

NSEC: Center for Nanotechnology in Society at Arizona State University

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CNS-ASU attempts to create a new institutional capacity for understanding and governing the transforming power of nano-scale science and engineering (NSE) through *real-time technology assessment* (RTTA; [2]). RTTA is an ensemble of social scientific methods arranged to track and evaluate emerging nanotechnologies as well as to promote *reflexivity* (the ability of NSE researchers to be more aware of the kinds of decisions they were making, on behalf of society, in their research) and *anticipatory governance* (the ability of a variety of stakeholders and the lay-public to prepare for and manage the issues that NSE may present before those issues are reified in particular technologies).

RTTA pursues four inter-related research programs:

RTTA 1: Research and Innovation Systems Analysis (RISA) characterizes the scope and dynamics of the NSE research enterprise, public and private, and plausible linkages between it and public values and outcomes. RISA's working assumption is that a clear empirical understanding of the specific research enterprise, including its promise and achievements, is a critical component to sound governance of NSE. RISA consists of three activities: Research Program Assessment, which develops empirically-based insights about the dynamics of the NSE enterprise, as indicated by publications, patents, and other data sources; Public Value Mapping, which assesses the social outcomes or "public value" of NSE research activities by comparing the societal goals articulated for NSE with actual performance; and Workforce Assessment, which conducts supply and demand analyses for regional labor markets in nanotechnology.

RISA's principal outcome to date is a sophisticated bibliographic definition of nanotechnology, developed through a process that included significant collegial consultation and a small survey of NSE researchers [3]. The Research Program Mapping team is conducting three types of analyses with the data: 1) mapping emerging US and international NSE developments in research and early commercialization; 2) identifying and probing the drivers of leading regional clusters in NSE research and commercialization worldwide; and 3) assessing the extent to which NSE is emerging as a convergent, general purpose technology.

RTTA 2: Public Opinion and Values (POV) monitors the changing values of the public and researchers regarding NSE and examines the role of the media in reflecting and influencing those values. Its working assumption is that a clear understanding of the values that both lay-citizens and researchers themselves bring to bear is also a critical component of sound governance for NSE. POV's three activities are: Public Opinion Polling, which conducts a national random-digit dial telephone survey to understand the knowledge of and attitudes toward nanotechnology by the US public; Media Influence, which explores the role of the media in public opinion around NSE through experimental interventions; and Researchers' Values, which surveys NSE researchers to understand their knowledge and attitudes.

POV activities are in various stages of data collection. We expect the public opinion survey to provide the first significant longitudinal data with earlier surveys and comparative data with Eurobarometer surveys. The Researchers' Values project is critical because value-laden choices made during knowledge creation are critical for research outputs and, ultimately, outcomes. To hone this perspective, we extend the frame of the Researchers' Values inquiry to

conduct telephone and face-to-face interviews with Hispanic and Latino/a NSE researchers, to understand if values derived from their ethnic background provides them with any distinctive perspective on nanotechnology in society.

RTTA 3: Deliberation and Participation engages researchers and various publics in forums about NSE and its plausible futures. D&P assumes that iterative and interactive deliberations can catalyze a greater capacity to anticipate potentially troublesome issues in the development of NSE and steer away from them. D&P consists of four activities: Scenario Development, which develops a variety of plausible, technically validated NSE futures to serve as a substrate for analysis by other CNS-ASU activities; InnovationSpace, which includes NSE within a undergraduate course that involves students from the ASU schools of design, engineering, and business in cross-functional teams to develop new venture proposals for products – in this case nanotechnological ones; CriticalCorps, which helps illuminate the social significance of nanotechnological products by applying techniques of cultural criticism; and the National Citizens' Technology Forum, which organizes six networked groups of lay-citizens to deliberate on questions about the societal implications of NSE that they themselves frame.

The scenarios developed in our first round of activity are drawn largely from examples in literature – scientific, political, and fictional. To validate them, we are creating an on-line, wiki-like site through which various communities of experts and publics can comment and construct more elaborate scenarios, which will serve as important inputs for the other D&P activities.

RTTA 4: Reflexivity Assessment and Evaluation (RAE) assesses the impact of the information and experiences generated by CNS-ASU, and CNS-ASU activities more generally. RAE assumes that we can build a successful, long-term collaboration with NSE researchers, as envisioned by the 2003 legislation, and in the process create better outcomes for researchers themselves and for society at large. RAE has two activities: Reflexivity Assessment, which documents over time any changes in the identity, knowledge, or practice of the NSE researchers with whom we work; and Evaluation, which attempts to understand the role of CNS-ASU in the larger context of nanotechnology-in-society, how well its programs are conceived, and how well they are operating.

RAE assesses CNS-ASU at a variety of levels. Interviews on identity, knowledge, and practice suggest what kind of impact the center's engagement is having on individual NSE researchers. E.g., one senior NSE researcher at ASU attributes his success in getting an award from NSF in 2006, after failing in the previous cycle, to reconceptualizing his work following interactions with CNS-ASU. The evaluation activities investigate the success CNS-ASU might have as an agent of institutional change. E.g., in AY05-06, a doctoral student CNS-ASU funded at the University of Colorado conducted his research as an "embedded humanist" in a mechanical engineering laboratory to probe a central concept in RTTA that choices researchers make in the laboratory are subject to what the student called "mid-stream modulation" [4]. RAE activities also compare CNS-ASU and RTTA activities with those of our European, particularly Dutch, counterparts through collaboration in the International Nanotechnology and Society Network (www.nanoandsociety.org), personnel exchanges and international writing projects [5].

In addition to these more directed RTTA research programs, CNS-ASU also maintains two research thrusts in areas of substantive interest for nanotechnology: Freedom, Privacy, and Security (FPS); and Human Identity, Enhancement, and Biology (HIEB). FPS develops cases of surveillance and nano-sensing technologies, including issues of effectiveness, potential ubiquity and embeddedness, and impacts on practices of surveillance and on the individuals and communities subject to surveillance. One current project assesses nano-sensors designed for use

on or in the human body. The design of such sensors represents a strategic site for potential collaboration between CNS social scientists and NSE researchers to consider how and when to embed safety and access controls into the devices being envisioned or produced, and to identify areas where such safeguards cannot be assured. HIEB explores the historical, philosophical, cultural, and political dimensions of the interactions between human biology and human values in the context of new nanotechnologies. One current project targets our understanding of the prospects for human nano-biotechnology in the context of ongoing bioethics research into chimeras and hybrids, i.e., biological entities that join the characteristics of more than one species. HIEB thrives on close collaboration with NSE laboratories, particularly those in ASU's Biodesign Institute, in one case facilitated by a CNS graduate student with a biology background who, in addition to her ethics work with the center, also works ten hours a week in a collaborating wet lab.

CNS-ASU also pursues ambitious education and outreach programs. At the undergraduate level, in addition to InnovationSpace described above, we have created a Learning Community in which students take nine credits of coursework that integrates technical, social, and political perspectives on nanotechnology. At the graduate level, a seminar in "Science, Technology, and Societal Outcomes" that focuses on nanotechnology is, for NSE doctoral students, complemented by the "PhD plus," in which such students – advised by a social science mentor – will include a chapter on the societal context or implications of their NSE research in their dissertations.

Public outreach and engagement at CNS-ASU focus on the large-scale National Citizens' Technology Forum (NCTF), akin to a consensus conference or citizens' jury, in which about 15 ordinary citizens inform themselves and deliberate on a science policy issue. We will assemble (Spring 2008) six such panels across the country and link them electronically for a truly national perspective. Given the novelty and ambition of the project, and the specific call for such public engagement in the 2003 Act, we hope not only to demonstrate the capacity to engage the public, but also to provide useful input to public and private sector decision makers in nanotechnology.

At the smaller scale, CNS-ASU has created a Science Café series in which NSE researchers at ASU head off-campus to speak with a small group of citizens in an informal environment, like a coffee shop or café. Held roughly on a monthly basis, the Science Cafés regularly attract two dozen people and generate interesting conversation. Given the ethnic background of our Phoenix-area community, we have also pioneered a Spanish-language café, held at a community center in a Hispanic community. Although not formally linked to the broader movement, the CNS-ASU Science Café is akin to any one of a number of efforts now emerging across the globe to create informal cultural dialogue around scientific issues.

References (10 point font)

- [1] CNS-ASU has major subcontracts and additional personnel at University of Wisconsin-Madison, Georgia Tech, North Carolina State, Rutgers, and University of Colorado, Boulder. For further information about this project link to cns.asu.edu or email David.Guston@asu.edu.
- [2] Guston, D.H. and D. Sarewitz. 2002. Real-time technology assessment. *Technology in Society* 24:93-109.
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