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# SCIENCE, ETHICS AND NEW EMERGING TECHNOLOGIES

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**Abstract:** In this paper, we will examine the relationship between science, ethics, and emerging technologies, with a particular focus on nanoscience and nanotechnology. Our goal is to demonstrate that all sciences, including these most recent ones, originate from philosophy, which has always strived to maintain an integral, holistic approach to reality. In contrast to philosophy, individual sciences gradually lose interest in philosophical views of a higher level of generality and a holistic approach to reality. As a result, sciences often neglect ethics and value judgments that assess the consequences of their activities and outcomes. Nanotechnology, along with other convergent technologies such as biotechnology, information technology, artificial intelligence, and neurotechnology, differs from other technologies in its ability to operate at the atomic and molecular levels. This enables its impact on the natural environment and the human organism to often remain beyond public awareness. Such a situation raises legitimate concerns and calls for addressing the issue of responsibility for the development of these technologies. Strict and organized action by the broadest possible public is needed to ensure the responsible development and application of nanotechnology. In this paper, we will consider potential coalitions for overseeing these technologies, as well as some key questions that must be answered before these technologies "slip" beyond our control. In this context, special attention will be given to promoting a multidisciplinary approach and involving various stakeholders from the fields of science, philosophy, ethics, and representatives of civil society in the decision-making processes related to the development and regulation of nanotechnology.
*Keywords:* philosophy, society, ethical capacity, responsibility, nanotechnology,, coalition, collaboration, multidisciplinary.

## Introduction: The Evolution of Sciences from Philosophy: A Historical Perspective

All contemporary natural and social sciences have emerged from philosophy, which represents humanity's first attempt to rationalize and understand the reality that surrounds it. Philosophy arose from a sense of "wonder" at the magnificence, perfection, and even inscrutability of the world, the universe, and particularly life in all its diversity and richness. Philosophy seeks to provide a comprehensive picture of the world, its perspective, value, and the meaning of human existence within it. There is a saying that "philosophy knows a little about many things," while "science knows a lot about a few things." In the initial stages of humanity's reflective efforts to understand the world, philosophy was the "science" that dealt with all aspects of knowledge about reality. However, from the Renaissance period (15th century onward), specific sciences gradually emerged from philosophy, focusing on smaller parts of reality in order to achieve a deeper understanding of as many aspects of that reality as possible.

The relationship between science and philosophy in modern times was most vividly described over a century ago by the renowned German philosopher Friedrich Nietzsche, who stated:

“Today, science is flourishing and its face clearly reflects a tranquil conscience, while what the entirety of modern philosophy has gradually sunk into—a remnant of today’s philosophy—elicits distrust and ill will, if not mockery and pity...”

For a discipline to be distinguished from philosophy and established as a separate science, it is essential to have a defined subject of study, a categorical-conceptual apparatus employed, and a method of investigation suited to that defined subject. Thus, science becomes an activity through which humans acquire knowledge about the world around them. It is a method of approaching the empirical world accessible to human experience, founded on principles of objectivity, reliability, precision, verifiability, systematicity, and so forth. However, despite this distinction, every scientist, whether engaged in the natural, technical-technological, or social sciences, is consciously or unconsciously also a philosopher. In the course of their work and study, they inevitably grapple with ontological, epistemological, ethical, and even aesthetic questions, which are fundamentally philosophical disciplines.

## Why ethic is important for the further development of nanoscale science

Ethics is, in the simplest terms, a philosophical discipline that systematically examines human values and the distinction between good and evil. It seeks to resolve questions of human morality by defining concepts such as good and evil, right and wrong, virtue and vice. While science deals with factual judgments, ethics employs value judgments that incorporate not only attempts at rational, objective assessment of situational facts but also the subjective, personal perspective of the one making these judgments.

Morality is a historical category and its content changes from one epoch to another. Each era strives to "re-evaluate" established values and moral norms in accordance with the reality it constructs, and history has shown that it generally succeeds in doing so. Thus, we can distinguish between ancient morality, Christian morality, bourgeois morality, communist morality, and so on.

Emerging technologies, such as biotechnologies, nanotechnologies, and complementary technologies, bring with them new moral dilemmas. As a result, many authors argue for the legitimacy of entirely new and independent fields of ethics, such as bioethics and nanoethics.

Unlike other emerging technologies that have also reached a high level of development, nanotechnologies are particularly unique due to their ability to precisely characterize, design, and control matter at the atomic, molecular, and supramolecular levels (on a scale of approximately 1–100 nm). They have already found extensive applications across various fields, including industry, agriculture, and medicine. Given that fundamental processes in the human body occur on the nanoscale, this discussion gains even greater significance not only for the scientific community but also for the general public.

## The Socio-Historical Context of Technological Development – Science, Technology, and Morality

To engage in rational, argumentative, and meaningful discussions about the impact of new technologies on society today and the changes they bring, it is necessary to establish the broadest socio-historical context of human development. It is crucial to define a universal ontological framework through which human society, and consequently science, has existed and developed from its inception to the present day.

According to this ontological framework, humans, through labor—an active, productive, creative, sensory-material, conscious, and purposeful activity—use their natural organs, and later tools and technology as extensions of these organs, to transform nature, their locus standi, and adapt it to their needs, thereby creating their own history.

This seemingly simple and self-evident relationship between humans, labor, technology, nature, and history provides a foundational basis for any further analysis of the impact of technological development on society, including the influence of nanotechnologies on the reality we live in today and the perspectives of social development in the immediate and distant future.

Since the 17th century, modern science has sought to portray itself at all costs as an autonomous and (self-)sufficient means of representing the world. It has established a new concept of reality based on a strong bond between logic and experimentation. When scientific truth became equated with technical effectiveness, the rationalization and scientification of human culture reached its peak.

Technology is a fully social phenomenon. It arises from society, which enables and encourages it. It shapes us as much as we shape it. Technology influences every aspect of our lives—the places we live, the ways we communicate, how we perform our jobs, our forms of recreation, our institutional arrangements, and how we organize our time and lives (Ronald (Sandler 2009). When science and technology, united in this way, are put in the service of the economy and business, the meaning of human existence acquires a purely materialistic concept.

## Science, Technology, and Ideology

The rapid development of nanoscale technologies brings new moral dilemmas and controversies. These arise from genuine concerns about their potential impact on the environment, human health, the human genome (and thus human nature), human rights, freedoms, democracy, societal surveillance and control, and the concentration of social, political, and economic power. Such power structures are increasingly controlled by those who oversee the development, commercialization, and application of these technologies globally.

Humankind has found in technology a substitute for its own strength, but humans remain irreplaceable in determining the purposes of this multiplied power.

Today, as nanotechnologies and their complementary technologies can influence human lives and even the entirety of human civilization in much more subtle and pervasive ways, the level of concern and attention must be higher than ever before (e.g., risks of bioterrorism, technoterrorism, or even nanoterrorism).

According to Klaus Schwab, the Fourth Industrial Revolution is characterized by a range of new technologies that merge the physical, digital, and biological worlds, affecting all disciplines, economies, and industries, while challenging fundamental ideas about what it means to be human (Schwab, 2016).

Every new technology offers an opportunity to engage stakeholders in social and ethical debates to achieve the broadest possible societal consensus regarding its application. The nanotechnological revolution is still in its early stages, providing a window for open public discourse on both its intended and unintended consequences. It is imperative to establish the widest coalition of stakeholders and achieve the greatest possible public consensus on critical issues related to the development, commercialization, and application of nanotechnologies.

To initiate this process, the following questions may be considered:

- Who comprises the coalition of key stakeholders in this debate?
- How can they be connected and motivated to participate in the discussion?
- How can public attention on the importance of these issues be maintained?

This groundwork aims to find answers and consensus on fundamental questions, such as:

- What are the boundaries of nanotechnology development?
- How far is it permissible and wise to go?
- What are the later-stage implications (currently unknown) of these technologies?

Moreover, as new questions arise over time, answers will need to be sought, ensuring these revolutionary technologies serve humanity responsibly and ethically (Ferreira and Filipe, 2022).

## The Role of Ethics in the Responsible Development of Nanotechnologies

Ethical reflection can clarify what constitutes a fair development process and how nanotechnologies can promote human flourishing and prosperity while ensuring the sustainability of their progress (e.g., extending lifespan, enhancing cognitive abilities, food production). The goal-means dilemma is ever-present—some means are not ethically acceptable, even if the goals they serve are worthwhile. Ethical analysis helps identify boundaries regarding how goals should be pursued (e.g., the use of stem cells and chimeras in medical research, synthetic biology). There is a saying: “The worst things are done with the best intentions.” A laudable goal does not always guarantee ethically acceptable practices (Sandler, 2009).

Ethical and socio-scientific research not only identifies opportunities for nanotechnology to achieve its aims but also predicts non-technical barriers to realizing these goals (e.g., religious beliefs and prejudices, experiences with prior technological innovations, resistance to change, and the political and strategic interests of specific states, organizations, and groups).

The ethical capacity of society is critical for the responsible development of nanotechnologies. This encompasses tools and resources that assist governments, individuals, and organizations in making decisions based on ethical considerations. These include:

- An informed public opinion
- A developed non-governmental sector and civil society
- Professional associations and adopted codes of conduct
- Case studies based on prior experiences and historical precedents

Ethical observations also aim to overcome misconceptions and prejudices related to the development and application of nanotechnologies. The first misconception suggests that there is nothing socially or ethically problematic in the practice of nanoscale science and engineering (Sandler, 2009). Arguments here often highlight that nanotechnology has not yet "taken off" on a large scale, with relatively few products containing nanoscale particles, processes, or devices that are not yet commercially effective.

The second misconception is rooted in the familiar phrase: “Science creates, industry applies, and society adapts.” (Sandler, 2009). This techno-optimism assumes that technological innovations are unstoppable, driven by their internal logic, and inherently welcome and positive. Thus, raising social and ethical questions about nanotechnological innovations is seen as futile, if not harmful, as it could slow the exponential development of nanotechnology, which is deemed inevitable.

Most earlier technological innovations (from the Industrial Revolution to the present) have proven unsustainable. These innovations facilitated production systems and consumption patterns that treated Earth's natural capital merely as a resource, negatively impacting living systems, biodiversity, and their regenerative capacities (e.g., pollution, toxicity, climate change, food insecurity, and species extinction) (Sandler, 2009). While some argue that further technological advances, particularly in nano- and biotechnologies, might rectify these issues, such beliefs are currently rooted more in faith than in evidence-based knowledge.

Moreover, these technological changes have not been accompanied by significant shifts in value systems, consumption habits, or economic models. Specifically, the capitalist economy—focused on maximizing utility rather than optimizing the balance between natural, technical, and human resources—remains dominant. As a result, there is no inherent guarantee that nanotechnologies and their applications will inevitably lead to societal flourishing or a more sustainable relationship with natural resources.

Historically, our perception of nature has become increasingly mediated by technology, leading to the marginalization of natural values. Risk assessments for new technologies often rely on quantitative methods (which are sometimes questionable) instead of inclusive approaches that involve a broader range of stakeholders. Furthermore, the precautionary principle is frequently overlooked in favor of an unwarranted belief that technology will resolve all adverse side effects of technological innovations. This overconfidence also reflects an overestimation of our ability to predict and control technologies, especially in complex and dynamic biological systems.

Additionally, the practice has shown that developed nations often externalize the negative consequences of new technologies onto less developed countries and regions to capitalize on the benefits for themselves. A current example is the exploitation of lithium resources to revitalize the struggling automotive industries of Western European manufacturers, particularly Germany's. Given the global socio-economic context, nanotechnology and nanoengineering are likely to perpetuate or even deepen environmental injustice.Thus, the responsible development of nanotechnology is incomplete without addressing ecological justice.

**Example: Prejudices Around Artificial Intelligence (AI)**

There is a pervasive belief that the latest technologies are "clean technologies," implying they do not rely on the exploitation of natural resources or human labor. However, this belief is misleading, as AI systems are inherently materialistic, built from natural resources, energy, human effort, infrastructure, and logistics. The term "artificial intelligence" may evoke images of algorithms, data, and cloud architectures, but these technologies cannot function without the minerals and resources that make up their essential components, such as rare earth elements like cobalt, lithium, and neodymium (Krawford, 2021).

AI's massive ecosystem depends on various forms of extraction, from data collection sourced from our everyday activities without consent, to the depletion of natural resources and the exploitation of labor globally to maintain and develop this extensive planetary network (Krawford, 2021). These practices give rise to numerous ethical and ecological issues not immediately apparent to average users.

For example, Amazon's Mechanical Turk platform originated from an unsuccessful attempt to automate retail tasks effectively. As a corrective measure, an army of workers—mainly from developing countries—are employed to carry out micro-tasks to enhance AI systems. These workers compete for tasks at meager wages, often receiving only gift vouchers that are redeemable exclusively through Amazon. Jeff Bezos has openly described this system as "artificial artificial intelligence (Krawford, 2021)."

## Nanotechnology - Between Hype and Reality

New technologies, including nanotechnology, have undeniably become a topic of discussion not only in scientific and professional circles but also in the media and public debates concerning their potential impacts on nature and humanity. Several reasons contribute to the proliferation of hype surrounding nanotechnology.

First, the general public often lacks understanding of the current state of nanotechnology development, existing applications, real benefits, and potential risks. This gap in knowledge can be exploited by those who exaggerate or even construct negative and catastrophic forecasts regarding their future implications (so call "conspiracy theorists"). On the other hand, there are groups that uncritically or even deliberately emphasize the positive aspects of nanotechnology, ranging from techno-optimists and transhumanists to research institutions seeking financial support for various projects, and corporate interests aiming for profit maximization.

Moreover, strictly speaking there is no such thing as 'nanotechnology', so to be in favour of or against it as a whole makes little sense (José Manuel de Cózar-Escalante, 2021). Nanotechnology, along with other converging disruptive technologies, undoubtedly represents both our future and present. It has found applications in areas such as materials science, medicine, pharmacology, and electronics. However, there are still many technical limitations, particularly in the realm of nanotechnology engineering. Concepts like nanobots remain within the realm of science fiction, with limited near-term prospects.

Promising applications of nanotechnology include water purification technologies, medical advancements, and new materials that could provide basic goods to a significant portion of the world's population currently deprived of them. However, the history of previous technologies that were expected to fulfill similar roles, only to be co-opted by the interests of the wealthy and powerful, raises concerns about the equitable distribution of these advancements. Without a strong social movement mobilizing critical stakeholders, the decisions surrounding the development and application of nanotechnology are likely to favor those with economic and political power.

## The Question of "Coalition"

Ethics can provide standards for evaluating the impact of nanotechnologies. Since nanoscale science and technology encompass various fields and applications, such as energy, agriculture, computing, medicine, weapons, materials, and the environment, ethical assessments must be context-specific (Sandler, 2009). These evaluations depend on individual cases and should focus on specific research, technologies, and their applications. Only through such evaluations can more informed decisions be made, minimizing negative public reactions that may hinder the development or commercialization of socially desirable nanotechnologies. This includes government policy adoption, allocation of public resources, legislation, regulations, and oversight of corporate policies, research, commercialization, and applications of nanotechnologies across various sectors like pharmaceuticals, agriculture, and healthcare.

While most nanotechnology research occurs within academic settings, such as universities and institutes, the commercialization of ideas is often driven by corporate interests. In these cases, researchers have limited influence over how the results of their work are applied. Although researchers engage in revolutionary scientific advancements, their initial intentions may be detached from how their work is later used in practical applications. Consequently, it is unreasonable to expect individual researchers to bear the entire responsibility or to manage the technological pathways that result from their work (Spruit and Hoople, 2015).

Thus, while the ad-hoc nature of scientific research, particularly in the context of nanoscience and nanotechnology, creates challenges, it does not absolve scientists and engineers of ethical responsibility. (Spruit and Hoople, 2015)

They must share this responsibility with others involved in the research and development process, forming coalitions of stakeholders who can collectively oversee and guide nanotechnology development for the betterment of society as a whole.

Regarding "specialized" NGOs and other civil society organizations that see themselves as representatives of specific social groups, they can play a role as partners in dialogues concerning the development of new technologies. Traditional participatory forms of political representation should simultaneously be complemented by other types of networking, such as community-based research[1] and science shops[2], 'creative appropriation' of scientific findings and innovations, different kinds of activism, etc. (José Manuel de Cózar-Escalante, 2021).

However, their role should not be limited to merely identifying those who may be affected by nanotechnology applications without immediate visibility, such as patients, consumers of food products, farmers, etc. There should be more comprehensive involvement.

Higher educational institutions, colleges, and universities should integrate interdisciplinary courses into their curricula that place specialized knowledge in a broader societal and ethical context (e.g., Sociology of Technology, Philosophy of Technology, Ethics and Science, Digital Ethics, Nano-bioethics, etc.). Research institutions and specialized scientific bodies, which possess unique expertise and in-depth insights into possible applications of their work, must include sessions dedicated to social and ethical considerations in their projects. These sessions should result in project documentation that includes thorough discussions of social and ethical implications.

Collaboration with academic communities, including social science and philosophy faculties and institutes, and organizing public conferences and open debates, are essential for fostering an inclusive dialogue. Additionally, considering the institutionalization of employing social science scholars in technical institutions could facilitate a more ethical and socially responsible approach to technological

[1] Community-based research is defined as an approach to public health research that emphasizes active participation of community members, collaborative partnerships, and the integration of knowledge and action to address shared needs and health determinants.

[2] Science shop: "a unit that provides independent, participatory research support in response to civil society's concerns about scientific or other technological innovations and their social applications."

development, ensuring that technical advancements contribute positively to the community.

To expand the coalition and strengthen the ethical capacities of society for controlling the development of nanotechnology, the following initiatives should also be considered:

- Creating more science-shops and strengthening community-based research in general.
- Combining conventional, formal, representative procedures with existing participatory methods, while also including activism and social movements. However, the integration of these various elements should not be forced into a supposedly all-purpose problem-solving method
- Creating hybrid forums, an organisational methodology designed to manage scientific and technological controversies in which diverse (human) actors participate (José Manuel de Cózar-Escalante. 2021).

Therefore, we can conclude that there is no predefined coalition or public that can be engaged in all cases and situations. Instead, the public must be sought anew, depending on the specific issue at hand.

Additionally, the question of a critical public or coalition is not merely a technical issue of organization and interaction, but touches on fundamental questions related to how our societies function.

## Conclusion

**New emerging technologies and the Future of Human Society:** Technologies have always influenced social forms, structures, standards, production practices, institutions, and lifestyles. Karl Marx noted that capitalism and the Industrial Revolution transformed people's lives from the rhythm of the seasons (associated with agricultural societies tied to farming and seasonal changes) to the rhythm dictated by machines and factory work organization. New emerging technologies, including nanotechnologies, are likely to reshape this situation, establishing new rhythms of human life.

Technological and social transitions once occurred more slowly, allowing societies more time to adapt. Today, multiple technological transitions can occur within a single human lifespan. Information technologies have redefined social interaction, production organization, education, lifestyles, and even philosophical systems of values over just a few decades.

Nano and biotechnologies, along with convergent technologies, have the potential to deeply transform society and human lives. For example, advancements in nanomedicine could redefine human progress, enhancing longevity and expectations regarding health. This extends to environmental protection and sustainability, with new material sciences creating synthetic alternatives to previously exploited natural resources.

In synergy with other convergent technologies, nanotechnologies may influence the concept of human nature, psychological identity, and even metaphysical questions about life's meaning. This raises new ethical landscapes that require reevaluation and redefinition. The boundaries of nanotechnology are still largely unknown, but they introduce paradoxical possibilities in science and ethics, particularly in areas such as neurotechnology, which could alter moral capacities (Bensaude and Vincent, 2010) and transform humans into utilitarian biomachines.

Alongside the development of nanoscience and its transformative potential, transhumanism has emerged as a new ideology, often starting from unsubstantiated premises and lacking clear criteria for evaluating its impact on humans and society. Given the growing public scrutiny of technological advancements and diminishing trust in science's self-regulation, establishing a new social contract between science and society is becoming increasingly necessary. Nano-bio-neuro technologies require an interdisciplinary approach and a coalition including anthropologists, sociologists, philosophers, and ethicists, always guided by the principle of precaution (Ferreira and Filipe, 2022).

**Conflict of interests**

The authors declare no conflict of interest

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