Nanotech: Early Lessons from Early Warnings

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Late lessons from early warnings for nanotechnology

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A new technology will only be successful if those promoting it can show that it is safe, but history is littered with examples of promising technologies that never fulfilled their true potential and/or caused untold damage because early warnings about safety problems were ignored. The nanotechnology community stands to benefit by learning lessons from this history.

Nanotechnology is the latest in a long series of technologies that have been heralded as solving its own or even the next industrial revolution. Since 2001, nanotechnology has grown from little more than a glimpse in the eyes of researchers to a technology projected to be worth $107 trillion in manufactured goods in 2014. So in a new nanotechnology move from the lab to the marketplace, have we learned the lessons of past technologies, or are we destined to repeat the mistakes made with previous technologies? In 2001, an expert panel commissioned by the European Environment Agency (EEA) published a report, late lessons from early warnings: The precautionary principle, how it works, why it matters, which explored how common beliefs, among which demonstrates basic reasoning early warnings to protect human health and the environment.

However, much has changed as adhesives, chlorofluorocarbons, sun blocking radiation and toxic control, the EEA report examined the failure between the emergence of scientific evidence of harm and action being taken to reduce risks. The expert group identified a "late lesson" for this issue how avoided past mistakes as new technologies are developed. These lessons bear an important reminder to many of the concerns now being raised about new forms of nanotechnology.

A comparison between the EEA recommendations and where we are with nanotechnology shows we are doing some things right, but we are still in danger of repeating old, and potentially costly, mistakes. This commentary explores these 3 lessons in the context of nanotechnology.

**CONCLUSION — LEARNING FROM LATE LESSONS**

According to the EEA report, "no matter how sophisticated knowledge is, it will always be subject to some degree of ignorance (i.e., inevitable surprises, or unexpected events). To be able to — and humble about — the potential gaps to these technical knowledge but are included in our decision making is fundamental."

"We are still in danger of repeating old, and potentially costly, mistakes.

By examining these primary examples and reflecting on the challenges associated with nanotechnology, we can learn from the lessons of the past. The EEA report emphasizes the importance of early warnings, the precautionary principle, and the need for interdisciplinary collaboration to ensure that new technologies are developed safely and sustainably.

In conclusion, the EEA report highlights the importance of learning from past mistakes to avoid repeating costly errors in the development and implementation of nanotechnology. By recognizing the potential gaps and uncertainties in our knowledge, we can make more informed decisions and take proactive measures to protect human health and the environment.

21 Nanotechnology — early lessons from early warnings

Stineen Iversen, Andrei Maynard, Andrey Ivanov, (re) A. Thirion and Elena M. Bermejo

Nanotechnology is the latest in a long series of technological revolutions ushering in a new era of technology-driven prosperity. Current and future applications of nanotechnology are expected to lead to further revolutions in technology, industry, and society. This report is the first global assessment of nanotechnology's environmental impacts. The report assesses the potential environmental impacts of nanotechnology, identifies emerging issues and sets the scene for future research and development.

Nanotechnology is defined as the manipulation of matter at a scale of 1-100 nanometers, using physical, chemical, biological, or materials engineering techniques. The field of nanotechnology is thus broad and covers a multitude of materials, technologies, scientific and commercial applications and products. It is a diverse and interdisciplinary field that involves the manipulation and manufacturing of matter at the nanoscale.

21.1 What is nanotechnology and what are nanomaterials?

Nanotechnology is often described as having roots in a wide range of scientific and technical fields, including physics, chemistry, biology, materials science, and engineering. The field of nanotechnology is thus broad and covers a multitude of materials, technologies, scientific and commercial applications and products. It is a diverse and interdisciplinary field that involves the manipulation and manufacturing of matter at the nanoscale.

Nanotechnology is the understanding and control of matter at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications. Nanomaterials are typically small, engineered materials that can be used to improve the performance of products, such as electronics, medical devices, and construction materials.

Nanomaterials can be divided into two main categories: inorganic and organic. Inorganic nanomaterials are made up of materials such as metals, semiconductors, and ceramics. Organic nanomaterials are made up of materials such as polymers and biopolymers. The properties of nanomaterials can be tailored to specific applications, making them useful in a wide range of industries.

Nanotechnology promises to revolutionize many industries, including medicine, electronics, and transportation. However, the potential risks associated with nanotechnology must be carefully considered to ensure that the benefits are realized without compromising human health and the environment.
Chapter content

- What is NT & NM
- Current, future develop.
- Signs of early warnings
- (Lack of) nano-specific regulation
- Late lessons for nanotech
- So have we learned the LL1?
- Precautionary strategies for NT
Early Warnings Triggered!!!

Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study

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Nanomaterials in the Environment

EFFECTS OF PARTICLE COMPOSITION AND SPECIES ON TOXICITY OF METALLIC NANOMATERIALS IN AQUATIC ORGANISMS

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So How Are We Applying the 12 LL?

Box 1: The 12 lessons outlined by the EEA²

1. Acknowledge and respond to ignorance, uncertainty and risk in technology appraisal.
2. Provide long-term environmental and health monitoring and research into early warnings.
3. Identify and work to reduce scientific ‘blind spots’ and knowledge gaps.
4. Identify and reduce interdisciplinary obstacles to learning.
5. Account for real-world conditions in regulatory appraisal.
7. Evaluate alternative options for meeting needs, and promote robust, diverse and adaptable technologies.
8. Ensure use of ‘lay’ knowledge, as well as specialist expertise.
9. Account fully for the assumptions and values of different social groups.
10. Maintain regulatory independence of interested parties while retaining an inclusive approach to information and opinion gathering.
11. Identify and reduce institutional obstacles to learning and action.
12. Avoid ‘paralysis by analysis’ by acting to reduce potential harm when there are reasonable grounds for concern.
So Have We Learned the Lessons?

- Seems that we have, but that we are not applying them effectively
- Good start, now seems that we have become distracted
  - Nanotechnology is being overseen by the very government organisations that promote it;
  - Research strategies are not leading to clear answers to critical questions;
  - Collaboration continues to be hampered by disciplinary and institutional barriers; and
  - Stakeholders are not being fully engaged, or not being engaged early enough.
- Lots of bureaucratic inertia, claims that “risk research jeopardises innovation and “regulation is bad for business”
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+ mentioned in passing; ++ substantially discussed and/or analysed; +++ strategy suggested/implemented 
Thank U

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