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Introduction

Technology at a Turning Point?

New technologies have long been a contentious issue. From the 18th century riots precipitated by the introduction of machinery into the textile industry to the mass demonstrations against nuclear power in the 1970s and the destruction of genetically modified crops in the 1990s, people have protested against certain technological developments. What is new is that, with the rejection of genetically modified food by the European public, for the first time the protesters may have won a significant, if local, victory, resulting in severe restrictions being put on a technology that had the backing and support of governments and major companies. This has perhaps created a space in which it may be possible to change the forces controlling the development of new technology; to think differently about technology, its significance and meaning, and how we should assess it and make decisions about it.

In recent decades protests have generally been regarded as being about the risks associated with a technology: industry and government portray the public as being concerned about the risks of physical harm, to people or to the environment, posed by a technology. Risk assessment has become the dominant framework within which regulators consider technological developments. However, while people often are concerned about risks, it is apparent from the debates about genetic engineering that risks of physical harm are not the limit of their concerns. Debates have also raised issues about the power of multinationals, the direction of agricultural development, food security, the preservation of biodiversity and how we should be relating to other living organisms.

It is therefore clear that we need to break out of the narrow confines of risk assessment and develop an enlarged framework for thinking about and assessing technology in the context of public policy.

Towards a New Framework for Making Public Decisions about Technology

For some, changing how decisions about technology are made (or perhaps *become* made) involves challenging and changing the social forces and interests at work. The problem is identified as the distribution of power between those interests and

the solution a matter of changing that distribution: reducing the power of capital and increasing the power of deliberative democratic institutions, for example. By contrast, the focus here is on the intellectual underpinnings of the current framework and the development of a possible alternative framework. Social and political institutions need intellectual justification if they are to endure. Cogent criticisms of that justification, and the provision of intellectual justification for alternative institutions, is part of how change happens.

To examine the intellectual underpinnings of the current dominant approach to technology, I look at contemporary UK government policy on technology and the relationships implied by that policy between science, technology and the economy. This discussion is informed by a review of the philosophy of technology that considers the various answers that have been given to the question 'What is technology?' To give focus to my examination of decision making about technology I look in some detail at policy in a specific area of technology: synthetic chemicals.

From my review of the philosophy of technology, in Chapter 2, I conclude that technology is not merely useful machines and tools, rather that it orders and structures human life. I suggest in Chapter 3 that we should think of technology as 'world-building': it is both how we add material things to the world and the things we have added to the world that we use. That world is public, in the sense of being shared or had in common by different people, each of whom has a different perspective on it. As well as technology, it consists of human-constructed laws, institutions and cultural norms. The nature of the world that people share affects the scope for human action and the possibilities for human relationships. It is a condition of our existence: it conditions us, affecting, if not determining, who we are. The world should be a home for its inhabitants and is the proper concern of politics. It is the context for human life that gives life human meaning. So aside from biological necessities, what the interests of individuals are depends on the world that they live in.

This world is constructed on the earth. And the earth consists of the totality of life, including our own, together with all the non-living elements that play an active part in that life: the seas, air, soils and rocks. The earth is in a sense what is 'given' – it is not of our making. We build a world using materials taken from the earth, a taking that necessarily involves doing some violence to it (mining, quarrying or the felling of trees, for example). More recently we have started creating new types of matter, such as novel synthetic chemicals, that interact with the materials of the earth to start new processes. And these processes put at risk the earth itself, including the life of our own species, not merely the human-constructed world or human relationships.

The nature of the world that technology creates and constitutes is obviously important for the quality of human life and the future of the earth. From the perspective that I present it should be at the heart of thinking about technology. In contrast, as I show in Chapter 4, government policy on technology does not acknowledge such a shared human world, but is concerned with the economy and with science.

Science is seen as perhaps the most important source of new technologies, and the development of new technologies the primary role of science. Within public

policy discourse science and technology are linked together to such an extent that what are in fact concerns about technology are regarded as concerns about science. I argue that this privileges scientific understandings over other types of knowledge, narrows legitimate concerns to those that can be addressed by science and effectively closes down what should be an open public political debate.

Science and technology obviously are related, but what is the nature of that relationship? I argue that when one looks at science one does not find an integrated single entity but many different sciences, each with their own methods, domains and theories, and relationship to technology. Some sciences lead to technological innovation, others reveal the effects of technology on natural systems, while others simply give us a better understanding of the world. The theories, models and laws of a science apply only within the domain of that particular science, so no one science provides a complete account of the world, or of a particular technology within it. To predict the effects of a new technology we have to know what domains we should consider, and thus what sciences need to be involved. This is often only revealed after the introduction of a technology, when effects have become apparent.

Government policy on technology is concerned with the economy; the desire to maintain economic prosperity is the primary reason the government gives for its promotion of technological innovation. Innovation is seen as necessary for national economic competitiveness. In Chapter 4 I argue that the primary responsibility of the government should be for the world, rather than for the economy. And in Chapter 8 I argue that current methods of assessing the impact of new legislation related to technology, such as the new European regulation on chemicals, REACH, misconceive the relationship between technology and the economy. Technology and legislation are usually seen as causes of changes in levels of economic activity, whereas I argue that technology, along with other aspects of the world, such as laws, institutions and cultural norms, are the framework or structure in which the causes of economic activity (human desires and needs) have effects. Technology changes the nature of economic activities and the effects that our economic activities have. Government should therefore have a more discriminating approach to technological innovation: it should consider whether the innovation in question would make for a better world. In contrast, the current approach regards innovation as inherently good because it is thought to lead to economic growth and increased competitiveness. The only possible downside to technological innovation that is recognized in government policy is risk of physical harm, either to human health or to the environment.

Synthetic chemicals are one area of technology where such risks have been of concern. In Chapter 5 I review European legislation on synthetic chemicals. Synthetic chemicals have been around rather longer than genetically modified organisms, so there is experience of producing, using and regulating them. It is also an arena in which risk assessment plays a central role, but in which, as I show, the problems and limitations of risk assessment are increasingly apparent. Risk-based regulation requires that there is good evidence that a chemical is likely to cause harm to human health or to the environment before actions to restrict its production or use are taken. However, as I discuss in Chapter 7, the current methods of investigating and assessing the risks from chemicals do not succeed

in providing evidence of sufficient weight to command the agreement of the scientific and regulatory communities as to whether or not harm is likely to be caused. Furthermore, limitations to our knowledge mean that we can never be sure that we know all the ways in which novel chemical substances may cause harm. The result is that risk assessment for chemicals has been characterized by procrastination and delay. And during such delay, the manufacture and use of suspect chemicals is allowed to continue unrestricted.

I argue that, rather than just known risks, regulation should consider the *riskiness* of a technology, a concept I introduce in Chapter 6. While risk is a matter of the probability of a harmful outcome, riskiness is a feature of a thing, situation or action relative to our knowledge about it. Situations of uncertainty and ignorance, in which risks cannot be calculated because we do not know the probability of harm, or cannot identify the harm that may be caused, are nonetheless risky situations if what we do know does not enable us to rule out significant harm occurring. To assess riskiness we do not have to be able to identify the type of harm that something might cause: something may be risky simply because there is much that we do not know about it, or because it puts at risk something of great value, or because its consequences are irreversible. The riskiness of a technology depends on the technology, whereas the probability that it will cause harm also depends on how people behave as a result of it. That behaviour may change as a result of the dangers presented by the technology, so that no harm actually occurs, but people's lives have been restricted. I suggest that the riskiness of synthetic chemicals depends on how novel they are, whether they start new processes in nature, their persistence and bioaccumulation, and their mobility, as well as their known capacities to affect biological or geochemical systems.

The focus on physical harm, to the exclusion of other considerations, is no doubt a result of the influence of the political philosophy of liberalism. One of the tenets of that philosophy is that government should not interfere in the actions of individuals unless those actions cause harm to others. In the arena of technology regulation this is in effect a reverse precautionary principle: technologies are assumed to be safe unless there is evidence that they cause harm. In Chapter 8 I examine liberalism and utilitarianism, the latter being the ethical theory that most influences public policy. I argue that neither recognizes the existence of a public world shared by individuals, both being concerned only with individual people – their welfare or the distribution of goods and rights between them. The republican tradition, I suggest, offers an alternative, as it is concerned with the preservation of a public realm – the world shared by the public in question – as well as with individual liberty. However, whereas liberalism tends to conceive of liberty in terms of non-interference, for republicanism it is more a matter of non-domination or independence. Being a free person is a matter of possessing the capacity to think for oneself and to take responsibility for what you do. It is a matter of having the virtues of a good citizen, the development of which requires that one take an active part in sharing responsibility for the public realm with others. One of the most important of these virtues is a sense of responsibility for the public world.

In contrast, the approach to technology in contemporary society has been characterized as 'organized irresponsibility' (Beck, 2000). In Chapter 9 I discuss responsibility and argue that this organized irresponsibility has two sides to it.

The first is that public decisions about technology are made without consideration being given to the nature of the world that the technology would bring into being, neglecting responsibility for the human-constructed world. The second is the fact that, despite technology clearly being something that humans are causally responsible for, rarely is anyone held responsible for the damaging effects of technology, such as the destruction of the ozone layer or the ill-health of humans and wildlife caused by synthetic chemicals.

In Chapter 10 I present proposals for reforming the way we make decisions about technology. These aim to put responsibility for the world at the heart of public decisions and to enable responsible individual choices about technology. I suggest that the UK system for control of built development – the planning system and building regulations – provides a possible model for public decision making about technology. Within that system the existence of a shared, public realm is recognized and the nature of that realm is seen as having an effect on individuals' quality of life, the wellbeing of communities, the environment and the economy. I suggest institutional arrangements for public decision making about technology and principles from which policies to inform the decisions made in those institutions could be developed. I further suggest ways of encouraging individual responsibility, such as by a levy on commercial advertising of products to provide a fund for 'public interest advertising'. Such advertising would allow public airing of concerns about the effects of particular types of products, thereby encouraging public debate and putting pressure on businesses to make products that contribute to making the world a better, rather than a worse, place for human life.

Chapter 10 also includes my proposals for reform of the regulation of chemicals. Chemicals should be regulated on the basis of their riskiness, rather than just of known risks, but we should also take a wider view: synthetic chemicals are not just isolated substances but things that have been made, whose making requires particular technologies and that are used for particular purposes. I therefore suggest that we should consider the nature of the world constituted by the process of production of a synthetic chemical, compared to that of alternative substances, and that each practice that uses synthetic chemicals should develop an 'ethic' of that practice to regulate its use of chemicals. Such an ethic would set out principles to inform the development of acceptable and recommended methods and materials for the particular tasks and functions involved in the practice. Those principles should require that, where possible, risky chemicals are not used, but they should also set out criteria in other domains, so that methods have positive effects when considered from a variety of perspectives. A current example of such an ethic is that of organic methods in agriculture.

The importance of multiple perspectives, which provide different descriptions of the same thing and different criteria by which it is to be judged, is one of the key conclusions of this book. There are many different conditions that must be met if human life is to be lived well. Recent times have perhaps become dominated by meeting the condition of providing material comfort and convenience. This has been at the expense of a world in which responsible human action is possible. It has also meant that we are living in a way that cannot be sustained on this earth. We now need to think about what sort of world we should be building with our technology.

Philosophical Sources

Thinking about technology requires both a political philosophy and a philosophy of science: the latter because of the obvious importance of science in the development of technology *and* in the assessment of its effects; the former because technology constitutes part of the public world and thus is of political concern.

It is in the work of Hannah Arendt that I have found a political philosophy adequate to the task of thinking about technology. Hannah Arendt was a pupil of Martin Heidegger in the 1920s, fled Germany in the 1930s and became a citizen of the US in 1951. Her work is an outcome of her attempt to come to grips intellectually with what happened to the world she was born into, and to herself as a Jew, during the first half of the 20th century. In many ways she stands alone as a philosopher, though depending on what aspect you consider she can be considered a phenomenologist, Aristotelian, Kantian or Republican. From Arendt's thought I have developed my view of technology as 'world-building' and derive principles for assessing whether technology will help to make the world a fit home for human life on earth. Linked with Arendt – he was her life-long friend – is Hans Jonas, whose work on responsibility is central to Chapter 9.

My main source for a philosophy of science is Nancy Cartwright. In contrast to that of Arendt, the work of Cartwright is very much within a particular 'school' of the philosophy of science, the 'Stanford school'. This school includes Ian Hacking and John Dupré, whose work I also draw on.

While having very different concerns, there are commonalities between Arendt and the Stanford school. One is that the origin of events lies in the natures, or capacities, of things or people, not in 'laws' imposed on things from the outside. Arendt's concern with politics means that she generally considers only human beings as having this capacity to act, though in one of her later works she notes how studies of the behaviour of animals have shown that much of what we previously thought only occurs in humans, and that we know about precisely because we are human beings, also occurs in animals (Arendt, 1970, pp59–60).

A second commonality is the importance of a plurality of perspectives. In Cartwright's view of the world as 'dappled' (Cartwright, 1999), the limitedness of scientific laws and theories – the fact that they only apply under particular circumstances, in particular domains – means that to get a complete picture (or as complete a picture as possible) a phenomenon, problem or issue must be investigated by the many different disciplines that make up what we call science, perhaps also drawing on knowledge and experience that is external to science. Similarly, in the conclusion to his book *Human Nature and the Limits of Science*, Dupré says that his argument has been that:

> *a proper understanding of a domain as complex and richly connected to diverse factors as that of human behaviour can only be adequately approached from a variety of perspectives.* (Dupré, 2001, p154)

In the work of Arendt the presence of a plurality of perspectives on the common world is vital to our sense of reality and objectivity, as well as to politics. She also gives us different perspectives: the different conditions of human life mean that

there are a number of different perspectives from which it is possible to 'think what we are doing' (Arendt, 1958, p5). The three activities of human life that she identifies – labour, work and action – are descriptions of what we are doing that take into account different conditions of our existence (Chapman, 2004). They are thus 'what we are doing' seen from different perspectives.

A third commonality is the importance of attention to phenomena, to what appears. For Cartwright this means studying what actually goes on in laboratories, how experiments are done, what they are intended to achieve. It means an approach to science where what is important is the evidence we have for our beliefs. For Arendt, it means trying to discover the essence of the experience that is being articulated by ideas and concepts. Cartwright is opposed to 'fundamentalism' in science (Cartwright, 1999, pp23–24), Arendt to ideology in politics (Arendt, 1966, p468). Fundamentalism and the ideologies of totalitarian governments involve logical deduction from what are thought to be fundamental laws, of nature or history, regardless of reality. Where reality conflicts with these deductions the fundamentalist or ideological response is to attempt to remake the world according to the ideal contained in the law. Thus Hitler's 'prediction' in 1939 that the Jewish race in Europe would be annihilated were there to be a world war was one that he set about making into a reality (Arendt, 1966, p349). At the mundane level of kitchen renovation Cartwright points out the disaster that can be created if we start from our ideal kitchen, rather than the kitchen that we actually have (Cartwright, 1999, p13).

Outline of Chapters

Chapter 2 considers the question 'What is technology?' I examine the origins of the word 'technology' and how its meaning has changed over the centuries, from a description or study of arts, where arts refers to the means by which artefacts are produced, to those means themselves. Philosophical accounts of technology have regarded it in various ways. I discuss accounts that see technology as the following: knowledge, artefacts, the extension of human capabilities, a means for improvement, a substantive force, devices, a social construction and a contingent social structure. From these accounts I draw out what I think is useful for thinking about technology in the context of its public assessment. Technology involves knowledge of how to produce things, the artefacts that are used in production and, to a lesser extent, artefacts that are used for doing other things. It is a matter of doing that involves both things and knowledge. It is often a means to ends, but it is not simply this. Rather, technology affects the structure and pattern of human life, including what ends it is possible to have. The everyday word that best encompasses that which orders and structures human life is the word 'world'. Technology forms part of the world that we inhabit together, the outcome of the activity of past and present generations, and that we can change.

Chapter 3 sets out my view of technology as 'world-building'. I suggest two definitions of technology: how we add things to the world, and the things that we have added to the world that are used, where 'things' are either material things or

are embodied or realized in material things. The world is always to some extent public, in the sense of being shared by more than one person. In that decisions about technology are decisions about the world, they are always of public concern. I suggest that the goal of public policy should be to make the world a fit home for human life on earth. Because we are biological beings (and therefore part of the earth), moral beings and beings who make aesthetic judgements, the human world should not significantly change the natural processes and cycles of the earth; it should be a place for responsible human action, and it should be beautiful rather than ugly. I consider the first two of these requirements in some depth to translate them into principles on which more concrete policies to inform decisions about technology could be based.

Chapter 4 considers the relationships between technology, science and the economy. I critically review UK government policy on science and technology. This regards science as leading to technological development and technological innovation as necessary for a competitive national economy. I consider arguments about the nature of science and introduce Cartwright's 'dappled world' view of science. I argue that although science, like technology, can be considered to be 'world-building' it adds knowledge, rather than material things, to the world. The norms and criteria of judgement that apply to the acceptance of that knowledge are quite different to those that are appropriate for judging whether a technology should form part of the world. I criticize the contemporary framing of debates about technology as debates about science. This framing narrows the debate, excluding important concerns and perspectives. Finally, I develop the account of technology introduced in Chapter 3 by considering the relationship between the world and the economy and the connection between technological innovation and economic growth.

Chapter 5 introduces synthetic chemicals as a technology and summarizes the European system of controls over the manufacture, importation and use of synthetic chemicals. Major problems for regulation have been the lack of data on the long-term health and environmental effects of most of the chemicals currently in use and the delays in carrying out risk assessments. Out of several tens of thousands of synthetic chemicals marketed in Europe since before 1981 and still in use, risk assessments have been carried out for less than 100 substances. To address these problems a major new European Regulation, REACH (Registration, Evaluation, Authorization and restriction of Chemicals), was brought into force in 2007. I outline this new system and discuss the key issues that emerged in the debates about it.

Chapter 6 explores the concept of risk. In technical risk assessment, risk is often conceived to be the probability of harm. The harm is not a property of a technology, but an unwanted event that it causes. So one problem for risk assessment is the establishment of a causal connection between a particular event and the technology. I suggest that rather than trying to assess risks we should ask how risky a technology is, where the riskiness of a technology is a matter of the possibility of it causing harm. This possibility is a function of our knowledge: as we

do not know how things are independent of our knowledge of them, we have to recognize that something is possible if it is not ruled out by what we do know. In technical risk assessments it is generally concluded that there is no risk if it is not possible to identify a specific type of harm caused by the technology. This means that where there is a great deal of ignorance about a technology and its effects (as there is if it is a novel technology) the assessment concludes that there is no risk. In contrast, assessments of riskiness would conclude that the technology is risky: it is risky because, for all we know, it is possible that it causes harm. Finally, in this chapter I discuss how the context of a risky situation affects our evaluation of it. Risks are 'taken' in exchange for benefits and our moral evaluation of the risk-taking depends on whether the person who makes the decision is the one who is put at risk. Our attitude to a risk is also dependent upon whether those put at risk have any agency in the situation to affect the outcome, as well as whether the risk-taker will take responsibility if harm occurs.

Chapter 7 describes how risks from chemicals are assessed. It concludes that the many uncertainties mean the assessment process generally does not succeed in providing evidence that commands agreement as to whether or not a chemical poses a risk. Hence the frequent disputes as to whether restrictions on chemicals are justified. Rather than trying to assess the risks from a chemical, I suggest we should aim to assess how risky a chemical is in a more everyday sense. Risky chemicals are ones where, given our state of knowledge, it is possible that they cause harm. I discuss four things that make a chemical more risky: (1) its capacity to cause harm, (2) its novelty, (3) its persistence and (4) its mobility.

Chapter 8 considers the ethical theory (utilitarianism) and the political philosophy (liberalism) that underlie the existing regulatory system. I use Cartwright's concept of a nomological machine to critique the socio-economic impact assessment of REACH and consider Arendt's view that the world has interests which are not reducible to the self-interests of individuals. I then examine the arguments for the harm principle of liberalism. This restricts the legitimate use of coercive government interference in the actions of the individual to instances where those actions cause harm to others. I claim that neither utilitarianism nor liberalism recognizes the existence of a public world shared by individuals. That world is the context in which individuals have interests, and individual life has value and meaning. I suggest that the classical republican tradition offers a better basis for a public technology assessment process that has the nature of the public world at the centre of its concern. As well as being concerned for the preservation of the public realm, republicanism values the freedom of the individual, where that freedom is conceived as consisting in the possession of the virtues of citizenship, including a sense of responsibility for the world.

Chapter 9 is about responsibility. I look at the various ways in which the word responsibility is used. One of those ways – responsibility *for* things – I discuss in some detail, using the work of Hans Jonas. We are responsible for things that are good but vulnerable, where we have some power to protect or nurture what is good about the thing or person. Governments and citizens are responsible for

the public world. I examine how, in making decisions about technology, that responsibility is neglected. I examine why, with respect to synthetic chemicals in particular, there is a lack of accountability for technology and what could be done to remedy this. Finally, I consider whether basing decisions on the outcomes of risk assessments itself constitutes responsible conduct. I argue that assessments of risks must be supplemented by at least two other considerations: the completeness and degree of certainty of our knowledge and who or what is put at risk.

Chapter 10 sets out my conclusions with respect to how we should make decisions about technology, synthetic chemicals in particular. Using the UK system of controls over built development as a model, I argue that controls over technology should consist of two types of systems: technical standards equivalent to building regulations and a system of political oversight over technological development equivalent to the planning system. In both systems decisions should be made on the basis of policies that outline the attributes or features that technology should have if it is to make for a better world, and I suggest that the principles derived in Chapter 3 could inform the development of such policies. I also present proposals for the reform of chemical regulation and suggest ways of enabling responsible individual decisions about technology. In conclusion, I draw some lessons from synthetic chemicals: our knowledge is limited, if we introduce novel things into the world we cannot know what will happen, and we should avoid solving old problems in ways that create new ones. Finally, to provide the many conditions needed for human life to be lived well, we must consider what we are doing from many different perspectives.

References

Arendt, H. (1958) *The Human Condition*, University of Chicago Press, Chicago, IL
Arendt, H. (1966) *The Origins of Totalitarianism*, Second Edition, Harcourt, Inc, New York
Arendt, H. (1970) *On Violence*, Harcourt, Brace & World, New York
Beck, U. (2000) 'Risk society revisited: Theory, politics and research programmes', in B. Adam, U. Beck and J. Van Loon (eds) *The Risk Society and Beyond: Critical Issues for Social Theory*, Sage Publications, London
Cartwright, N. (1999) *The Dappled World: A Study of the Boundaries of Science*, Cambridge University Press, Cambridge
Chapman, A. (2004) 'Technology as world building', *Ethics, Place and Environment*, vol 7, nos 1–2, pp59–72
Dupré, J. (2001) *Human Nature and the Limits of Science*, Clarendon Press, Oxford