



## BOOK REVIEW

*Nanoethics: Big Ethical Issues with Small Technology*, by Dónal P. O'Mathúna.  
ISBN 978-1-8470-6395-3. Pp. xii + 235. Continuum (2009). £11.69 (pbk).

This is an easily readable well researched book about ethical questions raised by science and in particular by nanotechnology. It aims to draw lessons from history where instances of unfettered science and its pursuit without consideration of some of the wider social issues have caused problems.

The book is prefaced by a realistic assessment of nanotechnology in terms of current research, so-called normal nanotechnology, and futuristic nanotechnology involving molecular manufacturing and human enhancement.

The first chapter, “**Nanotechnology: in search of a definition**” provides an extensive review of the definitions of nanoscience and nanotechnology with some history from Feynman to Smalley. The author notes the converging technology approach of nanoscale science with its multidisciplinary covering medicine, biology, chemistry and physics but with no mention of mathematics or artificial intelligence at this stage. The promise of the technology has resulted in an exponential rise of research funding starting most notably with the Clinton initiatives in the USA in 2000. The growth of the technology, the problems of public awareness and the use of fiction as a means to examine ethics are all ably described, but we have to wait another two chapters for the definition of ethics.

“**Developing the technology: in the beginning**” traces the use of the narrative from Feynman's original factual description of possibilities at the nanoscale to Drexler's part fictional and part factual description of the future. Nanotechnology is conceived in terms of incremental improvements in the natural sciences, which are only considered to be “nano” where the technology or the application employs nanoscale objects. Futuristic nanotechnology is treated separately and concerns molecular manufacturing and the possibility of human enhancement. The author notes that some of Drexler's visions are showing considerable development, for instance the recent interest in carbon nanotubes and the possibility of many new materials derived from atomic carbon has led to the term “the diamond age” gaining currency.

“**Ethics and nanotechnology: what's the story?**” Now we find a definition of ethics that includes the role of the narrative and the need for inclusion of nonscientific issues such as emotion. The author draws many examples from literature and film that have been used to portray the moral values associated with the effects of technology. The use of literature and film falls into two distinct types of prediction: dystopian, the worrying “grey goo” briefly mentioned by Drexler; or utopian as portrayed by the *Star Trek* series. Interestingly Reagan's Star Wars initiative, which was effectively a marriage of science fiction and science, hardly worked but then the motivation was more economic than the search for understanding. The temptation by scientists to use science fiction to promote their ideas is inevitable simply because scientists are

human: an example is a liposome developed as a drug delivery system advertised as being a “nanobot”. Such misuse of language and the corrupting effects of advertising ineluctably leads to the credibility of scientists and their claims being questioned.

The fourth chapter, “**Dealing with risk: preying on fear**”, deals with molecular manufacturing and, indeed, with the concerns raised originally by Drexler. The science fiction view of science as being driven by deadlines to take shortcuts and incur risks is perhaps not that realistic. However, a number of other areas are currently raising concerns and the author provides numerous examples, such as electronic miniaturization for surveillance and individual monitoring impinging on privacy, although a generation of Internet chat room users is possibly changing attitudes towards personal privacy. Cosmetics are another area where the risks are only just becoming known, although the author fails to note the rather grey area between cosmetics and drugs that is appearing, whereby the penetration into cellular structures by nanoparticles is being considered as a means of delivering anti-aging preparations such as those based on vitamin A. Such deep skin penetration might well be considered as the application of a drug but as a cosmetic it is unregulated. The risks associated with nanoparticles are only just beginning to be addressed and the funding levels to look at safety issues are still tiny by comparison to the overall research expenditure. Conflicting results from toxicity testing means that the ability to ascribe probabilities to risks are still not available and thus conventional risk assessment in many areas of nanotechnology will not be possible for some time.

The next chapter concerns the **precautionary principle**, which the author advocates with a good series of examples, of which the most notable is the negative one of the failure to apply it to the widespread use of asbestos, all the more surprising given that deaths were known about even in 1911. There is, however, a problem with definition in that the ethical basis of the principal is rooted in the “do no harm” or nonmaleficence approach of Hippocrates. This places responsibility for any harm firmly at the door of the developer of the new technology.

In chapter 6 the author looks at global nanotechnology and uses the subtitle **turning the world upside down**. Much has been made of the potential benefits of nanotechnology for the less developed countries (e.g., potable water and cheap energy) but little has materialized into reality. The result seems to be further divisiveness between the developed and the developing worlds. Some countries are actively trying to invest in the technology so as not to be left behind, while others who are unable to afford the research (despite its low entry costs) call for the cancellation of patents so that they can benefit. It is interesting that funding to cure the so-called neglected diseases prevalent in the developing world is so small: only some 1% of developed drugs are aimed at these diseases. From an ethical standpoint the author argues that developed world scientists have a moral obligation to use nanotechnology for the benefit of the developing world.

The next chapter is devoted to **nanomedicine** and provides a good review of nanoparticles used as drug delivery vehicles, magnetic and fluorescent nanoparticles used to target tumours, and point of care diagnostics. These are mostly covered by existing medical regulation but the use of implants and stimulants is now raising further ethical issues concerning enhanced human performance.

This concept of “**Enhancement: becoming better than healthy**”, is examined in Chapter 8. Complex bacterium-sized nanobots circulating in the bloodstream repairing damage and

fighting disease is the utopian vision of the future for mankind. At this point, the ethical discussion begins in earnest. Throughout the western world the aim has been to achieve the highest attainable health of the population, but one must now ask whether this includes enhancement. Cosmetic surgery is now commonplace but not essential to health, but no one would deny that the vaccine which enhances an individual's capability to survive a disease is within the remit of achieving the highest attainable health. The edges are now very blurred and the ethics of nanotechnology employed for human enhancement needs to be considered carefully. Striving for the greater good, although seemingly ethically laudable, may not be fully justified as the consequences for society and individuals are often not predictable. This is increasingly true of "medicalization" (the use of medicine to treat behavioural conditions), which for well understood problems is acceptable but treating difficult individuals to make them "normal" is like a scenario from the film *Clockwork Orange*.

Five questions are posed to elicit the ethics of enhancement therapies. These are aimed at eliminating the obviously ethically acceptable in order to determine the ethics of the most difficult application of enhancement therapy. A good example is the narcolepsy drug *Modafinil* the benefit of which has side-effects still being discovered, but it is increasingly being used as a means of keeping individuals awake and focused. It is interesting that competitive advantage gained by using physically stimulating drugs is regarded as unethical in sport but using them for enhancing the performance of scientists and doctors might be more acceptable. Another problem is that such drugs are expensive (also true of some cancer treatments) and thus they could provide an advantage for the rich over the poor. Equal availability of such drugs might provide justice (although it might be unaffordable) but might also change society's norms and create further problems. The author also reminds us that the pursuit of enhancement to change society ignores our human frailties and the compassion and empathy that often grows from adversity.

**"Post human future: making room for human dignity"**: in this penultimate chapter the author's views are finally clearly revealed. There is a good review of posthumanism as elucidated by Bostrom and finally the role of artificial intelligence and brain implants appears in the narrative, which tackles the capability to create better-than-current human beings. Bostrom considers this a worthy goal: aging will be eliminated and life could extend to 1000 years. The breathtaking optimism of these posthumanists is examined. The protagonists see a Star Trek world where overpopulation is supported by molecular manufacturing producing material and food for all, and ultimately off-world settlement. Although denied by the posthumanism movement, the author notes that the posthumanists constitute a self-interest group and division is inevitable between the achievers who want and demand enhancements and nonachievers who are perhaps unable to afford them. Such an attitude disregards the ethics of altruism and helping. It is questionable whether anti-aging beyond 100 years is even achievable; as body parts wear out and are replaced more strain is inevitably placed on what remains. The author is rightly sceptical of the posthumanism claim to be able to guide enhancement in what amounts to goal-oriented human evolution and notes that despite all their denials they are effectively "playing God". While currently regarded as unethical, germline gene therapy leading to modified inherited traits is advocated by posthumanism. There then follows a comprehensive review of current gene therapy and examples of cinematographic films depicting the societal conflicts between those born with enhanced capabilities and those not.

The final chapter, “**Technology and the future: revisiting Daedalus and Icarus**”, summarizes the author’s views. Science should strive for the betterment of humanity and our planet and not just the pursuit of perfection for an elite. Taking heed of Icarus’s fate, the warning of Daedalus not to fly too close to the sun should not be ignored. History is replete with examples of the lessons of the consequences of expressing the bad side of human nature not being learnt. In essence the book is a plea for science with ethics rather than keeping the two fields in isolation.

In summary, the issues raised are well presented and thought-provoking but they are issues of science in general and not just of nanotechnology. Overall an excellent book; essential reading for scientists motivated to pursue some of the more futuristic claims of nanotechnology.

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