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**4:20 p.m. PLENARY I- The Curious Case of SPICE: Deliberating Geoengineering as Anticipatory Research Governance?**

Nick Pidgeon

In the face of the growing threat from dangerous climate change some scientists and engineers are beginning to envision and research technologies for climate geoengineering, including techniques for solar radiation management and carbon dioxide removal. As a quintessential emerging 'upstream' technology the human and environmental risks of geoengineering are highly uncertain, while the question of whether this approach will be acceptable to society is as much a matter of perceptions, ethics and governance as it is a technical issue. This paper contributes to the emerging debate about the societal acceptability of geoengineering and its governance by presenting current evidence on public responses. Using methodology initially developed in the domain of nanotechnologies, the paper discusses qualitative deliberative data recently obtained from UK publics as part of the Integrated Assessment of Geoengineering Proposals (IAGP) project. The work aimed to investigate responses to one aspect of a second proposed UK geoengineering research project – the Stratospheric Particle Injection for Climate Engineering (SPICE) delivery test-bed. The paper concludes that, aside from technical considerations, public perceptions and governance structures are likely to prove key elements influencing the debate over geoengineering acceptability.

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**8:30 a.m. PANEL SESSION I**

**Panel 1: Nanomaterials, Toxicology & Risk**

**Undone Science and Science Un-done at Nanotechnology's Periphery**

Frederick Klaessig

The magnitude and range of multidisciplinary nanotechnology activities allow for an examination of shifting priorities relative to the same fields prior to the nanotechnology funding impetus. In this paper, the concept of "undone science" suggested by Hess and colleagues will be applied to several EHS concerns surrounding toxicity, nano-Ag and product labeling. These issues were peripheral to nanotechnology at the outset, but are now considered central to the responsible development of nanotechnology products. Circumnavigating nanotechnology's perimeter is used to place shifting priorities into greater relief. As there are topics that have gained a higher priority, so are there ones that have been deemphasized, becoming "un-done." With the latter, data that were once valid information become invisible as terminology and priorities shift the conceptual framework. Conclusions are drawn towards the "old" and "new" material debate.

**Impacts of Zinc Oxide Nanoparticles on the Mussel**

Shannon Hanna, Robert Miller, Hunter Lenihan

The impacts of commonly used metal oxide nanoparticles (NPs) on the environment remains understudied. The majority of current work examines extremely high concentrations and uses mortality as an endpoint. Our goal was to measure environmentally relevant concentrations with sub lethal

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endpoints. We examined the toxicity of a prevalent metal oxide NP, zinc oxide (ZnO), to the marine mussel *Mytilus galloprovincialis*, to determine the impacts of chronic exposure of a widely used NP on a sentinel organism. Mussels were exposed to concentrations of ZnO NPs up to 2mg L<sup>-1</sup> along with feed for 12 weeks and sampled intermittently. Growth of mussels decreased in our highest exposure treatment, while accumulation of Zn increased with increasing ZnO NP concentrations. These differences were dependent on exposure time as well as mussel size. Our data indicate toxicity of ZnO NPs at environmentally relevant concentrations and suggest possible exposure pathways to higher taxa. Additionally, our consumption of mussels raises the concern of human exposure as well as implications for risk assessment and decision making. We will discuss how our work fits in to the current understanding of nanotoxicity as well as challenges associated with this type of research.

### **Antimicrobial Metal Nanoparticles: Science, Practice, and Unanswered Questions**

Kathleen Eggleston

In this paper, I will put the advent of antimicrobial applications of metal nanoparticles into historical and biomedical context. I will provide brief explanations of the mechanism of action of metal nanoparticles on bacteria, differences between this mechanism and those used by other antimicrobial agents, and the risks of indiscriminate application of broad-spectrum antimicrobials to public health. I will then explore the question of where, for the common good and protection of vulnerable individuals, metal nanoparticles *should* be applied, justifying my answer with biomedical ethics. I will illustrate the clash between this ideal and the reality of current metal nanoparticle employment for antimicrobial purposes. Financial and ethical evaluations of labeling, advertising, and sales of products containing antimicrobial nanoparticles will also be provided.

### **Panel 2: Nano, Media & the Public**

#### **ATTITUDINAL COMMUNITIES AND THE INTERPRETATION OF NANOTECHNOLOGY NEWS: FRAMES, SCHEMAS, AND ATTITUDES AS PREDICTORS OF READER REACTIONS**

Susana Priest and Ted Greenhalgh

While a number of scholars have speculated as to the likely influence of media framing (variously defined) on public opinion about nanotechnology, only limited experimental results exploring or demonstrating such effects are available. This study used exploratory experimental research with a student population to compare the influence of pre-existing attitudes and reader interpretations (schemas) to the effects of media framing of nanotechnology stories for four different applications (in electronics, food, medicine, and energy production, respectively) using four different "information order" frames (emphasizing social risk, physical risk, regulatory status, and benefits, respectively). Only very limited direct media effects were suggested, whereas the effects of pre-existing attitudes appeared quite strong, as did the effects of schema processing whereby the articles were classified by subjects as having particular forms of emphasis. While this experiment used a conservative (and

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carefully controlled) definition of framing, involving manipulation of information order rather than manipulation of information content, thus controlling for actual information effects, the results suggest the current fixation on media framing as a determinant of reactions overlooks other important factors. Reader interpretations (schemas), which likely result from a variety of factors in addition to media frames (including nanotechnology topics encountered and pre-existing attitudes toward such things as science and technology, authority, and governance), appear more important. This is an explicitly exploratory study, the results of which are subject to further exploration and replication, but provide food for thought with respect to the present tendency to privilege media “framing” over other explanations of reader reactions.

### **A COMPUTER-AIDED AFFECTIVE CONTENT ANALYSIS OF NANOTECHNOLOGY NEWSPAPER ARTICLES**

Robert Davis

This paper explores the application of an affective content analysis to a selection of nanotechnology news articles gathered in popular newspapers. Thematic content analyses dominate current efforts to mine large text collections of popular science media; the addition of an affective analysis element can yield useful information to supplement future content analysis efforts. Using Whissell's *Dictionary of Affect in Language*, the analysis rates news articles gathered over a twenty-year period for their pleasantness, activeness, and imagery, determining the mean affective tone in each category for the entire collection, four 'content themes' (business, national security, health, and environment), and the change in affective tone over the twenty-year period these articles represent. Whereas the entire collection analyzed as a whole rates very similarly to the average found for everyday English language use and the 'content themes' show similar results, the change in affective tone over the years has been both significant and striking. A sample of results from three years of the twenty-year period is then qualitatively explored to demonstrate to the reader the connection between the quantitative results of the *Dictionary* and the qualitative effect of the article's word use and phrasing. The paper ends with a review of the technique's success and avenues for future use.

### **Business as Usual: Mass Media Coverage on Nanotechnologies in Three European Countries, 2000-2010**

Christiane Hauser, Peter Hocke, and Torsten Fleischer

Is it possible that mass media coverage on nanotechnology and nano sciences follows the patterns of reporting about sports? Based on empirical research about media coverage of nano issues in high-quality newspapers in three European countries (Germany, Austria and Switzerland) from the multidisciplinary project “NanoPol”, the authors can show that basic research is the main focus of media coverage. Furthermore, the time series data show that if there are no extraordinary accidents or scandals about missing risk management and communication, emerging technologies are obviously integrated in established discourses of modern industrial societies. Therefore, the authors argue that media coverage on science often follows external inputs (e.g. by scientists, scientific institutions and their professional networks) and focuses on public relation – similar to coverage of sports and sporting events. In this mode of reporting examples of investigative journalism

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are rare as long as technology research and development follows “business as usual” and scandals and dramatic accidents are an exception. To analyze these and further aspects of mass media coverage on nanotechnologies, the authors use a multidisciplinary approach integrating concepts from communication research, policy analysis and technology assessment.

### **Panel 3: Studying Emerging Innovation**

#### **Identifying Emerging Topics and Predicting Structural Changes in Nanoscience**

Kevin Boyack, Richard Klavans, and Henry Small

This presentation will utilize three recent methodological improvements in science mapping. First, we create a highly detailed and accurate map of the content and context of nanoscience based on a global model of the scientific literature. Second, we utilize advanced metrics and full text analysis to identify emerging topics. Third, we implement a new model for predicting structural change. The combination of these recent improvements into a single analysis provides unique insights and enables strategic decisions in the field of nanoscience. We will also explore the use of advanced full-text analytics to identify the social and political issues being discussed in this literature-based model of nanoscience.

#### **Diffusion and Network Formation of Emerging Technologies: The Case of RNA Interference**

Ismael Rafols, Michael Hopkins, and Loet Leydesdorff

Fast diffusion is, by definition, one of the characteristics of emerging technologies. This diffusion involves spread over various analytical dimensions. How are these parallel processes of diffusion achieved?

In this article we explore how an emerging technology, RNA interference (a process of gene silencing with potentially powerful biomedical applications), diffuses across cities and across disciplines –and how this diffusion is associated with the formation of collaborative networks. Since such a process involves hundreds of organizations, we use bibliometric data as a point of entry, complemented with interviews and analysis of health-care firm databases.

The findings show that RNA interference has quickly diffused over most of the world (Figure 1) and to disparate disciplines. The associated network formation appears to be achieved, first, by a process of preferential attachment to highly active loci, followed by the consolidation of a small set of dominant research centres. These results will be compared with those for nano-crystalline solar cells.

#### **Nanotechnology and International Security: The Russian Federation**

Margaret Kosal and Graham Sweeney

Marching to war against Sweden in 1654, the army of Tsarist Russia discovered the inferiority of their bow and arrow technology. Since the brutal defeat, Tsarist Russia and her successor states have attempted to match and surpass the military technologies of the industrialized world. The newest

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technology the Russian Federation is attempting to apply to the military is nanotechnology.

The Russian nanotechnology program's study of military applications raises the problem of the security dilemma and its effect on perceived international security. The threat of new types of weaponry or enhancements to established types of weaponry negatively affect the perceived security of the international system, especially as the system still struggles to emerge from Cold War sentiments. Nanotechnology adds a new layer of uncertainty to an already paranoid and polarized world as researchers across the globe continue to develop new uses - both beneficial and harmful.

To review the literature – both primary and secondary accounts – regarding the research, development, funding, implementation, and views of nanotechnology in the Russian Federation, key speeches, official documents, and Open Source Center translations of Russian language documents were reviewed and analyzed. The dates of these articles range from 18 January 2006 to 4 June 2010. Eight key topics were examined: Technical Aspects, Budget/Funds, Elites' Statements, Infrastructure, Military Applications, Education Programs, International Collaboration, and Nanobiotechnology. Common themes were identified: “prestige” (statements regarding the use of nanotechnology to gain prestige), “nanoconstruction” (nanotechnology used in the construction industry), or “market goals” (the goals set forth by the elite regarding nanotechnology in the Russian goods market and the global market).

From the Druzhyna and Voyi of Kievan Rus' to the Soviet Armed forces, the military of the Russian Federation's predecessor states have always been instrumental to the security and expansion of the state. Military technology, therefore, has always received generous funding and government encouragement. As such, the threat of Russian militarization of nanotechnology is a likely possibility. However, most Russian military technology advancement occurred during the reign of autocratic regimes. With the continued power diffusion in the democratic Russian Federation, the likelihood of successful military technology advancement diminishes. The Russian Federation seemingly breaks the pattern of militaristic autocratic regimes and therefore seemingly decreases the threat posed to international security. Three main factors prevent the research of military applications of nanotechnology in the Russian Federation from heightening the perceived threat to international security: misuse of money, failure to convert from research to development, and President Medvedev's views on the nanotechnology program.

The security culture of the Russian people is that of heavy reliance on and support for the military and constant development of military technology advances, but the security culture also suggests autocratic rule by the strong central Russian governments. The current state of affairs in the Russian Federation – the current political body governing the Russian territory – does not allow for a strong central autocrat and therefore limits the ability for an unequalled focus on military technologies.

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#### **Panel 4: The Governance of Ethically Controversial Emerging Technologies, I**

Increasingly, ethical controversies about emerging technologies concern not only the legitimacy of applications or the pros and cons of specific technologies, but also visions of the future in which these technologies are embedded, underlying notions of humankind, nature and society, the social dynamics that shape them, and the processes and structures of their governance.

The session will provide a forum for a deeper exploration of core problems of scholarly research into emerging technologies and of the relationships between ethics, societal dynamics and policy issues in their governance, focusing on such issues as 'human enhancement', nanotechnology and synthetic biology. The role of ethical reflection will be discussed against the background of the 'participative turn', the rise of 'soft law', 'ethicisation', and 'speculative ethics' in the governance of emerging technologies. Upon which facts are far-reaching techno-political visions based? Is there a trade-off in the 'policy arena' whereby the ubiquity of 'ethics' results both in less genuinely ethical reflection and in neglect of other scholarly research? What are the merits and problems of participatory, reflexive governance procedures? What is the role of supranational and international law concerning global innovation networks? And how are anthropological notions, societal visions, regulatory activities and political interests interrelated?

#### **Panel 5: Emerging Technologies and the Future of Medicine**

##### **Responsible Innovation and the Multiple Futures of Diagnostic Instruments for Alzheimer's Disease**

Yvonne Cuijpers and Harro Van Lente

The development of molecular diagnostic instruments for Alzheimer's Disease promises to make an early and reliable diagnosis of Alzheimer's Disease (AD) possible, and to enable prevention and personalized treatment of AD. Within the broader AD landscape different actors articulate different uncertainties and expectations concerning possible ways to deal with AD in society. We analyzed how expectations and uncertainties are played out in Alzheimer Cafes, where patients and informal care givers get together with professionals working in the field of Alzheimer's Disease to exchange experiences and information. This research explores the multiple futures connected to the development of early diagnostic instruments for Alzheimer's Disease, that actors envisaged and act upon. Mapping of the multiple (implicit) futures, creates possibilities to position and account for choices in further critical reflection.

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## **Well-Constructed Systems Biology. Integrating Socio-Humanist Research**

Rune Nydal, Sophia Efstathiou, and Astrid Lægreid

Systems biology is conditioned by successful interdisciplinary collaborative research between scientific fields. In particular, it is well recognized that molecular biologist need to crossover the disciplinary boundaries to computational science. This paper discusses the rationale for an analogous crossover to socio-humanist research fields. If systems biology--socio-humanist collaboration is aimed for, we argue, the reasons for collaboration should not be of a different kind than biology—computation collaboration. As systems biology emerges in the intersection between currently disparate scientific fields, collaborations between the fields should not be understood as summoned around common research problems. Rather, collaborative efforts should evolve around the task of building common research systems. Research systems change and vary, but provide at any given time a common arena that inspires a range of different interconnected research questions, which also include socio-humanistic research questions. Integrated projects provide a good basis for pursuing such collaborative research system issues.

### **10:30 a.m. PANEL SESSION II**

#### **Panel 6: Regulating Nano in Europe and Asia**

##### **Nano Registers in Germany and Europe – Prospects and Challenges**

Torsten Fleischer, Christiane Hauser, and Peter Hocke

Many participants in the recent debate on nanoregulation demand a “register” on the EU and/or on national levels. But they often do not clearly differentiate between publicly available registers and registers for use by public authorities and between registers for nanomaterials and registers for “nanoproducts”. Some proponents even advocate “all-in-one” solutions. Ignoring these distinctions might provoke resistance among stakeholders.

Various surveys and participatory exercises – including those performed by our institution – have shown that most consumers want to be empowered to make informed choices when it comes to nanoproducts. This request, although immediately understandable, results in a number of operational challenges. What constitutes a nanoproduct? How to provide reliable, honest and candid information to the consumer? Who is responsible for checking and validating the respective claims? These issues also need to be discussed by regulatory agencies or other bodies that will have to perform a certain amount of market intelligence in order to be prepared to support emerging risk governance policies and to monitor, develop and maintain soft regulation instruments like product inventories or (positive or negative) labeling. In addition, their legal scope to collaborate with consumer protection organizations – which are usually the first point of contact for consumers – needs to be considered.

The contribution will focus on the advantages and disadvantages of the different approaches in order to find criteria for a design with purpose. It will

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link these discussions to recent developments to implement nano product registers in the European Union and in Germany.

### **One Size Fits All? The Debates about the Regulation of Manufactured Particulate Nanomaterials in the European Union and Germany**

Torsten Fleischer, Christiane Hauser, and Peter Hocke

In the last few years, the debate about environmental, health and safety (EHS) risks of manufactured particulate nanomaterials (MPN) – and their governance – became the dominant nano regulation discourse in both the European and the German contexts. Various stakeholders called for a development of new regulatory approaches for MPN. This is a demanding task since a number of fundamental questions have accompanied this process, and many of them appear to be still unanswered. This is partly due to a number of still unsolved scientific problems and uncertainties as well as technical challenges, partly also due to different normative perspectives on regulation of chemicals and technologies, and the “right” balance between a responsible development and safe use of nanomaterials. The paper will present a short overview of the current legislative and pre-regulatory activities regarding nanomaterials in the European Union and Germany. It will then discuss various stakeholder expectations on an “adequate” risk governance of or regulatory framework for MPN under scientific uncertainty and the attributed roles of politics and science. Finally, some of the regulatory challenges and options to deal with them within “hard law” and “soft law” approaches will be analyzed.

### **Informational Regulation of Nanotechnology in India: Lessons from Agricultural Biotechnology**

Indrani Barpujari

Informational regulation (IR), increasingly projected as an alternative to traditional ‘command and control’ regulation, requires no government action apart from obliging facilities to disclose information, which is expected to be acted upon by a third party (consumers and civil society) creating pressure on the creator of the ‘social’ costs’ to consider voluntary action to reduce it.

This paper explores the possibilities of using an ‘incremental’ approach to IR of nanotechnology, involving adaptation of existing information obligations under different Indian legislation to regulate its risks. Interesting lessons can be gleaned by understanding the political economy of civil society activism and governmental control of risks in the agricultural biotechnology sector in India, which has seen a long drawn out controversy on the right of the producer/ manufacturer to his confidential business information vs. the right of the public to information. On the basis of the experiences in the two sectors, the paper attempts to gauge the basic policy framework in terms of its conduciveness to ‘informational regulation’ of emerging technologies in India.

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## **Panel 7: Gaining Traction on Futures**

### **The Security Implications of Cognitive Neuroscience Research**

Margaret Kosal and Jonathan Huang

Research that taps into and to elucidate the biological basis of human potentials, especially that of the human brain and cognition, has been particularly active and driven in the past decade. Spanning fields as disparate as psychology, medicine, computer, mathematics, and chemistry, research venturing into the broad fields of cognitive science and brain research is fundamentally interdisciplinary. Perhaps the most interesting of all and most alarming to some are the military's interests in the potentials of cognitive sciences and technologies. Multiple government agencies have seen rising interests in the research and applications of neuroscience. Through the Defense Advanced Research Projects Agency (DARPA) alone, the Defense Department has invested over \$3 billion to conduct research on defense-related innovations, including neuropharmacology, neural imaging, and brain-machine interaction. This work explores ethical and security issues raised by cognitive neuroscience in regards to its military, intelligence, or other potentially security-related application and the potentials for offensive or malignant applications these emerging technologies. The limitations of international regimes to regulate the dual use or potential misuse are examined. This work will leverage technical security study methodologies, an ethnographic survey of over 400 active cognitive and neuroscience researchers, and comparative IR methods.

### **Developing a Methodology for Rapid Response Social Science Research Using Leading Edge Information Technology in the Context of ELSI Research at ORNL**

Christopher Lenhardt, Amy Wolfe, David Bjornstad, and Barry Shumpert

This paper will present a summary of efforts to develop a novel participatory social science research methodology that utilizes leading edge information technology and web-based technologies such as social media. The purpose of this methodology is to facilitate the development of a proof-of-concept, web-based, role-playing simulation tool that will allow researchers a means to set-up, run, and evaluate hypothetical scenarios much more efficiently and we believe will extend the potential for new social science insights. The vision is to provide a computer-mediated environment to enable rapid inquiry and assessment of complex, fast-changing research questions. The context for this research is a Department of Energy-sponsored (DOE) Ethical, Legal, and Social Issues (ELSI) activity at Oak Ridge National Laboratory (ORNL) that seeks to understand societal responses to emerging technologies, e.g. nanotechnology, in the context of the research and development life-cycle.

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## **Emergent Technology Assessment: The Transition Initiative and Energy Futures**

Gretchen Gano

The Transition Initiative (TI) is a fast growing environmental social movement. Its adherents strive for local self sufficiency, community resilience, and an intentional reduction in energy use in response to climate change, peak oil, and the global economic downturn. Though TI activities are not explicitly aimed at the prospective governance of technological systems, taken together they amount to an emergent technology assessment (ETA). ETA is comprehensive assessment of technological landscapes as a consequence of the desire for social change. It differs from formal participatory technology assessment (PTA) in that it confronts systemic technology choices and future innovation pathways, rather than single sector or product impacts. This paper outlines a framework for ETA in a review of TI activities aimed at reducing future community energy use. The author reflects on whether design principles for citizen engagement for governing emerging technologies can be derived from an ETA framework.

## **Technolife: Films, Social Media, and Imaginaries in Emerging Technologies**

Kjetil Rommetveit

In this talk I will give an overview of the EU FP7 project Technolife: its methods and assumptions as well as some of its main results. The goal of Technolife was to search for improved ways of communicating about social and ethical aspects of three technologies: biometrics, body enhancements and geographical imaging systems (GIS/digital globes). The project produced short films in order to trigger debate whereas trying to avoid imposition of narrow frames on the issues to be discussed. Discussions were carried out in an online discussion forum (including social media) and in some offline settings. Results were analyzed searching for socio-technical imaginaries and broad concerns. Although participation was not quite as hoped for, a significant amount of high-quality responses emerged from the exercise, frequently challenging us, the researchers, to rethink our assumptions.

## **Panel 8: The Governance of Ethically Controversial Emerging Technologies, II**

See Panel 3 abstract

## **Panel 9: What are WE Doing?**

### **Current Activities of Nano ELSI in Korea”**

Ivo Kwon and Jeongyim Seo

South Korea has eagerly sought for the development of nanotechnology(NT) since 2002 when the “Act for Promoting the Development of NT” was stipulated. Since then, Korean government and industries has invested a large amount of budget to the R&D projects of NT(1 billion USD during

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2001~2005, 5 billion USD during 2006~2015), and has gained a reputation as one of the most active player in the field of NT. However, the interests and activities regarding “Ethical, legal, and societal implications(ELSI) of NT has been relatively weak among the both of public and private sector compared with those of other advanced countries regarding NT. The relative disinterest seems to be due to the immaturity of deliberative democracy of the Korean society, insufficient understanding of the ordinary citizens and scientists themselves to the implications of science on the society, and lack of experience in multidisciplinary approach to critical scientific issues to the country.

In this presentation, the authors will critically review the past ELSI activities conducted in Korea during the last 10 years, and explore the implication of ELSI activities on the society of a rapidly developing and aggressively changing country.

### **The Challenges that the Debates on Nanotechnology are Bringing to Social Studies of Science**

Julia Guivant

In social sciences usual inside criticisms had appointed since the nineteen century the problems of 1) eurocentrism; 2) evolutionism; and 3) naturalization of the social (Bourdieu et al. 1973, for example.) In this article I argue that these 3 sins can be found easily in the increasing bibliography in social studies of science (SSS) emphasizing the growing importance on public participation in the governance of emerging and controversial technologies, including nanoscience and nanotechnology. It seems that a consensus has been crystallized in the hermeneutical and practical value of participation of the public. Among some problems that these sins can cause I will analyze in the paper: 1) Idealization of the relations between lay and expert's knowledge: a. For Giddens in reflexive modernity there is in some areas a lack of belief in expert knowledge. b. Wynne, for example, criticizes this saying that in premodern societies this phenomenon was already taken place. c. I argue: trust in science and scientists are still strong in some places. And there is no clear evolutionistic possibility of a change. 2) Idealization of participatory strategies for governance that demand a discussion on the following topics: a. Limits of participation; b. Uninterest to participate; c. Difficulties in translating consultation into policies; d. Manipulation of the strategies; e. Difficulties on the identification of the public. 3) Idealization of the reflexivity of public institutions ; and 4) Compartmentalization of the scientific community, that it is not global.

In spite of its political importance, public participation cannot be assumed neither a panacea for top down scientific politics, neither as a general nor without considering national political cultural specificities. Already some literature, that I will analyze in the paper, is stressing the limits of public participation, and I hope to contribute to it, bringing the perspective from the Brazilian context, focusing in nanocosmetics, already with a significant presence in the market.

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**Nanoscale Science Ethical, Legal, and Social Issues (ELSI) Analyses: Issues, Nano-Attributes, and Potential Applications**

Amy Wolfe, David Bjornstad, Christopher Lenhardt, Barry Shumpert, Stephanie Wang, and Mitchell Doktycz

History repeatedly has shown that societal responses to the same technology vary, even in seemingly similar contexts. Our work is structured to identify the extent to which science and technology (S&T)-related attributes versus application-related attributes (e.g., energy versus environmental applications) influence choices, issues, and tradeoffs that arise as technologies are integrated into society. We examine the nano-related ELSI literature and seek to draw new conclusions with regard to its linkage with particular categories of:

- (a) nanoscale science and technology—the extent to which the kind of nanomaterial or process matters; and
- (b) sphere of application—the extent to which different uses of nanomaterials or processes matter, where we focus on energy versus environmental applications.

This paper presents findings from our analysis of approximately 85 nano-related ELSI (Ethical, Legal, and Social Issues) publications and implications for our goal of disaggregating the evolving societal considerations associated with emerging nanoscale S&T.

**Panel 10: Demonstration/Discussion—Making Makers: New Tools and Transformative Organizations in DIY Technoscience**

Science as an epistemic institution began with amateur “tinkerers” making tools and apparatus in order to conduct experiments and share results. Just as these early do-it-yourself (DIY) “Makers” created the Royal Society over 350 years ago, the Makers of today - equipped with new tools, organizations, and concepts like 3D printers, “hackerspaces,” and open source design - are creating and fostering new organizations and incentives that are poised to change the way things are designed, fabricated, distributed, and owned. For example, while a far cry from self-replicating nanobots, the RepRap Challenge “Grand Personal Manufacturing Prize” of \$80,000.00, to be awarded on 12/31/2015, will go to the person who has come closest to building a robot that can reproduce itself (<http://makerblock.com/2010/03/the-reprap-prize/>).

This alternative format session will invite participants to a hands-on demonstration of a Makerbot (see <http://www.makerbot.com/> ) and open discussion of how new tools and organizations, namely 3D printers and “hackerspaces” (see <http://gangplankhq.com> and <http://techshop.ws>) are co-evolving and how they might affect industry, design, and patterns of production and consumption.

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**2:00 p.m. PANEL SESSION III**

**Panel 11: Food, Nanotech Food**

**The Social and Ethical Dimensions of Biosensors: A Case Study from Animal Production**

Kyle Whyte, Paul Thompson, John Stone, Lawrence Busch, and Monica List

The case explored in this paper involves the development of nano-enabled biosensors for real-time tracking of the identity, location, and properties of livestock in the U.S. agrifood system. Biosensors promise many dramatic real-time applications, from monitoring of blood parameters to watch for the presence of metabolic diseases, to cortisol levels in cattle as one potential measure of animal welfare. The primary method for research on this case was an expert forum. Developers of biosensors see the tracking capabilities idealistically as empowering users to control some aspects of a situation that they face, improving public health, security, and preventing wrongs like counterfeiting. However, the ways in which social and ethical frameworks are built into standards for the privacy/access, organization, adaptability, and transferability of data are crucial in determining whether the diverse actors in the supply chain will embrace sensing technologies and advance the ideals of the developers.

**International Standards for Trade of Nano-coated Produce?**

Steve Suppan

The current lack of binding nanotechnology rules means that discussion of agri-nanotechnology standards for trade is somewhat conjectural. Unlike previous extrapolations of a nanotechnology regulatory framework from present laws and regulations, this paper is not structured as a pre-commercialization “dialogue” between regulators and industry, e.g. as in Michael Taylor’s “Assuring the Safety of Nanomaterials in Food Packaging” (PEN, 2008). Rather, this paper presents post-commercialization issues in inspection and testing of internationally traded nano-coated fruits and vegetables, and the Codex Alimentarius Commission standards to facilitate that trade. The regulatory scenarios presented have some basis in current reality, e.g. the likely approval of nanotechnology standards as an objective of the Commission’s 2012-2018 Strategic Work Plan, and the Codex methodology for standards development. However, there are also conjectural elements, e.g. the feasibility of setting and testing for nanoscale Maximum Residue Levels and for predictive modeling of interactions among the ingredients of proprietary nano-coatings.

**Politics of Biotechnology in Latin America: The RR Soybean Argentina Case Study**

Pierre Delvenne

Our presentation is based on Argentina and it focuses on biotechnology in agriculture. Argentina today is the second largest exporter of GM crops and it has been the first country in Latin America to establish a professional regulatory framework in the early 1990s. GM soy crops is specifically analyzed because of its importance — more than 60% of the cultivated areas

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— and its controversial aspect : it is presented at the same time as an elixir for agro-industrial ills and as a techno-economic network increasing the benefits of the global North while dramatically affecting public health and the environment. We suggest to diagnose developments and perceptions of issues related to health, economy, ecological diversity, fertility of soils, regulation and intellectual property. Our methodology favors qualitative data collection and analysis, while using quantitative data when available and relevant.

### **Panel 12: Grasping the Future, or Grasping at Straws?**

#### **Ethics of Technology and the Prejudice in Favor of the Real**

Simone Van Der Burg

Ethics of technology usually starts on the basis of an ontology of technologies that are already in use. The focus of this type of ethics is on issues of safety and reliability, analyses of risk and benefit, and principles are being developed to regulate the use of technologies such as the precautionary principle. The dramatic attention in ethics is paid to human beings who use technology, or who make it, or who suffer its effects when it is used by others. The starting point of these views is the presence of a technology and the presence of human beings.

Technology, however, passes through many phases before it is 'present' so that human beings can relate to it. Technology-during-research differs from technology-in-use: especially during the earlier phases of research, technological artifacts do not yet have a (stable) function, nor an individual material body. It is therefore difficult to characterize what they are, and how they might matter ethically to human beings. This is a problem, especially because these last years there has been a growing interest into the engagement of ethicists during the research phase into technology. The point of this early engagement of ethicists is that they can anticipate proactively how they will affect human (social) life and wellbeing, at a stage when it is still possible for techno-scientists to incorporate the ethicist's views into their work and eventually produce a better technology.

The question that this endeavor frequently raises, however, concerns the object of this ethical evaluation. What is the ethical evaluation in the lab about? As Deborah Johnson stated, ethicists who are engaged in the laboratory examine the ethically relevant aspects of a technology 'in the making', which means that they consider the ethical quality of something that is actually not yet a 'something'. But if it is not a 'something', what are ethicists in the lab considering? Is it anything at all?

This is the question that I would like to explore here. There are several ways available to deal with this question, such as the one by Bruno Latour (1996) and Arie Rip (2009), but in this lecture I would like to share my explorations of the work of the Austrian philosopher Alexius Meinong, who wrote an ontological work on object theory that became famous mostly because of the criticism it received from Bertrand Russell. In his work *Über Gegenstands theorie*, Meinong takes distance from what he calls 'Das Vorurteil zugunsten des Wirklichen', the prejudice in favor of the real, and that he thinks forms the background of a lot of philosophy of his time. Meinong, on the contrary, wants

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to abandon this Vorurteil and introduce a broader conception of being, which includes also 'nonexistent objects'.

While Bertrand Russell was very much inspired by Meinong's arguments, Meinong mostly figures as the bad guy in his classic paper *On Denoting* in which he argues that there are no objects that don't exist. Russell's view has become broadly accepted for a long time. It has been interpreted by Terence Parsons (1980) as offering the best words to the position in which most people of his time were entrenched. The merit of Russell's approach was, according to Parsons who adopts a Kuhnian perspective, that it fits with a paradigm philosophy that offers beliefs and techniques which many work with very fruitfully, and that nobody seriously questions. The key belief in these approaches is that objects exist and that there are no objects that do not exist. Shortly this is the view that everything exists.

The ontology that Russell defended, also seems to form the tacit background of a lot of ethics of technology, which looks at existing objects. Therewith ethics of technology would be guilty of what Meinong called the prejudice in favor of the real. What about the nonexisting objects, such as the technologies that are being researched? Meinong's approach is interesting because of his focus on nonexistent objects. Examples that Meinong investigates of these objects are the golden mountain, the winged horse Pegasus, the round square. Since technologies during research are often nonexistent objects, I want to explore to what extent Meinong's work could be helpful to point out what we're talking about when we do ethics in the laboratory – and if we talk about, and evaluate, anything at all.

### **Talking Future: On the Grammar of Anticipation Practices in the Context of Emerging Technosciences**

Ulrike Felt

Investing energy into developing methods and techniques of anticipating futures is nothing new. Yet what seems different in contemporary dealing with future, in particular when it comes to emerging technosciences, is its quasi-objectification. This development does not go without contradiction: while future has become something to be actively imagined, shaped and traded, it simultaneously gets agency attributed and is framed as somehow independent, threatening and to be tamed.

Considering these tensions, this contribution looks at the way scientists and citizens alike deploy/develop anticipatory practices when it comes to positioning themselves in the context of emerging technosciences. More precisely it investigates the grammars of anticipation practices, thus structural regularities and habitual ways of addressing future(s) in a specific technopolitical culture.

The paper will build on material (discussion groups and interviews) collected in the project "Making futures present: The co-production of Nano and Society in the Austrian Context". (FWF, P20819)

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### **Governance of and by Expectations**

Kornelia Konrad

In recent years, various studies have examined how expectations – in the form of promises or risk concerns create shared and contested socio-technical futures, shape technologies and coordinate innovation actors in emerging science and technology fields. At the same time, expectations are themselves continuously coordinated and shaped in distinct ways in public discourses, in professional communities, in organizations and as part of systematic envisioning and assessment in foresight and technology assessment. Hence, expectations play a decisive role in ‘governing’, that is, coordinating and shaping processes in emerging science and technology and they are themselves ‘governed’ in distinct ways.

The paper elaborates the conceptual framework and investigates recent changes and the underlying dynamics in the governance of and by expectations for the cases of nanotechnology and fuel cells. It shows that changes were induced by the reflexive relations between expectations and the actors and institutional arrangements within an innovation field, when expectations which emerged within a field fed back on the structure that shaped them.

### **No Time like the Present (The Whole Story)**

Alfred Nordmann

Arguments against speculative ethics or speculative TA of nanotechnology prompted definitions of robust, realistic, plausible socio-technical scenarios of the nanotech future. There appears to be an art of balancing conflicting demands: to think about the future which is taken to be inevitable for the responsible development of emerging technologies, and to avoid outrageous assumptions or irresponsible credulity. This paper questions the need to accept the first of these demands: Is it really inevitable to think about the future when one thinks about emerging technologies and their responsible development?

The paper surveys a host arguments to show that we are incapable, that it is not necessary, and that it is politically and morally questionable to conceive of emerging technologies in terms of what will or what might be coming. To forego references to future states of development does not so much curtail assessments or ethical judgments but empowers them in meaningful ways. As such, the paper brings to the fore those arguments against speculation, credulity, and the hubris of shaping the future that have been lost in arguments for and against speculative ethics.

### **Panel 13: Behind the Promises of our Biotechnical Futures**

Narratives of technoscientific progress - such as that which conflates general societal "progress" with technological "advance" - have existed for decades and, in this context, emerging technologies like nanotechnology and synthetic biology do not make exception. Both technologies are often staged in the scientific discourse as the solution to a range of social and environmental ills, including the problematic sustainable development. However, current disagreements about the management of these emerging technologies make them a particularly fascinating case-study through which to analyze the wider

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uncertainties about the relationship between science, society and sustainability.

This session takes as its point of departure the assumption that Science and Technology Studies (STS), rather than existing as a mere playing field between natural and social sciences, offers solid and productive theoretical models to approach sustainability challenges. Especially in the case of emerging technologies branded as "sustainable" - like synthetic biology - science and technology studies provides useful critical lenses for approaching 1) emerging technologies' promises and their actual relevance to sustainable development; 2) socio-technical alternatives in the development of these emerging technologies; and 3) the dynamics at stake in the co-evolution of these technologies and society.

Synthetic biology in the scientific community discourse is staged unambiguously as the solution to a range of social ills, including the problematic sustainable development. Up to date, there is no solid reason to deny or question that synthetic biology may offer an unprecedented opportunity to transform modern medicine, generate clean biofuels and create millions of green jobs, but it is also not impossible that the technology may develop in an unsustainable way – as regard to environmental and societal concerns. For example, algae, which synthetic biology proponents claim are the solution to our fuel crisis since they do not require land-based biomass to produce fuels, are not necessarily 'the technological fix.' Yet, contrary to some of the techno-scientific promises made by researchers and investors, algae, synthetic or otherwise, require much more than carbon dioxide to grow – they also require water, nutrients for fertilizer and also sunlight – and consequently they need land or open ocean. The bio-processing cannot be done in vats without also consuming vast quantities of sugar. Finally, scaling-up this technology in the least energy-intensive manner will likely need large open ponds sited in deserts, displacing desert ecosystems.

Against this background, there is a need for critical reflections into how human societies make choices impacting the design of current socio-technical systems and how these choices and their spill-over effects influence how societies envision the systems of tomorrow. Such reflections would gain to be "co-produced" and invite inputs from researchers studying the functioning of socio-technological systems, socio-ecological systems, and biotechnical futures.

#### **Panel 14: Inequity in Emerging Technologies?**

##### **Impact on Abilities Seen as Essential for Democracy**

Gregor Wolbring

Nanoscale science and technology products and processes (NSTPP) are developing at a rapid pace, enabling products and processes within other science and technology fields such as physics; chemistry; material sciences; biotechnology; biology; genetics; synthetic biology; information and communication technology; cognitive sciences and neuro-engineering; bioengineering and geo-engineering. Each field enabled by NSTPP will pose distinct challenges and impact various segments of society and influence how we relate to each others on the individual and societal level, locally and

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globally. Democracy is one aspect of how we relate to each others on the individual and societal level, locally and globally. Many countries define themselves as democracies. Various abilities are seen as essential for a functioning democracy. This paper looks at whether and how NSTPP can help or hinder democracy and the abilities needed for it.

### **Career Pathways of Female and Male Nanoscientists**

Suzanne Gage Brainard

Funded by the National Science Foundation through the National Nanotechnology Infrastructure Network (NNIN), the purpose of this research project is to assess differences or similarities in career paths between female and male nanoscientists and nanoengineers at three NNIN university facilities. More specifically, the following three areas were examined: 1) career pathways of female and male scientists, 2) influence of mentors, and 3) decision-making processes for specializing in nanotechnology. Thirty-one male and female scientists at Cornell and Stanford Universities, and the University of Washington were interviewed using structured interviews lasting between 30-45 minutes. Using NVivo 9, data was coded through an iterative process, first through established codes while allowing new codes to emerge. Results from this study show some interesting differences and similarities in female and male nanoscientists and nanoengineers' career paths.

### **Nanoremediation: Are There Equity Concerns?**

Mary Collins

Nanoremediation, or the use of engineered nanomaterials in the cleanup of contaminated waste sites, is a technological advancement that has the potential to reduce cleanup costs while increasing overall quality. Although this technology is being widely used, the environmental and human health risks are poorly understood and debates between those subscribing to the precautionary principle versus proponents of rapid dissemination continue. In light of uncertainty, populations living close to sites could be viewed as subject to either potentially adverse exposures or as lucky beneficiaries of modern cleanup technology. This exploratory study addresses whether any socio-demographically defined subpopulations are disproportionately represented in the communities surrounding nanoremediation sites. Preliminary results indicate a general balance in the distribution of risks and benefits. It nevertheless raises questions about the role of communities in local environmental decision making under conditions of technological uncertainty and the evolution of application-specific technological risk perception in society.

### **Institutional Path Dependency, Inequality, and Nanotechnology**

Walter Valdivia and Susan Cozzens

This paper introduces the concept of institutional path dependency. Path dependency occurs when the current institutional structure constrains the design of new institutions or redesign of existing ones, which is to say, the evolution of institutions follows definite paths. However wide these paths may be, a policy problem arises when a desired set of outcomes falls outside the range of possible institutions. The canonical example is that of a judge who

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constrained by statutes and legal precedent must rule in contradiction to his personal view of justice.

We illustrate institutional path dependency examining the emergence of nanotechnologies aimed at harnessing solar energy. We seek to anticipate the likely evolutionary paths of the institutions supporting these technologies. The policy problem of interest in this illustration is inequality; specifically, distributive asymmetries in asset ownership, employment, and costs and benefits for three types of actors—laboratories/universities, developing and commercializing firms, and consumers. We find that while inequality is pervasive under the current institutional path, it is not completely outside the range of policy possibilities to mitigate some of the most harmful inequalities.

#### **Panel 16: Roundtable—Responsible Innovation and Responsible Governance**

The session will explore the theme of how actors conceive of, and importantly operationalise across a variety of geo-political and sectoral settings, a notion of 'Responsible Innovation - Responsible Governance' (RI-RG). RI-RG has multiple complex and heterogeneous dimensions, including the dynamic nature of the technology and the important role of global value chains. This session will address these broad concepts in a more concrete manner by considering actual regulatory decisions. By doing so we can see that one of the underpinning features of emergence – being a tendency to fall between the gaps of existing classificatory systems – can and does produce strange and contradictory (if perversely logical) regulatory decisions. A case in point would be the 2007 decision by the US Environmental Protection Agency to classify the Samsung Silvercare washing machine as a pesticide, whilst noting that this does not represent a general principle when dealing with products incorporating silver nano-particles. Discussing the wider practice implications of concrete governance and regulatory decisions; whilst also considering the concrete decision making implications of wider intellectual and normative orientations and policy stances, will be a particular focus of the session. The session – which we envisage as a 90 minute participatory roundtable - will be organized around short presentations after which responses will be invited from roundtable participants. It will be an aim to publish the outputs of the in the proceedings of the SNET conference, to highlight key implications for policy makers and for re-energizing relevant multi- and inter-disciplinary social science research.

**4:00 p.m. PANEL SESSION IV**

#### **Panel 16: Roundtable—Pacing Law and Policy with Science and Technology**

This session proposes to (i) interrogate the suggestions that law and policy are unable to keep pace with science and technology, (ii) consider the implications if this suggestion is accurate, and (iii) develop solutions to address this problem. The session will consist of an interactive discussion, led off by opening comments and diverse perspectives offered by (i) Gary Marchant, ASU College of Law; (ii) Brad Allenby, ASU College of

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Engineering, (iii) Joseph Herkert, ASU/CSPO; (iv) David Gartner, ASU College of Law, and (v) Jennifer Kuzma, U. Minnesota School of Public Affairs.

**Panel 17: Roundtable—Engaging the Public in Nanotechnology: Strategies, Approaches, and Resources**

This session provides a comprehensive introduction to strategies and resources for engaging the public in current science and emerging technologies. Presenters will discuss effective strategies for scientists and educators to collaborate in educational outreach that engage the public in future implications of emerging technologies. Participants will be able to try out a variety of educational experiences designed for use in museums, community events, and schools, including hands-on activities, demonstrations, exhibits, media, and classroom programs. Participants will also gain access to instructions and resources for a variety of public educational experiences developed by the Nanoscale Informal Science Education Network (NISE Net), a national collaboration of museums and research institutions that partners with the Center for Nanotechnology in Society at Arizona State University (CNS-ASU).

**Panel 18: Roundtable—Using Large-scale Datasets to Understand the Trajectories of Emerging Technologies**

The aim of this panel is to discuss the types of large scale datasets available to understand how emerging technologies develop. We seek to assemble a group of scholars who use publication, patents, and other similar types of datasets to discuss the issues around the use of these datasets in an interactive format. The questions that this session will address include the following. How does one delineate and bound an emerging technology. Should this delineation change over time as the technology changes? What methods are used to make sure that the data are in a form that is usable for analysis. What types of analysis are most appropriate for understanding the development of emerging technologies. What visualization methods yield particularly good insights into the development of emerging technologies. Are there certain indicators are metrics that should be tracked over time with respect to emerging technologies?

We seek to gather case examples from participants to illustrate the various points. We also hope to hear about failures as well as successes with regard to the use of these types of databases. The session also wishes to understand how scientists or others with a technical background have been used to make the datasets more robust and enhance their validity.

**Panel 19: Integration Research: Sites of Inquiry and Application, I**

Socio-technical integration is meant to refer to a reconstitution of practices and their structures, whereby normally segregated elements are brought into a more dynamic relation to one another, such that a richer variety and quality of outcomes are possible. Accordingly, socio-technical integration refers to social, cultural and institutional reconstitutions of scientific practices.

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Integration research thus refers to efforts to explore the possibility and utility of socio-technical integration, primarily through intervention-oriented collaborations between social and natural scientists. In response to various science policies around the world, primarily in Europe and North America, that have mandated socio-technical integration, science studies scholars have undertaken various forms of integration in terms of their methods, sites and justifications. This session chronicles the recent past and history of one such approach, known as STIR (socio-technical integration research). Specifically, it will introduce the approach as it has been applied in approximately 30 sites internationally, describe integration outcomes, including changes in practices and practitioner learning, contextualize these outcomes in terms of cybernetic systems and leadership theories, and finally, describe how they have guided plans to apply the STIR platform to multiple sites and sectors that extend beyond the lab and into the urban context of emerging nanotechnologies.

### **Panel 20: Gender, Race, and Nanotechnology**

How do gender and other social locations impact risk perception of nanotechnology? A well established finding in the psychometric risk perception literature documents the ubiquity of gender (and race) differences in perceived risk, with women and people of color consistently found to be more cautious, risk averse, and precautionary in approach to technological advances. In spite its pervasiveness, surprisingly little research effort has been devoted to understanding and explicating the reasons for and implications of this pattern, which is reproduced in the case of nanotechnologies. This panel examines the potential of a feminist intersectional approach to social location and risk perception within qualitative and quantitative studies of nanotechnology. The diverse methodological approaches in this panel focus on the microlevel dynamics of power in “talk” during public deliberations, the impact of gendered and raced dynamics in democratic participation and risk perception, the effect of social constructions of masculinity in risk perception, and the complex intersections of social location, worldviews, and application on perceptions risks and benefits of nanotechnology.

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**8:30 a.m. PANEL SESSION V**

### **Panel 21: Roundtable—What We’ve Learned about Nano and Society: A Working Session on Data Sharing for NSF NSECs**

By 2015, NSF Centers for Nanotechnology in Society as well as other NSECs conducting social dimensions research will have spent 10 years collecting qualitative and quantitative data and developing analytic and methodological tools for examining the ethical legal and social impacts of nanotechnology. Organizers of this working session will bring together researchers with key data products together for a strategy session on how the data and tools developed for the analysis of social legal and ethics implications research can be collected, curated, hosted and archived.

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### **Panel 22: Roundtable—Tales of Engagement and Emergence**

This 'story-telling forum' aims at exploring what we mean when we talk about emerging technologies and when we talk about engaging with them.

The we here is a community of researchers (STS, post-ELSI, sociologist and philosophers of science), who are increasingly being funded to research on emerging technologies and engagement. The emergence of this community is linked to technological emergence. In different parts of the world, we research on and experience technology emergence and engagement in diverse and differing ways. We research on a number of technologies such as nano, synthetic biology, biometrics or geo-engineering, but what do we really mean when we say that these technologies are "emerging"? What is the nature of those "emergences" and how do the differences between these technologies matter for the shaping of research agendas and forms of engagement? How is our role as researchers shaped within those entanglements? Are we not contributing to make still "fictional" technologies 'real' by making them an object of social research and something to engage with? What do we actually mean by engaging with those technologies? What is the object and dynamics of those engagements? Engagement with what: science, citizens, and institutions?

As a scholar who has been doing research on social movements and biodiversity conservation, nanotechnology and public engagement and now working with synthetic biologists in their labs, I see that it is important to consider the diversity of entanglements and configurations of technological emergence and social engagement to better understand our role and what we are talking about when we talk about engaging with emerging technologies.

This will be a story-telling session in which a number of scholars are invited to tell short "tales of engagement and emergence" (5-7 min depending on the final number of participants), combined with inclusive group discussions around the type of questions presented above.

### **Panel 23: Emerging Histories of Emerging Technologies, I**

Though there are many different definitions of nanotechnology, most emphasize the field's novelty and revolutionary break with the past. The papers in this session apply the tools of historical analysis – i.e., the study of the past that is supposedly being broken with – to better understand the implications of nanotechnology's novel self-definition. Allen Driggers offers a counter-narrative to nano's claims to novelty by exploring the deep history of a field (nanocatalysis) that became "nano" relatively late in its development and with few changes in its practitioners' methods. Jody Roberts maps the limits of nano's claims to novelty by exploring the regulatory context where such claims are often minimized. Cyrus Mody notes that, even if nano is novel, the phenomenon of boosters' making grand claims for the novelty and revolutionary potential of their technologies is a very old story. Roger Eardley-Pryor delves into the folk histories that informed nanotechnology policy in the US in the early 2000s. Finally, Matt Eisler attempts to understand why nanotechnology has been subject to occasional political crises, but not to significant public epistemological disputes. Collectively, the authors hope to

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make the methodological case that historical analysis can offer insights relevant to nanotechnology policy today.

**Panel 24: Roundtable—What World Do Nano Images Afford?**

In recent years, visualization-practices in science and technology have attracted considerable attention not only by historians of science but also by cultural studies, art history, or Bildwissenschaft. Some of this attention is focused on the elusive ideal of representational veracity and the role of conventions, visual culture, and pictorial traditions. From the viewpoint of sociology and history of visualization, others have studied the practices that make something visible and representative, in short, the production of reality (Lynch 2006). Regarding the images obtained from scanning tunneling microscopy and other popular as well as intra-scientific images of nanoscale phenomena, it is a kind of commonplace that these suggest a familiar world. Despite the rhetoric of strangeness and novelty that surrounds nanotechnology, these images affirm first and foremost that the nanocosm is a place where human engineering can take place – it is a world that waits to be colonized and, in a sense, inhabited by humans.

The aim of the workshop is to go beyond this commonplace. It is not enough to note that visualizations conjure a familiar world but to ask what notions of familiarity are evoked by these visualizations. To make an obvious point: many nano-images present vaguely familiar depopulated landscapes, hardly any refer to the familiar experience of urban living. In other words, the workshop asks what is the world that nanoimages afford?

The notion of affordances was put forward by psychologist James J. Gibson in his book *The Ecological Approach to Visual Perception*: "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (Gibson 1986: 127). On the one hand, the notion of affordance is directed against cognitivist accounts of perception. Perceptions are not the product of cognitive processes (construction, interpretation), but instead they are immediate and irresistible. On the other hand, this immediacy and irresistibility is a feature of the environment: "An important fact about the affordances of the environment is that they are in a sense objective, real, and physical, unlike values and meanings, which are often supposed to be subjective, phenomenal and mental. But, actually, an affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer" (ibid. 129).

By no means uncontroversial, Gibson's proposal was taken up by art historian Ernst Gombrich, by design theorist Don Norman, by the philosopher of chemistry and scientific experimentation Rom Harré. "Affordance" is therefore a promising explanatory concept for understanding the irresistible "pull" of many nanoimages that draw their viewers into a world that is subject to human design. For a range of images we can ask what they suggest in terms of action, interaction, immersion, or use. Do they evoke a habitable world and what would it take to work there, to exploit its resources, or even to live there?

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The discussion of these questions is part of a research project initiated at the Centre for the Study of the Sciences and the Humanities in Bergen, Norway. The workshop opens with short presentations by collaborators to the project and co-organizers of this workshop, including Alfred Nordmann (Darmstadt), Rasmus Slaattelid (Bergen), Astrid Schwarz (Basel), Colin Milburn (UC Davis), Arie Rip (Twente).

### **Panel 25: Regulatory Challenges of Nanotechnology**

The presence of engineered nanomaterials (ENMs) in industrial and consumer products is increasing at a rapid rate. At the same time, nano-specific regulation is lagging as is the human and environmental toxicity research that regulations are typically based on. Nanotechnology, as a rapidly growing industry, presents governments with a dilemma. The promise of technological advances and the benefits that can follow needs to be weighed against the challenge of mitigating potential risks to human and environmental health. Government regulators are seeking to ensure safety in ways that do not stifle technological innovation. Papers in this panel will explore how regulators in the U.S. are confronting this dilemma and how experts in the U.S. and industry internationally may influence regulators' approach to balancing safety with innovation and growth. These papers also examine how regulators, experts, and industry perceive risks and navigate a context of uncertainty to make decisions and influence the development of safe practices.

### **1:30 p.m. PANEL SESSION VI**

### **Panel 26: Roundtable—What Does it Mean to Harm the Environment?**

There is general agreement that harm to the environment should be minimized during the development and commercialization of emerging technologies. But what does this actually mean? What constitutes harm to the environment? and How can we predict and avert it for new technologies shrouded in quantitative and qualitative uncertainties? In this workshop, participants will collectively explore how these questions are approached within both environmental risk-based science and ecophilosophy. Exploring the interface between environmental ethics and the standard scientific approach to environmental harm for new technologies, ecotoxicology, participants will discuss different concepts of environmental value and the human/nature relation, and consider how alternative philosophical frameworks shape the content and interpretation of scientific research. The aim of the workshop is to better appreciate the interface between science, philosophy and policy in understandings of environmental harm and to discuss how the integration of these fields can be made more transparent and socially robust.

### **Panel 27: Roundtable—Public Engagement with Science in Informal Learning Environments**

What does recent research say about the ability and proclivity of informal science education organizations to engage the public in societal implications

of emerging technologies? What approaches do informal science organizations take to go beyond the “public understanding of science”

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paradigm to engage participants in consideration of, and decision-making about, societal implications and public policy? What conditions support this role for museums? What ideas emerge as various publics participate in dialogue activities in science museums? Can science museum exhibits help visitors develop socio-scientific argumentation skills? Recent projects in the U.S. and in Europe are developing answers to these questions, suggesting that there is an untapped resource in communities throughout the U.S. and beyond. Principals in research related to the work of the Nanoscale Informal Science Education Network and several related research activities will present results and illustrate findings related to these questions. Following these brief presentations small group discussions and a large group report-out will explore areas of mutual interest and potential future collaborations between the academic research and the informal science education communities.

### **Panel 28: How Green is Your Nano, I**

#### **LCA, Nanotechnology, and Scale: Assessing the Promise of Nanomaterial-Enabled Energy Storage Technologies**

Ben Wender and Thomas Seager

Successful adoption of renewable energy technologies, including electric and hybrid vehicles, will be effected to a large extent by the development of low cost, high capacity batteries. Lithium-ion (Li-ion) batteries have taken an increasing share of the rechargeable battery market because of their high energy density compared to other battery chemistries. Single walled carbon nanotubes (SWCNTs) are an appealing anode material because of their high conductivity and large surface area to weight and volume ratios. Free standing SWCNT anodes could eliminate the need for current collecting metal foil, thereby increasing battery capacity while minimizing weight. This improvement in performance is not reflected in cradle-to-gate analysis (CtGA) of nanomanufacturing processes, which often choose a functional unit of mass of nanomaterial produced as opposed to a more lifecycle perspective in which the functional unit is generally a measure of some function provided. At present CtGA analysis reflects that SWCNT manufacturing processes are energy and material intensive. This establishes a trade-off between energy and material investments in the manufacturing phase and increased battery capacity and performance in the use phase. By combining laboratory-scale inventory data and battery performance improvement modeling we evaluated the application of free standing SWCNT anodes in Li-ion batteries from a life cycle perspective. At present the material and energy requirements are prohibitive, however in the future this will be significantly affected by the extent to which nanomanufacturing processes improve in efficiency with increased rate and scale. At present there is no consensus regarding how to apply life cycle assessment (LCA) methodologies to technology in its nascent stages. This analysis represents a novel attempt to make LCA a prospective, rather than retrospective, tool used to guide emergent technologies towards being as environmentally beneficial as possible.

#### **What is Nano Doing for Solar? A Report on Notes from the Field**

Chris Newfield and Daryl Boudreaux

This paper reports on research into the current status of nanoenabled R&D in the realm of solar photovoltaic (PV) research. We pay particular attention to

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research based on close-packed arrays of quantum dots (an approach favored by NREL) and to QDs bound into conducting polymers. Extrapolating from International Energy Agency calculations, we show that maintaining CO<sub>2</sub> levels at 450 ppm will require that the solar contribution to electricity generation increase by nearly an order of magnitude over a 25-year period. Our paper reports on a series of industry studies and interviews that ask participants about how solar's share of electricity generation could grow either by this amount or more ambitiously by something closer to Moore's Law in which 10x growth happens in 7 years. We use our previous research aimed at developing a non-linear model of innovation to test whether elements we consider important to our improved model are being implemented in selected technology subareas, laboratories, or firms.

### **Regulation and the Global Nanotechnology Industrial Workplace**

Cassandra Engeman, Lyn Baumgartner, Patricia Holden, and Barbara Herr Harthorn

Research has suggested that the nanotechnology industry is shifting from a research and development phase to commercialization. With this shift, the need to mitigate the potential risks of handling engineered nanomaterials becomes more urgent, especially for the workers who regularly handle these materials. A global perspective of this global industry is necessary as is special attention to private companies, given their higher volume of nanomaterial use in the commercial phase. This paper analyzes 78 responses to an international survey of private nanomaterial companies from 14 countries. Research found that companies defined nano-specific health and safety programs with a narrow set of practices. Additionally, larger companies and companies with greater numbers of workers handling nanomaterials were more likely to report some safe-handling practices. Our research suggests some challenges to risk management, from a regulatory perspective, specifically the wide variety of nanomaterials being handled and the difficulty in identifying the nanomaterial workforce.

### **Panel 29: RELANS: Latin American Network on Nano and Society, I**

#### **The Path of Nanotechnologies in Mexico**

Edgar Zayago Lau and Guillermo Foladori

By various accounts, nanotechnology is portrayed as the new industrial revolution. Developing countries see this technology as an important tool to become more competitive, conquer international markets, and improve their economic performance. Within Latin America, Brazil and Mexico emerge as the leading countries in the nanotechnology field. The Mexican case stands out due to the absence of a National Plan or Initiative for the promotion or direction of research related to the development of this technology. The lack of planning can cause redundant efforts, which later could be the origin of economic and environmental tragedies, particularly if research centers and high-tech parks are competing against one another rather than moving

together toward a common goal. Despite the number of universities and laboratories, as well as some enterprises, researching nanotechnologies, by **Wednesday, November 8<sup>th</sup>**

following an unmarked path regarding nanotechnology development, Mexico's risk of being led astray is significant.

### **Mexico-US Bilateral Scientific Collaboration on Nanotechnology**

Richard Appelbaum, Guillermo Foladori, Rachel Parker, and Edgar Zayago Lau

A joint project by the Center for Nanotechnology and Society at UC Santa Bárbara and the Doctoral Program on Development Studies at the Universidad Autónoma de Zacatecas (UCMexus-Conacyt Grant CN-10-420) is mapping out and analyzing several scientific collaborations between Mexican and U.S. institutions in the field of nanotechnology. We examine the main institutions involved, the partners from the productive sectors, and the topics and purposes of the agreements, in order to visualize the main trends developed over a decade of scientific collaborations.

### **The Chilean Nanotechnology Sector: Catching up or Falling Behind?**

Rodrigo Cortes-Lobos

The recent integration of Chile into the OECD has generated an intense debate about the role of the national scientific community in producing valuable knowledge that can be applied to practical uses. The comparative analysis of Chilean S&T indicators with other OECD countries show several deficiencies in the Chilean Innovation System, in particular, a low level of cooperation between research organizations and the industrial sector. Chilean S&T policy-makers have directed their efforts towards establishing several new S&T policies in order to improve linkages among the actors of the national innovation system. In this scenario, nanotechnology shows a unique opportunity to generate multidisciplinary research programs that could promote university-industry interactions. This presentation focuses on the Chilean S&T policy framework to promote nanotechnology research, and identifies the areas and actors in which nanotechnology is showing higher levels of advancement. It discusses to what extent these areas can contribute to Chilean economic development.

### **Panel 30: The Challenges of Equity, Equality and Development**

For at least the past decade, nanotechnology has been touted as the Next Big Thing in technology. The hope is that many of the problems of today can be addressed using nanotechnology enabled products. There has been a particular push in nanotechnology to use the new advances to help address problems in developing countries. This panel will explore the attempts to develop pro-poor nanotechnologies in the developing world, with a particular emphasis on India and South Africa. It will begin with an opening activity to get conference participants thinking about the matches between nanotechnology and the problems of the developing world. There will be a chance for participatory discussion about this activity as a bridge to the formal academic work of the author presenters. There will then be a broad theoretical exploration of the topic followed by two papers that each focus on a particular state context: South Africa and India.

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3:30 p.m. PANEL SESSION VII

**Panel 31: How Green is your Nano, II**

**Systemic Analysis of Nanoscale Science and Engineering Applications:  
Are They Emerging to Address Urban Sustainability Challenges?**

Arnim Wiek and Rider Foley

Nanoscale science and engineering applications (NSEAs) are emerging within the urban environment through established pathways for new products (i.e. infrastructure, building materials, commercial products). The current emergence pathways through existing governance structures are allowing product commercialization without consideration for the socio-environmental implications of NSEAs embedded within the urban context. Major sustainability challenges are facing cities today, from economic constraint to societal disturbances and ecological stress. These sustainability challenges will be impacted, both negatively and positively, by NSEAs as they are increasingly integrated across temporal and spatial scales. Our research illuminates the problem-oriented challenges undertaken during NSEAs development and commercialization and how those problems align with current urban sustainability challenges. Systematic analysis of current NSEAs, emergence pathways, and urban sustainability challenges provides insight and reflection for scientists, engineers, policy-makers, product developers, institutional actors, and citizens broadly.

**How Green Is Nano?: Evidence from USPTO Green Patents**

Jose Lobo and Deborah Strumsky

Much of the discourse in support of public and corporate funding for nanotechnology research suggest that advances in nanotechnology can help address sustainability, environmental and energy challenges. But how “green” is nano? One way to ascertain this is to gauge the prevalence of nanotechnology among the patents granted by the U.S. Patent Office (USPTO) which can be classified as “green.” In this talk we will present preliminary results using a classification which selects USPTO patents whose technologies involve alternative energy production (wind, solar, geothermal, gasification, biofuels); energy storage and distribution; devices and procedures for energy conservation; environmental purification, protection, and remediation; and environmentally Friendly Farming. (Our taxonomy is based on a list of “green” patent technologies devised by the Patent Office in 2009 augmented with semantic search of the patents’ claims). We then identified those green patents which utilized nanotechnology as classified by the USPTO). We are particularly interested in which green technologies nano plays a role and conversely in which green technologies it does not; we also report on which types of institutions are involved in “green nano” research.

**Does Nano Have a Green Thumb?**

Astrid Schwarz

The saying Nano has a green thumb refers to a style of advertisement in governmental or likewise industry road maps and reports, that

nanotechnology simultaneously embraces concepts of innovation and conservation. Asserted is the compatibility of nanotechnology with principles

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of sustainability and sustainable engineering, in general with ecotechnologies such as renewable energies or environmental remediation. The questions discussed in this contribution are: What constitutes the green in nanotechnology, which concepts and discourses allow for the integration of “gentle technologies” that are identified as “green” and “sustainable” with nanotechnology? Which objects can be identified at all as “green nano-objects” and what exactly do they afford in the sense of criteria for sustainability criteria? Do we need to think about a green ontology of technological artifacts to capture this tension between innovation and conservation and to finally escape the conflicts and antinomies of “sustainable engineering”?

### **Panel 32: Upstream Engagement**

#### **How Do We Engage with People Who are Unengaged on Science and Technology Issues?**

Craig Cormick

A presentation of the results of a series of nanodialogues with audiences who are unengaged on science issues, including AV footage of dialogue participants. As many as 35% of the population in Australia and the UK are not very interested in seeking information on science, and holding discussions with recruited members of non-engaged publics reveals that they have very different values and attitudes to those members of the public who participate in most science and technology engagement activities, or are generally more interested in science. Linked with the findings of a five year tracking study into public attitudes in Australia towards nanotechnologies, the research shows that very different communication strategies and framing techniques need to be employed to effectively engage with unengaged audiences if they are to be included in national discussions on the social impacts of new technologies.

#### **Nano is Like That and That and That...The Role of Analogical Discourse in Public Engagement with Nanotechnology**

Claudia Schwarz

The increasing use of public engagement with nanotechnology has raised questions about how citizens discuss emerging technosciences and form opinions in such settings. Drawing analogies to known and familiar phenomena, esp. to former technologies, plays a central role here. Building on a detailed analysis of analogical discourse in four discussion groups with Austrian citizens on different nanotechnological fields, the paper explores which analogies are constructed and how they are negotiated. Analyzing which comparisons are accepted or refused by participants helps to capture why some positions become dominant and others marginalized. Analogies are thus understood as dialogically co-constructed, performative and culture-bound outcomes of comparison and distinction processes. The paper will show that such an approach is particularly promising for investigating national and cultural specificities in the public assessment of nanotechnologies. It will also critically reflect the general role of analogies in debates on emerging technosciences—their potential and limitations.

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### **The Dutch Societal Dialogue: A Multilevel Analysis of Communication as Transaction in Nanotechnology**

Lotte Krabbenborg

The current governance discourse of 'responsible development and innovation of nanoscience and nanotechnology' offers opportunities to experiment with communication as transaction. Communication as transaction is not about providing information from technology to society, but includes active two-way interactions about meanings, values and consequences of new and emerging technologies for society.

Although communication as transaction is currently predominately a normative ideal of STS analysts and some policymakers, within the development of nanotechnology initiatives are taken by different societal institutions to put some elements of communication as transaction in practice. One such initiative is the Dutch Societal Dialogue (2009-2011). The explicit aim was to offer a 'platform for exchanging thoughts, ideas and opinions on the 'broader ethical and societal aspects' of nanotechnology. This Societal Dialogue took place in a 'multilevel configuration'.

The Dutch government initiated the Societal Dialogue as part of their attempt to create a 'responsible development', an independent Committee was appointed to stimulate and facilitate the Dialogue. The Committee delegated organization and content (within certain limits) to 35 projects that were funded. In my presentation I will show, using qualitative research, how activities at the different 'levels' mutually enable and constrain communication as transaction between representatives from 'technology' and 'society'.

### **Empowerment and Social Learning: Long-Term Benefits of Citizen Deliberation about Nanotechnologies for Human Enhancement**

Michael Cobb and Gretchen Gano

Many who advocate for structured citizen deliberation as a component of technology assessment assert that these activities citizens' capacity to participate in political and social issues over the long term. According to this literature, structured deliberation empowers citizens by rendering them more knowledgeable, trusting, and inclined towards social and political participation. Thus deliberative activities enable members of the general public to participate meaningfully in the democratic governance of technoscientific issues. This research contributes to our understanding of deliberation as a method for achieving empowerment and social learning. Specifically, it investigates empirically whether these effects persist over time. We report results of a follow up survey of both participants and a control group of applicants in a national citizens' technology forum (NCTF) about the use of nanotechnologies for human enhancement (HE). The NCTF was a month-long structured process involving six groups of between nine and fifteen ordinary citizens who deliberated in different locations across the United States with the goal of reaching consensus about policy recommendations within their groups. We find that compared to the control group of applicants a year following the event, participants remain more knowledgeable about HE and believe they are more involved, but actually participate less in a broad spectrum of activities associated with the

development of social capital except for events specifically about human enhancement.

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**Panel 33: Translational Research—Perspectives from the Humanities and Social Sciences, I**

Biomedical research in the 21st century, enabled by developments in nanotechnology and ICT, is very much focused at identifying the molecular basis of disease processes. This molecular approach is often claimed to enable a 'truly scientific' reconstruction of the disease process. It has also, however, widened the gap between research and clinical practice. The concept of 'translational research' (or 'translational medicine') has been coined to address this gap. It designates the attempt to improve the connection between basic science and clinical practice, and eventually to increase the health gains to be won from biomedical innovation. In the USA as well as in many European countries governments have recently allocated substantial budgets to such translational research.

From a philosophy of emerging technologies and innovation studies perspective the assumptions underlying the concept of translational medicine are rather crude. Attempts at translational research (even though interpretations may differ) are hardly connected to developments in these fields. This panel of 6 papers aims to critically analyze the various meanings of translational research as put forward in policy documents and as it is performed in practice. In addition, it aims to investigate how the various disciplines dealing with emerging science and technologies might contribute to attempts at translational research.

**Panel 34: Mapping Responsible Innovation in Public and Private Sectors**

Responsible Innovation is a concept of increasing interest to scholars, practitioners, and policy makers involved in the advancement of nanoscience and emerging technologies. However, Responsible Innovation is situated in a conceptual landscape that is mostly uncharted territory with little knowledge of the structural landmarks, environmental patterns, and the contours that form and shape this fascinating and potentially transformative science policy region. This panel presents empirical research to map some of the critical theoretical, conceptual, and practical elements of Responsible Innovation. Comparisons of the forms, contexts, and discourses of Responsible Innovation in public (university) and private (industrial) settings provide insights for our panel discussion of exploring and defining this new frontier.

**Panel 35: RELANS: Latin American Network on Nano and Society, II**

Over the last decade, several countries in Latin America started supporting nanotechnology research through different institutional designs. As a common trait, these initiatives considered nanotechnology as a strategic field in their Science and Technology Plans and as a catching up window of opportunity opened up by an emerging technology in the context of persistent low

industrial innovation. Competitiveness enhancement was then stated as the main goal of nanotechnology promotion.

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Social and Natural Scientists interested in discussing the implications of nanotechnology for development, as well as the social implications and risks of this technology, gathered at the Latin American Network on Nanotechnology and Society (ReLANS) in 2006. Among other activities, ReLANS maintains a record of nanotechnology policies in the region. This panel is based on ReLAN's forthcoming book, *Nanotechnology in Latin America* (to be published soon), in which case studies from several countries are presented. The panel will compare the cases of Brazil, Mexico, Argentina, Venezuela and Chile, discuss policy designs and nanotechnology trajectories, and reflect on their implications for development in the region.

#### **Panel 36: Anticipating Future Commercial Applications of Nanotechnology**

In this panel, we will examine the trajectory of emerging technology applications. Forecasting future applications of nanotechnology offers great potential, but nanotechnology applications also are associated with many risks and uncertainties, diverse directions of possible development, and large and disconnected footprints of information. Many of these footprints are evidenced in large scale compilations of information from the key science and technology databases such as publications, patents, and press releases and in company web sites. This session will draw on these diverse sources to discuss issues around charting the innovation pathways future of various applications of nanotechnology. In addition to the role of science-based developments highlighted in, for example, publications, we also acknowledge the important role of national and global contexts – through US, Europe, and Asia comparisons—as well as novel institutional arrangements such as the US nanoscale science and engineering centers (NSECs).

This session will discuss questions such as:

- \*What is the nature of corporate relationships with nanoscientists and science centers?
- \*To what extent are small start-ups involved in commercialization versus large corporations?
- \*Are the applications originally envisioned for the technology the ones to emerge in the early phases of commercialization?
- \*Is the commercialization taking place in the same location as where the research is being conducted?
- \*How is uncertainty about commercialization prospects being addressed?
- \*To what extent is attention given to environmental, health, and safety aspects in the commercialization of these nanotechnology applications?

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**8:30 a.m. PANEL SESSION VIII**

**Panel 37: Roundtable—The Science Policy and Regulatory Implications of Emerging Technologies**

**Hungry for Information: Exploring the Public's Perception of Nanotechnology in Food Using Conversational Settings**

Jonathan Brown, Jennifer Kuzma, and Andrew Merrill

Seven focus groups were hosted in three U.S. locations in order to examine public perception of food nanotechnology in dialogue settings. Key research questions focused on the public's perceptions of food nanotechnology in general, of its application across different food products or production processes, of regulatory issues and agencies, and of the need for labeling of nanofoods. Focus group data were analyzed by coding statements across several themes and risk perception factors from the literature. Significance was assigned according to discussion depth and statement frequency. Preliminary results reveal several distinct themes including citizen's recognition of risk-benefit tradeoffs for food nanotechnologies, the desire for more information before judging applications, labeling as fulfilling consumers' right to be informed, and variable trust in regulators and companies. These insights from conversational settings provide an important step in considering the complexities of public perception as they apply to crafting effective policy surrounding food nanotechnology.

**In Search of the Anti-Nanotech Movement. A Survey of Germany, the UK, and the International Arena**

Franz Seifert and Alexandra Plows

We choose a movement approach to explore whether and in which form an anti-nanotechnology movement has emerged. We compare movement actors at the international level and in two national arenas—Germany and the UK—to examine general movement activity, action repertoires and alliances. We further study variation across the arenas and, more specifically, ask how movement actors interacted with dialogical forms of communicating nanotechnology to the public, often called upstream public engagement. In the three arenas—Germany, the UK, international—we identify some, albeit low, levels of movement activity, and a rather weak potential for public mobilization and movement expansion. We suggest that it would be more appropriate to call we can identify in terms of movement “nano-watch” movement rather than anti-nanotech movement. We explain national and international variation in movement activity and structure as a function of the prior movement against agro-food biotechnology, rather than through differences in opportunity structures.

**Opening up 'Lay Expertise': The Role of Different Repertoires of Expertise in Public Engagement on Nanotechnology in the Food Domain**

Simone Schumann

Over the past years a whole body of STS-literature critically dealt with the distinction of expert and lay knowledge, showing that citizens, as experts of their life world, are using their own knowledge, acquired through experience

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and practice, to build an understanding on (emerging) technologies. What often remains unquestioned is the interplay of different repertoires of "lay expertise" present in interactive engagement settings. Moreover, how personal expertise is employed and valued by citizens and which experiences they select to create and justify their positions varies according to different settings, group constellations, cultural/political contexts and issues. This paper aims at opening up the very notion of lay-expertise through a detailed study of a group discussion on "nanofood". This will offer an in-depth understanding of different forms of lay-expertise and show that power relations constructed over expertise are not only situated in lay-scientist interaction, but also inherent to those within lay groups.

### **Ethical Issues Associated with Human Cloning Aspects of Biotechnology for Producing Tailored Babies**

Arvind Jain, Sanjeev Kumar Sharma, and Era Upadhyay

Biotechnology is a revolutionary branch of technology having its applications from days of brewing to the current researches in genomics, stem cells etc. Broadly speaking, Biotechnology is the synthesis of ideas of science and technology leading modification and production of tailored organisms for human welfare. However, plentiful applications of biotechnology alone cannot establish the viability without its socio-ethical acceptability.

Cloning of a human being is one of its major applications and is chiefly aimed to provide a 'biologically related child' to an infertile couple. Human cloning can put an end to genetic and degenerative diseases such as Alzheimer's disease can also be used to generate tissues and organs for transplants and preservation and repopulation of the endangered species. However, this type of research involves high risk and may disturb the whole fabric of the society, even if it has high future potential.

The idea of using genetic manipulation to produce 'designer babies' with particular sex and qualities according to parental specification is matter of great concern in many nations including India .It is not only disturbing the male/female ratio but some fanatic parents would try to create tailored babies, which may be the carbon copies of themselves or certain famous personalities. In this way man is trying to create human life and increasing trying to control its destiny and play the role of God. It can also be used for the reproduction of children with certain peculiar and grotesque characteristics who can become a threat to the world at large. As suggested by the animal studies, the reproductive cloning of humans would similarly pose a high risk to the health of both fetus or infant and mother and lead to associated psychological risk for the mother as a consequence of late spontaneous abortions or the birth of a stillborn child or a child with severe health problems". Moreover, women from poor section of society in greed of some monetary incentives etc. may consent to take the risk of their own health. Cloning threatens confusion of identity and individuality and it is a giant step towards transforming procreation into a manufacture leading to

increasing depersonalizing of the process of generation and increasingly towards the production of the human children as artifacts, products of human will and design. They may be utilized as a source of various organs as per needs. Getting a clone from a laboratory will be getting a puppy from a store.

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Moreover, unclaimed clones would be disposed of, the same way as unclaimed puppies are killed. The programmed reproduction of man will, in fact, dehumanize him Through the rental of surrogate-womb services and through the buying and selling of tissues and embryos, priced according to the merit of the donor, the commodification of nascent human life will be unstoppable There are many other issues like inheritance of property, civil liability and religious perspective involved in human cloning.. In near future we may develop clones entirely in the laboratory without natural birth leading to compromising attitude of parents toward the infant.. In April 1998, scientists Jeremy Rifkin and Stuart Newman, applied for a patent for a “humanzee,” part human and part chimpanzee, to fuel debate and to draw attention to potential abuses on this issue.

Cloning in India is not regulated by legislation but by ethical guidelines adopted by authoritative bodies. The department of Biotechnology (Govt. of India) has banned any research towards human cloning. The institutional ethical and national apex committees focused Indian Council of Medical Research (ICMR) as the nodal governmental body to operationalise the established protocol of ethical guidelines on issues for biomedical research on human subjects through clearances. The need of expertise for understanding and utilizing these technologies is also creating a gap in the society .The severity of the problem further rises due to difficulty in understanding that absolutely certain answers often cannot be given to complex questions and that every element of risk can seldom be eliminated. These issues needs strong deliberation and all questions need to be answered before we have an adequate basis of knowledge for utilizing the potential of this technology and reaching final ethical decisions.

### **Panel 39: Nanotechnology in the Private Sector**

While venture capital for nanotechnology may have decreased in recent years, private funding remains an important driver of nano research in the US and around the world. Comparatively, however, the sector is understudied, leaving open a swathe of questions regarding the similarities and differences of the imaginaries of public and private research, the needs and drivers of nano-business, and the dynamics of private innovation and R&D. This panel seeks to open up a conversation on these issues by showcasing research on private sector nanotechnology innovation and development.

### **Panel 40: Exploring the Uncertain Technological Future: Lessons in Anticipatory Governance**

This session will combine a general introduction to the idea of anticipatory governance and foresight on emerging technologies, with discussions of how to consider the potential future ramifications of scientific and technological changes in ways that will both seem relevant for informal science education audiences and appropriate within our existing institutional missions and obligations. Panelists from a number of science centers and university

scholars will present models for envisioning, exploring, and conceptualizing the future of emerging technologies through methodologies such as media, deliberation, architecture, theater, and museum exhibits, while exploring and discussing the role of informal science education in providing activities to build these skills and put them into action. Participants will consider a number

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of examples, ask questions, discuss potential challenges, and brainstorm ideas for collaboration and potential projects around a number of emerging technologies.

### **10:30 a.m. PANEL SESSION IX**

#### **Panel 41: Language, Image and Discourse**

##### **The Enclosed Language of Collaboration: Practices of ‘Sponsored Research’ Around Nano in the United States**

Elena Simakova

The paper will examine discourses and practices at the university-industry interface in the context of “sponsored research” - an institutionalized way of formalizing exchange of resources and knowledge between university scientists and external sources, such as industries, government agencies and foundations, managed by university offices. I will discuss documentary practices around nanotechnologies in a US university sponsored research office. The data mainly consist of files containing email exchange, sponsored research contracts and forms used to manage university-industry relations of exchange. It also draws on interviews with sponsored research and technology transfer officers. Through examining the contingencies of arrangements and negotiations of sponsored research, the paper aims to interrogate the ways in which technological futures are constituted and managed in the situated discourses of innovation at the university-industry border. The paper will explore the construction of collaborative spaces and of content of nano research in a setting involving non disclosure.

##### **Nanotechnological Icons**

Alexei Grinbaum

Modern microscopes create a capacity to see and act at the scale where unassisted human senses are powerless. Nanoscale images represent a world that effectively intervenes in the human life while remaining distant and ineffable. This combination of an unbridgeable distance between man and technology with a real power of the latter over the human condition is characteristic, not only of nanotechnology, but of the theology of sacred icons that mediate in the knowledge of divine reality. We draw an anthropological analogy between nanotechnological images and sacred icons and we employ it to analyze the functioning of such images in the society. This work has repercussions for a wide variety of disciplinary accounts and practices, from the anthropologist and the philosopher to the laboratory scientist, the art critic, and the engineer who conceives and designs nanoscale instruments.

##### **Boundaries of Science Communication in the Era of Nanotechnology: The Department of Energy and Discourses of Revolutionary Applied Science**

Matthew Eisler

Nanotechnology has been interpreted as the subject of an exemplary public science debate of the sort elaborated by Gieryn and Bucchi. This paper argues that nanotechnology should be seen as a boundary object not of

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science discourse but of science policy discourse. The precipitating crisis involved contested social, not physical, knowledge: the implied theory of the social relations of linear innovation, and, hence the presumed economic value of basic science. In the early 1990s, representatives of state-funded science communities conceived nanotechnology and its matter-as-machine metaphysics as a kind of symbolic capital at a time when their political masters pondered the future of the federal science establishment and how it could be made to better serve the national interest. This account of the politics of taxonomy in the Department of Energy's Office of Basic Energy Sciences in the 1990s shows how actors introduced nanotechnology into science policy discourse as an alternative expression for materials science.

#### **Panel 42: What Do the Scientists Think?**

##### **How Should We Regulate Nanotechnology? Perceptions of Leading USA Nano-scientists**

Youngjae Kim, Elizabeth Corley, and Dietram Scheufele

Government regulations to address technological risks are important for the successful development and application of nanotechnology, but there is an ongoing debate in the U.S. about who is responsible for the regulation of nanotech. In this study, we analyze data from a 2007 mail survey of 363 leading U.S. nano-scientists conducted through the Center for Nanotechnology in Society at Arizona State University (CNS-ASU). Specifically, we examine scientists' perceptions about nano-regulation, including the governmental level (local, national, or international) at which the scientists believe nanotechnology regulation should be implemented. This regulatory discussion is important because international regulations are often difficult to adopt and implement (Marchant & Sylvester, 2006); yet, local or state-level regulations could lead to the nanotech equivalent of the Pollution Haven Hypothesis (PHH) (Levinson & Taylor, 2008). We conclude that leading U.S. nano-scientists have varying perceptions about nanotech regulations with some scientists supporting local regulations, but most scientists supporting national level or international level regulations. Additionally, the results of significance tests and cluster analysis yield three categories of nano-scientists that have unique perspectives on nano-regulation: "technology optimists," "technology pessimists," and "nano-regulators." We outline the differences between these groups and explore what these differences mean for the future regulation of nanotechnology.

##### **Patents and Profs: How Do Researchers at Large Centers View IP Rules and Incentives?**

David Bjornstad

This paper discusses Professional Researchers and University Professors ("Profs") beliefs and practices regarding formal and informal intellectual property rights rules and guidelines (IP) at two types of U.S. Department of

Energy Research Centers (Nanoscale Science and Bioenergy Research Centers). It follows from a recent paper by Bjornstad (“Comparative Analysis of Intellectual Property Rights Management Practices at DOE Bioenergy Research Centers), [submitted for publication]), and from other relevant

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literature. The “Comparative Analysis...” paper described IP rules promulgated by DOE at three Bioenergy Research Centers, the management systems the Centers chose to implement the rules, and the behavioral incentives that the rules implied. That work drew upon written documentation of the rules and responses and the views of professional technology transfer staff at the Centers obtained through interviews. This paper considers the views of principle investigators (PI’s) regarding IP and technology transfer at the two ORNL Centers, recognizing that DOE emphasized technology transfer through patent licensing at the Bioenergy Research Center and emphasized knowledge transfer through peer-reviewed publication at the Nanoscale Science Research Center, while neither actively encouraging or discouraging patenting. Through a series of twenty ethnographic interviews we query whether profs at the two institutions feel responsibilities for seeing their research results advanced to downstream applications and, if so, what steps they take personally, if any, to promote their technologies. We identify key choices made by PI’s at both institutions that would influence information transfer and seek to link choice behavior to the information management practices. Finally, we seek to identify if systematic differences between the formal management practices and actual behavioral practices could be identified.

#### **Perception of Risk among Scientists Working with Nano**

Mikael Johansson

Based on ethnographic fieldwork among scientists working with nanomaterials this paper explores how researchers perceive risk of working with such novel materials. Different types of researchers perceive different types of risk based on their scientific outlook. Engineers working with nanomaterials on a daily basis do rarely discuss potential risk of their labor. Working so closely with nanomaterials creates a familiarity, which makes the substances less threatening. Engineers working with nanomaterial have a deep understanding of the properties of the compounds but a shallow understanding of the potential risks. Toxicologists working with nanomaterials, in contrast, focus specifically on the potential dangers. Their perception of risk is not only imagined but also embodied as they actually see and feel the potential dangers. This gives the toxicologists a deep understanding of potential risk of nanomaterial in comparison to engineers who work on the same compound.

#### **Panel 43: Novel Science**

This paper session attends to the function of novels and novelistic discourse in the development of new and emerging technologies. In particular, the panel examines the rhetorical shaping of novelty and innovation in contemporary technoscience in relation to the novel as a generic way of representing the present. With its characteristic attention to narratives of the everyday and the new, the recent and the quotidian, the novel as a literary genre both animates

the present and opens to the unknown future: indeed, this could be considered the defining form of the novel, whether in its mode of realism (the 'science novel') or hyperrealism (the 'science fiction novel'). The panel draws upon critical frameworks from the humanities and social sciences to illuminate the novelistic strategies used by scientists, government officials, lawyers, and

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literary writers to affect research directions, to launch both small-scale and large-scale technoscientific programs, and to interrogate the legal and social implications of new technologies. If the traditional distinctions between novel and romance no longer hold in an age where fantastic novelties have become a commonplace condition of everyday life, the role of the novel in articulating newness, in narrating the news and the newsworthy, becomes evermore tasked to account not only for science today, but also for science five minutes from now, the present and the future present. The three papers will address such issues from the perspectives of literary studies, science studies, and legal studies.

Paul Youngman's paper will be called "The Science Novel in Nanodiscourse." German nanoscientist Antonia Fehrenbach's first novel, *Der Lotus Effekt* (2008), is a self-proclaimed "science novel" describing a laboratory accident that, but for the heroic efforts of the protagonist, almost becomes a worldwide disaster. Notable about this novel is the fact that Fehrenbach self-consciously writes "against" popular science fiction. In doing so, she sets up several interesting dichotomies – science vs. science fiction, U.S. nanoscience and nanotechnology (NST) vs. its German or European counterparts, transhumanism vs. humanism, etc. My talk will analyze Fehrenbach's dichotomies in light of the 2002 report "Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology, and Cognitive Science (NBIC)" commissioned by the National Science Foundation and the U.S. Chamber of Commerce and the "Converging Technologies: Shaping the Future of European Societies (CTEKS)" sponsored by the European Union – its 2004 response to the U.S. NBIC report. In the course of my discussion, Youngman will address several questions central to any analysis of the discourse surrounding NST. First, are science novels, as opposed to works of science fiction, an effective bridge between C.P. Snow's scientific and literary cultures as Fehrenbach's editors maintain? Second, is there a distinct U.S. nanodiscourse that differs from the European discourse? Finally, what roles humanism and transhumanism play in the development of nanodiscourse and, by extension, NST?

Colin Milburn's paper will be called "Engines of Convergence: Science Fiction as Cognitive Technology." In the discourse of technological convergence—often imagined as the mutual alignment of nanotechnology, biotechnology, informatics, and cognitive science—the figure of "cognitive technology" looms as perhaps the most provocative, if not even disquieting, outgrowth of what the molecular future holds: brain implants, mental enhancements, neural-computational networks, artificial superintelligence, smart drugs, mind control. Though discussions of cognitive technology typically present it as a new and emerging field, promising over-the-horizon innovations and endless novelties that will transform the human condition—provoking both ecstatic and paranoid speculations on the posthuman future—this paper will argue that cognitive technology, as an instrumental means of literally "changing your mind," has a particular low-tech pedigree in the form of the science fiction text. This paper will show that the literature of science fiction has, throughout its history,

explicitly fashioned itself as a cognitive technology. By looking at some examples of recursive science fiction—that is, science fiction texts that represent science fiction as an element in their own plots—this paper will show that science fiction has persistently constructed itself a low-tech tool for achieve high-tech cognitive effects. That is to say, the field of science

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fiction—novels, films, and interactive media narratives, as well as critical and fannish discourse about these narratives—has long maintained that engaging with science fiction not only makes you smarter, but might even turn you posthuman.

Michael Bennett's paper will be called "The Zeroth World of Legal Scholarship." Contemporary legal scholarship has largely discounted two regular concerns of the broader social science research community: first, the latter's emphasis on the foundational importance and stewardship of data, its generation, access, referencing and preservation; second, social scientific claims for the importance of science fiction, as a generic field and as a concept, to the generation of more robust understanding of technoscience, particularly in various emergent areas. The presentation will share some preliminary results of grounded theory-derived qualitative and quantitative studies of science fiction in North American legal scholarship. This research merges the two sociological concerns by probing legal literatures, with their traditionally exhibited empirical aversion, with science fiction, a genre critically characterized as empirically dissonant relative to the "real" (or, "zeroth") world. A crucial goal of the research is to contribute to a lessening of the aforementioned double indifference of legal scholars by three means: (1) contribution to the on-going debate in the legal academy regarding the relative merits of traditional logico-deductive theory formation and empirically-grounded theory formation techniques; (2) heightening awareness of the data stewardship issues within social science research areas bearing on technoscience research and development, particularly when data-driven research, at least in part, relies on proprietary databases; and (3) examination of the rhetorical, descriptive and conceptual deployments of science fiction in academic legal literatures.

#### **Panel 44: Roundtable—Finding Futures**

This 'non-traditional' activity will engage conference attendees in an exploration of place, futures, and mundane technologies. Confronted with a series of challenges, participants will take to the streets and capture their impressions of the urban scene. Their photographic and reflective efforts will be part of an installation and gallery talk on the closing day of the conference.

"The future is already here, it is just unevenly distributed."  
- William Gibson

The urban landscape is teeming with intensive technological systems and inextricable "forms of life" (Winner 2004) that enable, dictate and modulate our everyday experiences. As we move about our day, flicking switches and taps to be bathed in light and treated with water we experience momentous technological achievements that operate behind the scenes, often out of sight and out of mind. At the same time, mundane technologies – walking shoes, street sweepers, sunscreen, street signs and mobile GPS— facilitate our

urban experiences in particular ways. Finding Futures asks you to notice the momentous and mundane technologies that underpin Tempe.

Kevin Lynch in *Images of the City* (1960) explores the “visual quality” of cities honing on the “legibility” of patterns and systems within the cityscape as

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picked up by assorted cues. He develops the concept of wayfinding, which renders personal mental maps of urban places explicit. Lynch’s frameworks

and methodologies prompt us to take stock of the city with a different intentionality and gaze. Wayfinding offers a potentially productive method for untangling human relationships to the built socio-technical environment. In this same way, the organizers of this session will employ a similar set of techniques to conduct a critical empirical study of technology futures in urban settings.

While Lynch’s quietly influential notions about wayfinding have permeated diverse practice-oriented fields from urban planning to museum studies, they have not been taken up in STS literature or practices, particularly those concerned with citizen participation. In STS scholarship, citizen consultations that involve understanding of technology choices rooted in place, such as those about environmental impacts and facility siting, frequently fail to connect with the embodied relationships urbanites have with technology and the environment. They focus on the discursive – formal meeting and consultations with experts as deliberation -- and ignore the material, affective, creative or visual. Inspired by Lynch’s wayfinding as a means to make the city legible, we are working to rethink the tools of public engagement in way that take STS’s commitment to artifacts, the material, and everyday experience seriously. Thus, as part of a larger research project to define and explore ‘material deliberation’, we find that Lynch’s attention on the sensorial and kinetic renderings of the environment fills a gap in analytical and design tools for participatory decision making in the STS toolbox.