Nanoethics and Technological Revolutions: a Précis

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Some eleven thousand years ago, in the neighborhood of Mesopotamia, some of our ancestors took up agriculture, thereby beginning the end of the hunter-gatherer existence that our species had lived ever since it first evolved. Population exploded even as nutritional status and quality of life declined, at least initially. Eventually, greater population densities led to greatly accelerated cultural and technological development.

In 1448, Johan Gutenberg invented the movable type printing process in Europe, enabling copies of the Bible to be mass-produced. Gutenberg's invention became a major factor fueling the Renaissance, the Reformation, and the scientific revolution, and helped give rise to mass literacy. A few hundred years later, *Mein Kampf* was mass-produced using an improved version of the same technology.

Work in atomic physics and quantum mechanics in the first three decades of the 20th century laid the foundation for the subsequent Manhattan project during World War II, which raced to beat Hitler to the nuclear bomb.

In 1957, Soviet scientists launched Sputnik 1. In the following year, the US created the Defense Advanced Research Projects Agency to ensure that US would keep ahead of its enemies in military technology. DARPA began developing a communication system that could survive nuclear bombardment by the USSR. The result, ARPANET, later became the Internet—the long-term consequences of which remain to be seen.

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Suppose you are an individual involved in some way in what may become a technological revolution. You might be an inventor, a funder of research, a user of a new technology, a regulator, a policy-maker, an opinion leader, or a voting citizen. Suppose you are concerned with the ethical issues that arise from your potential involvement. You want to act responsibly

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and with moral integrity. What does morality require of you in such a situation? What does it permit but does not require? To what questions do you need to find answers in order to determine what you ought to do?

If you consult the literature on applied ethics, you will not find much advice that applies directly to this situation. Ethicists have written at length about war, the environment, our duties towards the developing world; about doctor-patient relationships, euthanasia, and abortion; about the fairness of social redistribution, race and gender relations, civil rights, and many other things. Arguably, nothing humans do has such profound and wide-ranging consequences as technological revolutions. Technological revolutions can change the human condition and affect the lives of billions. Their consequences can be felt for hundreds if not thousands of years. Yet, on this topic, moral philosophers have had precious little to say.

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In recent years, there have been increasing efforts to evaluate the ethical, legal and social implications ("ELSI") of important new technologies ahead of time. Much attention has been focused on ethical issues related to the human genome project. Now there is a push to look at the ethics of advances in information technology (information and computer ethics), brain science (neuroethics), and nanotechnology (nanoethics).

Will "ELSI" research produce any important findings? Will it have any significant effects on public policy, regulation, research priorities, or social attitudes? If so, will these effects be for better or for worse? It is too early to tell.

But if we believe that nanotechnology will eventually amount to a technological revolution, and if we are going to attempt nanoethics, then we might do well to consider some of the earlier technological revolutions that humanity has undergone. Perhaps there are hidden features of our current situation with regard to nanotechnology that would become more easily visible if we considered how our moral principles and technology impact assessment exercises would have fared if they had been applied under equivalent circumstances to any of the preceding technological revolutions.

If such a comparison were made, we might (for example) become more modest about our ability to predict or anticipate the long-term consequences of what we were about to do. We might become sensitized to certain kinds of impacts that we might otherwise overlook—such as impacts on culture, geopolitical strategy and balance of power, people's preferences, and the size and composition of the human population. Perhaps most importantly, we might be led to pay closer attention to what impacts there might be in terms of further technological developments that the initial revolution would enable. We might also become more sophisticated, and perhaps more humble, in our thinking about how individuals or groups might exert predictable positive influence on the way things develop. Finally, we might be led to focus more on systems level aspects, such as institutions and technologies for aggregating and processing information, for making decisions regarding for example regulations and funding priorities, and for implementing those decisions.

About the author:

Dr Nick Bostrom is Director of the Future of Humanity Institute at Oxford University. He previously taught in the Faculty of Philosophy at Yale University. His research covers the foundations of probability theory, scientific methodology and risk analysis, and he is one of the world's leading experts on ethical and practical issues related to human transformation and emerging technologies such as artificial intelligence and nanotechnology. He has published more than 100 papers and articles, one monograph, Anthropic Bias (Routledge, New York, 2002), and two edited volumes with Oxford University Press (in preparation). His writings have been translated into 15 languages, and he is frequently consulted as a commentator by the media, having done close to 200 interviews with television, radio, and print media.