



Nanotechnology

Maximizing the benefits
Minimizing the risks

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Emerging Nanotechnologies
at the Woodrow Wilson International Center for Scholars

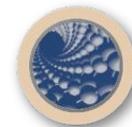


THE PEW CHARITABLE TRUSTS

“A tsunami is unnoticeable in the open ocean - a long, low wave whose power becomes clear only when it reaches shore and breaks...

Nanotechnology has been around for two decades, but the first waves of applications are only now beginning to break. As it does, it will make the computer revolution look like small change.”

National Geographic, June 2006



Personal Benefits

Nanotechnology: The “I Wish” Technology

I wish my sunscreen wasn't so unsightly



I wish my socks didn't smell so much!



I wish my tennis racquet was lighter and stronger



I wish I could keep leftovers for longer, before they go off



I wish spilt red wine would run off my pants without staining



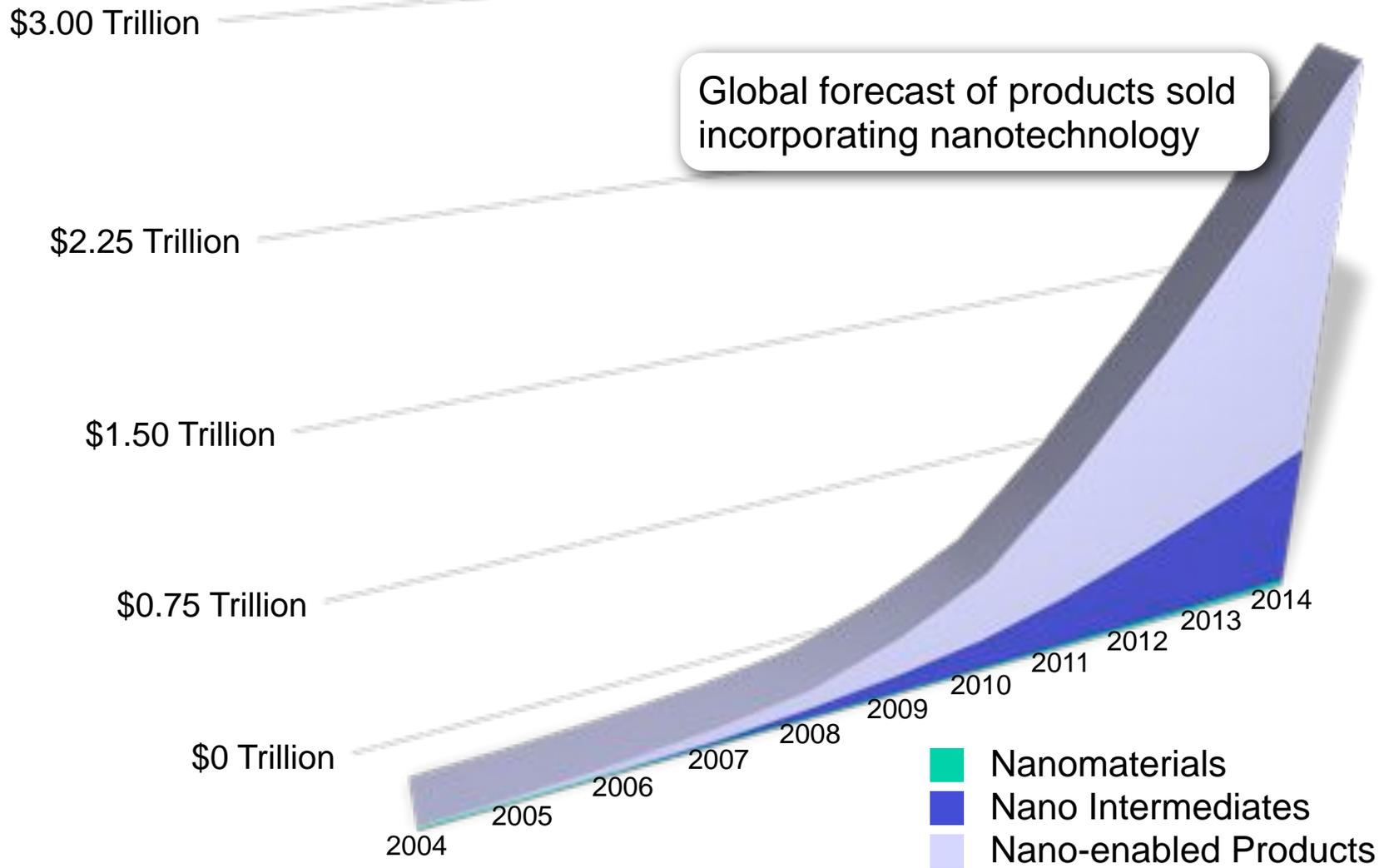
I wish I could get more songs on my iPod



Nearly 400 listed nanotech consumer products: www.nanotechproject.org/consumerproducts

Commercial Benefits

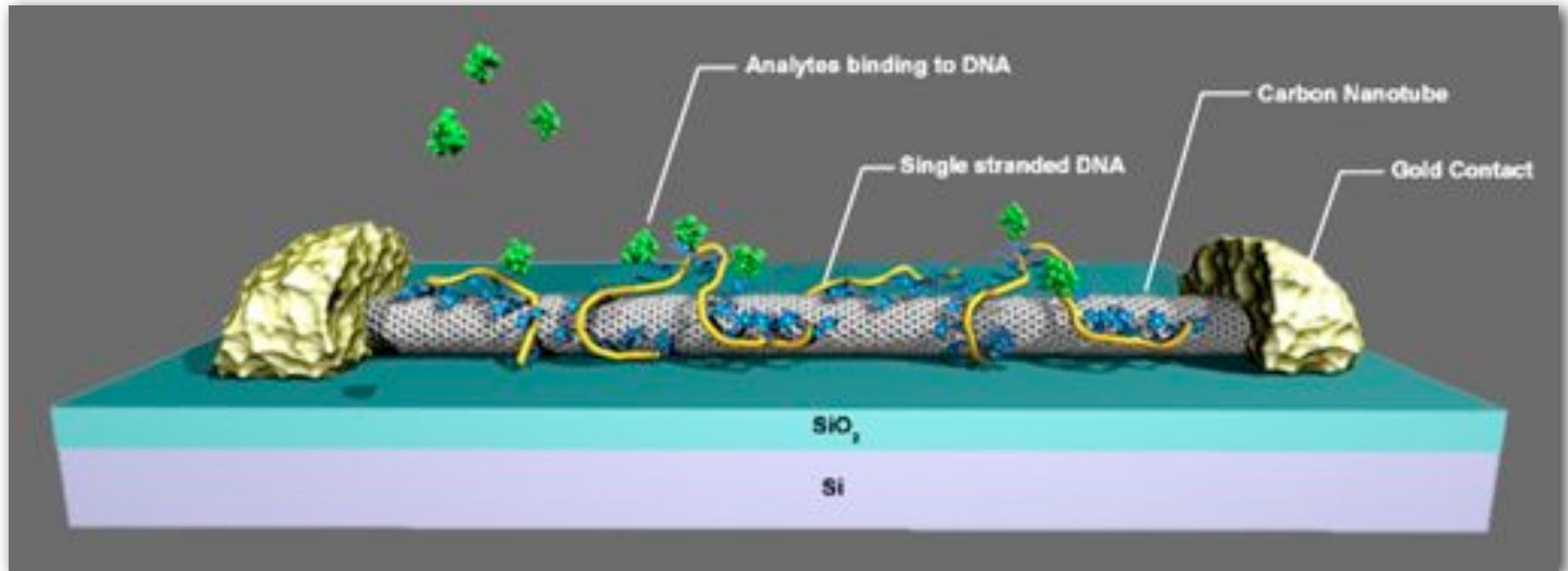
Nanotechnology: Projected worth of nanoproducts



Source: 2004 Lux Research Report: "Sizing nanotechnology's value chain"

Scientific benefits:

Nanotechnology: Stimulating cutting-edge research



Source: Robert Johnson and A. T. Charlie Johnson, University of Pennsylvania. <http://www.lrsm.upenn.edu/~nanophys/biosensors.html>

Combining electronics, nanotechnology and biotechnology, to form advanced sensors

Societal Benefits

Nanotechnology: Solving the world's problems



Carbon Nanotubes



Materials

Light as plastic, strong as steel

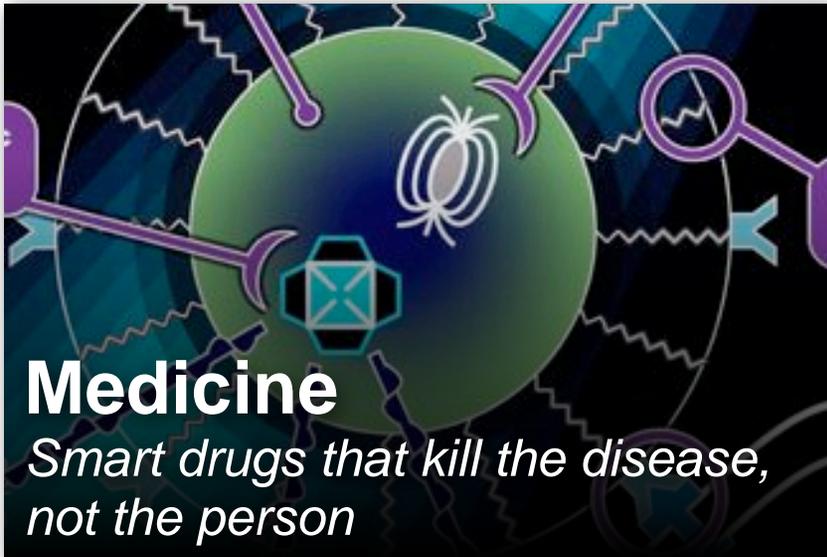
Nanotech and water treatment
www.meridian-nano.org



Water

Clean water any time, any place

Smart nanoparticles for cancer treatment
www.nci.gov



Medicine

*Smart drugs that kill the disease,
not the person*

Printable photovoltaics
www.konarka.com



Energy

*"PowerPlastic™ that converts light
to energy - anywhere"*

**There's no such thing as a free
lunch, and nanotechnology is no
exception**

Developing sustainable nanotechnologies

The Three R's:

RISK

RESPONSE

REGULATION

RISK

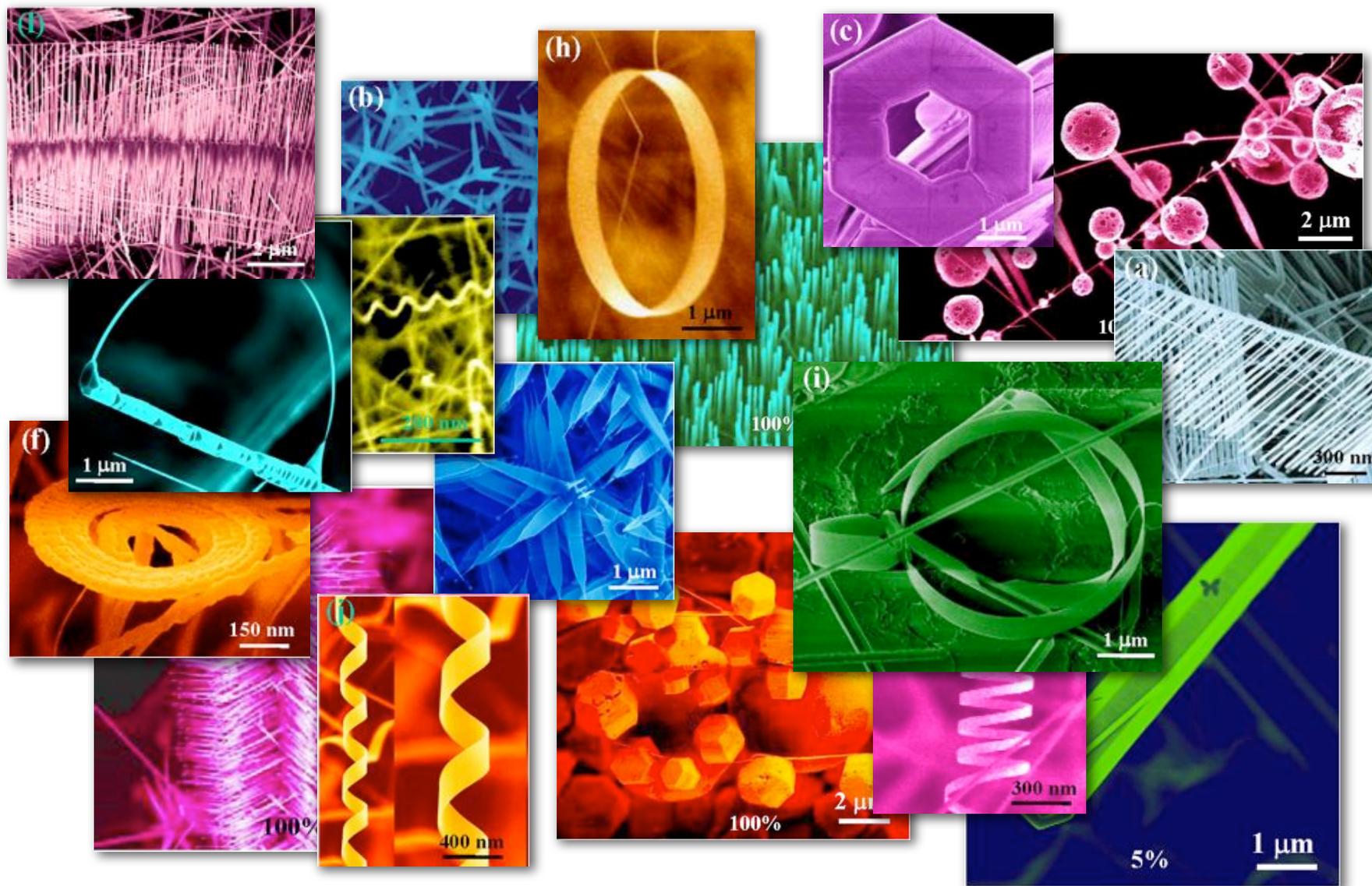
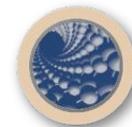
...of causing harm to humans
and the environment

Nanotechnology uses our ability to manipulate the world at the nanoscale, to develop increasingly sophisticated materials and products that behave in **new and unexpected ways**

Things that behave in new and unexpected ways present **new risks**

The Significance of Structure

ZnO: One chemistry, many shapes - Courtesy of Prof. Z.L. Wang, Georgia Tech

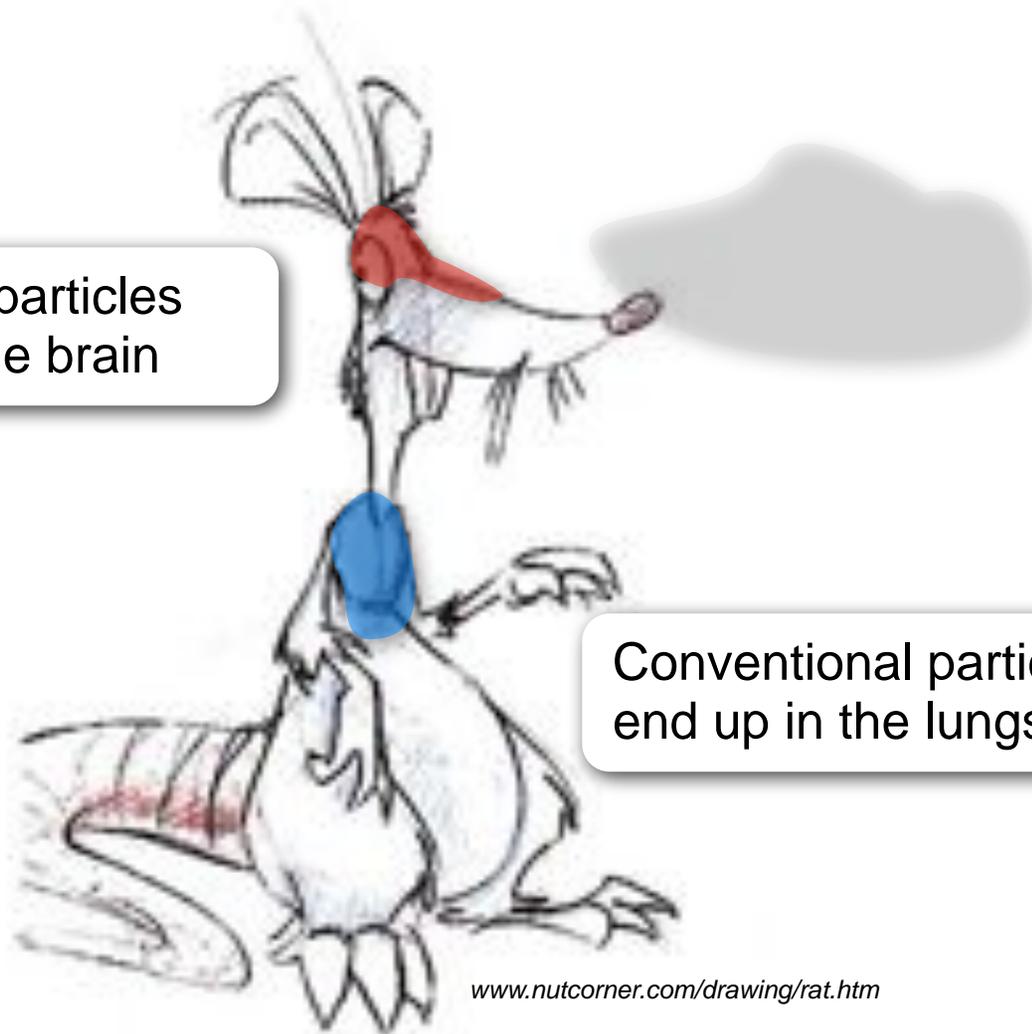


Nanoparticles in the Brain

An example of unusual behavior

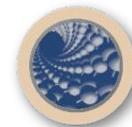


Nanoscale particles
end up in the brain



Conventional particles
end up in the lungs

Oberdörster, G., *et al.*, *Inhal. Toxicol.* 16 (6-7), 437-445, 2004.



Nanotech Risks: An Industry Perspective

Corporation

“We’ve stopped development where costs were too high to ensure no exposure or risk... It’s quite complicated; we can’t set decision points today”

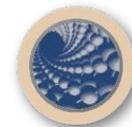
Corporation:

“We’ve cancelled several projects because of a lack of EHS information from the supplier”

Startup:

“Almost every time we talk with a company that will incorporate our material into products, EHS is one of the most important topics... Compared to companies that don’t have this data, it puts us ahead of the curve ...”

Source: Taking action on nanotech environmental, health and safety risks. Lux Research. May 2006



Nanotech Risks: An Industry Perspective

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Understanding risk is essential to the commercial success of nanotechnology

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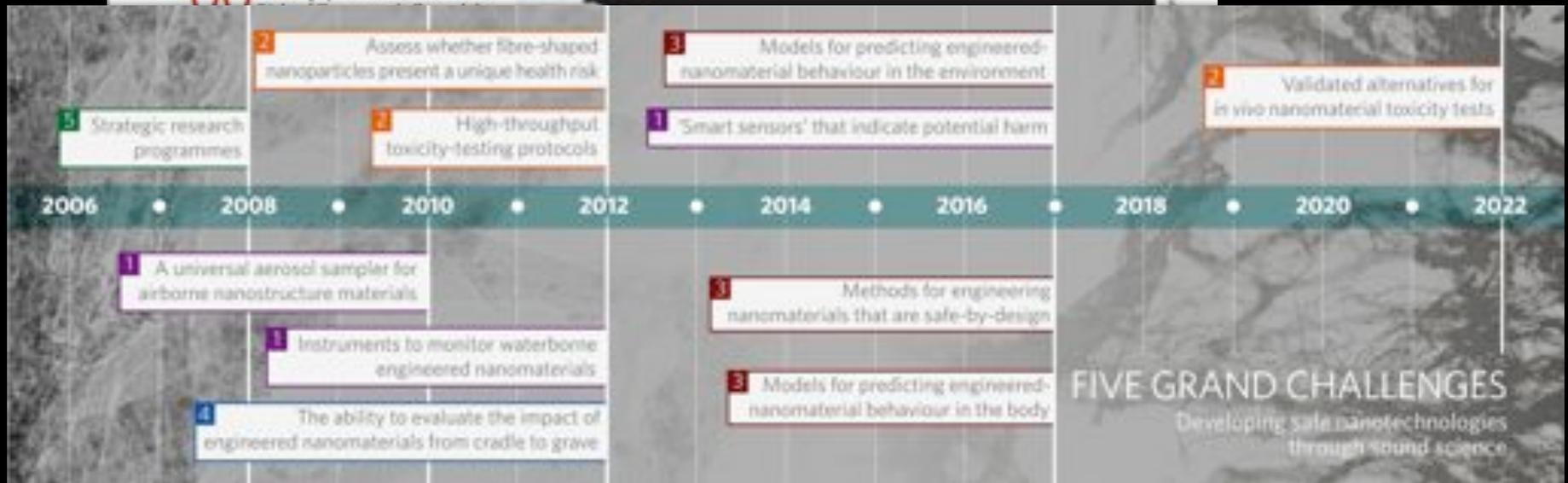
Source: Taking action on nanotech environmental, health and safety risks. Lux Research. May 2006

COMMENTARY

Safe handling of nanotechnology

The pursuit of responsible nanotechnologies can be tackled through a series of grand challenges, argue **Andrew D. Maynard** and his co-authors.

When the physicist and Nobel laureate



FIVE GRAND CHALLENGES
Developing safe nanotechnologies through sound science

ing nanotechnologies can be realized while minimizing potential risks¹. Yet despite a clear commitment to support risk-focused research, opportunities to establish collaborative, integrated and targeted research programmes are being missed². In September, Sherwood Rowland, chair of the US House Science Committee, testified in a hearing that "we're on the right path in dealing with the problem, but we're missing some of the more important research". And in October, Richard Lord, Secretary of the Royal Society, stated publicly that the UK government had not made enough progress in reducing the uncertainties surrounding the health and

to the safety of nanotechnology. Fears over the possible dangers of some nanotechnologies may be exaggerated, but they are not necessarily unfounded. Recent studies examining the toxicity of engineered nanomaterials in cell cultures and animals have shown that size, surface area, surface chemistry, solubility and possibly shape all play a role in determining the potential for engineered nanomaterials to cause harm. These are exciting, yet basic, issues that require more focus, funding, and time. These fundamental insights are both what they are made of and their physical nature. Environmental, small particles of various

to address novel risks associated with emerging technologies. Research into understanding and preventing risk often has a low priority in the competitive worlds of intellectual property, research funding and technology development. And yet there is much at stake in how potential nano-specific risks are understood and managed. Without strategic and targeted risk research, people producing and using nanomaterials and developing nations (and those arising from their exposure) could be exposed to uncontrolled dangers and loss of respect that could severely damage the structure to societies and the international economy. The nanotechnology research must have a strategic approach to support responsible research

"Understanding and preventing risk often has a low priority in the competitive world of research funding."

RISK Challenge

**Identifying, addressing and
minimizing nano-specific risks to
health, safety and the environment**

RESPONSE

...of potential users and
“beneficiaries”



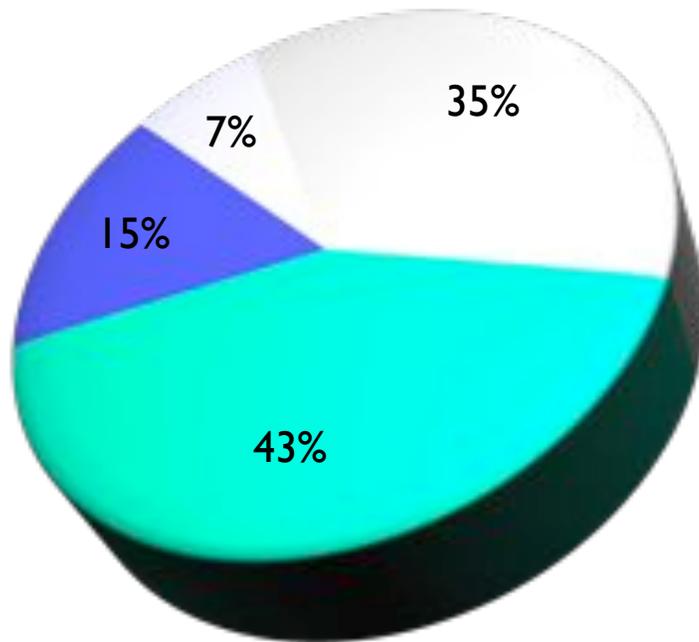
Topless Humans Organized for Natural Genetics (THONG)

Public Opinion Poll: Attitudes Towards Nanotechnology

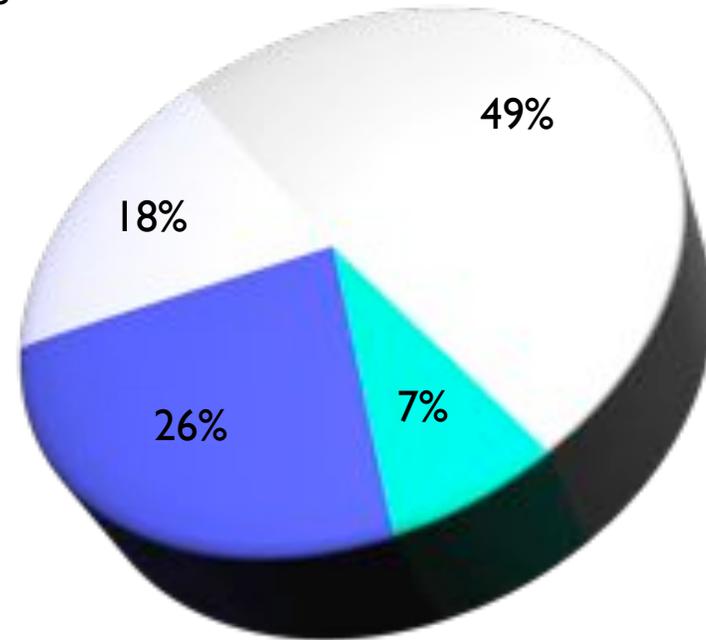
Hart Research Associated, published September 2006



- Not Sure
- Benefits will outweigh risks
- Benefits and risks will be about equal
- Risks will outweigh benefits



Initial impressions



Informed impressions

1014 adults polled

www.nanotechproject.org/77/Hart

RESPONSE **Challenge**

**Working with stakeholders and users
towards mutually acceptable and
beneficial nanotechnologies**

REGULATION

Avoiding undue risk through
appropriate oversight

Nanotechnology Oversight

Recent Developments



Davies

Managing the effects of nanotechnology

Wilson Center, 2006

A new law may be needed
New mechanisms and institutions are needed

United Kingdom

Voluntary Reporting Scheme:

Engineered Nanomaterials

Initiated September 2006
Fixed term (2 years)
Aimed at informing regulation

Food and Drug Administration

Public Meeting on Nanotechnology Materials in FDA Regulated products

October 10 2006

FDA assessing response to nanotechnology
Agency comments anticipated July 2007



Taylor

Regulating the products of nanotechnology

Wilson Center, 2006

Lack of pre-market oversight
Need early information on new nano products
Inadequate authority for post-market adverse events reporting

Environmental Protection Agency

Toxic Substances Control Act (TSCA)

Proposed Voluntary Stewardship Program

Engineered Nanomaterials

Possible Launch, 2007

Berkeley City Council

Nanotechnology Amendment to Hazardous Materials Ordinance

December 2006

Specific reporting requirements for manufactured nanoparticles
Toxicity information, if available
Handling, monitoring, containment and disposal practices
No lower limits on materials quantities for disclosure

DuPont

Environmental Defense

Nanotechnology stewardship framework

To be launched 2007

Environmental Protection Agency

Federal Insecticide, Fungicides, and Rodenticide Act (FIFRA)

Action on the use of silver ions in washing machines

Pending Federal Register notice
Broader implications to the use of nano-silver?

Cambridge City Council

Considering Local Nanotechnology Regulation

January 2007

Following the lead of Berkeley City Council

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Current oversight activities primarily address first generation nanomaterials
Policy decisions on nanotech oversight are being made NOW

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**“Under-regulation will be a bigger
threat than over-regulation”**

Lux Research.

Taking action on nanotech environmental, health and safety risks. May 2006

REGULATION **Challenge**

Developing effective oversight which supports business and protects people and the environment, as nanotechnology becomes increasingly sophisticated

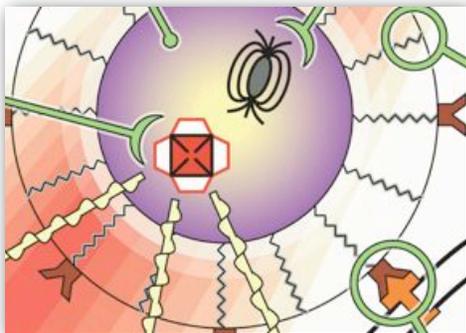


Nanotechnology: Maximizing the benefits: Minimizing the risks



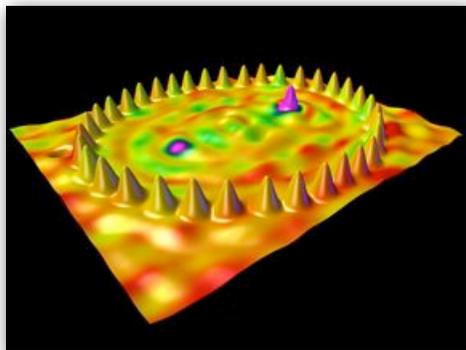
We can not afford NOT to develop nano

Nanotechnology offers the promise of benefits at the personal local and global scale



Sustainable nano needs smart science

Underpinning nanotechnologies with multi-way conversations between scientists, policy-makers, producers and end users



Nano without foresight will lead to a wreck

Nano will only deliver through innovative foresight and actions, including effective risk management, transparent stakeholder engagement and relevant oversight



Further Information

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