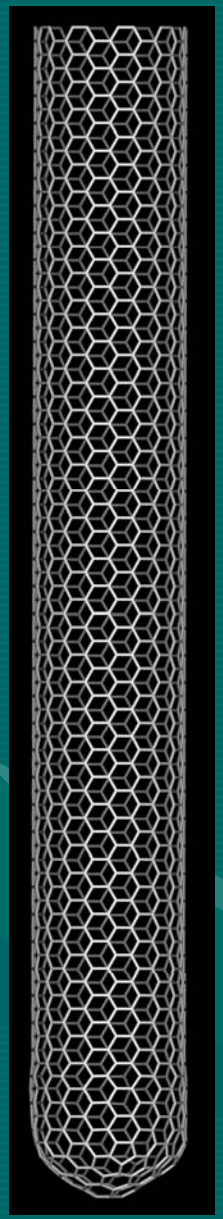
Nanotechnology, Risk and Sustainability:
Moving Public Engagement Upstream

IEPPP

DEMOS

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL



Nanotechnology and 'upstream' public engagement

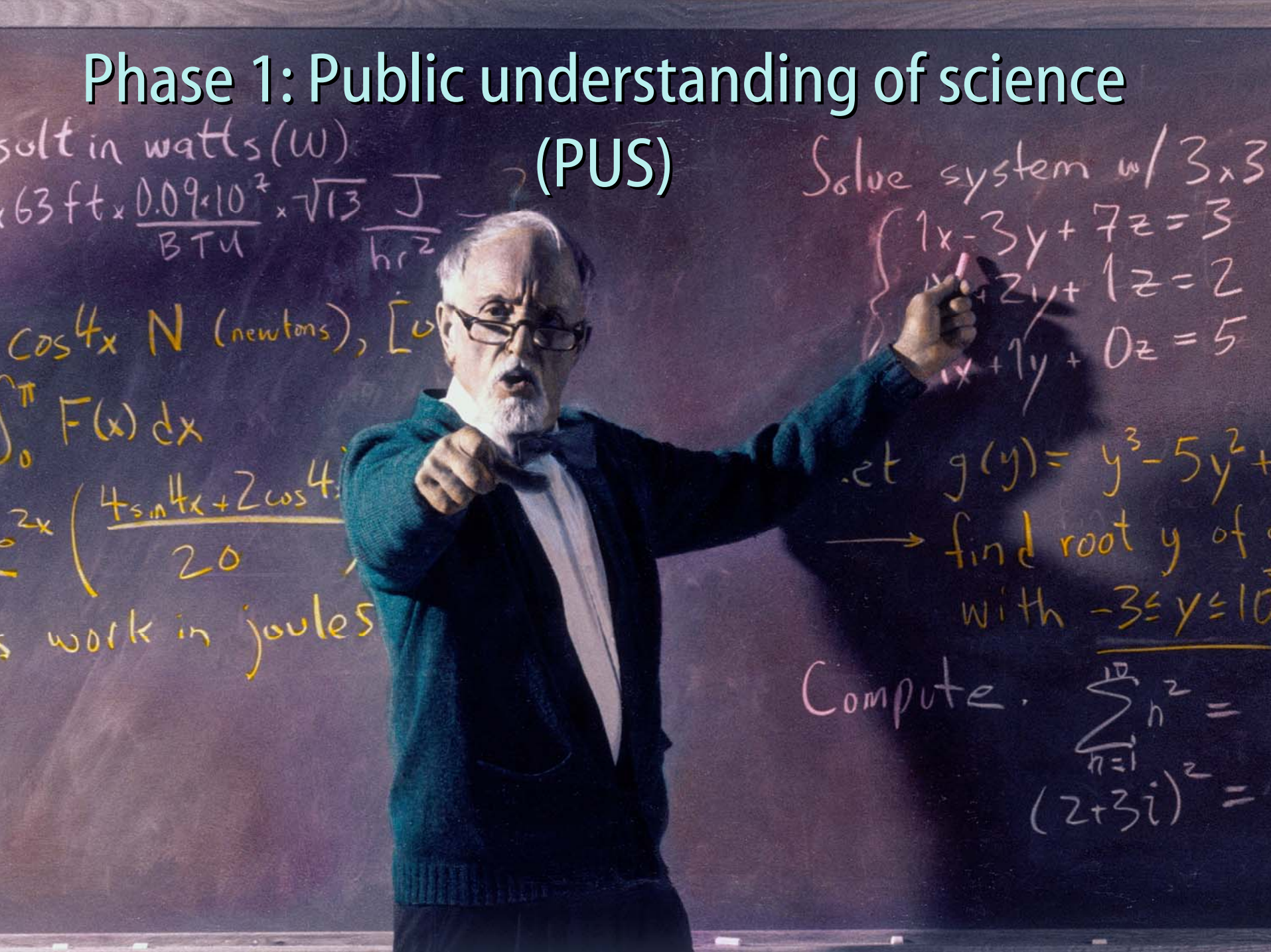
Articulating the controversy potential of a 'technology-in-the-making'

Upstream public engagement

Science and society interactions

- Phase 1
  - deficit 'we know best' model
- Phase 2
  - dialogue model
- Phase 3
  - upstream public engagement

Phase 1: Public understanding of science (PUS)



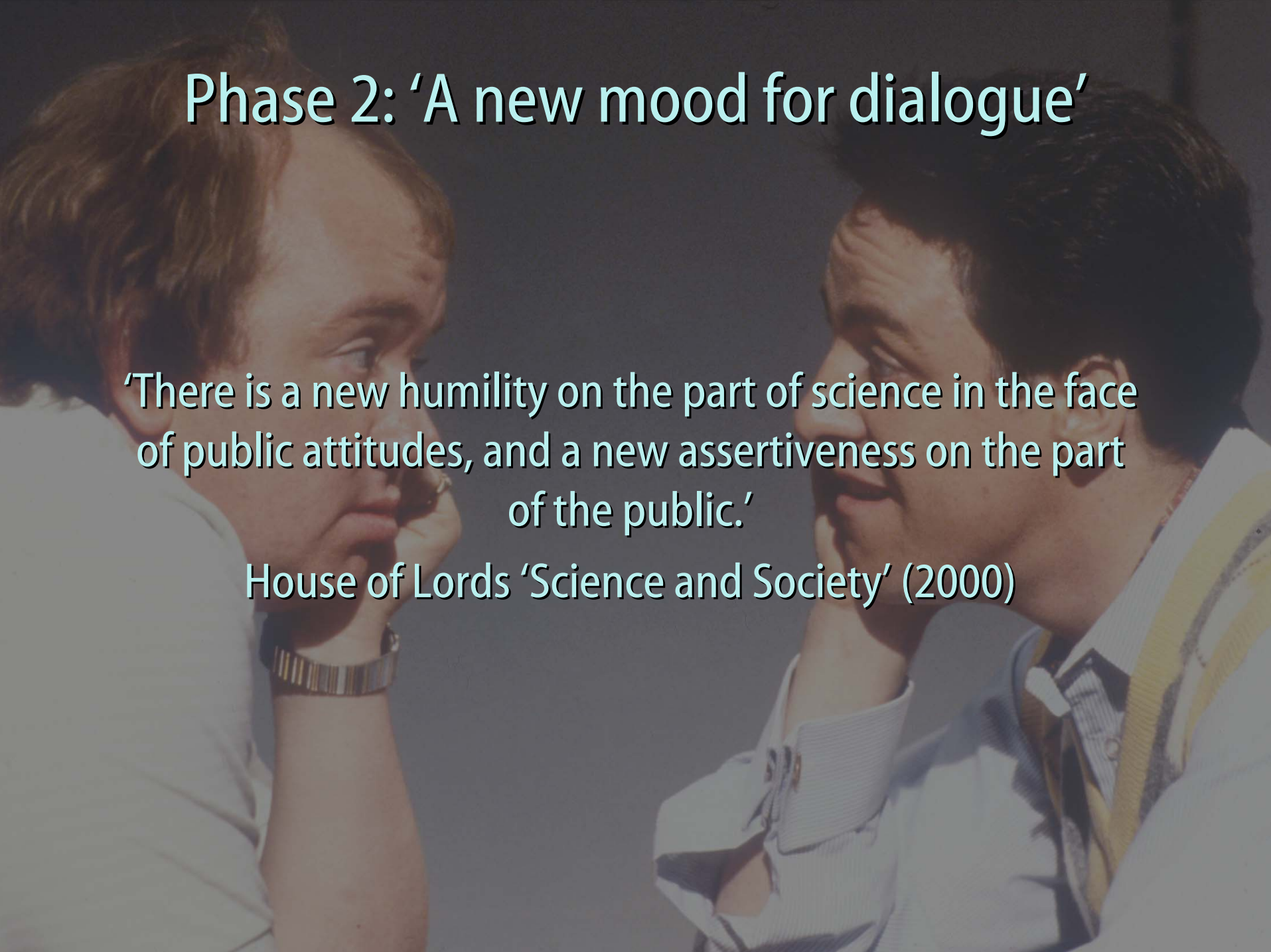
Phase 1: Public understanding of science (PUS)

‘It is clearly a part of each scientist’s professional responsibility to promote the public understanding of science’

Sir Walter Bodmer, Royal Society (1985)

Phase 2: ‘A new mood for dialogue’

Phase 2: ‘A new mood for dialogue’



‘There is a new humility on the part of science in the face of public attitudes, and a new assertiveness on the part of the public.’

House of Lords ‘Science and Society’ (2000)

Phase 3: Paddling upstream

Phase 3: Paddling upstream

‘We have learnt that it is necessary with major technologies to ensure that the debate takes place “upstream”, as new areas emerge in the scientific and technological development process.’

Lord Sainsbury, Science Minister (July 2004)

The upstream argument

Many of the issues currently surrounding nanotechnologies are 'upstream' in nature, providing a real opportunity for engagement to be designed in early. (Royal Society/RAE 2004)

As we have seen, the science community has travelled a long way in a short time. In less than 20 years, the style of its conversation with society has changed from the patronising tones of 'public understanding' to the warmer banter of dialogue. Now it is changing again, to a more honest and reflective mode of listening and exchange.

Welcome to see-through science. (Wilsdon, 2004)

Research activities

- ESRC project
  - 'Nanotechnology, risk & sustainability – moving public engagement upstream' (with Demos)
- UK Gov 'Sciencewise' project
  - 'The Nanodialogues: 4 experiments in upstream public engagement' (with Demos, Environment Agency, EPSRC & BBSRC, Practical Action, Unilever)
- Cross-European 'Science and Society' project (in negotiation)
  - 'Deepening Ethical Engagement and Participation in Emerging Nanotechnologies' (UK, Germany, Netherlands, Portugal)

Researching the upstream

The challenge

1. It is not simply the 'risks' of a technology that concern people but also the future social worlds that novel technologies will enable
2. Public concerns do not necessarily fit within a 'risk' and 'benefit' rubric
3. Nanotechnology is an open ended and largely contested category
4. Nanotechnology exists largely in terms of its 'promise'
5. Since people are unfamiliar with the term, and due to all the factors above, the notion of attitudes is largely redundant

Engaging publics upstream

How to develop a social space in which to enable a robust imagination of potential nanotechnology futures, aimed at understanding the factors that are likely to mediate its reception

Methodological criteria

- Group work
- Attention to conceptual design
- Attention to recruitment
- Attention to the emergence of attitudes

A two stage methodology

1. Public focus groups

- to encourage discussion of potential issues arising for nanotechnology, within a framework set by participants rather than imposed a priori by given official regulatory and risk-assessment vocabularies
- not to engage with a cross-section of opinion, but to engage with groups selected on the basis of their existing participation in local community or political or technology issues, but with no prior involvement or exposure to nanotechnology

2. Scientists-meets-publics

- a conversation between 12 selected members of our nano-informed (and animated) publics and 12 nanoscientists at the National History Museum on the ethical and social dimensions of nanotechnologies

The sample

They included:

- a group of **professional men** (doctors, architects, civil servants etc)
- a group of **professional women** (mostly employed as middle managers in business)
- a mixed group with demonstrable **political** interests
- a group of **mothers** with children of school age
- and a mixed group with an interest in **technology**

The groups were conducted in Manchester and London

The design

- Discussion of technology
- Introduction of nanotechnology
- Different visions of nanotechnology (positive and negative)
- Homework – do own research
- Principle issues for society
- Exploration of dilemmas
  - Enhancement
  - Messing with nature
  - Privacy
- Messages for government

Ambivalence to technology

- Ambivalent experience of technology
  - Enabling, transformative, mobile, connected, global
  - Loss of community, invasion of privacy, impact on family/ work boundaries, info overload and difficulty of 'keeping up'
- Technology as transformative
  - Initially seen as 'a good in itself'
  - On reflection understood as potently shaping society albeit through its own (commercial) logic and largely beyond personal and collective governmental control
- Technology may have brought undoubted 'benefits but has it made our lives 'happier'

GM as symbol

- People used the GM experience – symbolically - as grounds for caution
  - Would they would have much of a say in the direction and pace at which technologies developed?
  - Would control and ownership of technologies would be further consolidated in the hands of the few?
  - Would governments would be able to address the ethical, social and health implications of a technology in advance of its application

‘We haven’t had a say again’

F What you’re saying is we haven’t had a say again, I think that goes back to we haven’t had a say doesn’t it? In that these things are just coming through and...

F They don’t feel the need, no.

F But also that the speed with which things are going forward as well, like I was trying to say before, I don’t know, there are a lot of well publicised questions around genetic modification which … I don’t feel have been addressed, ethical questions haven’t been addressed really or publicly. … I’m a bit wary about jumping into, rushing forward with another new technology where I feel that the old questions haven’t even been addressed.

Professional women

Perceptions of nanotechnology

- Little knowledge or familiarity
- When pressed, people tended to define it as something that was
  - scientific
  - clever
  - small
  - possibly medical
  - futuristic and
  - associated with science fiction

‘Bewildering really’

Int So when I say [nanotechnology] what comes to mind?

M Alien.

F Very little understanding of it.

F Very scientific.

M Well I do think quantum theory and strange, strange effects at that kind of level.

M You just think it’s so futuristic that it wouldn’t be in our lifetime but then you think the way things are going so quickly.

M Bewildering really.

Technology group

‘I actually have no idea what they’re really doing’

F I know the idea that nanotechnology is really small technology and occasionally I’ll read something in the *Guardian* or wherever about ‘it’s amazing, these guys have written their names in atoms on something’ and you’re like, wow, that’s cool. And you have this very nebulous notion that this is really clever, you’re told there are all these possibilities that are waiting to be unlocked in nanotechnology. But I actually have no idea, you know, what they’re really doing and what these possibilities are. I just have this very vague notion that it’s very clever and it could be really important.

Political group

NANOTECHNOLOGY 1

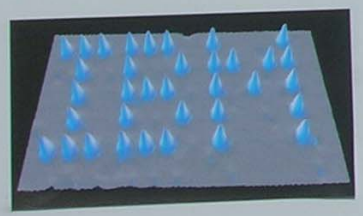
Nanoscience:

The study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale.

Nanotechnologies

The design, characterisation, production and application of structures, devices and systems by controlling shape and size at nanometre scale.

(Royal Society Report)



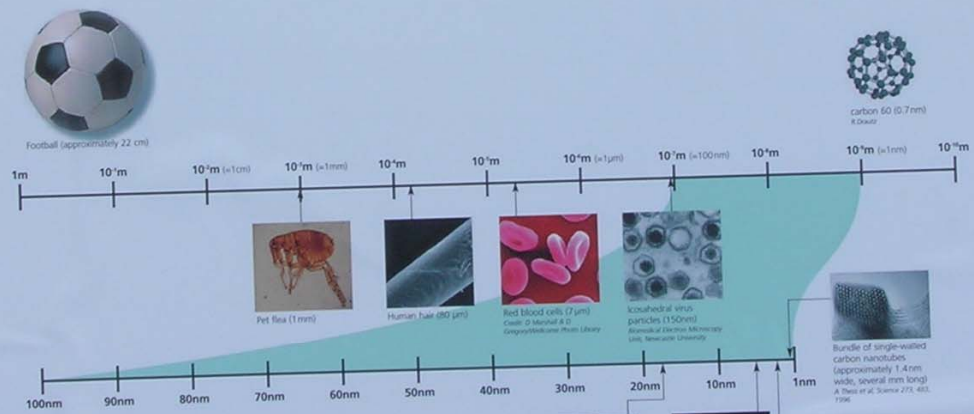


Figure 2.1. Length scale showing the nanometre in context. The length scale at the top ranges from 1m to 10^{-10}m, and illustrates the size of a football compared to a carbon 60 (C_{60}) molecule, also known as a buckyball. For comparison the world is approximately one hundred million times larger than a football, which is in turn one hundred million times larger than a buckyball. The section from 10^{-7}m (100 nm) to 10^{-9}m (1 nm) is expanded below. The lengthscale of interest for nanoscience and nanotechnologies is from 100 nm down to the atomic scale - approximately 0.2 nm.

Platinum/Titanium dioxide particles (Platinum particles less than 3 nm in diameter are indicated by arrows on titanium dioxide)
R Strobel et al, J Catal 222, 296, 2003

Each letter in the logo is about 5 nm from top to bottom.
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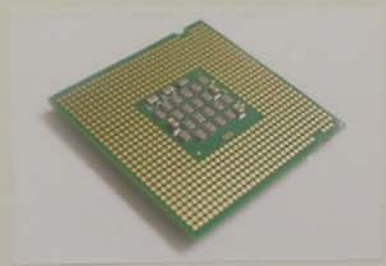
NANOTECHNOLOGY 1a

Medicine

- Nano-optical and imaging technologies
- Targeted drug delivery
- Cancer therapies
- Prosthetics and implants
- Tissue engineering

- A longer term ambition is the enhancement of human capacities – such as 'brain-to-brain interaction', the amelioration of aging and cryo-preservation.



Nanomaterials

- Nanomaterials are increasingly being used in particulate form within sunscreens and cosmetics, coatings, surfaces and paints.
- Existing chemical and industrial process may also be made less polluting through the use of nanomaterials.
- Car production may include nanomaterials in new fuel systems (both carbon and hydrogen based), lighter and stronger materials, more efficient production techniques, nano-coatings and paints.

Information and Communication Technologies

- Nanoscale electronic components
- Flexible display systems
- Ubiquitous computing in which nano-scale sensors are linked using distributed networks to create 'intelligent' environments and new human-machine interfaces.
- Non-silicon based data storage and processing in order to pursue radical advances in miniaturisation, data-storage and processing speed.

Top Down – Bottom Up

Nanotechnologies are often separated into 'top-down' and 'bottom-up' approaches.

- Top down = the miniaturisation of components from the 'top down' to take advantage of different properties that emerge at the nanoscale.

- Bottom up = the growth and self-assembly of components from the 'bottom up' either by directly manipulating individual atoms or utilising chemical reactions and biological processes.

Developing a nano-imagination

- A common process
  - from a state of ignorance, to
  - surprise at levels of research and R&D, to
  - enthusiasm as to the potential for social good, to
  - unease and anxiety over potential unanticipated and disruptive effects in real-world circumstances
- Participants also struggled to envisage the scale of nanotechnologies

‘It’s just so difficult to grasp’

M What I’m struggling to visualise is what they’re [nanotechnologies] actually producing and what they’re doing, it just seems incredible that something so small, you know, what is it replacing and what happens to…

M It is hard to grasp the concept of what sometimes is actually going to be. In other areas it’s just a bit vague about yeah somebody works some magic somewhere but how it’ll integrate into the way you live is a different thing.

M Just exactly that. It’s just so difficult to grasp.

Technical Group

Visions of nanotechnology

- The groups then explored the three visions of nanotechnology – mainstream, utopian and sceptical – depicted on a series of concept boards
- Responses to the mainstream vision ranged from genuine surprise as to the extent of investment in nanotechnology research, to scepticism as to whether such investment would bring any real benefits
- Much of the discussion centred on how commercial considerations are likely to drive the technology

NANOTECHNOLOGY 3

Nanoscience and nanotechnologies are attracting rapidly increasing investments from governments and from businesses in many parts of the world; it has been estimated that total global investment in nanotechnologies is currently around €5 billion, €2 billion of which comes from private sources.

One estimate puts the annual value for all nanotechnologies-related products at $1 trillion by 2011–2015.

Nanotechnologies are seen to have huge economic and social potential, ushering in a 'new industrial revolution' that will include breakthroughs in computer efficiency, pharmaceuticals, nerve and tissue repair, surface coatings, catalysts, sensors, materials, telecommunications and pollution control. Worldwide research funding for nanotechnologies is increasing rapidly, and is estimated to have reached $8.6 billion in 2004.

BRIEFING **BUSINESS** 51

SMALLER STOCK TO WATCH

Polaron, the nanotechnology developer that was floated on AIM at 150p in March, firmed 1p to 181½p on telling investors at its annual meeting that trading was in line with expectations. The company also announced an option to buy the 80 per cent of EPIIC, an Imperial College start-up, it does not own, and a deal to license Imperial's quantum laser-dot technology. Polaron has hired Fraser Searle, from Turbo Genset, as its finance director.

QinetiQ Nanomaterials

Unlocking the potential of nanotechnology

British cash delay 'lets rivals steal march in nanotechnology'

By Mark Henderson
Science Correspondent

BRITAIN is throwing away an opportunity to lead Europe in nanotechnology because hundreds of millions of pounds has been held up for Whitehall, scientists said yesterday.

The Department of Trade and Industry is expected to announce more than £200 million of new money for the emerging field — which involves building machines on a molecular scale — in the next month. But leading research-ers said that strategy could have been published months ago, and that other countries have used the delay to gain a competitive advantage.

At present, Britain spends about £50 million a year on nanotechnology, and this is expected roughly to double. That is dwarfed, however, by other countries. Japan spends almost £400 million a year, and the US will spend more than £500 million next year. The Netherlands, Denmark, Sweden, France, Germany and Spain have all announced substantial nanotechnology strategies and scientists fear that Britain may be left behind.

Mark Welland, Professor of Nanotechnology at Cambridge University, said: "Every month that goes by without the decision being made is a month in which our competitors get further ahead. We were in a position to take a lead, and while I'm sure that we will be a very strong performer, it would have been nice to have led the way rather than scrambling along behind."

Nanotechnology is a fancy word for something that chemists have been doing for decades: constructing ever-smaller functional molecules, thousands of times thinner than a hair. By manipulating chemicals at a molecular level, it is possible to give them new properties such as enhanced strength, and to construct nanoscale machines.

The field is considered one of the most exciting in modern science, promising important breakthroughs in medicine and computing, as well as the creation of "smart" materials such as self-cleaning clothes.

It has, however, raised safety concerns from environmental groups, who fear that nanoparticles might have toxic properties. This month the Government commissioned an inquiry into the potential risks and benefits.

Campaigners have also suggested that it could allow the creation of miniature self-replicating "nanobots", which could copy themselves uncontrollably, transforming the world into a mass of "grey goo". The concept, which features in Prey, a novel by the Jurassic Park author Michael Crichton, was recently raised by the Prince of Wales, to the derision of scientists.

Dozens of nanotech products are already on the market, including cosmetics, tennis rackets and dental fillings, but for the science to be exploited fully, Britain needs a network of laboratories that can manufacture new designs on a tiny scale. "As the applications come on stream, we need places where companies can go and say 'We need this made'," Professor Welland said. "At the moment we don't really have this capacity."

Andy Carland, of the Institute of Nanotechnology, said: "The link between research and industry is poor compared with other countries. We should be competing with the US and Japan, and directing a lot more funding into the field."

The DTI said: "Nanotechnology has the potential to improve our quality of life. We also need to understand whether it raises any ethical, health, safety or social issues not covered by current regulations."

Leading article, page 17

Small is beautiful

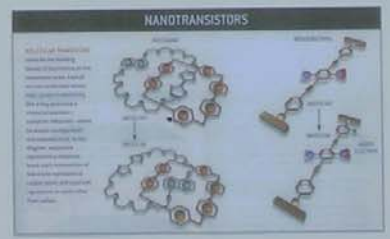
Nanotechnology is the science of manipulating atoms and molecules on a scale measured in nanometres — billionths of a metre, or 80,000 times smaller than the thickness of a human hair (Mark Henderson writes).

The idea is to build miniature machines, creating ever-smaller computers, medical devices that travel around the body delivering drugs or diagnosing diseases, or "smart" materials for use in clothing or construction.

Nanotech products on the market include:

- Tennis rackets made with carbon fibres at molecular level. The carbon is 10,000 times stronger than steel, giving a light racket with great power.
- Dental fillings that use nanoscale plastics and ceramics. These are extremely hard wearing.
- Cosmetics using "nanocapsules" that can deliver the active agent through the skin highly efficiently.
- Nanocrystals of silver used in a burn dressing.
- Nanomolecules broken down by sun and water are used in a "self-cleaning" glass.

Nickel microcogs just 150 microns thick



Big budgets emerging for tiny products

NANOTECHNOLOGY 2

Converging Technologies for Improving Human Performance:

NANOTECHNOLOGY, BIOTECHNOLOGY, INFORMATION TECHNOLOGY AND COGNITIVE SCIENCE

We stand at the threshold of a new renaissance in science and technology, based on a comprehensive understanding of the structure and behaviour of matter from the nanoscale up to the most complex system yet discovered the human brain.

The unification of science based on unity in nature and its holistic investigation will lead to technological convergence and a more efficient societal structure for reaching human goals.

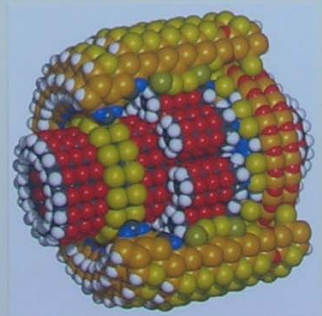
In the coming decades nanotechnologies promise to increase significantly our level of understanding, transform human sensory and physical capabilities, and improve interactions between mind and tool, individual and team.

- The vast promise of outer space will finally be realized by means of efficient launch vehicles, robotic construction of extraterrestrial bases, and profitable exploitation of the resources of the Moon, Mars, or near-Earth approaching asteroids.

- Agriculture and the food industry will greatly increase yields and reduce spoilage through networks of cheap, smart sensors that constantly monitor the condition and needs of plants, animals, and farm products.

(National Science Foundation Report)

- Rapid advances in nanotechnology have the potential to enhance both human performance and the nation's productivity. Examples of payoffs will include:
  - Improving work efficiency and learning
  - Enhancing individual sensory and cognitive capabilities
  - Fundamentally new manufacturing processes and improved products
  - Revolutionary changes in healthcare, improving both individual and group efficiency
  - Highly effective communication techniques including brain-to-brain interaction



- The human body will be more durable, healthier, more energetic, easier to repair, and more resistant to many kinds of stress, biological threats, and aging processes.

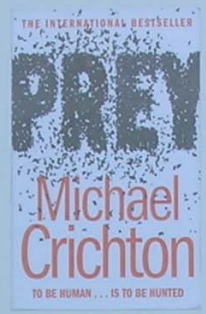
- Transportation will be safe, cheap, and fast, due to ubiquitous real-time information systems, extremely high-efficiency vehicle designs and the use of synthetic materials and machines fabricated from the nanoscale for optimum performance.

- The ability to control the genetics of humans, animals, and agricultural plants will greatly benefit human welfare; widespread consensus about ethical, legal,and moral issues will be built in the process.

NANOTECHNOLOGY 4

The small size of nanoparticles ensures that a high proportion inhaled from the air reaches and is deposited in the deep lung. The size of nanoparticles appears to influence their uptake into cells. Nanoparticles because of their small size may pass into cells directly through the cell membrane with the possibility of interfering with important cell functions such as motility and ability to remove bacteria.

(Royal Society Report)



Our most powerful 21st-century technologies - robotics, genetic engineering, and nanotech - are threatening to make humans an endangered species.

Robotics, genetic engineering, and nanotechnology - pose a different threat than the technologies that have come before. Specifically, robots, engineered organisms, and nanobots share a dangerous amplifying factor: They can self-replicate and quickly get out of control.

(Bill Joy – Chief Scientist, Sun Micro Systems)

CANCER FEARS SPARK CALL FOR NANOSCIENCE SAFETY RULES

Mark Henderson Science Correspondent

REGULATIONS are needed to ensure that the products of industrial nanotechnology do not pose unexpected risks to human health, British scientists say.

They called yesterday for safety protocols for industrial chemicals to be redrawn to consider the different properties that some materials have when manufactured as nanoparticles, which can be up to 800 times thinner than a human hair. As the behaviour of some chemicals changes at this scale, there are fears that some nanoparticles may be found to be toxic or carcinogenic, even though larger particles of the same substance are harmless.

The different properties of nanoparticles arise because their surface area is much larger in proportion to their mass than larger molecules. Also, they are so small that they evade both man-made filters and natural filters within the body, such as the epithelium that lines the lungs.

At present companies proposing to make nanoparticles for non-medical purposes are not required to show that their products are safe. But this had to change if public fears were to be calmed, and for the benefits of the field to be harnessed, Ken Donaldson, Professor of Respiratory Technology at the University of Edinburgh, said.

There was increasing evidence that inhaled nanoparticles could cause lung inflammation and enter the blood and the brain, with unpredictable consequences, he said. While this did not necessarily mean that they were dangerous, more research was required.

"There are problems with very small particles even if their contents are very innocent," Professor Donaldson said. "If very different nanoparticles are manufactured, we need to be concerned that they might have very different effects in the body."

Nanoparticles can occur naturally, through burning, for instance, but they are increasingly being manufactured for industrial and medical applications. Carbon "nanotubes", for example, are a hundred times stronger than steel, yet lighter than aluminium, making them very valuable in engineering.

Mike Horton, Professor of Medicine at University College London and co director of the London Centre for Nanotechnology, said that the problem did not lie with nanoparticles designed for medical use, as these had to undergo the same toxicology tests as any new drug.

Companies that are using nanoparticles for products as diverse as sunscreens, tennis rackets and strengthened steel cables, however, do not have to conduct any special toxicity assessments. "If we're manufacturing thousands of tonnes of nanotubes a year, whatever you do there is going to be significant loss," Professor Horton said. "There could be issues there."

PARTICLES OF FAITH

Scientific advances offer the chance for health and beauty products to penetrate deeper into our bodies. But is it safe? By Sarah Boseley

The Ubiquitous ID Center has authorized Hitachi's mu-Chip and Toppan's T-Junc
ucode tags for embedding in or attaching to objects in ubiquitous environments

‘I just am a bit cynical’

F I just am a bit cynical about it because from experience, my experience is, … is that there’s so many great uses, um, that it could be put to, to help people you know, to, to, but it seems to me that those uses don’t really generally get through, the way that these technologies are applied are by the people who have the money to put behind it, and those are the corporations or, whoever stands to make a profit from it and, [you] don’t generally see technologies applied in a more humanistic or social, socially beneficial way.

Professional woman

Responses to Visions

- Is this Nano-hype
  - Who is investing in nanotechnology and why?
  - Who will benefit from the hype?
- Is this Nano-hubris
  - Are overtly utopian scenarios the ones to be genuinely fearful?
  - Is it realistic to imagine adequate forms of control?
  - Should we be rushing ahead when social and ethical considerations from existing technologies have not been resolved?

‘Nanotechnology’s the new God’

M That really is quite a frightening scenario that when you read through that. . . . So this wonderful nanotechnology is going to be a cure-all for all human ills, it’s going to make us all super brilliant and clever and work that much better, our transport’s going to be far better, even though the fact that nobody will be dying of old age, nobody will be dying of any illnesses, means we won’t be able to move on this planet. . . . OK, if it’s used to treat cancers and stuff like that but we’re getting into this Brave New World scenario here where everyone lives forever and everybody has everything, everybody can do everything. . . . It’s a very, very frightening scenario . . .

Professional group

F It’s like nanotechnology’s the new God.

Technology group

‘This is the vision of the robotic environment’

F It’s amazing.

F I find it quite daunting actually, I find it a bit scary.

F This is the vision of the robotic environment with everything controlled for you and everything 100 per cent perfect and plastic.

F It’s like even the food. . . .You buy a piece of fruit, it’s healthy, after a period of time it wrinkles, you throw it away or whatever and that is a natural process and I think in some ways it’s kind of fiddling with that natural process.

Mothers

The consolidation of concern

- During the week between the two sessions, participants engaged in their own research on nanotechnology, through the internet or discussions with family and friends
- For many participants, the greatest area of anxiety was in relation to nanoparticles entering and harming the body, either through cosmetics or foods
- The invisibility of nanoparticles exacerbated this concern

Nanoparticle Risk

- A visceral example of this dynamic was explored in the mothers' group
- In the initial session, these women were largely enthusiastic at the prospect of consumer benefits from nanotechnology, particularly in ameliorating signs of ageing
- Now, when confronted by uncertainty as to the toxicological effects of nanoparticles, they were more doubtful

‘I wouldn’t touch it now with a barge pole’

F Since last week I’ve completely changed my approach to these creams. When you said it had those nanosomes I thought, ‘oh great, fantastic, I’d use it’ – I wouldn’t touch it now with a barge pole if you paid me money to put that stuff on my face. It’s so frightening.

F I think we’re very trusting as buyers in the market, we’re very trusting of the products we’re given. .We’re suddenly having to become very sceptical because things come out afterwards.

F Well you sort of assume it’s always been tested.

F Clearly things like cosmetics don’t have the controls that the drugs do.

F But surely wouldn’t they be better to say, right, we don’t know enough and until we know enough or we’ve changed our regulations then we don’t let it go on the market.

F There’s too much money in it I think.

Mothers

Reflections on ethical dilemmas

- In the middle of the second sessions, the questions or concerns raised by this research were explored with the help of three more concept boards on the themes of
  - 'privacy'
  - 'human enhancement'
  - 'meddling with nature'

"Smart dust" is a cute name for a technology that, if it pans out commercially, could improve the whole damn world. Essentially, smart dust is made up of thousands of sand-grain-sized sensors that can measure ambient light and temperature. The sensors have wireless communications devices attached to them, and if you put a bunch of them near each other, they'll network themselves automatically. (Wired Magazine)

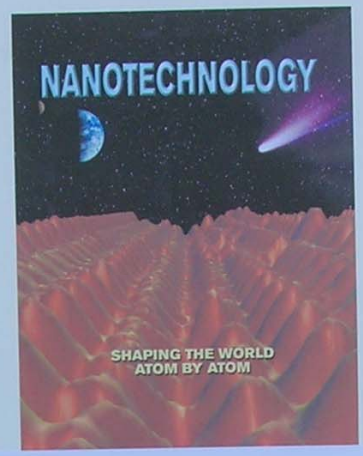
If cameras keep getting smaller and mobile (e.g., mosquito-scale drones), what kind of defences might protect us against Peeping Toms, or police spies, flying such devices through the open windows of our homes? (Wired Magazine)

PRIVACY vs. SECURITY

National security will be greatly strengthened by lightweight, information-rich war fighting systems, capable uninhabited combat vehicles, adaptable smart materials, invulnerable data networks, superior intelligence-gathering systems, and effective measures against biological, chemical, radiological, and nuclear attacks.(NSF Report)

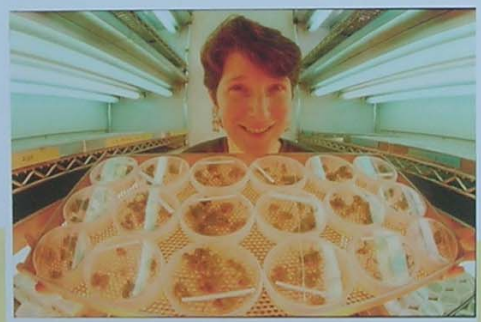
They will watch you. They will know you. They will be all but invisible to you. By 2010 there will be 10,000 connected microsensors for every person on the planet. The broad idea of "pervasive" computing – a galaxy of devices connecting seamlessly in a world of whenever. (Small Tech, Industry Magazine)

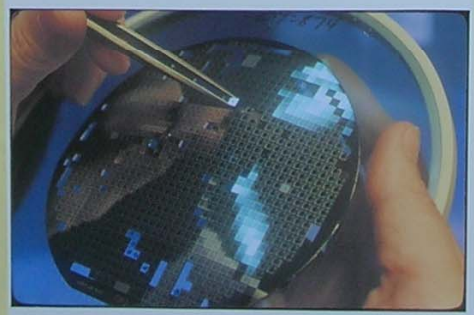
Gaining better control over the structure of matter has been a primary project of our species since we started chipping flint. The quality of all human-made goods depends on the arrangement of their atoms. The cost of our products depends on how difficult it is for us to get the atoms and molecules to connect up the way we want them. The amount of energy used - and pollution created - depends on the methods we use to place and connect the molecules into a given product. The goal of nanotechnology is to improve our control over how we build things, so that our products can be of the highest quality and while causing the lowest environmental impact. (Foresight Institute)



While biotechnologists build new life from stripped-down microbes, nanotechnologists are busy building biological machines - or hybrid machines employing both organic and inorganic matter - from the bottom-up. The two trends converge on the shifting shores of nanobiotechnology. The implications are breathtaking: not just new species and new biodiversity - but life forms that are human-directed and self-replicating. Nanobiotechnology is moving science from genetically-modified organisms to atomically-modified organisms. (ETC Group)

MEDDLING vs. PROGRESS

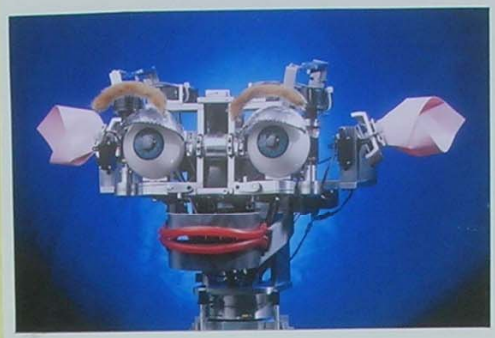




A brand of nano-engineering is emerging. The field's driving question is this: What could we humans do if we could assemble the basic ingredients of the material world with even a glint of nature's virtuosity? What if we could build things the way nature does—atom by atom and molecule by molecule? (NSF Brochure)

Nanotechnology could be seen as "messing with nature" in a specific way by "manipulating the building blocks of nature". People also concerns about whether scientists are trying to "play God". (BBC)

The human body will be more durable, healthier, more energetic, easier to repair, and more resistant to many kinds of stress, biological threats, and aging processes. (NSF Report)



Concerns over nanotech applications for enhancing th performance of the human body might also arise. A majo question here is whether such enhancements can be force upon people, either when in a position to make a decisio for themselves or, more controversially, against their wi (Greenpeace)

THERAPY vs. ENHANCEMENT

In the coming decades, technologies like genetic engineering, artificial intelligence, and nanotechnology will transform humanity. A strange new world is unfolding -- nightmarish to some, utopian to others. Soon we'll have the power to reshape our children's genes, build machines that think, and upload our minds into computers. And Earth no longer confines us. Space tourism, mining the Moon and asteroids, a settlement on Mars: all are dreams poised to take wing. (www.cyborgdemocracy.net)

Particularly troubling and internationally destabilizing are "Converging technologies for domination on the battlefield." They exploit the most dangerous potential of nanotechnology, including technologies for surveillance and invasions of privacy, for the enhancements of soldiers' bodies, for remote manipulation of soldiers' minds, and for autonomous killing machines. (European Report)

Factors likely to underpin public concern

Although concern was latent, the factors underpinning such concern reflected familiar themes, but ratcheted up to a new level

- The body
- Nature's revenge
- Control society
- Increasing inequalities
- Potential for misuse
- The military imaginary

‘It’s the invisible threat’

F The face cream which has got very small nanoparticles in it . . . if I rub that on my skin, there’s things going into my skin I’m not aware of. No one knows exactly what that’s going to do and it might have long-term effects. Any little bit of dirt, like something that shouldn’t be in there, pops into the cell, messes with the actual sequence of what that cell does and you know, that’s so scary.

F Yeah because it can happen without you realising whereas before if things were going to invade your body, you would see it happening.

M It’s the invisible threat….

M I think it’s the mixing of the science and the biology. I think it’s when those two, you know, mix. I think when everything’s thinking for themselves that you start to worry

Technology group

‘We’ll be the guinea pigs’

F It’s like trying to make a perfect race again.

F We just don’t know the long term effects do we? That’s the problem.

F So basically our generation’s going to be the ones that they test this all out on. If it all goes horribly wrong, we’ll be the guinea pigs.

Mothers group

M It’ll get out of the cage I’m sure and evolve through various biostrains and mechanisms and it will be adapted, possibly. There are cases with GM super weeds now.

Professional men

‘Evil applications’

M The more I think of the dangers, the more evil applications I can think of using nanotechnology.

M Well I just find it quite frightening really. I think it’s quite disturbing. The potential to harm seems to me to be greater than the potential for good if it gets into the wrong hands.

Technology group

‘There are some scary dark futures’

M I think the worrying thing for me . . . is that it’s almost as though we lose control of what’s going on because the technology itself is capable of replicating and you know pretty much making its own decisions.

M I think that is a big problem. It’s like the thing you were saying with creativity as well. If the human controls the technology that’s fine; as soon as it becomes the technology making all the decisions then that’s when you have a problem because humans are completely different from a computer.

M There are some scary dark futures where you have strains of children who are and are not enhanced in some way, and that’s a really dodgy thing.

M Do you have your kids injected at birth to enhance the way their muscles grow and things?

Technology group

‘It makes the rich richer and the poor poorer’

M And the other feeling I was left with was it was almost like a nano race to be the first to do it – because the impression I got was that whoever really is the first to do it well is going to pretty much monopolise everything.

M Yeah it makes the rich richer and the poor poorer.

M The gap just gets bigger.

M I agree, but I don’t necessarily think everyone’s going to benefit from it.

M Oh no certainly not everyone. Only the very rich few.

Technology group

‘Why can’t we slow it down’

F The whole thing we’ve been talking about is that these things happen so quickly, why can’t we slow it down? Is it going to matter that much if it is slowed down?

F But the only thing is, say this country do that and slow it down then you’re gonna go abroad…yeah, and it’s gonna come back into this country anyway.

Professional women

Reflecting on public concern

- Context matters
  - technology, GM, political economy of research
- Considerable latent ambivalence towards nanotechnology
  - Ambivalence did not diminish through greater knowledge and awareness
  - Instead, through exposure to the multiple ways in which the debate was being characterised, and through debate and deliberation, our participants moved towards a more sceptical view as to the ability of government and industry to represent the public interest

‘It must be an absolute Godsend to the terrorists’

Int How controversial do you think it’s going to be?

M Far more than genetic modification.

M It’s going to be more. And what are the fault lines through which it’s going to become politically controversial?

M The medical, the human biological angles as well as the food chain.

M I would have thought in the present climate particularly terrorism. It must be an absolute Godsend to the terrorists, this sort of technology.

Professional men

Wider Reflections

- Although further research is required to corroborate the reliability of these findings across more diverse social groups, our research suggests that there is considerable – if latent – potential for controversy around nanotechnologies
- It points to the density of issues – moral, social, political, as well as technical – posed by nanotechnologies and of the fundamental challenges for governance
- And it suggests that the public can differentiate these issues, and deliberate their social meanings in more complex terms than simply as 'risks' and 'benefits'

Introducing the Film

- Now… to the final phase of the research
  - 12 selected members of our nano-informed (and animated) publics and 12 nanoscientists
  - an afternoon's discussion at the National History Museum to encourage a new form of conversation on the ethical and social dimensions of nanotechnologies.
- This was conducted very much as an experiment.
  - Was such a conversation be possible?
  - Would it be productive?
  - Would the scientists and public participants argue or agree?
  - Would there be a meeting of minds?