

# FORECASTING ETHICS AND THE ETHICS OF FORECASTING: THE CASE OF NANOTECHNOLOGY

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Abstract

This paper argues that social foresight and technological forecasting are essentially fraudulent activities which at best are temporarily delusive but at worst may constitute a waste of valuable resources. Futurists conceive of forecasting as a contribution to ethical debate about the future impacts of technology. This paper makes forecasting itself the focus of ethical attention. I use nanotechnology as a paradigm case of a technology about which many and often conflicting claims are made regarding its future impacts. Nanotechnology follows in a long tradition of technologies which are claimed to be fundamentally transformative being described as ‘revolutionary’ in their social, economic and political implications. It is suggested that we ought to anticipate the kinds of moral problems and dilemmas that such transformations may produce. I challenge the view that there can be any such moral obligation to foresee such transformations. I argue that given that we cannot in fact know the eventual outcomes of current social and technological changes then we cannot be under any such obligation to anticipate them. Those who make large scale claims about the future can have no reasonable warrant for doing so. I reinforce my position by arguing the essential unknowability of the kinds of values and choices future generations will make.

## 1 Introduction

If technologies were wholly benign then there would no need to give them ethical consideration just as Kant’s angels would need no instruction in the notions of moral obligation. However, given our experiences of the ways in which at least some technologies have been deployed in the past to human harm the ethical assessment of technologies appears essential. Jim Moor has stated that we need ‘better ethics’ to deal with the problems of emerging technologies (Moor 2005). The idea of ‘better ethics’ may be interpreted in at least two senses in this context. In the first sense we might think of ‘better ethics’ as maybe improving the application of our existing ethical concepts to channel the development and application of new technologies in life enhancing ways. This implies attempting to ensure moral considerations have a much greater purchase on those institutions and decision makers whose responsibility it is to control and regulate technology from social, economic, and cultural points of view. In some circumstance this may be a radical enough claim in itself. The second sense in which we might think about ‘better ethics’ is that concerned with states of affairs where our existing moral concepts or understanding seem inadequate for the job. We might think here of situations where, given advances in Artificial Intelligence, machines are not only ‘the instrumentation of human action’ (Johnson, 2001, p.16) but substitute for human beings as surrogate agents in more profound and morally disturbing ways. In both these senses of ‘better ethics’ it seems to me that it has been thought that anticipation ought to play an important role. In other words if we could only develop the right tools and methodologies for prediction, foresight,

forecasting and so on we would be in a much better position to make ethical judgements about technological futures and thus have 'better ethics'.

To this end a whole new putative profession of 'futurists' has emerged to embrace this challenge. Richard A. Slaughter, President of the World Futures Studies Federation, in a recent book, 'Futures beyond dystopia: creating social foresight' (2004) presents a confident 'twenty-first-century agenda' for futures work. The central theme is that the way to avoid descent into cataclysmic economic and technological dystopia is to develop some kind of social foresight that will enable us to peer over the horizon of the present into alternative futures. Thus armed with information about these possible futures we can steer our way '...toward more consciously chosen futures' (Slaughter, 2004, p.5). The use of the maritime metaphor here implies that futures are there like continents over the horizon – just there and waiting to be discovered; time is being envisaged as space. These potential navigators are described thus 'A futurist is someone who has learned how to study the future (as a symbolic realm of understanding [sic]) and understands how to use this knowledge to enable others to identify options and choices in the present. The point of studying the future is to move away from a passive or fatalistic acceptance of what may happen to an active and confident participation in creating positively desired futures' (Slaughter, 2004, p.37). He is critical of past work with its modernist obsessions about methodologies such as Delphi studies, scenarios, extrapolation techniques, used in isolation and with an overly rationalistic approach. Slaughter champions a more holistic, integral approach referring to 'social foresight' rather than 'technological forecasting'. Even so the implication is that the future or a range of possible futures can be somehow known in advance and on the basis of such 'knowledge' wise and morally sound choices may be made. Whilst the aspiration is laudable I believe the approach is fundamentally in error and we should be wary of talking in the future tense about outcomes, which in principle, cannot be known. This in itself is an ethical issue.

Thus in this paper I want to discuss some ethical problems associated with the idea that foresight about the future impacts of radically new, potentially disruptive technologies can contribute to the creation of 'better ethics' in the social control of technology. I have argued elsewhere for a radical scepticism towards the claims of forecasters and futurologists. I don't believe that 'policy vacuums', for example in the case of nanotechnology, might be filled in advance by anticipating them (Horner, 2005a). Our knowledge and beliefs about the future are constrained by the effects of imperfect information, the Oedipus effect (self-fulfilling prophecies), discontinuity effects, and revenge effects (Horner, 2004). In section 2 of this paper, Nanofutures, I will again take nanotechnology as a paradigm case of a technology about which many and often conflicting claims are made regarding its future impacts. Nanotechnology follows in a long tradition of technologies which are claimed to be fundamentally transformative being described as 'revolutionary' in their social, economic and political implications (and which we should endeavour to anticipate). In section 3, Ought Implies Can, I challenge the view that there can be any such moral obligation to foresee such transformations. I argue that given that we cannot in fact foresee such large scale changes then we cannot be under any such obligation. In section 4, The Ethics of Forecasting, I explore the objections to this argument and its ethical implications. Section 5 then attempts to reinforce my position by arguing the essential unknowability of the kinds of values and choices future generations will make. This compounds the problem of foresight or forecasting. I conclude that social foresight

and technological forecasting are essentially fraudulent activities which at best are temporarily delusive but at worst may constitute a waste of valuable resources.

## 2 Nanofutures

Writing about nanotechnology and its likely impacts is a paradigm case of the mixing of present fact and future speculation. Nanotechnology is conceived as a generic technology with applications in IT, energy production and storage, materials, manufacturing, instrumentation, food, water and environment, and security. There is an extensive and often contradictory literature on what nanotechnology either threatens or promises. There are competing claims as to the extent to which its social and economic impacts may be revolutionary or incremental. Similarly, even at the level of the knowledge base there are widely varied assessments as to what may be scientifically or technologically possible or impossible (Jones, 2004). Again there is no consensus about the extent to which the consequences of research and development in the field are deterministic or indeterminate in their possible effects (Horner, 2005b). The outcomes are undecided yet there is a sense generated of definiteness about benefits as much as about ethical concerns. However, all this is against the background of the fact that actually few genuinely nanotechnological products or devices have made it to the market (Jones, 2004).

However, in spite of this Nanofutures are often expressed in categorical terms as though the choices were clear and the road leading to one or the other was open and straightforward. For example, Saxl in discussing a wide range of contributions that nanotechnology might make to a more sustainable future, remarks that ‘...it is a ‘given’ that the nanotechnology-based products will be cheap to produce, less resource intensive and are ‘smart’, i.e. respond to the demands of their immediate environment’ (Saxl, 2005, p.12). Research in the field of nanotechnology is clearly exciting work at the limits of our current knowledge and understanding. The research is often multidisciplinary and fundamental aiming to harness basic knowledge about natural processes at the nanoscale to produce new processes and products with a wide range of applications from medicine to computing. One area of research illustrative of this is so called ‘biomimetics’ where the objective is to produce nanoproductions that emulate nature. For example, the development of novel, polymer-based solar cells which emulate photosynthetic processes and which are flexible and cheap to fabricate. It is claimed (Saxl, 2005, p.10) that these novel solar cells have a good solar-to-light energy conversion efficiency and would constitute an appropriate technology for less developed areas. But without widespread diffusion of the technology – we just don’t know!

What are we to make of this; is it intended as a prediction, a possible future or an aspiration. Frequently, as we do know, technologies are oversold and hyped. Seidensticker (2006) has argued that claims about the rate of technological change are often wildly overstated. Technologies which are claimed as revolutionary often turn out to be little more than refinements and variations of past discoveries and breakthroughs. Thus in spite of past experience of failed technological futures, and the immense uncertainties involved, nanotechnology is promoted by Saxl in a report for the European Commission as ‘a key technology for the future of Europe’ (Saxl, 2005). The perspective presented is that of a global situation in which human action, particularly through industrialisation, is threatening the planet with destabilisation and

collapse. What seemingly beckons is a dystopian future along the lines suggested by Richard Slaughter (2004). At the same time, however, an alternative and more utopian vision is also held out to us: '...New technologies, including nanotechnology, may provide a part of the answer of how to create alternative life styles for the population that will be in harmony with the planet' (Saxl, 2005, p.6). No mean claim! However, this claim comes with the caveat that '...technology alone will not provide a solution to the planet's serious ills. The solution is down to each of us, as individuals, to take the necessary action before it is too late' (Saxl, 2005, p.4). Here then is a report with a serious moral message and purpose aimed at EU decision makers, industrialists and each one of us. Its theme is that the simple pursuit of 'growth' and 'competitiveness', the corner stones of EU strategies of the 1990s, are no longer sustainable.

Saxl presents us with a sample optimistic version of a possible 'nanofuture'. He gives us 'A Day in a life in 2025' an account of an imaginary character, Rogerio, who is benefiting from many advances in nanotechnology from a house that is constructed from energy-efficient nanocomposite materials, nanocoated dirt repellent windows, voice activated electronics of various kinds, water recycled through nanofilters etc. He himself is equipped with various implants and monitors to enhance and safeguard his physical well-being. Rogerio reflects on the era of nanotechnology: '...life was generally good. Surprisingly, people understood they had been saved from the brink of extinction – there was still a long way to go to be sure, and all the indicators of climate change were currently monitored, almost obsessively, using nanosensors. It was interesting to see, though, how attitudes to waste and recycling had changed; small plots of land were again being nurtured in the quest for good food; less travel had meant more social interaction, and the cheapness, ubiquity and user-friendliness of information and communication technology meant that education and entertainment were available on demand. Technology had certainly made this new era much better than he'd ever hoped.' (Saxl, 2005, p.28)

Whilst on the one hand nanotechnology is held out as a solution to problems of sustainability it brings along in its train its own ethical problems. This Janus-like quality of technology again is a common theme in the genre of 'futurism'. The two key ethical areas that are often highlighted in this context are: military and medical applications. Just over a quarter of the US nanotechnology research budget in 2005 was consumed by the Department of Defence. On a more modest scale Britain's Ministry of Defence is supporting research and development in new structural materials and various electronic devices with military applications. This work is often done in collaboration with academia. And the EU is seeking to enlist nanotechnological research in the 'war against terrorism' with a budget for 2004 – 2006 of 65 million euros. Of course the extent to which we perceive this work in the defence sector as an ethical issue depends on one's general moral position on military and security matters. It can't be the case that the technology in itself has moral properties but the question is the potential use of such technology viewed again as 'the instrumentation of human action' i.e. the way the technology may be used or the extent to which it designed to embody certain values and ends. Seen in this way we don't need to anticipate any outcomes here; we could just decide to reduce expenditure on military research and development!

The second area of ethical concern highlighted by Donald Bruce of the Science, Technology and Religion Project of the Church of Scotland, in an appendix to Saxl's

report (2005, pp.32 – 33) is the that of the possibilities of a ‘nanomedicine’ devoted not merely to ameliorative medical treatment but to the improvement or enhancement of human performance. Could nanotechnology be the gateway to a new Eugenics? Bruce sees possible threats here to traditional cultural and moral constraints which prevent interventions that radically interfere with human nature. ‘Transhumanist’ beliefs in pushing beyond the current limitations of the human could possibly be empowered by nanotechnology. It thus may pose a threat to our very conceptions of the nature of what it is to be a human being. He argues that nanotechnology raises conflicts between ‘holistic’ and ‘functional’ views of human beings and between what is ‘fixed’ and what is ‘changeable’. For Bruce physical limitations are beside the point. What matters in our being persons is our creative, relational and aesthetic characteristics seen holistically. The transhumanist position jettisons these more static and holistic views of humanity in favour of malleability and functionality. Bruce maintains that a focus on ‘functional enhancements’ may promote a view that emphasizes ‘improvement’ whilst at the same time stigmatising disability or what is seen to be in some sense ‘defective’. Such an approach begs all the moral questions.

Bruce raises the prospect of a possible general breakdown of the distinction between medical and (strictly) non-medical interventions. It may then be the case that procedures developed for use in a medical context come to be employed non-medically. For example, The European Convention for Human Rights is opposed to sex selection in IVF with the exception of those cases where serious sex-related hereditary diseases are involved. Devices may be developed and be used in the context of disablement to facilitate greatly enhanced and intimate control from the brain to prosthetic limbs. Should these be made available to the able bodied for example to enhance say sporting performance? Similarly if it were possible should we enhance vision, for example for night driving, by extending sight into the infrared part of the spectrum? Perhaps more importantly much has been made in the literature of nanoscale devices which could be inserted into the body and operate at the cellular level to repair cells and combat aging. The consequences of greatly extended average life spans may have vast social implications. But, of course such devices do not exist! And at the same time we don’t know what the potential unintended harms might be from interventions at the cellular level.

There are also areas of ‘crossover’ between the military and the medical. Nanoscale devices offer the potential to be implanted in the body to continuously monitor a variety of medical indications. For example, these might be used for diabetics to monitor blood sugar level. Bruce argues that in principle it may be possible to adapt such technology for increased surveillance of citizens or for military applications. The general problem is debating the risks and benefits in the context of ignorance about the future. In the USA, the UK and the EU and many other countries initiatives and programmes have been launched to research public attitudes to nanotechnology and to stimulate public dialogue around nanotechnology. But the prior ethical question is ‘what does it makes sense to debate?’ For example, it may be the case that the concept of ‘nanotechnology’ is intrinsically delusive. It may not be ‘a’ technology but simply a relatively disparate collection of gadgets and applications. Existing regulatory frameworks may be quite adequate to deal with nanotechnological products. In the absence of evidence about the future what can usefully be said?

I want to suggest that in meeting these types of ethical challenge we already have pertinent distinctions that we can simply decide to sustain. There is a sense here that in fact we don't need further information i.e. we just don't need information from or about the future to make such decisions. We just can make those decisions on the basis of ethical reflection. We often can make ethical choices where the facts don't change anything. In those more speculative cases where we just don't know what is going to happen and where we might be confronted by demands to revisit or extend our moral concepts then these are matters for decision at the time. The history of our moral language is one of evolution, redesigning our moral conceptual apparatus to cover new circumstances as and when they arise. As Austin puts it '...our common stock of words embodies all the distinctions men have found worth drawing, and the connections they have found worth making, in the lifetimes of many generations: these surely are likely to be more numerous, more sound, since they have stood up to the long test of the survival of the fittest, and more subtle, at least in all ordinary and reasonably practical matters, than any that you or I are likely to think up in our arm-chairs or an afternoon – the most favoured alternative method' (Austin, 1970, p.182).

### **3 Ought implies can**

So given this plethora of possible futures is forecasting or foresight really defensible as an ethical enterprise. Is it something we ought to do? The claim is often made that science fiction is prescient in its anticipation of 'the shape of things to come' and we are often enjoined to consider all those examples where some science fiction story appears to have successfully foretold the future. H. G. Wells is the frequently cited example here. But we ought also to throw into the balance all the numbers of stories (greater by orders of magnitude) where various scientific and technological futures are not realised. It seems to me that the direction of the analogy works the other way – scientific and technological forecasting is more like science fiction than science fiction is like forecasting. It may be entertaining to conjure up a variety of technological futures but is it helpful or is it harmful? The fact that we can pose these questions simply does make this an ethical issue.

Radical scepticism towards the efficacy of technological or social foresight is symmetrical, with respect to technological optimists and to technological pessimists, to utopians and to dystopians alike. It seems to me that the key to the ethics of forecasting is summed up in that traditional slogan of moral theory that "ought" implies "can". It only seems to make sense to say that we have a responsibility or an obligation to do something if in fact we are able to do it (Hare, 1963, p.51). Our responsibilities become increasingly stretched in proportion to our capacities to fulfil them – and these responsibilities may extend in time or space. To the extent that past events may be infeasible then we cannot (logically) have an obligation to change them although if we were responsible for them in the first place then we have a duty to acknowledge at least that much. But it seems unreasonable to claim that we ought to have responsibility for states of affairs that we can't in principle know about. And it seems to me that future events fall precisely into this category, particularly and most acutely, when we are discussing the medium to long term effects of widespread technological change as in the case of claims about nanotechnology.

However, as we have seen, the futurists' claim rests on a belief that it would certainly be unethical not to use our powers of foresight to avoid approaching disaster. So it

may be the case that in some circumstances it must be ethical to predict. For example, if we can see (predict?) that a car is about to strike a pedestrian, then it seems irresponsible not to shout a warning to prevent injury or death. Certainly a knowledge claim about, say, the consequences of nanomedicine may turn out to be mistaken without being necessarily ethically improper. But a forecast may only be properly made if it is made on the basis of sufficient knowledge, experience and evidence. It must surely be improper if those conditions are lacking. Toulmin (1969, p.183) argues that if a prediction is to be that is more than guess work then the forecaster must be in a position to produce sufficient warrant for the prediction. Here we must make a distinction between the scientific concept of prediction and the futurological concept of prediction. In the former case it is possible to produce clear accounts of both initial conditions and relevant natural laws. However, in the latter case, in trying to develop social foresight about the embedding of technology, we are always in a state of double ignorance both in terms of being able to specify the initial conditions and the relevant (social) laws (in the absence of any 'science of society').

#### **4 The Ethics Of Forecasting**

My argument therefore is that the conditions required for the kind of foresight (knowledge about the future) to warrant the use of forecasting are almost entirely lacking. This is a radically sceptical position. We simply don't have and indeed cannot have the requisite information about the future. Anthony O'Hear, just one of many critics of technological forecasting writes: '...In so far as such predictions cannot be made with any certainty, technological forecasting is largely a bogus and fraudulent enterprise' (O'Hear, 1989, p.221). This is a strong assertion. O'Hear's reasons for this claim include: our ignorance of nature and the uncertainty of technical effects; uncertainties and complexities associated with the social embedding of technologies; and our ignorance (in principle) of technologies not yet invented. In fact forecasting can cultivate dangerous delusions either about the beneficial effects or the harmful effects of some putative technology or social policy (Sherdan, 1998 ). Dublin (1990) provides ample evidence in the education, military and health sectors of the baleful effects of forecasting.

The history of technology is replete with examples too numerous to mention of unpredicted, undesirable and unintended consequences of technologies promoted to shape the future. Remember the 'atomic age'? The lesson of history is that we just don't know how things will turn out. Saxl (2005, p.31) acknowledges in the case of the application of nanotechnology to medicine that this is at an 'exploratory' and 'discovery' phase so that an ethical or social assessment is almost bound to be tentative. He comments: '... This future orientation has also made nanotechnologies vulnerable to the current *zeitgeist* of overclaiming in science, either the potential benefits or harm. Perhaps the first ethical issue is the frequent use of the word 'will', about future outcomes that cannot be known. This sometimes seems to express an 'article of faith' about science that would present a problem if it generated a false impression of the inevitability of future developments. Equally there is a need to be careful about placing premature weight on speculative concerns about nanotechnologies raised ahead of evidence' (Saxl, 2005, p.31). Here, of course, we must distinguish between those who use forecasting simply as a means of promoting their particular cause and those who genuinely think they may have some insight into the future. The former are morally culpable in a different way.

The case here is not simply that of the philosophical sceptic's criticisms of induction on the grounds that we may be mistaken although this is indeed the case. There is plenty of empirical evidence that contemporary forecasting techniques are no more successful than traditional prophetic techniques involving yarrow sticks or the entrails of various animals. For example, Philip E. Tetlock's (2005) study of expert political judgement took a sample of around 300 political experts (pundits given to pronouncing on current and future political events) and assembled more than 80,000 predictions. How well did they do? Well, they did very badly in foretelling the future course of events – it seems rather like the game of pinning the tale on the donkey whilst blindfolded. The success rate was little better than chance. Similar results were obtained by Sherden (1998) in a study of economic and technological forecasting. You might as well toss a coin as pay for a consultant. The claim is more than that forecasters may be simply be mistaken. It is that they just can't have the warrant for the claims they make even when these are made in a guarded way with liberal sprinklings of 'may' or 'probably'.

O'Hear's charge that social foresight and technological forecasting are '...largely a bogus and fraudulent enterprise' (O'Hear,1989, p.221) may appear to be a rather harsh judgement. This is saying more than the forecasters are just plain wrong but also that they are morally culpable in some way as well. What can we make of this, given the claims made by futurists for professional status? Richard Slaughter devotes a whole chapter of his book to 'professional standards in futures work (Slaughter, 2004, pp. 31–46). Slaughter discusses quality control and differentiates 'good' futures work from 'bad' futures work in the following way '... 'good work' could simply be work which is clearly productive and which achieves positive aims and goals that it set out to achieve. 'Bad work' might be defined as work that is mystificatory, unclear, aligned with the interests of regressive social entities and/or motivated by lower level human motives such as power, greed, or in a word, ego'. This is all very fine no doubt but the criterion being invoked here for 'badness' or 'goodness' is one that is related to political or moral position. But surely what we have a right to expect from the futurist is truth?

One defence of forecasting is to claim only that we are claiming that some state of affairs 'may' come about or some event is 'probable'. There are obviously clear distinctions to be made between claims to 'know' something is the case, that something 'may' happen or that something is 'probable'. But these are much weaker claims but even so don't get us out of the moral fix of having to deliver. Toulmin (1969, p.50) points out the logic of the meaning of such words. For example, we are prohibited from saying 'I know it is so, but I may be wrong' and just as we are prohibited from saying 'I promise I will, but I may fail'. Promising is a moral commitment to success just as 'to know' is a commitment that not only do you believe something is the case but that it is, in fact, the case and that you are in a position to know that it is the case. Similarly even if one says that something 'may happen' or 'probably will happen' this carries with it a moral charge. Toulmin (1969, p.52) writes that '...if you use the word 'probably' in predictions correctly, you are not permitted to prove mistaken either always or often, even though you are expressly covered every time. In predictions as in promises, by saying 'probably' you make yourself answerable for fulfilment on a reasonable proportion of occasions'. And, of



course, as we have seen, even on empirical grounds, our forecasters cannot deliver on their promises.

## 5 Forecasting Ethics

The problems of scientific and technological forecasting are often assumed to be a matter of tracing the various alternative trajectories of change. However, a much more profound and problematic requirement is an ability to be able to foresee the kinds of choices people might make in the future – forecasting the moral future. As in other areas we cannot just assume that the future will be in some way like the present; that future generations will share the same values that we have. The history of morality is a history of changing values or at the very least a history of the changing interpretation of fundamental values. We cannot simply assume that our current moral assessments will continue to obtain into the future. The values and moral vocabulary that we do in fact have are the outcome of, and have evolved to meet, past human predicaments. The application of moral concepts and principles to new situations shaped by radical new technologies may be a matter of decision rather than definition; decisions which cannot be made before the event.

In reflecting on the problem of predicting the moral future A.C. Grayling (1997, p.1) writes that: ‘...Predicting the future is a mug’s game. Consider horse-racing: you can be an experienced punter who knows exactly the form and going, but your horse might lose nevertheless. Yet this is a simple species of prediction where chances are calculable. It is infinitely otherwise with social attitudes and practices, where ‘chaotic’ effects – in the sense of small initial factors ramifying into large differences later – apply to already complex questions’. To assume that the kinds of technologies we end up with in future are indifferent to human values and action is to espouse a ‘hard’ determinism which is untenable when confronted with the realities of human freedom and human choice. Again we simply cannot know what kinds of choices human beings, either individually or collectively, are likely to make in the future. As Grayling observes ‘...the difficulty increases when one adds the fact that, in thinking about moral values, there is a close relationship between saying how things might be and how things should be – at very least because when one says ‘matters will probably be thus’ one is immediately tempted to add either ‘and so they should’ or ‘they should be otherwise’ (Grayling, 1997, p.1)

Just how can we know what future generations may or may not value? It is difficult to see how we might address our moral obligations to future people if we really are unable to forecast accurately the consequences of the adoption of radical technologies (Parfit, 1985). This value uncertainty is linked to the ways in which in retrospect our moral assessments change. Moral values change over time and those who promote revolutionary conceptions of technological change (‘the nanotechnological revolution’) in particular suggest that values often shift quite rapidly. The emergence of new facts and events change our valuations - the defeasibility of past moral judgements. Again the relevant principle (it seems to me) in forecasting ethics is that of ‘ought implies can’. If we agree that we are ignorant of the kinds of choices people will make in the future, that is we just cannot know, then we cannot reasonably have a responsibility to predict what those choices are – since this would be clearly paradoxical.

## 6 Conclusion

I want then to conclude by agreeing with O'Hear that social foresight and technological forecasting are essentially fraudulent activities which at best are temporarily delusive but at worst may constitute a waste of valuable resources. Futurists simply can't deliver what they claim to deliver. The reasons for this are both empirical and ontological. The very nature of the world and of human freedom is such that we just cannot have the kinds of insights that Futures Studies are after. If we accept this conclusion then we can't have moral obligation to approach making 'better ethics' in the case of nanotechnology or any technology in this way. This is not necessarily a negative conclusion in the sense that it should free us up to focus on the ethical issues at hand. The positive conclusion is then one of developing and maintaining ethical awareness and responses as events unfold. Of course we need to make plans and project ourselves into the future but this is rather different to conceiving of the future as some set of possible worlds waiting to greet us. As Wittgenstein puts it in the 'Tractatus':

- 5.1363 We cannot infer the events of the future from those of the present.  
Superstition is nothing but belief in the causal nexus.
- 5.1364 The freedom of the will consists in the impossibility of knowing actions that lie in the future. We could know them only if causality were an inner necessity like that of a logical inference.

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