Nanotechnology scenarios: ethics and science fiction

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This is the third in a series of commentaries on the Center for Responsible Nanotechnology (CRN) Scenario Project.1,2 The assumption underlying the scenarios is that molecular manufacturing is drawing ever closer. As a result, the CRN states that the warnings issued by it and others should be taken seriously. They want a prompt and thorough investigation into the potential benefits and anticipated risks of molecular manufacturing.

The CRN Introduction mentions that the US National Research Council (NRC) called for experimental research to support molecular manufacturing.3 It didn’t mention that the NRC also stated that molecular manufacturing’s potential cannot yet be evaluated because the tools needed to build such devices do not exist. As a result, the NRC concluded that molecular manufacturing is “currently outside the mainstream of both conventional science … and conventional engineering” and exists in the realm of “visionary engineering analysis,” similar to proposals to build space elevators.4

The CRN scenarios have the potential to allow such visionary analysis of molecular manufacturing. They are also offered to initiate discussions about possible societal responses to molecular manufacturing. Although not explicitly mentioning the ethical or moral aspects of molecular manufacturing, these must be taken into account. Several organizations have developed scenarios to assist ethical reflexion on emerging technologies. They echo the finding that many people connect better with narratives when thinking about the world. Fiction is increasingly being used to engage people with the complexities of emerging technologies,

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whether it be in the form of novels, films, role-playing or specially written scenarios. In this article, the term narrative will be used for all these formats.

Nanotechnology and science fiction

Nanotechnology has had a close, and maybe controversial, connexion with science fiction. Various devices that nanotechnology might some day develop have been incorporated into science fiction to such an extent that “nanotechnology has become one of the core plot devices on which science-fiction writers draw”. The imaginative flow has not been one way, with nanotechnology researchers sometimes linking their developments to science fiction. Molecular manufacturing roots itself in Richard Feynman’s seminal 1959 lecture. However, some of his ideas can be traced to earlier science fiction writings. Feynman talked about using smaller and smaller hands to build smaller and smaller devices, much as Robert Heinlein’s character Waldo did in his 1942 short story. More recently, researchers likened their liposome developments to a submarine from Fantastic Voyage, complete with a “nano-GPS system”, but without enough room for Raquel Welch, although the corresponding technical report in Science revealed a much more mundane scientific development. Indeed the interconnections have been so complex that some have claimed that “molecular nanotechnology should be viewed as simultaneously a science and a science fiction”.

Debate over this relationship centres on the way science fiction is used to present nanotechnology to the public and other potential stakeholders. A general concern about the use of narratives with science, or ethics, is that that they can promote a specific vision, but in an implicit or covert way. The Information and Communication Technologies Advisory Group (ISTAG) advises the European Commission on future technologies and views scenarios as “a tool to help us invent our future”. Thus even the use of scenarios carries ethical implications.

Scenarios 6–8

The overall future envisioned in the CRN Scenarios 6–8 is explicitly declared: they claim that molecular manufacturing will develop. Scenario 6 is based on the gradual acceptance of molecular manufacturing, even by those who initially were not enthused by it. It claims that in

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7 Dónal P. O’Mathúna, Nanoethics: Big Ethical Ethics with Small Technology (London: Continuum, 2009).
2015 most scientists will accept that molecular machines will some day build molecules. However, they use DNA-based manufacturing as the example, which is somewhat disingenuous given the more controversial methods usually entailed by molecular manufacturing. The Scenario degenerates into the typical visionary claims of genuine molecular manufacturing soon providing products at $100 per kilogram. The Scenario does acknowledge that the majority will continue to say, “We’ve heard it all before, and we’ll believe it when we see it.”

Scenario 8 has basically the same theme: molecular manufacturing will arrive and save the planet. In this case, it will be through the courage of an environmentally-conscious US president. His policies will take molecular manufacturing out of the control of the military and use it to overcome global warming. Similarly, Scenario 7 uses a secret Chinese programme to sponsor the necessary research. This Scenario envisions the collapse of China as a nation, leading to a diaspora of molecular manufacturing experts. Hopes are high that they will work for the good of humanity and the planet, but the military win them over and the world is brought to the brink of global war.

There are certainly ethical issues in all these Scenarios. But all of them fail to capture the imagination and lead to deeper reflexion on the ethical issues. The problem is that the scenarios simply outline various possible events. They primarily list potential benefits and anticipated risks. Little in the scenarios helps us understand the major forces driving the events. There is nothing to suggest why one outcome is more likely than another, or what might shift things towards a better future.

Narratives in ethics

The potential value of narratives in ethical analysis is that they can reveal underlying driving forces behind events. We learn from fiction and stories because they offer various explanations for why things happen, not just predictions of what might happen. Human motivations, desires and goals are central to what we believe is ethically praiseworthy or problematic. The three CRN scenarios are not sufficiently complex to stimulate the deep moral reflexion needed for the relevant ethical issues. For the most part, the events just happen, leaving us with little insight into how current decisions or motivations might affect future developments. Having molecular manufacturing develop in secret adds to this sense of a lack of control or influence. For ethics or politics to make a difference, the relevant ethical principles and moral motivations need to be revealed so they can be assessed and evaluated.

Purposefully written scenarios are one way of analysing social, political and ethical implications of future technologies. ISTAG has developed some for ambient intelligence, highly integrated electronic networks that can sense and respond to people. The development of ambient intelligence will require devices heavily dependent on nanotechnology. Because scenarios involving such environments have tended to be very positive, another EU-funded


project, Safeguards in a World of Ambient Intelligence (SWAMI), has developed “dark scenarios”.

Scenarios have various formats and are written for different purposes. In general their aim is not to pinpoint future events but to highlight the significant forces pushing the future in different directions. By making such forces more visible, decision-makers can take them into account as they develop plans and policies today. Scenarios like those of ISTAG and SWAMI can be distinguished from the CRN ones because they centre on people, not events or devices. For example, the ISTAG scenarios revolve around five people: Maria, a young salesperson travelling overseas; Dimitrios, a young man with a digital avatar of himself; Carmen, who uses several new devices to plan her travel to and from work; and two students learning with ambient technologies that provide immediate feedback and create shared memories. The characters and their responses to events and devices become central to evaluating possible futures.

More generally, narratives (and fiction in particular) bring an added dimension to ethical reflexion when they portray the inner drives and thoughts of characters. Some narratives do focus on the intellectual debate involved in ethical issues. For example, one of the short stories in The Nanotech Chronicles involves six characters openly debating the ethics of nanotechnology research and development, with each character presenting different arguments. In a narrative format, the debate is more than just a rational exercise, as the personal motivations and conflicts of interest give the discussion a more real-world appearance.

Such personal factors, along with emotions, are important aspects of ethics, which were widely recognized in classical and religious ethics. Post-Enlightenment ethics tended to neglect those dimensions and emphasized a highly rationalist approach to philosophical ethics. Recent decades have seen renewed interest in the role of emotion, character and motivation in ethics, which has led to a revival of virtue ethics and narrative in ethics. Character traits and emotions must be taken into account for fuller ethical deliberations, combined with critical and rational reflexion on the issues and moral principles.

Science fiction

Science fiction is the most obvious genre to help examine the ethics of future technologies. The settings, devices and events in science fiction may be hypothetical or even fantastical, but their purpose is not predictive. Michael Crichton’s Prey has become synonymous with “gray goo” dystopian scenarios involving self-replicating nanodevices. The novel has been dismissed as raising an unlikely, if not impossible, scenario. While it provides little to assist in a risk–benefit analysis, it raises other ethical issues of current significance. For example, the story can stimulate discussion about collaboration between military and commercial research institutes, about the pressure to produce practical outcomes quickly, and the potential for research initiated

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14 David Wright, Serge Gutwirth, Michael Friedewald, Elena Vildjiounaite and Yves Punie (eds), Safeguards in a World of Ambient Intelligence (Dordrecht: Springer, 2008).
for humanitarian reasons being diverted towards military applications. In a similar way, the fictional film *I am Legend*\(^\text{19}\) may be based on an unlikely series of events, but it raises questions about how to handle unforeseen disastrous consequences from clearly beneficial technology. In the film, what is initially announced as the cure for cancer turns out to almost annihilate humanity.

Science fiction can point to character qualities and moral obligations that have always been ethically significant and need to be taken into account as new technologies develop. For example, K. Eric Drexler’s writings present molecular manufacturing as a way to solve all humanity’s problems by providing unlimited products along with space colonization to provide raw materials and living space.\(^\text{7}\) The novel, *Chasm City* describes a world with many of these devices and programmes.\(^\text{20}\) The narrative adds the impact of human character qualities. In spite of the unlimited resources, personal ambition drives one man to take control of a fleet of spacecraft, with destructive consequences. Another character is driven by revenge to kill those who killed his family. Personal motivations (like greed) are strong driving forces that need to be taken into account in planning for the future.\(^\text{15}\) Narratives help to ensure they are considered. These stories can engage people intellectually and emotionally and make use of people’s imaginations and intuitions.\(^\text{13}\) In the face of enthusiastic pursuit of technology, narratives can remind us of human fallibility, where mistakes, tiredness or laziness can overcome even the most sophisticated safety or security technology. Narratives bring the human dimension back into ethical deliberations.

Some have raised concerns that science fiction can lead to ethical deliberation of only the highly futuristic developments in nanotechnology. It is important to distinguish between what I have called “normal nanotechnology” and “futuristic nanotechnology”.\(^\text{7}\) The former raises significant ethical and environmental issues that require immediate attention. But science fiction is not primarily about the ethics of the future. Its purpose is not to leave us in a future world wondering about whether the weird, wonderful and amazing gadgets are ethical or not. Good science fiction, and literature more generally, will transport us to another world, creating distance from our present setting to help us examine our own assumptions and beliefs.\(^\text{12}\) It should bring us back to reflect on our present world, and how the values, motivations and goals we see played out in another world are influencing today’s world. Science fiction often arises out of today’s moral concerns and angst, and should bring us back from the future to critique the present.\(^\text{15}\)

One ethical concern with nanotechnology has been the potential loss of privacy from constant surveillance with practically invisible electronic devices. Some have minimized such concerns, claiming that the necessary totalitarian or Big Brother society is unlikely to develop. Steven Spielberg’s film *Minority Report* highlights such concerns about future loss of privacy. However, rather than showing the loss of privacy being driven by a desire to spy on people or control them, it arises as a way to prevent crime and to sell products. The screenwriters deliberately raised their concern about people being tracked and their habits monitored so that personalized advertising could increase sales.\(^\text{21}\) Such a driving force fits clearly into our present

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\(^{19}\) Directed by Francis Lawrence. Warner Bros (2007).


consumer society and the growing efforts to personalize internet marketing. A narrative like this can help reflexion on current practices and whether nanotechnology should be used or regulated today in relation to such advertising. Such reflexion could also examine Spielberg’s receipt of around $25 million from manufacturers to place their products prominently throughout his film, a method of advertising called “product placement”.  

In the CRN scenarios, Scenario 7 suggests another example. The social unrest of its future begins in China because a thousand million citizens realize they are not benefiting from China’s economic boom. By 2014 the narrator is shocked by the terrible conditions, lack of health care and devastating pollution that no one had seen or reported before. Yet this describes much of our world today, and is actually readily visible for anyone who takes the time to investigate. The naïve reflexions of the future narrator should lead us to question why we allow millions to wallow in poverty and disease. Even the field of bioethics has been criticized for failing to concern itself with the ethical issues impacting the poor parts of the world.  

Such blind spots in our ethical reflexions can be highlighted by narratives. One study noted that science and engineering students studying ethics had not considered the needs of poorer people in reflecting on the ethics of emerging technologies. When an intergenerational dialogue was arranged with senior citizens, the older people’s life stories exposed the students to these concerns. Encounters with fiction can thus enlighten people to issues they had not previously perceived. Narratives can expose people to the ethical significance of decisions regarding the goals and funding of nanotechnology, and who will benefit from the resulting products. Will lighter, stronger sports equipment be developed before improved agricultural tools? Will more durable spacecraft be built before better fishing boats? Will cognitive enhancement drugs be developed before treatments for malaria or sleeping sickness?

**Personal values**

Fiction can also raise ethical issues that centre more on our personal belief systems. *Chasm City* is set in a world embedded with nanotechnology and other future technologies; “Mixmasters” provide genetic technology whereby people can change their bodies in any way they want. One of the characters is nicknamed Zebra because her skin has been genetically modified to look like the animal. We are told that while the technology was developed to correct genetic abnormalities in newborns, it soon became available to anyone with enough money to use it for whatever purpose they desired. Parlours cropped up where people looked over brochures to select their next makeover. Personal autonomy and the free market were all that were required to ethically justify this use of the technology.

The value of such fictional accounts is not primarily in helping us determine whether the services provided by Mixmasters are ethical or not. They may or may not ever be developed. But fiction can be used to stimulate reflexion on the ethics, values and moral motivations of current practices and technologies. Similar ethical issues are raised by today’s ever-expanding...

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_Nanotechnology Perceptions* Vol. 6 (2010)
range of cosmetic surgeries, and the use of pharmaceuticals for lifestyle satisfaction or cognitive enhancement. Basic moral issues such as satisfaction with one’s self, the limits of bodily change or the goals of medicine are as relevant today as in the future. By putting absolute autonomy into a story, even if fictional, we may be able to perceive its moral implications for our society more clearly than with rational debate alone. By transporting us to another time and society, fiction can provide enough distance to allow us to more carefully reflect on the values and ideas that are widely accepted in our society. Returning to our own settings with these new insights and perceptions can assist with the ethical decisions we ourselves need to make in our own lives or as we contribute to developing policies.

Conclusion

Science fiction and other narratives are usually created with entertainment as their primary purpose. For that reason, using fiction to discuss nanotechnology ethics will often require complementary materials and some guidance. Whether for classrooms, public discussions or to assist in policy development, narratives will need to be carefully selected for their relevance. They may be read or viewed as purely entertainment, and thus a facilitator may need to direct discussions towards the ethical issues. The stories may only present one aspect of the issue, or one side of a debate, and may need to be supplemented with other materials. While the narratives may engage people’s emotions or imaginations, the importance of including rational reflexion may need to be emphasized. The particularities of the stories and characters are important, but discussion of general ethical principles, theories and virtues may need to be encouraged.

The CRN scenarios are not engaging examples of how fiction can promote ethical dialogue and discussion. Nonetheless, carefully selected or well-designed narratives can be an invaluable tool to engage people with ethical issues and encourage deeper ethical reflexion on the moral dimensions of emerging technologies.