act as a destabilizing force, rather than a stabilizing one. Nuclear weapons, while extremely powerful and providing military superiority, acted as a stabilizing force due to various factors, including the probability of complete human annihilation of an all-out nuclear conflict; long-term high costs of use, such as radioactive contamination; indiscriminate destruction; and massive research and development programs which are expensive and difficult to conceal. While nanoweapons also can result in the destruction of the human race, nanoweapons have no long-term costs for use, can implement targeted destruction and can be developed—once the technology is available—far more quickly, cheaply, and covertly than nuclear capabilities. As such, countries may be quicker to use nanoweapons since they do not suffer from the same negative aspects of nuclear technology.

The second danger—given the size of nanoweapons—would be if they were to fall into the hands of rogue nations or terrorist groups. Once nanoweapons exist, they can be reverse engineered much easier than nuclear technology. Detection would be very difficult, and the ability to carry out a large-scale attack with limited participants would be possible. The cost of defending against such attacks would become prohibitive, requiring massive shifts in social interactions.

Socioeconomic Aspects
As with any expensive cutting-edge technology, developed nations have an edge over developing nations, in regards to having resources available for advancing nanotechnology. This will naturally give them an edge in succeeding in the development of nanotechnological advances, which in turn may result in unacceptable disparities between nations. This raises various risks of increases in the gap between rich nations and poor nations. Within a particular nation, adoption of nanotechnology can be expected to make some jobs obsolete. New jobs in nanotech will favor those with higher standards of education, and perhaps a younger population as well.

Early nanotechnology research can negatively impact a nation as a result of poor decisions based on hype and bad information. While these impacts would affect all nations undertaking research, developing nations will have more difficulty dealing with these impacts due to more limited resources at the outset. Another societal risk is that new technologies will inevitably replace old technologies and their component resources. Developing nations supply these component resources will lose valuable markets of trade. Even if nanotechnologies incorporate these component resources, it is likely that the value added via nanotechnology will result in higher end-user costs, making acquisition of goods more expensive to developing nations.

All new technologies result in various social risks. In the past, these risks were addressed after the technology was released and society was required to react to correct unacceptable risks. With the attention focused on nanotechnology and the inherent risks, these social risks are being discussed among various parties during the evolution of nanotechnology, rather than afterward. It is hoped that by raising social risks early in the development process, harm will be mitigated.

See Also: Nanomaterials in Commerce; Nanoweapons, Ethical Issues of; Precautionary Principle; Public Values; Risk Assessment; Risk Management.

Further Readings
http://www.springerlink.com/content/w3j81857t3727761 (cited July 2009).


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Social Science

*Social science* is an umbrella term for a broad variety of disciplines concerned with “the social” and all the particular aspects relating to it—in short, human societies, institutions, and activities as they have developed throughout history and around the globe. Rather than a singular social science, it is more accurate to speak of the social sciences comprising a plurality of diverse and often competing—or even incommensurable—concerns, theories, research methods, and bodies of empirical data or knowledge. Compared to the natural sciences and the humanities (i.e., the classical liberal arts and sciences), most social sciences do not date back as far in history.
They have mostly been formed and expanded with the formation of the modern nation state and the far-reaching effects of the industrial revolution.

While engineering is obviously dedicated to advancing social purposes (e.g., by creating inventions or reshaping the built environment), science has long been considered an activity concerned with something purely nonsocial (i.e., objective and natural). Studies in the history, philosophy, and sociology of science have challenged this assumption, arguing, for example, that scientific paradigms are influenced by their sociohistorical context and that scientific investigations are inseparably bound to the scientist’s perspective. In addition, the conditions under which science is practiced and the forms in which science takes part in generating outcomes are evidently social. These conditions and forms, together with scientific practices themselves, have been subject to social science inquiry.

Each social science discipline has embodied a characteristic interest in science and technology (S&T). For example, anthropology examines the role of S&T in different societies or cultures; economics is interested in how S&T contribute to economic innovation across sectors; political science investigates the role of the state in funding or regulating S&T; and sociology analyzes the societal configuration of institutions and organizations concerning S&T, among other things.

The interdisciplinary field of science, technology, and society studies (STS) shares a constitutive perspective on the interrelation between S&T and society—be it articulated as the “coproduction of science and society,” the “mutual shaping of technology and society,” or the “interdependency of social and technological change.” Thus, rather than being viewed as given entities, S&T are analyzed with regard to how they are constituted by, while also constituting, society (or its respective units, e.g., organizations).

Most social science research, including STS, has typically been conducted in settings removed from those in which the natural and engineering sciences are practiced, which is essentially true for participant observation or ethnographic laboratory studies as well because their pursuit is based on the methodological ideal of upholding an analytical distance that remains untainted by the deep research engagement with the subject of study. However, recent developments in genomics and particularly in nanoscale S&T have brought about remarkable change to this constellation.

In light of the intense controversy about the potential future impacts of genome analysis in the early 1990s, major research funding agencies decided that a substantial part of the funding for research and development (R&D) should be allocated to investigate important ethical, legal, and social issues (ELSI). Despite the proliferation of such studies, there has been criticism that they have not become embedded in the R&D process and thus have not gained influence on the course of genomics.

For this reason, with the advent of nanoscale S&T high-powered S&T policy initiatives in several countries have attempted to strengthen the role of social science research in the R&D process to pursue three major goals: to increase the anticipatory knowledge about potential social consequences; to help orient the work of scientists and engineers toward socially desirable goals; and to enable better communication to the public of issues concerning nanoscale S&T in society. The creation of such new arenas of problem-oriented, integrated, and forward-looking social science research has brought about valuable opportunities for social scientists to work in close relation to the enterprise of emerging S&T—yet also challenges to uphold their reflexive distance.

Some countries have reacted faster than others in using the knowledge gained from the social sciences, educating nonscientists about nanotechnology, and giving them a role in the decision-making process—an effort that has improved public approval of nanotechnology while informing scientists about the need to consider the social consequences of their research. In the United Kingdom (UK), the effort to democratize the decision-making process in science dates back at least to the 1980s and the work of the Lancaster group.

In the United States, this process developed later. For example, in 2005 in Madison, Wisconsin, the idea of the “consensus conference” (pioneered in Denmark in the 1980s) was used to develop the first consensus conference on nanotechnology. This conference allowed members of the community to read and discuss articles on nanotechnology, to hear testimony from scientific experts, and to make a list of recommendations for policy makers and the general public. Participants reported that the process was beneficial and that they learned not only about nanotechnology but also about the scientists’ perspective, but some expressed doubt that their recommendations would have any practical consequences. This remains a problem with all attempts at democratizing decision making regarding science and technology. While many
scientists and public officials are interested in informing people about scientific research, fewer are willing to grant the general public any real decision-making power, particularly if that power might be expressed by banning or placing serious restrictions on nanotech research.

See Also: Acceptance Politics; Anticipatory Governance; Public Engagement; Reflexive Governance; Social Risk; Transparency.

Further Readings
Wilson, James, and Rebecca Willis. “See-Through Science: Why Public Engagement Needs to Move Upstream.”

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Societal Implications of Nanotechnology

For many centuries, the pursuit of truth about the natural world has been the focus of modern science. Through scientific exploration, important pieces to this puzzle are slowly being revealed, such as the role of atoms and molecules in the basic formation of life. This and other scientific breakthroughs are considered the apogee of human achievement. However, scientific achievement is not without risk; a viewpoint that is increasingly being shared in the international dialogue on the short-term and long-term societal implications associated with the rapid evolution of nanotechnologies.

The global proliferation of nanotechnology offers much promise but at the same time raises concern for human health and occupational safety. There are also many questions about the role of nanotechnology in the enhancement of human life, particularly, the strains that will be placed on healthcare and socioeconomic systems if life can be prolonged. Finally, whether or not the public understands the impact that nanotechnology will have on society is also of concern, particularly the unintended social consequences. However, we should not be disillusioned about nanotechnology’s impact on society. While there are many unknowns, there is also much promise, in that nanotechnology can potentially impact the lives of underprivileged communities around the world, particularly in the agricultural sector.

Environment, Health, and Occupational Safety

Nanotechnology is allowing for radically different options in the treatment of chronic and infectious diseases. Already receiving much attention is the ability to deliver nanoencapsulated drugs to target areas in the body; eliminating many side effects associated with conventional pharmaceutical treatments. In addition to drug delivery, there is significant development in the monitoring, repairing, construction, and control of human biological systems at the cellular level by using materials and structures engineered at the molecular level. At this level, properties of nanoparticles, such as size and shape, as well as properties such as surface area, charge and reactivity have tremendous influence over biological activity.

Nanotechnology is also redefining clinical medicine through point-of-care testing (POCT), which uses nanoenabled devices and nanosystems for the development of portable test kits that can provide rapid results on site. While the use of POCT has been described as effortless, the reality of this technology is that it will allow primary care physicians to diagnose chronic, and in some cases communicable diseases, in a medical setting as well as in remote locations.

The expectation is that nanotechnology will reduce the cost of medical care. However, there is also the potential for third parties such as insurance companies and employers to access healthcare information systems. A heightened awareness of one’s health status could increase an individual’s level of fear and anxiety.

Worker safety is also of equal concern. As nanomaterials become more available and are used in consumer products such as cosmetics, there is still much that remains unknown about the health impact on those who work with these materials. Knowledge on the environmental, human health, and safety (EHS) impacts of engineered nanomaterials is still unknown, and as new engineered particles are fabricated, new properties are continuously discovered. Of central concern are issues