Social, health and ethical implications of nanotechnology

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Outline

- Sociology
- Ethics
- Motivation to deal with sociology and ethics regarding nanotechnology
- Social implications of nanotechnology
- Health implications of nanotechnology
- Ethical implications of nanotechnology
- Conclusions and outlook

Sociology 1/6

- The word sociology was coined by Auguste Comte in **1838** from Latin ***socius*** (companion, associate) and Greek λ□γος, ***logos*** (word).
- Comte hoped to unify all studies of humankind - including history, psychology and economics.

Sociology 2/6

- Sociologists study **society** and **social action** by examining the groups and social institutions people form, as well as various social, religious, political, and business organizations.
- Sociologists also study the social interactions of **people and groups**, trace the origin and growth of social processes, and analyze the influence of group activities on individual members and *vice versa*.

Sociology 3/6

- Sociologists study **institutions** such as the family and social processes that represent deviation from, or the breakdown of, social structures, including crime and divorce. And, they research micro-processes such as interpersonal interactions and the socialization of individuals.
- In short, **sociologists study the many faces of society**.

Sociology 4/6

- Sociology is an **academic and applied discipline** that studies society and human social interaction.
- Sociological research ranges from the analysis of **short** contacts between anonymous individuals on the street **to** the study of **global** social processes.

Sociology 5/6

- The field focuses on **how and why people are organized in society**, either as individuals or as members of associations, groups, and institutions.
- As an academic discipline, sociology is typically considered a social science.
- There is ongoing lively discussion about whether social science can be classified as "science".

Sociology 6/6

- Sociological research aids **educators**, **lawmakers**, **administrators**, **developers**, **business leaders**, and **people interested in resolving social problems and formulating public policy**.

Ethics 1/2

- Ethics (from the Ancient Greek ἠθικός *ēthikos*, the adjective of ἦθος ***ēthos*** **"custom, habit"**), a major branch of philosophy, is the study of values and customs of a person or group.
- Ethics covers the **analysis and employment of concepts** such as **right and wrong**, **good and evil**, and **responsibility**.

Ethics 2/2

- Ethics is divided into **three primary areas**:
  - ***meta-ethics*** (the study of the concept of ethics)
  - ***normative ethics*** (the study of how to determine ethical values)
  - and ***applied ethics*** (the study of the use of ethical values).

Motivation to deal with sociology and ethics regarding nanotechnology 1/2

- **Nanotechnology** will have broad applications across all fields of engineering, so it will be an **amplifier of the social effects of other technologies**.
- It will be important to **integrate social and ethical studies** into nanotechnology developments **from their very beginning**.

Motivation to deal with sociology and ethics regarding nanotechnology 2/2

- Technically competent research on the societal implications of nanotechnology will help **give policymakers and the general public a realistic picture free of unreasonable hopes or fears**.

Background facts

- In **2002**, the US **National Nanotechnology Initiative** had a budget of **$697 million**.
- **0.04%** of this budget was invested to **study the social and ethical implications** of nanotechnology.
- **None** of this money was allocated to studying **risk perception**.

Social Implications of Nanotechnology

- **Social scientists** are professionally trained **representatives of the public interest**.
- They are capable of functioning as **communicators** between nanotechnologists and the public or government officials.

Social Implications of Nanotechnology

- Sociologist Etzkowitz states three different but mutually supportive roles the social sciences can play in the development of nanotechnology (see next slides).

Etzkowitz H.: Nano-science and society: Finding a social basis for science policy. In: Societal Implications of Nanoscience and Nanotechnology, ed. by M. C. Roco, W. S. Bainbridge, Kluwer, Dordrecht, p. 121–128, 2001

Roles of the social sciences in Nanotechnology 1/5

1. Analyzing and contributing to the improvement of the processes of scientific discoveries that increasingly involve organizational issues where the social sciences have a long-term research and knowledge base.

Etzkowitz, 2001

Roles of the social sciences in Nanotechnology 2/5

2. Analyzing the effects of nanotechnology, whether positive or negative, expected or unintended, hypothetically and proactively and as they occur in real-time.

Etzkowitz, 2001

Roles of the social sciences in Nanotechnology 3/5

3. Evaluation of public and private programs to promote nanoscience and nano-technology.

Etzkowitz, 2001

Roles of social scientists in Nanotechnology 4/5

- **Social scientists** are professionally trained representatives of the public interest and capable of functioning as **communicators** between nanotechnologists and the public or government officials.

Roles of social scientists in Nanotechnology 5/5

- Their input may help **maximize** the societal **benefits** of the technology while **reducing** the possibility of **debilitating public controversies.**

Health implications of nanotechnology

- Roblegg and coworkers from the Nanonet Styria, an Austrian Nanotechnology Network, published in 2006 a report on health risks of nanotechnology. This report stresses the **need for long-term studies on health implications of nanotechnology**.
  - Roblegg E., Sinner F. and Zimmer A.: Gesundheits-risiken der Nanotechnologie, 2006 http://www.bionanonet.at/Publikationen_PDF/nanoGesund.pdf

A case study

Nanoparticles

- Oberdörster *et al.* showed in animal experiments that there is **translocation of inhaled nanoparticles** (smaller than 100nm) **along the olfactory nerve into the brain**. The translocation of particles along nerve fibers could provide a **portal of entry** into the central nervous system for solid ultrafine particles, **circumventing the tight blood–brain barrier**.
  - Oberdörster G. et al. Translocation of inhaled ultrafine particles to the brain, Inhalation Toxicology 16(6-7), p. 437 – 445, 2004

Nanoparticles

- There are currently **no studies on the behaviour of nanoparticles in cosmetics products**.
- Nanoparticles are for example found in sunscreen products and in skin creams.

Nanoparticles: legal situation

- Long term studies are necessary, since currently, the US Food and Drug Administration, the **FDA**, as well as the US Scientific Committee on Cosmetic Products and Non-Food Products intended for Consumers of the European Commission **regard nanoparticles in cosmetics as a variation of the bulk material**, **ignoring possible non-scalable size effects**. There is currently no legal requirement to perform time consuming and expensive toxicological tests.

Contergan

- **Until 1999**, the **FDA** regarded chiral pharmaceuticals (left- and right-handed isomers, **enantionmers**) of the same molecule as the **same component**.
- An impressive (and tragic) example on how different the enantiomers of the same molecule can act in the human body was given by the substance Thalidomide (Contergan).

Contergan

- One enantiomer of Thalidomide is effective against morning sickness (this is why it was administered to pregnant women). The other enantiomer causes birth defects.
- The enantiomers are converted to each other *in vivo.* Approximately 10 000 “Contergan babies” were born in the 1950s and 1960s.

Contergan

- At the end of the 1990s a paradigm shift took place in the FDA and today, left- and right-handed isomers of pharmaceuticals are treated as two different substances.
- Strong M.: FDA policy and regulation of stereoisomers: paradigm shift and the future of safer, more effective drugs, Food and Drug Law Journal 54, p. 463-487, 1999

Ethical Implications of Nanotechnology

- The best way to reassert the truth-oriented professional norms of science would be to rebuild good channels of communication and cooperation, reattaching the researchers to each other and to the scientific community.

Ethical Implications of Nanotechnology

- Ethical questions related to nanotechnology are not limited to the ways people might use it to harm others intentionally, but also include obligations to avoid potentially harmful unintended consequences.
  - Tenner E.: Nanotechnology and unintended consequences. In: Societal Implications of Nanoscience and Nanotechnology, ed. by Roco M.C. and Bainbridge W.S., Kluwer Dordrecht, p. 311–318, 2001.

Ethical Implications of Nanotechnology

- Lewenstein attempts to answer what counts as an ethical issue in nanotechnology. He concludes that the attempts to define ethical issues narrowly is itself an exercise of power that can prevent us from understanding how central ethical issues are to the development of scientific knowledge and its implementation through technology in the modern world.
- Lewenstein B.V.: What counts as a ‘social and ethical Issue’ in nanotechnology?, HYLE-International Journal for Philosophy of Chemistry 11(1), Special issue on "Nanotech Challenges", Part II, p. 5-18, 2005.

Some links

Discussion and literature on ethics in nanotechnology:

http://www.ethicsweb.ca/nanotechnology/

http://www.foresight.org/

“The Center for Responsible Nanotechnology”:

http://crnano.org/

Possible Ethical Guidelines for Nanotechnology 1/6

- Nanotechnology's highest and best use should be to create a world of abundance where **no one is lacking for their basic needs**. Those needs include adequate **food**, safe **water**, a clean **environment**, **housing**, **medical care**, **education**, public **safety**, fair **labour**, **unrestricted travel, artistic expression and freedom from fear and oppression**.

Possible Ethical Guidelines for Nanotechnology 2/6

- High priority must be given to the **efficient and economical global distribution of the products and services created by nanotechnology**.
- We recognize the need for reasonable return on investment, but we must also recognize that our planet is small and we all depend upon each other for safety, stability, even survival.

Possible Ethical Guidelines for Nanotechnology 3/6

- **Scientists** developing and experimenting with nanotechnology must have a solid **grounding in ecology and public safety**, or have someone on their team who does.
- Scientists and their organizations must also **be held accountable for** the willful, fraudulent or irresponsible **misuse** of the science.

Possible Ethical Guidelines for Nanotechnology 4/6

- All published **research and discussion** of nanotechnology should be **accurate** as possible, adhere to the scientific method, and give due credit to sources.
- **Labelling** of products should be **clear and accurate**, and promotion of services, including consulting, should disclose any conflicts of interest.

Possible Ethical Guidelines for Nanotechnology 5/6

- Published debates over nanotechnology, including chat room discussions, should focus on advancing the **merits** of the arguments **rather than personal attacks**, such as questioning the motives of opponents.
- Business models in the field should incorporate long-term, **sustainable** practices, such as the efficient use of resources, recycling of toxic materials, adequate compensation for workers and other fair labour practices.

Possible Ethical Guidelines for Nanotechnology 6/6

- Industry leaders should be collaborative and self-regulating, but also support public education in the sciences and reasonable legislation to deal with legal and social issues associated with nanotechnology.

Conclusions and Outlook 1/2

- Currently there is a lack of capacity with regard to aspects of risk and health-related, environmental and societal implications of nanotechnology.
- In accordance with the **Institute of Technology Assessment of the Austrian Academy of Sciences** we propose to earmark a certain part (min. 5%) of the special funding for nanotechnology for risk research and accompanying measures.
  - Institut für Technikfolgenabschätzung der Österr. Akademie der Wissenschaften, Nanotechnologie-Begleitmassnahmen: Stand und Implikationen für Österreich, 2006. http://epub.oeaw.ac.at/0xc1aa500d_0x0013e2a8

Conclusions and Outlook 2/2

- Ultimately, the **test of** the various **nanotechnologies** will be their **benefit** for human beings, as measured by economic growth, improved health and longevity, environmental protection, social vitality, and enhanced human capabilities.