Societal Dimensions of Responsible Innovation for Nanotechnology

December 14, 2012

Welcome to NACK's Webinar

Presenter

Barbara Herr Harthorn

Director, CNS-UCSB and Prof, UCSB
Group co-leader, UC CEIN

Who Are You?

A. K-12 Educator
B. Community College Educator
C. 4-year College/University Educator/Researcher
D. Industry scientist, engineer or technologist
E. Government agency or nonprofit organization

Outline

- What is responsible development of nanotechnology (and why should you care?)
- Will the public accept these new technologies?
- How can public participation lead to better outcomes?
- What about the experts?
- Governance challenges

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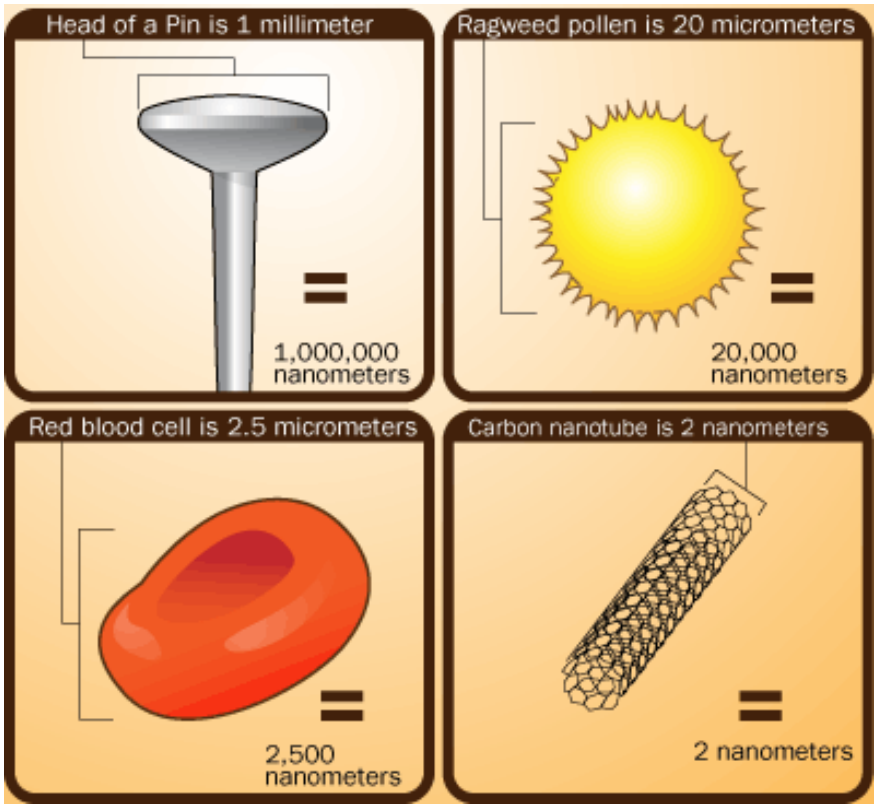
What is nanotechnology?

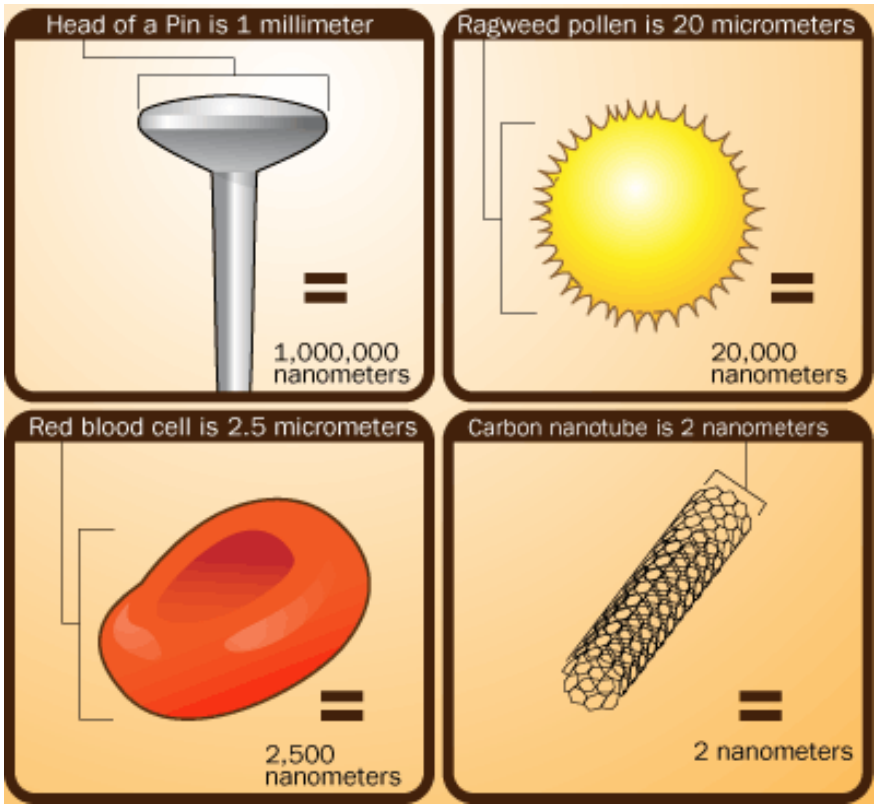
- Group of technologies using extremely small particles



S.K. Hanna & M. Collins CNS-UCSB and UC CEIN 2012
http://www.howstuffworks.com/nanotechnology.htm

What is nanotechnology?

- Group of technologies using extremely small particles
- New and exciting characteristics and possibilities



S.K. Hanna & M. Collins CNS-UCSB and UC CEIN 2012
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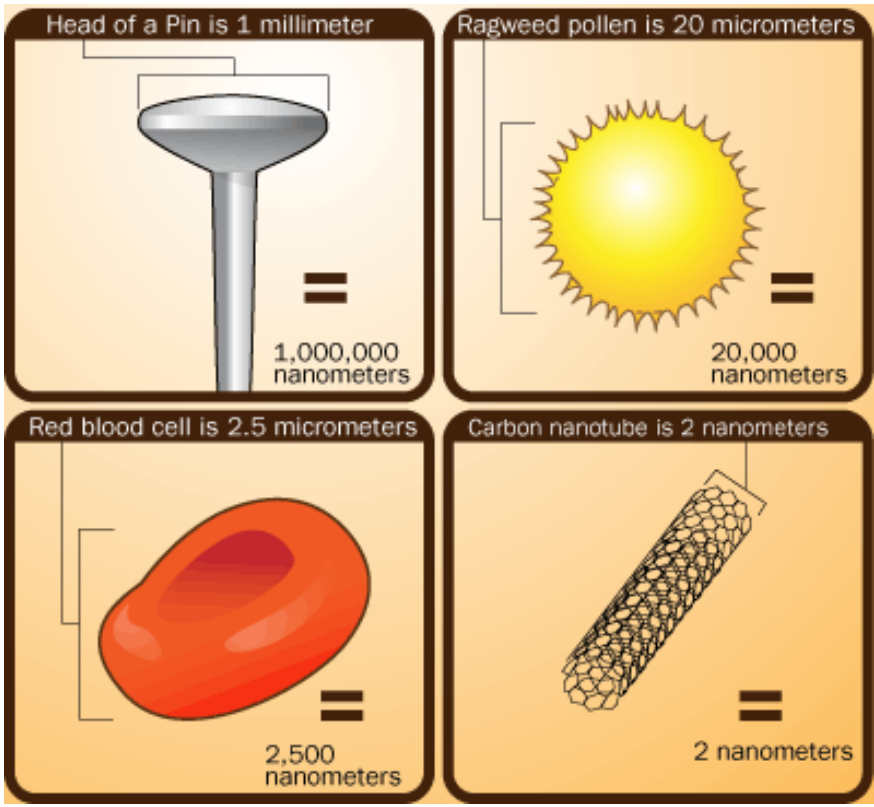
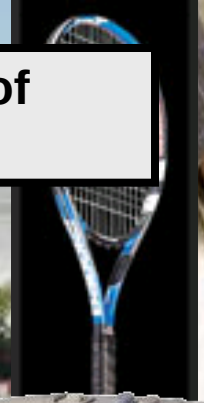
What is nanotechnology?

- Group of technologies using extremely small particles
- New and exciting characteristics and possibilities
- Significant number of unknown risks (health, environmental, etc.)



Not one technology but a large class of technologies across many industries



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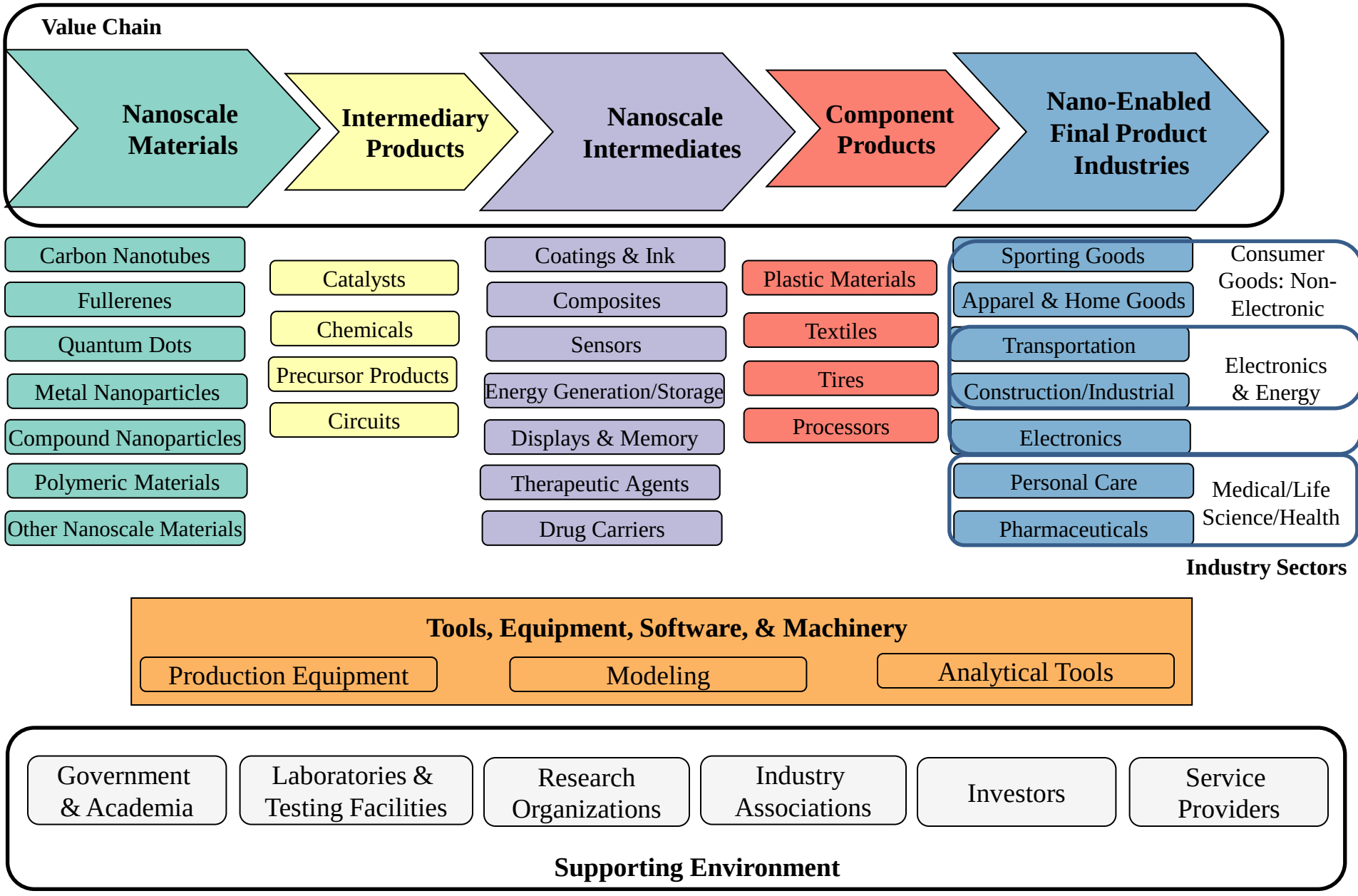
Parts of the Nano Value Chain Model

http://californianoeconomy.org/

CENTER ON GLOBALIZATION
Governance & Competitiveness



CNS·UCSB
Center for Nanotechnology in Society

Parts of the Nano Value Chain Model

http://californianoeconomy.org/

CENTER ON GLOBALIZATION
Governance & Competitiveness

Value Chain

Nanoscale Materials → **Intermediary Products** → **Nanoscale Intermediates** → **Component Products** → **Nano-Enabled Final Product Industries**

- Carbon Nanotubes
- Fullerenes
- Quantum Dots
- Metal Nanoparticles
- Compound Nanoparticles
- Polymeric Materials
- Other Nanoscale Materials

- Catalysts
- Chemicals
- Precursor Products
- Circuits

- Coatings & Ink
- Composites
- Sensors
- Energy Generation/Storage
- Displays & Memory
- Therapeutic Agents
- Drug Carriers

- Plastic Materials
- Textiles
- Tires
- Processors

- Sporting Goods
- Apparel & Home Goods

Consumer Goods: Non-Electronic

- Transportation
- Construction/Industrial

Electronics & Energy

- Electronics

- Personal Care
- Pharmaceuticals

Medical/Life Science/Health

Industry Sectors

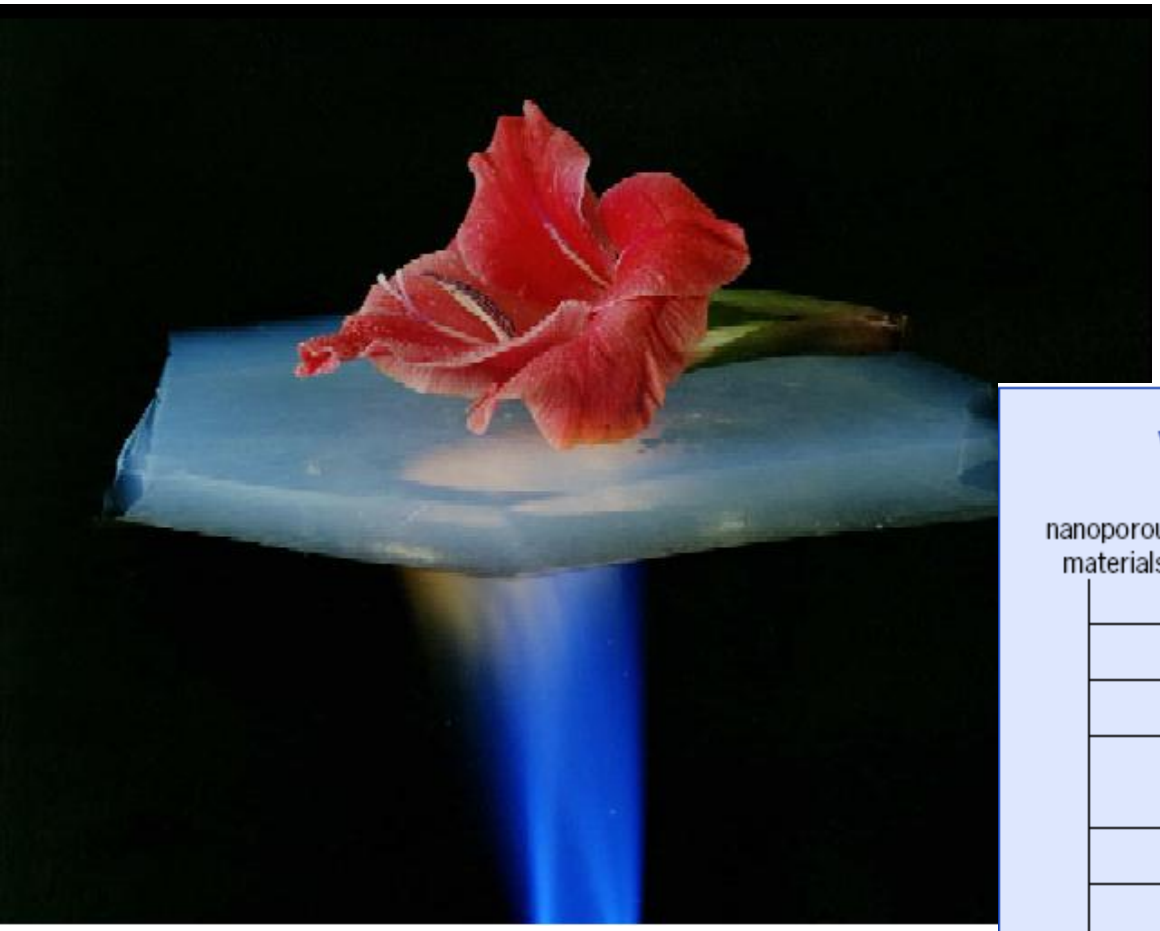
Tools, Equipment, Software, & Machinery

- Production Equipment
- Modeling
- Analytical Tools

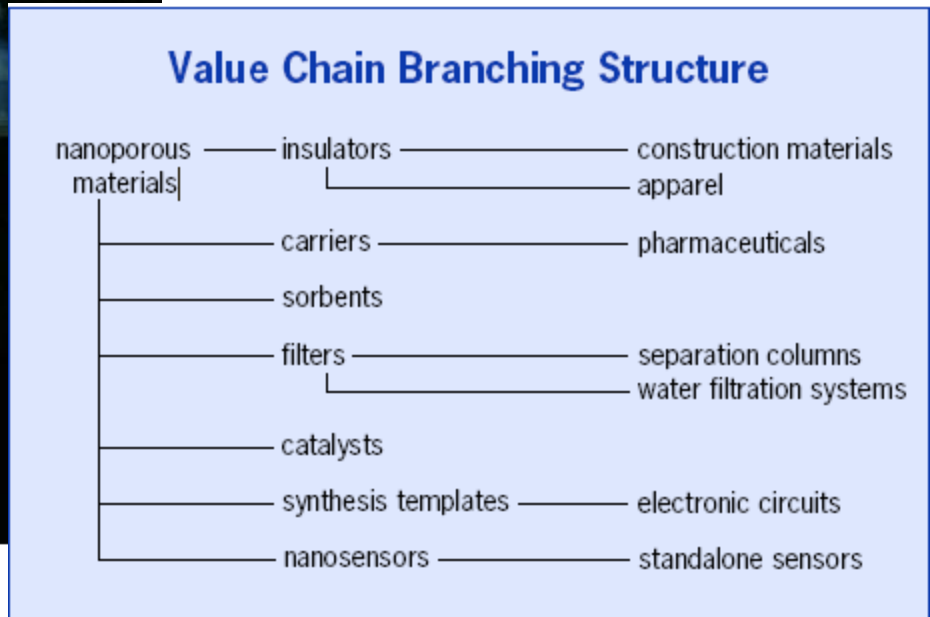
- Government & Academia
- Laboratories & Testing Facilities
- Research Organizations
- Industry Associations
- Investors
- Service Providers

Supporting Environment

Example: Nanotechnology as enabling technology



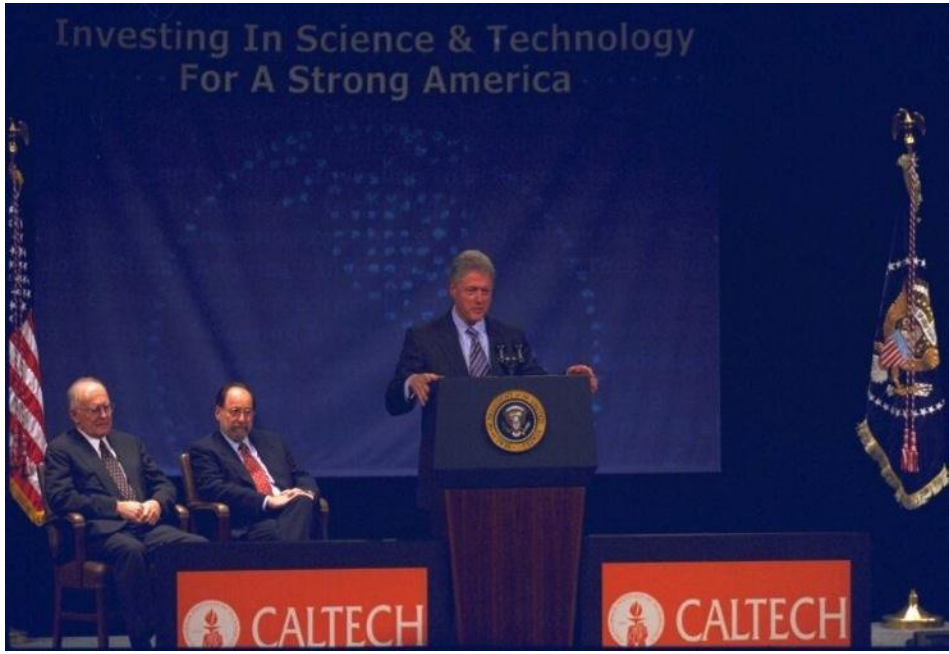
Nanoporous materials can have remarkable insulating properties



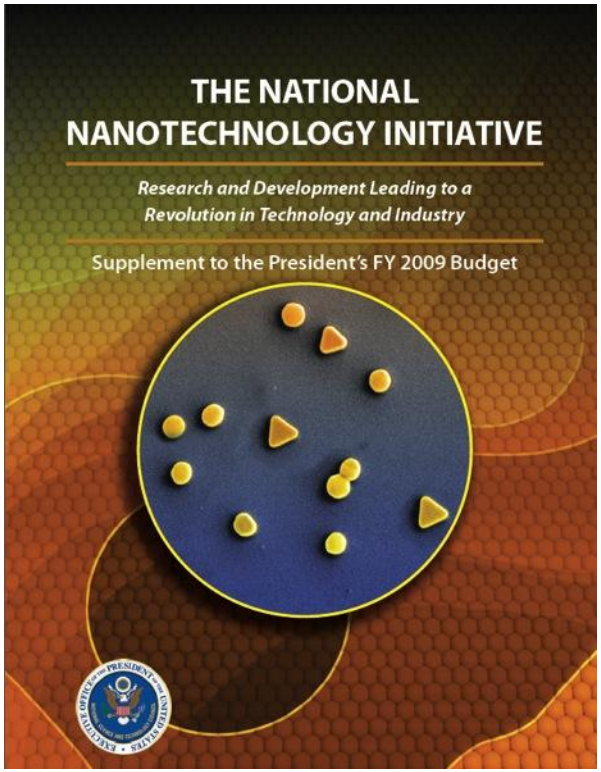
US National Nanotechnology Initiative
NNI

Pres. Clinton on nanotech January 2000:

"Just imagine, materials with 10 times the strength of steel and only a fraction of the weight; shrinking all the information at the Library of Congress into a device the size of a sugar cube…"



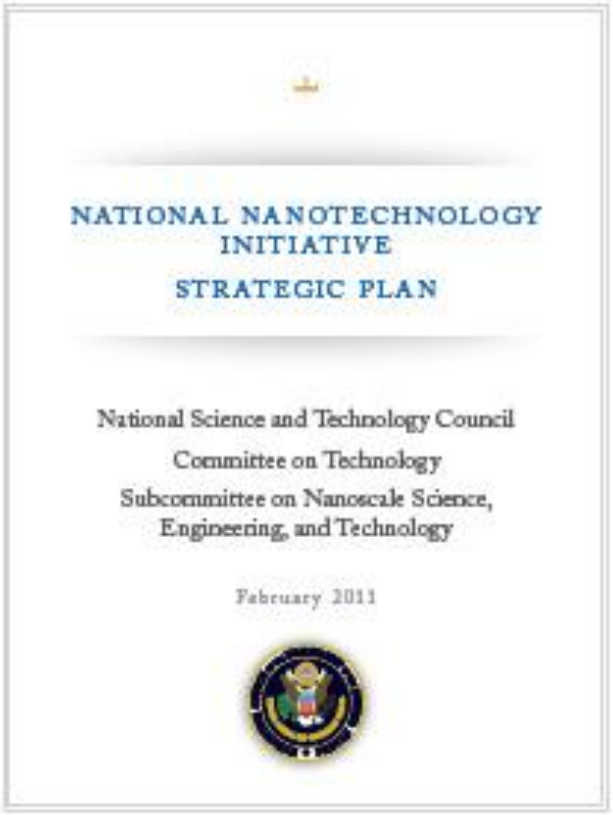
National Nanotechnology Initiative



- 26 federal agencies (2012)
- "…a future in which the ability to understand and control matter at the nanoscale leads to a revolution in technology and industry that benefits society"

NNI 2008, p. 3

NNI → 4 main goals



- Advance world-class R&D program;
- foster transfer of new technologies into products *for commercial & public benefit*;
- develop and sustain educational resources, a skilled workforce, and supporting infrastructure and tools to advance nanotech; &
- *support responsible development* of nanotechnology

The National Nanotechnology Initiative Strategic Plan, February 2011,http://www.nano.gov/sites/default/files/pub_resource/2011_strategic_plan.pdf

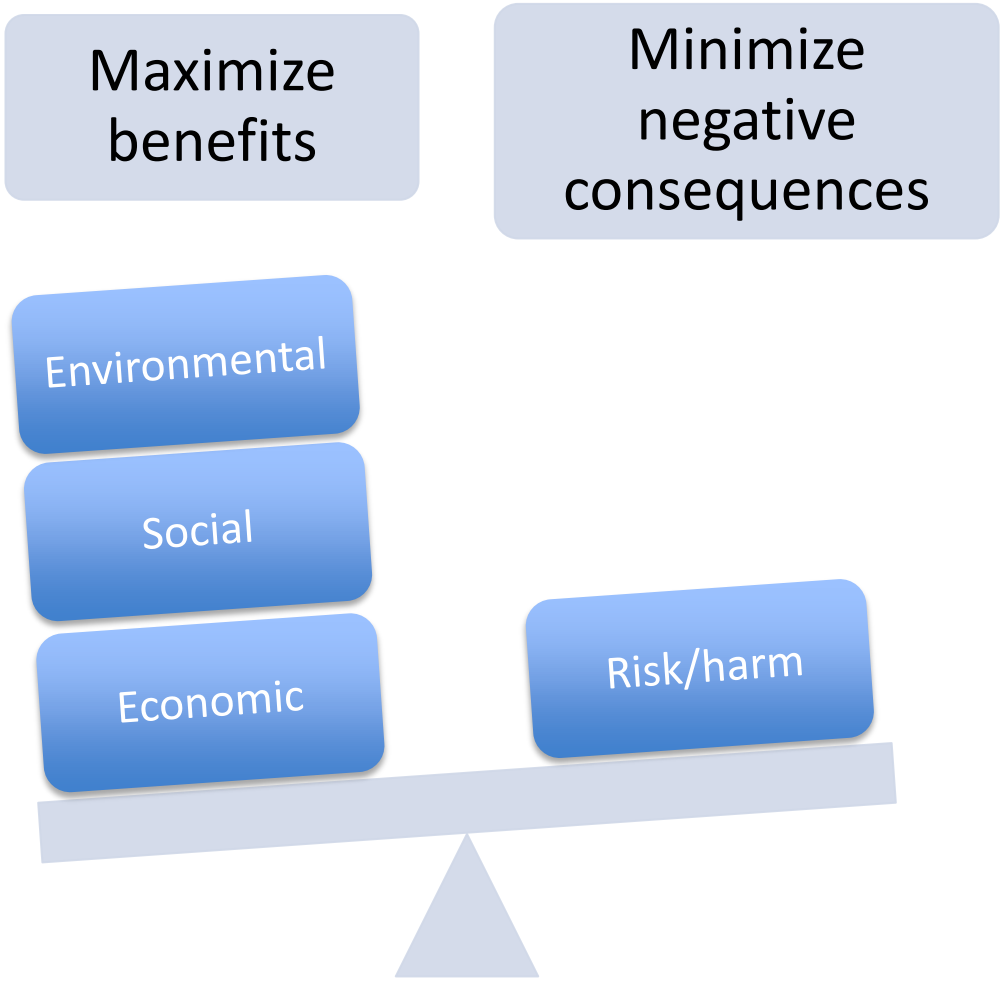
21st Century Nanotechnology R&D Act of 2003
US Congress (PL 108-153)

"Ensure that ethical, legal, environmental and other appropriate society concerns…are considered during the development of nanotechnology."

- Established societal dimensions research program/centers
- Mandates public involvement in the NNI
- Requires integration of societal & EHS w/ nano R&D
- Creates ethical standard for nano development as equitable

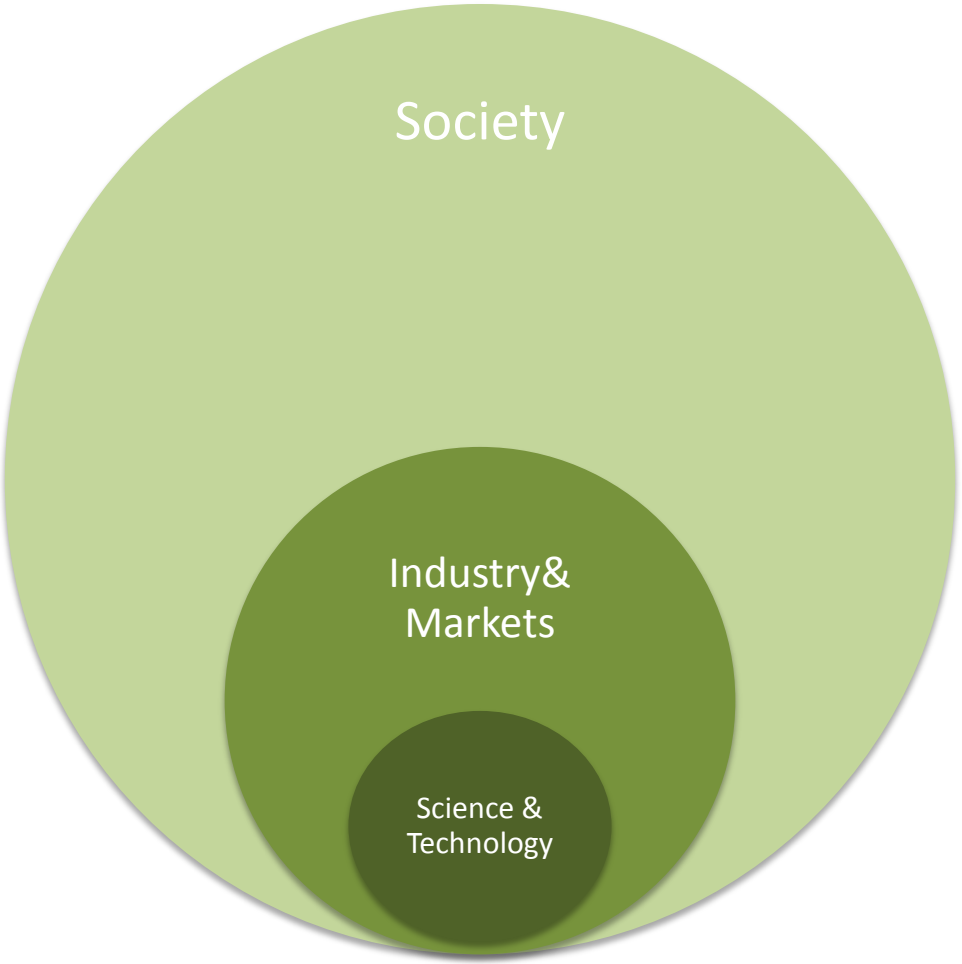
What is meant by responsible development?

Responsible development



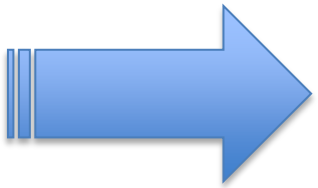
What are societal implications of new technologies?

Technology *in* Society



Societal ≈ ELSI

- Ethical
- Legal
- Social
- Economic



Nano ELSI

US National Nanotechnology Initiative, 2011

ELSI (ethical, legal, and societal implications) considerations "are deeply embedded in the NNI's commitment to **responsible development** of nanotechnology."

"The NNI seeks to generate ELSI knowledge and insights through:
(1) research in the areas of **public perception** and understanding expected benefits, anticipated risks, and safety that can help society assess potential impacts of nanotechnology and possible responses;

(2) **scientific meetings and workshops** at the local, state, national and international levels; and

(3) **public engagement** activities to identify stakeholder perspectives on nanoEHS and ELSI issues."

NNI Environmental, Health, and Safety Research Strategy, 2011: 10

Ethical, Legal, and Societal Issues

Responsible development of nanotechnology is one of the four goals of the NNI and central to advancing the other three (specifically, continuing a world-class R&D program; fostering the transfer of new nanotechnologies into products for commercial and public benefit; and educating the workforce, engaging the public, and sustaining an effective nanotechnology R&D infrastructure).

An important component of responsible development is the consideration of the ethical, legal, and societal implications of nanotechnology. How nanotechnology research and applications are introduced into society; how transparent decisions are; how sensitive and responsive policies are to the needs and perceptions of the full range of stakeholders; and how ethical, legal, and social issues are addressed will determine public trust and the future of innovation driven by nanotechnology.

Related Resources

The NNI has centers that focus on ELSI issues:

- Center for Nanotechnology in Society at Arizona State University
- Center for Nanotechnology in Society at the University of California Santa Barbara

The NNI is committed to fostering the development of a community of experts on ethical, legal, and societal issues (ELSI) related to nanotechnology and to building collaborations among ELSI communities, such as consumers, engineers, ethicists, manufacturers, nongovernmental organizations, regulators, and scientists. These stakeholder groups will consider potential benefits and risks of research breakthroughs and provide their perspectives on new research directions. With its industry stakeholders, the NNI will also develop information resources for ethical and legal issues related to intellectual property and ethical implications of nanotechnology-based patents and trade secrets. To date, the cumulative NNI investments in education and societal dimensions totals $350 million.

To help explore the ELSI issues, NNI agencies are supporting the two centers for nanotechnology in society noted in the "Related Resources" box, and where possible, are incorporating ELSI components into their new nanotechnology R&D

Nanotechnology and You

- Benefits and Applications
- Environmental, Health, and Safety Issues
- **Ethical, Legal, and Societal Issues**
- Federal Legislation
- International Engagement
- Standards for Nanotechnology

Societal benefit?

- "Moral progress" rather than just "material progress" as goal
- (*The Economist* Dec 19 2009)→ social sustainability
  - Make decisions based on what is good for society
  - Support those decisions with legal and social system
- Fairness: Distributive Justice; Procedural Justice
- Informed consent of those affected: public participation, deliberation

Determining 'what's good for society'

- EH&S—***essential*** but not sufficient
- Assess benefit and risk perceptions of multiple stakeholders
  - Diverse publics
  - Experts
  - Industry
  - NGO, community-based organizations
- Engagement for *mutual* education and deliberation
  - CNS-UCSB (cns.ucsb.edu)
  - CNS-ASU (cns.asu.edu)
  - NISEnetwork (www.nisenet.org)
- Studying the future--scenarios, experimental designs
- Innovation system
- Legal/regulatory studies

CNS-UCSB
Center for Nanotechnology in Society

SES 0938099

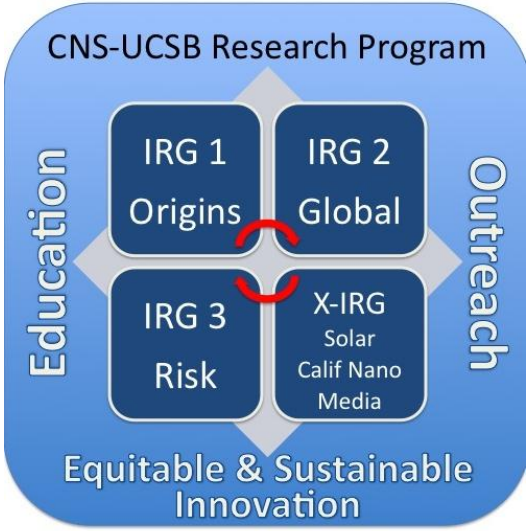
Mission: Nanotechnology Origins, Innovations, and Perceptions in a Global Society

CNS-UCSB challenge: Will nanotechnology mature into a transformative technology, in our rapidly changing international economic, political & cultural environment?

- Social and environmental sustainability, 'responsible development'
- Many methods, disciplines, new approaches

Key factors we focus on:

- Global nano-enterprise (US, Asia, Europe & Latin America)
- Multiple party risk perception
- Modes of dialogue with the public
- Historical contexts for S&T development



http://www.cns.ucsb.edu/

NSEC/Center for Nanotechnology in Society at Arizona State University

- **Research** the societal implications of nanotechnologies
- **Train** a community of scholars with new insight into the societal dimensions of nanoscale science & engineering (NSE)

- **Engage** the public, policy makers, business leaders, and NSE researchers in dialogues about the goals and implications of NSE
- **Partner** with NSE laboratories to introduce greater reflexiveness in the R&D process

http://cns.asu.edu/

UNIVERSITY OF CALIFORNIA

UC CEIN Center for Environmental Implications of Nanotechnology

about | research | education | people | places | resources | events | publications

Nano News

Nano-safety studies urged in China

Ions, not particles, make silver toxic to bacteria

Advantages of mechanisms-based toxicity testing of nanomaterials

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Study Shows Confusion On Protecting Nano Workers

CEIN Home

How to Reach Us

Nano News

Employment

Research Highlight

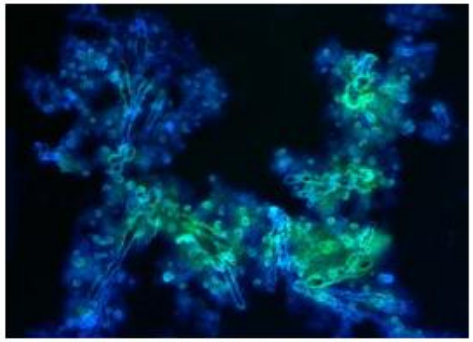
PerkinElmer, the world's largest supplier of analytical instruments, has just featured the work of UC CEIN associate Prof. Jorge Gardea-Torresdey and his group at the University of Texas at El Paso and their research in nanomaterials in our food supply . . . more

Events

Recent Events . . . more

Challenges and Opportunities for Businesses Engaged in Nanotechnology
September 25, 2012 • CNSI Auditorium • UCLA
Workshop to discuss the current state of the nanotechnology industry in California and identify opportunities and pitfalls for the continued expansion of this key technology sector. . . . more

Nano Art - Science and Art Intersect



"Nano Puppy" by Dr. Tian Xia

Public Release of High Throughput Data Analysis Tools

The UCLA Center for the Environmental Implications of Nanomaterials (CEIN) is proud to announce the public release of an integrated set of High Throughput Data Analysis Tools (HDAT) for rapid analysis of HTS nanotoxicity data. HDAT allows analysis of . . . more

SPECIAL NEWS

The CEIN was honored to host a visit by EPA Administrator Lisa Jackson in February 2012. She chose to visit the Center, toured labs, met with . . . more

About

The mission of **the University of California Center for Environmental Implications of Nanotechnology (UC CEIN)** is to use a multidisciplinary approach to conduct research, knowledge acquisition, education and outreach to ensure the responsible use and safe implementation of . . . (more)

Nanotoxicology Training Program

http://www.cein.ucla.edu/

CEINT Member Resources | Login

CEINT | Center for the Environmental Implications of NanoTechnology

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Former CEINT REU Student Honored at White House Events

Ms. Shorma Bianca Bailey, CEINT REU student (summer 2011) has been invited to the White House twice in the last year by the Obama administration for her inspirational work as a mentor and as role model for minority women in science and engineering.

READ MORE

Center for the Environmental Implications of NanoTechnology

The **Center for the Environmental Implications of NanoTechnology (CEINT)** is exploring the relationship between a vast array of nanomaterials— from natural, to manufactured, to those produced incidentally by human activities— and their potential environmental exposure, biological effects, and ecological impacts. Headquartered at Duke University, CEINT is a collaborative effort bringing together researchers from Duke, Carnegie Mellon University, Howard University, Virginia Tech, University of Kentucky, and Stanford University. CEINT academic collaborations include on-going activities coordinated with faculty at Baylor, Clemson, North Carolina State, and North Carolina Central universities, with researchers at NIST and EPA government labs, and with key international partners.

Created in 2008 with funding from the National Science Foundation and the US Environmental Protection Agency, CEINT performs fundamental research on the behavior of nano-scale materials in laboratory and complex ecosystems. Research includes all aspects of nanomaterial transport, fate and exposure, as well as ecotoxicological and ecosystem impacts. Additionally, CEINT is developing risk assessment tools to provide guidance in assessing existing and future concerns surrounding the environmental implications of nanomaterials.

Upcoming Events

December 13, 2012
Seminar: Menachem Elimelech

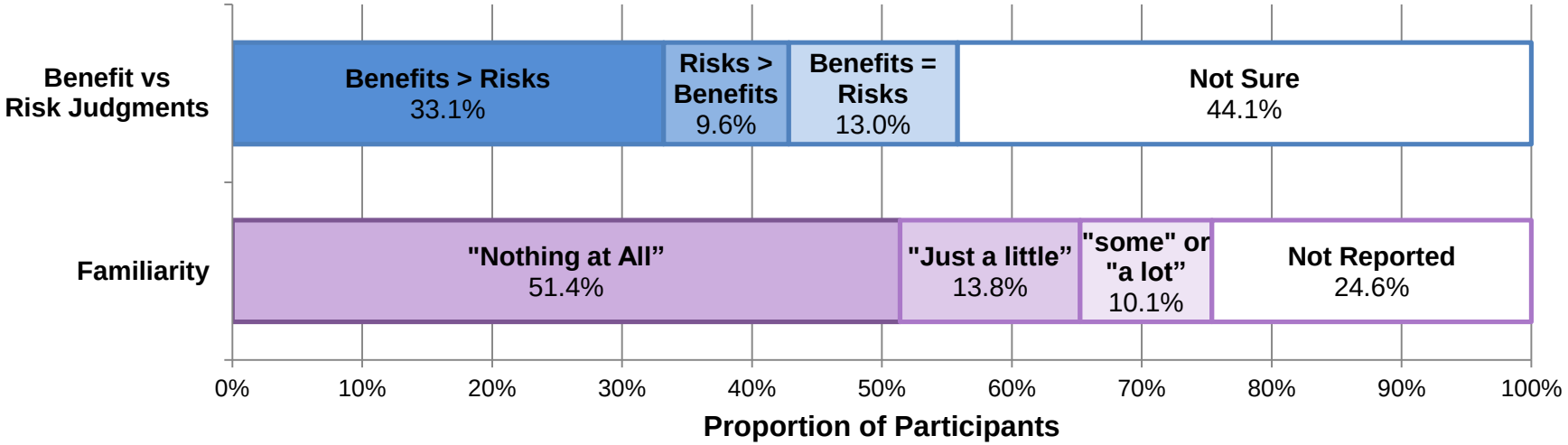
http://www.ceint.duke.edu/

Outline

- What is responsible development of nanotechnology (and why should you care?)
- Will the public accept these new technologies?
- How can public participation lead to better outcomes?
- What about the experts?
- Governance challenges

How aware are the public of nano? and how do they view nanotechnology's benefits and risks?

CNS-UCSB quantitative meta-analysis of 17 published surveys in 22 papers in US, Canada, Europe, Japan, 2002-2008



Satterfield, Kandlikar, Beaudrie, Conti & Harthorn, 2009. *Nature Nanotechnology* 4: 752-758.

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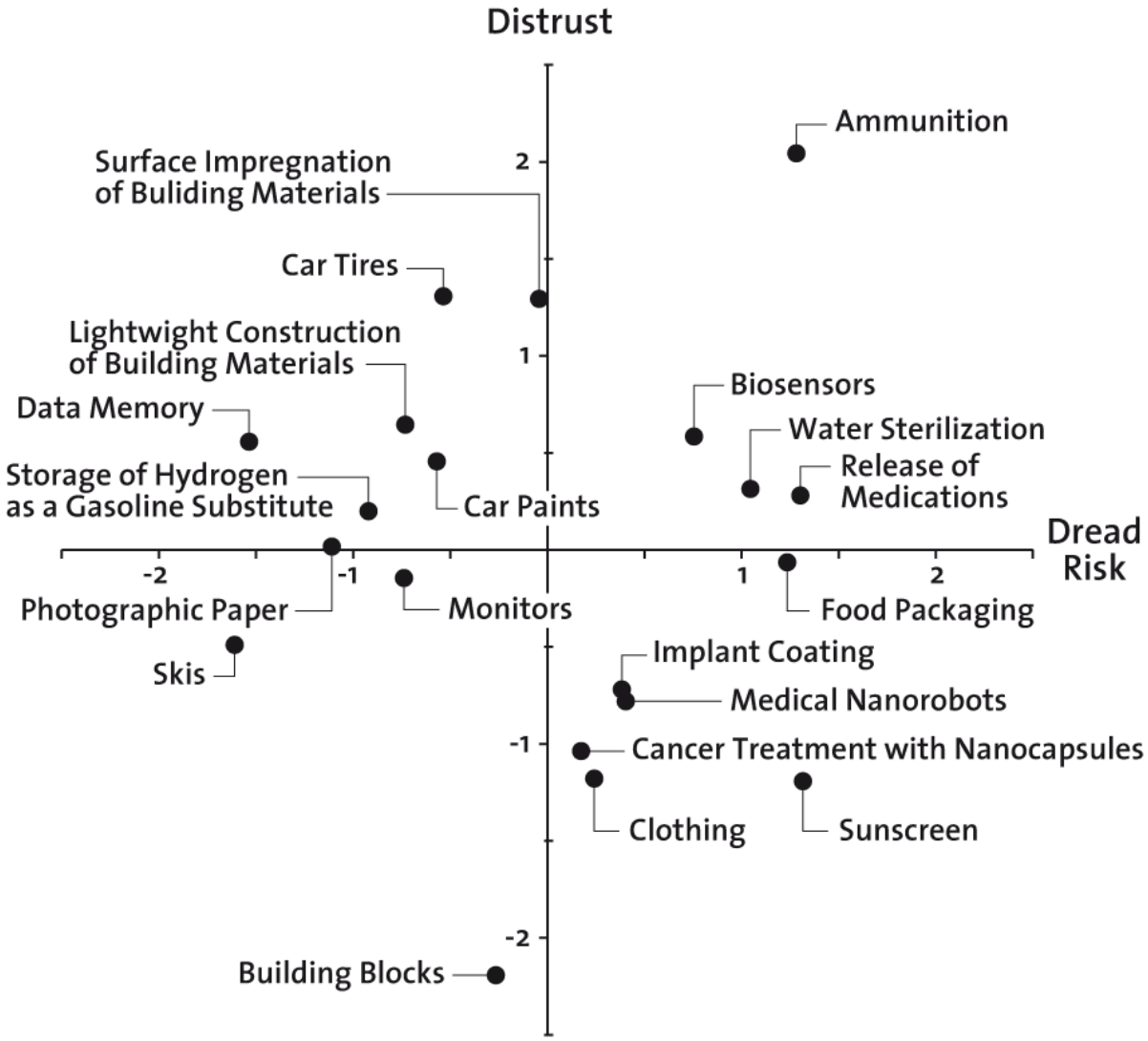
Distribution of Perceptions for Different Nanotechnology Applications – Switzerland



Source: Siegrist et al, 2007, *Risk Analysis*, v27, 59-70, n=375

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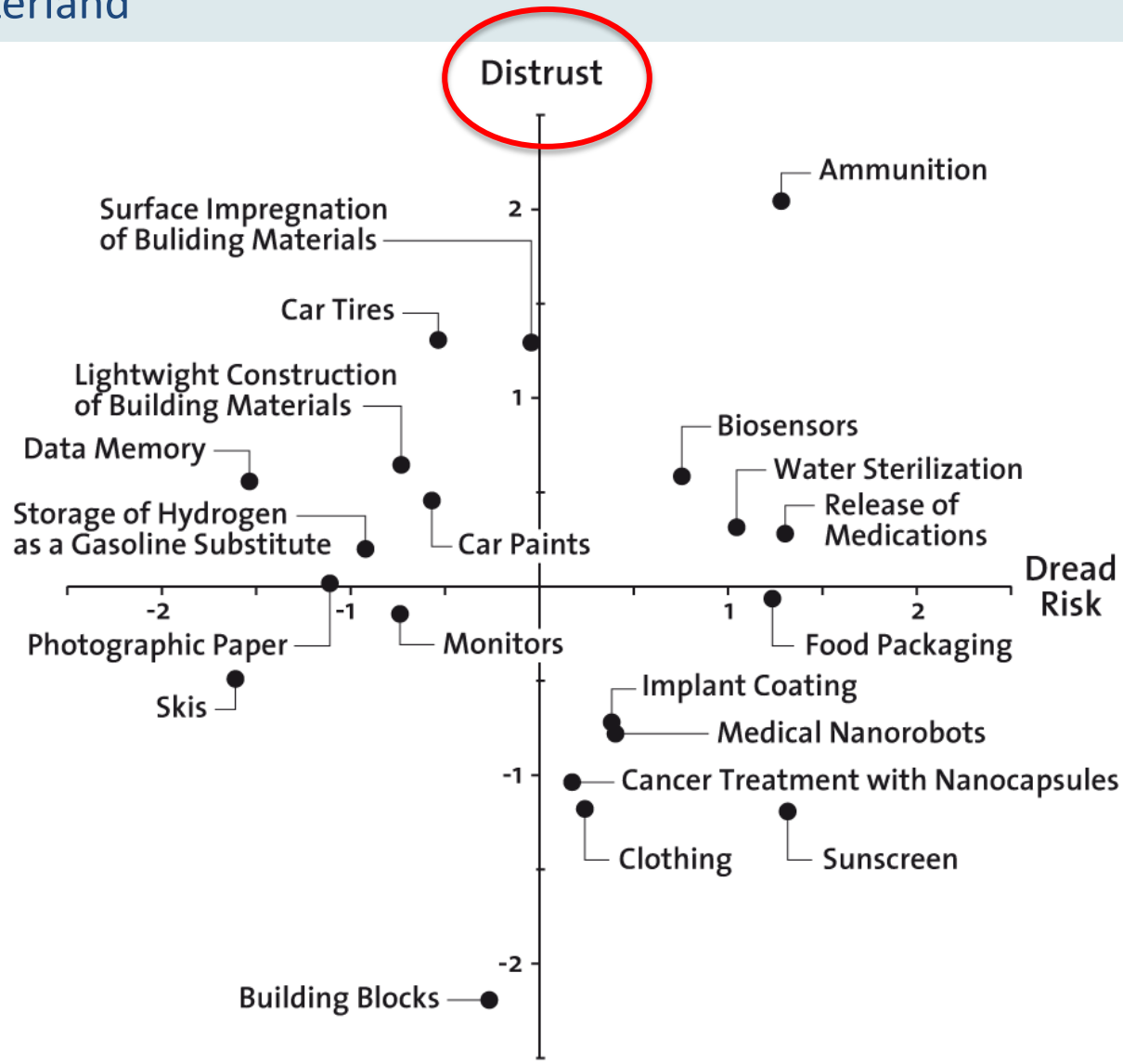

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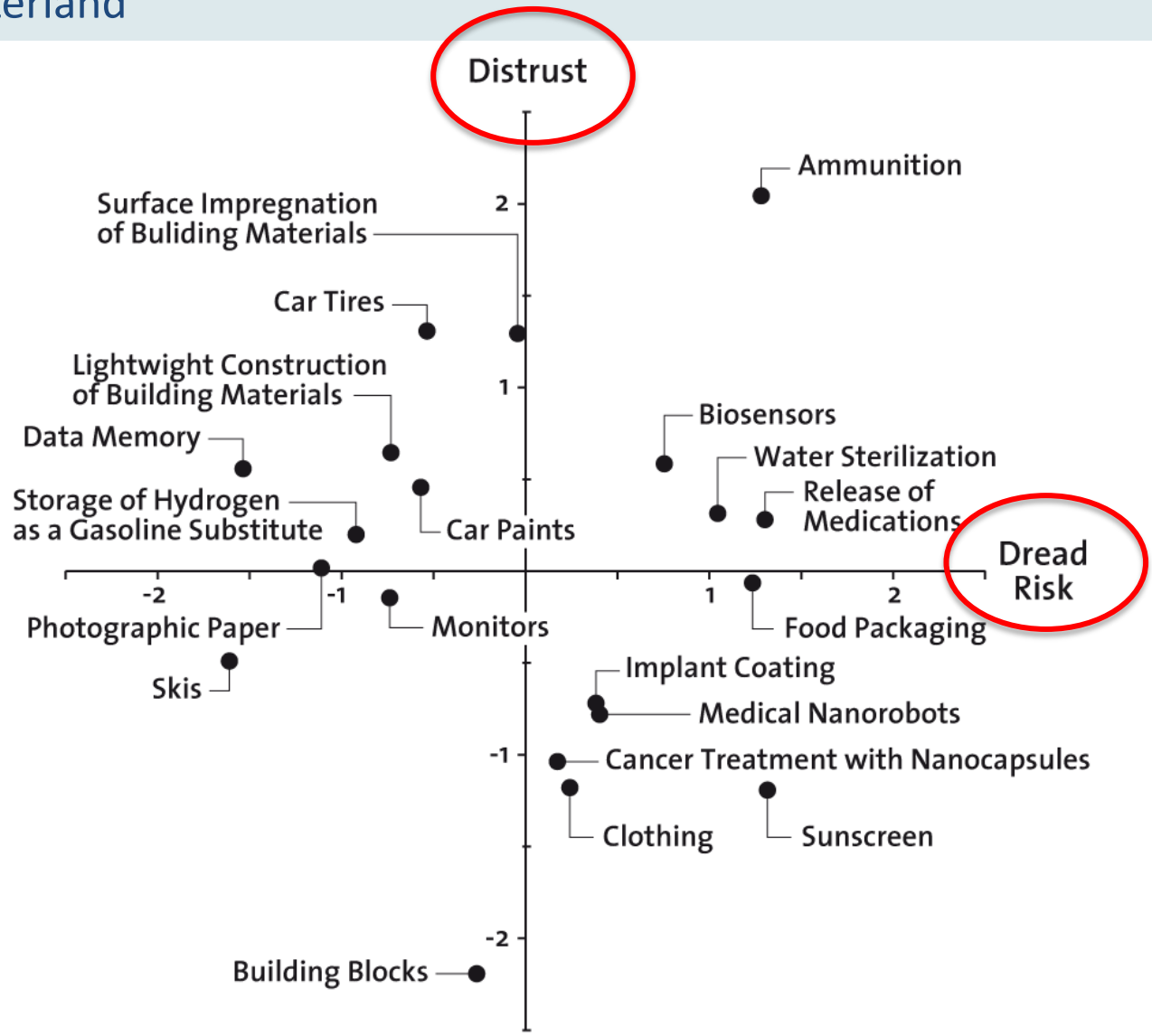

Source: Siegrist et al, 2007, *Risk Analysis*, v27, 59-70, n=375

Application Matters: Cross-National US-UK Energy-Health Deliberation of Nanotechnologies

1. Benefits Rather than Risks Continue to Frame Nano Risk Perception

2. Cross-Cultural Differences: subtle and contextual

3. Different Application: Different Perceptions: Energy vs. Health applications

4. The Social Trumps the Technological in the Discussion of 'Risk'

Pidgeon, N., Harthorn, B., Bryant, K. & Rogers-Hayden, T. 2009. *Nature Nanotechnology* 4 (2): 95-98.

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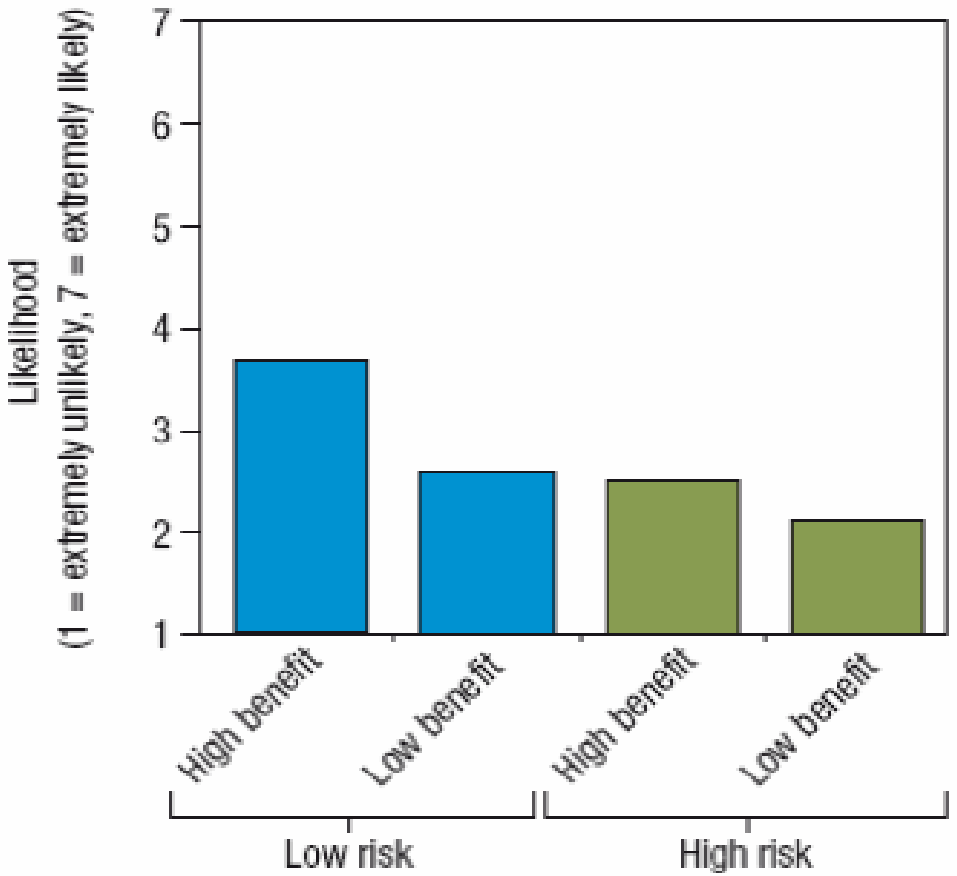
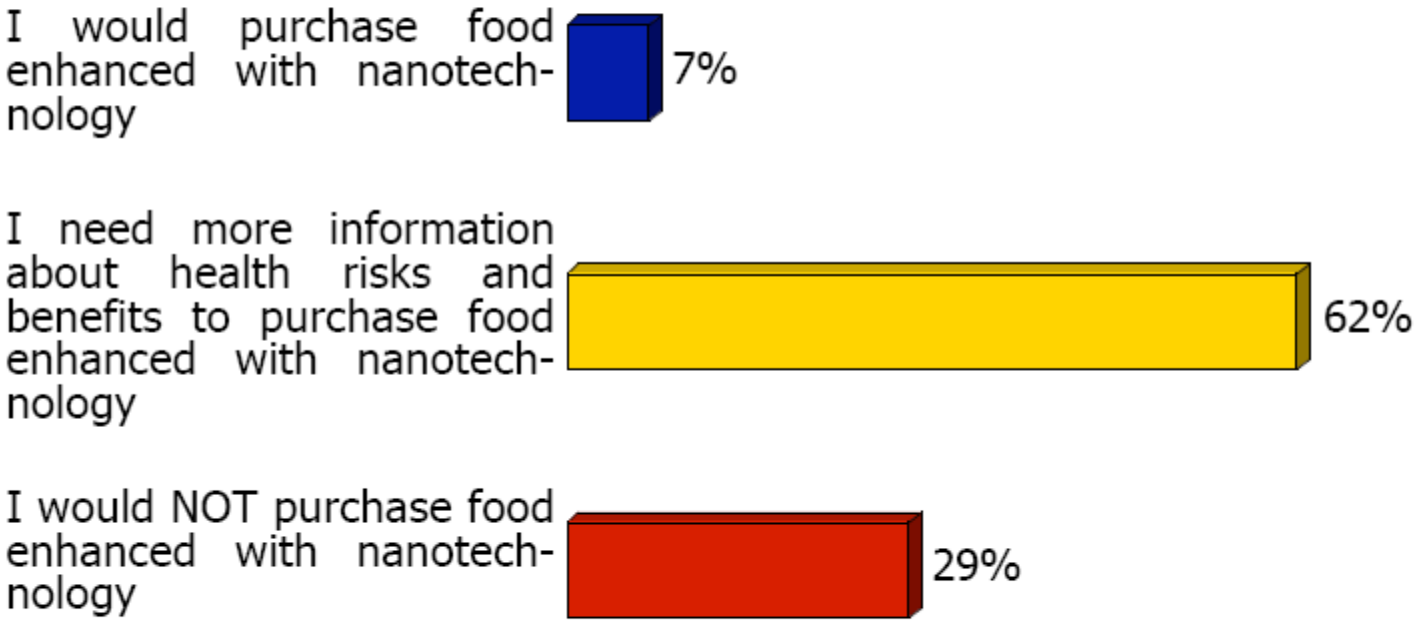
Interaction of US public nanotech benefit & risk perceptions

Willing to purchase?



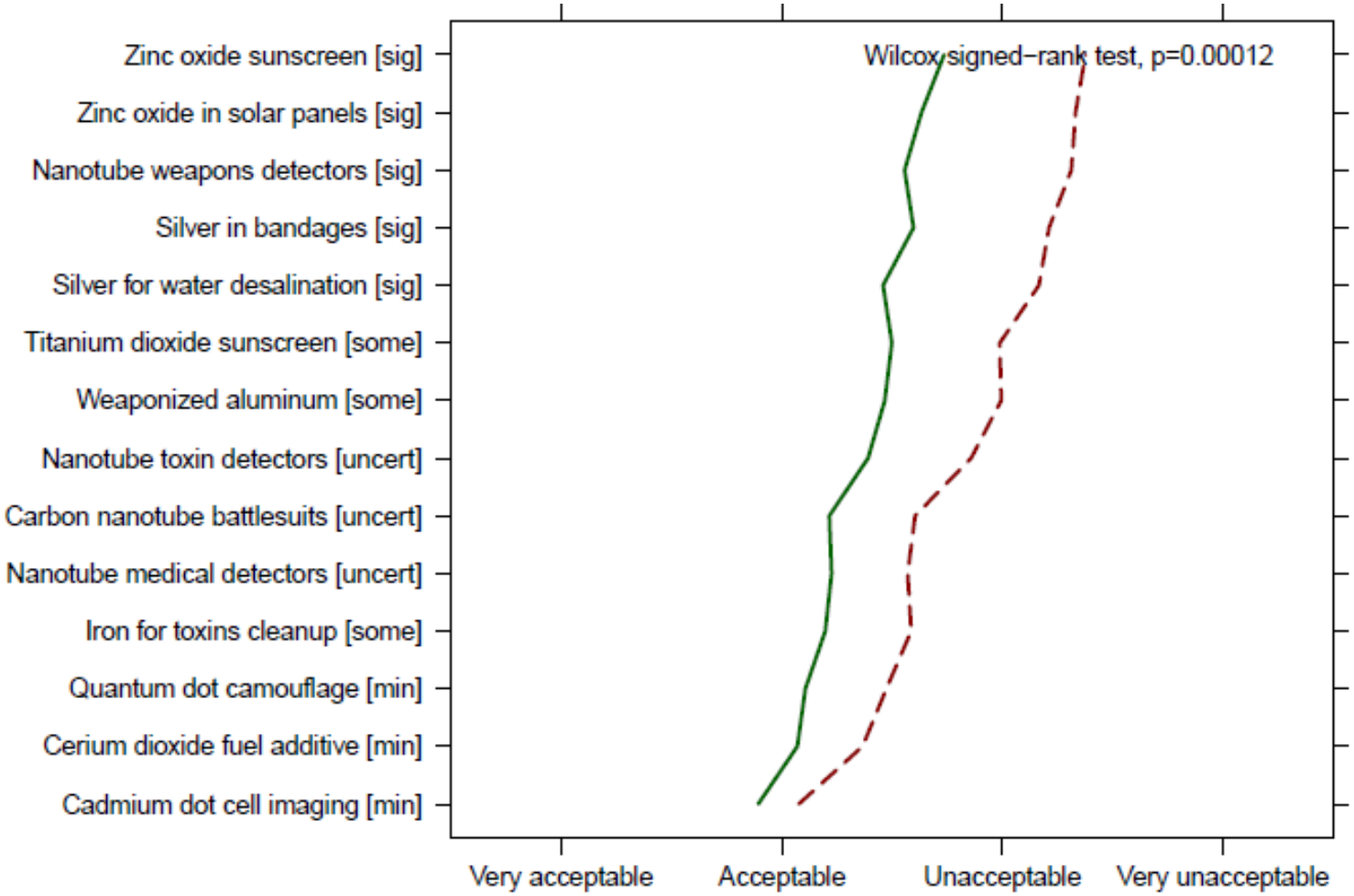
Source: Currall et al. 2006, *Nature Nanotechnology 1:153-155*

Purchase Of Food Enhanced With Nanotechnology



Source: Peter D. Hart Research, Inc. "Awareness of and Attitudes Toward Nanotechnology and Federal Regulatory Agencies," 2007

Public Perception of ENM Environmental Risk: Shaped by Risk Messages & Environmental Values



Green: Air/water/soil recover easily, self clean, mostly pure & controllable.

Red: Air/water/soil recover poorly, need human intervention to become clean, are mostly contaminated and difficult to control.

Satterfield, DeVries, Pitts, & Harthorn. In prep

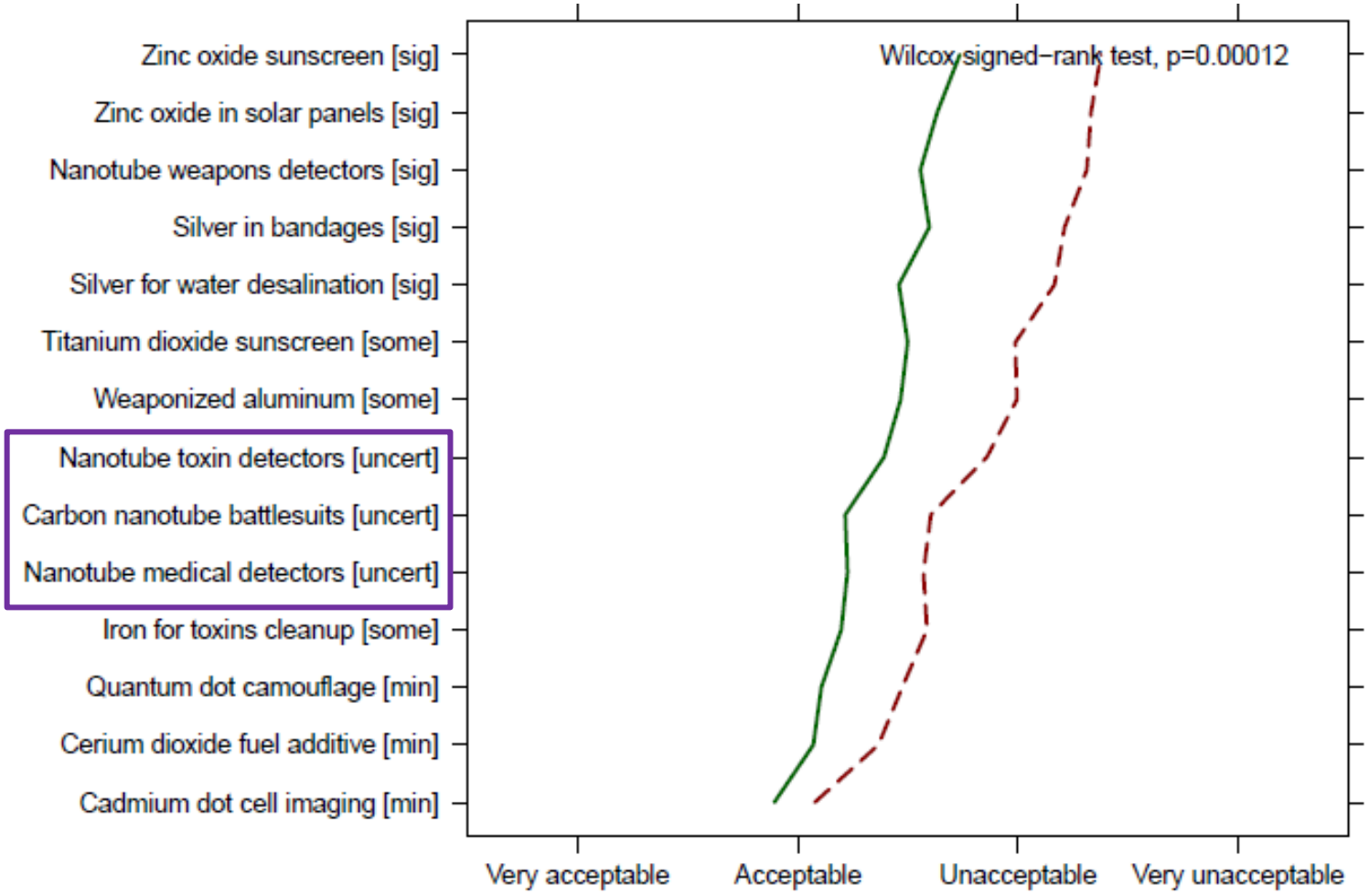
UC CEIN

Environmental risk perception

- Stated risk level affects acceptability
- Perceived environmental 'resilience' (environmental values) affect acceptability

UC CEIN

Public Perception of ENM Environmental Risk: Shaped by Risk Messages & Environmental Values



Purple: Uncertain risks – reluctant to judge

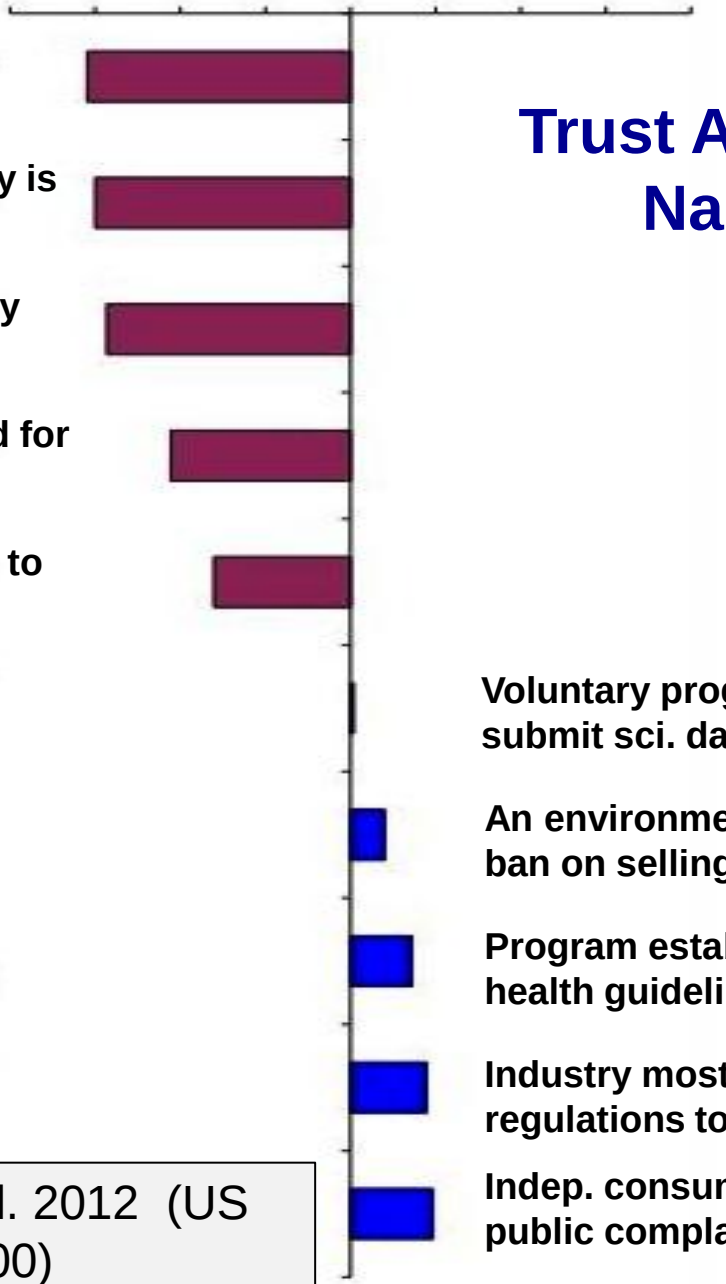
UC CEIN

Satterfield, DeVries, Pitts, & Harthorn. In prep

Environmental risk perception

- Risk uncertainty -- reluctant to judge at all (need for information)

Trust Asymmetry in the Nanotech Case



Source: Satterfield et al. 2012 (US national survey, n = 1100)

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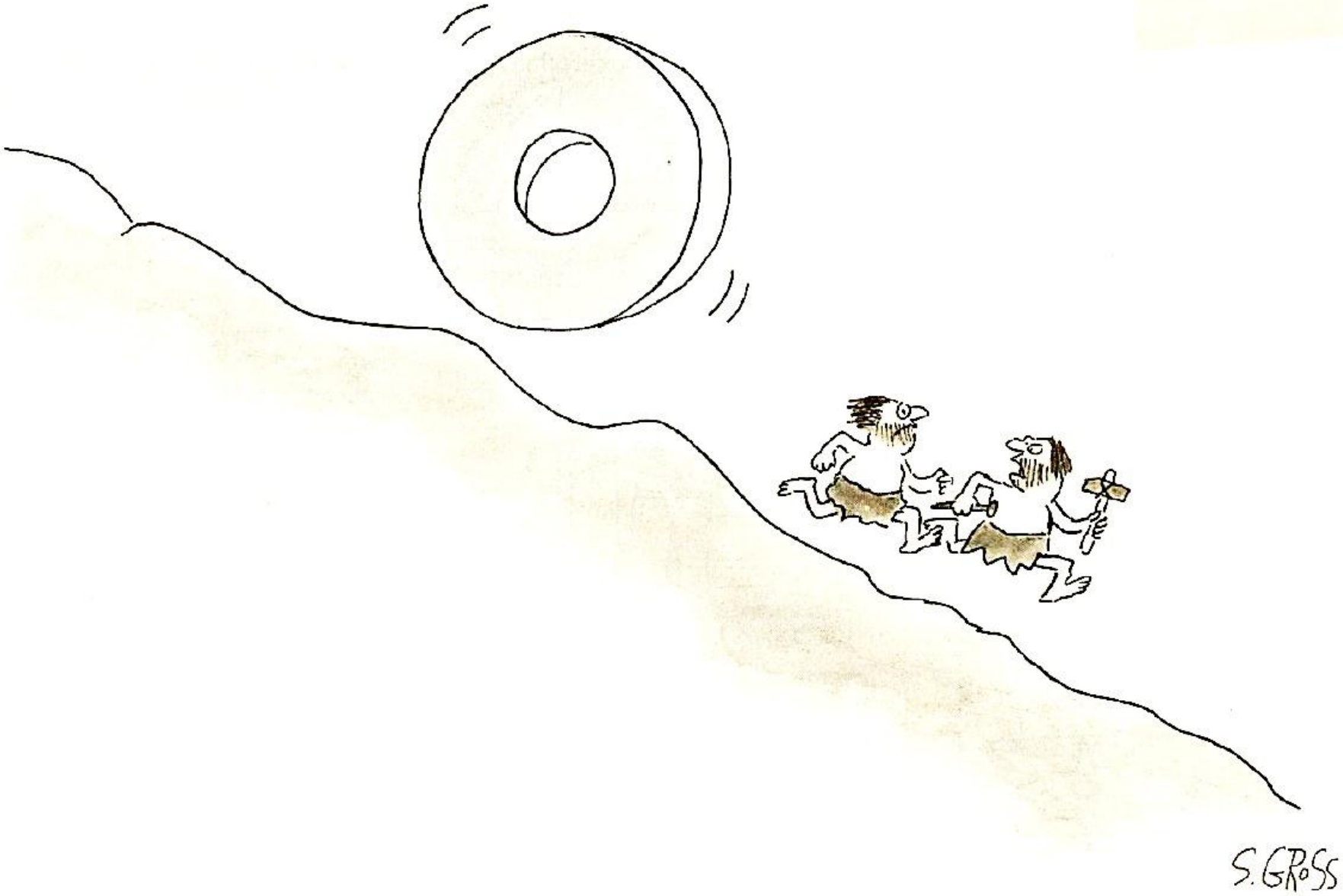
Importance of Trust

Linked to regulation

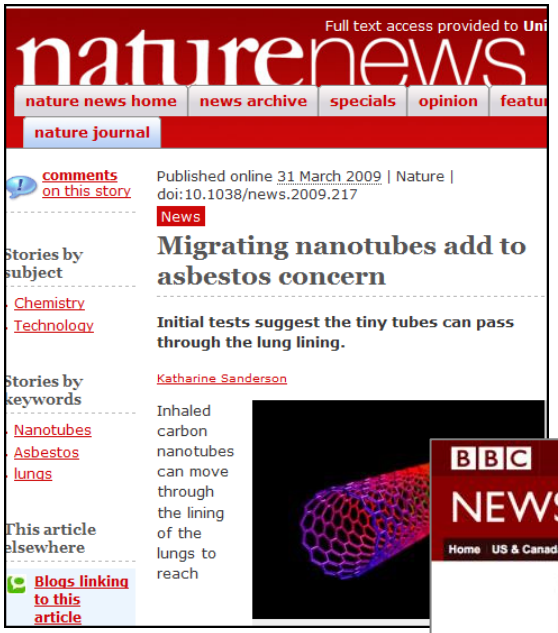
> "When it comes to nanotechnology, I would trust a system that has, using the car as an analogy, a brake as well as an accelerator. … The accelerator works just great now as far as I can tell from reading things that you brought, from talking with the experts, *I'm much less convinced that there's a braking mechanism*."

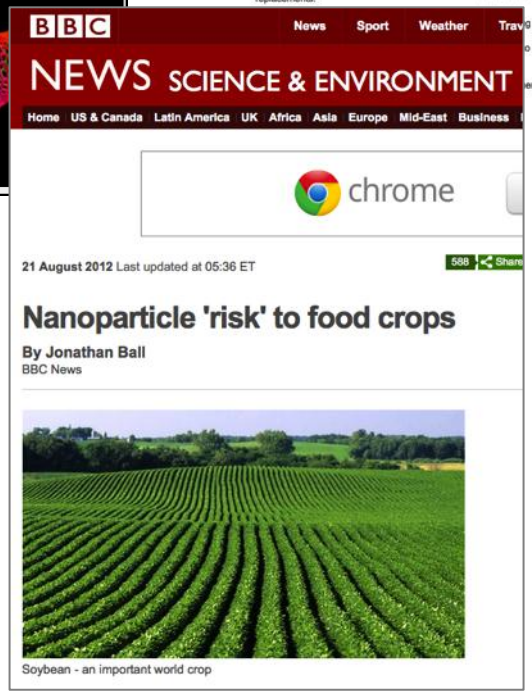
CNS-UCSB US Health deliberation workshops, Feb 2007, male respondent; italics added

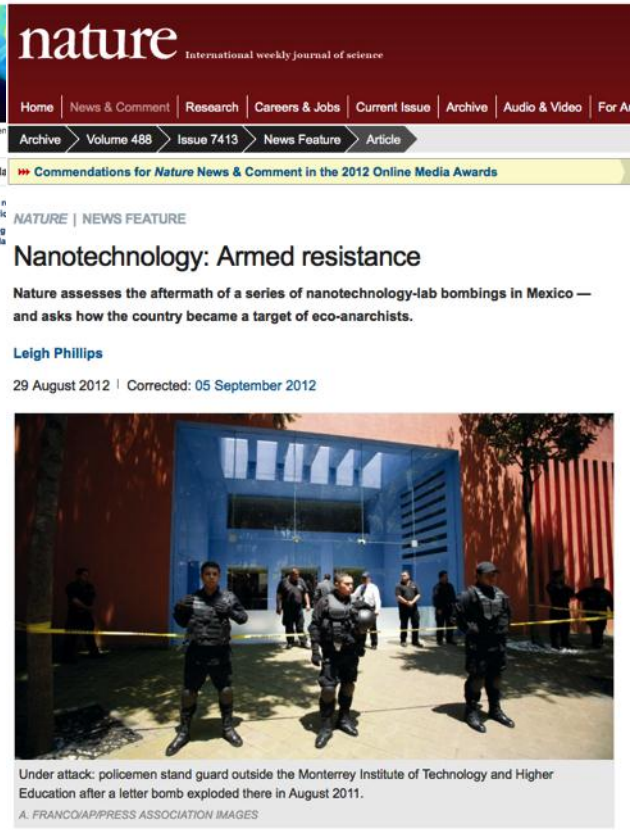


"My next big project is brakes."

What has the media had to say about nano?







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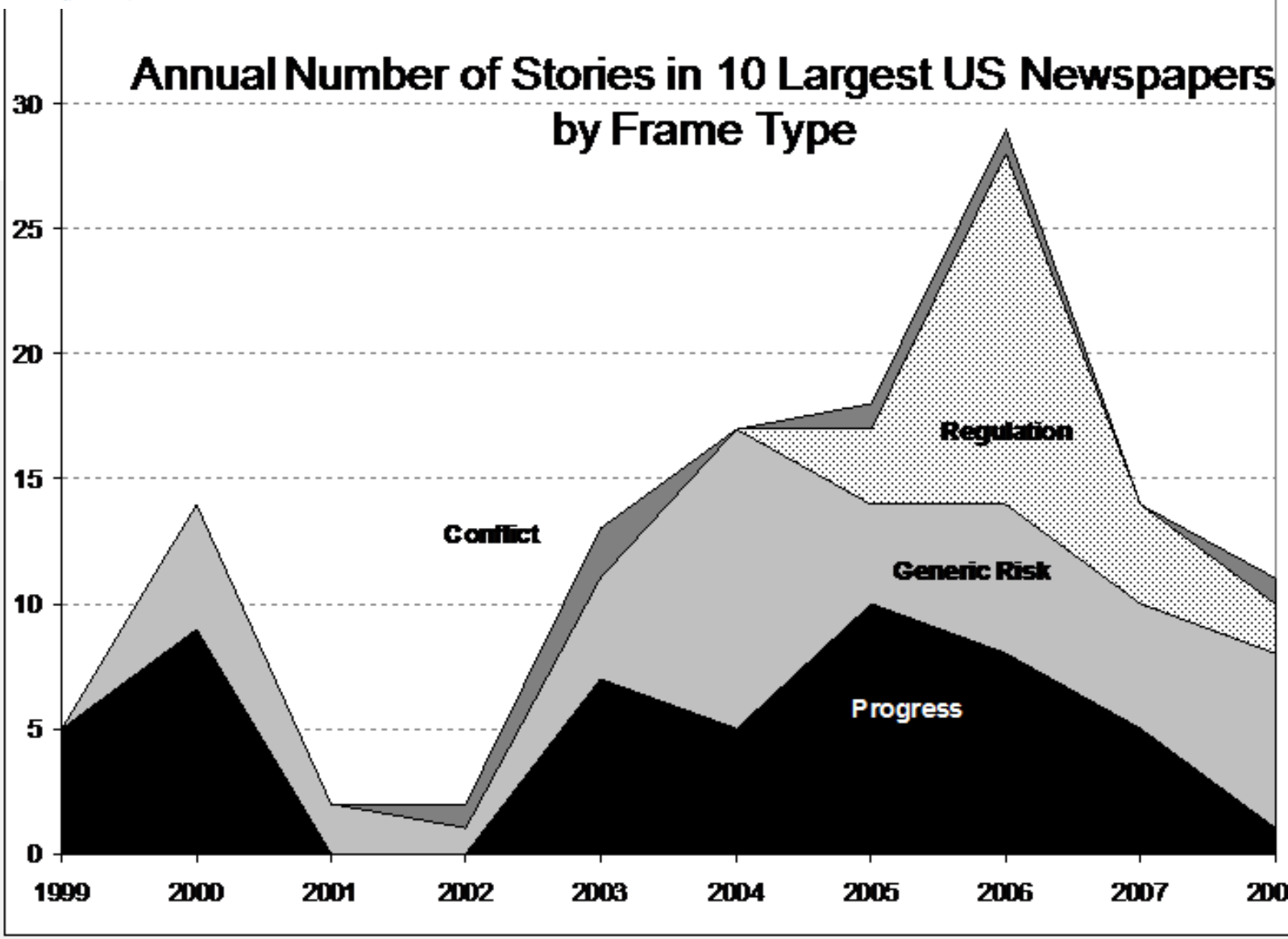

Weaver, D., Lively, B., & Bimber, B. 2009. Search for a Frame: News Media Tell the Story of Technological Progress, Risk, and Regulation. *Science Communication* 131(2): 139-166.

Public perceptions of benefits & risks of new technology

- Benefits predominate thus far—what will constrain (other than EHS)? Views are contingent on:
  - Publics' low familiarity/unformed views
  - High uncertainty/need for information
  - Media coverage low & mixed message
  - Inequality/social justice key
  - Trust or betrayal by government, industry?
  - Application-specific views
  - Environmental values (resilience); intuitive toxicology
  - Gender, race, other social differences (next up)

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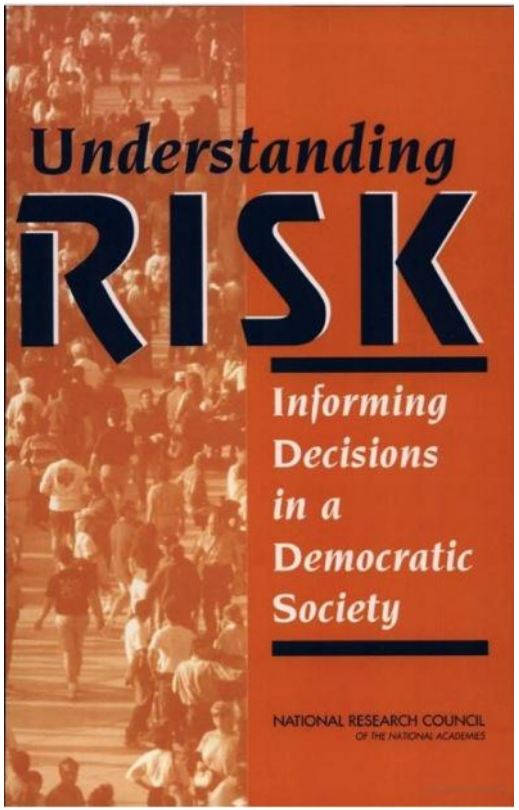
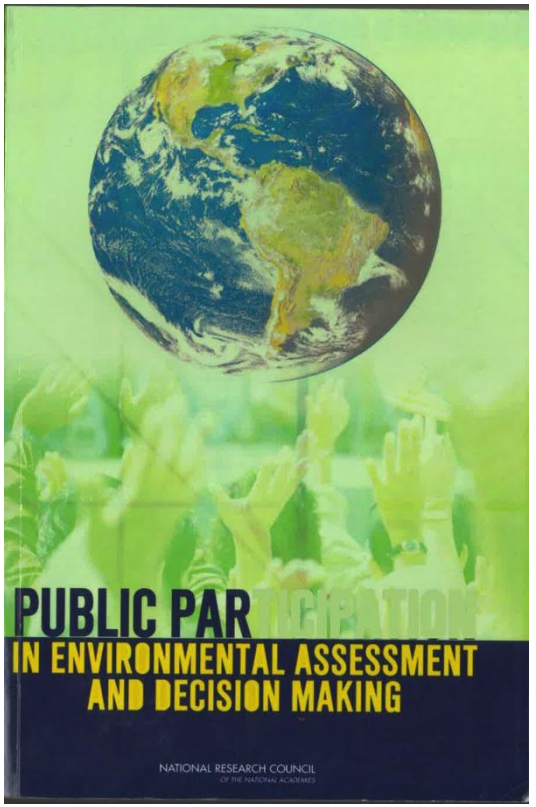
- Governance challenges

Engaging diverse publics: Part of much broader ‘deliberative turn’ in US and abroad



NRC: Stern & Fineberg (1996)



NRC: Dietz & Stern (2008)

Why public participation in governance?

- Should Technology Assessment be participatory?
  - Right thing to do—those affected should share in decision-making (see *21st Century Nanotech R&D Act*)
  - Useful thing to do--equitability and substantive input are good for outcomes

Key aspects of successful public participation

Aims:

- addresses needs and concerns of publics
- reduces mistrust between stakeholders
- results in all participants (including scientists) being better informed about both the issues *and* about one another

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Key features:

- Two-way *dialogue*
- "early and often"
- procedural fairness
- well managed process
- implementation that includes breadth, intensity, and integration of scientific expertise

Gendered aspects of talk in US nano deliberation

- Men speak more than women and use more intrusive interruptions in deliberations on nano
- Whites use more intrusive interruptions than people of color
- Women speak more, use more backchannels/cooperative overlaps, and use more self-disclosure when discussing ***health and human enhancement applications vs. energy/environment applications***
- Men's patterns of talk do not vary across applications

Implications: subtle and overt group dynamics play a major role in deliberative settings, largely unexamined thus far

Cranfill, Whirlow, Hanna, Shearer, Bryant and Harthorn, 2012. Under review.

Outline

- What is responsible development of nanotechnology (and why should you care?)
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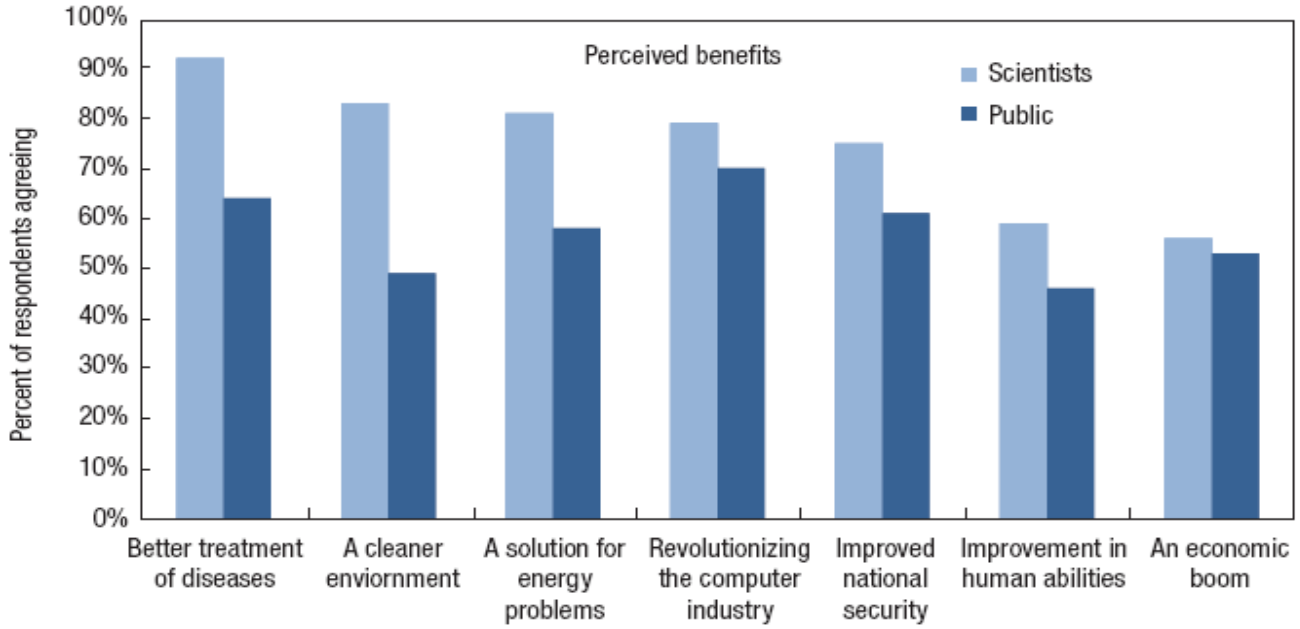
a



Scientists are more optimistic than the public about potential benefits

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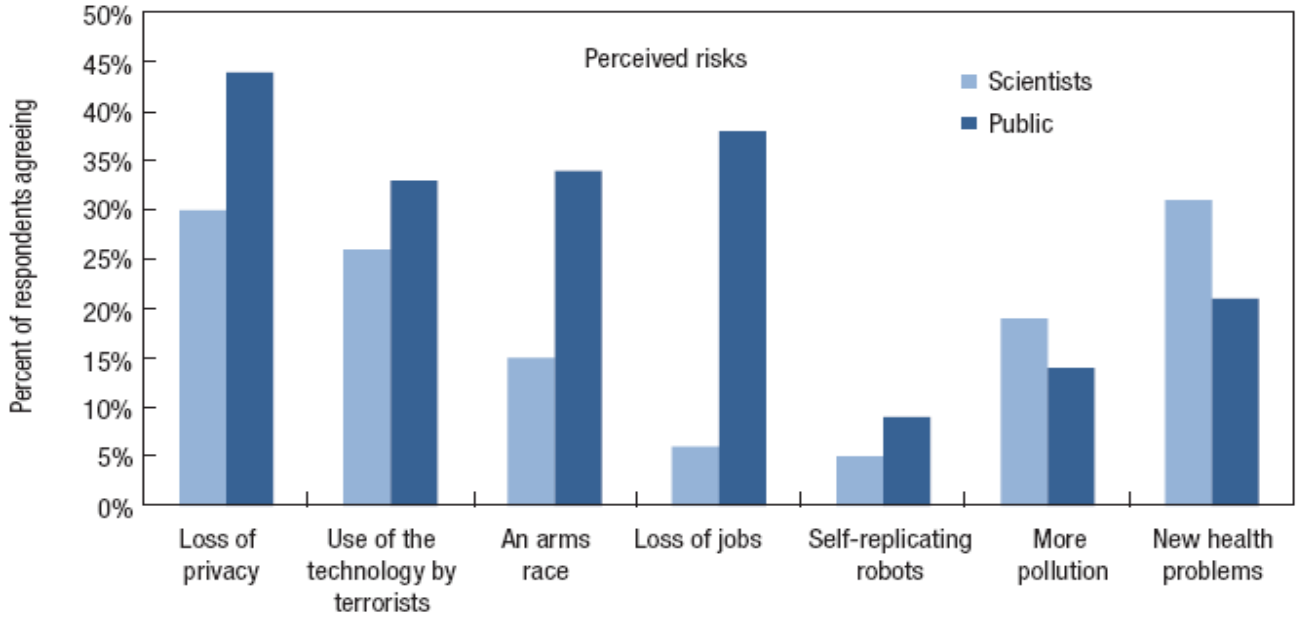
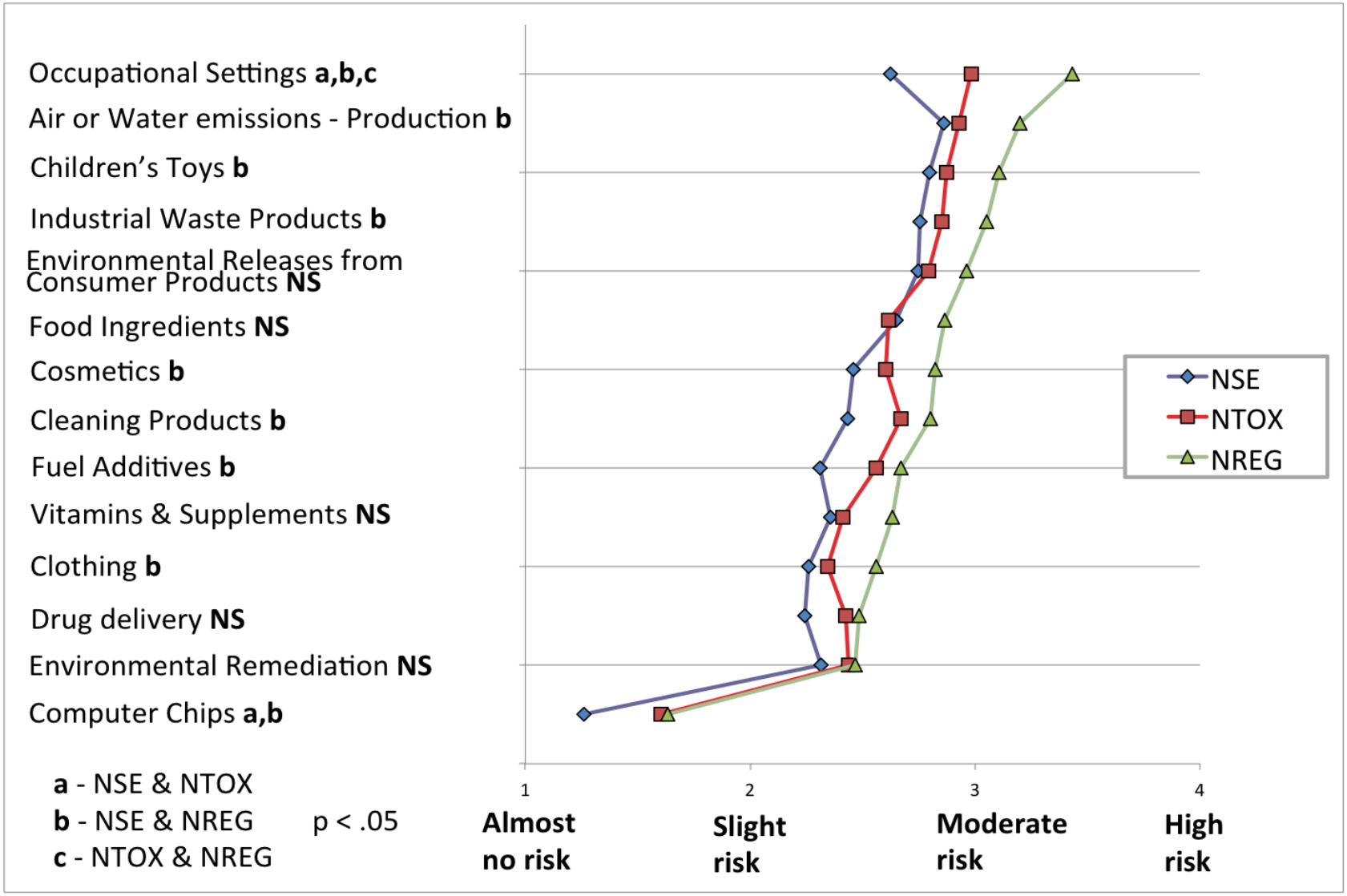


Scientists are less concerned about risks other than environment & health

Source: Scheufele et al. 2007 *Nature Nano*

Scientists' and Regulators' ENM Risk and Benefit Perceptions—Small but Consistent Differences



CNS-UCSB Center for Nanotechnology in Society

UC CEIN

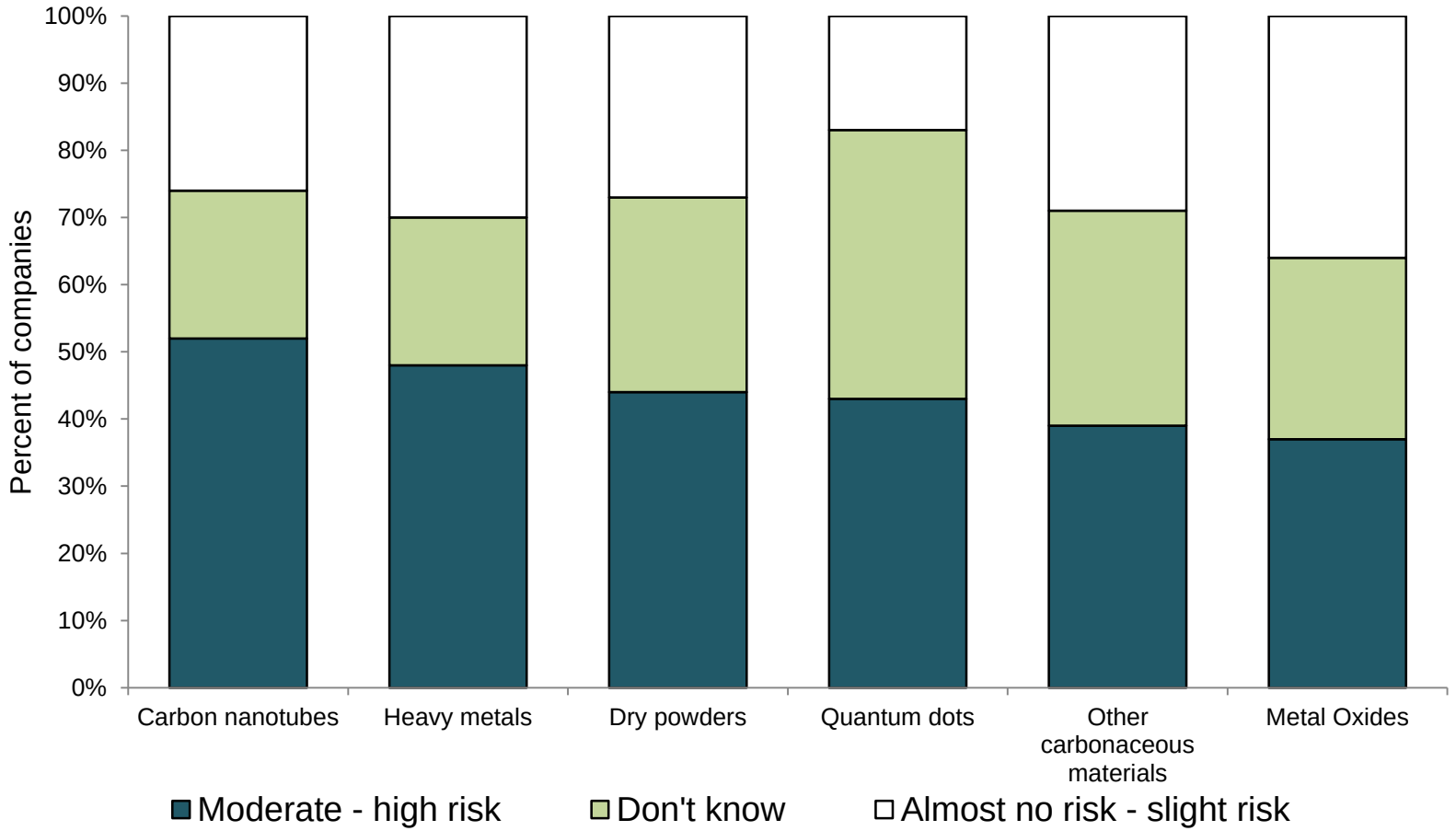
Beaudrie, Satterfield, Kandlikar, Harthorn. Under review

Expert Judgments

- Small but significant differences in risk views by expert affiliation/discipline, with ***regulators judging risks to be higher***
- Greatest disagreement in views about ***workplace risk***
- Most agreement about ***nano-remediation***

Beaudrie, Satterfield, Kandlikar, & Harthorn. Under review

Industry Risk Perception—International Survey of Private Nanomaterials Companies



Phone & web survey of 78 companies in 14 countries; US oversample

DBI-0830117

Engeman et al. *Journal of Nanoparticle Research 14(3):749-760*

Industry judgments

- Large majority of industry leaders are **uncertain or show moderate/high perceived risk** re: ENMs, combined ‘don’t know’ plus moderate/high risk = 64%(metal oxides) - 83% (quantum dots)
- yet *not* self protective
- and prefer autonomy from regulation

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"How am I supposed to think about consequences before they happen?"

The Strategic Vision

Anticipatory Governance

1. Foresight
   - All governance requires a disposition toward future
2. Engagement
   - Crucial normatively, strategically, pragmatically
3. Integration
   - Scientists know things we don't, and vice versa
4. Ensemble-ization
   - Because none of these works in isolation

CNS-ASU: Guston, *Nature*, 454:940-41 (2008); Barben et al. *STS Handbook* (2008)

Governance & Regulatory Issues

- EH&S (Env Health & Safety)
  - Safeguard environment (UC CEIN & CEINT)
  - Ensure human health and safety
- Standards, nomenclature, tools
- Protecting intellectual property
- Societal—anticipatory governance
  - Socially disruptive technologies
  - Unanticipated consequences

Comparative Lessons re: Longer-Range Governance Questions

- Risks *beyond EHS/toxicity*:
  - Surveillance and civil liberties
  - Lack of trust over responsible governance
  - Profound lack of trust of industry
  - Human enhancement and impacts upon identity
  - Equity of access and exposure to harm big issues for *health technologies*
  - *Energy technologies* perceived as so urgent, people not at all sensitive to risks (new in our nano work?)
  - Military developments? (not raised in our delibs in US or UK)

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Societal Aspects of Responsible Development

- NNI's support of societal research is generating new knowledge about upstream perceptions and attitudes, among publics and experts
- Public participation is essential to nano governance
- New mechanisms for integration of science/society (CNS-UCSB, CNS-ASU)
- Knowledge and resources: yes
- Will to pursue??

Thank you.

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nano4me.org/webinars.php

2013 Events Calendar

January 25: Trends in Nano: Technology
Webinar (Three Part Series)

February 22: Nanotechnology Demos & Simulations
Webinar

March 22: Trends in Nano: Program Development
Webinar (Three Part Series)

Visit www.nano4me.org/webinars for more details about these and other upcoming webinars.

Thank You!

Thank you for attending the

NACK Network webinar

Societal Dimensions of Responsible Innovation for Nanotechnology