CNS-ASU Report #R11-0004

CNS-ASU Workshop Report

Nanotechnology, Business, and Anticipatory Governance

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Background to the workshop

CNS-ASU is an NSF-funded research center. With a recently renewed $6.5 million grant, CNS-ASU is an internationally-known center for research, education and outreach on the societal aspects of nanotechnology. CNS affiliates publish dozens of articles each year on topics from trends in patenting to future scenarios involving nanotechnology.

CNS-ASU is seeking to develop a more extensive and coherent engagement with private sector organizations involved in nano-scale science and engineering. Successful CNS-ASU engagement programs include activities with the general public (in science centers, through K-12 education programs, and in dialogue processes such as the National Citizens Technology Forum) and with academic nano-scale science and engineering researchers (including through long-term interactions with ASU labs). In recent months there has been a focus on creating similarly sustained and mutually beneficial interactions with the private sector. Given that private sector research and development is key to how nanotechnology will be understood, applied and regulated in the US over the coming years, this is a priority area for CNS-ASU activities. In this context, private sector nanotechnology is understood as inclusive of all nano-related activity that is not publically funded, including business, law, private policy research, computing and high-tech industry, housing and architecture, and NGOs and civil society organizations. The workshop was convened as a part of this program of activities, and was an opportunity for participants – who were drawn from nanotechnology-oriented business, law, NGOs and policy – to inform the research that CNS-ASU carries out, as well as to hear about some of the relevant work CNS does in researching, communicating and discussing the societal dimensions of nanotechnology.

This document reports the key points which emerged from these discussions. The workshop was structured around four sessions, each oriented around a particular topic area: each of these is summed up in nine summary points – three for the presentation, three for the response, and three for the plenary discussion. Shorter discussions and small group work are similarly summarized. Other than those directly presenting or acting as respondents, discussion is not directly attributed. A full agenda and participant list can be found in the Appendix.

1. Mapping nanotech development: Patents, publications and locations

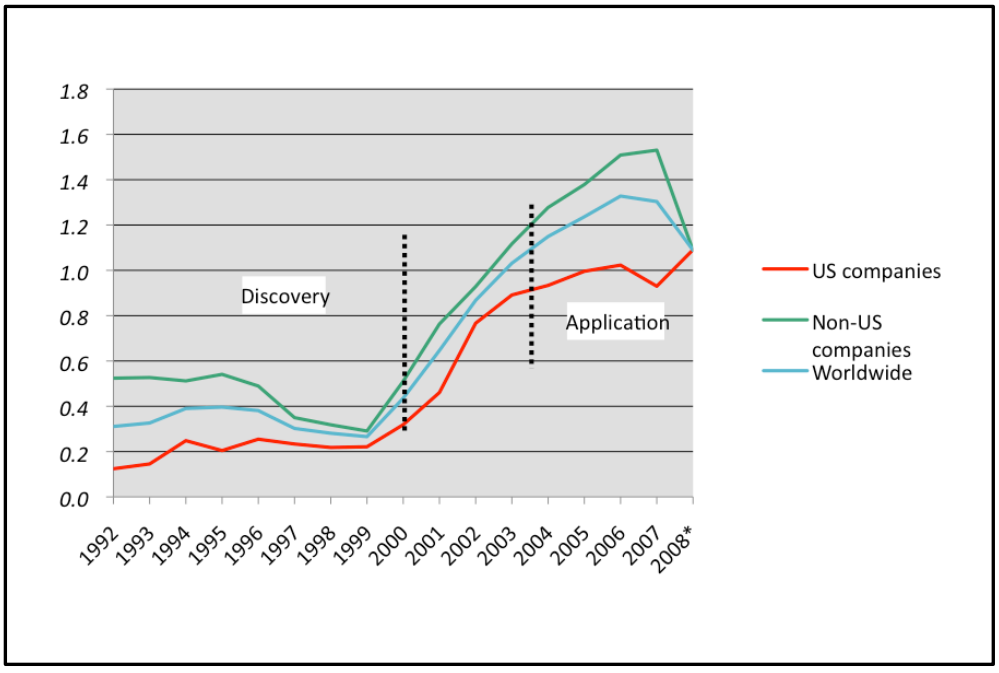
The first session focused on the ways in which nanotechnology is being commercialized. Led by Jan Youtie (CNS-ASU at Georgia Tech), with a response by Fred Klaessig (Pennsylvania Bio Nano Systems), discussion focused on issues such as the degree to which patent database searches can capture patterns in commercialization, the behaviors of small nanotech companies, and the extent to which the nano-biotech comparison is shaping development of nanotechnology.

Presentation: Nanotechnology firms from discovery to commercialization (Youtie)

1.1.1 Nanotechnology corporate activity is starting to move from discovery to commercialization. A decisive shift occurred in 2002.

1.1.2 There are key differences between sectors: electronics is the most dominant overall, while nanobio is most common as a basis for small firms.

1.1.3 Commercialization is dynamic. Small firms in particular appear to have relatively volatile development paths.



Source: Shapira, P., Youtie, J, Kay ,L. (2011). *National innovation systems and the globalization of nanotechnology innovation*. Journal of Technology Transfer.

Response (Klaessig)

1.2.1 Patents are an important point in the commercialization process to study. They are the point at which previously confidential business information becomes public.

1.2.2 Publications are similarly important, but much of what is interesting about them – for instance speculative comments in a discussion section – may not be captured by publication and citation metrics.

1.2.3 The regulatory process should also be an important stage for CNS-ASU research. It is here that definitions become fixed.

Plenary discussion

1.3.1 The nano-biotech comparison is important in structuring commercialization. Practices have changed in response to experiences with biotech: genetic engineering is held up as an example of what might happen if things go badly.

1.3.2 Terminological and definitional issues are a real challenge. Legacy terminology – such as 'micro-electronics' – may affect how commercialization is being captured in analysis.

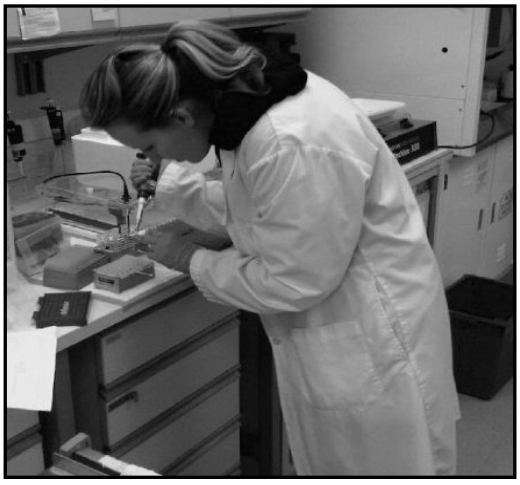
1.3.3 Small companies behave rather differently to others. They may 'go dark' for a period – or simply not apply for patents – and therefore seem to disappear.

2. Decision support in the laboratory and beyond

The second session focused on the ways in which calls for greater integration between scientific research and reflection on nanotechnology's societal dimensions are being operationalized. Led by Erik Fisher (CNS-ASU at ASU), with a response by Celia Merzbacher (Semi-Conductor Research Corporation), discussion topics included the degree to which such integration is 'business as usual' for industry, how liability and legal issues may drive reflection, and whether a crowd-sourcing model could be applied to the integration process within a company.

Presentation: Decision support in the laboratory and beyond (Fisher)

2.1.1 Integration is mandated by the US Nanotechnology Research and Development Act, as well as many other national nanotechnology programs. There is a widespread sense that social concerns should be integrated directly into the technology development process.



2.1.2 The STIR (Socio-Technical Integration Research) project responds to this mandate by embedding social scientists into laboratories around the world and in various disciplines.

2.1.3 The project seeks to clarify values and expand the options available to bench scientists. Outcomes have included renewed interests in safety practices, publications calling for clearer policy in particular areas, and stronger dialogue with patient groups.

Response (Merzbacher)

2.2.1 From a spot check with colleagues in the semi-conductor industry: companies do a lot of these kinds of activities already, on an intuitive rather than a formal basis.

2.2.2 There is also a trend towards promoting responsible development. Company policies are increasingly ensuring sensitivity towards and awareness of risk issues as well as standard environmental health and safety (EHS) processes.

2.2.3 Commercial experience with genetically modified organisms is a frequent reference point, with companies moving away from anything that might repeat this.

Plenary discussion

2.3.1 The extent to which STIR-like integration is already happening within companies remains unclear. While anecdotal evidence suggests this is the case, and there is a whole industry around EHS, there will inevitably be sites where reflexivity is not well engrained.

2.3.2 Questions similarly remain around how – and if – integration processes can be scaled up to the level of whole companies, and whether integration needs to be done systematically.

2.3.3 There is therefore a need to break down legacy cultures. Many in industry are not familiar with the EDF-DuPont Nano Risk Framework, for instance. Industry-university collaborations in general may help increase reflexivity.

3. Discussion: Challenges and research needs in four private sector domains

During this small group discussion session participants were asked to consider a number of specific topics relevant to private sector nanotechnology in more detail. The group split into four to focus on nanotechnology and regulation, new materials and architecture, intellectual property law, and commercialization, discussing key issues (problems, concerns, uncertainties) and research needs in each domain. The key points raised by each discussion group are summarized below.

Nanotechnology and commercialization (Rapporteur: Gregg Zachary, CNS-ASU at ASU)

3.1.1 Key issues in this area include user attitudes towards nanotechnologies, current uncertainty as to how regulation is being applied and developed, and questions of terminology, including whether nanotechnology is primarily a product or process.

3.1.2 Key research opportunities include work to understand where, and to what extent, job creation is occurring through the development of private sector nanotechnology, research into consumer profiles and needs, and the potential for unintended consequences.

Nanotechnology, materials and architecture (Rapporteur: Peter Yeadon, Decker Yeadon)

3.2.1 Key issues in this area are focused around questions of speculation (understanding path dependencies, equitable uses of nanotechnology), application (regulations, buildings codes), and experimentation (with potential new materials).

3.2.2 Areas for further research include how different communities, including those oriented towards design, engineering, and retail, can best communicate, how governance of nanotechnology in the built environment can be handled, and how design and architecture can develop with an awareness of the city as "metropolitan organism."

Nanotechnology and IP law (Rapporteur: Cindy Pillote, SW Law)

3.3.1 The top two issues in this area are a potential nanotechnology "patent thicket," in which a large number of similar patents are issued, stifling innovation, and the degree to which there is international protection of patents.

3.3.2 Research needs in response to these issues are the investigation of patent thickets, including the extent to which they exist and are in fact inhibiting

innovation, and of how patent standards vary in different countries, and whether any such variations can be dealt with at the point of innovation.

Nanotechnology and regulation (Rapporteur: Susan Brienza, Ryley Carlock & Applewhite)

3.4.1 The key issue in nanotechnology regulation is that there is no existing nanotechnology-specific regulation. This has implications across the FDA and EPA, product labeling, and advertising, as well as for worker health.

3.4.2 This lack of specific regulation raises a range of normative and empirical questions towards which research could be directed, including whether new regulation (for instance of labeling and of cosmetics) is needed, the extent to which nano-scale materials may result in toxicity, and how to regulate the scientific process.

4. The STIR City Project: Building Networks between Public, Private and Academic Sectors

The workshop lunch break included the presentation of CNS work focused on understanding the role that nanotechnology may play in urban development. Arnim Wiek (CNS-ASU at ASU, ASU School of Sustainability) presented plans to develop CNS integration research by applying it to nanotechnology's potential uses in the City of Phoenix.

Presentation: STIR City – From the Lab into the City (Arnim Wiek)

4.1.1 The STIR City project plans to connect existing engaged research in nanotechnology laboratories with research in the City of Phoenix.

4.1.2 CNS scholars have already carried out a number of deliberative and reflexive activities with the City of Phoenix Planning Department, including seven public engagement events (with between 10 and 120 people), which sought to facilitate dialogue across different stakeholder groups and to aid in the production of the Draft General Plan for the City of Phoenix.

4.1.3 STIR City will engage with different stakeholder groups along nanotechnology innovation pathways. Students will be embedded into a number of different sites (including in academic, private, and public labs, departments and organizations) so as to build capacity for responsible innovation and facilitate communication between stakeholders.

5. Futuring and foresight in nanotechnology

The third session focused on research on futuring and foresight. Led by Cynthia Selin (CNS-ASU at ASU), with a response by Jake Dunagan (Institute for the Future), discussion focused on practical ways in which forecasting can be carried out and researched.

Presentation: Futuring and foresight in nanotechnology (Selin)

5.1.1 CNS research on futures involves both looking *at* the future (understanding how the future is a component of social reality) and looking *into* the future (foresight and other mechanisms which harness the future orientation of actors).

5.1.2 One such mechanism is scenario development. Scenarios are "stories describing different but equally plausible futures" that have been used by CNS to explore the future of, for instance, "doc-in-a-box" medical diagnostic technologies.

5.1.3 Outcomes of such processes include dialogues between different stakeholders, changes in the ways in which technologies are being developed, and new social science research questions.

Response (Dunagan)

5.2.1 The Institute for the Future (IFTF) also develops methodologies to forecast the future. IFTF aims to set up a "virtuous circle" of foresight, insight and action.

5.2.2 Methodologies used include mapping, ethnographic techniques, expert workshops, scenario development, surveys, content facilitation, prototyping and artifacts, and gaming and collaborative forecasting.

5.2.3 Case studies include visioning processes for public agencies, product development, idea development for a medical research charity, and public engagement events.

Plenary discussion

5.3.1 The time period given is important in visioning and forecasting process. A 10 to 25 year horizon is often productive in encouraging a balance of creativity and pragmatism.

5.3.2 The historical context is also an important part of forecasting. Including the long history of things can enable participants to see the big story about what's happening.

5.3.3 More research needs to be done around the extent to which the use of these forecasting methodologies is affecting decision making, specifically regarding under what contexts and for what kinds of decisions these tools work best.

6. Public perceptions of nano: Trends and key developments

The final session focused on public opinions of nanotechnology. Led by Dietram Scheufele (CNS-ASU at University of Wisconsin, Madison), with a response by Jason Gallo (Science and Technology Policy Institute), discussion focused on the role of news media in shaping public opinion, the problems of using the single term "nanotechnology," and the ways in which new media may shape public debate.

Presentation: The 'science' of communicating risk at the intersection of science, policy and markets (Scheufele)

6.1.1 Science and technology are vital to US national interests, but emerging technologies get little public attention. There are disconnects between scientific consensus and public opinion in key areas such as stem cell research and climate change.

6.1.2 Public awareness of nanotechnology is low. Heuristics, or frames, will be important in shaping opinion as audiences process unfamiliar information through filters, including religion, political affiliation, and trust in scientific authority.

6.1.3 While there may currently be a narrative vacuum around nanotechnology, this will not last long and terminology and framing, once established, is difficult to change. Communication around nanotechnology therefore needs to be proactive.

Response (Gallo)

6.2.1 So far public opinion has not had much effect on federal nanotechnology policy – but this is likely to change. Opinion can be shaped by key events such as accidents.

6.2.2 It is important to address valid claims and concerns. Open public conversations about nanotechnology will help to allay fears.

6.2.3 There doesn't have to be a "narrative vacuum" around the technology: positive frames can be developed and used. Laypeople do, however, need to experience tangible benefits – for example in job creation or health – for these frames to be validated.

Plenary discussion

6.3.1 Social media are having important effects on how people consume news stories. While more information is available, this tends to exist in very separate opinion environments.

6.3.2 These trends have significant democratic implications. The ideal is a system within which people can articulate their values but that can also help adjudicate amongst them to make the wisest decision for the general population.

6.3.3 There are terminological issues in this context given that it is unclear that "nanotechnology" is a singular body of scientific and technological research. The term may be unhelpfully confusing and therefore may not last.

7. Key themes and ways forward

The workshop concluded with an open discussion around key points that emerged throughout the day, useful ways of following up from the workshop, and remaining needs in the development of CNS's relationship with private sector nanotechnology. A selection of the closing points made in this final session are given below.

7.1 There are clearly research needs in the private sector to which CNS could speak. However, given time pressures and companies having to prioritize their own innovation and business practices, it is unclear how easy **gaining access** for research will be.

7.2 One aspect of debate on private sector nanotechnology which was under-represented in the workshop – though which is present in CNS activities – was the **international** development of the technology.

7.3 There are a range of potential **user groups** for CNS research. These include the organizations represented at the workshop but also, for instance, media organizations, policy-makers, and bodies such as the International Organization for Standardization (ISO).

7.4 CNS could provide resources to help ensure an easy take-up of its expertise, for instance through the development of an online **press kit** or through funding journalists to spend time investigating nanotechnology's societal implications.

7.5 **Future workshops** and related activities – which were viewed as a positive and productive move – might take the form of a foresight process, involve a more international group of participants, or deal with a more specific set of questions through more extended small group discussion. CNS might also run complementary or additional activities on the East Coast through its Washington DC office.

In sum, the workshop covered a wide range of topics and was seen as a positive move by participants. Contacts were built both between CNS and those involved in different sites of private sector nanotechnology, and between individual participants. New learning was developed around the research needs, interests, and priorities of those working in the private sector. Future activities are likely to build on these successes by continuing to focus on networking and enhancing communication between different actors with interests in the societal implications of private sector nanotechnology.

Appendix 1: Participant List

Rob Barnett, Ping
Larry Bell, Museum of Science Boston
Susan Brienza, Ryley Carlock & Applewhite
Susan Cozzens, Georgia Tech
Kurt Creager, Stardust Center for Affordable Homes and the Family
Sarah Davies, ASU
Jake Dunagan, Institute for the Future
Erik Fisher, ASU
Rider Foley, ASU
Jason Gallo, Science and Technology Policy Institute
Steve Goodnick, ASU
Dave Guston, ASU
Sean Hays, ASU
Matt Kim, QuantTera and Arizona Nano Cluster
Fred Klaessig, Pennsylvania Bio Nano Systems
Michael Kozicki, ASU and Axon Technologies
Celia Merzbacher, Semi-Conductor Research Corporation
Evan S. Michelson, New York University
Clark Miller, ASU
Robert Ott, ASU
Cindy Pillote, Snell & Wilmer
Rex R Raimond, Meridian Institute
David Roessner, SRI International
Dietram Scheufele, University of Wisconsin Madison
Ronald J. Schott, Arizona Technology Council
Cynthia Selin, ASU
Phil Shapira, Georgia Tech and University of Manchester
Ahmad Soueid, HDR Architecture
Arnim Wiek, ASU
Peter Yeadon, Decker Yeadon
Jan Youtie, Georgia Tech
Gregg Zachary, ASU

Appendix 2: Workshop Agenda

Thursday May 5th : Downtown Tempe

17.30: Reception and student poster presentations. Introduction to CNS and to the workshop by David Guston.

19.00: Dinner.

Friday May 6th : The University Club, ASU.

08.00: Breakfast

08.30: Introductions

09.00: Session 1: Mapping nanotech development: Patents, publications and locations
Presentation by Jan Youtie, Georgia Tech.
Response by Fred Klaessig, Penn Bio Nano Systems.
Discussion

09:50: Session 2: Decision support in the laboratory and beyond
Presentation by Erik Fisher, Arizona State University.
Response by Celia Merzbacher, Semi-Conductor Research Corporation.
Discussion

10:40: Coffee break

11:00: Discussion groups: What are the key issues currently at stake within:
1: Nano and regulation? (Led by Susan Brienza, Ryley Carlock & Applewhite, with Sarah Davies)
2: Nano, materials and architecture? (Led by Peter Yeadon, Decker Yeadon)
3: Nano and IP law? (Led by Cindy Pillote, SW Law)
4. Nano and commercialization? (Led by Gregg Zachary, Arizona State University)

12:00: Lunch and presentation: The STIR City Project: Building Networks between Public, Private and Academic Sectors (Arnim Wiek, Arizona State University).

13:00: Session 3: Futuring and foresight in nanotechnology
Presentation by Cynthia Selin, Arizona State University.
Response by Jake Dunagan, Institute for the Future.
Discussion

13:50: Session 4: Public perceptions of nano: Trends and key developments
Presentation by Dietram Scheufele, University of Wisconsin Madison.

Response by Jason Gallo, Science and Technology Policy Institute.
Discussion

14:40: Break

15:00: Final discussion: CNS and the private sector.

16:00: Workshop close.