Managing Technology in Society

Upstream public engagement in R&D decision making

the case of
Nanotechnology in Health Care

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CTA on Nanotechnology

- Nanotechnologies are fast becoming "the next big thing"
  - Only not big at all

- Attracting considerable investment from Government & Industry
  - Hoping to drive economic development
  - (NSF forecast $1 trillion by 2015)

  - The potential is apparently endless, BUT
    - How to weigh benefits against possible downsides
    - And how to get from the lab to the high street and the hospital

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Content

- Introduction
  - Nanotechnology
  - Why Constructive Technology Assessment
  - Challenge of new & emerging technologies
- CTA approach for assessing healthcare applications
- Methodology and research approach
- Results
- Brief concluding remarks

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Nanoscience & Nanotechnology

Nanotech

Why CTA?

Challenges

- In a nutshell: The science of extremely tiny. "Dwarf" Technology

- Nanoscience: Study of fundamental principles of molecules and structures with at least one dimension roughly between 1 and 100 nanometers

- Nanotechnology: is the application of these molecules and structures in useful devices.

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Nanoscience & Nanotechnology

- One nanometer represents one billionth of a meter

- 1/100000 of the diameter of human hair

- 1/5000 of the diameter of a red blood cell

- A DNA molecule has a diameter of approximately 1 nm

- Ten hydrogen atoms in line make up one nanometer

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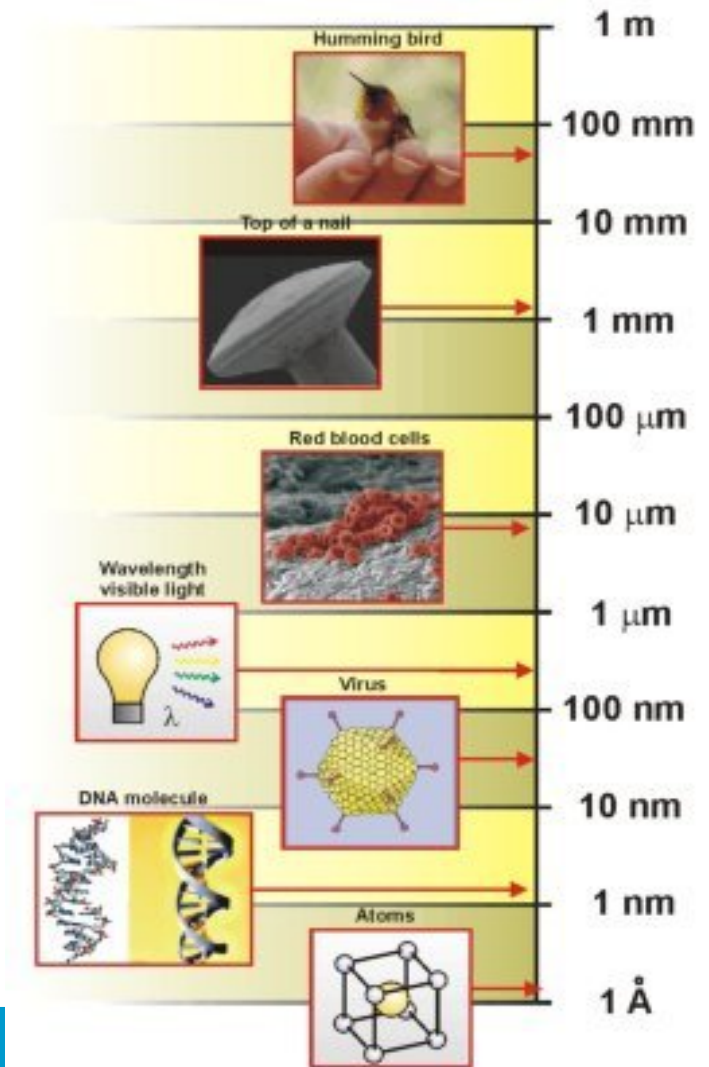
Nanoscience & Nanotechnology

The smallest things ever possible to make

- Very special kind of small

Fundamental properties of materials begin to change at this dimension (viscosity, force, surface to area ratio)

- Hence:

    Nanotechnology enables us to work at atomic and molecular levels, to understand, create and use material structures and devices with fundamentally new properties and functions.

- Important characteristics
    - Disruptive
    - Enabling technology
    - Multi-Disciplinary

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Personal benefits in short term

 Lighter & Stronger Tennis Racquets
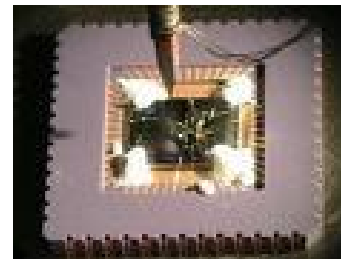
 Self cleaning surfaces
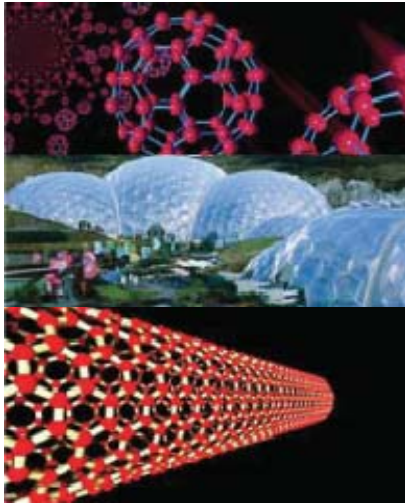
 Colorless sunscreen lotion
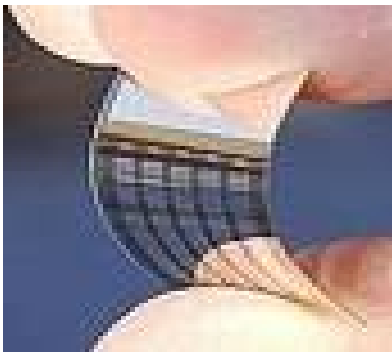
 Stain resistant Textiles

 Odorless socks

 Faster computer chips / larger storage

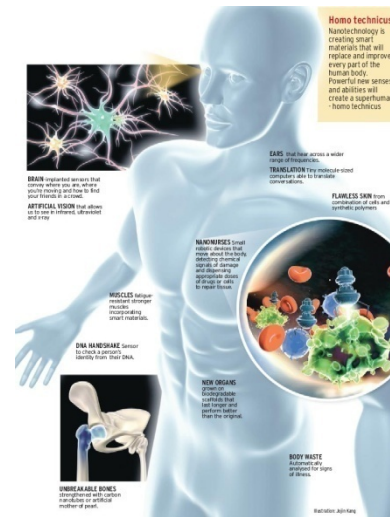**TU**Delft

There's far more: Social Benefits

New Materials
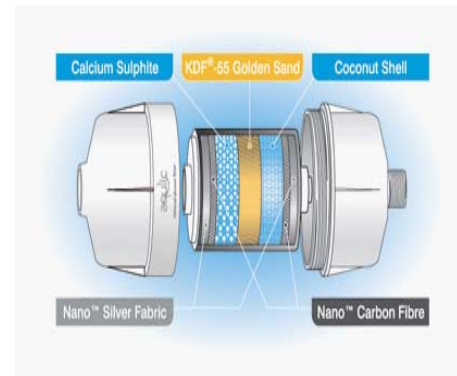(Carbon nanotubes)

Light as plastic strong as steel

Medicine
Targeted Drug delivery

Intelligent implants

Energy
(Organic Solar cells)

Printable electronics

Water
(Nanoenabled filters)

Cheap and efficient

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Introduction

Successful embedment is a complex process which involves multiple answers.

In this process it is vital to:

- Meet user needs without raising public controversy

To do this firmly:

- Identify public value and concerns in early stages of development

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Introduction

Knowledge & Control Dilemma

Low insight into indirect effects in early stages of development	⟷	Reduced flexibility due to Societal embediing of technology

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Introduction

Using CTA approach to bypass control dilemma

Low insight into indirect effects in early stages of development

Reduced flexibility due to Societal embediing of technology

CTA
Circumventing the problem
By involving stakeholders in dialogue in early stages of development

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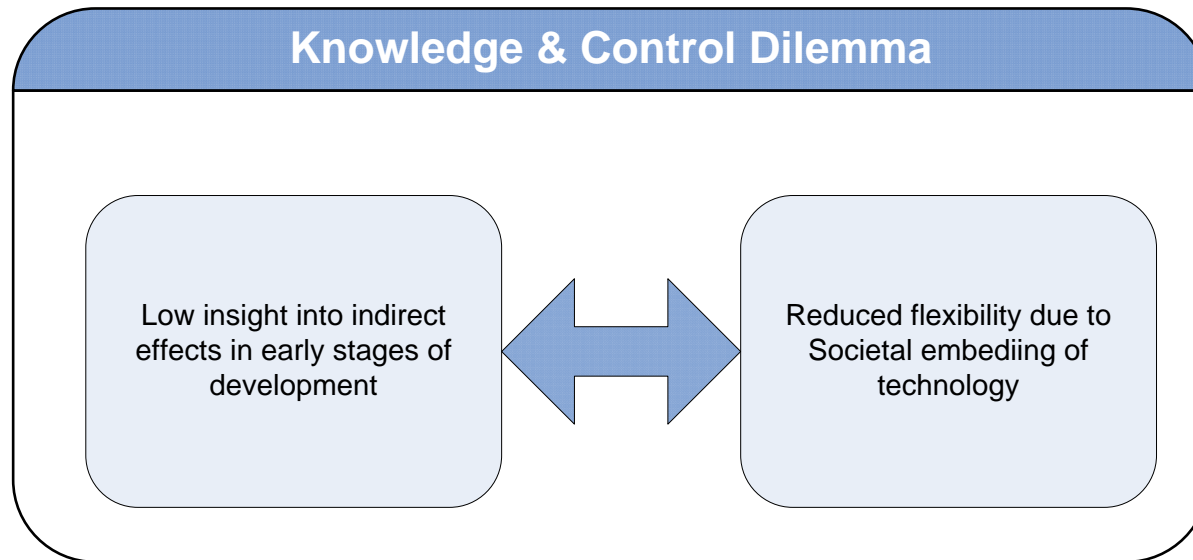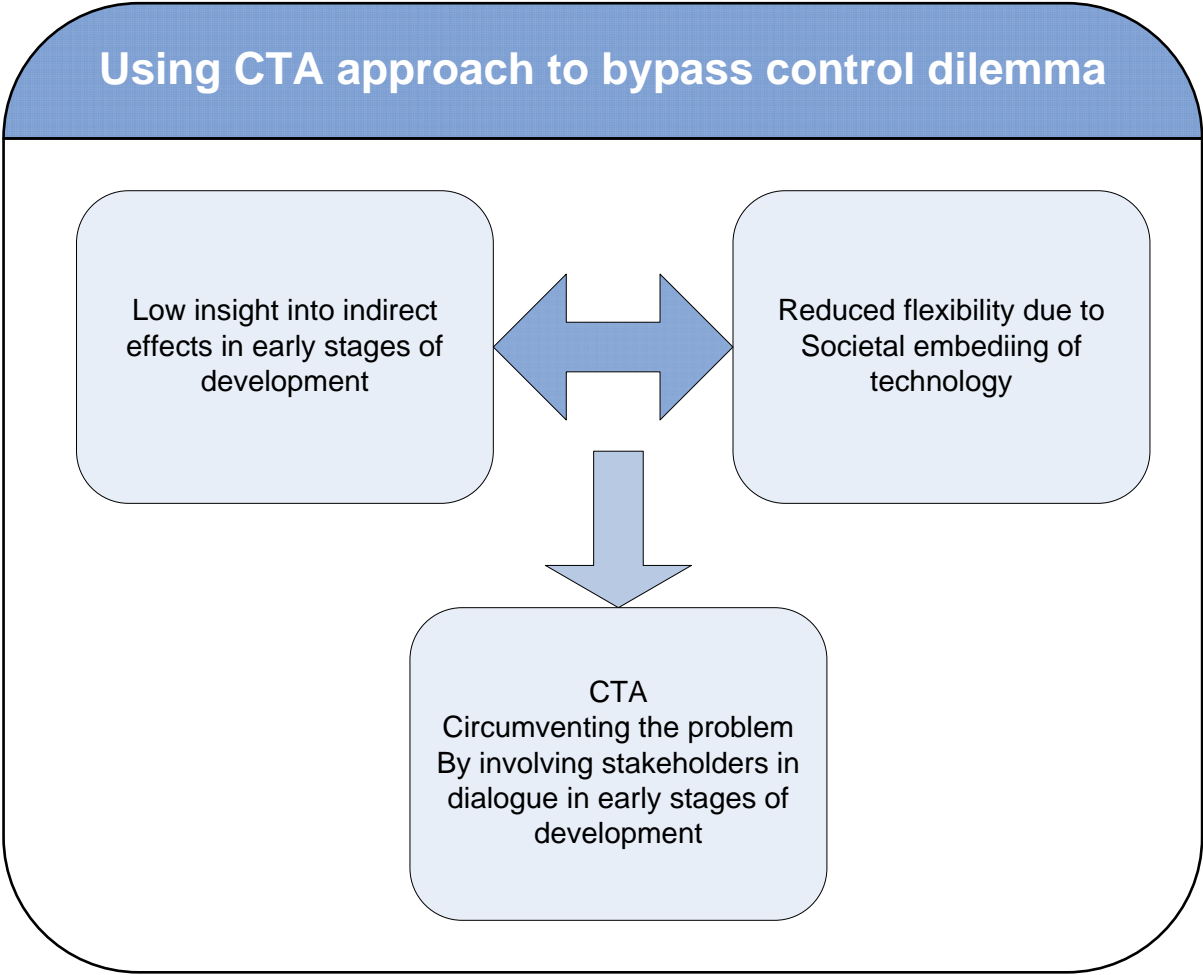
Introduction

Nanotechnologies pose new challenges

- Vague definition: what should be accepted as nanotechnology?

- Characteristics : Enabling and multi disciplinary

- Public does not have the necessary knowledge about complex science and technologies

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Importance of public engagement in R&D decisions of healthcare

- Dependency on high tech artifacts and procedures
- Competition on basis of new and advanced technologies

1. Acceptance without discussing underlying assumptions

2. Physicians intermediate role in the introduction

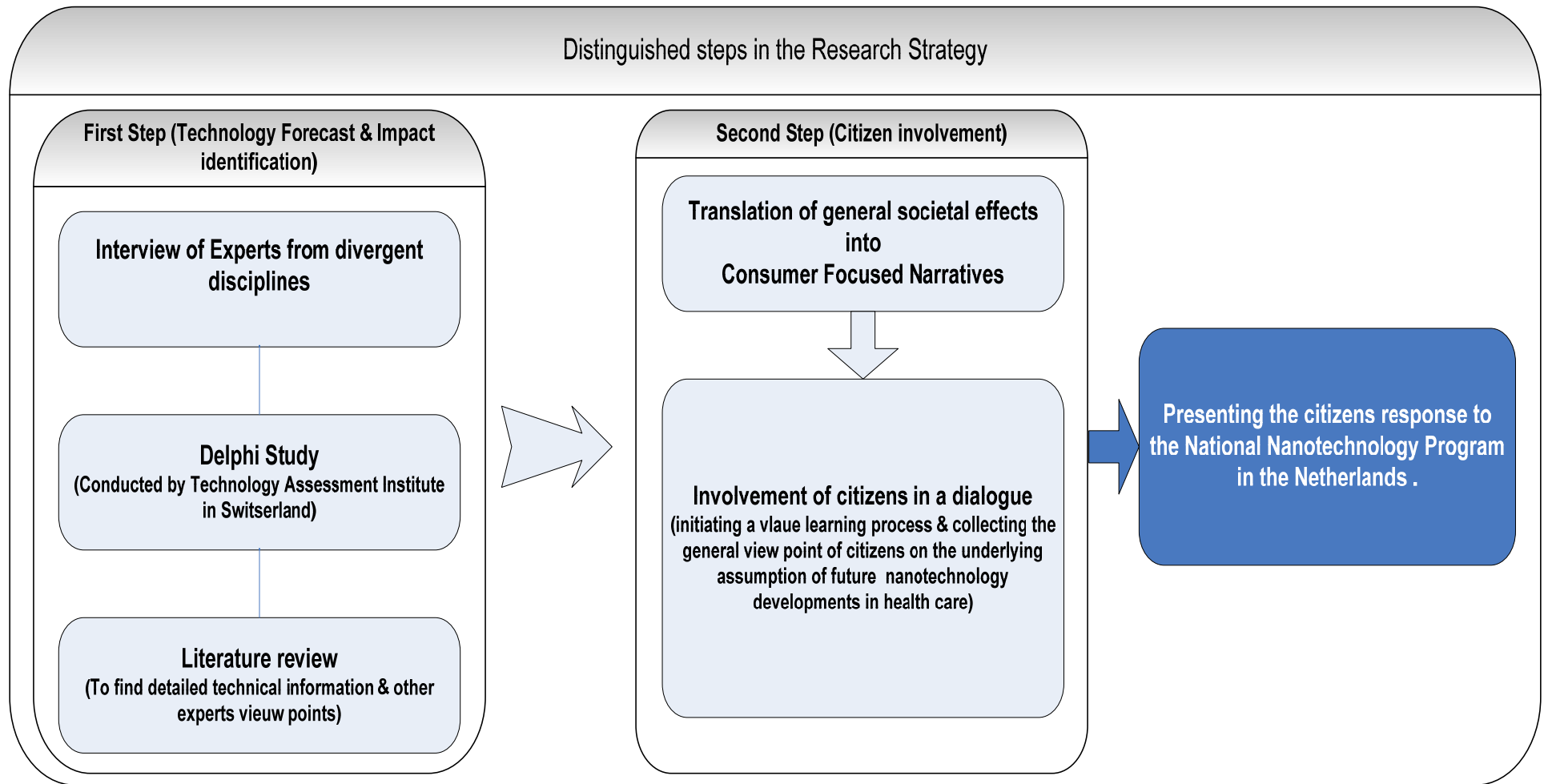3. Technology Assessment comes usually after development

Aim

- Innovative mix of methodological practices from the CTA toolbox.

- Enable and motivate public debates on nanotechnologies

- Identify public concerns and values about these advances

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Methodology

- Collecting the point of view of citizens
- Focus group approach with citizens as participants
- Interactive approach with consumer narratives as input

- Alternative to other methods such as questionnaires which is not interactive

Research strategy and approach
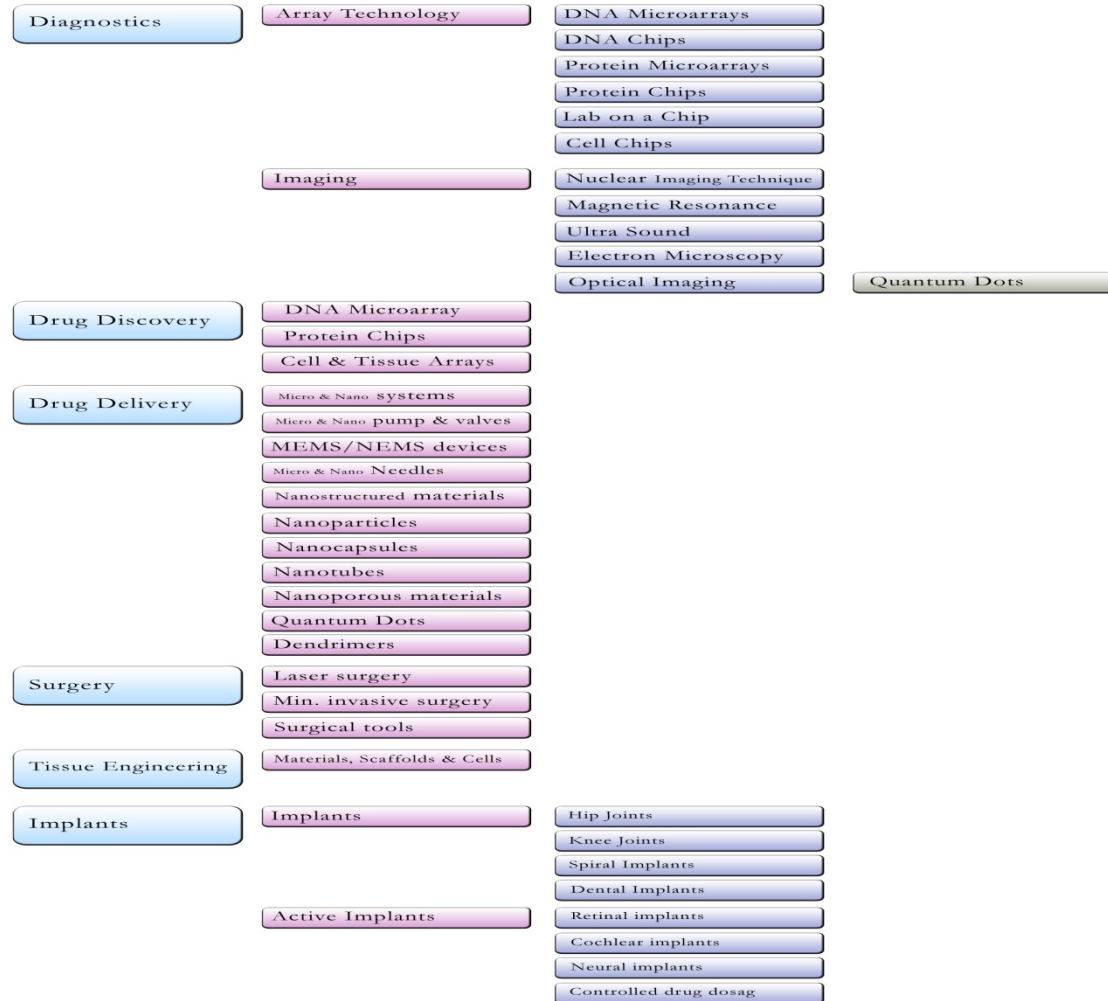
Distinguished steps in the Research Strategy

First Step (Technology Forecast & Impact identification)

Interview of Experts from divergent disciplines

Delphi Study
(Conducted by Technology Assessment Institute in Switserland)

Literature review
(To find detailed technical information & other experts vieuw points)

Second Step (Citizen involvement)

Translation of general societal effects into Consumer Focused Narratives

Involvement of citizens in a dialogue
(initiating a vlaue learning process & collecting the general view point of citizens on the underlying assumption of future nanotechnology developments in health care)

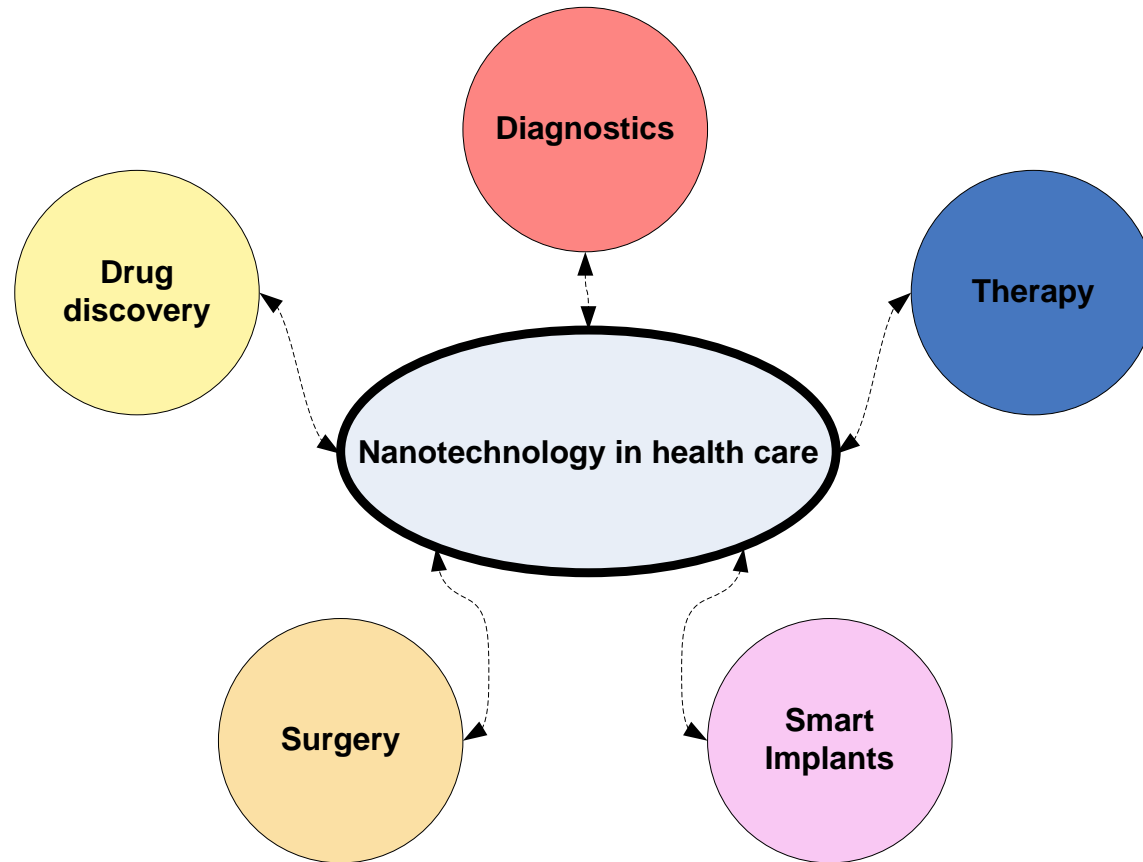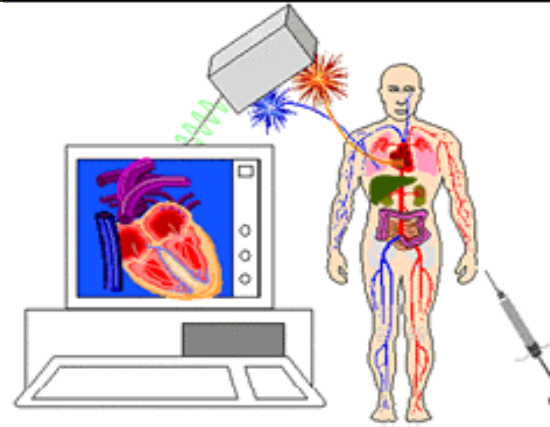**Presenting the citizens response to the National Nanotechnology Program in the Netherlands .**

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Applications

Applications

Impact

Public
controversy

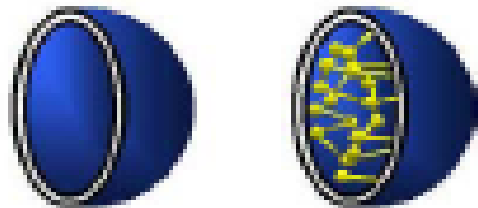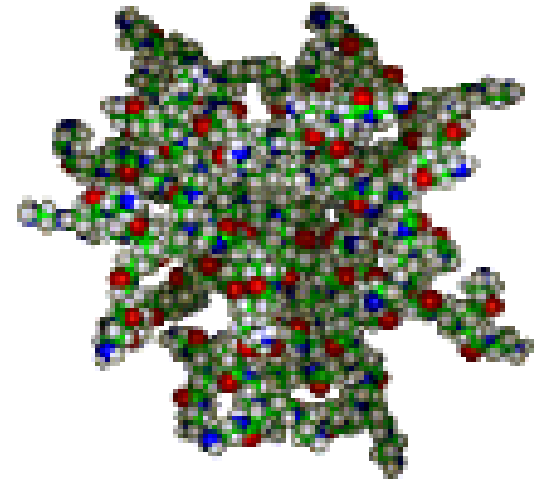| Diagnostics | Array Technology | DNA Microarrays |
		DNA Chips
		Protein Microarrays
		Protein Chips
		Lab on a Chip
		Cell Chips
	Imaging	Nuclear Imaging Technique
		Magnetic Resonance
		Ultra Sound
		Electron Microscopy
		Optical Imaging	Quantum Dots

Drug Discovery	DNA Microarray
	Protein Chips
	Cell & Tissue Arrays

Drug Delivery	Micro & Nano systems
	Micro & Nano pump & valves
	MEMS/NEMS devices
	Micro & Nano Needles
	Nanostructured materials
	Nanoparticles
	Nanocapsules
	Nanotubes
	Nanoporous materials
	Quantum Dots
	Dendrimers

Surgery	Laser surgery
	Min. invasive surgery
	Surgical tools

| Tissue Engineering | Materials, Scaffolds & Cells |

Implants	Implants	Hip Joints
		Knee Joints
		Spiral Implants
		Dental Implants
	Active Implants	Retinal implants
		Cochlear implants
		Neural implants
		Controlled drug dosag

Applications

Diagnostics

Drug discovery

Therapy

Nanotechnology in health care

Surgery

Smart Implants

Applications

Diagnostics

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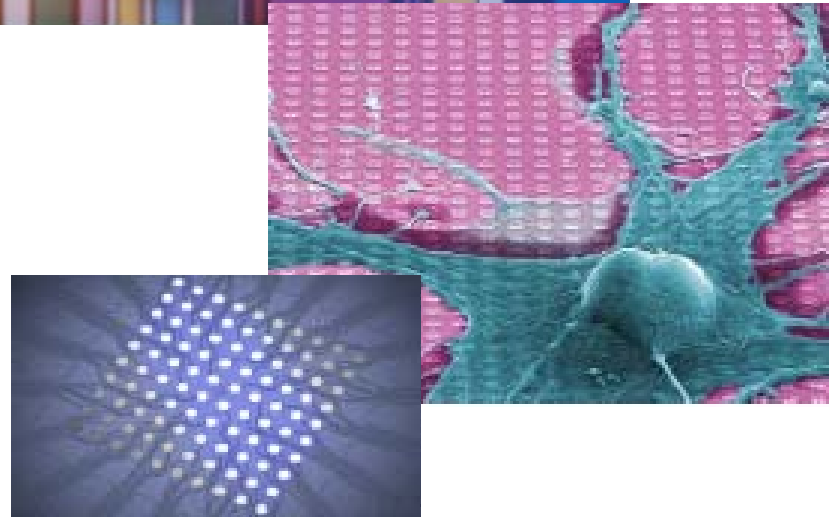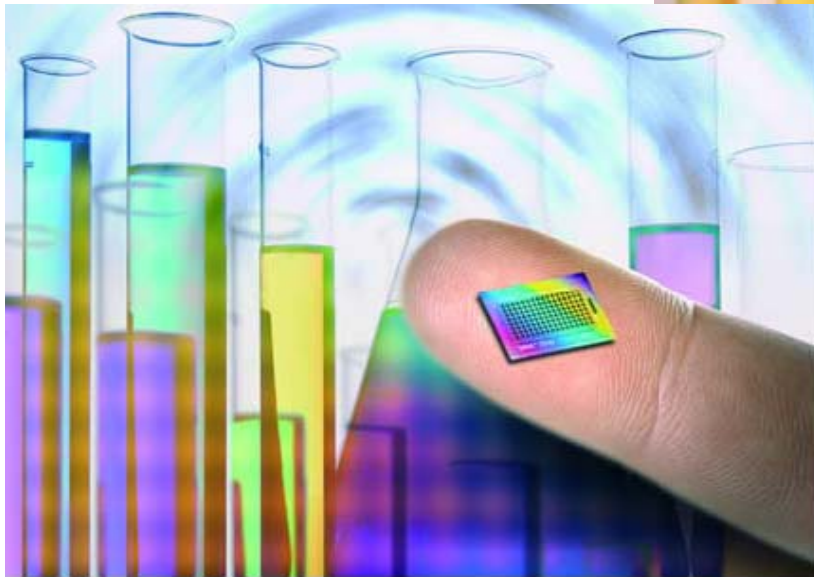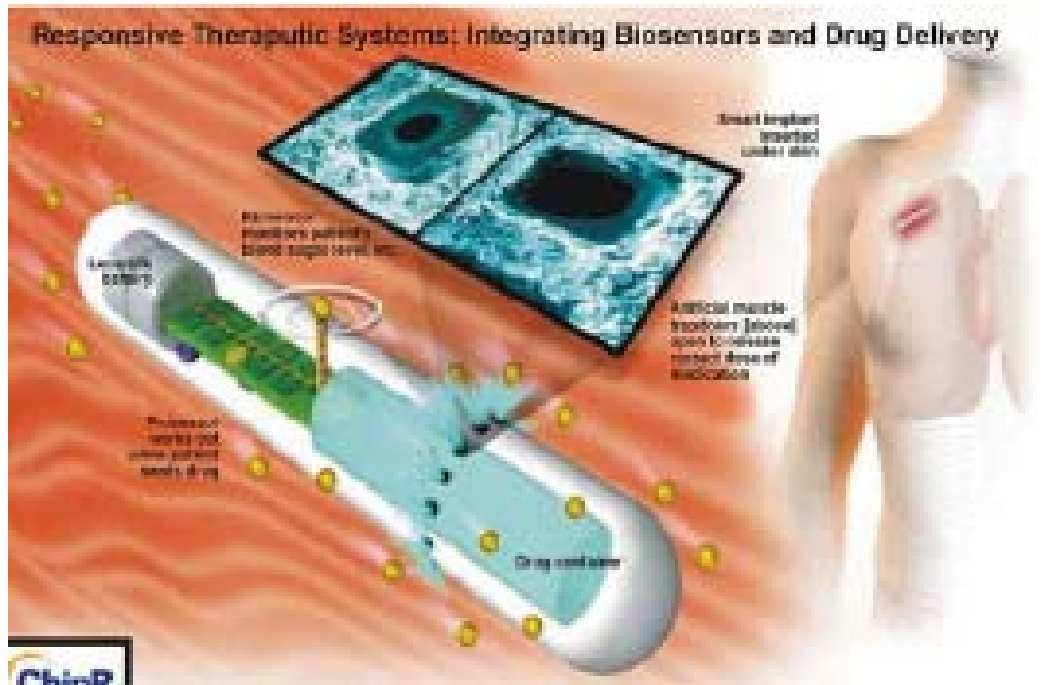# Applications

Therapeutics
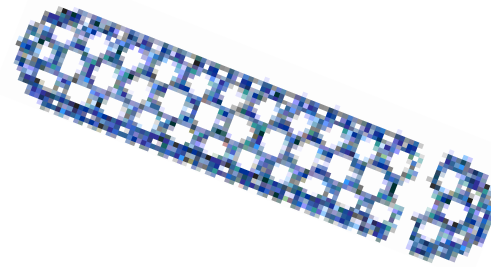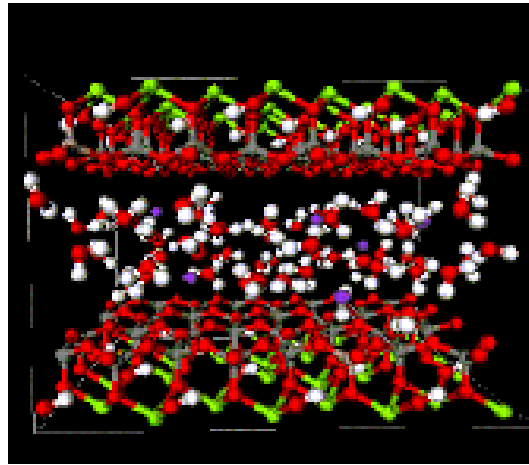
Applications

Drug discovery
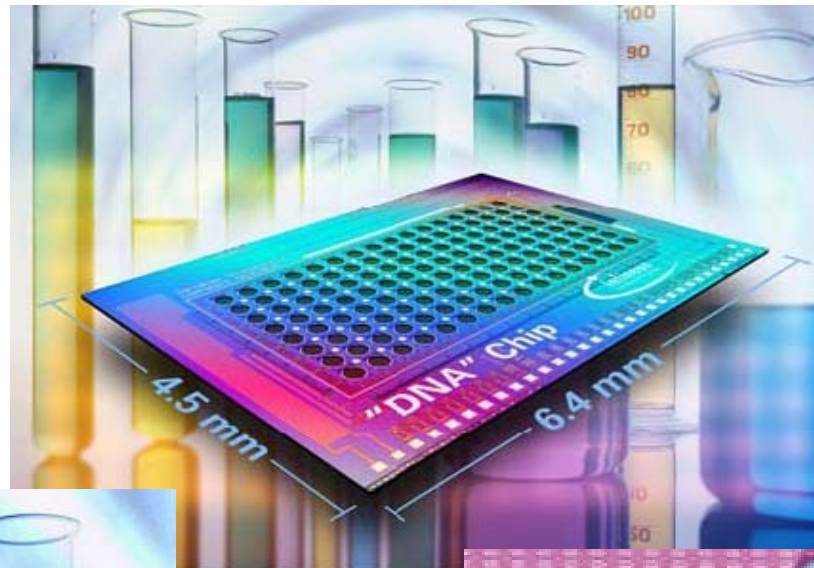
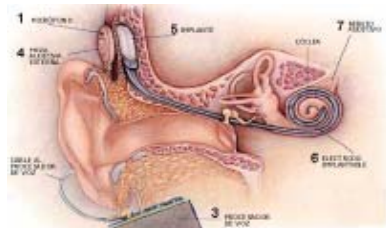# Applications

Surgery

Applications

Smart implants

Responsive Theraputic Systems: Integrating Biosensors and Drug Delivery

Four major changes in health care

Applications

Impact

Public controversy

Treatment & Diagnostics Moving to molecular levels

From traditional hospital setting to electronic monitoring on distance

Point of Care

Preventive health care

Enhancing human performances

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Four major changes in health care

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Point of Care

Preventive health care

Enhancing human performances

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Potential sources of controversy

- **Risk** of nanoparticles

- And **lack of a solid detection** method

- **Enhancement of human functions** and military purposes.

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Potential sources of controversy

- More surveillance, Less privacy

- Burden of self responsibility increases due to prevention based health services

- **Divide** between Rich and Poor

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Tricky innovation

- S&T offer huge possibilities but only some become part of our life

- The road from idea to application is long and rocky

- Many factors will influence social embedment

THE VISIONARY

COMPETITION

REGULATOR

THE ACTIVIST

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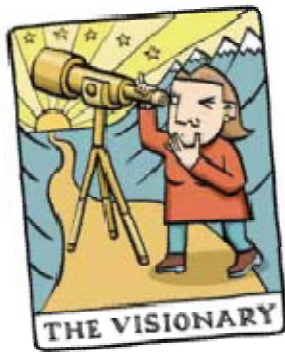
Social Embedment

- Social embedment depends on many factors
  - Safety & reliability
  - Compatibility with manufacturing capabilities
  - Fit into the regulatory frame
  - Clarity about pro and cons
  - Fit with norms and values of the public

  - Visions and expectations of future applications enable assessment of such issues

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Second research step

- Stepwise discussion of the consumer narratives

- Four categories of future emerging shifts

- Narratives presented a situation of change due to nanotechnological advances and incorporated a potential source of controversy

- Objective was to evaluate the opinion, values and acceptance level of participants

Results second research step

Identification of priority points of attention:

- Acceptance on voluntary basis

- Issue of transparency, communication and accountability

- Need for some structure of regulatory control

1. Unclear risk of nanoparticles for health and environment
2. The rising healthcare costs
3. Miniaturized technologies for enhancing human functions & military applications

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Conclusion

- Looking at specific areas of developments in nanotechnology makes it easier to debate its impact with the public.

- By doing a systematic foresight study, we were able to find some concrete and tangible expectations about the future of healthcare.

- Debating nanotechnologies on basis of narratives that visualizes future state by using tangible and concrete examples, we make the impact of nanotechnologies more clear to the users and even appealing to be subject of debate.

- This enables and motivates the debate on their underlying assumptions.

- It is evident that the public wants to participate in debate.

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Thank you for your attention!

Discussion!