formulas for identifying prominent bloggers (Herring et al 2005; Nakajima et al 2005), assessing the style of argumentation in weblog conversations (de Moor and Efimova 2004), and documenting the connectivity of blogs (Herring et al 2005). While traditional social science methods for analyzing text appear to be appropriate, we did not want, at this early stage, to commit to a particular approach but rather to explore alternatives. As well, and in light of the CNS commitment to foster

reflexivity among stakeholders, we wanted to develop visualization techniques to help communicate what we were learning about what was being said in the blogs. With this in mind we explored a number of different innovative methods for analyzing and visualizing the blog data using; 1) a coding software; 2) tag clouds; 3) a qualitative coding scheme; before 4) conducting a more traditional textual analysis.

In order to achieve a simplified view of the richness of the discussions, we began with the two visualization techniques. Crawdad textual analysis software promised a means to quantitatively grasp the relationship among different reoccurring concepts in a large body of text and had the capacity to compare, classify, sequence and browse text. The “Visualizer” feature yielded the most useful result by identifying the most influential words in the text and constructing a concept map. As figure 1 illustrates, the Visualizer’s coherence measure was not “smart” enough to give any greater meaning to the text; it also did not provide information on frequency of the influential words.

Figure 1: Crawdad Visualizer for Living with a Brain Chip



These shortcomings lead us to experiment with tag clouds, a technique to represent the most frequent terms by size thus enable the analyst to get a quick grasp of the gist of the text. The tag clouds are effective at capturing the predominant themes and their relative importance (displayed larger and bolder) and quickly shows the types of discussions that occurred around each scene. For instance, “technology” can be considered a main actor in Tissue Engineering (Figure 2), whereas “DNA”, “System” and “Government” are the main actors in the Automated Sewer Surveillance scene (Figure 3)—potentially important distinctions in terms of how notions of accountability might evolve. We also noted that some scenes brought forth words related to the ambiguity of the reality status of the scene, whereas others did not. To preserve such ambiguity we did not clean the text for “really”, “question”, “probably” and “early”- words that might normally be considered common and eliminated, because such terms highlight uncertainty, indeterminacy and indicate the degree to which plausibility is a concern.

Figure 2: Tissue Engineering Tag Cloud**Figure 3: Automatic Sewer Surveillance Tag Cloud**

While the Tag Clouds offered a quick, instructive sketch of issues raised by the users, they lacked analytical detail. To more closely identify and scrutinize the themes raised in the blog discussions, we conducted a multi-tiered coding process. The radar graphs below indicate the relative distribution of attention to varied themes for Bionic Eyes (Figure 4) and Living with a Brain Chip (Figure 5). The former highlights the fact that conversations did not focus on the technological workings of the bionic eyes, while the latter highlights the broader discussion (with the exception of laws/regulation). Again, these differences hint at how different types of technologies and different types of scenes stimulate different areas of concern and, thus, potential intervention. While our analysis of the data gathered is essentially complete, we continue to explore the implications of this first version for subsequent data collection.

Figure 4: Bionic Eyes Radar

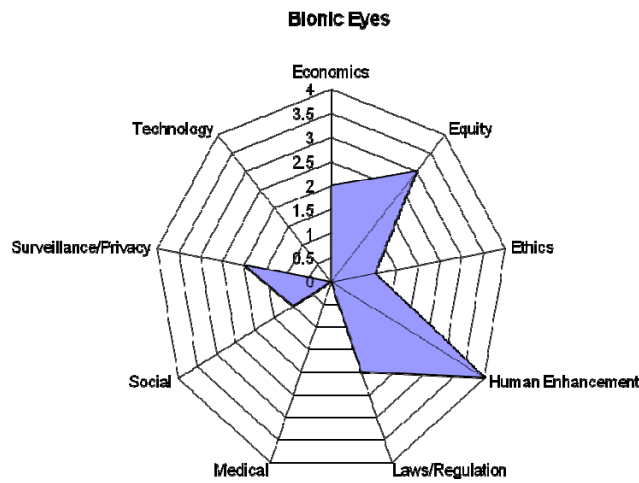
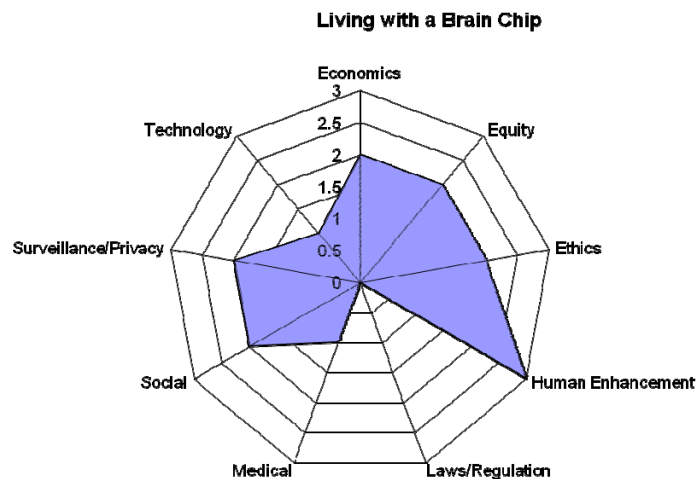


Figure 5: Living with a Brain Chip Radar



Using more traditional textual analysis of the postings, [Selin](#) and Hudson (under review) uncovered a range of compelling societal issues.

The Disease Detector scene describes a technology that tracks a patient’s protein levels to monitor variations that imply illness or disease before symptoms appear. Conversations for this scene were oriented towards issues of equity. One user said: “Presumably this will be very expensive, at least at first, so most people won’t have access to it, certainly poor people won’t. Won’t this mean a rapid exacerbation of health inequities?” Another user wondered: “Won’t a lot of people be treated unnecessarily, since diseases detected at such an early stage might or might not actually develop into illnesses, the body manages to stave off lots of diseases without outside help. So what’s the potential here for a huge upsurge in iatrogenic illness, i.e., illness caused by the treatments themselves?”

While such comments highlight a surveillance function of NanoFutures – providing an early perspective on what ethical, legal and social issues people may perceive in emerging nanotechnologies, it also provides a space to reflect on the role of technology in society. Many entries raised the complex interplay among values, politics and metaphysics and the mutual shaping of technology and society: “This technology begins to break the plane between what is human and what is mechanical. Should we be gradually building ourselves into cyborgs? My inclination is that most people would object to the full integration of human machinery and technological machinery; however, it remains unclear at precisely what point altering human functions becomes morally unacceptable.”

Another user noted the complexity of interdependencies among technological systems: “Convergent technologies to enhance human performance will combine into a system, either well or poorly. So a future generation might have the option of combining bionic eyes, enhanced tissue-engineered organisms, neural implants, novel pharmaceuticals, clothing with embedded smart sensors, genetic enhancements, etc. How will we monitor the interaction among these technologies, as they develop?”

Dual use was a common theme in the blog posts. The technologies in the scenes were considered to have the potential to be used in dramatically different contexts. For instance, participants discussed how tissues engineered for organ replacement could be transformed to edible meat, or DNA in sewers could be used for tracking biological contaminants, criminals, or illegal immigrants. One user wrote: “There's nothing wrong with the technology itself, in my opinion. However, it does open the door to interesting abuse - extrapolate towards the movie GATTACA, perhaps, where only 'genetically healthy' people can receive extended training due to the risks ...”

This use of science fiction was not dominant in the forum as a means to relate to the future, but analogy was. “Given the demonstrations of hacking pacemakers, what security protects the brain chip from malicious use?” A user commenting on the presymptomatic disease detector noted, “The current furor over genetic testing for disease proclivities being potentially made available or required for medical insurance is just the starting point of this. The capability discussed here is just an extension.” So while the scenes are framed in the future tense, most users readily showed how their thinking is conditioned by already existing technologies and contemporary social effects and responses.

Rather than in utopic or dystopic future social structures the future technologies presented in the scenes were also regularly understood as becoming embedded into current social structures. Indicative of this is the entry: “Our prison system is already so corrupt I only see this going very wrong.” Some users argued that our current social ills require consideration of new technologies: “Considering our negligence in addressing environmental challenges and increased resource scarcity ... pressure to amend our physiology and that of other species may be a course of action we have little choice to pursue without considering longer term socioeconomic, medical, and environmental consequences. Now is the time to prepare our society accordingly.”

There was debate about the timing of the intervention: when is the right time in the innovation cycle to debate social and ethical issues? Some users were bold: “Just do it... make it happen! Prove the capability, and then we can argue the ethics and other issues”. Others in the same vein conditioned their view: “I feel we should first develop this technology to save lives & enhance lives rather than worry about insurance/price increases etc.” In a sort of cost/benefit analysis, the user implicitly states that the security, equity and privacy issues are secondary to the benefit of saving lives. Clear disagreement came from another user, who covered many different issues in their comment including equity, economics, affordability, and regulation, and then responded to the above comment by saying: “The key, actually, will be to address these questions early on--NOT, as the first comment says, after the capability has been proved...” This exchange from a methodological perspective, also indicates that users were in

conversation with each other, rather than just asserting their views without attention to the collective dialog on the blog.

We emphasize that these posts—and the project at large—were not attempts to get the future right. Instead, CNS is exploring the idea that scenaric thinking, here implemented through new media, can help build a broader social capacity for anticipation. This exercise in anticipatory governance invited users to reflect on values, the role of technology in society, and some of the stubborn problems—and solutions—proposed by new technologies.

The next iteration of NanoFutures will follow the same structure of activities:

1. *Scene Development*: construct short vignettes of possible nanotechnological futures (which we call “scenes”) relevant to CNS-ASU activities.
2. *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;
3. *Evaluation and Elaboration*: is evaluate the developed and vetted scenes with targeted audiences and consequently elaborate them into scenarios; and
4. *Outreach and Use*: use the vetted scenes and elaborated scenarios in other CNS-ASU activities, e.g., InnovationSpace, deliberative engagements, NISE Net, etc.

The next NanoFutures topic of inquiry Energy, Equity and Nanotechnology follows TRC 1 and corresponds to the thematic focus of the current year’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. Technical scenes have been carefully selected to fall across a range of 1) applications including generation, transmission and distribution; 2) long and short time horizons; 3) fuel sources, i.e. solar, wind, coal, nuclear, and bio. CNS-ASU is also particularly interested in those technological systems that raise some societal dilemmas. Just like NanoFutures v. 1, this program seeks to explore the values informing technological priority setting and choice.

Vetting for NanoFutures v. 2 will evolve from v. 1 by supporting more targeted and more diverse participation. We will secure active participation of ASU scientists and engineers (through CSPO’s Energy and Society program, the Tubes in the Desert project, and the Arizona Institute for Renewable Energy). Additional vetting participants have already been precisely identified through bibliometric searches of relevant researchers by Georgia Tech, and the vetting protocol will be improved through a more systematic inquiry into plausibility and a better capturing of “data” through the use of an online survey.

At reporting time in Sp 09, we have identified 8 key nano-enabled energy products and developed scenes that capture the critical societal issues surrounding them. Keywords were generated from the scenes and Georgia Tech has produced lists of authors who have published in the scientific literature in the technical area described in each scene. In Apr 09, these individuals will be invited to take a survey that investigates the technical plausibility of the scene, based on their specific area of expertise. In Jun 09, the survey will be analyzed and the scenes will be reinterpreted. (If the industry liaison Postdoc is hired, a special vetting session on commercial plausibility will be conducted.) In Fa 09, we will design research-based engagements and outreach involving diverse stakeholders in collaboration with TRC 1. Attention will be paid to the capitalizing on the successes of NanoFutures v. 1 and correcting for some of the obstacles. The YR 5 deliberation activities, both virtual and face-to-face, will intensively focus on aligning with already existing communities with a stake in energy futures and will connect with policy-oriented conversations in order to enable a more sustaining dialogue. Learning from the experiences with the first iteration of

NanoFutures, this more targeted approach to encouraging participation will seek to embed the dialogue in established communities, extending their scope of concern to include nanotechnology, equity and energy.

In addition, greater attention will be on supporting ongoing participation through systematic follow-up on emergent opportunities for engagement with relevant stakeholders.

RTTA 3/2 InnovationSpace

InnovationSpace is an entrepreneurial joint venture among the College of Design, Ira A. Fulton School 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 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.

Since 2006, CNS-ASU has supported the work of three transdisciplinary teams annually (total of 12 students). CNS-ASU has partnered with InnovationSpace to investigate nano-based technologies that ensure the freedom, privacy and security of citizens (AY 06-07) and to visualize socially beneficial opportunities for nanotechnology in the areas of human health and enhancement (AY 07-08). In AY 08-09, CNS-ASU charged student teams to develop product concepts that utilize nano-enhanced solutions for ensuring equitable access to clean energy.

InnovationSpace is led by Boradkar, and CNS researchers Guston, Selin, Wetmore, Bennett, Robert, and Wolbring each had significant interaction with the students. The three inventions this year were: 1) a personal transportation device for environmentally conscious urban commuters whose paper-thin nano-enabled batteries can be easily recharged through an electrical outlet or in full sunlight; 2) a nano-enhanced device that captures and purifies water from humid air for use by rural households that lack easy access to drinking water supplies; 3) a portable shelter for natural disaster victims that uses nano-enabled photovoltaic material for capturing solar energy. Outcomes from InnovationSpace include not only spectacularly detailed documentation of the student-led innovation process known as Innovation Proposals. These include summaries of user research, product renderings, engineering specifications, branding and communication strategies, ecological impact assessments and business plans.

Student teams also submit invention disclosures – three from the AY 06-07 class in the last reporting year (although not reported last year) and three from the AY 07-08 class in this reporting year. In 2009 Boradkar and IS program manager Fischer, together with Guston and Selin, submitted a grant to the Kauffman Foundation-funded Pathways to Entrepreneurship grant program at ASU. The project will review the work that has been produced during the three-year collaboration between CNS-ASU and InnovationSpace and identify three commercially promising product concepts. Under the direction of faculty from InnovationSpace, CNS-ASU and ASU's Technology Venture Services Group, graduate students enrolled in the New Product Innovation (NPI) concentration will lay the groundwork for commercialization. (The NPI concentration is a new academic offering in the Master of Science in Design program in the College of Design.) This includes carrying out additional user and market research, building design and engineering prototypes, conducting usability testing and establishing go-to-market strategies.

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). This activity is winding down.

RTTA 3/4 National Citizens’ Technology Forum.

In Mar 08, CNS-ASU held its National Citizens’ Technology Forum (NCTF) 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. In this section, we discuss additional findings and follow-on activities that have occurred in YR 4.

The general portrait of deliberation that emerged from the NCTF was one that strongly supports the contention that lay citizens are capable of deliberating in a thoughtful way that can contribute to public discourse and even to policy decisions – with a few caveats. Overall, the participants showed significant mastery of the technical aspects of NBIC developments, and they were able to engage content experts in active, informed, and critical questioning (as attested to by the experts themselves).

Of particular significance, the deliberating groups appear to have escaped reputational cascades and social effects, two affective and cognitive pathologies very well documented in small group decision making. Both pathologies can lead participants to sometimes endorse recommendations they perceive as holding majority group support even though they, individually, object. Their endorsement, thus, may reflect the pressures the participants may have felt to “go along” rather than stand aside from the majority, rather than their true feelings as individuals. Pre- and post-test examination found that neither pathology played a significant role, and that individual support for group recommendations was quite high.

The general portrait of attitudes toward nanotechnologies for human enhancement that emerged from the NCTF was one that strongly suggests that popular unease with enhancement technologies exists alongside of hope for nano-enabled therapies.

In earlier deliberative exercises, a general tendency to support the development of the technology in question has been coupled with concerns about effective public monitoring of unexpected negative consequences across a variety of technologies. This tendency may have been augmented in the NCTF on human enhancement because of the highly future-oriented, even speculative, character of the technologies examined. The participants had no personal experience with the technologies because they do not yet exist, and this ephemeral nature may enhance the desire both to see the technologies deployed and that they are carefully monitored by appropriate authorities.

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 are contributing to data analysis and publication. The Wisconsin team has been particularly productive, in part because of the earlier consensus conference conducted there allows for comparative analysis at one site. The following brief paragraphs detail those activities.

In a chapter in preparation for the *Yearbook of Nanotechnology in Society, Volume III: Nanotechnology, Equity and Equality*, GA Tech doctoral student Ravtosh Bal (in preparation, 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 concern underlying

policy formulation in the area of nanotechnology for human enhancement. She finds the issues of equity and fairness were important across all sites.

In a paper submitted to *Science and Public Policy*, Berkeley graduate students Philbrick and Barandiaran (under review) 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 submitted to *Public Understanding of Science*, Delborne and colleagues (Delborne et al under review) 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 paper also submitted to *Public Understanding of Science*, Kleinman and colleagues (Kleinman et al. under review) perform a comparative analysis of 2005 nanotechnology consensus conference in Madison, WI and 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.

In one working paper, Wisconsin researcher Powell and colleagues (Powell et al. 2009) explore various conceptualizations of ideal participants for engagement exercises such as the NCTF. They then uses 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.

In a second working paper, Powell and colleagues (Powell et al. 2009) draw 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.

In addition to these efforts, the NCTF was featured in presentations by Guston and Cobb at the “Nano and the Public: Data for Decision Makers” briefing for the Congressional Nanotechnology Caucus organized by Guston in Mar 09.

Connection to Anticipation, Engagement, and/or Integration.

RTTA 3/1 Scenario Development, through the NanoFutures project, is the primary anticipatory activity at CNS. InnovationSpace also contributes to the goal of anticipation by imagining and then rendering as concrete as possible – in the form of disclosable inventions – visions of nanotechnologies. Like the RTTA 2 surveys but in a more intensive fashion, the RTTA 3/4 NCTF contributes to anticipation by disseminating an empirical understanding of what citizens understand, feel, and expect of nanotechnologies in preparation for any particular ones that might develop.

RTTA 3/4 NCTF is the primary engagement activity of the Center, but RTTA 3/1 and 3/2 have important engagement activities. NanoFutures reached out to involve many different publics, including a

generalized one of ASU alumni/ae, to involve them in thinking about nanotechnologies and this year has made efforts to publicize the Medical Diagnostics workshop. InnovationSpace has, as part of its research methodology, intensive contact with potential users of its technologies. Those users this year include Native Americans living on reservations, disaster victims, and urban commuters.

RTTA 3/1 Scenario Development contributes to integration through the necessary collaboration of social scientists and NSE researchers in the vetting process of the scenes. A process underway, the NanoFutures project investigating nanotechnologies' role in energy has made contact with engineers at ASU working with energy and has compiled large lists of NSE experts to consult with in the vetting process.

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

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

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 3/2 worked with TRC 1 to ensure that equity and responsibility themes were well understood and integrated into the InnovationSpace team projects.

Connection to Education, Training, and Outreach.

Research in RTTA 3 has been presented to a variety of public, private sector, technical and policy audiences. Highlights and more detail are presented in the Outreach and Publications sections.

RTTA 3/4 NCTF has generated data in the form of video, audio, web-based transcripts, forum notes, and participant observer material that is being mined by graduate students across the participating sites and beyond.

RTTA 3/1 co-authored with graduate student Panjwani, Greenwood and Wang a journal article about modeling social values related to surveillance technologies.

RTTA 3/1 worked closely with undergraduate intern Hudson to analyze the NanoFutures data and develop a journal article which has been submitted to *Science Communication*.

RTTA 4: Reflexivity and Integration

Personnel – faculty and senior participants

Erik Fisher, RTTA 4 leader (ASU, assistant research professor, CSPO)

Elizabeth Corley, RTTA 4 co-leader (ASU, associate professor, Public Affairs)

Ira Bennett (ASU, assistant research professor, CSPO)

Kevin Corley (ASU, assistant professor, Carey School of Business)

Dave Conz (ASU, assistant research professor and lecturer, CSPO and Bachelor of Interdisciplinary Studies)

Cynthia Selin (ASU, assistant research professor, CSPO)

Jameson Wetmore (ASU, assistant professor, School of Human Evolution and Social Change)

Personnel – graduate students (14), undergraduate students (2)

Goals. RTTA 4 attempts to implement the integrative agenda of anticipatory governance through activities that CNS-ASU performs with NSE researchers. It seeks to document the influence of CNS-ASU research and engagement activities on the knowledge, values, and choices of NSE researchers and others, and to track the participation of natural scientists and engineers in CNS-ASU activities. Projects under the RTTA 4 rubric include: annual interviews with collaborating NSE researchers, exit interviews with graduating affiliates, and qualitative evaluations of co-curricular and workshop activities involving integration and reflexivity as key goals; laboratory studies and engagements, including the (separately funded) STIR project, the Photon project, the Tubes in the Desert project, the (separately funded) Ethics in the Lab project, and scenario development projects; co-curricular activities including the DC Summer Session; and a small number of other projects about the role of societal aspects of nanotechnologies and reflexive knowledge more generally.

Research Accomplishments and Plans.

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 May/June. 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 and Sp 08. The Sp 09 interviews are currently being scheduled.

Findings from the Sp 07 include reports of higher familiarity and involvement with CNS-ASU among senior faculty and graduate students, but less on both dimensions among junior faculty and post-doctoral trainees. For both senior faculty and graduate students, the high levels of familiarity and involvement are associated with noted changes in knowledge and emergent changes in practice. Findings from Sp 08 indicate that some senior faculty and graduate researchers in the Biodesign Institute perceive CNS-ASU as a potential influence on the thinking that goes in to research and as a potential value provider. Reports suggest that CNS-ASU is becoming embedded in some parts of the Biodesign Institute in the sense that it is becoming part of the institutional background.

Interviews are also conducted before and after co-curricular activities like the DC Summer Session organized for NSE graduate students in the Biodesign Institute and the Ira A. Fulton School of Engineering in Jun 08. These interviews indicate students involved become more comfortable and sophisticated in talking about the societal aspects of their work after the activity.

Dynamic Network Analysis of Engagement: We are using dynamic network analysis (DNA) in the Visone software package to study the outreach and retention efforts of CNS-ASU with undergraduate, graduate, and faculty scientists and engineers. DNA provides a moving model showing how and when actors enter, engage, persist, and exit the network. For this purpose, we classify types of CNS-ASU activities into four categories:

Courses: Graduate and undergraduate, individual and team-taught

Co-curricular Activities: Advising, PhD+, Special trips (International Perspectives in Nanotechnology in Society; Washington, DC Policy [dis]Orientation)

Collegial Activities: Colloquia, Symposia, Lab Studies, Workshops

Public Engagement: Science Cafes, National Citizen's Technology Forum, NanoDays

Static excerpts of the nets are presented here to illustrate preliminary analysis. While the full model includes science, technology, engineering and mathematics (STEM) undergraduates, graduates, and faculty, for legibility and simplicity we focus here on STEM graduate students.

Figures 1 – 4 show graduate student involvement with CNS-ASU by category for each year (each year lasts through the end of the spring semester, roughly mid-May). Students persisting from at least one previous year are marked with an asterisk (*).

Please note: Year 1 is shorter than other years due to the mid-year inception of CNS in 2006 and Year 4 is right censored as activities are ongoing at the time of this writing.

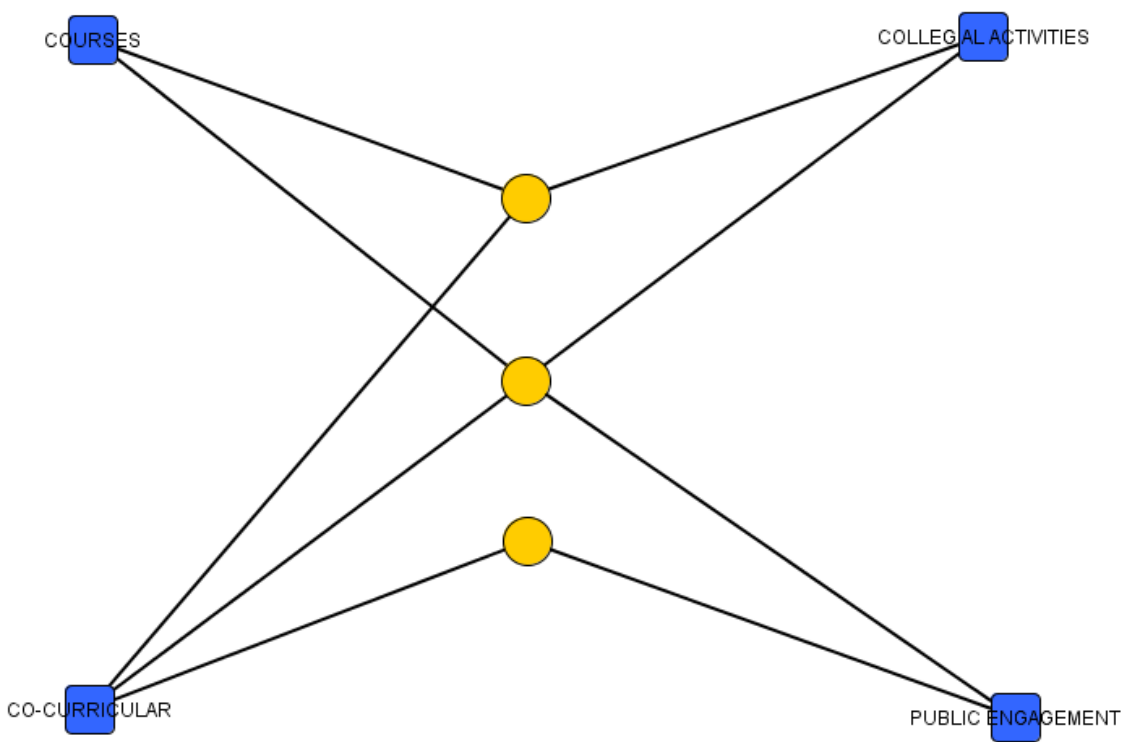


Figure 1. Year 1 STEM Graduate Student Engagement

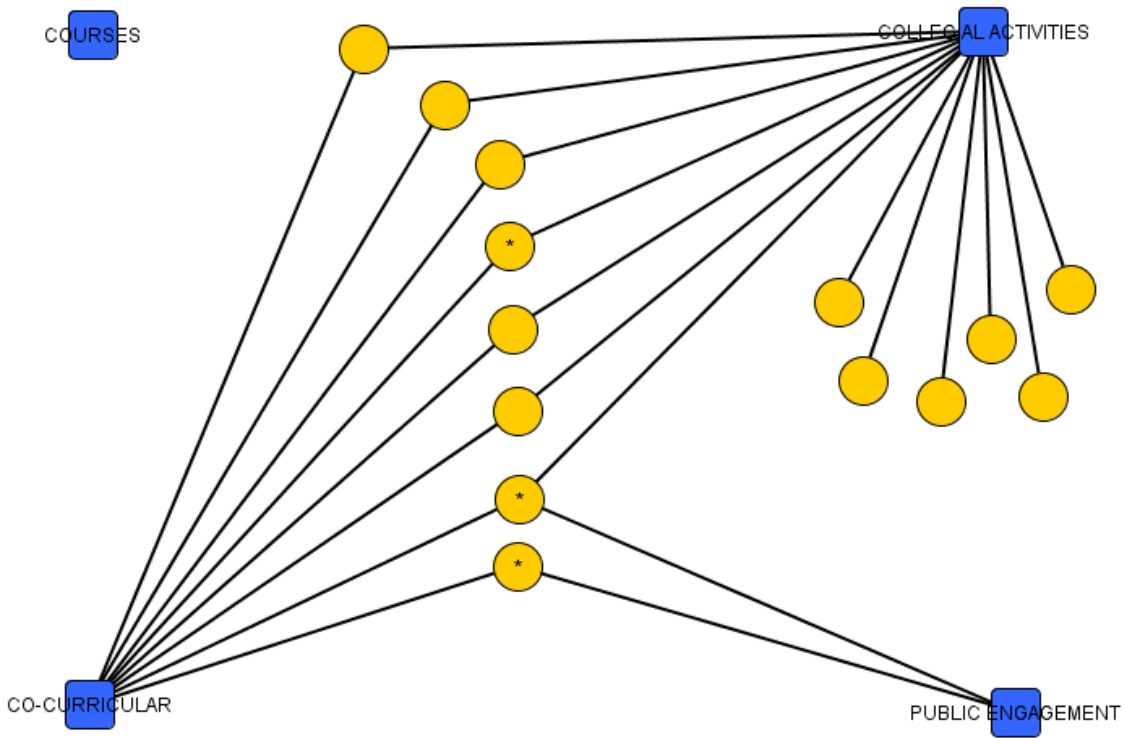


Figure 2. Year 2 STEM Graduate Student Engagement (* = persisting)

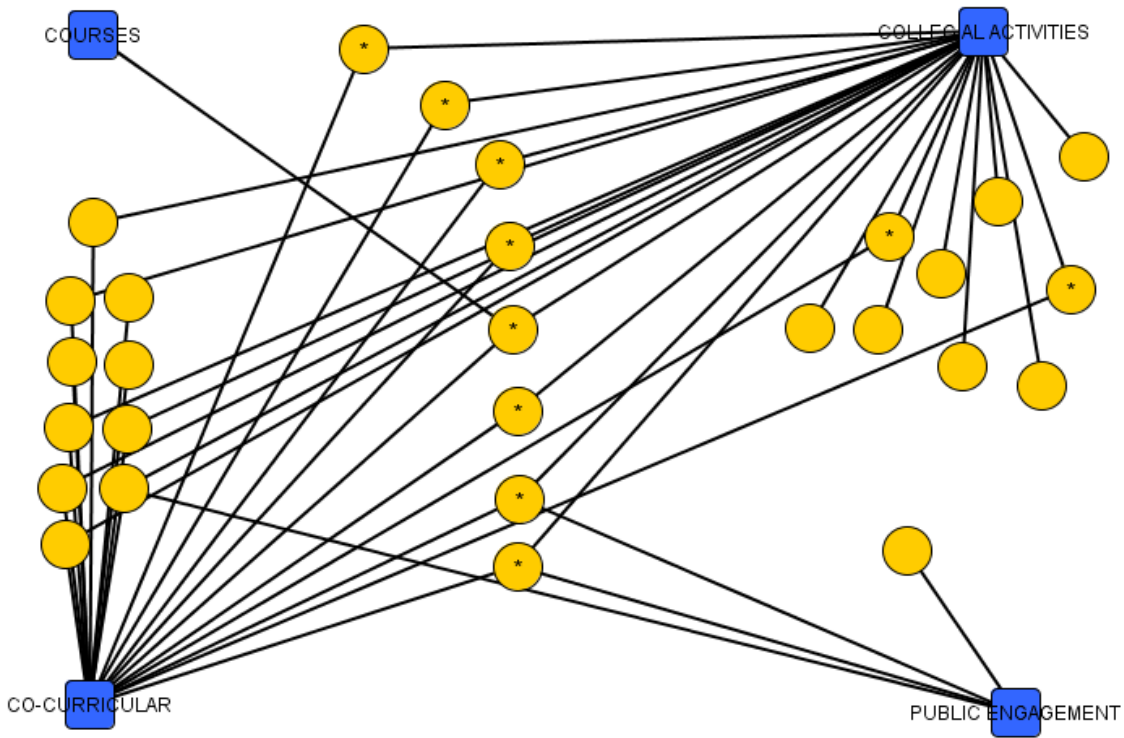


Figure 3. Year 3 STEM Graduate Student Engagement (* = persisting)

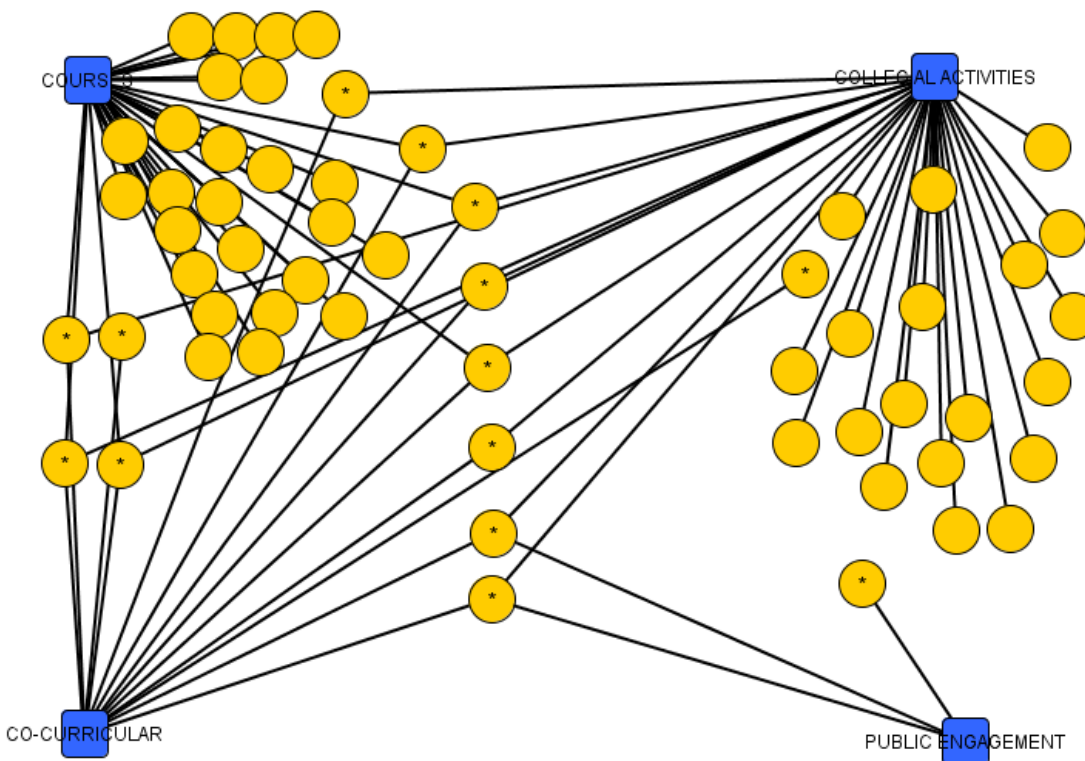


Figure 4. Year 4 STEM Graduate Student Engagement (* = persisting)

During YR 1, CNS established ties with three STEM graduate students. Two of these students remained engaged with CNS-ASU (persisted) until graduating from ASU; the third is still active in YR 4. During YR 2, CNS engaged eleven new graduate students, six through Collegial Activities (CA) and five through both Collegial and Co-Curricular Activities (CC), for a total of 14 STEM graduate students. In YR 3, seven new STEM grads were engaged through CA, one through Public Engagement (PE), and ten through CC activities. Of the 28 STEM graduate students in YR 3, ten persisted from previous years. YR 4, while ongoing, is noteworthy for the addition of 25 new graduate students through Courses offered by CNS-ASU, the addition of 14 new STEM graduate students through CA, and the persistence of 5 students through the new Courses. Of these 58 current students, 14 persisted from previous years. Based on data from years 1-3, composite persistence rates are better than 33%. It should also be noted that over 50% of STEM graduate students tend to be engaged in more than one activity category during YRs 1-3, and we expect this trend to continue through the remainder of YR 4. This underscores both the breadth and depth of CNS-ASU engagement activities.

Initial Engagement: How does CNS first engage the most involved, persistent STEM graduate students? Figure 5 indicates the type of initial activity during YRs 1-3 that result in graduate students persisting with CNS-ASU (YR 4 initial contact is currently unfolding and therefore excluded from this analysis). Out of 19 students, the majority (n=15) first experienced CNS through Co-Curricular activities such as the IPNS and DC Policy trips. Two students arrived through Collegial Activities (Lab Studies and Colloquia) and two students found CNS through Public Engagement activities (Science Cafes). These findings highlight the long-term impact of Co-Curricular activities, especially trips, to expose STEM graduate students to “science outside the lab.” It remains to be seen how future persistence rates will compare based on the YR 4 increase of engagement of STEM graduate students through Courses and Collegial Activities.

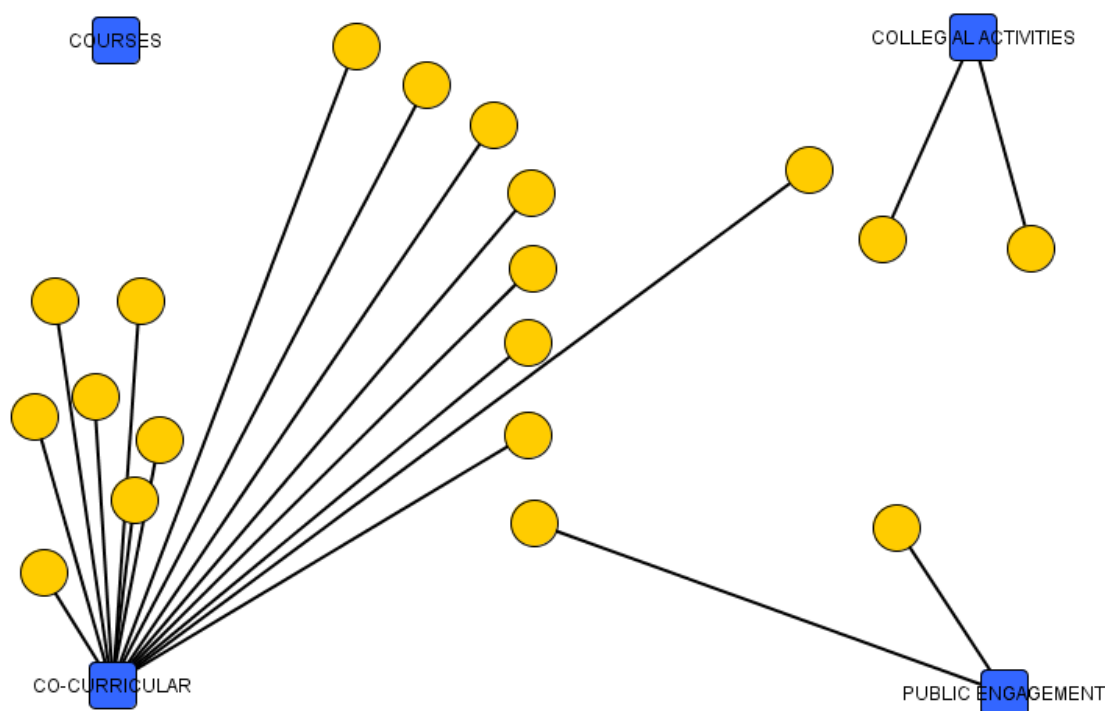


Figure 5. Initial Activity Type for Persistent STEM Graduate Students (Years 1-3)

Note: Strength of ties is not depicted in the static models. Node distance is arbitrary for visual clarity and line thickness is uniform whether nodes have single or multiple ties. In other words, if a graduate student took more than one course in a reporting year their link appears the same as a student who took only one course. Strength of tie is depicted in the dynamic model by line thickness.

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 years, we report on the following integrative lab studies and engagements, which CNS-ASU continues to conduct from the previous year and/or which continue to serve as the basis for interaction with NSE scientists and engineers:

- The Photon project, in the Lindsay lab;
- Tubes in the Desert, in Biodesign;
- Medical Diagnostics, with the Johnston lab in Biodesign.

In the Photon project, CNS-ASU collaborates with the Center for Single Molecule Biophysics, directed by Lindsay, on a \$1.1 M NIRT award that asks if DNA can be used to self-assemble complex photonic and electronic structures. In this study, Fisher has fulfilled roles as an observer, facilitator and member. He attends lab meetings and interacts with the four co-PIs and 14 other group members who cover a wide interdisciplinary space. In Feb 09, Fisher introduced graduate student Callejos to the Photon project team as the participant-observer attached to the project. A significant part of the project's framing is derived from RTTA 1/2 Public Value Mapping, and from Fisher's on-going work about the possibility of

midstream modulation of research practice. Fisher organized a workshop in Apr 08 meant specifically to explore the relation of public values to the Lindsay group's research. The workshop brought the lab members in contact with several experts in energy, policy, and values. Results from the workshop include observations by the NSE faculty involved that it led to "breakthrough" and "useful" ideas, and by the graduate students involved that it provided new perspectives on the potential value of their work for practical applications beyond the laboratory. The lab participants desired more such interactions, expressing a desire to meet quarterly on the public values agenda. Graduate students repeatedly expressed an interest in hearing their professors discuss the broader dimensions of the research projects to which they contribute. The workshop also inspired two graduate students to try to attend a green chemistry workshop scheduled to occur in Feb 09 in connection with their research.

As a result of feedback and findings from the Photon workshop, Fisher, Anderson and Renolds created a database of policy documents in order to map public values across science policy prescription and implementation processes. The database consists of approximately 250 Congressional reports, 100 NSF program solicitations, and 800 corresponding NSF funded award summaries. This database will provide an empirical basis for understanding the public values content embedded in the policy context of NSE laboratories. RTTA 4 researchers will thus track and map sequential changes in values across multiple levels of the science policy implementation process. RTTA 4 researchers will collaborate with Corley, who spans RTTAs 2 and 4, on content analysis methods and also to conduct this policy content analysis in parallel to RTTA 2's media content analysis of nanotechnology. Enlarging in this way the sources of public values considered advances the original RTTA 4 objective while providing an opportunity to work synergistically with RTTA 2 researchers to explore similar and overlapping questions in a parallel fashion.

In another potential follow-on to the Photon project, ASU doctoral student Luk, under the supervision of Fisher, is conducting pre-engagement research for a planned project that will re-examine the notion of epistemic cultures within a highly interdisciplinary laboratory. To this end, she is currently taking a class with Lindsay on quantum mechanics and is seeking co-funding from his laboratory to engage in the study.

In the Tubes in the Desert project, CNS-ASU collaborates with a major use-inspired research project in the Biodesign Institute, performed in collaboration with British Petroleum. The purpose of the Tubes in the Desert project is to pilot a system for producing biofuels that uses genetically modified cyanobacteria. The project is currently staged into a benchtop photobioreactor and a roof-top test bank of tubes and a co-located demonstration-scale rooftop photobioreactor (innoculated in Feb 09). A large-scale testbed is in the advanced planning stage. CNS-ASU's role is co-funding Conz and Bhadra to observe the project, interact with project members on relevant societal aspects, and perform research on aspects of the project including potentially conflicting goals between Biodesign and BP and comparisons with similar projects at ASU's Polytechnic campus. To date, Conz and Bhadra have successfully embedded themselves in the project (including representation on the overall project organization chart), conducted two rounds of interviews with principals in the project, attended project meetings, and planned research and intervention activities including a survey of public attitudes, comparative case analysis with the Polytechnic project, and a societal implications workshop with Biodesign personnel. In Dec 08, Conz moderated a focus group of eight local participants randomly sampled from Census data profiles developed by graduate students Bhadra and Moore. The focus group was funded by the Biodesign Institute and administered by the Institute for Social Science Research at ASU. Conz and Ovitt, director of marketing and public relations at Biodesign, co-developed the focus group questions with input from CNS-ASU faculty and Tubes researchers. Moore interviewed these researchers in conducting an analysis of the "back stage" preparation of the focus group. Ovitt and Conz will present the findings of the focus group at an upcoming Tubes All Hands meeting.

The Medical Diagnostics project, run by Selin, is also affiliated with RTTA 3/1 Scenario Development. In this project, CNS-ASU collaborated with Johnston and other colleagues at the Biodesign Institute in a two-day scenario development workshop held in Nov 07 that identified and explored four future visions for the “doc-in-a-box” pre-symptomatic medical diagnostic technology that Johnston’s lab works on. Workshop participants identified a large number of potential issues involved, including issues of privacy and security, affordability and access, the location of decision-making, new taxonomies of health and wellness, the importance of first applications and path dependence, and the outstripping of treatment capacity by diagnostic capacity. In addition to the production of the scenarios themselves and a report (Selin 2008), outcomes of the workshop included:

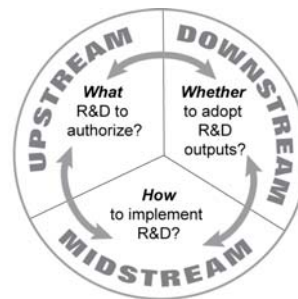
- One graduate student who participated in the workshop who took the dilemma of detecting diseases without offering cures so seriously that she changed her research from diagnosing an exotic disease to a more common infectious one.
- Insights by the scientists involved into
 - the “political implications and social backlash” of use of the technology;
 - the importance of looking “at the impact of the technology early in the development;”
 - the role that stories had in helping elucidate “the connections between decisions made early in the development process and outcomes.”

Nearly all the participants valued the “unique variety of perspectives” and the way a “diversity of participants” could sustain a rich dialogue. As described in greater detail in the **Outreach** section, in Dec 08 CNS-ASU was contacted by a former staffer to of the President’s Council of Advisors on Science and Technology (PCAST) requesting the full report in order to share it with current PCAST members. As another outcome of the workshop, Selin is currently working on a NIH CEER ELSI grant application on personalized medicine and public health with Marchant as PI.

In the current year, the following integrative lab studies and engagements have commenced:

- The Socio-Technical Integration Research (STIR) Project in the Lindsay, Rittman, Vermass, and Seo laboratories at ASU as well as 16 other laboratories around the world)
- Engaging epistemic cultures

Fisher is PI and Guston Co-PI on the “Socio-Technical Integration in Research” (STIR) project. It will fund 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 in Fisher’s midstream modulation techniques in order both to conduct socio-technical collaborations and to assess the policy relevance of their outcomes. The first of several workshops was held at ASU in Jan 09. Sixteen faculty members (including five international and three from science/engineering), fourteen doctoral students (including six international and one from physics), and one private sector research manager participated. As of Apr 09, seven of the ten students have begun or are about to begin conducting their first of two rounds of laboratory engagement studies. The remaining three students plan to begin their first round of studies later this year. In conjunction with the STIR project, Schuurbiens and Fisher have an article forthcoming at the European science journal *EMBO Reports*; Callejos and Fisher have a paper accepted at the upcoming Society for the Philosophy and Technology conference; Queraltó is preparing a paper for the 2009 Meeting of the International Academy for Philosophy of Sciences; and Fisher has presented at a Mar 09 conference on research funding and the good life in the Netherlands.



RTTA 4 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. Wetmore and McGregor plan to conduct an Ethics in

the Lab project that builds on their early work and that is funded through an NSF EESE grant on integrating micro- and macro-ethics.

In Feb 09, the EESE project held its opening workshop, bringing together senior scholars in the field from across the US to advise on the program. The invitees were charged with helping to define the learning objectives of the different models, the strategies for successfully implementing the different models, and the best ways to assess the models. Two of the three models that were originally developed by CNS are already being offered on a regular basis. The stand alone course was offered in F 08 and Sp 09 and is already on the books for F 09. The embedded course model was offered in F 08 and will be offered next year as well. The ethics in the lab modules is currently being refined and developed. Plans are being made to conduct a version of the project in F 09, although the precise lab has yet to be determined.

RTTA 4 also involves a set of additional research projects that investigate the role of societal aspects of nanotechnologies and reflexive knowledge more generally, including:

- 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 led to a poster at the 2008 Gordon Research Conference on Science and Technology Policy. Fisher and Garay are also preparing a proposal for NNIN SEI funding that would send Garay to various NSCE sites to interview SEI officers;
- research by Garcia-Mont, under the supervision of Conz, on the knowledge, practice, and identity of Hispanic and Latino/a NSE researchers, leading to a journal manuscript in preparation;
- research by Callejos, under the supervision of Fisher, leading to a conference paper at the upcoming Society for Philosophy of Technology conference.

CNS-ASU held a Visioning Workshop in Oct 08. This activity was led by Selin and involved a group of interdisciplinary researchers from across CNS-ASU, including collaborating NSE researchers Woodbury, Lindsay, and Goodnick. The group participated in a scenario building exercise that took the tools of real-time technology assessment (Guston and Sarewitz 2002) as a social technology. Making use of background talks by Guston and Sarewitz on RTTA and by Fisher on reflexivity, the 1.5 day activity explored what the future of governing new technologies would look like in 2025. Using the “intuitive logics” approach to scenario development (Wack 1984), Selin facilitated the group through a sustained inquiry into the potentials and challenges attending anticipatory governance. The purpose of the workshop was to:

- Identify the variables that condition the effectiveness of anticipatory governance- now and in the future;
- Explore how the varied human and social systems that embed real time technology assessment might change over time and with what consequences;
- Find alternative ways of thinking about how social science knowledge can improve the effectiveness of human interactions with technology;
- Determine which designs and decisions bring about “ideal” anticipatory governance.

Our key research questions were: What are the alternative pathways for the development of anticipatory governances? How might anticipatory governance play a constructive role in mediating the relationship between technology and society? The outcomes achieved were the development of a collective understanding of the key uncertainties confronting anticipatory governance; an enhanced capability to make sense from the signals in the operating environment of CNS-ASU; and the creation of robust

strategies for advancing real time technology assessment. These results were fed into a CNS strategic management meeting in Nov 08 and are presented in Selin (2008).

Connection to Anticipation, Engagement, and/or Integration.

The RTTA 4 activities of laboratory engagement and scenario development projects, and co-curricular activities all fall under the rubric of integration in that they (1) seek to introduce nanoscale scientists and engineers to explicitly normative concepts, discourse, and deliberations; and (2) seek to understand and assist in their assimilation into NSE research practices and education. A central focus of the STIR project is on understanding the possibility, utility, and conditions for integration. Several RTTA 4 activities, including the Photon workshop, Medical Diagnostics workshop, and aspects of the IPNS program used anticipatory concepts and techniques, including scenario development, multi-path road mapping, and science fiction writing. Several combined aspects of engagement as well: the Photon workshop included the participation of Rahi Khan from the Loka institute, who described the potential interest and roles of citizens with respect to decisions about science.

The Medical Diagnostics workshop built upon the NanoFutures project by utilizing a technical scene as the object of deliberation and focus of scenario development.

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

RTTA 4 works with TRC 2 and the E2E project to find effective means of building communication between E2E and scientists and users working to apply NSE research to neuroscience and the brain.

In addition to providing a means to showcase the Center’s intellectual and bridging capacities, the Medical Diagnostics workshop’s utilization of foresight methodologies, coupled with the purpose to integrate social science research into the lab, utilized the unique competences of the Center as an integrative whole.

Connection to Education, Training, and Outreach.

The co-curricular activities and workshops used as methods in RTTA 4 are important aspects of education and outreach. The STIR project is developing an educational platform for doctoral students who seek to incorporate an intervention-oriented laboratory study into their dissertations.

The integrative activities also contribute to the education and training of NSE students as potentially more reflexive researchers.

TRC 1: Equity 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 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 – its first full year of operation – the Thematic Research Cluster (TRC 1) on Equity and Responsibility has largely been focused on two interrelated projects: an international workshop on its major theme and Volume III 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.

Since the workshop, the participants have been hard at work turning their nascent ideas into full fledged research papers. Cozzens and Wetmore are coordinating this effort and serving as editors for the *Yearbook in Nanotechnology in Society, Volume III*, tentatively titled “Challenges of Equity and Equality.” The *Yearbook* is slated to include 18 articles originally developed for the workshop and reworked into academic papers (the majority of which will be individually peer reviewed), at least five other articles commissioned specifically for the yearbook, and a handful of republished articles and reports created independent of the *Yearbook* that are important recent contributions to the study of nanotechnology and equity.

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 in 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.

Doctoral student Bal, advised by Cozzens, has presented results of the equity theme in the National Citizens Technology Forum at one professional meeting as well as at the Nov workshop. This material will also form one chapter in her dissertation, which examines how participatory processes in science and technology policy making can lead to policies that are based on public values such as equity and fairness. 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. Fields such as nanotechnology represent those areas where public participation in governance can be particularly effective. Politics and science intertwine in these fields and they are characterized not just by a high uncertainty of risk but also conflicting values and ethical concerns. 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. The dissertation will also include analysis of two other participatory processes, including an additional set of deliberations on nanotechnology in a different format from the NCTF.

In Dec 08, theme co-leader Wetmore served as a faculty member for the National Nanotechnology Infrastructure Network – Indian Institute of Technology, Kanpur winter school for graduate students. The winter school, organized by NNIN director Sandip Tiwari and colleagues in India, brought together 12 American graduate students and 12 Indian graduate students for a week's worth of classroom sessions on organic and opto-electronics and a week in rural areas in the state of Orissa with the goal of helping alleviate the poverty of local people through technology. Part of Wetmore's task was to run classroom sessions to introduce students to the social and political aspects of science and technology. But perhaps more importantly he was charged with mentoring students through the process of acclimating to the Indian environment and learning about the local culture and practices so that the technological interventions they proposed would have a positive effect. Wetmore facilitated large discussions about technology and development with the students and faculty at IIT Kanpur, a number of faculty and trustees of the Jagannath Institute for Technology & Management in Paralakhemundi, the faculty and director of the Centurion School of Rural Enterprise Management, and the local organizers and participants in the Association for India's Development in Orissa. Wetmore is writing up some of his experiences and lessons learned to be included in the third *Yearbook*.

The Dialogue on Religion and Nanotechnology that was conducted in Feb 08 was completed at the end of the third year. Since then, undergraduate Milford, who coordinated the effort under Wetmore's mentorship, successfully turned his research into an undergraduate honors thesis entitled (Milford 2008). For this work and the activities associated with it, Milford was awarded the Kelly Maxwell "Outstanding Graduate Student" Award from the Intergroup Relations Center Awards Committee and the Religious Studies award for "Outstanding Concurrent Major."

Connection to Anticipation, Engagement, and/or Integration.

- Cozzens and Wetmore participated in CSPO's Oct 08 Visioning Workshop, making sure that equity considerations were taken into account in the scenarios developed for the future of anticipatory governance.

- The members of TRC 1 have also collaborated with others at CNS to scope out and define objectives for the newly proposed TRC 2.

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

- Post-doctoral fellow Harsh has been working with the existing E2E group in TRC 2 to learn from their activities and find additional ways to connect TRC 1 with the rest of CNS. The TRC 1 team used this year’s workshop and *Yearbook* as a way to broadly coordinate with other CNS members and groups.
- Doctoral student Bal has analyzed the ways in which equity was addressed by the participants in the Mar 08 NCTF as well as the public opinion survey (RTTA 2/1). The work was presented at the November workshop and will be a chapter in the third *Yearbook*.
- RTTA 1 participant Youtie worked closely with TRC 1 over the last year to examine some of her work from an equity perspective. The result was a workshop presentation and a chapter for the *Yearbook* (with RTTA 1 leader Shapira).
- RTTA 1 graduate student Kay participated in the Nov 08 workshop and worked his research into a *Yearbook* chapter entitled “Equity, Development, and the Potential of Nanotechnology in Latin America.”
- Post-doctoral fellow Slade (RTTA 1/2) has analyzed some of her research on nanotechnology and cancer diagnosis from an equity perspective, presented it at the workshop, and has written a chapter for the *Yearbook*.
- Doctoral student Meng (RTTA 1) is doing analysis of gender issues in nano patenting, and is preparing a chapter for the *Yearbook* on this work.

Additional Connections to Education, Training, and Outreach.

- TRC 1 is working to assure that issues of equity and responsibility are integrated into other education projects sponsored by CNS-ASU, e.g., the May/Jun 09 “Policy Dis-orientation” summer session for graduate students will feature at least one ethicist and a session on equity;
- Equity and nanotechnology has been by introduced using the debate between Salamanca-Buentello et al. and Invernizzi and Foladori in POS 598 Science, Technology & Societal Outcomes, ASB 394 Technology & Society, and CHM 501 “Science Policy for Scientists and Engineers,” a one credit course designed to introduce graduate student scientists and engineers to the social and political implications of their work. The debate is also included in Wetmore (2008).
- Equity is also a prominent theme in the CNS Short Course “Introduction to Making STEM Research Socially Relevant,” sponsored by the Hispanic Research Center. For instance, US Army Senior Scientist Claire Gordon guest lectured in the course to describe how she has spent the last 25 years making sure that military equipment is not just designed for white men, but for a broad spectrum of minority groups to reduce the chances of death and injury.
- Cozzens and Valdivia are writing a chapter on distributional consequences of nano-solar technologies for a volume Cozzens is editing on emerging technologies and inequalities. The work has been discussed with policy audiences in Mozambique, Brazil, Turkey, South Africa, and the Caribbean and is scheduled for presentation in Brussels to staff of the European Commission.

Yearbook 3 Description

The third volume of the *Yearbook of Nanotechnology in Society* is being edited by TRC1 team leaders Susan Cozzens and Jameson Wetmore and will be focused on the ways in which nanotechnology may exacerbate or help to reduce inequalities and inequities in societies around the world.

The Yearbook of Nanotechnology in Society, Volume III
The Challenges of Equity and Equality
(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 will examine 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 four articles to fill in some of the gaps left by the original participants. Finally the yearbook will include 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 section will cover 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. **Monica 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.

One group that is often critiqued as promoting inequities by generating new (and potentially expensive and inaccessible) abilities through nanotechnology are the Transhumanists. **John Carter McKnight** (ASU) will tackle this question head on and analyze the ways in which the Transhumanists have argued that inequity is not the outcome they are pushing for. **Gregor Wolbring** (University of Calgary) will respond to the ideas in this article by questioning many of these arguments and making a plea for the lessons of equity to be applied to abilities and not simply gender, race, and class.

One area where the equity issues will be most clearly seen (or at least most easily measured) is in economics. **Part two** will focus on “Economic Transformation and Distribution.” **Mark Knell** (Norwegian Institute for Studies in Innovation, Research and Education) opens the section by connecting 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) will follow 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. **Susan Cozzens** (Georgia Tech) looks beyond the US by cataloguing a set of national conditions that often differ strongly between developed and developing countries, and traces the different impacts high technology developments have under those different national conditions.

² See: “Special Issue on Science, Policy & Social Inequities”, *Science and Public Policy*, March 2007.

Because there was not an express focus on economics in our workshop we've decided to supplement those articles with two already published. Roco and Bainbridge published an interesting article by **Louis Hornyak** in their 2007 book which argues that nanotechnology can lessen economic inequities if it is done right. We will republish that along with an issues statement published by **Friends of the Earth, Australia**, an organization that's been examining nanotechnology for a long time and are a bit less optimistic – they argue that a nano-divide is inevitable.

The **third part** of the yearbook will focus 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) will open 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. **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.

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 will include to show some of the latest political movements to protect workers from potentially harmful effects of nanotechnology. **Matthew Harsh** (ASU) will conclude part three and help to transition into part four by looking 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.

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 starts with an article by Profs. **Sharan** and **Mohapatra** (IIT Jaipur and IIT Kanpur) 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. 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. **Luciano Kay** and **Phil Shapira** (Georgia Tech) compare the academic and patent output by a number of countries in Latin America. **Noela Invernizzi** (Federal University of Parana) looks at government policy in Brazil that specifically addresses equity issues and assess the successes and failures it has had. **David Grimshaw** (Practical Action, UK) then 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.

Again, there are a number of articles and artifacts worth reproducing in this area. We will include two: An analysis of using lab-on-chip technology to address health and environment problems in developing countries by **Michael Mehta** and sections of a report by the **Meridian Institute** that outlines the opportunities and risks of using nanotechnology to benefit the poor in developing countries.

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 will provide a chapter on the lessons learned in parliamentary technology assessment. **Evan Michelson** (Rockefeller Institute) formerly of the Wilson Center's Project on Emerging Nanotechnologies, will reflect on his experiences there and on ways in which equity and equality can be advanced in NGOs and governments. The goal of this final section is to encourage readers to not just consider the issues of

equity and equality as they promote, research, design, regulate, and disseminate nanotechnology, but to recognize that there are concrete steps that can be taken to make the world more equitable and that nanotechnology can play an important role in the solution.

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)
Arnim Wiek (ASU, assistant professor, Sustainability)

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 the prior reporting year, E2E project made substantial progress, including:

- With RTTA 1, the creation and preliminary analysis of a database of 1739 nano-neural research publications in the period 1990-2006, particularly a subset of publications related to cochlear research; biocompatibility, neuroscience, and neural nets and artificial intelligence;
- 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.

- 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.
- With RTTA 4, integrative work around student training, deliberative activities (NCTF), etc.
- With RTTA 2, RTTA 3, and TRC 1, the development of the national public opinion survey fielded in Sp/Su 08.
- The creation of a database of NSF research grants on NSE applications in neuroscience and brain research.
- 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.
- A preliminary literature review of the application of NSE for the delivery of drugs across the blood-brain barrier.
- A preliminary analysis of NSE applications in neural prosthetics research.

In YR 4, E2E project has continued to make significant progress, leading to the anticipated publication in late 2009 of the second volume of the *Yearbook*, which will constitute the final report of the project and present a wide range of important findings.

Principal among the YR 4 efforts has been 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. Scheufele and Corley from RTTA 2, Miller and graduate student Hays from TRC 2, Guston and Cobb from RTTA 3, and Wetmore and Cozzens from TRC 1 were all involved in the construction of the survey.

This survey constitutes the first national survey of US public attitudes toward human enhancement, making it of particular significance to emerging political and ethical deliberations. Several significant findings have emerged. First, and not surprisingly, respondents are relatively uninformed about human enhancement technologies, in comparison to nanotechnology more broadly. Most people (61%) report having heard nothing about the use of nanotechnology for human enhancements, while just 38% say they have heard nothing about nanotechnology in general. Fewer than 2 in 10 felt they knew enough to rate themselves higher than 3 on a 10 point scale of familiarity.

Second, respondents clearly differentiate between the use of nanotechnologies for improving impaired health outcomes (therapy) and the use of nanotechnologies for non-health related (enhancement) purposes. Support is very high for the former therapies – 88 % for a video-to-brain link to allow artificial eyesight and 84% for medical devices to detect changes in human biomarkers for early disease detection – but low for the latter non-therapeutic applications – 22% for nano drugs to prevent prisoner escapes, 30% for implants to improve performance of soldiers on the battlefield, and 20% for brain implants to permit basic computer-to-brain connections. Support among women for enhancement technologies was approximately 10% less than among men across applications. Likewise, when asked to indicate how likely they would be to support their child in obtaining human enhancements for several competitive purposes – getting a job (51%), competing in amateur sports (65%), taking college entrance exams (55%), or running for public office (63%) – a majority of respondents in each case indicated they would be *very* unlikely to offer their support, with roughly an additional 15% in each category reporting that they would be somewhat unlikely.

The third set of findings concerns public attitudes toward risks, benefits, and costs. Respondents were roughly balanced between those who judged that the risks of using nanotechnology for human enhancement would outweigh the benefits (24.5%) and that the benefits would outweigh the risks (29%). The majority (34%) judged that the risks and benefits would likely be about the same. At the same time,

significant numbers of respondents indicated very little or no confidence in either business (42%) or government (57%) to protect the public from risks of nanotechnologies applied to human enhancement. Only 4% felt that nanotechnologies for human enhancement would be affordable for most Americans, while 32% felt enhancements would be quite costly for the average American, and 62% felt they would be available to only the wealthiest Americans. Not surprisingly, 72% of respondents supported government guarantees to ensure equal access to enhancement technologies, while only 13% thought the free market should decide who gets access to human enhancements.

In addition to expected contributions to the Yearbook from the survey, ASU doctoral student Hays, advised by Guston, is working to complete by Aug 09 his dissertation, which mobilizes some of the survey's findings. The dissertation is an effort to introduce 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 emerging debate surrounding human enhancement and the socio-economic and political implications it has for democratic societies is an ideal candidate for attempting to bring political theory – particularly contemporary democratic theories focused on popular participation in opposition to older more hierarchical theories of political decision-making – to bear on how best to make decisions about policy through the political process. Hays inserted questions about human enhancement's impact on competition in the US into both the NCTF pre- and post-tests and the national survey. 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.

Other TRC 2/E2E projects in YR 4 included many student projects leading up to *Yearbook* publications:

- Philosophy doctoral student Milleson helped Robert to mentor bioengineering undergraduate Naufel on the ethics of NSE-enabled neural prosthetics. As a result, Naufel is contributing a chapter to the *Yearbook* exploring 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.
- Milleson also restarted an earlier, incomplete project surveying the full range of moral issues comprising the terrain of “nanoethics.” In addition to relying on the earlier results from searches undertaken in YRs 1 and 2, Milleson used standard social science and natural science and engineering scholarly indices to create a more comprehensive database and then cross-referenced this database with a database created through RTTA 1/1 (see below). This literature review and analysis will also be included as a chapter in the *Yearbook*.
- TRC 2/E2E collaborated with RTTA 1/1 to build a larger and more ambitious database of articles published since 1991 on the topic of NSE and the human brain, building on their prior collaborative construction of a preliminary database on this subject. The resulting search terms were used by Singh and Porter to query the RTTA 1 database of nanotechnology research articles to generate the new database. The new database expanded the total number of research articles identified from approximately 1700 to approximately 10,000, covering a much wider array of relevant search terms drawn from diseases of the brain and brain structures and functions.
- Graduate student Nulle pursued a systematic analysis of the expanded database, 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. This work will be published as a chapter in the *Yearbook*.

- Completing work from YR 3, TRC 2/E2E collaborated with RTTA 2/2 to develop an analysis of media articles published on NSE and the human brain. A database of 840 entries was identified via a Lexis-Nexis search from 1991-2007 by Wisconsin graduate student Hillback. This set was cleaned by ASU undergraduate Doom of TRC 2/E2E to create a database of approximately 100 news articles (the other 700+ entries included misclassified articles and press releases) for the period. Using methods developed by RTTA 2/2, Doom is now analyzing these articles under the supervision of Miller and Wiek to identify themes (e.g., health, environment, business, etc.), content (discussions of risks, benefits, technologies, etc.), and perspectives (controllable vs. uncontrollable, speculative vs. descriptive, etc.). This analysis will be completed in Apr 09 and included as a chapter in the *Yearbook*.
- TRC 2/E2E also collaborated with RTTAs 3 and 4 in pursuit of a developing, real-world case of anticipatory governance taking place in the city of Cambridge, MA. Led by ASU doctoral student Conley and 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, to be published as a chapter in the *Yearbook*, 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.
- Robert, influenced by the findings of Naufel, Milleson, and the public opinion and deliberation work undertaken through RTTA 2 and RTTA 3, is preparing a monograph tentatively titled *Chimeras, Cyborgs, and the Moral Limits of Science*, (Robert under contract). While the work is not dedicated entirely to NSE, NSE does figure as one of a suite of emerging and enabling technologies generating interesting normative questions about the limits, if any, of scientific inquiry.

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, particularly their development, uses and deployments of nanotechnologies in and as a result of systems biology research. They have begun to use ethnographic methods, including interview-based and participant-observation approaches, to engage with scientists in key laboratories at Wisconsin engaged in nanobio. They are tracing the interactions and processes by which emerging nano- and biotechnologies and associated theoretical advances are converging, intersecting and together creating new specialties and sub-disciplines that span the sciences and engineering, including systems biology and synthetic biology. In preliminary work, they have found that nano-scale technologies are not simply the output of nano-biotechnological research but are often used as tools within the research itself, particularly in the hunt for therapies and treatments that exploit the structural properties of nanoscale biological agents such as viruses or proteins. Scientists in nano-related disciplines of the biological sciences are also consumers and users of nanotechnological equipment and instrumentation. Currently, Fujimura and Rajagopalan are analyzing how these new technologies may be revolutionizing biological and biomedical research and, in turn, contributing to the development of new nanotechnologies and new sub-disciplines. They will

continue to track the movements of nano-scale technologies as they mediate collaborations across disciplines and push the field of NSE forward.

Connection to Anticipation, Engagement, and/or Integration.

The E2E initiative is a prototype for the design of an integrated suite of RTTA capacities that can provide anticipatory insights into the development and societal implications of new and emerging technologies.

E2E has developed insights into:

- Research and innovation in NSE applications to neuroscience and brain research, including the scale and scope of research, publication, and grant activity in the field, as well as projections of scientific aspirations and detailed insights into specific sub-areas of research;
- Public attitudes regarding NSE application to neuroscience and brain research, as well as the character and impacts of public deliberation on this topic;
- Media coverage of NSE application to neuroscience and brain research; and
- Potential analogous societal implications and concerns that may arise from neural prosthetics research.

The E2E project has also been integral to a range of engagement and integration activities in CNS-ASU:

- Human identity, enhancement, and biology was the central focus of the RTTA 3 NCTF project, and numerous aspects of NSE application to neuroscience and brain research were highlighted in the NCTF background document and process, including the participation of TRC 2 co-leader Robert and Helms-Tillery.
- TRC2 and E2E have worked with Helms-Tillery and Poste to begin integration of social and natural science research. Five undergraduate students and one graduate student from the sciences and engineering have participated actively in E2E research, and Naufel's honors thesis will include not only her laboratory work on neural prosthetics but also – akin to the PhD+ – an ethical analysis of the moral dimensions of this research.

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.

Connection to Education, Training, and Outreach.

A key element of E2E has been the creation of an ongoing research seminar on “Nanotechnology, the Brain, and the Future” that has operated as a focal point for the training of both undergraduate and graduate researchers involved in the E2E project. Taught by Robert and Miller, this seminar met first in Sp 08 and continued through Sp 09 and provided students with learning opportunities in NSE applications to neuroscience, research methods in RTTA data collection and analysis, and research presentation and writing skills. In addition, national survey data were included in the Congressional Nanotechnology Caucus briefing on public attitudes about nanotechnology organized by CNS in Mar 09. There have also been four Science Cafes in conjunction with TRC 2, including one in the reporting year. In future years, we are considering developing outreach and educational materials looking at nanotechnology and the brain that could be used in informal or K-12 science education.

Yearbook 2 Description

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

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

Volume II 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. Media coverage of nanotechnology, the brain, and the future in the United States (Travis Doom and Arnim Wiek)
6. Nanoethics and the brain (Valerye Milleson)
7. Nanotechnology and religion: A dialogue (Tobie Milford)

II. Brain repair

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

III. Brain enhancement

14. Technologically facilitated competition in liberal democracy (Sean Hays)
15. Human enhancement: The legislative context (Sean Hays and Gregor Wolbring)
16. Towards responsible use of cognitive-enhancing drugs by the healthy (Henry T. Greeley et al. – **REPRINT**)
17. The opposite of human enhancement: Nanotechnology and the blind chicken debate (Paul B. Thompson – **REPRINT**)
18. 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

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

TABLE 2: NSEC PROGRAM SUPPORT

Projects	(1)current year 10/01/08- 09/30/09 Budget (NSF)	(2)current year 10/01/08- 09/30/09 Budget (Cost-Share)	(3)current year 10/01/08- 09/30/09 Budget (Other Support)	(4)Sum 1-4 Current year Total Budget	(5)Next year 10/01/09- 09/30/10 Proposed NSF Budget
RTTA 1	\$280,413	\$22,327	\$0	\$302,740	\$78,956
RTTA 2	\$237,495	\$0	\$0	\$237,495	\$172,461
RTTA 3	\$89,672	\$19,379	\$43,125	\$152,176	\$267,401
RTTA 4	\$64,209	\$139,402	\$0	\$203,611	\$125,480
TRC 1	\$17,069	\$10,973	\$39,600	\$67,642	\$27,466
TRC 2	\$17,649	\$28,550	\$0	\$46,199	\$47,500
Seed Projects	\$0	\$0	\$0	\$0	\$0
Total Projects	\$705,507	\$220,631	\$82,725	\$1,008,863	\$719,264
Education	\$8,718	\$13,116	\$0	\$21,834	\$25,873
Administration	\$126,257	\$31,942	\$0	\$158,199	\$139,098
Equipment	\$0	\$0	\$0	\$0	\$0
Knowledge Transfer	\$8,740	\$2,681	\$0	\$11,421	\$15,888
Indirect Costs	\$350,455	\$0	\$0	\$350,455	\$292,661
Subtotals	\$1,199,677	\$268,370	\$82,725	\$1,550,772	\$1,192,784
Total Budget	\$1,205,000	\$268,370	\$82,725	\$1,556,095	\$1,205,000
Uncommitted	\$5,323	\$0	\$0	\$5,323	\$12,216

Please note that Seed Projects have been included in the individual research program to which they are relevant.

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. This has included broad efforts, such as 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) and its renewal phase. 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 4 review, Carlson and Corley are co-PIs and Corley, Cozzens, and Fujimura are team leaders, for a total of 4 of 15 (27%). 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 and research program leader; 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 also increased the number of women faculty involved in Center research (non-leadership) from an initial seven (7 of 31, 23%) to twenty-eight (28 of 94, 30%).

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 four include seven Asian American faculty (7 of 94, 7%) and one African-American and five Hispanic faculty (6 of 94, 6%).

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 4, the Center has four women postdoctoral researchers out of seven (57%).

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 four in YR 4 (4 of 7, 57%). 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 4, the Center has thirty-seven women (37 of 80, 46%), twenty-four Asian or Asian American (24 of 80, 30%), one Native American (1 of 80, 1%), one African American (1 of 80, 1%), and nine Hispanic (9 of 80, 11%) graduate students.

The percentage of women graduate students involved in Center research exceeds 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, exceeds the percentage of doctoral degrees awarded to students from underrepresented groups nationally (10%, data from 2006; no data available for the social sciences separately from other science and engineering fields).

Undergraduates: The Center has also made some 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 the fourth year, the

Center has five women undergraduate students (5 of 13, 38%) and three Hispanic undergraduate students (3 of 13, 23%).

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. The Center has had, during its first four years, two African American faculty involved in specific events (Berne, Pauley) and an African American postdoctoral researcher (Jenkins) visit. We propose to work with these individuals to identify potential opportunities for them to participate in additional Center events and activities, and perhaps become involved in Center research.
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 established a relationship with the Hispanic Research Center 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 of the Y4 annual report) 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 at least three of the students applying to be part of the CNS summer 2009 DC policy experience. 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. As noted in the letter of support from Dr. Felicia Benton-Johnson, CNS will collaborate with the College of Engineering Dean's Office at Georgia Tech, through their Engineering Education Outreach Office to improve recruitment of African American students (as well as Hispanic and Native American students) into CNS.
3. Finally, during the renewal period, CNS anticipates that some of the undergraduate students involved in the REU program (see below under Undergraduate Students and in the Renewal Proposal Education Section) will apply to graduate programs and become involved as graduate students in the CNS research effort.

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. With the addition of an undergraduate honors research program and a Research Experience for Undergraduate (REU) program (see the Renewal Proposal Education Section), we anticipate growing the number of undergraduate students from diverse backgrounds involved in CNS activities. 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.

Over the five years of 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 especially anticipate leveraging these networks to support recruiting for the REU program, but we will also use them for other recruiting purposes as well. 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.

Post-doctoral training and junior research scholars. CNS-ASU has put significant effort into building a cohort of junior researchers. 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. The Center is also training 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:

- Four 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, and Wang at Florida International University in Public Administration.
- Four 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 (this year), Barben, Conz, and Selin.
- Three have or are planned (in the renewal) to take on formal leadership roles in the Center: Wetmore is currently a co-leader of TRC 1, Fisher is currently a co-leader of RTTA 4, and Selin will be a co-leader of RTTA3 in the renewal. 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 was hired this year to take the lead in developing from the work of TRC 2 E2E a generalized framework for end-to-end RTTA assessments that CNS can use to guide future this sort of activities.
- Two have been crucial in obtaining 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. 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 both of these grants have roots in the Center's program.
- Several have been involved in the Center's *Yearbook of Nanotechnology in Society*: Fisher, Selin and Wetmore (2008) edited the first volume, Bennett is editing with Robert and Miller the second volume, Wetmore is editing with Cozzens the third volume, and Barben is editing with Miller the fourth volume.
- Collectively, they have published nine CNS-related research publications in the last year (including the high-profile chapter on anticipatory governance in the *STS Handbook* [Barben, Fisher, Selin and Guston 2008]), with another six manuscripts currently under review. Many will also contribute articles for the *Encyclopedia of Nanoscience and Society*, edited by Guston.

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, eight doctoral students (Hays and Conley [Political Science], Valdivia [Public Affairs], Milleson [Philosophy], Lidberg, Bhadra, Luk, and Moore [Human and Social Dimensions of Science and Technology]) and five master's students (Anderson [Public Affairs], Calleja-Lopez [Political Science], Nulle [Global Technology and Development], Pirtle [Mechanical Engineering], and Wheelock [Liberal Studies]) are currently involved in CNS projects. Garcia-Mont and Lidberg (2008) completed their master's theses in the last reporting year, the latter on a CNS-related topic. 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).
- At Wisconsin, six doctoral students (Dudo, Ho, Dalrymple, Shih, Hu, and Hillback, all in Journalism and Mass Communication) have been working with RTTA 2 data. Ho graduated recently (2008) with a PhD in Journalism and Mass Communication and is now a tenure-track assistant professor at Nanyang 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.
- At GA Tech, eight doctoral students (Carley, Galope, Kay, Meng, Subramanian, Tang, Bal, and Thakur), two visiting doctoral students (Guo and Wang, Beijing Institute of Technology), and four master's students (Kamdar, McKeon, Narayanan, and Singh) work with RTTA 1, RTTA 3, and TRC 1 all using CNS-ASU data and analyses, many toward their theses. One student (Singh) graduated this year with an MS in Quantitative and Computational Finance and another (McKeon) graduated with an MS in Public Policy. 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.
- An additional graduate student at Rutgers (Cleary, Planning and Public Policy) is conducting doctoral thesis research to develop a survey of education in nanotechnology, and others 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.

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. This year, the Center will graduate its second CNS-Biodesign Fellow, Jason Lappe (Chemistry and Biochemistry; Woodbury lab), who has been active in designing scenes and other futures thinking for his work on lab-on-a-chip, designer enzymes, and directed evolution. Lappe's PhD+ project, "Innovation and Obviousness," examines the role of obviousness in patenting research findings since the 2007 *KSR v Teleflex* decision of the US Supreme Court. CNS also added a new PhD+ student, Tomasz Kalinowski (Biodesign; Rittman lab), who has been working with RTTA 3 to generate the next round of energy-related scenes. Later this year, another new CNS-Biodesign Fellow, Jennifer Watkins (Chemistry and Biochemistry; Wachter lab) will join CNS and work with the Science Café program. In the prior reporting year, CNS graduated its first CNS-Biodesign Fellow, Quinn Spadola (Physics; Lindsay lab), who subsequently enrolled in a

master of fine arts program at Montana State University to specialize in making documentary science and nature films. Agrawal (School of Materials; Zenhausen lab) also assisted with the TRC 2 HIEB/E2E project.

CNS-ASU has also attracted additional PhD+ students, not affiliated with the CNS-Biodesign Fellows program, including:

- Troy Benn (Civil and Environmental Engineering, Westerhoff lab), whose work on the fate and transport of nano-silver derived from socks has garnered significant attention. CNS-ASU has supported this work by helping him travel to Washington, DC to consult with EPA officials, the Woodrow Wilson Center, and others about how to design his research so that it feeds more productively into the agency's knowledge needs. Wetmore and Bennett have also worked with him to develop a demonstration project based on his research for museum audiences, which is now available through the NISE Net resource database; and
- Ashley Kibel (Chemistry and Biochemistry), who initially invited Fisher to interact with her in the summer of 2006 and then attended a course taught by Miller is considering two options for the PhD+: a midstream focus on decisions she makes over time as a laboratory researcher in light of concerns about human and environmental health; or a downstream focus on consumer behavior in relation to envisioned technologies and questions of sustainability.
- Two additional students, Berea Williams and Rebecca Allen have indicated an interest in joining the PhD+ program.

In association with the Ethics in Science and Engineering Education grant mentioned above Bennett participated in the new Biological Design Graduate Program's core course Fundamentals of Biological Design. The nine-credit course which meets for 15 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 presenters 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 one new Biodesign Fellow, Kalinowski and one potential PhD+ student, Allen.

In Su 09, 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. One will be funded by CNS and will be available only for students at ASU. The second will be funded by NSE faculty sponsoring individual students and will draw from students at other universities. These build 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 held in a congressional hearing room and chaired by a former congressional committee staffer with many staff in attendance. After participating in CNS immersion projects, taking multiple courses, and being mentored by Bennett and Wetmore, NSE graduate students Berea Williams and Punarvasu Joshi have gained the skills, knowledge, and enthusiasm about the social and political implications of nanotechnology to serve as student leaders in the two 09 DC Summer Sessions.

In the prior year, CNS-ASU also developed a partnership with a new Professional Master of Science degree program in nano-science, led by the departments of physics and chemistry, to offer a 3-credit

graduate course in the societal aspects of nanotechnology required in the program. 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 six graduate courses at ASU, including three that are new in this reporting year:

- “Science Policy for Scientists and Engineers,” taught by Bennett and Wetmore in F 08 and S 09, 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. The class also produced cart demonstrations designed to educate the public on the technical aspects and social implications of nanotechnology. The students presented these to the public first at the Tempe Festival for the Arts and subsequently at the Arizona Science Center.
- “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 Political Science Department 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.
- “Nanotechnology, the Brain, and the Future,” taught in the School of Life Sciences and the Department of Political Science, 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 07 and F 07 but not in the current reporting year;
- “Nanotechnology: Law and Regulation,” was taught by Sylvester in the O’Connor School of Law. Several other CNS-ASU faculty participated in the course, including Guston, Robert, Marchant, 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.

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, and Wetmore serve on its Executive Committee. CNS-ASU funded one member of the first cohort of students, Lidberg, who worked on design policy and innovation, especially with regard to the preparation of the new TRC 2 for the renewal proposal. A second student, Bhadra, who is funded 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. CNS also housed and worked with several other members: Schwartz (who is interested in RTTA 1/2 PVM), Luk (who is interested in socio-technical integration research), and Moore (who is interested in environmental policy). All seven HSD students participated actively in the CNS Visioning Workshop in F 08 by drafting the four scenarios, and Luk has planned her second-year research project (an HSD degree requirement) in collaboration with CNS and will pursue an in-depth ethnographic study of an NSE laboratory. CNS will

fund Lidberg and likely a second HSD student in the coming reporting year, while Bhadra will continue to be funded via CNS's partnership with the Biodesign Institute.

Undergraduate Education and Training. CNS organizes a variety of undergraduate education and research training experiences.

At ASU, numerous undergraduates have written honors theses with CNS faculty. Honors theses completed in the past year include Tobie Milford (2008; Wetmore, director), and Timothy Shaw (2008; Boradkar director). Undergraduates – mostly from the Carey School of Business – also complete honors theses in conjunction with their InnovationSpace coursework. An additional five expect to complete theses by May 09.

In the current year, Pirtle holds a Fulbright Scholarship, “Nanotechnology in Mexico: Scenarios, Outcomes, and Democratized Science Policy,” which he is pursuing in Mexico with Foladori to work on new versions of NanoFutures scenes that incorporate development issues. He is also conducting 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 is also interviewing key members of the nanotechnology community about how they try to connect their research to societal problems; writing a research paper on how real-time technology assessment can best benefit Mexico; and has attended and presented at two key Mexican nanotechnology meetings (NanoMex and Nanotech 2008)

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 second 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 Religion and Nanotechnologies workshop, will publish his work in the second volume of the *Yearbook of Nanotechnology in 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: 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), Mark Peterson (Spanish translation of NanoFutures scenarios), and Dusana Schnell-Vivas (NanoFutures).

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 three 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. “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. Wetmore's “Technology and Society” course included a week's worth of discussion that explored the regulatory history of nanotechnology as well as the equity issues raised by it.

This reporting year, InnovationSpace remains a central activity of CNS-ASU. It 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-ASU joined Herman Miller and the ASU Flexible Display Center to sponsor three, four-person InnovationSpace teams. This year CNS-ASU challenged the students to explore nanotechnologies that improve energy equity (AY 08-09). InnovationSpace is led by Boradkar, and CNS researchers Guston, Selin, Wetmore, Bennett, Robert, and Wolbring each had significant interaction with the students. The three product concepts this year are: an energy-providing and temperature-regulating shelter for victims of natural disasters; a domestic system designed for Native American communities that collects and purifies water from moisture in the air; and a compact solar portable personal transportation device for urban commuters. Outcomes from InnovationSpace include not only spectacularly detailed documentation of the student-led innovation process (e.g., notebooks, drawings, models, and other ephemera) and a number of honors theses, but also invention disclosures – three from the AY 08-09 class in this reporting year.

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 offered a modified version of the course again (taught by Bennett) in the current reporting year, as a required course in the nano-science professional master's degree described above. Two teachers participated in the course this year, 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.

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. We will further develop these plans in the coming year.

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. Last year, CNS produced a guide to this topic (Miller et al. 2007) that NISE Net distributes as part of its Forums Guide and Nano Days Kit. This year, the framework developed in this guide has been taken up by NISE Net as the standard against which to measure the adequacy of NISE Net activities in engaging publics with the full range of social science research findings. In addition, NISE Net Director Larry Bell, who has attended all three annual CNS All-Hands Meetings held to date, has begun to identify 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). NISE Net has also encouraged CNS to develop model programs, activities, and demonstrations and make them available to NISE Net museums through its resource database, which we are now doing. This year, Benn, Wetmore, and Bennett developed a

demonstration Benn's cutting edge nano-silver research that both got children interested in science and their parents discussing the social and political implications of nano-enabled consumer goods. Wetmore and Bell are currently collaborating to develop a major activity surrounding social science-informed museum demonstrations about nanotechnology, including presentation of several demonstrations and training opportunities in demonstration design and development at the first annual meeting of S-NET in September 2009.

CNS sponsors a Science Café monthly 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 25 Science Cafes to date (one in Spanish), and the Center will continue these in the coming academic year. 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 during the prior year – continued in the present reporting year. The CNS Science Café is now listed on a web site dedicated to them, created by WGBH television in Boston (<http://www.sciencecafes.org/>).

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).

This 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.

Overall, survey respondents indicated that the video did not prompt significant questions or discussions about social and ethical issues in nanotechnology. Generally, they agreed that the content was important and worthwhile and should be taught to new users. Some also indicated ways in which the current presentation could be enhanced, e.g., providing a clearer connection to lab work; making the presentation more engaging; making concepts less abstract and less dense; using better examples; and providing interactive content. Only one site of the eleven provides an exit survey. That exit survey indicated that 90% feel that the video helped them better understand social and ethical issues in nanotechnology. A majority of respondents rated it "excellent" (6%) or "very good" (48%), while 44% rated it "average" and 2% "poor." Interestingly, among exit survey respondents, 42% indicated that they had either never been asked about social and ethical issues (10%) or rarely discussed them (32%), while 40% indicated that they had had a prior class on the topic, and 18% said they were commonly discussed in their lab. This may suggest the need for two levels of user training: one for individuals with more advanced prior training and one for users with little or no prior exposure to these issues.

In the future, we plan to produce a packet for trainers and a web site with a third layer of depth for further inquiry by interested parties. Planning for this work has now begun with a new coordinator for social and ethical issues at the NNIN, Katherine McComas, who joined NNIN in F 08.

Student Type	Total	Gender		Race					Mixed-incl.	Mixed-	Not Provided	Other Non-US	*Ethnicity Hispanic	Disabled
		Male	Female	NA	PI	AA	C	A	NA,PI,AA	C,A				
Enrolled in full degree programs														
Undergraduate														
Masters	1	0	1								1			
Doctoral	15	5	10				7				8			
Enrolled in NSEC Degree Minors														
Undergraduate														
Masters														
Doctoral														
Enrolled in NSEC Certificate Programs														
Undergraduate														
Masters														
Doctoral														
Practitioners taking courses														
Enrolled in NSEC Courses & Programs														
Undergraduate														
Masters	7	5	2				6				1			6
Doctoral	15	10	5				6	9						9
Practitioners taking courses														
K-12 (Pre-college) Education														
Teachers	1		1					1						
Students														
Total	39	20	19				6	23			1	9	0	15

Student Type	Total	Gender		Race					Mixed-incl.	Mixed-	Not Provided	Other Non-US	*Ethnicity Hispanic	Disabled
		Male	Female	NA	PI	AA	C	A	NA,PI,AA	C,A				
Enrolled in full degree programs														
Undergraduate														
Masters	1		1								1			
Doctoral	9	4	5				7				2			
Enrolled in NSEC Degree Minors														
Undergraduate														
Masters														
Doctoral														
Enrolled in NSEC Certificate Programs														
Undergraduate														
Masters														
Doctoral														
Practitioners taking courses														
Enrolled in NSEC Degree Minors														
Undergraduate														
Masters	8	5	3				7				1			6
Doctoral	15	10	5				9				6			9
K-12 (Pre-college) Education														
Teachers														
Students														
Total	33	19	14				23				1	9	0	15

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 technology transfer program associated with InnovationSpace. To bolster its relationship with private sector and industrial interests, CNS-ASU submitted a supplement in Mar 09 that would support a post-doctoral level coordinator for private sector engagement.

Engagement

“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.

NanoDays 2009

As in YR 3, CNS-ASU participated in NanoDays adding a societal twist on the information and materials provided by NISE Net. In Fa 08, Bennett attended the meeting of the southwest regional node of the NISE Net’s Nano Days, working with NSE researchers and museum professionals on new ways to engage the public in conversations about NSE. Bennett proposed a new tactic that used NSE graduate students to address nano-scale phenomena as well as societal and environmental implications. The workshop participants recognized this suggestion both as an educational tool for the graduate students and as a way to bring the social and environmental aspects of NSE to the public, a recognized challenge in the museum field. In coordination with the Nano Days national program, CNS-ASU sponsored three days of demonstrations about phenomena at the nano-scale. Twenty-three students from graduate classes taught by Bennett and by Bennett, Wetmore and Posner participated in public displays at the Tempe Festival of the Arts, a street art fair that attracted upwards of 200,000 visitors. 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 by showing how an AFM works, and how to build simple nano-robots. 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.

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. Although the series lost its supporting partnership with Agilent Technologies, it 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. One highlight of the recent year was a Science Café that featured citizens who participated in the National Citizens' Technology Forum and which provided them the opportunity to speak to a public audience about their experiences. In the current year, CNS faculty Selin, Miller, and Bennett have all contributed to the series, and Wetmore and Posner will conduct one in Apr 09. In addition to outreach and informal education opportunities, the Science Cafes operated by CNS-ASU provide continuing education credits to in-service teachers. Our Science Café is also now hosted on the WGBH Science Café web site (www.sciencecafes.org).

Triple Play Days

In Jul 08 CNS participated in the Arizona Science Center's "Triple Play Days." NSE doctoral student Benn worked with CNS faculty Wetmore and Bennett to translate his work on nano-silver socks (Benn and Westerhoff 2008) for the public. The team developed a hands-on demonstration for visitors as well as a series of four posters explaining the environmental and political implications of using nano-silver in such commercial products. Over the course of the day the team interacted with 50-100 visitors. The most interesting finding was that while the hands-on activities drew children to the presentation, once their interest waned, their parents continued to ask questions about the social and political implications of the nano-silver. In particular, they wanted to know what the health risks of the silver was to them, where it went after it washed out, what the environmental risk of the wastewater was, whether the risk was worth the benefit, and how the government was regulating the technology. Questions like these led to dialogues about the development and implementation of nanotechnology in consumer products.

Nano and the Public: Data for Decision Makers

In Mar 09, in conjunction with the Woodrow Wilson International Center's (WWIC) Project on Emerging Nanotechnologies and the Congressional Nanotechnology Caucus, CNS-ASU director Guston organized a briefing in Washington, DC to an audience of more than 60 (mostly public sector) individuals. The briefing featured four panels of two researchers each, including CNS-ASU director Guston, RTTA 2 co-leader Scheufele, and RTTA 3/4 researcher Cobb. The other panelists were Julia Moore (WWIC/PEN), Barbara Harthorn (CNS-UCSB), Dan Kahan (Yale), Larry Bell (NISE Net/MoS Boston) and Christine Reich (NISE Net/MoS Boston). RTTA 2 co-leader Corley and local NCTF staff Delborne (UW Madison site) and Philbrick (UC Berkeley site) were also present and participated in the question-and-answer session. CNS-ASU speakers highlighted findings from the RTTA 2/1 national public opinion poll, the RTTA 2/3 nano-scientists' survey, the RTTA 3/4 National Citizens' Technology Forum and the TRC 2/E2E national public opinion poll on nanotechnologies and human enhancement. ASU President Michael Crow also provided brief comments. In conjunction with the event, Guston recorded a podcast available at <http://president.asu.edu/node/661>.

Nanotechnology: Will It Drive a New Innovation Economy in the US?

In Mar 09, in conjunction with the Woodrow Wilson International Center's Project on Emerging Nanotechnologies, RTTA 1 leader Shapira and faculty member Porter presented a briefing in Washington, DC to a multi-sectoral audience of 77, including approximately one dozen from the private sector and a similar number from foreign embassies. The presentation emphasized the intellectual structure of NSE, emerging and anticipated consumer products, the broader market of nanotechnologies and the variety of uncertainties surrounding its future. The event was webcast live to an audience estimated at several hundred, and is archived (<http://www.nanotechproject.org/events/archive/shapira/>.)

NSF Workshop on "Centers, Universities, and the Scientific Innovation Ecology"

Wetmore was invited to participate in the Mar 09 NSF workshop on "Centers, Universities, and the Scientific Innovation Ecology," which was convened to discuss broadly the benefits and drawbacks of NSF centers and ways to make them more efficient and useful. He gave a presentation on the variety of ways that CNS-ASU has worked with graduate student scientists and engineers to better understand the context in which they work and how CNS-ASU helps them to develop the ability to communicate with a broad array of audiences. (Corley also participated in the workshop but did not present CNS-related material.) Both of these skills ultimately will help students develop practical applications of their theoretical work and enable them to work with institutions and policymakers to make such innovations a reality. A number of participants were enthusiastic about the talk including Lynn Preston, the NSF leader of the Engineering Research Centers Program, who remarked that the types of education programs that CNS-ASU runs are what she's been encouraging all center directors to develop and implement without much success.

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. Along with the nano-silver demonstration, NanoFutures was presented at the Jul 08 "Triple Play Days." Visitors could interact with the projected website and view a series of four large posters which explained the project and the scenes in accessible ways, including through a scene illustrated as a comic book storyboard (illustrated in 07 by a CNS-ASU student in InnovationSpace). The ReLANS network – an international group of scholars and others in Latin America interested in nanotechnology-in-society issues – has an ongoing interest in using the NanoFutures scenes in their outreach activities. The Center has translated the scenes into Spanish and more extended stakeholder engagement with the scenes is under development. Dr. Fern Wickson, Centre for the Study of the Sciences and the Humanities University of Bergen, is considering with European partners how to develop a deliberative platform for nano consumer goods and is discussing the idea of using scenarios and images online to help stimulate dialogue modeled after the NanoFutures project. As reported last year, the scenes developed by NanoFutures were featured in the materials provided to participants of the NCTF and have given shape to many of our Science Cafés, held at the local science museum.

Public and Policy Presentations

CNS-ASU researchers have made numerous presentations to public audiences, including some 26 cumulatively to specifically policy audiences and 20 to lay audiences. Beyond those mentioned above, highlights in YR 4 include:

- Fisher's (Nov 08) participation in the European Commission's Deliberation on the Implementation of a Code of Conduct and Fostering International Dialogue and Collaboration;
- Guston's (Jun 08) presentation to a delegation visiting from Japan to learn about technology assessment practices in the US; and Shapira's (Mar 09) presented to this same delegation in Tokyo on CNS-ASU and distributed technology assessment;

- Sarewitz's (Sep 08) presentation on science policy and innovation to the US President's Council of Advisors for Science and Technology;
- Wetmore's (Nov 08) presentation on "Nanotechnology – The Promise, Politics, and Personal Impact" to the Women's Symposium of the Bureau of Jewish Education of Greater Phoenix; and
- Fisher's (Nov 08) presentation to a joint meeting of the Environmental Professionals of Arizona / Academy of Certified Hazardous Materials Managers.

Integration

National Nanotechnology Infrastructure Network

CNS-ASU has developed and piloted training modules in the ethical and societal implications of nanotechnology for scientists and engineers working in user facilities at the Department of Energy's Center for Integrated Nanotechnologies (CINT) and the National Nanotechnology Infrastructure Network (NNIN). (Much of the DOE/CINT activities occurred in previous reporting years and have not continued in the current year for want of new users at CINT.)

For NNIN, CNS director Guston, with Douglas Kysar, the (now former) coordinator for societal and ethical issues of nanotechnology at the NNIN at Cornell (now at Yale) and Ana Viseu, formerly of Cornell and now at the University of Toronto, created a training video for users of NNIN facilities last year. Kysar and Guston signed a Memorandum of Understanding in Oct 07 outlining the collaboration over the training module. In prior years, the first version of the PPT presentation of the module was created, reviewed at CNS-ASU, piloted at Cornell, and distributed to NNIN users. Individual work by the participants of the group, as well as the Miller et al. (2007) working paper, were influential in framing the training. Other groups – including the Woodrow Wilson International Center – have expressed interest in helping to disseminate it.

This year, NNIN user facilities were strongly encouraged to use the video, and a survey was conducted to evaluate their experience. Respondents at 9 of 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.

Overall, survey respondents agreed that the content was important and worthwhile and should be taught to new users. They responded neutrally when asked if the video generated significant discussions about social and ethical issues in nanotechnology. Some indicated ways in which the current presentation could be enhanced, e.g., providing a clearer connection to lab work; making the presentation more engaging; making concepts less abstract and less dense; using better examples; and providing interactive content. Only one site of the eleven provides an exit survey. That exit survey indicated that 90% feel that the video helps them better understand social and ethical issues in nanotechnology. A majority of respondents rated it either "excellent" (6%) or "very good" (48%), while 44% rated it "average" and 2% "poor." Interestingly, among exit survey respondents, 10% indicated that they had either never been asked about social and ethical issues or rarely discussed them (32%), while 40% indicated that they had had a prior class on the topic, and 18% said they were commonly discussed in their lab. This may suggest the need for two levels of user training: one for individuals with more advanced prior training and one for users with little or no prior exposure to these issues.

In the future, we plan to produce a packet for trainers and a web site with a third layer of depth for further inquiry by interested parties. Planning for this work has now begun with a new coordinator for social and ethical issues at the NNIN, Katherine McComas, who joined NNIN in F 08. We also plan on working closely with Thornton, who is the PI on the new ASU node of the NNIN, and Prasad, who is the node's point of contact for SEI issues. These plans are described in the renewal proposal, but they generally include expanding our education and integrative outreach activities already performed at ASU to local NNIN participants and users, as well as having the ASU node explore the SEI interests of their users. Activities piloted with the ASU node can also be offered to the larger network.

Tubes in the Desert

In the Tubes project, CNS-ASU collaborates with a major, use-inspired project on biofuels in the Biodesign Institute in collaboration with British Petroleum. In a Dec 08 activity that was both research and outreach (of both the engagement and integration type) Conz moderated a focus group of eight local participants randomly sampled from Census data profiles developed by graduate students Bhadra and Moore. The focus group was funded by the Biodesign Institute and administered by the Institute for Social Science Research at ASU. Conz and Ovitt, director of marketing and public relations at Biodesign, co-developed the focus group questions with input from CNS-ASU faculty and Tubes researchers. This form of public engagement, though limited to 8 participants, was designed to not only cultivate dialog between local residents and CNS-ASU, but to provide input directly to Tubes researchers. In this sense, the level of integration in development, production, and analysis between CNS and Tubes was relatively high for an outreach activity. Public participants (who did not know the topic of the focus group upon arrival) reported very high levels of interest in and support for microbial biofuels, low levels of concern for GMOs used to produce fuel feedstocks, high levels of trust in scientists and engineers (although they wanted a specific timeline for results), and very low levels of trust in oil companies. Ovitt and Conz will present the findings of the focus group at an upcoming Tubes All Hands meeting.

Hispanic Research Center

In Sp 09 CNS decided to try a new approach in our partnership with the Hispanic Research Center (HRC). Because of the success of the one-credit courses that CNS has been running for graduate student scientists and engineers, we decided to run a short course with the graduate fellows supported by HRC. The result was a 7-week course, entitled "Introduction to Making STEM Research Socially Relevant," led by Wetmore and Bennett. Twenty-four students from under-represented groups (mostly African American and Hispanic) completed the course, which looked at science policy, the social implications of science and technology, and equity issues in science and technology. A highlight of the course was a guest presentation by Claire Gordon, Senior Research Scientist at the US Army Natick Research Center who works to make military (and civilian) clothing, equipment, and workstations better fit the body shapes and sizes of people of different genders and ethnicities. Three of the students from this course have applied to participate in the "Science Outside the Lab" workshop in Washington DC. The course was also used as a way to pilot the assessment procedures of ASU's NSF Ethics Education for Science and Engineering (ESEE) grant.

Georgia Tech Research Integration

RTTA 1/1 researchers have held exploratory meetings with individual NSE researchers at GA Tech including Jud Ready (senior research engineer jointly appointed to Materials Science and GA Tech Research Institute), Jochen Teizer (professor in Civil and Environmental Engineering), David Gottfried (senior research scientist and manager of the NNIN user facility at GA Tech). These meetings entailed introducing CNS-ASU projects and activities to the researchers, learning about the NSE research they

conduct, discussing opportunities for joint research projects (in the case of Teizer and Dr. Ready), arranging opportunities to speak at nanotechnology outreach events, and exploring interest in ASU's PhD+ concept (which is being developed for GA Tech). Several tangible outcomes have resulted from these meetings. RTTA 1/1 researchers are scheduled to present our work to the Nano@Tech series Aug 09; there is a joint project between Porter and Ready; a small proposal for funding was submitted to support joint work between RTTA 1/1 and Teizer; Gottfried has included discussion of CNS-ASU's activities on his blog (<http://nanotechmusings.blogspot.com/2009/04/nanotechnology-and-social-sciences.html>); and Ready expressed enthusiastic support to participate in the PhD+ initiative.

American University, Cairo

CNS researchers Bennett and Wetmore gave a series of lectures to science students and faculty at the American University in Cairo (AUC), Egypt. The talks with the students focused on issues of the governance of technology as well as regulation and policy, while the faculty seminar was about non-traditional science careers and the non-technical skills needed to be successful in them (as well as in traditional science careers). Discussion in the faculty seminar became quite animated about how to teach students when their home country has no science jobs for them after they graduate. This discussion has led to a developing collaboration between the Chemistry Department at AUC and CNS-ASU to help provide training and tools for science students at AUC. One concrete outcome from the visit was the commitment from the chair of the host department, J. Ragai, to send two or three of his students to the DC summer session planned for Jun 09

Research Integration Presentations

CNS-ASU researchers have made a cumulative 28 presentations to audiences with a specifically technical orientation. Beyond those mentioned above, highlights in YR 4 include:

- Bennett's (Mar 09) presentation on CNS-ASU's research and educational program at the annual meeting of the American Chemical Society;
- Corley's (Jul 08) presentation at the Young Scientists Nanotechnology Workshop at the French Embassy in Washington, DC;
- Scheufele's keynote on public perceptions of nanotechnology at the NSF Workshop on the Future of Education in Materials, Washington, DC; and
- Shapira and colleagues' (Mar 09) presentations on CNS and its research at the Chinese Academy of Sciences.

Workshops with Colleagues

Gordon Research Conference

Guston co-chaired the 2008 Gordon Research Conference (GRC) on Science and Technology Policy on "Governing Emerging Technologies," held in Big Sky, MT in Aug 08. Support for the conference came in part from CNS-ASU but also from a separate NSF award (# 0750075), the Greenwall Foundation, the Office of the President of Arizona State University, the V. Kann Rasmussen Foundation, Rice University/ICON, the CNS-UC/SB, Nature Publishing Group, Cell Publishing, and the Gordon Research Conferences itself.

The GRC included a diverse group of forty presenters and discussion leaders and approximately fifty additional presenters of posters. The program is available at <http://www.grc.org/programs.aspx?year=2008&program=scipolicy>. CNS-ASU participants in the

program included Hamlett, Selin and Sylvester, and in the poster session included faculty Cozzens, Fisher, McGregor, Selin, and Wetmore, post-doc Gatchair, and students Barandiaran, Garay, Hays, Lidberg, Maricle, Anderson, and Valdivia. In large part because of the diverse and interdisciplinary perspectives that generous funding allowed us to recruit, attendees were quite enthusiastic about their experiences at the meeting. But because GRC meetings are off-the-record and no proceedings are published, we are limited in our ability to report outcomes beyond GRC-structured evaluations and informal feedback from participants.

On overall quantitative evaluations conducted by GRC (N=117 of 130):

- 82% of respondents felt strongly or very strongly that “presentations were at the frontier of the field;”
- 90% of respondents felt strongly or very strongly that “the Conference was thought provoking, stimulating, exciting;”
- 80% of respondents felt strongly or very strongly that “discussions evoked and explored new directions;”
- 79% of respondents felt strongly or very strongly that there was a “good selection of topics” and a “good selection of speakers;”
- 88% of respondents felt strongly or very strongly that “the Conference met my expectations;” and
- 66% of respondents felt strongly or very strongly that “this was the best Conference in the field I attended this year.”

A selection of unsolicited comments includes:

“I just wanted to write...to say thanks for the conference, and the invitation to give a talk – it was great to connect with such a diverse group of scholars in the field, and to hear some inspiring discussions....” – Scott Vrecko, London School of Economics.

“Kudos on a terrific conference and panel! I found the conference enjoyable and educational and am pleased to have been part of it.” – George Kimbrell, International Center for Technology Assessment.

“I want to add my thanks...for the terrific conference – great panel presentations and wonderful opportunity to network and make new connections!” – Mary Saunders, National Institute of Standards and Technology.

“I wanted to thank you very much for putting on a great conference and for giving me the opportunity to participate. I thoroughly enjoyed the talks, the discussions, and the informal interactions with an eclectic and inspiring group of people. I take many new insights back to my practice of working with diverse groups of stakeholders on complex policy issues.” – Rex Raimond, Meridian Institute.

Workshop on Nanotechnology, Equity, and Equality

From November 20-22, 2008 TRC 1 leaders Wetmore and Cozzens organized and hosted a 3-day workshop co-sponsored by Project Resultar at the Technology Policy and Assessment Center (GA Tech). The workshop 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 (including CNS’s Benn, Youtie, Robert, and Lidberg, and WWIC/PEN’s Michelson). Some were very knowledgeable about

equity and technology but had not yet examined nanotechnology specifically (including Laurel Smith-Doerr, Dean Nieuwma, Jennifer Rogers, John Wooding, Mark Knell, and CNS-ASU postdoc Harsh). Some had already worked on linking nanotechnology and equity (including CNS's Sarewitz, Slade, Wolbring, Bal, Foladori, Valdivia, and David Grimshaw, Sonia Gatchair, Rinie van Est, Luciano Kay, Noela Invernizzi, and Dhanaraj Thakur). The workshop also included several scientists and engineers developing cutting edge technologies (including Benn, Woodbury, and Helms-Tillery). 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.

Socio-Technical Integration Research (STIR) Workshop 1

In Jan 09, Fisher conducted the first of several planned workshops as part of the NSF STIR project (#0849101). The 3-day workshop included a graduate student training day, preparatory and visioning exercises, discussions and presentations. Over 30 people participated in the workshop including: an international selection of senior scholars (De Marchi, deLeon, Horst, Pandza, Queraltó, Rabinow, Rip, Woodhouse); CNS-ASU faculty (Conz, Fisher, Guston, Miller); doctoral student investigators (Bhadra, Calleja, Conley, Kim, Phelps, Schuurbijs, Stavrianakis, Thoreau, Van Oudheusden, Zhu); scientists and engineers who will host and interact with project investigators (Kibel, Posner, Spencer, Vermaas, Woodbury); and graduate student note takers (Luk, Schwartz). The workshop set the stage for the 3-year project by laying out the objectives of the project, methodologically preparing participating doctoral students for their comparative laboratory studies, and further establishing an international network of scholars interested in the links between interdisciplinary collaborations and responsible innovation. The STIR project is itself a manifestation of this network which, through Fisher's leadership, has maintained extensive contact with over 20 laboratory directors from around the world.

Ethics Education in Science and Engineering (EASE) Workshop

In Feb 09, the NSF EASE project (#0832944) "Integrating Microethics and Macroethics in Graduate Science and Engineering Education: Development and Assessment of Instructional Models" convened a 3-day workshop at ASU with logistical and administrative support from CNS. This workshop kicked off the 3-year project by bringing together the project's advisory board (Rachelle Hollander, Nick Steneck, and Deborah Johnson), four consultants from across the country (Kristin Kulinowski, Dean Nieuwma, Sarah Pfatteicher, and Karl Stephan), and four visiting observers (Alice Pawley, Ken Pimple, Jason Borenstein, and Peter Asaro). The ASU faculty involved in the project were Herkert, Canary, Ellison, Wetmore, Allenby, Bennett, McGregor, Posner, Williams in addition to Fisher and Miller who are assisting with the project. The group received feedback on all four educational models that it is developing in conjunction with CNS: stand alone courses, online courses, embedded in required course, and laboratory engagements. Most importantly there was an extensive discussion about the necessity and difficulties of assessing what students ultimately get out of ethics education.

Manchester Workshop

Shapira co-organized an international colloquium at the University of Manchester, UK, on nanotechnology, policy and society in Oct 08 (with partial support from the UK Department for Environment, Food, and Rural Affairs and the UK Nanotechnology Transfer Network). Several CNS-ASU researchers participated, including Guston, who gave a keynote video presentation. Shapira is planning a second follow-up workshop in Fa 09.

Wisconsin Innovation Network Workshop

Scheufele organized a workshop in Sep 08 dealing with the value of high-quality public opinion survey research for companies in the tech sector. This workshop was hosted by the Wisconsin Innovation Network and focused on opportunities for systematic, long-term collaborations between CNS-ASU at UW researchers and Wisconsin tech-based businesses. This workshop was also designed as a first step toward creating a Center for Public Opinion and Technology Transfer that would foster collaborations between researchers and Wisconsin businesses. Since then, Scheufele has spoken to a number of other business organizations to build support for the center and present CNS-ASU research to a wider corporate audience.

Medical Diagnostics Workshop

In follow up to the Nov 07 CNS and Biodesign Institute sponsored “The Future of Medical Diagnostics” Workshop, Selin prepared a workshop report (Selin 2008) for distribution. In Dec 08, the CNS-ASU Report was distributed to a targeted list of nearly fifty private sector entities including medical diagnostics industry associations, trade publications, technology developers and proteomics researchers, as well as to approximately twenty public sector biomedicine and health policy makers. Celia Merzbacher, formerly of OSTP and NNCO, specifically requested the report to distribute to President's Council of Advisors on Science and Technology (PCAST) members interested in the topic.

Presentations to academic and professional audiences

CNS-ASU researchers have made more than 120 cumulative presentations to collegial academic and professional audiences. Beyond those mentioned above, highlights in YR 4 include:

- Cobb and Hamlett's (Jun 08) presentation on the NCTF to the Tenth International Conference on Public Communication of Science and Technology in Denmark and Sweden;
- Graduate student Conley's (Apr 09) presentation on local nano regulations to the Midwestern Political Science Association;
- Guston's (Jul 08) keynote on CNS-ASU to the annual meeting of the NanoNed Flagship TA and Societal Aspects of Nanotechnology group in the Netherlands;
- Graduate student Hays' (Mar 09) presentation on Nietzsche and human enhancement to the NanoEthics Working Group Conference at Western Michigan University;
- Graduate student Valdivia's (Jun 08) presentation on inequality and nanotechnology at the Workshop on Inequality and Emerging Technologies in Malta; and
- Presentations (May 08) by Shapira, Youtie and Carley; Fernandez-Ribas and Shapira; Porter and Rafols; Iacopetta; and Graham at the National Bureau of Economic Research (NBER) Conference on Emerging Industries: Nanotechnology and NanoIndicators in Cambridge, MA.

Planned workshops

European Union funding has been received through the EU Center at GA Tech for a US-EU young scholar's workshop on nanotechnology research and innovation assessment, followed by a US-EU comparative nanotechnology research policy workshop, to be held in Atlanta in Mar 10 in collaboration with CNS-ASU and its RTTA 1.

The STIR project of RTTA 4 will hold its second workshop in Norway in Su 08 with the intention of bringing together its cohort of doctoral students, most of whom will have completed their first semester of laboratory study, for discussion of preliminary experiences and findings.

RTTA 3/1 will organize a workshop in Fa 09 on “plausibility,” which its research has identified as a key and under-developed concept in scenario development and futures thinking. It will be organized in close collaboration with scholars from the Institute for Science, Innovation and Society at Oxford University.

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 will disclose 15 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 has 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.

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).

As detailed in the supplement proposal (#0936064), the specific tasks expected to be coordinated by the post-doctoral researcher include:

- Interact with the International Council on Nanotechnology (ICON). CNS-ASU is in the midst of preparing a brief background paper for ICON on social risk. ICON and CNS-ASU expect the paper will be a point of potential interaction between the two groups. When completed later this spring, ICON will circulate the background paper to its membership, which includes many of the kind of private-sector interests that CNS-ASU should be engaging. The post-doctoral researcher will coordinate the Center’s interactions with ICON, including our possible presence at ICON’s annual meeting in Oct 09, and any follow-on activities with ICON and its members.
- Liaison with the GA Tech/RTTA 1 group. Currently, the Center’s RTTA program on research and innovation systems analysis is deeply involved in researching (through patent analysis) the activities of and interacting with the private sector. This program is now planning the creation of a research panel of nano firms to follow with quantitative and qualitative methods for the renewal period. The post-doc will liaison with the GA Tech group to explore the opportunities raised by its activities and translate them to further opportunities for other research projects in the Center (e.g., next two items).

- Engage with the private sector for NanoFutures. CNS-ASU has heretofore relied primarily on academic researchers for vetting its scenes of plausible future nanotechnologies. Along with NanoFutures leader Cynthia Selin, the post-doctoral researcher will design and execute a strategy more substantive involvement of experts from the private sector in these activities.
- Organize a interviews and engagements that investigate private sector analogues to anticipatory governance. CNS-ASU has developed a strategic vision of anticipatory governance – comprising foresight and anticipation, engagement with publics, and integration between NSE and the social sciences/humanities – that should have private sector analogues, ranging from market research to predictive forecasting. Along with Selin, the post-doc will identify appropriate firms and coordinate visits to investigate these analogous activities.
- Create a new private sector advisory committee. Based on these and other activities, the post-doc will develop an appropriate concept for the Center’s new private sector advisory committee – a Private Sector Engagement Committee – and identify and recruit appropriate members for serve on it. By the end of the post-doc’s first year (i.e., Su 10), CNS-ASU will have a dedicated meeting of this committee to set a more complete and coherent agenda for private sector engagement.

In addition to these specific tasks, 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 21 presentations to audiences with a specifically private sector/industrial orientation. Beyond those mentioned above, highlights in YR 4 include:

- Scheufele’s (Feb 09) presentation at the Food and Drug Law Institute, Washington, DC;
- Shapira’s (Apr 09) presentation at the NNI Workshop on Regional, State, and Local Initiatives in Nanotechnology, Oklahoma City;
- Hamlett and Cobb’s (May 08) presentation on the NCTF to the University and Industry Consortium meeting in E. Lansing, MI;
- Selin’s (April 09) presentation on “Using Scenarios to Manage Turbulence” at the Organizational Design Forum’s (ODF) annual conference; and
- Fisher’s (July 08) participation in the panel “Collaborations for Financial Success: Universities Collaborating with Government and the Private Sector” as part of the Denver, Colorado Nano Renewable Energy Summit.

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 also 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, CNS-ASU has hosted numerous visitors including well over 30 international scholars, students, and policy practitioners from more than 15 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 (who has a Fulbright scholarship to attend ASU and work with CSPO and CNS), Bal, Gatchair, Kay, Kim, Luk, and Schuurbiens (who receive some form of support from ASU or elsewhere, e.g. Georgia Tech); or international post-doctoral scholars such as Hannot Rodriguez Zabaleta who has an appointment 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, but not the other three scholar-practitioners from the Japanese delegation.

In Years 1-3, CNS-ASU was visited by eleven 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 4, eighteen visitors who fit the three criteria specified visited CNS-ASU, including:

1. Bruna De Marchi - Institute of International Sociology of Gorizia, Italy
2. Paul Ellwood - The University of Leeds, United Kingdom
3. Guillermo Foladori - Universidad Autonoma de Zacatecas, Mexico
4. Silvio Funtowicz - European Commission, Italy
5. Maja Horst - Copenhagen Business School, Denmark
6. Mitsuaki "Mickey" Hosono - Tokyo Institute of Technology, Japan
7. Noela Invernizzi - Federal University of Parana, Brazil
8. Beate-Josefine Luber - University of Bielefeld, Germany
9. Rohan Nelson - CSIRO Sustainable Ecosystems, Australia
10. Krsto Panzda - The University of Leeds, United Kingdom
11. Ramon Queralto Moreno - University of Sevilla, Spain
12. Arie Rip - University of Twente, The Netherlands
13. Roger Strand – University of Bergen, Norway
14. Tatsujiro Suzuki - The University of Tokyo, Japan
15. Francois Thoreau - University of Liege, Belgium
16. Rinie van Est - Rathenau Institute, The Netherlands
17. Michiel van Oudheusden - Universiteit Antwerpen, Belgium
18. Brian Wynne – Lancaster University, United Kingdom

These visitors consist of faculty, students, and policy practitioners who come from twelve countries. Of these, eleven are faculty from academic institutions in nine nations. Four of these have published articles or have articles under review that cite Center published research or otherwise grew out of their interactions with the Center. Six of these faculty members have returned for follow-up visits, at least one has participated in Center activities organized elsewhere, and at least three have hosted Center researchers who were visiting them in their native countries. Five are collaborators on the separately-funded STIR project. One of these visitors was part of a delegation on a fact finding mission, some were conducting research, and still others came to present their research to one of our groups and/or participate in a Center-organized workshop. From their accounts to us we learn that CNS-ASU has “a clear presence and high reputation in Europe,” that it conducts “theoretically ground-breaking work,” and that 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 the delegation of Japanese researchers “had a chance to visit the US, CNS-ASU was certainly the place to visit (on their so-called “not-to-miss” list).” These visitors have stated that collaborating with CNS-ASU “is considered strategic” for their institutions and is viewed as “of critical importance to our research projects.”

Four of these visitors were students. A total of four students – three doctoral students and one masters student – from four academic institutions in three countries spent time with us. One has an article forthcoming that was shaped in a significant way by work at CNS-ASU, has returned for a second visit, and has hosted two Center researchers who were visiting in his home country. Three are participating in



the STIR project and the fourth has taken a class while here. Thus, all received mentorship from CNS-ASU researchers. From their accounts, we learn that CNS-ASU has provided them 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.”

Three of the international visitors to the Center in Year 4 were policy practitioners: one works for a publicly funded technology assessment institution, one holds a position in the European Commission, and one is with Australia’s national science agency. At least one has hosted Center faculty within his home country, two have been involved in Center activities organized elsewhere, and one has returned for follow-up visits. From their accounts we learn that the Center 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 4 by these and other international visitors to the Center and that stemmed from or were shaped by their visits include:

1. Horst, M. (2010, forthcoming). Taking Our Own Medicine: On an Experiment in Science Communication. *Science and Engineering Ethics*.
2. Laurent, B. (2010, forthcoming). Scholarly intervention in public engagement: The example of nanotechnology policy in France. *Science and Engineering Ethics*.
3. Laurent, B. and **Fisher, E.** (Under Review). Integration Discourses: Neo-determinism, Reflexivity, and Mainstreaming STS. *Science, Technology and Human Values*.
4. Schuurbiens, D. (2008). *Ethics in Action*. Awarded the Mekelprize 2008 for PhD students of the Platform for Ethics and Technology.
5. Schuurbiens, D. (2009, March). In Amerika. A tryptic on daily life at ASU for *TU Delta*, the weekly magazine of Delft University of Technology.
6. Schuurbiens, D. and **Fisher, E.** (in press). Laboratory-scale Intervention. *EMBO Reports*.
7. Schuurbiens, D., Osseweijer, P. and Kinderlerer, J. (2009, forthcoming). Implementing the Netherlands Code of Conduct for Scientific Practice—A Case Study. *Science and Engineering Ethics*.
8. Smits, R.; van Merkerk, R.; **Guston, D.H.**; and **Sarewitz, D.** (2009, in Press). “Strategic Intelligence: The Role of TA in Systemic Innovation Policy” in *The International Handbook of Innovation Policy*. Northampton, MA: Edward Elgar.
9. te Kulve, H. and Rip, A. (2010, forthcoming). Constructing Productive Engagement: Pre-engagement Tools for Emerging Technologies. *Science and Engineering Ethics*.
10. 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 4 visits also led to several instances of knowledge transfer, dissemination, and application. These include an attempt to mimic CNS-ASU at Tokyo Tech, the uptake of anticipatory techniques from RTTA 3 and integrative techniques from RTTA 4 in a collaborative project in Norway, and the fact that “knowledge that CNS-ASU has generated is being actively transferred and applied in Australia – in both research and policy.”

Plans for future visits are underway, with a number of potential new and returning international visitors currently planning multiple month visits including, for example, Tsalling Swierstra (Twente University), Matthew Kearnes (Durham University), Silvio Functowitz (European Commission), Ulrich Fiedeler (Institute of Technology Assessment), Michiel van Oudheusden (Antwerp University), Francois Thoreau (Liege University).

14. Personnel

CNS-ASU has experienced some modest personnel changes that are being implemented with this annual report. 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 (Guston, Sarewitz, Miller, Poste, Carlson, and Corley), plus senior investigator Allenby. The Executive Committee meets once per semester.

Sarewitz is now based in the Washington, DC office of the Consortium for Science, Policy, and Outcomes (CSPO), but he is in e-mail contact with Guston daily and telephone contact with him weekly. Miller and Guston work together on a daily basis.

Director Guston has 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 Iafra, Administrative Associate, who reports to the Program Manager. In Aug 09, the Center will hire 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 from the last annual report include:

- E. Corley is added to RTTA 4 to represent collaboration on the content analysis project and the Center's aspirations to take advantage of her evaluation skills in the broader reflexivity context..

CNS continued to have a monthly telephone conference among center principals, including the leadership of each of the RTTAs and TRCs, throughout much of YR 4.

Guston is in additional contact with most program and project leaders about specific elements of their work on a frequent but as-needed basis, e.g.,:

- Monthly or more often interactions with RTTA 1 Shapira, generally about the uses to which the nano databases are being put;
- Monthly interactions with RTTA 1/2 leader Bozeman about progress on Public Value Mapping, including meetings at ASU twice in the last year;
- Monthly interactions with RTTA 1/3 leader Van Horn or his staff about their progress on the workforce and education reports;
- Weekly interactions with RTTA 2 leader Scheufele around the analysis of and publications from the first group of surveys and planning for the second group;
- Daily direct contact with Selin, leader of RTTA 3/1 scenario development activities;

- Weekly interaction with RTTA 3/2 InnovationSpace leader Boradkar, including two personal appearances in the fall semester and two in the spring semester in the class;
- Monthly interaction with RTTA 3/4 leader Hamlett over the National Citizens' Technology Forum follow-on;
- Daily direct contact with RTTA 4 leader Fisher on plans for annual interviews, etc.;
- Daily direct contact with Wetmore, and monthly interaction with Cozzens, co-leaders of TRC 1; and
- Weekly direct contact with Robert, and regular email contact with Fujimura, co-leaders of TRC 2.

CNS-ASU also communicates internally through a listserv dedicated to CNS-ASU affiliated personnel at all its institutions, and through an electronic newsletter describing (retrospectively and prospectively) CNS activities that has been less active in YR 4 than hoped. While graduate student Roxanne Wheelock had been our acting communication coordinator, she withdrew from the position for personal reasons, and we have not replaced her yet.

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 and staff), CNS-affiliated universities (researchers and students), and others in the nano-in-society field.

CNS-ASU Organizational Structure – April 2009

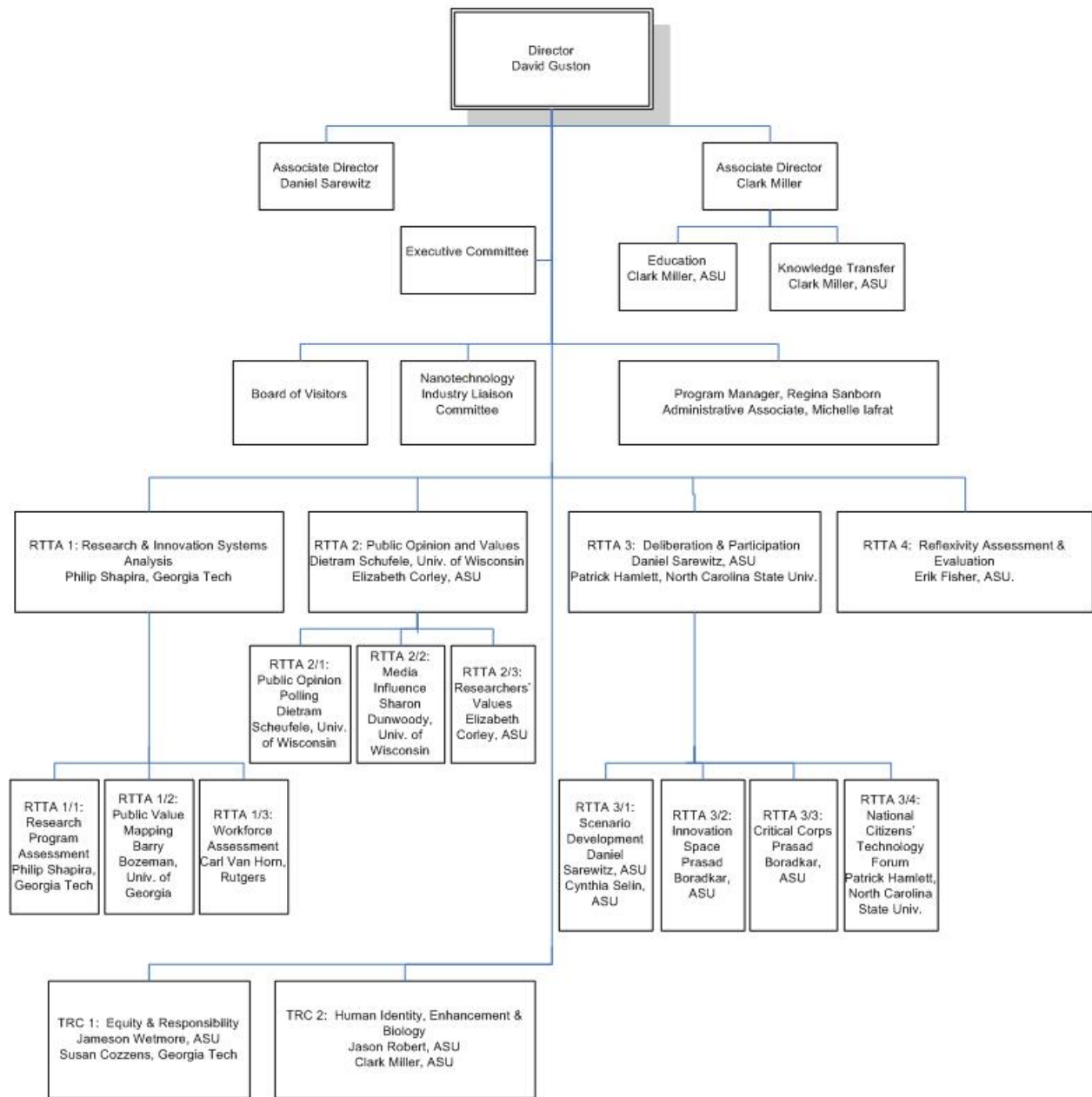


Table 4A: NSEC Personnel, Irrespective of Citizenship

Personnel Type	Total	Citizenship Status																% NSEC Dollars
		Gender		U.S. Citizen or Permanent Resident										Other Non-US	*Ethnicity Hispanic	Disabled		
		Male	Female	Race					Fixed-Incl/Not Provided									
NA	PI	AA	C	A	NA,PI,AA	C,A	Not Provided											
Director	1	1	0	0	0	0	0	1	0							0		
Asc. Dir.	1	1	0	0	0	0	0	1	0							0		
Team Leaders	9	6	3	0	0	0	0	8	1							0		
Staff	2	0	2	0	0	0	0	2	0							0	100%	
Collaborators	94	66	28	0	0	1	75	7				6			5		0%	
Research																		
Post Docs	7	3	4	0	0	0	3	4								0		
Doc/Mas. Students	80	43	37	1	0	1	38	24				7			9			
Undergraduate Students	13	8	5	0	0	0	10	0							3		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	207	128	79	1	0	2	138	36				13			17			

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

Personnel Type	Total	Gender		Race						fixed-ind		Not Provided	Other Non-US	*Ethnicity Hispanic	Disabled	% NSEC Dollars
		Male	Female	NA	PI	AA	C	A	NA,PI,AA,C,A	NA,PI,AA,C,A						
Director	1	1	0	0	0	0	1	0						0		
Asc. Dir.	1	1	0	0	0	0	1	0						0		
Team Leaders	9	6	3	0	0	0	8	1						0		
Staff	2	0	2	0	0	0	2	0						0		100%
Collaborators	94	66	28	0	0	1	64	0			29			0		
Research																
Post Docs	7	3	4	1	0	1	2	0			3			0		
Doc/Mas. Students	80	43	37	0	0	0	29	3			48			0		
Undergraduate Students	13	8	5	0	0	0	10	0						3		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	207	128	79	1	0	2	117	4			80			3		

15. Publications and Patents

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

Books

1. ‡**Fisher, E., Selin, C. and Wetmore, J.** (eds.). (2008). *Yearbook of Nanotechnology in Society, Volume I: Presenting Futures*. D.H. Guston (series editor). New York: Springer.
2. ‡**Guston, D.H.** (ed.). (In preparation). *Encyclopedia of Nano-science and Society* (two volumes). Thousand Oaks, CA: Sage Publications.
3. ‡**Miller, C. and Barben, D.** (eds.). (2011, in preparation). *Yearbook of Nanotechnology in Society, Volume IV: Nanotechnology and Democracy*. D.H. Guston (series editor). New York: Springer.
4. **Robert, J.S.** (Under contract). *Chimeras, Cyborgs, and the Moral Limits of Science*. Prescott, AZ: One World Press.
5. ‡**Robert, J.S., Miller, C. and Bennett, I.** (ed.). (2009, in preparation). *Yearbook of Nanotechnology in Society, Volume II: Nanotechnology, the Brain and the Future*. D.H. Guston (series editor). New York: Springer.
6. ‡ **Cozzens, S. and Wetmore, J.** (eds.). (2010, in preparation). *Yearbook of Nanotechnology in Society, Volume III: Nanotechnology, Equity and Equality*. D.H. Guston (series editor). New York: Springer.
7. **Wetmore, J.** and Johnson, D.G. (2008). *Technology and Society: Building our Sociotechnical Future*. Cambridge, MA: MIT Press.

Peer Review Journal Articles

1. Abbot, K.W., **Marchant, G.E.** and **Sylvester, D.J.** (2006). "A Framework Convention for Nanotechnology?" *Environmental Law Reporter*, 36, 10931-10942.
2. Alencar, M.S.M., **Porter, A.L.** and Antunes, A.M.S. (2007). "Nanopatenting Patterns in Relation to Product Life Cycle." *Technological Forecasting & Social Change*, 74(9), 1661-1680.
3. Alencar, M.S.M., Antunes, A.M.S. and **Porter, A.L.** (2007). "Patents on Nano and the Life Cycle & Value Chain Analysis of Related Products." *China Intellectual Property*, 865-866.
4. ‡**Bennett, I.** and **Sarewitz, D.** (2006). "Too Little, Too Late? Research Policies on the Societal Implications of Nanotechnology in the United States." *Science as Culture*, 15(4), 309-325.
5. ‡**Brossard, D., Scheufele, D.A.,** Kim, E. and Lewenstein, B.V. (2008). "Religiosity as a Perceptual Filter: Examining Processes of Opinion Formation about Nanotechnology." *Public Understanding of Science*.
6. Brown, M. and **Guston, D.H.** (2009, forthcoming). "Science, Democracy, and the Right to Research." *Science and Engineering Ethics*, 15(2).

7. ‡**Corley, E.A., Scheufele, D.A.** and Hu, Q. (Under review). “Of Risks and Regulations: How Leading U.S. Nano-Scientists Form Policy Stances about Nanotechnology.” *Journal of Nanoparticle Research*.
8. ‡**Delborne, J.A.**, Anderson, A.A., **Kleinman, D.L.**, Colin, M. and Powell, M. (Under review). “Virtual Deliberation? Prospects and Challenges for Integrating the Internet in Consensus Conferences.” *Public Understanding of Science*.
9. ‡**Fernandez-Ribas, A.** and **Shapira, P.** (2009). “Technological Diversity, Scientific Excellence and the Location of Inventive Activities Abroad: The Case of Nanotechnology.” *Journal of Technology Transfer*, 34(3), 286-303.
10. ‡**Fisher, E.** (Under review). “Integration Discourses: Neo-determinism, Reflexivity, and the Mainstreaming of Science Studies.” *Science, Technology and Human Values*.
11. ‡**Fisher, E.** (2007). “Ethnographic Invention: Probing the Capacity of Laboratory Decisions.” *NanoEthics*, 1(2), 155-165.
12. ‡**Fisher, E.** and Lightner, M. (Under review). “An Overlooked Responsibility: The Informed Consent of Graduate Engineering Researchers.” *Science and Engineering Ethics*.
13. ‡**Fisher, E.** and **Mahajan, R.L.** (2006). “Nanotechnology Legislation: Contradictory Intent? U.S. Federal Legislation on Integrating Societal Concerns into Nanotechnology Research and Development.” *Science and Public Policy*, 33(1), 5-16.
14. ‡**Fisher, E.**, **Mahajan, R.L.** and **Mitcham, C.** (2006). “Midstream Modulation of Technology: Governance from Within.” *Bulletin of Science, Technology and Society*, 26(6), 486-496.
15. ‡**Graham, S.** and **Iacoppetta, M.** (2009, forthcoming). “Nanotechnology and the Emergence of a General Purpose Technology.” *Les Annales d'Economie et de Statistique*.
16. ‡**Greenwood, P.**, Wang, X., **Selin, C.** and Panjwani, A. (Under review). “Privacy or Security? An Evaluative Model of Surveillance, Social Values and Technological Change.” *Technological Forecasting and Social Change*.
17. Heinze, T., **Shapira, P.**, **Rogers, J.D.** and **Senker, J.M.** (2009, forthcoming). “Research Creativity: An Exploration of Pathbreaking Science.” *Research Policy*.
18. ‡**Ho, S.S.**, **Scheufele, D.A.** and **Corley, E.A.** (Under review). “Communication Effects on Attitudes toward Nanotechnology: Experts versus Public Attitudes toward Nanotechnology.” *Communication Research*.
19. **Hogle, L.F.** (2006). “Enhancement Technologies and the Body.” *Annual Review of Anthropology*. W. Durham, J. Comaroff and J. Hill (eds.). Palo Alto, CA: Annual Reviews of Anthropology and Neuroscience, 34, 695-716.
20. ‡**Kay, L.** and **Shapira, P.** (2009, forthcoming). “Developing Nanotechnology in Latin America.” *Journal of Nanoparticle Research* (Online First, September 2008).

21. ‡Kim, E.S. (2008). “Directed Evolution: A Historical Exploration into an Evolutionary Experimental System of Nanobiotechnology, 1965-2006.” *Minerva*, 46(4), 463-484.
22. ‡Kleinman, D.L., Delborne, J. and Anderson, A. (Under review). “Engaging Citizens: The High Cost of Citizen Participation in High Technology.” *Public Understanding of Science*.
23. ‡Laurent, B. (2007). “Diverging Convergences.” *Innovation: The European Journal of Social Science Research*, 20(4), 343-357.
24. Laurent, B. and Fisher, E. (Under review). “Integration Discourses: Neo-determinism, Reflexivity, and the Mainstreaming of Science Studies.” *Science, Technology and Human Values*.
25. Lee, C. and Scheufele, D.A. (2006). “The Influence of Knowledge and Deference toward Scientific Authority: A Media Effects Model for Public Attitudes toward Nanotechnology.” *Journalism & Mass Communication Quarterly*, 83(4), 819-834.
26. Marchant, G.E. and Sylvester, D.J. (2006). “Transnational Models for Regulation of Nanotechnology.” *Journal of Law, Medicine, and Ethics*, 34(4), 714-725.
27. Maricle, G. (2010, forthcoming). “Unassigned and Unassumed Responsibilities: Integration of the Human and Social Sciences into Nanotechnology Research Priority Decisions,” *Science and Engineering Ethics*.
28. ‡McGregor, J. and Wetmore, J. (2009). “Researching and Teaching the Ethics of Social Implications of Emerging Technologies in the Laboratory.” *Nanoethics*, 3(1), 17-30.
29. ‡Miller, C.A. and Bennett, I. (2008). “Thinking Longer Term about Technology: Is there Value in Science Fiction-inspired Approaches to Constructing Futures?” *Science and Public Policy*, 35(8), 597-606.
30. Molin, C. and Selin, C. (Under review). “Institutionalizing Innovation: Instances of Changes in the Danish System of Innovation.” *Research Policy*.
31. ‡Monahan, T. and Wall, T. (2007). “Somatic Surveillance: Corporeal Control through Information Networks” *Surveillance and Society*, 4(3/4).
32. ‡Philbrick, M. and Barandiaran, J. (Under review). “The National Citizens’ Technology Forum: Lessons for the Future.” *Science and Public Policy*.
33. ‡Porter, A.L. and Youtie, J. (2009, forthcoming). “How Interdisciplinary is Nano?” *Journal of Nanoparticle Research*.
34. ‡Porter, A.L. and Youtie, J. (2009, forthcoming). “Locating Nanotechnology among the Disciplines, 2009.” *Nature Nanotechnology*.
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36. ‡Scheufele, D.A., Corley, E.A., Dunwoody, S., Shih, T-J, Hillback, E. and Guston, D.H. (2007). “Nanotechnology Scientists Worry about Some Risks More than the General Public.” *Nature Nanotechnology*, 2(12), 732-734.

37. ‡**Scheufele, D.A., Corley, E.A.**, Shih, T-J, Hillback, E., Dalrymple, K. E. and Ho, S.S. (2009). “Religious Beliefs and Public Attitudes toward Nanotechnology in Europe and the United States.” *Nature Nanotechnology*, 4(2), 91-98.
38. Schuurbiens, D., Osseweijer, P. and Kinderlerer, J. (2009, forthcoming). “Implementing The Netherlands’ Code of Conduct for Scientific Practice – A Case Study.” *Science and Engineering Ethics*.
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2. ‡**Scheufele, D.A.** and Brossard, D. (2008). “Nanotechnology as a Moral Issue? Religion and Science in the U.S.” *AAAS Professional Ethics Report*, 21(1), 1-3.
3. ‡**Scheufele, D.A. and Corley, E.A.** (2008). “The Science and Ethics of Good Communication.” *Next Generation Pharmaceutical*, 4(1), 66.

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1. ‡**Corley, E.A., Scheufele, D.A.** and Hu, Q. (In progress). “Nano-scientists’ Perceptions about Nanotechnology: Media, the Public and Risk Communication.” *Issues in Science and Technology*.
2. ‡**Fisher, E.** (2006). “Embedded Nanotechnology Policy Research.” *Ogmios*, 14, 3-4.
3. ‡**Fisher, E.** and Bird, S. (eds.). (2010, forthcoming). “Introduction: Science and Technology Policy in the Making: Observation and Engagement.” Special Issue of *Science and Engineering Ethics*.
4. ‡**Guston, D.H.** (2008). “Innovation Policy: Not Just a Jumbo Shrimp.” *Nature*, 454, 940-41.
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9. ‡Robert J.S. (2008). Review of *Nanoethics*, F. Allhoff, P. Lin, J. Moor and J. Weckert (eds.). *Studies in Ethics, Law, and Technology*, 2.1, Article 10. Online journal available at: <http://www.bepress.com/selt/vol2/iss1/art10>.
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2. ‡Barben, D., Fisher, E., Selin, C. and Guston, D.H. (2008). “Anticipatory Governance of Nanotechnology: Foresight, Engagement, and Integration.” In E.J. Hackett, O. Amsterdamska, M.E. Lynch and J. Wajcman (eds.) *The Handbook of Science and Technology Studies, Third Edition* (pp. 979-1000). Cambridge, MA: MIT Press.
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5. ‡Fisher, E. (2007). “The Convergence of Nanotechnology, Policy, and Ethics.” In M. Zelkowitz (ed.) *Advances in Computers 71: Nanotechnology* (pp. 274-296). London: Academic Press (Elsevier).
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Collaboration: Trading Zones and Interactional Expertise, Inside Technology Series. Cambridge, MA: MIT Press.

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11. ‡**Guston, D.H.**, Parsi, J. and Tosi, J. (2007). “Anticipating the Political and Ethical Challenges of Human Nanotechnologies.” In P. Lin and F. Allhoff (eds.) *Nanoethics* (pp. 185-97). New York: Wiley.
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19. ‡**Robert, J.S.** (2008). “Nanoscience, Nanoscientists and Controversy.” In F. Allhoff and P. Lin (eds.) *Nanoethics: Emerging Debates*. New York: Springer.
20. ‡**Sarewitz, D.** and **Guston, D.H.** (2008). “Public Engagement as Scientific Responsibility.” In D. Bennett-Woods (ed.) *Nanotechnology: Ethics and Society*. New York: CRC Press.
21. ‡**Scheufele, D.A.** (2006). “Messages and Heuristics: How Audiences Form Attitudes About Emerging Technologies.” In J. Turney (ed.) *Engaging Science: Thoughts, Deeds, Analysis and Action* (pp. 20-25). London: The Wellcome Trust.
22. ‡**Selin, C.** (2007). “Professional Dreamers: The Past in the Future of Scenario Planning.” In B. Sharpe and K. van der Heijden (eds.) *Scenarios for Success: Turning Insight into Action*. London: Wiley.
23. ‡Smits, R., van Merkerk, R., **Guston, D.H.** and **Sarewitz, D.** (2009, in press). “Strategic Intelligence: The Role of TA in Systemic Innovation Policy.” *The International Handbook of Innovation Policy*. Northampton, MA: Edward Elgar.
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25. ‡**Youtie, J.** and **Shapira, P.** (2009, under review). “Nanotechnology Trajectories, Metropolitan Development and Equity.” *Yearbook of Nanotechnology in Society, Volume III: Nanotechnology, Equity and Equality*. D.H. Guston (series editor). New York: Springer.

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1. ‡**Bhaskarabhatla, A.** (2006). *Spatial Analysis of Nanotechnology Enterprises in the U.S.: Structure and Location*. Master of Science in Public Policy (MSPP), Thesis. Georgia Tech School of Public Policy (Supervisor: P. Shapira). Atlanta, GA.
2. ‡**Brants, T.** (2009). Undergraduate Honors Thesis. Innovation Space, Arizona State University. Tempe, AZ.
3. ‡**Burdis, C.M.** (2008). *Nanotechnology and Electricitrees: A Strategic Plan for a Future-Oriented Technology and Product*. Undergraduate Honors Thesis. The Barrett Honors College, Arizona State University. Tempe, AZ.
4. ‡**Davis, R.W.** (2007). *Nanotechnology in Society: Stakeholder Analysis and Nanotechnology Stakeholders*. Undergraduate Honors Thesis. The Barrett Honors College, Arizona State University. Tempe, AZ.
5. ‡**Finney, S.** (2007). *Multinational Comparative Analysis of Nanotechnology Research: 1990 to 2005 Knowledge Flow Assessment*. Undergraduate Honors Paper. Georgia Tech (Supervisor: J Youtie). Atlanta, GA.
6. ‡**Fisher, E.** (2006). *Midstream Modulation: Integrating Societal Considerations Into and During Nanotechnology Research and Development: A Case Study in Implementing U.S. Federal Legislation*. Doctoral Dissertation. Environmental Sciences, University of Colorado. Boulder, CO.

7. ‡Fremling, A. (2008). *SCIO: An Innovative Health Product that Uses Nanotechnology to Monitor for Cancer*. Undergraduate Honors Thesis. Barrett Honors College, Arizona State University. Tempe, AZ.
8. Gallo, J. (2008). *Speaking of Science: The Role of the National Science Foundation in the Development of the United States Information Infrastructure*. Doctoral Dissertation. Media, Technology and Society, Northwestern University. Evanston, IL.
9. ‡Ho, S.S. (2008). *Value Predispositions, Communication, and Attitudes Toward Nanotechnology: The Interplay of Public and Experts*. Doctoral Dissertation. Philosophy, University of Wisconsin. Madison, WI.
10. Lappe, J. (2009, expected, May). *Photoreactivation and Positive Cell Selection for the Directed Evolution of Proteins*. Doctoral Dissertation. Chemistry and Biochemistry, Arizona State University. Tempe, AZ.
11. ‡Lee, C. (2008). *Innovation in Nanotechnology Services and Products: Strategic Marketing Plan*. Undergraduate Honors Thesis. Barrett Honors College, Arizona State University. Tempe, AZ.
12. ‡Leung, R. (2007). *Doing Nanotechnology in 21 Century China*. Doctoral Dissertation. Sociology, University of Wisconsin. Madison, WI.
13. ‡Lidberg, S. (2008). *Examining Potential Futures: A Designer's Toolbox for Identifying Potential Social and Cultural Implications*. Master's Thesis. School of Design, Arizona State University. Tempe, AZ.
14. ‡Lohmeier, S. (2008). *Innovation Space: Nanotechnology for Human Health*. Undergraduate Honors Thesis. Barrett Honors College, Arizona State University. Tempe, AZ.
15. ‡Lougee, M. *Bridging Technology and Environment to Provide Shelter for Natural Disaster Victims*. Undergraduate Honors Thesis. Innovation Space, Arizona State University. Tempe, AZ.
16. ‡Lowder, J. (2009). Undergraduate Honors Thesis. Innovation Space, Arizona State University. Tempe, AZ.
17. ‡Lull, M. (2008). *Innovation Space Strategic Marketing Plan for Braille PDA*. Undergraduate Honors Thesis. Barrett Honors College, Arizona State University. Tempe, AZ.
18. Maricle, G. (2008). *Shaping Science: How to Turn Science Studies into Science Action*. Doctoral Dissertation. Environmental Studies, University of Colorado. Boulder, CO.
19. ‡McIntosh, D. (2008). *Integrated New Product Development for Nanotechnology*. Undergraduate Honors Thesis. Barrett Honors College, Arizona State University. Tempe, AZ.
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23. ‡Schnell, D. (2008). *Innovation Space: Creating Sustainable Solutions with Nanotechnology, Energy, & Equity for Native Americans Living Off the Electricity Grid*. Undergraduate Honors Thesis. Innovation Space, Arizona State University. Tempe, AZ.
24. ‡Shaw, T. (2007). *An Innovation Space Addendum: An Analysis and Critique of the Dialog Design, with the Presentation of Alternate Designs and Implications*. Undergraduate Honors Thesis. The Barrett Honors College, Arizona State University. Tempe, AZ.
25. ‡Shih, T. (2009, expected Summer). *Public Opinion and Nanotechnology: Linking Psychological and Cultural Factors in Constructing an Integrated Theory of Public Understanding of Science*. Doctoral Dissertation. School of Journalism and Mass Communication, University of Wisconsin. Madison, WI.
26. ‡Silverman, A. (2007). *Healing the Blind? Perspectives of Blind Persons on Methods to Restore Sight*. Undergraduate Honors Thesis. The Barrett Honors College, Arizona State University. Tempe, AZ.
27. Spadola, Q. (2008). *Novel Approaches to DNA Sequencing*. Doctoral Dissertation. Department of Physics, Arizona State University. Tempe, AZ.
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29. Schuurbiens, D. (2009, expected). *Social Responsibility in Scientific Practice*. Doctoral Dissertation. Department of Biotechnology, Delft Technical University. Delft, The Netherlands.
30. ‡Tang, L. (2009, expected December). *US-China Scientific Collaboration and the Role of Knowledge Moderation in Nanotechnology Development*. Doctoral Dissertation. Georgia Tech School of Public Policy (Supervisor: P. Shapira). Atlanta, GA.
31. ‡Tassielo, L. (2009). Undergraduate Honors Thesis. Innovation Space, Arizona State University. Tempe, AZ.
32. van Merkerk, R. (2008). *Intervening in Emerging Nanotechnologies: A CTA of Lab-on-a-chip Technology*. Doctoral Dissertation. Innovation & Environmental Sciences, University of Twente. The Netherlands.
33. Verdiani, J. (2008). *Innovation Space*. Undergraduate Honors Thesis. The Barrett Honors College, Arizona State University. Tempe, AZ.
34. ‡Wang, J. (2007). *Resource Spillover from University to High Tech Industry: Evidence from New Nanotechnology Based Firms in the U.S*. Doctoral Dissertation. Public Policy, Georgia Tech School of Public Policy (Supervisor: P. Shapira). Atlanta, GA.

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1. ‡Anderson, A.A., Delborne, J.A., **Kleinman, D.L.**, Powell, M. and Colin, M., “Communication of Emerging Technologies: How Individuals Engage in Information Seeking in Deliberative Settings.” Working Paper.
2. ‡Carley, S. (2008). “RTTA1 Nanotechnology Research Publication Databases: Updated to 2008.” CNS-ASU Report # R08-0004.
3. ‡Carley, S. (2009, March). “Diffusion Indicators for Nanotechnology Research in the United States and Europe.” STIP Working Paper.
4. ‡**Fernández-Ribas, A.** and **Shapira, P.** (2008, January). “Technological Diversity, Scientific Excellence and the Location of Inventive Activities Abroad: The Case of Nanotechnology.” Working Paper Series, Number 541, Manchester Business School.
5. **Fernández-Ribas, A.** (2009). “Global Patent Strategies of SMEs in Nanotechnology.” STIP Working Paper.
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7. ‡**Hamlett, P.**, **Cobb, M.D.** and **Guston, D.H.** (2008). “National Citizens’ Technology Forum: Nanotechnologies and Human Enhancement.” CNS-ASU Report #R08-0003.
8. ‡McKeon, P. (2008, September). “Characterization of State-Level Nanotechnology Policy Initiatives and What It Means for Georgia.” STIP Working Paper.
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11. ‡**Miller, C.A.** (2006). “Nanotechnology in Society: A New Model of Anticipatory Governance,” Workshop on Societal Aspects of Nanotechnology, November 9, 2005, Barcelona. Workshop Report No. 8 (ECETOC: Brussels). CNS-ASU Report #R06-0002.
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13. ‡**Porter, A.**, **Youtie, J.** and **Shapira, P.** (2006). “Refining Search Terms for Nanotechnology.” Briefing Paper. CNS-ASU Report #R06-0003.

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17. ‡**Selin, C.** (In preparation). "Diagnosing Futures: Producing Scenarios to Support Reflexive Governance of Technology." *Social Studies of Science*.
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21. ‡**Shapira, P., Youtie, J.,** Bhaskarabhatla, A., Lamos, E., Malani, U., Slanina, J., Stephens, A. and Tang, L. (2006). "Connecting the Dots: Creating a Southern Nanotechnology Network," Southern Growth Policies Board and the Georgia Tech Program in Science, Technology and Innovation Policy. Southern Growth Policies Board, Research Triangle Park, NC.
22. ‡**Shapira, P., Youtie, J.** and Carley, S. (2008). "Prototypes of Emerging Metropolitan Nanodistricts in the United States and Europe." Working Paper. Georgia Tech Program in Science, Technology and Innovation Policy.
23. ‡Subramanian, V. (2009). "Active Nanotechnology – What Can We Expect? A Perspective for Policy from Bibliographical and Bibliometric Analysis." Working paper. Program on Nanotechnology Research and Innovation System Assessment, School of Public Policy and Enterprise Innovation, Georgia Institute of Technology.
24. ‡Subramanian, V., **Youtie, J., Shapira, P.** and **Porter, A.L.** (2009). "Is There a Shift to 'Active Nanotechnology'?" STIP Working Paper. (In preparation for submission to *J Nanoparticle Research*).
25. ‡Tang, L. and **Shapira, P.** (2007). "Networks of Research Collaboration in China: Evidence from the Emerging Domain of Nanotechnology." Working Paper. Under revision for journal submission.
26. ‡Tang, L. and **Shapira, P.** (2008). "Visualizing the Invisible College in China: Evidence from Nanotechnology Publication Activities, 1990-2006." STIP Working Paper.

27. ‡Valdivia, W. and **Guston, D.H.** (2006). “Public Value Mapping.” Workshop Report. CNS-ASU Report #R06-0004.
28. **Van Horn, C.**, et al. (Forthcoming). Education Report.

Internet Dissemination

Web site: <http://cns.asu.edu>

Nanofutures: <http://cns.asu.edu/nanofutures/>

NCTF: <http://cns.asu.edu/nctf/index.htm>

STIR: <http://cns.asu.edu/stir/>

Web site, Georgia Institute of Technology: <http://www.nanopolicy.gatech.edu/>

Web site, University of Colorado: http://sciencepolicy.colorado.edu/about_us/index.html

Web site: <http://studiesinthetranshuman.blogspot.com/>

D.H. Guston, NCLT podcast: <http://www.nanohub.org/resources/3270/>

D.H. Guston, “Nanotechnology and Public: Data for Decision Makers Briefing to the Congressional Nanotechnology Caucus” podcast: <http://president.asu.edu/node/661>

Web site, University of Wisconsin, Holtz Center: <http://www.sts.wisc.edu/index.html>

YouTube (animation): US Nanodistrict Development: 1990-2000,
www.youtube.com/watch?v=tpBxLGcFjug

Presentations (not including presentations internal to CNS by CNS personnel or those internal to reporting obligations to NSF)

1. **Allenby, B.** (2006, August). Chaired and contributed to a session entitled “Schumpeter’s Next Wave: Convergence of Nanotechnology, Biotechnology, Information Science, and Cognitive Science.” Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
2. **Barben, D.** (2006, August). “Visions of Nanotechnology in a Divided World: The Acceptance Politics of a Future Key Technology.” Panel Series on Social Studies of Nanotechnology at the Conference of the European Association for the Study of Science Technology (EASST), University of Lausanne, Switzerland.
3. **Barben, D.** and Laird, F. (2006, June). “Acceptance Politics of Contested Technologies: A Comparison between Nuclear Power, Biotechnology, and Nanotechnology.” Annual Meeting of the Science and Democracy Network, Kennedy School of Government, Harvard University, Cambridge, MA.
4. Benn, T. (2008, November). “The Transport of Nanomaterials in Various Environments.” Workshop on Nanotechnology, Equity, and Equality, Center for Nanotechnology in Society at

Arizona State University (CNS-ASU) and Project Resultar at the Technology Policy and Assessment Center Georgia Institute of Technology, Tempe, AZ.

5. **Benn, T., Wetmore, J. and Bennett, I.** (2008, July). “Nanosilver from Socks Into Wastewater.” Experiment Demonstration at the Arizona Science Center’s Triple Play Days, Phoenix, AZ.
6. **Bennett, I.** (2009, March). “Anticipatory Governance of Emerging Nanotechnologies.” American Chemical Society, Salt Lake City, UT.
7. **Bennett, I.** (2007). “Frozen in Time: A tour of Alcor Life Extension Foundation.” Spirit of the Senses, Scottsdale, AZ.
8. **Bennett, I.** (2007). “What if I Don’t Want My Advisor’s Job: Careers Outside (gasp) the Academic Laboratory.” Association of Women in Science Central Arizona Chapter, Tempe, AZ.
9. **Bennett, I.** (2006). “Emerging Technologies.” Spirit of the Senses, Phoenix, AZ.
10. **Bennett, I. and Selin, C.** (2006, November). “Visions of Nanotechnology.” CNS-ASU Science Café, Tempe, AZ.
11. **Brossard, D., Kim, E. and Scheufele, D.A.** (2007, May). “The Politics of Nanotech: Communication and Opinion Formation About Scientific Issues and Policies.” Paper presented to the annual convention of the International Communication Association, San Francisco, CA.
12. **Brune, D.C. and Conz, D.** (2006, October). “Alternative Fuels: What We Can Do (and Can’t Do) to Make Our Skies Blue Again.” CNS-ASU Science Café, Tempe, AZ.
13. **Carlson, M.P.** (2006, April). “An Overview of a Project to Improve Mathematics and Science Education for a Technical Society: Cognitive Research Informs Curriculum Development and Instructional Support.” Presented at the Materials Research Society Symposium on Education in Nanoscience and Engineering, San Francisco, CA.
14. **Carley, S.** (2007, October). “Nano Research Profiling on Demand.” Poster presentation on nanotechnology data mining techniques and applications at Atlanta Conference on Science, Technology, and Innovation Policy, Atlanta, GA.
15. **Cobb, M.** (2009, March). “Public Engagement: National Citizens’ Technology Forum.” Presented at the Nanotechnology and Public: Data for Decision Makers briefing to the Congressional Nanotechnology Caucus, Washington, D.C.
16. **Cobb, M.** (2009, January). “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.
17. **Cobb, M. and Hamlett, P.** (2008, June). “The First National Citizens’ Technology Forum on Converging Technologies and Human Enhancement: Adapting the Danish Consensus Conference in the USA.” Paper prepared for presentation at the Tenth International Conference on Public Communication of Science and Technology (PCST-10), Denmark and Sweden.

18. Conley, S. (2009, April). "Nanotechnology Policy in Cambridge, Massachusetts: Local Reflexive Governance." Midwest Political Science Association Conference, Palmer Hotel, Chicago, IL.
19. Conley, S. (2008, November). "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.
20. **Conz, D.** (2007). "Reflexivity Assessment of STS Engagement of Nanotechnology." Annual Meeting of the Society for Social Studies of Science, Canada, Montreal.
21. **Corley, E.A.** (2008, July). "Societal Dimensions of Nanotechnology: An Exploration of Public and Scientist Perceptions." Invited Presentation for Young Scientists Nanotechnology Workshop, French Embassy, Washington, D.C.
22. **Corley, E.A.** (2008, April). "Scientists and the Public: Comparing Views on Nanotechnology Risks and Regulations." CSPO Enlightening Lunch, Arizona State University, Tempe, AZ.
23. **Corley, E.A.** and **Scheufele, D.A.** (2008, February). "A Comparative Look at Markets, Media, and Emerging Attitudes about Nanotechnology." American Association for the Advancement of Science (AAAS) Annual Meeting, Boston, MA.
24. **Corley, E.A.** and **Scheufele, D.A.** (2006, November). "Factors Impacting Public Support of Federal Funding for Nanotechnology." Presented at the 28th Annual Association for Public Policy Analysis and Management Research Conference, Madison, WI.
25. **Corley, E.A., Scheufele, D.A., Dunwoody, S., Hillback, E., Shih, T.J.** and **Guston, D.H.** (2007, October). "Nanotechnology Attitudes among Scientists and the Public." Annual Meeting, Society for Social Studies of Science. Montreal, Quebec, Canada.
26. **Corley, E.A., Scheufele, D.A.** and Hu, Q. (2008, November). "Exploring Public and Scientist Attitudes About the Risks and Regulation of Nanotechnology Research: What Does the Future Hold for Policy-Making?" Presented to the annual convention of the Association for Policy Analysis and Management, Los Angeles, CA.
27. Dalrymple, K., **Scheufele, D.A.** and **Corley, E.A.** (2009, May). "Proximity to Experts? Rethinking Operationalizations of Cognitive Outcomes Based on Dual-source Measures." Paper presented at the International Communication Association (Mass Communication Division) Conference, Chicago, IL.
28. **Fernández-Ribas, A.** and **Shapira, P.** (2009, June). "Technological Diversity, Scientific Excellence and the Location Of Inventive Activities Abroad: The Case of Nanotechnology." Idem Academy of International Business, San Diego, CA. (Accepted for competitive presentation.)
29. **Fernández-Ribas, A.** and **Shapira, P.** (2008, May). "Technological Diversity, Scientific Excellence and the Location of Inventive Activities Abroad: The Case of Nanotechnology." National Bureau of Economic Research (NBER) Nanobank Conference, Boston, MA.
30. **Fichtner, A.** (2007). "Preliminary Results: The Workforce Needs of Companies Using Nanotechnology in Arizona." Nanotechnology 2007 Conference. San Jose, CA.

31. **Fisher, E.** (2009, March). "Socio-Technical Integration Research." Research Funding and the Good Life, University of Twente, The Netherlands.
32. **Fisher, E.** (2008, November). "Deliberation on the Implementation of a Code of Conduct and fostering International Dialogue and Collaboration." Expert Participant, European Commission, Brussels, Belgium.
33. **Fisher, E.** (2008, November). "Nanotechnology: Environment, Health, and Safety." Environmental Professionals of Arizona / Academy of Certified Hazardous Materials Managers, Tempe, AZ.
34. **Fisher, E.** (2008, October). "Laboratory Engagements: Risky Discourse and Research Decisions." Networks, Risk and Knowledge Sharing, University of Massachusetts, Amherst, MA.
35. **Fisher, E.** (2008, July). "Collaborations for Financial Success: Universities Collaborating with Government and the Private Sector." Panelist. The Nano Renewable Energy Summit, Denver, CO.
36. **Fisher, E.** (2008, July). "Midstream Modulation: Embedding the Humanities in Engineering Practice and Education." Kluver Colloquium, Delft Technical University, Delft, The Netherlands.
37. **Fisher, E.** (2008, April). "Embedded Humanists." *Engineering in Context*, Colorado School of Mines, Golden, CO.
38. **Fisher, E.** (2008, March). "Midstream Modulation and the Politics of Engagement." STS in Action, Claremont, CA.
39. **Fisher, E.** (2007). "Integrating Science and Society in the Laboratory." Presentation for the Center of Integrated Nanotechnologies.
40. **Fisher, E.** (2007). "Nanotechnology and Society: the Organization and Policy of Innovation." NNI Meetings & Symposia.
41. **Fisher, E.** (2007). "Social and Policy Issues in Nanotechnology." Presentation for the Center of Integrated Nanotechnologies.
42. **Fisher, E.** (2007, December). "Inventing the Socially Conscious Laboratory." Consortium for Science, Policy & Outcomes, Arizona State University, Tempe, AZ.
43. **Fisher, E.** (2007, September). "Integrating Social Considerations into Nanotechnology Research." 1st Rocky Mountain Nanotechnology Showcase, Denver, CO.
44. **Fisher, E.** (2007, August). "Broader Impacts and the Embedded Humanist." Making Sense of the "Broader Impacts" of Science and Technology.
45. **Fisher, E.** (2007, July). "Integrating Societal Considerations and Nanotechnology in the Four Corners Region." Colorado Nanotechnology Alliance, Denver, CO.

46. **Fisher, E.** (2007, June). “Drilling Down on U.S. Ethics Policy for Nanotechnology.” Center for Interdisciplinary Research (ZiF), Bielefeld University, Bielefeld, Germany.
47. **Fisher, E.** (2007, June). “Integrating Science and Society in the Laboratory.” Center for Integrated Nanotechnologies, Los Alamos National Laboratory, Los Alamos, NM.
48. **Fisher, E.** (2007, June). “Socio-technical Integration and the Nanotechnology Laboratory.” Visions about Nanoscience and Technology Workshop, Leuven, Belgium.
49. **Fisher, E.** (2007, June). “Investigating the Implementation of U.S. Ethics Policy for Nanotechnology.” Institute for Technology Assessment and Systems Analysis, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Karlsruhe, Germany.
50. **Fisher, E.** (2007, June). “Engaging the Reflexive Capacity of Nanotechnology Researchers.” Nanotechnology, Ethics & Sustainability; NANOMAT Conference, Bergen, Norway.
51. **Fisher, E.** (2007, June). “Socio-technical Integration at Macro and Micro Levels.” Rathenau Institute, Den Haag, The Netherlands.
52. **Fisher, E.** (2007, January). “Social and Policy Issues in Nanotechnology.” 5th CINT Users Workshop, Center for Integrated Nanotechnologies, Albuquerque, NM.
53. **Fisher, E.** (2006, November). “Current Societal Considerations in Nanotechnology.” Center for Integrated Nanotechnologies, Los Alamos National Laboratory, Los Alamos, NM.
54. **Fisher, E.** (2006, November). “Reflecting on the Shape of Nanotechnology Research from Within.” 4S Conference (Society for Social Studies of Science), Vancouver, Canada.
55. **Fisher, E.** (2006, September). “Socratic Engagement of Nanotechnology: A Case Study in Ethics Policy.” University of North Texas, Department of Philosophy and Religion Studies, Denton, TX.
56. **Fisher, E.** (2006, August). “From Upstream Engagement to Midstream Modulation: Shaping Technology from Within.” Poster presentation at the Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
57. **Fisher, E.** (2006, July). “Midstream Modulation: U.S. Federal Nanotechnology Policy Implementation.” TA NanoNed Day, Utrecht University, The Netherlands.
58. **Fisher, E.** (2006, May). “Midstream Modulation of Technological Trajectories.” Trading Zones and Interactional Expertise Workshop, Arizona State University, Tempe, AZ.
59. **Fisher, E., Anderson, D. and Reynolds, D.** (2008, August). “Mapping and Modulation: The Public Value of Academic Research.” Poster presentation at the Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
60. **Fisher, E. and Mahajan, R.** (2006 November). “Midstream Modulation.” International Mechanical Engineering Conference, Chicago, IL.
61. Gallo, J. (2007, October). “The National Science Foundation and the Creation of a Standing Army for Science.” Society for the History of Technology, Washington, D.C.

62. Gallo, J. (2007, April). "The National Science Foundation and the Control of Information." Department of Life Sciences Communication colloquium series, University of Wisconsin, Madison, WI.
63. Gao, Y., **Porter, A.** and Huang, L. (2009, April). "Nano-enhanced Thin-film Solar Cells: Global Activity and Forecast." Annual Conference of the International Association for Management of Technology, FL.
64. Garay, M. and **Fisher, E.** (2008, August). "NSECs and the Integration of Societal Concerns into R&D." Poster presentation at the Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
65. **Garcia, A.** and **McGregor, J.** (2008, October). "Will Genetic Discrimination Replace Racial Discrimination?" CNS-ASU Science Café, Tempe, AZ.
66. **Guston, D.H.** (2009, March). "Nano, Human Enhancement, and Public Engagement." Presented at the faculty seminar on transhumanism, Center for the Study of Religion and Conflict, Arizona State University, Tempe, AZ.
67. **Guston, D.H.** (2009, March). "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Presented at the Center for the Study of Institutional Diversity brown bag, Arizona State University, Tempe, AZ.
68. **Guston, D.H.** (2009, March). "Public Engagement: National Citizens' Technology Forum." Presented at the Nanotechnology and the Public: Data for Decision Makers briefing to the Congressional Nanotechnology Caucus, Washington, D.C.
69. **Guston, D.H.** (2009, March). "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Presented at the Department of Political Science brown bag, Arizona State University, Tempe, AZ.
70. **Guston, D.H.** (2009, March). "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Video lecture presented to graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.
71. **Guston, D.H.** (2008, September). "CNS-ASU and Nano in Society in the USA." Presentation for the Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK (by video).
72. **Guston, D.H.** (2008, July). "Reflections on CNS-ASU and Nano in Society in the U.S." Keynote talk at the Dutch NanoNed Flagship TA and Societal Aspects of Nanotechnology meeting, Utrecht, The Netherlands.
73. **Guston, D.H.** (2008, June). "The Center for Nanotechnology in Society at ASU and the Anticipatory Governance of Emerging Technologies." Presented at the Institute for Science and Technology Studies, Bielefeld University, Bielefeld, Germany.
74. **Guston, D.H.** (2008, June). "Anticipatory governance of Nanotechnologies: The Center for Nanotechnology in Society at ASU." Special talk for the visiting Japanese technology assessment delegation, Arizona State University, Tempe, AZ.

75. **Guston, D.H.** (2008, April). “Governing Emerging Technologies.” Arizona Institute of Nano-electronics opening ceremonies.
76. **Guston, D.H.** (2008, February). “Anticipatory Governance at the Center for Nanotechnology in Society at ASU.” Video lecture presented to graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.
77. **Guston, D.H.** (2007, November). “Towards anticipatory governance of emerging technologies” Special Series on Science and Public Policy, Brown University, Providence, RI.
78. **Guston, D.H.** (2007, November). “Governing Emerging Technologies.” Spirit of the Senses Salon, Phoenix, AZ.
79. **Guston, D.H.** (2006, December). “Anticipatory Governance of Emerging Technologies.” Monthly meeting of the Arizona Nanotechnology Cluster.
80. **Guston, D.H.** (2006, October). “Anticipatory Governance of Emerging Technologies: The Center for Nanotechnology in Society at ASU.” Stanford University Seminar in Science, Technology and Society, Stanford, CA.
81. **Guston, D.H.** (2006, August). “Anticipatory Governance of Emerging Technologies.” Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
82. **Guston, D.H.** (2006, May). “CNS-ASU: Interdisciplinary Programs in a Self-Styled Boundary Organization.” Conference of Trading Zones, Interactional Expertise, and Interdisciplinary Collaboration, Arizona State University, Tempe, AZ.
83. **Guston, D.H.** (2006, May). “What Do We Want to Learn from Public Participation in Nanotechnology?” NNI Public Participation in Nanotechnology Workshop, Arlington, VA.
84. **Guston, D.H.** (2006, April). “Social Science Engages Nanotechnology.” Invited talk at Virginia Tech, Blacksburg, VA.
85. **Guston, D.H.** (2006, February). “Anticipatory Governance at the Center for Nanotechnology in Society at ASU.” Video lecture presented to graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.
86. **Guston, D.H.** (2006, February). “Societal Implications of Nanotechnology Discovery Lecture Series 2006, Transforming Society Through Emerging Technologies: The National Nanotechnology Initiative at Five Years.” Purdue University, West Lafayette, IN.
87. **Guston, D.H.** (2006, February). “The Center for Nanotechnology in Society at ASU.” AAAS Annual Meeting 2006, Nanotechnology Seminar: Social Science Engages Nanotechnology, St. Louis, MO.
88. **Hamlett, P.** (2008, March). “Public Deliberations About Science and Technology: Should the Public Have a Say on the Future of Nanotechnology?” NSF Science and Technology Center Program, Center for Environmentally Responsible Solvents and Processes Innovation Seminar Series, North Carolina State University, Raleigh, NC.

89. **Hamlett, P.** and Cobb, M. (2008, August). “Reporting the Results of the first National Citizens’ Technology Forum.” Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
90. **Hamlett, P.** and Cobb, M. (2008, July). “The First National Citizens’ Technology Forum on Human Enhancement: Results and Prospects.” Paper presentation at VIPSI-2008 (Information Processing Society, International) Conference: “Knowledge Engineering, Tutorials, & Brainstorming,” Pisa, Italy.
91. **Hamlett, P.** and Cobb, M. (2008, May). “The First National Citizens’ Technology Forum on Nanotechnology – First Results.” University & Industry Consortium, Spring 2008 Meeting, Lansing, MI.
92. Hays, S. (2009, July). “Nietzsche and the Philosophical Underpinnings of Human Enhancement.” Presented at SPT 2009: Converging Technologies, Changing Societies. Society for Philosophy and Technology, University of Twente, The Netherlands.
93. Hays, S. (2009, March). “Transhumanism, Anti-humanism, and Nietzsche’s Overman.” Presented at Human Enhancement & Nanotechnology, Western Michigan University, Kalamazoo, MI.
94. **He, J.** and **Robert, J.S.** (2006, June). “Wiring Brains to Machines: Science Fiction or Science Fact?” CNS-ASU Science Café, Tempe, AZ.
95. **Hibner Koblitz, A., Greenwood, P.** and McNeill Bekki, J. (2008, March). “Women in Science: Various Issues and Viewpoints.” CNS-ASU Science Café, Tempe, AZ.
96. Ho, S.S., **Scheufele, D.A.** and **Corley, E.A.** (2009, May). “Making Sense of Policy Choices: A Closer Look at the Mediating Roles Of Elaborative Processing and Interpersonal Discussion on Public Perceptions of Nanotechnology.” Paper submitted for presentation at the annual convention of the International Communication Association, Chicago, IL.
97. Ho, S.S., **Scheufele, D.A.** and **Corley, E.** (2008, August). “Influences of Mass Media, Interpersonal Communication, and Cognitive Processing on Risks Versus Benefits Perception of Nanotechnology.” Presented to the annual convention of the Association for Education in Journalism and Mass Communication, Chicago, IL.
98. **Hogle, L.F.** (2007, March). “Stem Cells as a Study in Transience: A Future History.” Paper presented to the Max Planck Institute for the History of Science, on convergence of nanotechnologies with regenerative medicine and systems biology, Berlin, Germany.
99. **Holbert, K.** and **Miller, C.** (2008, January). “Why Not Nuclear Power? The Science and Politics Behind Nuclear Energy.” CNS-ASU Science Café, Tempe, AZ.
100. Huang, L., **Porter, A.** and Guo, Y. (2009, April). “Identifying the Role of Nanoparticles in Biosensors.” Annual Conference of the International Association for Management of Technology, FL.
101. **Johnston, S.** and **McGregor, J.** (2006, September). “Predicting Your Medical Future (Doc-in-a-Box).” CNS-ASU Science Café, Tempe, AZ.

102. Jung, R. and **Robert, J.S.** (2007, January). “Adaptive Technologies for the Central Nervous System: Are We Changing What It Means to be Human?” CNS-ASU Science Café, Tempe, AZ.
103. **Kambhampati, S.** and Calverley, D. (2007, November). “Do Robots Need a Bill of Rights? Implications of Artificial Intelligence.” CNS-ASU Science Café, Tempe, AZ.
104. Kay, L. (2008, January). “Nanotechnology in Latin America.” Paper presentation at the conference DRUID-DIME Academy Winter 2008 Ph.D. Conference on Economics and Management of Innovation and Organizational Change, Rebild, Denmark.
105. **Kim, M.** and **Boradkar, P.** (2007, September). “Designing Things: Balancing Beauty, Utility and Sustainability in Products.” CNS-ASU Science Café, Tempe, AZ.
106. Laurent, B. and **Fisher, E.** (2007, August). “The Integration of Public Input into the American Nanotechnology Federal Program: Meanings and Contradictions.” Third Living Knowledge conference, Ecoles des Mines, Paris.
107. Libaers, D. (2006, September). “The Role & Contribution of Foreign-born Scientists & Engineers to the U.S. Nano Science & Technology Research Enterprise.” 2006 Technology Transfer Society Conference, Atlanta, GA.
108. Lidberg, S. (2008, November). “Who Benefits? India's National Design Policy and the Setting of Designers' Priorities.” CNS Workshop on Nanotechnology, Equity and Equality, Tempe, AZ.
109. Lidberg, S. (2008, August). “Design Policy Around the Globe: How Developed and Emerging Markets are Using Design for Economic Competitiveness.” Poster presentation at the Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
110. Lidberg, S. (2008, March). “Examining Potential Futures: A Designer's Toolbox for Identifying Potential Social and Cultural Implications.” ST Global Conference, Washington, D.C.
111. **Lindsay, S.** (2006, March). “Humankind’s Future on the Head of a Pin: Nanotechnology – What is it? What can do it?” CNS-ASU Science Café, Tempe, AZ.
112. **Lindsay, S., Curtiss, R.** and **Guston, D.H.** (2007, May). “Forbidding Science: Is Some Science Just Too Dangerous?” CNS-ASU Science Café, Tempe, AZ.
113. **Lynch, J.** and **Samuelson, N.** (2009, February). “Evolution and Faith Revisited: Can the Two be Reconciled?” CNS-ASU Science Café, Tempe, AZ.
114. **Maracas, G., Phelan, P.** and **Allenby, B.** (2008, September). “Is Nanotechnology Good for Sustainability... or Not?” CNS-ASU Science Café, Tempe, AZ.
115. **Marchant, G.** (2006, July). “Nanotechnology Regulation: The United States Approach.” Monash University’s Conference on New Global Regulatory Frontiers: Evaluating what will work for Nanotechnology, Melbourne, Australia.
116. Maricle, G. (2008, January). “The State of Policy and Socio-Economic Research.” American Meteorological Society Annual Meeting, New Orleans, LA.

117. Maricle, G. (2007, December). “Shaping Science: Turing Science Studies into Science Action.” Center for Science and Technology Policy Research Noontime Seminar Series, Boulder, CO.
118. Maricle, G. (2007, October). “Wrestling with Engagement: Tools for Iterating Intervention in STS.” Society for the Social Studies of Science Annual Meeting, Montreal, Canada.
119. **McGregor, J.** and **Wetmore, J.** (2008, August). “Researching and Teaching the Ethics and Social Implications of Emerging Technologies.” Poster presentation at the Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
120. McKeon, P. (2008). “State-Level Nanotechnology Policy Initiatives and Implications for Georgia, September 23, 2008.” Nano@Tech, Atlanta, GA.
121. McKeon, P. (2008). “State-Level Nanotechnology Policy Initiatives and Implications for Georgia.” Fresh Perspectives on Economic Development, Georgia, Atlanta, GA.
122. **Meldrum, D.** and **Wetmore, J.** (2007, October). “‘Less is More’ Technology: Is Smaller and Cheaper Always Better?” CNS-ASU Science Café, Arizona Science Center, Phoenix, AZ.
123. Meng, Yu. (2009, April). “Female Involvement in Nanotechnology Patenting: Does it Make a Difference?” Workshop on Original Policy Research, Georgia Tech, School of Public Policy, Atlanta, GA.
124. **Miller, C.A.** (2007, April). “Commentary: The Law and the Future Brain.” U.S. District Court and Sandra Day O’Connor College of Law, Arizona State University, Tempe, AZ.
125. **Miller, C.A.** (2006, December). “Boundary Organizations: Strategies for Linking Knowledge to Action.” Workshop on Boundary Organizations, Tempe, AZ.
126. **Miller, C.A.** (2006, November). “Informing Anticipatory Governance of New and Emerging Technologies through Nanotechnology in Society Research.” Nanotechnology Informal Science Education Network.
127. **Miller, C.A.** (2006, October). “Reflexive, Anticipatory Governance of Science and Technology.” National Association of Schools of Public Administration and Affairs.
128. **Miller, C.A.** (2006, June). “Think Differently! Strategies for Success in Nano.” Food Research Institute, University of Wisconsin-Madison, Madison, WI.
129. **Miller, C.A.** (2006, April). “Nanotechnology in Society Education: Teaching the Mental Habits of Social Engineers and Critical Citizens.” Materials Research Society.
130. **Miller, C.A.** (2006, March). “Nanotechnology in Society.” Ohio State University, Columbus, OH.
131. **Miller, C.A.** and **Bennett, I.** (2009, March). “Imagining the Future: Can Science Fiction Help Us Govern Technology?” CNS-ASU Science Café, Phoenix, AZ.
132. **Miller, C.A.** and **Bennett, I.** (2007, April). “Science Fiction as Technology Assessment: Some Preliminary Thoughts on Anticipatory Governance for the Rest of Us.” Cornell University, Ithaca, NY.

133. Newman, N. (2006, November). “Nanotechnology research mapping and assessment,” STI Indicators Conference, Lueven, Belgium.
134. Newman, N. (2006, June). “Advancing Measures of Innovation: Knowledge Flows, Business Metrics, and Measurement Strategies.” Workshop on Research and innovation system assessment: a nanotechnology case study, National Science Foundation, Arlington, VA.
135. **Porter, A.L.** (2007, November). Keynote presentation. Conference on Competitive Intelligence, Madrid, Spain.
136. **Porter, A.L.** (2007, October). Public Lecture. Institute for S&T Information in Beijing, China.
137. **Porter, A.L.** (2006, November). “Mining Patents + Research Publications to Improve Technology Management: Nano Illustrations.” 2nd PATINEX Conference, Seoul, South Korea.
138. **Porter, A.L.** and **Patil, J.** (2007, March). “Where Is Nano Going?” Presented at Nano-Giga Challenges, Phoenix, AZ.
139. **Porter, A.L.** and **Rafols, I.** (2008, September). “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.” A Workshop at the National Science Foundation, Washington, D.C.
140. **Porter, A., Meyer, M.** and **Rafols, I.** (2008 May). “The Cognitive Geography of Nanotechnologies: Location and Knowledge Flows of Nano-Research in the Map of Science.” Presentation at the NBER Conference on Emerging Industries: Nanotechnology and NanoIndicators, Cambridge, MA.
141. **Porter, A.L., Shapira, P.** and **Youtie, J.** (2008, October). “Nano Social Science: An Emerging Specialization?” Nanotechnology and Society: Emerging Opportunities & Challenges – Networks, Risk and Knowledge Sharing, University of Massachusetts, Amherst, MA.
142. **Porter, A.L., Shapira, P.** and **Youtie, J.** (2006, September). “Defining the Nanotechnology Domain in a Real Time Technology Assessment,” Technology Transfer Society Annual Conference, Atlanta, GA.
143. **Porter, A.L., Youtie, J.** and **Shapira, P.** (2006, August). “Refining Search Terms for Nanotechnology.” Prepared for Presentation at the National Science Foundation.
144. **Porter, A.L., Youtie, J., Shapira, P., Schoeneck, D.J., Tang, L.** and **Mehta, P.** (2007, April). “Profiling Nano R&D.” Presented at Nano-Giga Challenges, Phoenix, AZ.
145. **Porter, A.L., Schoeneck, D.J., Bhaskarabhatla, A., Youtie, J.** and **Libaers, D.** (2006, May). “Explorations in Research and Innovation Systems Assessment: Where Is Nano Going?” The Atlanta Conference on Science and Technology Policy 2006 – US-EU Policies for Research and Innovation, Atlanta, GA.

146. **Porter, A.L.**, Schoeneck, D., Newman, N., **Shapira, P.**, **Youtie, J.** and Kolar, R. (2006, September). “Nano R&D Profiles: A Deeper Look.” Presented at International Conference on Science & Technology Indicators, Leuven, Belgium.
147. **Porter, A.L.**, Schoeneck, D.J., Newman, N., **Shapira, P.**, **Youtie, J.** and Kolar, R. (2006, September). “Nano R&D Profiles: A Deeper Look.” Presented at 2006 S&T Indicators Conference, Leuven, Belgium.
148. **Porter, A.L.**, Schoeneck, D., **Shapira, P.**, **Youtie, J.** and Kolar, R. (2006, September). “Defining the Nanotechnology Domain in Realtime Technology Assessment.” Presented at 2006 Technology Transfer Society Conference, Atlanta, GA.
149. **Posner, J.** and **Wetmore, J.** (2009, April). “Technologies of Distraction: Mobile Phones, iPods, and E-mail.” CNS-ASU Science Café, Phoenix, AZ.
150. **Rafols, I.**, Meyer, M., Park, J-H. and **Porter, A.L.** (2008, August). “The Cognitive Geography of Nanotechnologies: Location and Knowledge Flows of Nano-Research in the Map of Science.” Presented at Society for Social Studies of Science (4S), Rotterdam, The Netherlands.
151. **Rafols, I.** and **Porter, A.L.**, **Youtie, J.** and Tang, L. (2008, September). “Nanotechnology as a Multi-polar Science.” Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.
152. **Robert J.S.** (2009, January), “Technology and Human Enhancement: What’s the Connection?” Midwestern University, Glendale, AZ.
153. **Robert J.S.** (2007, June). “Braving the Brain.” Canadian Bioethics Society, Toronto, Canada.
154. **Robert J.S.** (2007, May). “Cyborgs, Ratbots, and Bionic Humans: Wiring Brains to Machines.” Discovery Center, Halifax, Nova Scotia, Canada.
155. **Robert J.S.** (2007, May). “Neural Interface Systems: Ethical and Conceptual Issues at the Frontier of Brain Repair.” Neuroethics Program, Stanford Center for Biomedical Ethics, Palo Alto, CA.
156. **Robert, J.S.** (2007, April). “Problematizing ‘Enhancement.’” Dartmouth College, Hanover, NH.
157. **Robert, J.S.** (2007, February). “Braving the World of Neurotechnology.” Health Law Institute Seminar Series, Dalhousie University, Halifax, Nova Scotia, Canada.
158. **Robert, J.S.** (2006, November). “Brain Repair and Neural Enhancement.” 4S Conference (Society for Social Studies of Science). Vancouver, Canada. (Session organized by Linda Hogle.)
159. **Robert, J.S.** (2006, October). “Nanotechnology, Neurotechnology, and Society.” *International Institute of Nanotechnology Symposium*, Northwestern University, Evanston, IL.
160. **Robert, J.S.** (2006, October). “Forbidden Science – Boundaries on New Emerging Science and Technology.” Presented at Jewish Women's Symposium, Tempe, AZ.

161. **Robert, J.S.** (2006, August). “Controversial Science, Controversial Scientists?” NABIS Conference, Chicago, IL.
162. **Rogers, J.** (2008, June). “Research Centers as Policy Tools in Emerging Technologies: Scientific and Technical Human Capital in Nanotechnology Centers in the U.S.” Chinese Academy of Sciences, Beijing, China.
163. **Rogers, J.** (2007, April). “The Role of Research Centers in the US Nanotechnology Initiative.” Workshop on Social Dimensions of Nanotechnology, Paris.
164. **Sarewitz, D.** (2008, October). “Paths to Outcomes Based Innovation Policy.” National Institutes of Health Science of Science Management Meeting, Bethesda, MD.
165. **Sarewitz, D.** (2008, September). “Science Policy and Innovation.” Presidential Council of Advisors on Science and Technology, Washington, D.C.
166. **Sarewitz, D.** (2007, November). “New Tools for Science Policy Making.” Harvard University Science, Technology, and Society Circle, Cambridge, MA.
167. **Sarewitz, D.** (2007, October). “Anticipatory Governance of Emerging Technologies: Competing Values, Irreducible Uncertainties, and Transformation Innovation.” University of Oviedo, Spain.
168. **Sarewitz, D.** (2007, October). “Technology and Effectiveness in Contested Political Settings, Center for Research on Energy, Environment, and Transportation.” (CIEMAT), Madrid, Spain.
169. **Sarewitz, D.** (2007, April). “Political Effectiveness in Science and Technology.” Workshop on Science and Social Values, Center for Interdisciplinary Research, Bielefeld University, Bielefeld, Germany.
170. **Sarewitz, D.** (2007, March). “Connecting Research to Social Outcomes.” Presentation to the University of Nebraska Board of Regents, Lincoln, NE.
171. **Sarewitz, D.** (2007, January). “Ways of Knowing Novel Materials, Symposium on Environmental Effects of Novel Materials and Processes.” Royal Commission on Environmental Pollution, London, England.
172. **Sarewitz, D.** (2006, August). Discussant: “Policy Perspectives” at the panel, “Meta-Analysis: Emerging Themes in Science Policy.” Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
173. **Sarewitz, D.** (2006, February). “Tools For Goldilocks: Rethinking the Relationships Among Research, Funding, and Progress.” AAAS Annual Meeting, Symposium on “The Goldilocks Dilemma Facing Science Funding: Can it be Just Right?” St. Louis, MO.
174. **Scheufele, D.A.** (2009, March). “Public Understanding of and Attitudes Toward Nanotechnology: An Overview.” Presented at the Nanotechnology and Public: Data for Decision Makers briefing to the Congressional Nanotechnology Caucus, Washington, D.C.
175. **Scheufele, D.A.** (2008, February). “A Comparative Look at Markets, Media, and Emerging Attitudes About Nanotechnology.” 90-minute panel organized for the annual convention of the American Association for the Advancement of Science, Boston, MA.

176. **Scheufele, D.A.** (2008, February). “Engaging Religious Audiences on Nanotechnology.” Presented to the annual convention of the American Association for the Advancement of Science, Boston, MA.
177. **Scheufele, D.A.** (2007, May). “Public Perceptions and Understanding of Nanotechnology.” Center for Nanoscale Science and Technology (CNST) Nanotechnology Workshop, University of Illinois, Urbana-Champaign, IL.
178. **Scheufele, D.A.** (2007). “How Media and Audiences Make Sense of Scientific Issues: The Case of Nanotechnology.” Talk at the CMCIS Research Lecture Series, University of South Carolina, Columbia, SC.
179. **Scheufele, D.A.** (2007). “Risky Business? Risk Perception & Nano Business.” Symposium panelist. Illinois Institute of Technology, Center on Nanotechnology and Society, Chicago, IL.
180. **Scheufele, D.A.** (2007). “Public Perceptions and Understandings of Nanotechnology.” Keynote presentation at the Nano and Giga Challenges in Electronics and Photonics conference, Tempe, AZ.
181. **Scheufele, D.A.** (2007). “Understanding the Opinion and Communication Dynamics Surrounding Nanotechnology.” Symposium on the Social Studies of Nanotechnology, University of Pennsylvania, Wharton School of Business & Chemical Heritage Foundation, Philadelphia, PA.
182. **Scheufele, D.A.** (2006). “Influences on Public Opinion About Nanotechnology.” Talk at the “Public Participation in Nanotechnology & Nanoscale Science” workshop, National Nanotechnology Coordination Office, Washington, D.C.
183. **Scheufele, D.A.** (2006). “It’s Not All About Information: Exploring People’s Attitudes Toward New Technologies.” Lecture at the Science, Democracy, and Public Policy colloquium, La Follette School of Public Affairs, University of Wisconsin, Madison, WI.
184. **Scheufele, D.A.** (2006). “Public Communication and Policy Making About Nanotechnology.” Talk at the “Baldwin Nano Workshop for Policy Makers, Materials Research Science and Engineering Center and Engineering Center on Nanostructured Interfaces, University of Wisconsin, Madison, WI.
185. **Scheufele, D.A.** (2006). “Successful Public Communication About Nanotechnology.” Talk at the Baldwin Nano Workshop for Journalists, Materials Research Science and Engineering Center and Engineering Center on Nanostructured Interfaces, University of Wisconsin, Madison, WI.
186. **Scheufele, D.A.** (2006). “Successful Public Communication About Nanotechnology.” Talk at the “Integration of Societal Implications into Science” workshop, U.S. Department of Energy, Washington, D.C.
187. **Scheufele, D.A.,** Brossard, D. and Dalrymple, K. (2007, November). “Whose Voice Matters Most? Public Opinion about the Role of Scientists, Religious Groups, Officials, and Citizens in Public Discourse about Science.” Presented to the annual convention of the Midwest Association for Public Opinion Research, Chicago, IL.

188. **Scheufele, D.A., Corley, E.A., Hillback, E., Shih, T., Dunwoody, S. and Guston, D.H.** (2007, October). “Nano Attitudes Among Scientists and the Public.” Presented to the annual convention of the Society for Social Studies of Science, Montreal, CA.
189. **Scheufele, D.A., Corley, E.A., Shih, T., Dalrymple, K.E. and Ho, S.S.** (2008, November). “Public Opinion Dynamics Surrounding Emerging Technologies in Europe and the U.S.” Presented to the annual convention of the Midwest Association for Public Opinion Research, Chicago, IL.
190. **Scheufele, D.A.** and Kim, E. (2006, May). “Public Opinion, Religiosity, and Nanotech: Examining Processes of Opinion Formation on Emerging Technologies.” Paper presented to the annual convention of the World Association for Public Opinion Research, Montréal, Québec, Canada.
191. **Selin, C.** (2009, April). “Using Scenarios and Foresight to Manage Turbulence.” Annual meeting of the Organizational Design Forum, Tacoma, WA.
192. **Selin, C.** (2008, May). Chaired panel, Managing the Uncertainty of Nanotechnologies, “Challenges to Law, Ethics, and Policy Making” conference at University of Padua, Padua, Italy.
193. **Selin, C.** (2008, February). “Evidencing the Future and other Dilemmas Working in the Future Tense.” Presented at the Anthropology Department, Rice University, Houston, TX.
194. **Selin, C.** (2007, October). “Between Hope and Prudence: Experiments in Scenaric Learning.” Society for the Social Studies of Science, Annual Meeting, Montreal, Canada.
195. **Selin, C.** (2007, October). “The Future Tense: The Ways and Means of Anticipation.” CSPO Enlightening Lunch, Tempe, AZ.
196. **Selin, C.** (2007, September). “The Future of Nano & Bio Technologies.” Chaired panel, CRN conference on Challenges & Opportunities, Tucson, AZ.
197. **Selin, C.** (2007, July). “Real Time Technology Assessment: Anticipation, Integration, & Engagement.” Presented at The Program on Technology Scenarios, Risoe, National Laboratory, Roskilde, Denmark.
198. **Selin, C.** (2007, April). “Hope and Prudence: Experiments in Scenaric Learning.” Presentation at the Futures of Life: Acquiring and Creating Anticipatory Knowledge, Cornell University, Ithaca, NY.
199. **Selin, C.** (2007, March). “Anticipatory Governance through Scenarios.” Presentation at Workshop on Global Environmental Futures: Interrogating the Practice and Politics of Scenarios, Watson Institute for International Studies, Brown University, Providence, RI.
200. **Selin, C.** (2006, September). “The Center for Nanotechnology in Society.” NanoTX Conference, Dallas, TX.
201. **Selin, C., Johnson, D., Manriquez, S., Ryan, T. and Zeise, L.** (2008, November). “Democratizing Science: Should the Public Have a Voice in Science Research and Development?” CNS-ASU Science Café, Arizona Science Center, Phoenix, AZ.

202. Shanley, L.A. (2006, June). "Privacy and Security: Internet Publication of Digital Spatial Data and Land Records in Wisconsin." Presentation at WLIA Regional Meeting on Privacy, Copyright, Data Distribution and GIS Law, Elkhart Lake, WI.
203. Shanley, L.A. (2006). "Control and Access: GIS Legal Issues for Indian Nations in the United States." In Proceedings from URISA 2006 Annual Conference, Chicago, IL.
204. Shanley, L.A. and Ventura, S.J. (2007). "Land Records and Map Services: Internet Privacy Policies in Wisconsin." Accepted for URISA 2007 Annual Conference, Chicago, IL.
205. **Shapira, P.** (2009, April). "State Models for Supporting Emerging Nanotechnology." Workshop on Regional, State and Local Initiatives in Nanotechnology, National Nanotechnology Initiative, Oklahoma City, OK.
206. **Shapira, P.** (2009, March). "Anticipating Nanotechnology: Real-Time Technology Assessment of Research and Innovation Systems." Invited presentation, School of Management and Economics, Knowledge Management and Data Analysis Laboratory, Beijing Institute of Technology, Beijing, China.
207. **Shapira, P.** (2009, March). "Anticipating Nanotechnology: Real-Time Technology Assessment and the Center for Nanotechnology in Society." Invited presentation, Institute for Future Technology (IFTECH), Tokyo, Japan.
208. **Shapira, P.** (2009, March). "Emergence of Distributed Technology Assessment in the USA: From OTA to the Center for Nanotechnology in Society." Invited presentation, International Workshop on Innovation and Institutionalization of TA in Japan, I2TA, University of Tokyo, Japan.
209. **Shapira, P.** (2007, June). "Nanotechnology in Society: Research and Innovation Systems Program Assessment." Invited presentation, Beijing Institute of Economic Management, Chinese Academy of Science, June 19, 2007; and at Institute of Policy and Management, Chinese Academy of Sciences, June 20, 2007, Beijing, China.
210. **Shapira, P.** (2007, February). "Societal Assessment of Nanotechnology – U.S. Experience." Symposium on Nanotechnology organized by the Ministry of Research, Science and Technology at the Advanced Materials and Nanotechnology (AMN-3) 2007 Conference, Wellington, New Zealand.
211. **Shapira, P.** and **Guston, D.H.** (2007, March). "Societal Assessment of Nanotechnology – US Experience." Invited presentation at the Ministry of Research, Science and Technology, Wellington, New Zealand.
212. **Shapira, P.** and **Porter, A.** (2009, March). "Nanotechnology: Will it Drive a New Innovation Economy for the U.S.?" Project on Emerging Nanotechnologies, Woodrow Wilson International Center for Scholars, Washington, D.C.
213. **Shapira, P.** and **Porter, A.L.** (2005, September). "Mapping the Nanotechnology Enterprise." Presented at American Political Science Association Annual Meeting, Washington, D.C.

214. **Shapira, P.** and **Youtie, J.** (2008, May). “What’s New About Emerging Metropolitan Nanodistricts in the United States and Europe? Characteristics of Research and Commercialization.” Presentation abstract accepted by the NBER Conference on Emerging Industries: Nanotechnology and NanoIndicators, Cambridge, MA.
215. **Shapira, P.** and Wang, J. (2008, April). “From Lab to Market: Strategies and Issues in the Commercialization of Nanotechnology in China.” 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.
216. **Shapira, P., Porter, A.** and **Youtie, J.** (2006, August). “Refining Search Terms for Nanotechnology.” Presented at the National Science Foundation.
217. **Shapira, P., Porter, A.L., Youtie, J.** and Tang, L. (2008, September). “Nanotechnology Questions, Methods, Metrics and Results: CNS.” Manchester International Workshop on Nanotechnology, Society and Policy, Manchester, UK.
218. **Suchman, M.C.** (2007). “The Implications of Nanotechnology for Social Science and Social Policy.” Presented to the Cornell CNF Public Interest Talk Series in Ithaca, NY.
219. **Suchman, M.C.** (2007). “Sharing is (S)caring on the Digital Frontier: The Challenges of Information Technology Governance in Health Care Organizations.” Presented to the Cornell Center for the Study of Economy and Society, 2006-2007 Seminar Series on Institutions, Market Processes, and the Firm, in Ithaca, NY; and to the Brown University Department of Sociology Colloquium in Providence, RI.
220. **Suchman, M.C.** (2007). “HIT or Miss? The Governance Challenges of Health Information Technology.” Presented to the Cornell Law School Faculty Workshop in Ithaca, NY; and to the Duke Law School Faculty Workshop in Durham, NC.
221. **Suchman, M.C.** (2006). “Taming the Market for Medical Information: Sharing is (S)caring' on the Digital Frontier.” Presented to the University of California-Irvine Critical Legalities Symposium in Irvine, CA.
222. van Merkerk, R., **Guston, D.H.** and Smits, R. (2006, November). “An International Comparison of Recent Technology Assessment Approaches: Bypassing Collingridge.” 4S Conference (Society for Social Studies of Science), Vancouver, British Columbia, Canada.
223. Tang, L. (2008, April). “Networks of Research Collaboration in China: Evidence from nanotechnology publication activities, 1990-2006.” Invited Presentation at the University of Maastricht, The Netherlands.
224. Tang, L. (2008, February). “Nanotechnology Knowledge Networks in China.” Invited participation and presentation at the PRIME Nanotechnology Winter School, Grenoble, France.
225. Tang, L. (2007, October). “Networks of Research Collaboration in China: Evidence from nanotechnology publication activities, 1990-2006.” Presentation at Atlanta Science and Technology Policy Conference, Atlanta, GA.
226. Tang, L. (2007, October). “New Argonauts & Scientific Networks: Evidence from China’s Nanotech Publication,” Atlanta Science and Technology Policy Conference. Atlanta, GA.

227. **Thorpe, M.** and **Laubichler, M.** (2007, April). "Reductionism and Emergence in Science: New versus Old Views of Nature and the Universe." CNS-ASU Science Café, Arizona Science Center, Phoenix, AZ.
228. Valdivia, W. (2008, August). "Technology, Growth, and Inequality." Poster presentation at the Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
229. Valdivia, W. (2008, June). "Inequality and Nanotechnology." Workshop on Inequality and Emerging Technologies, Valleta, Malta.
230. Valdivia, W. (2008, January). "Science Policy and Inequality." First Indo-American Institute of Nano-scale Science and Engineering, Chennai, India.
231. Valdivia, W. (2008, January). "Science Policy and Inequality: A Research Program." Invitation to NISTADS by Director Banerjee, New Delhi, India.
232. Valdivia, W. (2007, October). "Non-Cooperative Games in Science Policy." Atlanta Conference on Science and Innovation Policy, Atlanta, GA.
233. Valdivia, W. (2007, March). "Anticipatory Governance of Emerging Technologies." Invitation to Université de Lausanne by Director Kaufmann of Science-Society Interface, Lausanne, Switzerland.
234. **Vermaas, W., White, M.** and **Ritchie, B.** (2008, February). "Evolution and Faith: Room for Both." CNS-ASU Science Café, Arizona Science Center, Phoenix, AZ.
235. Wang, J. (2008, January). "From Lab to Market: Strategies and Issues in the Commercialization of Nanotechnology in China." Presentation at the National Academy of Sciences, Student Forum on Science and Technology Policy, Washington, D.C.
236. Wang, J. (2007, October). "Nanotechnology in China: Research, Development, and Commercialization." Atlanta Science and Technology Policy Conference, Atlanta, GA.
237. Wang, J. (2007, September). "From Lab to Market: Strategies and Issues in the Commercialization of Nanotechnology in China." Poster presentation at National Science Foundation, Science and Technology in the New Global Economy: Policy Workshop, Washington, D.C.
238. Wang, J. (2007, September). "From Lab to Market: Strategies and issues in the commercialization of nanotechnology in China." National Academy of Science, Conference on the Dragon and the Elephant: Understand the Development of Innovation Capacity in China and India, Washington, D.C.
239. Wang, J. (2006, September). "Resource Spillover from Academia to High Tech Industry: Evidence from nanotech start-up enterprises." 2006 Technology Transfer Society Conference, Atlanta, GA.
240. **Wetmore, J.** (2009, March). "Innovation and Graduate Education." Presented at Centers, Universities, and the Scientific Innovation Ecology: A Workshop, National Science Foundation, Arlington, VA.

241. **Wetmore, J.** (2008, December). “Amish Sociologists: Building Society with Technology.” National Nanotechnology Infrastructure Network, Indian Institute of Technology, Kanpur Winter School on Organic Electronics, Kanpur, India.
242. **Wetmore, J.** (2008, November). “Nanotechnology – the Promise, Politics, and Personal Impacts.” Presentation to the Women’s Symposium, co-sponsored by the Jewish Studies Department at Arizona State University and the Bureau of Jewish Education of Greater Phoenix.
243. **Wetmore, J.** (2008, August). “A Dialogue on Nanotechnology and Religion: Using Religious Expertise to Build Nanotechnology.” Poster presentation at the Gordon Research Conference on Science and Technology Policy, Big Sky, MT.
244. **Wetmore, J.** (2008, June). “The Challenge of Path Dependence.” IEEE Symposium on Technology & Society, Fredericton, New Brunswick, Canada.
245. **Wetmore, J.** (2008, April). “Ethics in Biotechnology.” Presentation in MBB 490: Capstone: Issues in Biotechnology, Arizona State University, Tempe, AZ.
246. **Wetmore, J.** (2008, April). “What do you Think About a Technology You Can’t Even See?” CNS-ASU Science Café, Arizona Science Center, Phoenix, AZ.
247. **Wetmore, J.** (2007, December). “Amish Technology.” Spirit of the Senses Salon, Phoenix, AZ.
248. **Wetmore, J.** (2007, November). ASB 591: Seminar on Professionalism, on the Academic job search.
249. **Wetmore, J.** (2007, October). “Building a Better Air Bag: the Continuing Search for a Technical Fix.” Mobility History, Heritage and Design Fifth Annual Conference on History of Transport, Traffic and Mobility (T2M), Helmond, The Netherlands.
250. **Wetmore, J.** (2007, September). “Bureaucrats, Lobbyists, and Regulators, Oh My! Introducing Graduate Students to Science Outside the Lab.” CSPO’s Enlightening Lunch, with Ira Bennett, Arizona State University, Tempe, AZ.
251. **Wetmore, J.** (2007, August). “Cat’s Cradle, by Kurt Vonnegut.” Spirit of the Senses Salon, Scottsdale, AZ.
252. **Wetmore, J.** (2007, June). “Teaching the Ethics and Social Implications of Emerging Technologies to Graduate Level Students.” With Joan McGregor, American Society for Engineering Education Annual Conference, Honolulu, HI.
253. **Wetmore, J.** (2007, March). “STS in the Trenches: Engaging Scientists and Engineers.” STS Engaged Workshop, University of Virginia Department of Science, Technology and Society.
254. **Wetmore, J.** (2007, February). “Nanotech and Religion: Ambitions, Influence, and Policy.” Invited presentation to CNS-UCSB, Santa Barbara, CA.
255. **Wetmore, J.** (2006, August). “Religious Forays into Nanotechnology Policy.” Poster presentation at the Gordon Research Conference on Science and Technology Policy, Big Sky, MT.

256. **Wetmore, J.** and Jacobs, B. (2007, March). “Transferring Western Technology to Developing Countries: Good Intentions, Unexpected Outcomes.” CNS-ASU Science Café, Arizona Science Center, Phoenix, AZ.
257. **Wolbring, G.** (2006, August). “Governance of nano-bio-info-cogno-synbio.” Presentation at NABIS Conference, Chicago, IL.
258. **Wolbring, G.** (2005, December). “The Triangle of Enhancement Medicine, Disabled People, and the Concept of Health: A New Challenge for HTA, Health Research, and Health Policy. Health Technology Assessment (HTA) Initiative #23.” Alberta Heritage Foundation for Medical Research, Edmonton, Alberta, Canada.
259. **Woodbury, N.** (2006, April). “Evolution on a Chip: Making Molecules Work for Us?” CNS-ASU Science Café, Arizona Science Center, Phoenix, AZ.
260. **Youtie, J.** (2009, January). “Center for Nanotechnology in Society.” Presented at Biotechnology and Public Policy Forum, Georgia Tech, Atlanta, GA.
261. **Youtie, J.** (2007, November). “Nanotechnology Workshop: Definitions, Directions, Debate.” Presentation at the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers, Atlanta, GA.
262. **Youtie, J.** (2007, October). “Nanodistricts in the United States: Metropolitan Trajectories and Clustering.” Presented at the Atlanta Conference on Science, Technology, and Innovation Policy, Atlanta, GA.
263. **Youtie, J.** (2006, October). “Nano Research Enterprise Assessment.” Workshop on Next Generation Metrics, SRI, Arlington, VA.
264. **Youtie, J.** (2006, September). “Searching for Nanotechnology: Explorations in Research and Innovation Systems.” Presented at Technology Transfer Society Annual Meeting, Atlanta, GA.
265. **Youtie, J.**, Iacopetta, M. and Graham, S. (2006, September). “Long Views of Nanotechnology: Is it a General Purpose Technology?” Technology Transfer Society Annual Conference, Atlanta, GA.

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 – New Senior Personnel

Andrea Fernandez-Ribas, Ph.D., is a Research Associate in the School of Public Policy and Enterprise Innovation Institute at the Georgia Institute of Technology. She received her Ph.D. in Economics and Business Sciences from the Universitat Autònoma de Barcelona, Spain in 2004.

Fernandez-Ribas' current research interests include microeconomics of innovation, technological and non-technological innovation, regional innovation, corporate R&D, emerging technologies, and emerging markets.

She was a Research Fellow and Lecturer in the Department of Economics at the Universitat Autònoma de Barcelona, Spain from 1998-2004. From 2004 to 2005, she was an Economist at the Austrian Institute of Economic Research (WIFO). Since 2005, Fernandez-Ribas has been at the Georgia Institute of Technology in various capacities: Scholar (2005-2007), Visiting Assistant Professor (2007-2008), and Research Associate (2008-present).

Publications include “Do R&D programs of different government levels overlap in the European Union?” (Instituto de Estudios Fiscales, 2007), “The impact of participation in R&D programs on R&D partnerships.” (Research Policy, 2008), “Technological diversity, scientific excellence and the location of inventive activities abroad: the case of nanotechnology.” (The Journal of Technology Transfer, 2009), “The role of national innovation programs in stimulating international cooperation in innovation.” (International Journal of Technology Management, 2009), and “Knowledge, capabilities, and manufacturing innovation: a U.S.-European comparison.” (Regional Studies, forthcoming).

17. Honors and Awards

In 2008, the Center for Nanotechnology in Society at Arizona State University was approved by the Arizona Board of Regents (ABOR) as a Center for Research Activity. The purpose of a center review by ABOR is to assess the unit's viability, quality, and progress. Most new centers are expected to be self-sustaining in a very short period of time. Each has to undergo a required Arizona Board of Regents review every five years to assess viability of the center program, activities, and resources.

Calleja-Lopez, A., a Ph.D. student in Philosophy at the University of Seville, is a master's student in Political Science at Arizona State University with a MED-Fulbright grant. His fields of research include ontology, philosophy of technology, and science & technologies studies.

Corley, E., Associate Professor in the ASU School of Public Affairs, has been named a Lincoln Professor of Public Policy, Ethics, and Emerging Technologies for the Lincoln Center for Applied Ethics. Lincoln Professors serve as liaisons between the Center and his or her respective college or school. Lincoln Professors serve as advisors and mentors in their colleges and schools regarding the development and offering of courses containing ethical content in the various disciplines within their colleges.

Milford, R., a graduate student in the ASU Biology and Society program, was awarded the Religious Studies Award for Outstanding Concurrent Major in 2008. Milford's combination of majors (Biology and Society, Religious Studies) exemplified a creative bridging between the humanities and the social sciences.

Robert, J.S., Associate Professor at the ASU School of Life Sciences, was selected by ASU President Michael Crow in 2009 as one of a handful of Promotion and Tenure "Exemplars" who exhibit the characteristics of excellent scholarship, teaching, and service that represent the New American University.

In 2009, Scheufele, D.A., Professor at the University of Wisconsin, Madison, was named as one of the twelve (12) finalists to compete for five (5) spots in the Wisconsin Institute for Discovery, which will open in 2010, due to his work on the CNS-ASU RTTA 2 project. Scheufele was recognized for his work on the ethical, legal, and social implications of nanotechnology, biotechnology, and stem-cell research.

In 2009, Scheufele, D.A., Professor at the University of Wisconsin, Madison, was selected to receive the 2009 Pound Research Award for his publications, grants, and research productivity. This award recognizes Scheufele's work on the ethical, legal, and social implications of new technologies that will change the way the public and stakeholders view critical issues.

Schuurbiers, D., Project Manager and Researcher, was awarded the Mekelprize 2008 for PhD students for his essay, *Ethics in Action*. The Mekelprize is an annual essay prize for student of Delft University of Technology, awarded by the Platform on Ethics and Technology.

Wetmore, J., Assistant Professor at the ASU School of Human Evolution and Social Change, has been nominated in 2009 for the Faculty Award for Significant Contribution to Undergraduate Education.

Table 6: Partnering Institutions (cumulative)

	Name of Institution	Receives Financial Support from Center	Contributes financial support to the center	Minority Serving Institution Partner	Female Serving Institution Partner	National Lab/other gov't. 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 Design	x								
	College of Liberal Arts and Sciences		x							
	College of Public Programs	x								
	Consortium for Science, Policy and Outcomes		x							
	Decision Theater for a Desert City									x
	Global Institute of Sustainability									x
	Graduate College	x								
	Hispanic Research Center		x	x						
	Ira A. Fulton School of Engineering	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 Human Evolution and Social Change	x								
	School of Letters and 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										
	Beijing Institute of Technology, China								x	
	Carnegie Mellon University									x
	Case Western Reserve University									x
	Center for Nanotechnology 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	
	Ecoles des Mines, France								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
	Institute of International Sociology of Gorizia	x							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								
	Northeastern University									x
	Northwestern University									x
	NSEC/CNS-University of California, Santa Barbara (UCSB)									x
	Rensselaer Polytechnic Institute	x								
	Rice University									x
	Rice University/ICON		x							
	Rutgers, The State University of New Jersey	x								
	The Center for International Development, Harvard University									x
	UCLA/Harvard/NBER: Collaborative Research; Personnel Exchanges									x
	University of Zacatecas, Mexico	x							x	
	University of Antwerp, Belgium								x	
	University of Arizona								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								

