

Nanotechnology and Technomoral Change

Tsjalling Swierstra

University of Maastricht

Centre for the Ethics and Politics of Emerging Technologies

t.swierstra@maastrichtuniversity.nl

ABSTRACT

If nanotechnology lives up to its revolutionary promises, do we then need a ‘new’ type of ethics to guide this technological development? After distinguishing different senses in which ethics could be ‘new’, I focus on the phenomenon of TechnoMoral Change. Emerging technologies like nanotechnology have the potential to destabilize established moral norms and values. This is relevant because those norms and values are needed to discuss whether technological developments are desirable or not. I argue that to respond adequately to technological changes in our lifeworld we cannot afford moral rigidity but should rather develop ‘moral resilience’. This requires that we stop framing the relation between technology and humans in terms of who governs over whom. Instead, we have to explore how both mutually shape one another. I conceptualize technology’s influence on morality in terms of de- and restabilization, identify several mechanisms of technomoral change, argue that such change usually doesn’t occur on the level of individual norms but on the level of moral constellations, and end with a plea for technomoral learning.

KEYWORDS

Nanotechnology, technomoral change, hard and soft impacts

1. Introduction

Nanotechnology was born in a cradle of great expectations. (e.g. Roco & Bainbridge 2002). Its proponents claim that this family of technologies will revolutionize our ability to manipulate matter, and that as a result nothing will ever be the same again. The question the organizers of this seminar have asked us to reflect on is whether this means that nanotechnology demands for a new type of ethics ? Does it?

First, it is not clear how best to understand this question. It is not evident in what sense ethics – understood as the systematic reflection on morals – can be ‘new’ at all. For example, since its conception ethics has always concentrated on two problem fields. On the one hand *rule-ethics*, which deals with establishing what people owe to each other in specific contexts (and sometimes even: what they owe to non-humans, as in the case of animal ethics). On the other hand *good life ethics*, which deals with the question that Socrates already pressed on his unwilling co-citizens: ‘How should one live?’ Now, it is

quite implausible that the emergence of nanotechnology will add a third problem fields to these two existing ones.

Furthermore, ethicists more or less agree that ethical reasoning is guided by a limited set of ‘grammars’ or ‘logics’. When agents justify or condemn, praise or blame certain situations or actions, they typically point to consequences (consequentialism); to rights and duties (deontology); or to virtues that are conducive to human flourishing (virtue ethics). These three strands of ethical thought are respectively linked to the names of Bentham, Kant, and Aristotle. Now, whatever nanotechnology will bring us, I am confident that we will discuss its impacts in terms of these consequences, obligations, and/or virtues. Thus far, all arguments pro and against nanotechnology or its applications have followed these argumentative structures. More specifically, all stock arguments related to new and emerging science and technology (NEST) in general, like ‘One cannot/shouldn’t stop progress’, ‘God wants us/doesn’t want us to innovate’ and ‘One should/should not take citizen’s responses seriously’ can also be traced in nanotechnology discussions. (Swierstra & Rip 2007). So on this level too, there seems to be nothing new under the sun.

It seems unlikely that nanotechnology impacts the basic structure of ethics. However, I do think it is possible that nanotechnology will cause ethical innovations on on at least four points. First, there can be a shift in the relative importance of the ethical problem fields or grammars. At his moment, public ethics is usually rule-ethics. Good life ethics is oftend treated as subjective and privat. This hierarchy is reflected in the public concerns about nanotechnology. For instance, at this moment 99% percent of public attention is devoted to the toxicity of nanoparticles and/or to it environmental impacts. These issues squarely belong to the problem field of what we owe each other, and are typically discussed in terms of consequentialist and deontological ethics. As yet, there is little public concern about nano-enabled devices, for instance nano-cameras or theranostics, will affect our practices, the quality of our lives. But when non-toxic nano-devices will become available, we can expect a more prominent role for ‘good life ethics’ (virtue ethics) as the question ‘Do these devices, even if safe, really contribute to human flourishing?’ is then bound to become more pressing.

A second point where nanotechnology may affect ethics, is in the identification of who, or what, belongs to the moral community of subjects whose rights and interests should be taken into account by other agents. One way of understanding ‘moral progress’ is by seeing it as the gradual expansion of the moral community so as to include strangers, women, slaves, children, animals, micro-organisms, plants.... It is interesting to note that technology is an important driver of this type of moral progress. For a long time human splendour manifested itself in *combating* nature by applying technology. But ever since we started to believe that we are actually going to win this battle, our former enemy is generally transforming from an enemy into a stakeholder with rights and legitimate interests. If we take nanotechnology’s rhetorics seriously – that it will allow us to manipulate nature from the atomic scale up – then this technology is bound to transform the entire earth, with everything on it, into a moral subject: an entity that we have to take care of.

A third – connected - ethical innovation may occur with regard to the question to what practices we extend our moral considerations and ethical reflections. Normally vast domains or human activity are more or less exempted from ethical reflection. At

the one side of the spectrum we find activities supposedly governed solely by self-interest. For a long time ‘business’ was perceived in this way, with moral responsibility for the common good conveniently outsourced to an ‘Invisible Hand’. At the other side of the spectrum we find practices that are thought to be so morally unproblematic that they don’t merit ethical reflection either. Until recently science was perceived to be ‘beyond ethics’ because its practitioners were supposed to be so ‘rational’ and ‘truth oriented’ that they were considered to be by definition ‘moral’. Ethics was simply superfluous. Interestingly however, the last decades have witnessed a gradual opening-up of both these domains to ethics. As it became increasingly clear that economy’s Hand is not only Invisible but also Blind to legitimate concerns – for example those of People and Planet – Business Ethics and Corporate Citizenship have made considerable progress. At the other side of the spectrum, Science and Technology Studies opened up science and technology for ethical reflection by showing that both are human – Nietzsche would say: all too human – activities with no transcendent qualities. Nanotechnology might give an additional boost to this ‘ethicisation’ of both business and science, as it straddles the two domains while at the same time raising public concerns. More particularly, if nanotechnology manages to evolve into a field of its own, ethics can be expected to play a role in the setting of the research agenda: what is to be developed, under what conditions, why, and for whom?

Finally, the more important nanotechnology will become, the more it will add fuel to already existing debates about the meta-ethical implications of the increasing entanglement of humans and technologies. For example, this entanglement has given rise to a call for a form of posthuman ethics that also includes non-human agents (Latour 1992 and 2005, Verbeek 2010). Also, the network character of modern science and technology has called forth increased reflection on the individual and collective responsibility. And, last but not least, the dynamic character of our technological culture has provoked calls for dynamizing morality, and ethical reflection, itself – so as to keep pace with the changing world in which humans are seeking to act. (Swierstra et al 2009, Boenink et al 2010, Stemerding et al 2010)

Nanotechnology, being a common denominator for a family of emerging technologies that are bound to change our world in manifold and profound ways, will contribute to changes that are already going on at all these four levels of ethics. This is relevant because we need those norms and values to establish whether certain technological developments are desirable or not. However, in this paper I concentrate on the last, meta-ethical, level, and then particularly on the need to dynamize ethics. Rather than in a biotope, modern people inhabit a *technotope*: a world in which human-made artefacts (devices, machines) have invaded every nook and cranny of our life world.¹ If we want to become able to respond adequately to technological changes in our lifeworld – including those summoned by nanotechnology - we cannot afford moral

¹ For my country this can be taken quite literally. If tomorrow the pumps would break down, more than half of the country disappears under sea level. Indeed, the Netherlands themselves constitute one big technological artefact. This might explain why here ‘technophobia’ seems less a viable option than in some other countries.

rigidity but should rather develop what I would like to label as ‘moral resilience’: an attitude that is simultaneously robust and flexible.

In section 1 I introduce two kinds of impacts of technology: ‘hard’ and ‘soft’ ones. Hard impacts are quantifiable, they involve a harm that is widely recognized as such, and the cause of the harm is identifiable. Think about pharmaceutical companies marketing drugs that turn out to impact our health adversely; or think about exploding nuclear reactors. However, technologies also have less tangible ‘soft’ impacts; they modify our relations, our values, our norms, our aspirations, our situation definitions, the meanings we attach to the world. In one word: technologies impact our culture. And a central part of that culture is our morality. One of the most important, but also one of the most understudied, ‘soft’ impacts of technology then is its impact on established morals.

Section 2 explores the interaction between technology and morality in general, pragmatist, terms. I argue that technology destabilizes moral routines, which then provokes ethical reflection and discussion, which then do or do not result in new ethical answers that re-stabilize into new moral routines. I’ll describe the relation between technology and morality as a *marriage*, but without the possibility for divorce. Both partners have no option than to make the best of their relation. This implies that they should be willing to learn from each other, protect each other, and help each other to flourish. My approach in this article is deliberately one-sided. I don’t discuss morality influencing technology, as I consider this side of the coin to be well documented by now. Instead I want to focus on the more controversial thesis: that technology deeply affects morality, *and that this can be okay*. I will be talking mostly *to* morality, trying to persuade it to finally wholeheartedly embrace its partner: technology. Allowing technology to influence morality doesn’t automatically turn us into technology’s slaves and victims. In section 3 I refer to so-called ‘technological mediation’ to distinguish different ways in which technology can influence – destabilize - morality. Section 4 then argues that moral change rarely manifests itself at the level of individual norms or values, but can better be understood as a shift in the *force field* that constitutes morality. The final section then concludes by pleading for techno-moral learning and by offering some ‘relation therapy’.

2. ‘Hard’ and ‘soft’ impacts

Without the permanent help of a pervasive technology, modern society would break down immediately. We therefore value technology as our indispensable servant who provides the means to our ends. The problem, however, is that technology hardly ever proves an obedient, trustworthy servant. (Tenner 1996; Geels & Smit 2000) Technology typically enters the stage couched in instrumental promises but after a while these promises invariably turn out to have been inflated and partial. (Van Lente 1993; Borup et al 2006; Selin 2007) We have learned the hard way that technology also carries serious risks to our Health, Environment, and Safety (Beck 1992; Giddens 1999).

But technologies do a lot more than being instrumental or risky. Apart from these ‘hard’ impacts, they also have ‘soft’ impacts: they co-shape our society and culture (Swierstra et al. 2009; Swierstra & te Molder 2012). An early example of such a soft impact can be found in Plato. In the *Phaedrus* (275a-c) Socrates warns that the alphabet – a human-made artefact and thus a form of technology - degrades people by making re-

membrance skills superfluous. Furthermore, Socrates continues, the alphabet is politically disruptive, as written texts provide the masses access to esoteric knowledge only meant for natural rulers. Since Plato, technologies have been permanently accompanied by concerns about their ‘soft impacts’. For example, as in the nineteenth century machines became common in the work place, people started to worry that technology would turn the tables on its creators, taking over their jobs, powers and privileges. Through Mary Shelley’s *Frankenstein* (1818/1831) this motif of a creator losing control over his technological creature, reached public consciousness. And already in 1872, long before anyone thought about computers or artificial intelligence, Samuel Butler’s *Erewhon* introduced its readers to the discomfoting idea that in the (then recently proclaimed) Darwinian ‘survival of the fittest’ machines would prove to be ‘fitter’ than their imperfect, inefficient creators.

Are we not ourselves creating our successors in the supremacy of the earth? Daily adding to the beauty and delicacy of their organisation, daily giving them greater skill and supplying more and more of that self-regulating self-acting power which will be better than any intellect? (Butler 1872, 90)

Especially in the first three-quarters of the previous century, cultural spokespersons – following the lead of Weber and Heidegger - worried that the rationalized order, the cold efficiency, and technology’s tendency to cater to material rather than spiritual needs, would eventually turn humans into slaves and ‘cogs in the machine’, even if happy and comfortable ones. And the happier the ‘slaves’, the less they would of course be inclined to revolt against unjust power hierarchies that oppress them (Marcuse, 1964). Aldous Huxley’s *Brave New World* and Charlie Chaplin’s *Modern Times* provide us with the paradigms for this classic, technophobic, approach to technology.

Over the past two centuries, the relation between humans and technology has been perceived predominantly in terms of a power struggle. At one extreme we find authors who argue, as we saw above, that it is the humans who should be in the director’s chair. Technology’s only legitimate role is to serve humans to realize their values and to satisfy their preferences. At the other extreme we find authors who side with technology. According to them, humans are unable to influence the autonomous pace of technological development, and thus have no choice but to cheerfully adapt themselves to technology’s demands. *Science Finds – Industry Applies – Man Conforms*, as the (in)famous motto of the Chicago World’s Fair in 1933 sternly informed the flocking visitors. Most of these enthusiasts hail science and technology for their calm rationality, cool objectivity, and imperturbable efficiency. In the famous words of Vannevar Bush, adviser to the USA President in 1945: “New products, new industries, and more jobs require continuous additions to knowledge of the laws of nature, and the application of that knowledge to practical purposes. “ (1945) But it should be noted that there are other enthusiasts, with an inclination towards romanticism, who hail science and technology for exactly the opposite reasons, for its being dynamizing and creative-destructive. (Berman, 1991) A classic example of this latter approach is the *Futurist Manifesto* from 1909. (http://www.shafe.co.uk/art/The_Futurist_Manifesto_1909.asp):

‘We declare that the splendor of the world has been enriched by a new beauty: the beauty of speed. A racing auto-mobile with its bonnet adorned with great tubes like serpents with explosive breath. (...) We want to sing the man at the wheel, the ideal axis of which crosses the earth, itself hurled along its orbit.’

Both kinds of enthusiasts stress that humans cannot – really, ultimately – change the course of technological development, even if they grudgingly admit that humans can somewhat frustrate and slow-down that development. But, they assure us, we shouldn't worry about the fact that our values are powerless to steer science and technology. Values are flexible and in the end always adapt to the technologically inevitable. Of course people are at first shocked and appalled by vaccinations, trains, and in vitro fertilisation. As yesterday's revolutions have become today's routines, today's revolutions will inevitably become tomorrow's routines.

My point is that these conflicting visions on 'who dominates who' are mistaken, because technology and society in fact co-shape each other. On the one hand, a plethora of sociological and historical studies has by now shown that societal influences do co-shape technology development's course. There is nothing autonomous about technology. (Bijker et al 1987, Bijker 1992) Think for instance of the current trend towards sustainable technology where societal concerns evidently shape the technology. On the other hand, one glance suffices to see to what extent our society and culture have been shaped by science and technology. Think for instance about how the the car changed the landscape, urban planning, youth culture, etc. Neither science and technology, nor society and culture develop autonomously. They co-evolve, constantly influencing and provoking each other. (Rip & Kemp 1998; Jasanoff 2004)

It is my contention that this co-evolution also applies to the relation between technology and morality – that very special sub-set of norms and values guiding our relations to other beings and defining what constitutes a good (successful, admirable) life. That moral values influence technology's development is at this point in history hard to deny. Safety, health, and sustainability, are all important moral values that have been built into technological artefacts (even if only after sustained societal and political struggle). The reverse is less readily accepted. According to many, morality is autonomous, universal and immune to external influences. Immanuel Kant argued that moral change was both a logical and a moral impossibility (Kant, 1965, 5). It would imply that today we could rightfully be condemned for acts that only yesterday were considered a moral duty. This condemnation would constitute an obvious injustice that would conflict with morality's kernel. And to date, the majority of ethicists still abhor, and thus ignore, *moral change*, because acknowledging the phenomenon would equal admitting to moral relativism – the most cardinal sin in any ethicist's book. The very few publications on moral change dwindle in comparison with the libraries that can be filled with studies claiming to unveil, finally, the universal and unshakable foundations on which morality is built. (Van der Burg, 2003) Philosophical publications that investigate the specific phenomenon of *techno-moral change* are even more rare. (Keulartz et al 2004; Swierstra et al 2009; Boenink et al 2010; Stemerding et al 2010) I intend to show that techno-moral change is very, very real, but that acknowledging it doesn't imply moral relativism in any serious sense.

3. Technology destabilizing morality

People in parts of Asia have already benefited for some years from this particular technological innovation, but it has only recently been introduced into the Middle East: arti-

ficial virginal blood. By inserting a simple capsule into her vagina, the bride can simulate having her hymen still intact. This is very conducive to the relation with her husband, because in these territories the virginity of the bride is still highly appreciated.

It is clear that this technology meets a societal need and embodies a value: even a woman who is no longer a virgin should still be able to enjoy respect and marriage.² But of course not everyone endorses this value. “This product encourages illicit sexual relations”, according to religious authority Abdel Moati Bayoumi. (quoted in the Dutch newspaper *De Volkskrant* 2009; my translation) Indeed, as people in the West know all too well, this fear that novel technologies undermine established sexual morals is far from far-fetched. Only a few decades ago, for example, the Netherlands witnessed a similar moral panic when the contraceptive pill was introduced (Ketting, 2000).³ Religious authorities sternly warned against female licentiousness. And who would, after the sexual revolution of the sixties and the second feminist wave of the seventies, dare to deny that their fears were well grounded and that sexual morality in fact did change? Even if most readers today don’t regard this *change* as moral *corruption*, it is hard to deny that a technological device like the pill did contribute substantially to this change.

Both the hymen-substitute and the contraceptive pill illustrate how technology influences morality. To better understand the underlying mechanism, we best distinguish morality from ethics (Keulartz et al., 2004). ‘Morality’ refers to a particular sub-set of values and norms. ‘Values’ indicate what is important or desirable, ‘norms’ describe what one should do to realize these values. In a formula: a value gives the ‘why’ of a norm, whereas a norm provides the ‘how’ of a value. Trust is a value, that one should keep one’s promises is a correlating norm. But not all values or norms are *moral*. The adjective ‘moral’ is reserved for issues of considerable importance, dealing with mutual rights and obligations, or with a conception of the good life. Not everyone, of course, always agrees on whether something is indeed important. For some chastity is a moral value to be publicly sanctioned if not enforced; for others it is merely a private option best left to the tastes and preferences of the individual.

Morality, as the pragmatist philosopher John Dewey was the first to point out, primarily exists in the form of practical routines that seem so self-evident that their impact on how we act, think and feel usually goes unnoticed (Gouinlock, 1994, 21-22). And this is how it should be. Explicitness and reflexivity are not things to be valued under normal circumstances. For instance, if you first deliberate whether or not to kill your obnoxious colleague, only to decide after careful reflection that you cannot do this because it would be immoral, then there is already something deeply disconcerting about you. The taboo on killing should be so self-evident that under normal circumstances one obeys it unthinkingly. (Williams, 1985) The more self-evident a norm, the less visible it is; the less visible, the more effective.

*Ethics*⁴, by contrast, refers to the conscious reflection and discussion on morality. One doesn’t do ethics just for fun. That effort needs an occasion. That occasion is pro-

² That this technology embodies a value, doesn’t imply that the inventor endorses this value. Maybe (s)he only recognized a business opportunity and acted on it.

³ As a matter of fact, compassion with women’s fate to be victims of their fertility did lie at the basis of the pill’s invention (Ketting, 2000, 283-284).

⁴ Or, in Dewey’s terminology: ‘reflective morality’.

vided when established norms and values, or our interpretation or application of them, become *problematic*. This happens for example in situations when values or norms are not (or no longer) obeyed or shared by everyone. This is why the ratio between ethics and morality changes when communities with different value systems meet, clash or co-exist side by side. But values and norms can also conflict within a community, or within one person. What to do if your friend just confided in you that he is unfaithful to his wife, and his wife questions you about his whereabouts? In such a case normally uncontroversial values like confidentiality and truthfulness come into conflict and have to be weighed against each other by careful ethical reflection. In such dilemmatic situations morality loses its self-evidence and its invisibility, and turns into a topic for reflection and deliberation. ‘Cold’ morality turns into ‘hot’ ethics: reified norms and values become fluid again, as a result of which they can be – if necessary – adapted, reinterpreted, reformulated, etcetera. (Swierstra & Rip, 2007) Moral self-evidences thrive best in a stable environment where they find continuous confirmation. But modern societies are defined by their dynamism, which is fuelled by scientific and technological developments. The consequence is endemic moral uncertainty and controversy.

In practice, morals don’t rely on persuasion alone. They need to be backed up with a credible sanction. Let’s turn back for a moment to the hymen-substitute and the contraceptive pill. Both technologies are or were perceived to be a threat to established sexual morality. Why? Because they enable the users of these devices to get away unpunished with transgressing the moral rules. The capsule makes it possible to avoid the social punishments of pre-marital sex: shaming, cancelling the marriage, or much worse. The pill allows women to escape the ‘punishment’ for sex in general: an unwanted pregnancy (and social stigmatization for unwed women). It is undeniable that in practical terms these devices do make it easier to dodge those norms. And many do seize the opportunity – secretly, or openly.

It is worth stressing that this mechanism doesn’t imply *automatically* the end of the (public) existence of these norms. Artefacts are often morally ambiguous. The capsule for instance, makes it simultaneously possible to escape from the virginity-norm, and to confirm it. After the introduction and the diffusion into society of capsule and pill, there remain hosts of women and men who firmly stick to their moral beliefs. For them, chastity remains highly laudable and pre-marital sex remains highly reproachable. And the pill can, in a patriarchal context, actually disempower women, because the device makes it impossible for them to withhold sex from their husbands by ‘threatening’ with an unwanted pregnancy. In this context, the pill can increase women’s sexual availability. Furthermore: the immanent undermining of a norm or value often provokes powers to come to their defence, for example in the form of priests and imams, and the outcome of this trial of strengths is always uncertain. So, new technology challenges existing morals, but the outcome of the ensuing ethical controversy is always uncertain, as it depends on other factors too.

4. Technological mediation of morality

For decades now, philosophers have studied the various ways in which technology ‘mediates’ our relation to the world. Verbeek (2006) distinguishes two – complementary –

traditions. The *hermeneutical* tradition draws its inspiration from phenomenology, with Heidegger, Merleau-Ponty and Ihde as its main representatives. This approach explores how technology discloses the world to our sense experience, e.g. how new scientific instruments make new ways of perceiving reality and thus new forms of knowledge possible. The *existential* approach, as for example exemplified by Actor Network Theory, explores how technology affects our relation to the world by opening up (or closing off) practical possibilities. In short: technology influences, or mediates, how we interpret the world and how we interact with the world. This distinction is also useful for analysing technology's influence on morality.

The hermeneutic dimension

Technologies can destabilize morality by throwing a new light on things. Or by hiding morally relevant parts of reality from sight. I distinguish three such mechanisms.

First, technology can provide us with new knowledge about the *consequences* of our acts. That is morally relevant insofar we justify our norms, values, or practical choices by pointing at (intended) consequences. An example: when I was young it was fairly common to offer guests a cigarette. This was considered to be hospitable and civil. Were one to do the same today, the response would in all likelihood be shocked rather than pleased: 'Do you want me dead?!' Norms have changed because we now realize that smoking is dangerous. But this knowledge we owe to technology, for instance to the X-rays that made us aware of the tar and tumours in our lungs or to the computers that uncovered statistical relations between smoking and cancer. Similarly, when a visibly pregnant woman is enjoying a glass of wine, that will now be frowned upon by the rest of the party. Because today we know what alcohol does to the foetus. New science and technology help generate new knowledge with regard to the consequences of our actions. In this way it can make previously acceptable or laudable behaviour reproachable. Or vice versa: in earlier times washing oneself was considered not done, now it is a duty.

But technology can equally blind us to the consequences of our actions. It is characteristic of much technology that it increases the spatio-temporal distance between using the technology and becoming aware of (all) its consequences. When people chopped wood to warm their houses, it was fairly easy to see what that did to the local environment. But now that most enjoy central heating? That technology hides from sight where the energy we use comes from. And few will link the agreeable temperature in their rooms to the BP oil spill in the Gulf of Mexico in 2010.

Secondly, new technology can make us aware of *stakeholders* of whose existence we were previously not or only dimly aware. The concept 'stakeholder' refers to those parties who carry the consequences of our (in)actions, and thus have a 'stake' therein. In general terms, acting morally means at least that we take the rights and interests of these stakeholders into consideration while making practical choices that affect them. But who gets acknowledged as stakeholder? The answer to that important question turns out to be often mediated by technology. Our concern with the hungry and down-trodden in developing countries cannot be separated from the images our television shows us and from the stories in our newspaper (Boltanski 1993). As long as we were unaware of their misery, we were under no moral obligation to help. Now that technology

has opened our eyes, we are.⁵ So, morality has changed under the influence of technology

Another example, closer to home. Medical technology influences what we perceive to be truly human life, worthy of protection. Before technological progress enabled us to follow (and intervene in) life's progress from conception, life more or less started at birth. But technological progress now has us debate whether a single fertilized egg cell qualifies as human life, worthy of protection. (Singer, 1994) Similarly: embryos could only enter the stage as moral subjects since technology made them visible. (Verbeek, 2008) And it is only to be expected that the moral status of (many) animals will change, when MRI-scans start to show that their brains react to fear, pain and boredom as human brains do.

Again, the reverse also happens. Half a century ago, the German-American philosopher Günther Anders pointed out that modern weapons of mass destruction cut the tie between actor and victim. (Van Dijk, 2000) An employee in the Pentagon can now push a button before going home to eat with his family, while at the other side of the world people die as a result of this button-pushing. That is a radically different way of killing than killing from close-by, for instance with a knife.⁶ Modern technology can keep the stakeholders out of sight, and thus helps to still any moral qualms. On the other hand, the constant observation of the target that precedes a drone attack can help establish a (involuntary) bond between killer and victim.

In the third place, history has shown how technology is able to shake up established ways of perceiving the world's order, and our place therein. And sometimes this translates into destabilizations of existing conceptions of the good life. To take the most famous example: Galileo Galilei, looking through his telescope – the Renaissance's *high tech* – declared that the sun doesn't revolve around the earth, but the other way around. When the earth turns out to be an infinitesimal speck of dust in a dark corner of the Universe, the established worldview of a well-ordered Creation where God placed humans at the apex, crumbles. The biblical story of Genesis becomes untenable, and – at best – lingers on as an allegory. Similarly, genetic and aetiological research – building on foundations laid down by Darwin – has demonstrated how small the differences are that set us apart from apes. This finding has relocated morality itself firmly within the domain of natural history (de Waal, 2007). As a consequence, we now have to re-evaluate fundamental moral notions like responsibility and guilt. If criminal behaviour is partly produced by our brains, shouldn't we label an offender diseased rather than evil? And what exactly do we mean by 'diseased'? New technologies promise that soon diseases will be diagnosed long before they become symptomatic. That is good news, as it opens the door to preventive medicine. But will this imply that we can be 'pre-symptomatically ill'? (Boenink, 2009) Trying to answer such questions is not exclusively a theoretical af-

⁵ Or to put it more precisely: we find ourselves under a *prima facie* obligation to do so. In reality, there can be other obligations that are more pressing, and that overrule this obligation.

⁶ In Krzysztof Kieslowski's film *Dekalog 5* (1989), a cinematographic reflection on the Biblical commandment 'Thou shall not kill', he explores this contrast between direct and this indirect forms of killing in an extremely confronting way.

fair. Labels like ‘diseased’ or ‘healthy’ carry practical connotations, for instance whether one has to undergo therapy, or whether one is still insurable.

The existential dimension

To summarize, technology influences morality by making us interpret the world differently. But by allowing new novel ways of acting in this world, technology also effects moral change. Technology undermines the boundary between Fate and Will (Grunwald, 2007): what was ‘chance’ yesterday is transformed into ‘choice’ today. (Buchanan et al. 2001) And by increasing the domain of choice, technology also increases the domain of morality. For example: at this moment most people condemn ‘doping’ in sports because it makes the competition ‘unfair’. But hardly anyone protests against the ‘natural’ biological differences amongst sport men and women, although no one can deny that these too do affect chances of success. That’s just how it is, isn’t it? But what if gene doping evolves to a stage where these ‘given’ differences can be redressed? Where technology can finally create a ‘level’ playing field? Would the (controlled) use of doping then increase or decrease the ‘fairness’ of sportive competition? How ‘natural’ and ‘given’ are biological differences, if technology enables us to neutralize them (Buchanan et al., 2001; Sheridan, Pasveer & Hilvoorde, 2006)? Would we not be morally obliged to neutralize such differences? Don’t the people who are ill-treated by Nature have a moral right to medical – that is: technical – help? If we refrain from redressing such differences even when we could, this means that we deliberately choose them. And thus accept responsibility for their continued existence and role.

This extension of the moral domain rests on the ethical axiom that one can only be under an ethical obligation, or possess a moral right, when the moral action is in fact doable. *Ought implies can*, as David Hume put it in 1740. (Hume 1987, 521). I am under no moral obligation to save a drowning person when I cannot swim or when circumstances make saving impossible. But if my abilities (I learn to swim) or the circumstances change (the storm quiets down, a boat becomes available), then a moral obligation can arise. *Can* sometimes implies *ought*. In this way, by creating new practical opportunities, technology tends to create new obligations and rights.

Together with opportunities for new actions, new technology can help create new responsibilities and can cause existings distributions of responsibilities to be renegotiated. (de Vries, 1989) By increasing our powers, technology increases our accountability. The contraceptive pill makes women more accountable for their pregnancies. The increasing availability of personalized genetic risk profiles will make us accountable for our health to a degree that is as yet still unimaginable. The technological availability of pre-natal and pre-implantation diagnostics makes parents and doctors co-responsible for the quality of unborn life. In a ground-breaking court case in 1996 in the Netherlands, the parents of the severely handicapped child ‘Kelly’ sued the hospital, because the gynaecologist had judged it unnecessary to research the foetus, even though at the time it was known that the family had a history of severe hereditary disease. And it doesn’t require a leap of the imagination to see that in a not too distant future handicapped children might sue their own parents for ‘wrongful birth’.

The practical possibilities created through technology also call forth new questions pertaining to the question ‘What is a good life?’ Test tube babies, for example, can make us question whether there exist ethically relevant differences between ‘receiving’ and

‘taking’ children. The debate on human reproductive cloning revolved around the question whether it is allowed to turn humans into replicable products, even if these replicas wouldn’t suffer any physical or psychological harm. The possibility to genetically test or even enhance embryos raises similar issues. What kind of attitude toward imperfection manifests itself in these types of technological projects and fantasies? And how desirable do we deem such an attitude to be? Is a good life really a life with as little imperfections as possible, or is it a life that can deal with these imperfections by turning them into something meaningful? (Kass 2002; Sandel 2004) What is the ethical value of suffering, if any? Is it truly desirable to push back completely the role of Fate by extending our control over more and more domains of reality, or is openness towards what comes to us, towards what happens to us, essential for living a *human* life?

Technology doesn’t only causes us to raise moral questions about the good life, it also affects the answers. Technology makes some answers harder to defend, while other answers are made more acceptable. Take the example of Pre-Implantation Diagnostics. When in earlier times a child was born with a severe handicap, that was, as it of course still is, a tragedy for both child and parents. But as it was impossible to avoid such a tragedy, the only thing to do was to bear the burden as something decreed by God, or Fate.⁷ In such a case, ethics played an important role in answering the question how to integrate this tragic situation into one’s life story. And sometimes child and/or parents were indeed able to do so. It was even possible that afterwards they would conclude that their lives had been enriched and made more meaningful by the experience. Of course, this is never the whole story, and it certainly doesn’t hold for everyone in such a situation, and outsiders should never request such heroism from parent or child. But such enrichment did (and does) occur. And outsiders can admire it, even if they wouldn’t change places for anything in the world.

Now, this situation changes drastically when certain new technologies become available to prospective parents. First of all, thanks to these technologies we now know more about the consequences of the mother’s lifestyle for the foetus. This introduces novel responsibilities for the mother. Interesting prediction: the more we will learn about how the behaviour of the prospective mother influences the well-being of the foetus, the more this will translate in further moral obligations for these mothers. And in discussions how the conflicting interests between mother and child should be negotiated. Furthermore, thanks to new diagnostic technologies some handicaps become avoidable, at least in the sense that one can prevent such a child from being born by not implanting the checked embryo in the womb. Previously the prospective parents lacked a choice. Now technology provides them with one. And this fact alone changes their moral situation profoundly. This is manifest on the societal level, as there are some signs of a growing pressure on women in known risk groups to make use of the new diagnostic technologies. (Isarin, 2002)

On a deeper level, the situation is now also morally changed. If we understand Fate and Free Choice as the two extremes on a gliding scale, than Pre-Implantation Diagnostics alters the birth of a handicapped child from being a matter of Fate into something

⁷ Of course, one has to realize that medical technology here makes yet another difference: whereas in earlier days severely handicapped children would often die soon after being born, modern technology now keeps them alive longer and more often.

like a Conscious Choice – even if it goes much too far to say that parents who decline these diagnostic technologies freely choose to have a handicapped child. Technology has created a new situation in which abstaining from a choice is turned into a choice in itself. In the case of choices that weigh heavily on the well being of others, moral justifications may and will be demanded from prospective parents.

To conclude, new technologies do much more than expanding the space for free individual choice, because they turn existing, and potentially valuable, ways of dealing with Fate into something morally problematic. The availability of re-implantation diagnostics itself doesn't force people to use this technology, but it does fundamentally alter the ethical – and not only the social - field in such a way that it becomes harder not to do so.⁸

5. *Morality as a forcefield*

Until now I restricted my analysis to technology's influence on one isolated norm or value. This is of course a gross oversimplification.

Let's return for a moment to the example of the contraceptive pill. (Ketting, 2000) Before its introduction in the Netherlands a conservative sexual morality reigned: only sex with one's spouse; sex solely for sake of reproduction because hedonism is very wrong; women are allowed less than men and it is in particular their sexuality that is guarded; there is precious little talk about sexual autonomy for women (as a result of which marital rape is considered a logical and legal impossibility); and abortion is a crime. In the decades after the pill's introduction, under the headings of 'women's liberation' and 'sexual revolution', these sexual morals were radically transformed. In the Netherlands it is now acceptable to experiment sexually before marriage, the link between sexual intercourse and reproduction has become contingent on conscious choice, lust is no longer frowned upon, sexual autonomy for women has become firmly entrenched as a moral principle, marital rape has been made punishable by law, and children are planned rather than received.

⁸ By the way, this last example shows that we shouldn't attach too much weight to the previously introduced distinction between the hermeneutic and existential dimensions of technological mediation. The fact that we can change things that we previously had to accept (= existential) is sufficient to put the situation in a new perspective (= hermeneutic). In practice, both dimensions are often intimately connected. With another example: the increased mobility, enabled by technology, puts us into contact with other communities and cultures, which serves to destabilize established perceptions of the world. Or: when new technologies convince people that their miserable condition is changeable rather than given and unalterable, they will morally redefine these conditions as being unjust. Vice versa, when technology makes people aware of previously unknown consequences or stakeholders, this often motivates them to avoid these consequences and to help these stakeholders. Perception and action, action and perception, mutually inform each other.

In short, this technological device – the pill – has proven to be a motor of moral change. But let us not overstate the case. More than forty years after the pill was introduced, there are still many Dutch citizens for whom nothing has changed: they deliberately live their lives within the moral perimeters of the fifties. For another group the pill made little difference for the opposite reason: long before its introduction they had already opted for sexual libertarianism and/or female autonomy. And more generally: the desire for birth control and non-reproductive sex is considerably older than the technological devices that made both possible.⁹ So, the older morality has not completely been substituted with a modern one, nor is the modern one truly modern. On the other hands: sexual morality *did* change since the sixties. There is both continuity and discontinuity. In what terms, then, can this change best be described?

Morality should be understood as a *force field* wherein conflicting norms and values compete for hegemony. In this competition, technology can and does sometimes tip the scales. The pill created new conditions that enabled more people than previously to take the dominant norms and values less seriously, while previously marginalized norms and values could come to the fore and gain societal acceptability. As I pointed out in section 2, the pill helped undermine the moral principle of female chastity by enabling women to ignore this principle ‘unpunished’. But the same device also had a considerable influence on the moral perception of abortion. A pragmatic general objection against contraceptive devices was their unreliability. Using these devices could therefore result in unwanted pregnancies, and thus in an increase of (illegal, immoral, dangerous) abortions. The fear to become co-responsible for those abortions led a majority of General Practitioners to discourage these devices. The contraceptive pill proved to be a major technological breakthrough in this respect. In effect it constituted the first truly reliable contraceptive device in history. As a result, the previous pragmatic argument was now turned upside-down: if a general practitioner wanted to help decrease the number of unwanted pregnancies and abortions, (s)he from now on had to champion the pill.

This example of the contraceptive pill helps to illustrate a more general pattern. Moral change doesn’t take place on the plane of individual, isolated norms and values, but on the plane of morality as a whole. Morality should be perceived as a texture with admittedly vague boundaries, and as pervaded by tensions between conflicting values and norms. These tensions can be more or less pacified by allowing each a separate field of application or by establishing a hierarchy between them, or they can be hidden by compromises and trade-offs. This situation is usually referred to a value-pluralism, but this concept can be misleading. Research shows over and again that people don’t differ all that much when you ask them which values they hold to be important. Differences mainly show up when one tries to determine the relative force of these moral principles. This can only be determined in relative terms, that is: by comparing the force of one moral element with the force other moral elements exert. These relative differences show up when people find themselves in a situation where they are forced to choose between conflicting values and norms. For example, assume that I both attach value to the happiness of my daughter and to the social standing of my family. I will only find out which value exerts the most force upon me, when I arrive in the extremely unfortunate situa-

⁹ The relevant technology is also much older than the pill. In the Middle Ages condoms made out of a pig-bladder were already in use.

tion that I am forced to choose between the two. Then differences become visible between my choice and that of other parents faced with the same dilemma. In moments of truth, people choose differently. Some norms or values prove to be pulling harder than others.

Understanding morality as a force field helps to understand the interaction between technology and morality. By mediating our (hermeneutic, existential) relations to the world, technology influences a) the relative force of norms and values, and/or b) the quantity of people they appeal to. Take for example the situation where technology mediates our perception of the consequences of our actions. This mediation can strengthen or weaken the force of a norm. The prohibition to masturbate has by now lost virtually all its force, the ban on smoking and drinking for pregnant women grows more stringent every day. A norm also increases in strength when we perceive new stakeholders, as the obstetrics example illustrated. If technology makes it easier – or more difficult – to help those in need, the strength of the relevant norms and values waxes - or wanes - accordingly. And so forth.

It needs pointing out, though, that it is not always easy to determine how a norm or value is modulated by technology. For instance: does a hymen substitute undermine traditional morals underpinning the importance of virginity, or does this technology help to prolong these morals by enabling people to avoid a direct confrontation?

6. *Techno-moral learning*

Does the theoretical approach outlined above have practical relevance? More particularly: does it help to enhance ‘responsible innovation’ in the field of emerging technologies in general, and in that of nanotechnology in particular? I think it does. In the first place it provides us with an alternative to the traditional focus in philosophy of technology on the question: who dominates who? As stated at the beginning, it can no longer be denied that norms and values co-determine human decisions on the course of technology development. Morality helps to single out more desirable options from less desirable ones, even if she has to share the stage with economy and politics. But the hope that morality can constitute an autonomous force laying down the law to technology, is naive. She herself is constantly provoked and influenced by technological developments. I have tried to show that there is no reason to be concerned about that influence – notwithstanding what classic philosophers of technology like Heidegger, Ellul or Marcuse have told us. Specific technologies can modulate moral choices and decisions, by making some options more pressing or attractive, and others less so. But this doesn’t imply a loss of morality, or moral decay. It can easily lead to more or better morals, for instance by enlarging the moral community of stakeholders. In this way, the relation between technology and morality appears as a marriage between two partners who neither have nor desire absolute autonomy. Is it possible to say something about the quality of that marriage?

Technology can help to stabilize and affirm norms and values, as well as help to destabilize and undermine them. The latter possibility is the more interesting, even though destabilisation is usually primarily conceived to be a problem. When it is unclear what moral routines we can still rely on, that not only makes our own lives more difficult, it

also burdens our relations with others. These relations require mutual trust, but this trust is hard to establish when partners are uncertain what norms and values apply. So, a technologically induced destabilisation of morality constitutes a problem, but it is also a gift as it invites us to reflect, discuss, learn and improve. Anyway, fun or not, destabilisation is unavoidable in modern societies, as these are characterized by their dynamism. (Misa et al 2003) We simply have no other option than to reflect on how best to negotiate this fact of modern life.

Ethical controversies on emerging technologies like nanotechnology are often marked by a revealing asymmetry. Technology promoters stress that the *new* technology will help realize *existing* values: less disease here, less hunger there, and it is great for the environment too. Their conclusion: it is immoral to obstruct this marvellous new or emerging technology. Opponents and sceptics equally tend to stress the novelty of the emerging technology, but they present this novelty *as a threat* to existing values. For this reason, they argue that the technology is immoral. Notwithstanding these surface differences, we can now discern an underlying complicity between promoters and opponents: technological innovation may be good or not, but the standard against which this innovation is measured is current morality. *Moral* innovation, in stark contrast to *technological* innovation, is rarely acknowledged, and even more rarely applauded.¹⁰

One could say that Western cultures are, by and large, growing accustomed to the idea of scientific and technological innovation. One could even say that we have become addicted to it. But this is certainly not true for moral innovation. We may be or not be technological revolutionaries, but most of us remain moral conservatives. And that is probably understandable. Norms and values seem to a larger degree to constitute someone's identity than facts and artefacts do. (MacIntyre 1981) Although I have no evidence to offer for this claim, it is telling that most people are able to discuss the validity of their factual claims fairly detached, whereas the questioning of their normative claims easily runs into touching their nerves. Moral controversies get emotional much more quickly than scientific or technological discussions, even though there too emotions can flare. When our values and norms are seriously questioned, we experience this as a personal affront. But, understandable as our moral conservatism may be, it frustrates dealing in an open and fruitful manner with technology's challenges to morality. It keeps the door closed to *techno-moral learning*.

Let me try to clarify this with an example. (Swierstra et al 2010) The first organ transplantation – of a kidney – took place more than fifty years ago in the U.S.A. Reaping the benefits of this technological revolution was slowed down, however, by the then prevailing definitions of 'death'. It is clearly immoral to take vital organs out of living donors.¹¹ On the other hand, organ transplants only have a chance of success when the bodily functions of the donor haven't yet ceased completely at the moment of donation. In other words: the donor should be dead enough, but not yet completely dead. As a re-

¹⁰ What comes closest, is the 'argument of habituation' (Swierstra & Rip 2007), used by technology promoters, which holds that morals will slavishly adapt to the dictates of 'inevitable, unstoppable' technological progress. This argument acknowledges the phenomenon of moral change, but only by denying all agency to morality.

¹¹ This is why the first successful organ donation regarded a kidney, as people have two of them and can – in principle – spare one without dying themselves.

sult of the new transplantation technology, the rights of the donor now came into conflict with the rights of the patient in need of the organ. Techno-moral restabilization required a few years, but in the end the introduction of the morally innovative definition of ‘brain-death’ made it possible to take organs out of bodies that were still alive under the old definitions.

As crucial as this *moral* innovation was, it didn’t suffice to help transplantation technology make its decisive break. For this, a *technological* innovation was needed first: the invention of Cyclosporin, a drug suppressing immune reactions. Now, finally, organ transplantation could begin to fulfil its initial promise. But while doing this, it immediately created a new moral issue. Technological success transformed transplantation medicine from a marginal and experimental intervention into a mainstream treatment. But as more and more patients began to claim the new technological possibility as their moral right, a scarcity of donor organs soon ensued. As a result, there is in the Netherlands since the seventies a never-ending discussion about the best way to solve this scarcity. Interestingly, the proposed solutions involve both pleas for technological *and* for moral innovation. Some proposals focus on changing technology: artificial organs, xenotransplantation, or regenerative medicine. Other proposals lean towards changing morality, for instance by replacing the current consent-systems by a no-objection system.¹² But more bold moral innovations get explored too. Maybe government information should be a little less neutral and a bit more persuasive? Or maybe we should base organ donation on reciprocity rather than on need: only those indicating their willingness to donate can become receivers. Or maybe we should make it easier for relatives to donate to known relatives instead of having to donate anonymously, even if this would increase the risk of psychological and emotional pressure on possible donors. Or maybe we should declare moral what is at this stage already legal: to purchasing organs in countries where people are poor enough to consider selling a kidney a ‘good deal’?

At this moment, scarcity remains a problem in the Netherlands. And as yet it is not possible to predict which technological or moral innovation, or which combination thereof, will be selected in the future as solution to the problem. But there is no need to. To engage productively with the inevitable technology-morality interaction, we only have to expect, and allow, such competing proposals. The rest can best be left to open public discussion. Techno-moral learning just demands that we are willing to investigate, when problems pressure us into doing so, all thinkable solutions – be they primarily technological or be they primarily moral in character.

For our dealing with nanotechnology this implies that we stop focusing all attention on hard impacts like toxicity and environmental damage, and create public space to explore plausible ways in which current morals – in care, in the military, in the family, and so forth – may become challenged by new nano-enabled devices. Technology Assessment of this type requires that we train our capacities for techno-moral imagination by developing scenarios and vignettes about nanotechnology’s soft impacts, and then discuss these openly with the public.

¹² The two systems have a different default-mode: under the first system one has to take action if one wants to donate, under the second system one has to take action if one does *not* want to.

So, what marriage counselling do I have to offer? I realize that marriages come in all sorts and kinds, and what works for one doesn't work for someone else. But all the same it is possible to say something in general about the marriage between technology and morality. As divorce is not an option, the only way they can make their relation work is by respecting one another's differences. In most cases, morality will be the stiff, conservative partner, only willing to change when all other options are cut off. In comparison, technology is likely to be the investigative, dynamic partner, always open to new opportunities. Neither can make the other obey, but what they can offer to each other is to keep the other alert. And thus learn from one another. How the problems will be solved eventually, or who will solve them this time, is then of little consequence.

And sometimes, of course, it helps to bang the doors.

Bibliography

- Beck, Ulrich. 1992. *Risk society: towards a new modernity*. London: Sage Publications.
- Berman, Marshall. 1991. *All that is solid melts into air: the experience of modernity*. London: Verso.
- Boenink, Marianne, Swierstra, Tsjalling, Stemerding, Dirk. 2010. "Anticipating the interaction between technology and morality: A scenario study of experimenting with humans in bionanotechnology." *Studies in Ethics, Law, and Technology*, 4.
- Borup, M., Brown, N., Konrad, K., & Van Lente, H. 2006. "The sociology of expectations in science and technology." *Technology Analysis & Strategic Management*, 18 , 285-298.
- Buchanan, A.E., Brock, D.W., Daniels, N. & Wikler, D. 2001. *From chance to choice: genetics and justice*. Cambridge UK: Cambridge University Press.
- Butler, S. 1872. *Erewhon, or Over the range*. (gutenberg.org/files/1906/1906-h/1906-h.htm)
- Bush, V. 1945. *Science The Endless Frontier. A Report to the President*. Washington: United States Government Printing Office.
- Bijker, W.E., Hughes, T.P. & Pinch, T.J. 1987. *The Social construction of technological systems: new directions in the sociology and history of technology*. Cambridge, Mass.: MIT Press.
- Bijker, W.E. 1995. *Of Bicycles, Bakelites and Bulbs, Toward a Theory of Sociotechnical Change*. Cambridge, Mass.: MIT Press.
- De Vries, G. 1989. "Ethische theorieën en de ontwikkeling van medische technologie." *Kennis en Methode* 13, pp. 278-294.
- Geels, F.W. & Smits, W.A. 2000. "Failed technology futures: pitfalls and lessons from a historical survey." *Futures*, 32, pp. 867-885.
- Giddens, A. 1999. "Risk and responsibility." *The Modern Law Review* 62, pp. 1-10.
- Gouinlock, J. 1994. *The moral writings of John Dewey*. Amherst, NY: Prometheus Books.
- Grunwald, A. 2007. "Converging Technologies: visions, increased contingencies of the *conditio humana*, and search for orientation." *Futures* 39, pp. 380-392.
- Hume, D. 1987/1740. *A treatise on human nature*. New York: Penguin.

- Isarin, J. 2002. "Als het maar gezond is. Over ongelukkige kinderen, ongelukkige ouders en ongelukkige beslissingen." *Filosofie en Praktijk* 23, pp.243-249.
- Jasanoff, S. (Ed.). 2004. *States of Knowledge: The Co-Production of Science and Social Order*. New York: Routledge
- Kant, I. 1965. *Grundlegung zur Metaphysik der Sitten*. Leipzig: Felix Meiner Verlag.
- Kass, L.R. 2002. *Life, Liberty, and the Defense of Dignity: The Challenge for Bioethics*. New York: Encounter books.
- Keulartz, J.M., Schermer, M., Korthals, M & Swierstra, T. 2004. "Ethics in technological culture: A programmatic proposal for a pragmatist approach." *Science, Technology & Human Values* 29, pp 3-29.
- Ketting, E. 2000. "De invloed van orale anticonceptie op de maatschappij." *Nederlands Tijdschrift Geneeskunde* 144, pp. 283-286.
- Latour, B. 1992. "Where are the missing masses? The sociology of a few mundane artifacts." In W.E. Bijker and J. Law (Eds.). *Shaping Technology/Building Society, Studies in Sociotechnical Change*. Cambridge Mass.: The MIT Press, pp. 225-259.
- Latour, B. 2005. *Reassembling the social: An introduction to actor-network-theory*. Clarendon lectures in management studies. Oxford/New York: Oxford University Press.
- Lente, H. van. 1993. *Promising Technology: The Dynamics of Expectations in Technological Developments*. Universiteit Twente, Faculteit Wijsbegeerte en Maatschappijwetenschappen.
- Marcuse, H. 1964. *One-Dimensional Man*. London:
- MacIntyre, A. 1981. *After Virtue. A study in moral theory*. Notre Dame: University of Notre Dame Press
- Misa, Tom, Rip, Arie & Brey, Philip (Eds.). 2003. *Modernity and technology*. Cambridge, Mass.: MIT Press
- Plato. 1980. *Verzameld Werk*. Baarn: Ambo.
- Rip, A. & Kemp, R. 1998. "Technological Change". In S. Rayner & E.L. Malone (Eds.). *Human Choice and Climate Change*. Columbus, Ohio: Battelle Press, pp. 327-399.
- Roco, Mihail C. & Bainbridge, William S. 2002 "Converging Technologies for Improving Human Performance NANOTECHNOLOGY, BIOTECHNOLOGY, INFORMATION TECHNOLOGY AND COGNITIVE SCIENCE", NSF/DOC-sponsored report. National Science Foundation.
- Sandel, M. J. 2004. *The case against perfection*. *Atlantic Monthly*. (theatlantic.com/doc/200404/sandel).
- Selin, C. 2007. "Expectations and the Emergence of Nanotechnology. *Science*." *Technology & Human Values*, 32, pp.196-220.
- Sheridan, H., Pasveer, B. & van Hilvoorde, I. 2006. "Gene-talk and sport-talk: A view from the radical middle ground." *European Journal of Sport Science* 6, pp. 223-230.
- Swierstra, T. & Rip, A. 2007. "Nano-ethics as NEST-ethics: Patterns of Moral Argumentation About New and Emerging Science and Technology." *NanoEthics* 1, pp. 3-20.
- Swierstra, T., Stemerding, D. & Boenink, M. 2009. "Exploring Techno-Moral Change: The Case of the Obesity Pill." In P. Sollie & M. Düwell (Eds.). *Evaluating New Technologies: Methodological Problems for the Ethical Assessment of Technology Developments*. The International Library of Ethics, Law and Technology 3. Dordrecht: Springer, pp. 119-138.

- Swierstra, T., Bovenkamp, H. van de, Trappenburg, M. 2010. "Forging a fit between technology and morality. The Dutch debate on organ transplants." *Technology in Society* 32, pp. 55-64.
- Swierstra, T, Molder, H. Te. 2012. "Risk and Soft Impacts." In S. Roeser et al. *Handbook of Risk Theory*. Dordrecht (etc), Dordrecht (etc), Springer Academic Publishers, pp. 1050-1066
- Tenner, E. 1996. *Why Things Bite Back: Predicting the Problems of Progress*. Londres: Fourth Estate Edition.
- Van der Burg, W. 2003. "Dynamic Ethics." *The Journal of Value Inquiry*, 37, pp. 13-34.
- Van Dijk, P. 2000. *Anthropology in the age of technology: The philosophical contribution of Gunther Anders*. Amsterdam: Rodopi.
- Verbeek, P. P. 2006. "Materializing morality: Design ethics and technological mediation." *Science, technology and human values*, 31, pp. 361–380.
- Verbeek, P.P. 2008. "Obstetric Ultrasound and the Technological Mediation of Morality: A Postphenomenological Analysis." *Human Studies*, 31, pp. 11-26.
- Verbeek, P.P. 2010. *Moralizing Technology: Understanding and Designing the Morality of Things*. Chicago: University of Chicago Press.