

Mind the gap revisited

Alfred Nordmann and Arie Rip

It is important to consider the ethical aspects of nanotechnology, but it is equally important to ensure that these considerations do not end up as 'speculative ethics'.

In 2003, Anisa Mnyusiwalla, Abdallah Daar and Peter Singer of the University of Toronto issued their famous call to "mind the gap"¹. The only way to avoid a moratorium on the deployment of nanomaterials, they claimed, was to "immediately close the gap between the science and ethics of nanotechnology". Noting a shortage of serious publications on the ethical, legal and social implications of nanotechnology, they argued that "as the science leaps ahead, the ethics lags behind". Six years later, there is a welter of activity — a dedicated journal called *NanoEthics*, at least ten monographs and volumes of collected papers, more than 100 papers and reports (see ref. 2 for a review), and a wide variety of networks and other projects concerned with the ethical and societal dimensions of nanotechnology (refs 3–5 are good examples) — but a new gap has opened up because most nanoethics is too futuristic, focusing on nano-enabled devices that can read our thoughts, for example, at the expense of ongoing incremental developments that are more ethically significant.

This high level of ethics-related activities makes nanotechnology different to previous new technologies such as nuclear power, information technology and even biotechnology. Research on the ethical and social aspects of nanotechnology is carried out to build trust, involve the public, anticipate objections and offer guidance to the responsible development of nanotechnology. One consequence of this is that when philosophers and other researchers discuss the ethical aspects of nanotechnology, they lend further credibility to its power and promise. The most visionary promoters of nanotechnology are therefore the first to call for ethical consideration of the predicted applications. This is one reason for the bias towards what we call 'speculative ethics'.

In a sense, speculation is part of how ethics works and has to work. There is a long tradition of philosophers using thought experiments, hypothetical cases and 'what if' scenarios to pose questions about right and wrong, the limits of permissibility, human nature and the like. Ethicists and others engaging in ethical reflection are

therefore attracted by the promises that surround nanotechnology and by some of the concerns that have been voiced. They want to articulate what are challenging issues, discuss what possible actions can be justified, and how, and identify dilemmas that may have to be faced. However, this can give rise to the mistaken impression that ethical or philosophical discussions are addressing actual rather than hypothetical developments. (This can also happen when social scientists confront members of the public with dramatic visions of the future to get interesting responses when enquiring about their attitudes to the risks and benefits of nanotechnology.)

There is now a market for ethics of nanoscience and technology, and ethicists and others have responded to the demand for nanoethics with an over-supply of speculative ethics. Here we make a plea for less speculation.

As ethics leaps ahead...

Speculative ethics leaps ahead in time. It focuses ethical concern on future worlds full of advanced materials, theranostics, smart dust for ambient intelligence, and human enhancement. 'If-and-then' statements begin by suggesting possible technological developments and then indicate consequences that seem to demand immediate attention. What looks like a merely possible, and definitely speculative future in the first half of the sentence (the 'if'), turns into something inevitable in the second half (the 'then'). As the hypothetical gets displaced by a supposed actual, the imagined future overwhelms the present⁶.

Promoters of speculative ethics cite the need to reflect as early as possible on the profound changes that may be ahead⁷. As the editors of a recent book on nanoethics write: "Even if advanced nanotechnology is a remote possibility, its scenarios appear so disruptive that they merit consideration"⁸. The cost of raising irrelevant concerns is less, they suggest, than the cost of finding ourselves unprepared. However, this overlooks the opportunity costs: we can only do so much when our resources (ethical and

otherwise) are limited, and other ethical questions may be even more important.

There are good reasons to think that the opportunity costs of speculative ethics are too high, with less spectacular but more pressing 'here and now' ethical issues not getting the attention they deserve, and more speculative visions not being subjected to reality checks, as the following two examples show.

Current discussions about ethics and nanotechnology take considerable interest in nano-enabled brain implants, mind-machine interfaces and related developments — such as the privacy issues that arise when thoughts can be read routinely from brain activity. The underlying scenarios leapfrog crucial questions. First, the plasticity of the brain is well established, which suggests that many functions cannot be located in a simple manner, and that the brain will adapt to implants, with other parts of the brain taking over these functions. In other words, we lack the knowledge about the whole system that comprises the brain and the implant that we need to make predictions about the performance of nano-enabled brain implants. Furthermore, although there have been rapid advances in nanosensors, imaging techniques and the like, the visions that fascinate many ethicists assume that similar progress is being made in areas where progress tends to be much slower, such as linguistics, cognitive psychology and neurophysiology, not to mention the philosophy of mind. At the same time, other developments that demand ethical attention receive much less attention. For instance, nano-enabled advances in deep-brain stimulation can produce tremendous benefits for patients with Parkinson's disease, but they can also be used to alter moods and even personalities — but these issues are mostly overlooked by the nanoethics community⁹.

Promises about nanomedicine speak of new diagnostic possibilities. While ethical concerns have been voiced about the gap between diagnostic power and therapeutic possibilities, a reality check is more important. More data are of little use if the causal link with malfunction or disease cannot be established. Without this link, there is no increase in diagnostic power. Indeed, the

difficulty of establishing causal links between genetic data and disposition to a disease shows that the ideals of personalized medicine will not be available for many years. And again, other more pressing developments are now receiving less ethical attention: nano-enabled remote monitoring, for example, is likely to transform doctor–patient–hospital relationships¹⁰, but this has received relatively little attention from nanoethicists.

...current science is left behind

We recommend two strategies for closing the new gap. First, ethicists and social scientists need to squarely confront a predicament that they share with policymakers, journalists and even nanoscientists. This is the difficulty of knowing which predictions — technological, economic or otherwise — about the future of nanotechnology are sufficiently plausible to merit some reflection and action. There is little incentive or institutional structure to deliver reality checks or to hold people to account for the claims they make on behalf of nanotechnology. Instead of welcoming without scrutiny anyone who cares to add to the stock of promises and concerns about nanotechnology, we need to encourage discussions about quality of promises.

Just as everything that is physically possible is not always technically feasible, everything that can benefit an individual will not automatically benefit the whole of society. Distinctions need to be made that cut down to size the supposedly unlimited potential of nanotechnology. A good place for ethicists to start would be to consider the ‘responsible representation’ of nanotechnology and its possibilities by the media, university press offices and the scientific community.

Second, ethicists should help to distinguish between the extremely general ideas that are associated with nanotechnology in the singular (such as a next industrial revolution) and the various challenges that are presented by the development of nanotechnologies in the plural. Antibacterial surfaces and the further miniaturization of semiconductors raise different ethical questions, as do regenerative medicine and rational drug design. Scientists find it difficult to relate to the grand claims of speculative ethics, so a more focused approach could lead to more meaningful interactions.

Society would also benefit. Speculative ethics poses a twofold danger: present developments are not questioned because no one is paying attention to them, and worries about the most futuristic visions

of nanotechnology can cast a shadow on all ongoing work in nanoscience and technology. By focusing on specific areas of research — where they are coming from and where they are taking us — better choices can be made, and meaningful public debate will be possible. □

Alfred Nordmann is in the Institute for Philosophy, Technical University of Darmstadt, Darmstadt 64283, Germany. Arie Rip is in the Department of Science, Technology, and Policy Studies, University of Twente, AE Enschede 7500, Netherlands. e-mail: nordmann@phil.tu-darmstadt.de; a.rip@utwente.nl

References

1. Mnyusiwalla, A., Daar, A. & Singer, P. *Nanotechnology* **14**, R9–R13 (2003).
2. Kjolberg, K. & Wickson, F. *NanoEthics* **1**, 89–104 (2007).
3. <http://www.geography.dur.ac.uk/projects/deepen>
4. <http://www.teo.au.dk/cfb/forskning/omraader/nanoethics>
5. <http://www.thesnet.net>
6. Nordmann, A. *NanoEthics* **1**, 31–46 (2007).
7. Roache, R. *NanoEthics* **2**, 317–327 (2008).
8. Allhof, P. F., Lin, P., Moor, J. & Weckert, J. (eds), *Nanoethics: The Ethical and Social Implications of Nanotechnology* 12 (Wiley, 2007).
9. Berger, F., Gevers, S., Siep, L. & Weltring, K.-M. *NanoEthics* **2**, 241–249 (2008).
10. NanoBio-RAISE in *Nanobiotechnology, Nanomedicine and Human Enhancement* (eds Ach, J. & Lüttenberg, B.) 187–197 (Lit, 2008); available at <<http://tinyurl.com/crv9gk>>.