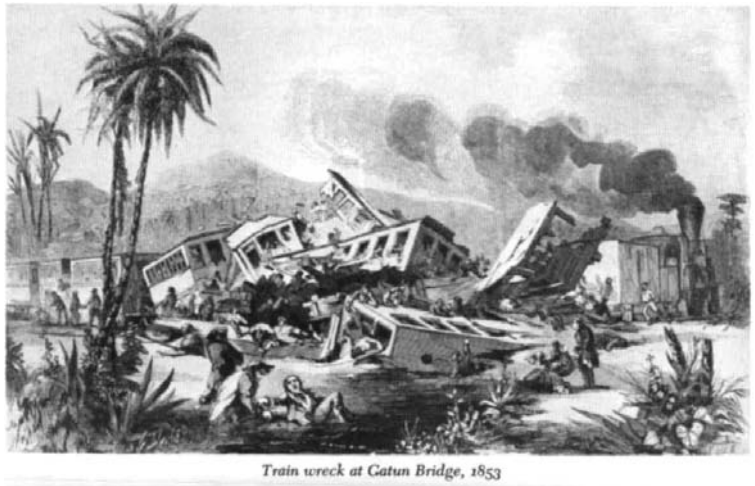

Train wreck at Gatun Bridge, 1853

NANOSAFETY 101
or
HOW TO AVOID THE NEXT LITTLE ACCIDENT

David Rejeski
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Project on Emerging Nanotechnologies
Woodrow Wilson Center
Washington, DC

Project on
Emerging Nanotechnologies
at the Woodrow Wilson International Center for Scholars

April 27, 2006
Harvard University

“There is a tendency of advanced technologies to promote self-deception”

Ed Tenner

Some Starting Assumptions

- Let's place a large bet: $1 billion+ from government and another ~ $2 billion from industry and venture capital.
- Crank up the hype factor (next industrial revolution,etc.).
- Make nano a "national prestige technology."
- Put 20-30 other countries into the competitive mix and add a few expert reports on why the U.S. might loose the nano-race.
- Start pouring consumer products into the global marketplace with little regulatory oversight.
- Under-invest in public engagement.

Place Skeptical Faces at the Window

"**The genie** is out of the bottle and I worry about controlling it and not hurting people. We could feed the world, but with money and power and politics, nanotechnology could be very scary."

"The problem is if these early release products that appear to be benign are suddenly found to be detrimental to human health, we'll all be hyper-skeptical of the industry."

"They can't regulate what we're doing now because they can't understand it. The regulators don't know. In one small aspect of nanotech, there may only be two people who know."

"We need different regulation than we have now. It's a new technology and we need a different set of people to set up a system to see if it's safe. The current system fails at some points. If the new technology is so extensive, we need a new system to regulate it."

Source: Francesconi, R. *Facilitator's Report, Informed Public Perceptions of Nanotechnology and Trust in Government*, Washington, DC: Project on Emerging Nanotechnologies, 2005

Now Go!

1st Nano-based Blockbuster Drug

Cash in Stock

A NO-NANO

Label Appears

Cut profits by 50%

Nanoparticle Spill in Los Angeles

Loose Face

The NanoFood Battles Begin

Loose Sleep and Vacation

What Would Constitute a Disaster?

- Human death or illness (workers, consumers).
- Impacts to other systems: biological, ecological, etc.
- Misuse (terrorist use, WMD).
- Missed opportunities: economic, environmental, social; including nanotech applications that could prevent other disasters (structural fatigue sensing to climate change).
- Reduced public confidence in government and industry vis-à-vis the introduction of future technologies.

Potential Failure Modes

Next 3 years

- Lack of information
- Corner cutting (first-to-market pressures)
- Error, oversight

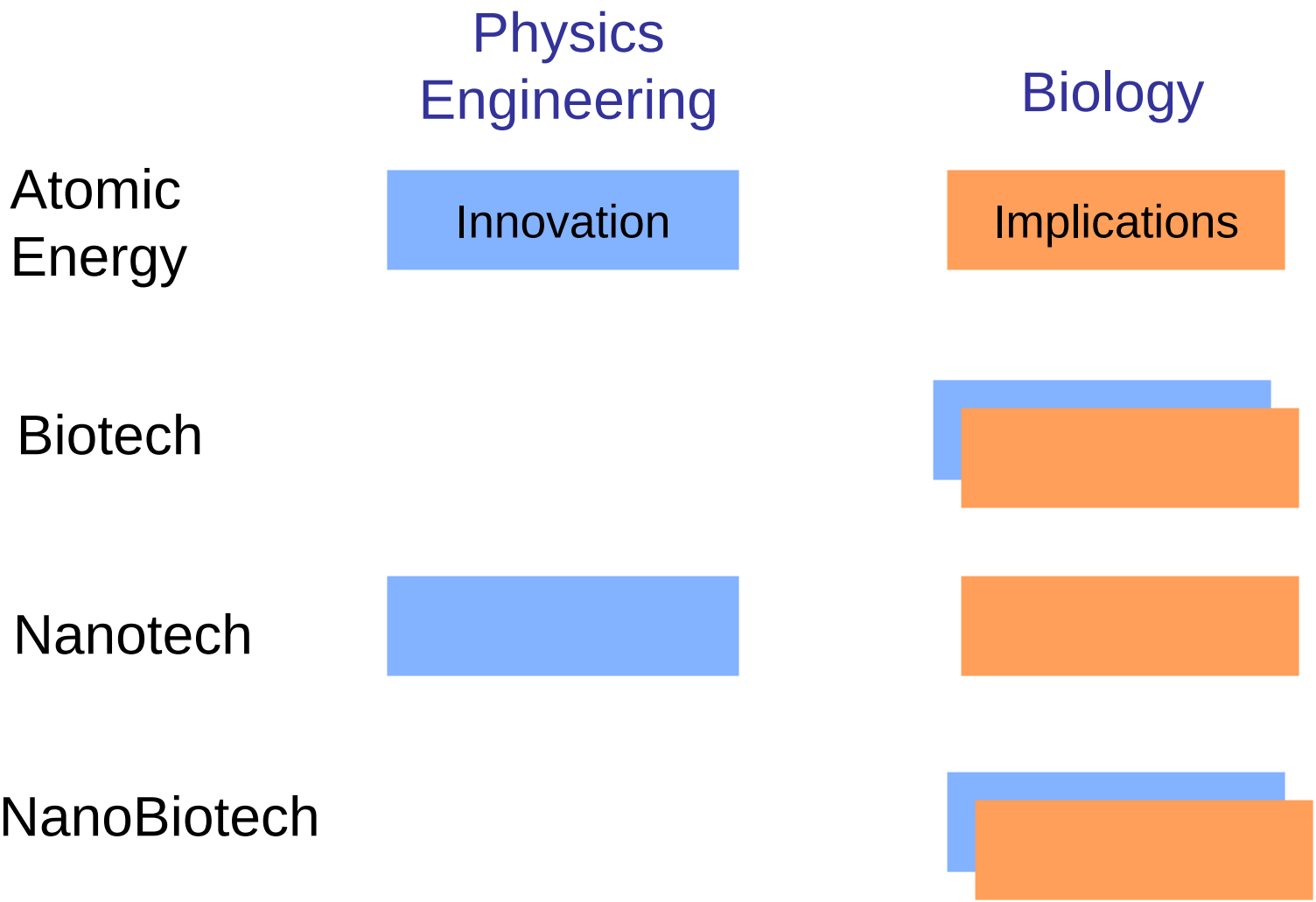
3-10 years

- System failures, cascades

Generally

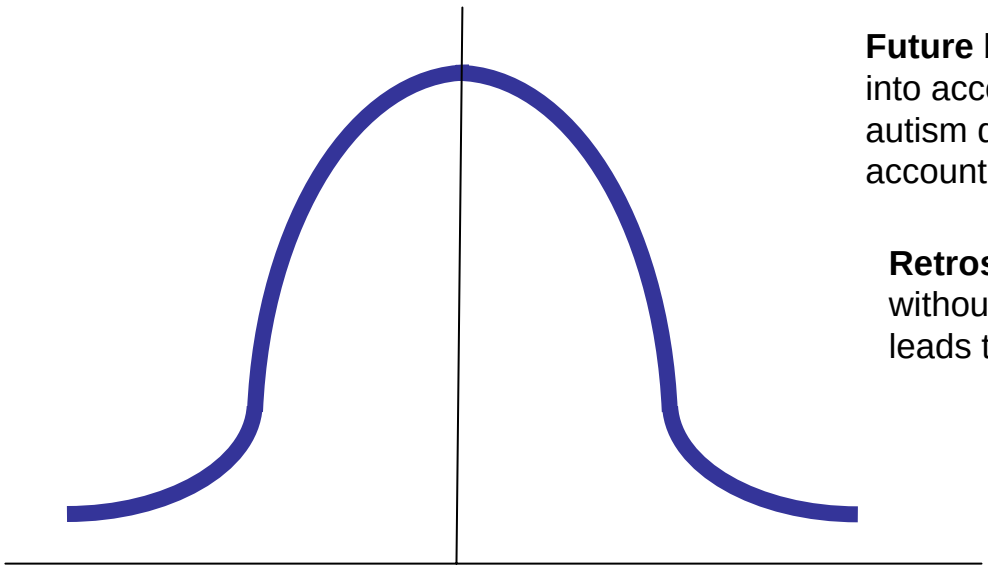
- Unknowns
- Failures of analogy

Is Nano like Bio?



Nano and The Black Swan

- *A priori* prediction impossible
- Surprise
- Large impacts



Black-Swan blindness: underestimation of the role of the Black Swan, and occasional overestimation of some specific one.

Platonic confirmation: You look for instances that confirm your construction (or model) –and find them.

Future blindness: Our natural inability to take into account the properties of the future –like autism does not allow the patient to take into account the existence of the minds of others.

Retrospective distortion: Examining past events without adjusting for the forward passage of time. leads to illusion of posterior predictability.

See: http://www.fooledbyrandomness.com/

Need a Comprehensive Policy Framework

Health & Environmental Risks

- Toxicity
- Life cycle impacts

Perception Risks

- What the public sees
- How the public responds

Structural Risks

- Regulatory system
- Industry structure

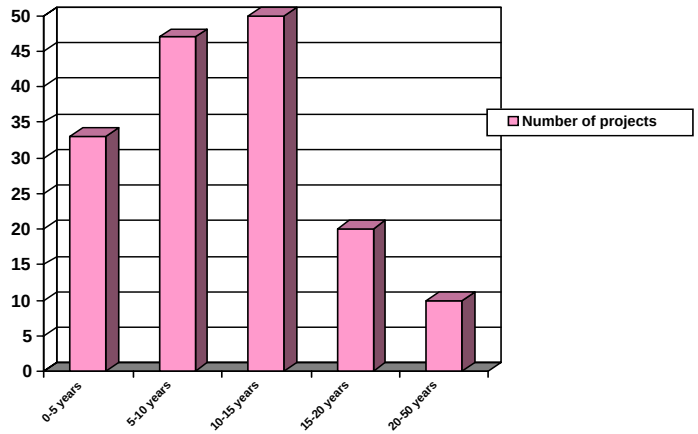
Wildcards

- Third rails
- Accidents
- Terrorists
- Hollywood

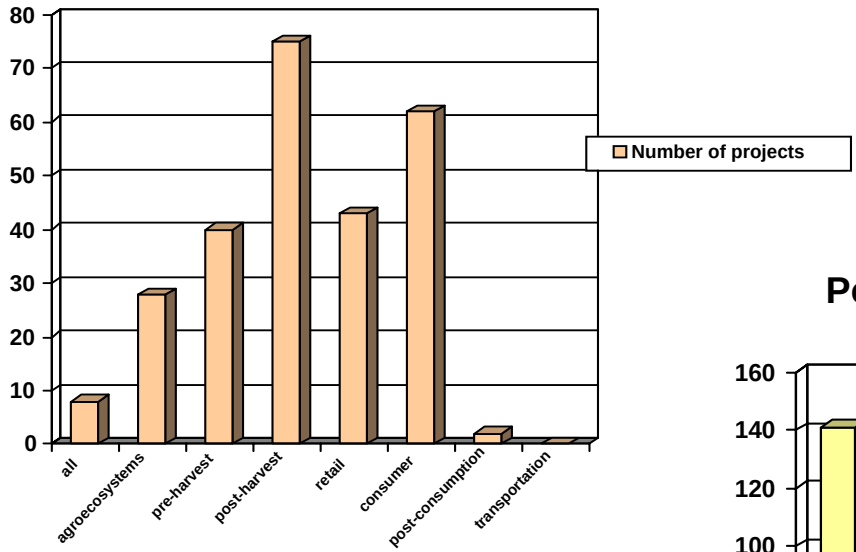
Level of effort by Policy Makers

Need Better Foresight

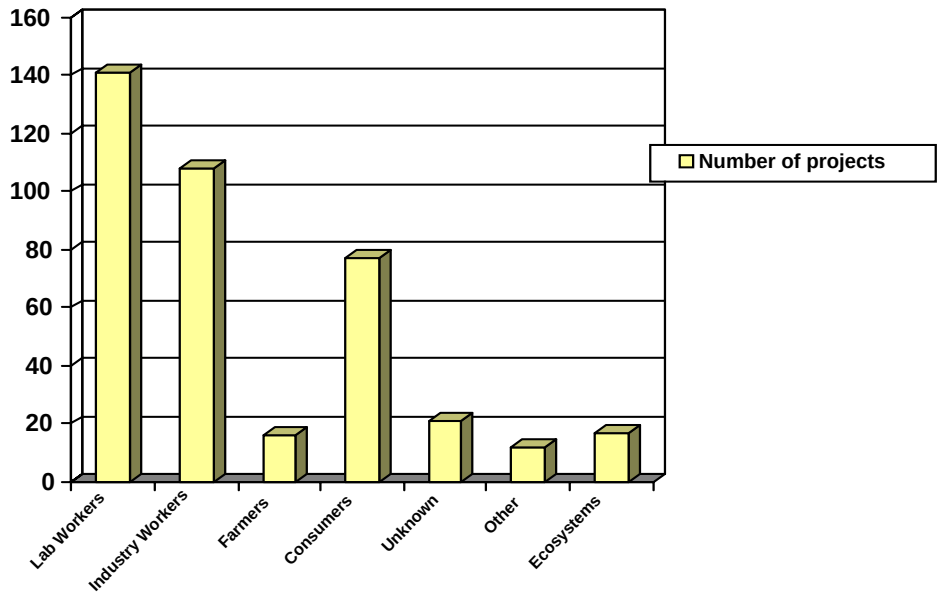
Estimated Time to Commercialization



Sector of Food Supply Chain Affected



Possible Exposure Endpoints

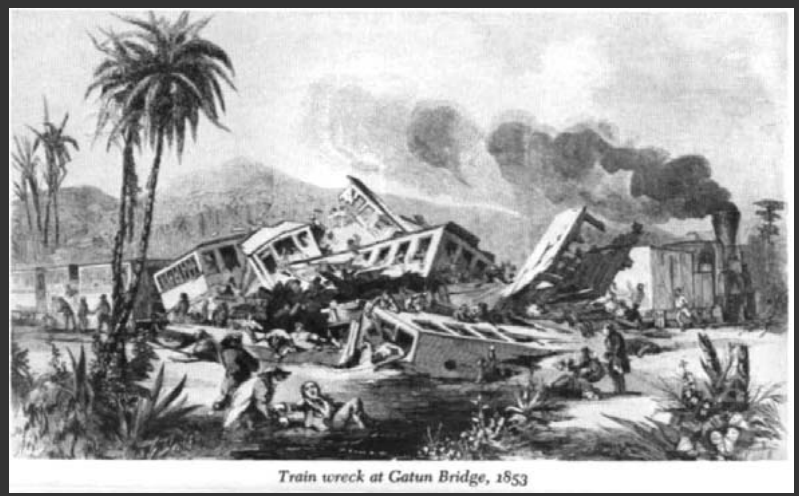


From: Kuzma, J. (2006): "Analysis of Early Stage Agrifood Nanotechnology Research and Development," Washington, DC: Project on Emerging Nanotechnologies (Forthcoming).

Other Strategies

- Increase awareness of failure modes (reduce the possibility of surprise)
- Focus on “bad” practices as well as “good” practices
- Game multiple scenarios and have a Plan B, and C…..
- Develop and implement “push” strategies to reach the most vulnerable players (small businesses, start-ups).
- Move impact assessments “upstream”
- Develop and disseminate a clear message about risks
- Increase public engagement by orders of magnitude

U.S. Department of Unintended Consequences



Train wreck at Gatun Bridge, 1853

"We fail so you won't have to"

"The most dangerous technology is one that is not allowed to fail, and then fails."

Freeman Dyson

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