Safe handling of nanotechnology

Vol 444|16 November 2006 nature

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.

D. RAMSEY

Potential health risks from exposure to engineered nanomaterials must be understood and minimized.

When the physicist and Nobel laureate Richard Feynman challenged the science community to think small in his 1959 lecture 'There's Plenty of Room at the Bottom,' he planted the seeds of a new era in science and technology. Nanotechnology, which is about controlling matter at near-atomic scales to produce unique or enhanced materials, products and devices, is now maturing rapidly with more than 300 claimed nanotechnology products already on the market[1]. Yet concerns have been raised that the very properties of nanostructured materials that make them so attractive could potentially lead to unforeseen health or environmental hazards[2].

The spectre of possible harm — whether real or imagined — is threatening to slow the development of nanotechnology unless sound, independent and authoritative information is developed on what the risks are, and how to avoid them[3]. In what may be unprecedented pre-emptive action in the face of a new technology, governments, industries and research organizations around the world are beginning to address how the benefits of emerging nanotechnologies can be realized while minimizing potential risks[4]. Yet despite a clear commitment to support risk-focused research, opportunities to establish collaborative, integrated and targeted research programmes are being missed[5]. In September, Sherwood Boehlert, chair of the US House Science Committee, commented in a hearing that "we're on the right path to dealing with the problem, but we're sauntering down it when a sense of urgency is required". And in October, Britain's Royal Society raised concerns that the UK government had not made enough progress on reducing the uncertainties surrounding the health and

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

grand challenges to stimulate research that is imaginative, innovative and above all relevant 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[7]. This is not surprising: we have known for many years that inhaled dusts cause disease, and that their harmfulness depends on both what they are made of and their physical nature. For instance, small particles of inhaled

cause harm to people and the environment. But the way science is done is often ill-equipped 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 could develop unanticipated illness arising from their exposure; public confidence in nanotechnologies could be reduced through real or perceived dangers; and fears of litigation may make nanotechnologies less attractive to investors and the insurance industry.

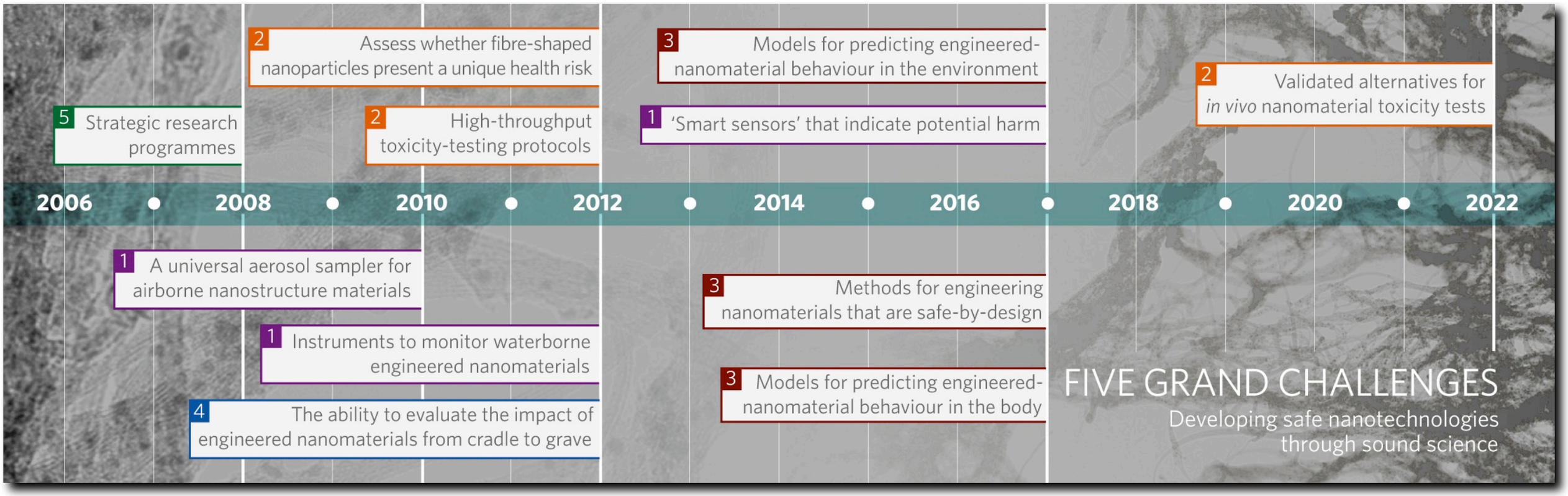
The science community needs to act now if strategic research is to support sustainable nano-

Andrew D. Maynard
Robert J. Aitken
Tilman Butz
Vicki Colvin
Ken Donaldson
Günter Oberdörster
Martin A. Philbert
John Ryan
Anthony Seaton
Vicki Stone
Sally S. Tinkle
Lang Tran
Nigel J. Walker
David B. Warheit

Project on Emerging Nanotechnologies
www.nanotechproject.org

Nature Vol. 444/16 November 2006 pp267-269

FIVE GRAND CHALLENGES



Developing safe nanotechnologies through sound science

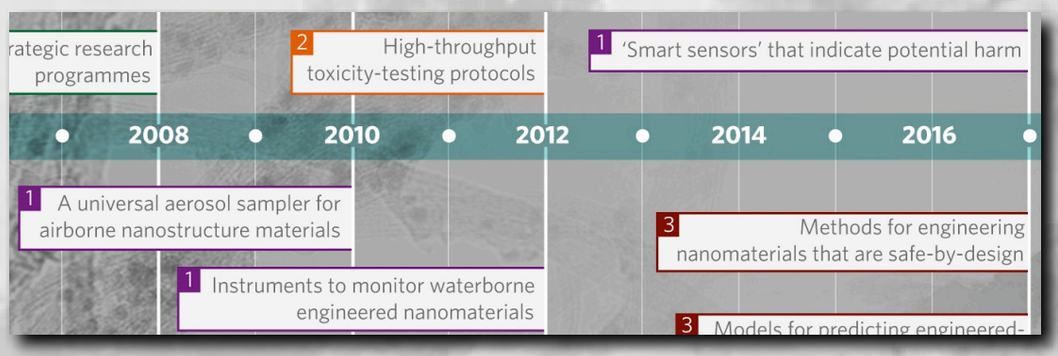
Project on Emerging Nanotechnologies
www.nanotechproject.org

Nature Vol. 444/16 November 2006 pp267-269

1 Instruments to assess exposure to engineered nanomaterials in air and water

3 - 10 years

- A universal aerosol sampler for airborne nanostructured materials by 2010
- Instruments to monitor waterborne engineered nanomaterials by 2012
- "Smart sensors" that indicate potential harm, by 2017



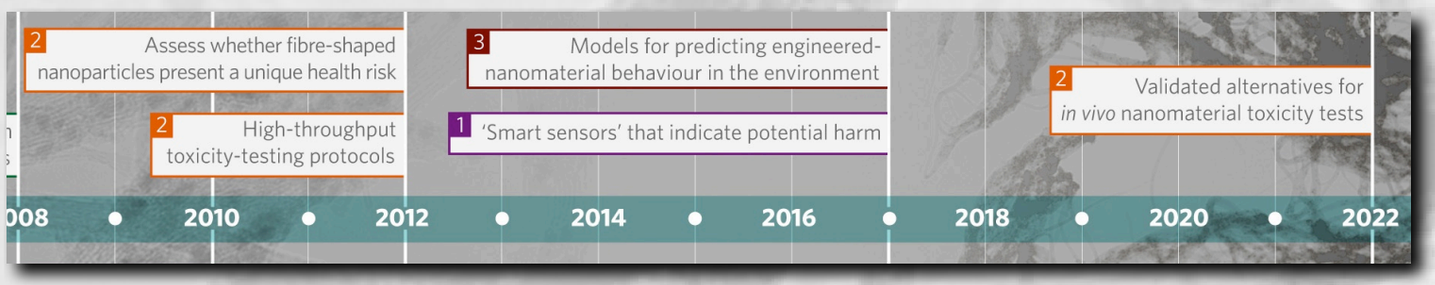
Project on Emerging Nanotechnologies
www.nanotechproject.org

Nature Vol. 444/16 November 2006 pp267-269

2 Effective and relevant nano-toxicity test methods

5 - 15 years

- High through-put toxicity-testing protocols by 2012
- Validated alternatives to *in vivo* nanomaterial toxicity tests by 2022
- Assess whether fibre-shaped nanoparticles present a unique health risk by 2012



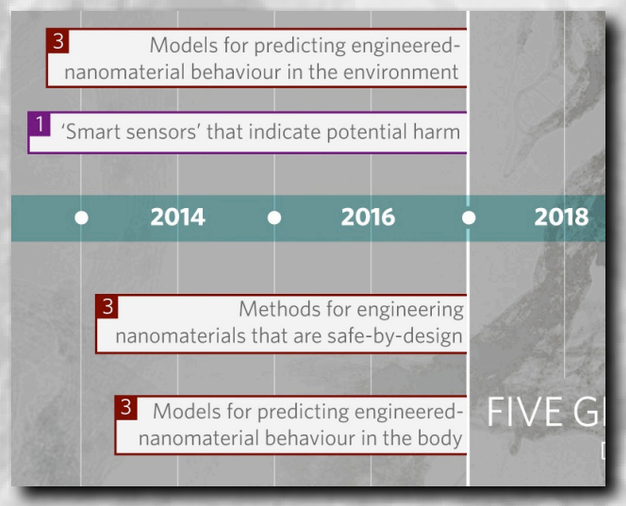
Project on Emerging Nanotechnologies
www.nanotechproject.org

Nature Vol. 444/16 November 2006 pp267-269

3 Systems that can predict the potential impact of new engineered nanomaterials

10 years

- Models for predicting engineered nanomaterial behavior in the environment by 2017
- Methods for predicting engineered nanomaterial behavior in the body by 2017
- Methods for engineering nanomaterials that are safe by design by 2017



Project on Emerging Nanotechnologies
www.nanotechproject.org

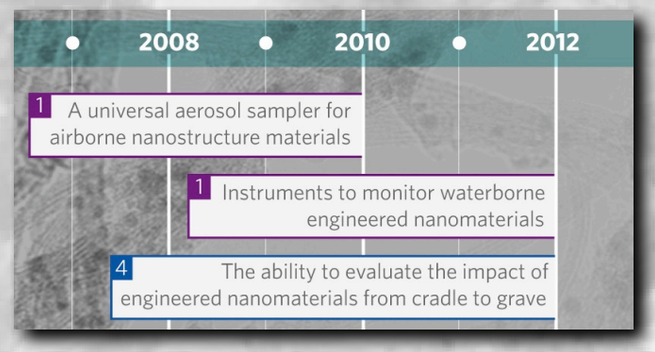
Nature Vol. 444/16 November 2006 pp267-269

4

Systems to evaluate the impact of nanomaterials from cradle to grave

5 years

- Develop robust systems for evaluating the health and environmental impact of engineered nanomaterials over their entire life by 2012



Project on Emerging Nanotechnologies
www.nanotechproject.org

Nature Vol. 444/16 November 2006 pp267-269

5

Effective strategic research programs

12 months

- Collaboration
- Communication
- Coordination

Project on Emerging Nanotechnologies
www.nanotechproject.org

Nature Vol. 444/16 November 2006 pp267-269

“If the global research community can rise to the challenges we have set, then we can surely look forward to the advent of safe nanotechnologies”

Andrew D. Maynard, Robert J. Aitken, Tilman Butz, Vicki Colvin, Ken Donaldson, Günter Oberdörster, Martin A. Philbert, John Ryan, Anthony Seaton, Vicki Stone, Sally S. Tinkle, Lang Tran, Nigel J. Walker, David B. Warheit

Project on Emerging Nanotechnologies
www.nanotechproject.org

Nature Vol. 444/16 November 2006 pp267-269