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1 INTRODUCTION: TECHNOLOGY AND ETHICS

Technology shapes every aspect of human experience. It is the primary driver of social and ecological change. It is a source of power, vulnerability, and inequality. It influences our perspectives and mediates our relationships. Given this, it is surprising that we spend so little time studying, analyzing, and evaluating new technologies. Occasionally, an issue grabs public attention – for example, the use of human embryonic stem cells in medical research or privacy in social networking. However, these are the exceptions. For the most part, we seem to suffer from technological somnambulism (to borrow a term from Langdon Winner [Ch. 4]) – we incorporate new technologies into our lives with little critical reflection on what the impacts will be.

The goal of this textbook is to help students develop linguistic, conceptual, critical, and perspectival resources for thinking carefully about the ethics of new technologies. Toward that end, this Introduction provides an overview on ethics and emerging technologies and suggests an approach to analyzing the ethical dimensions of emerging technologies. Section 1 discusses the significance of technology in human life and culture. Section 2 highlights several prominent themes in the ethics of emerging technologies and proposes a framework for ethical analysis and evaluation based on the themes. Section 3 is a primer on some common ethical theory and value concepts employed in the ethics and technology discourse.

1. TECHNOLOGY IN HUMAN LIFE

When analyzing and evaluating the ethical dimensions of emerging technologies, it is crucial to keep in view the robust interactions between technology and society, as well as the essential role that technology plays in our way of life. The aim of this section is to begin to elucidate these fundamental features of the human–technology relationship.

1.1 Technology and society: beyond technology as a tool

Technology is often conceived of as a tool, something that is developed and used by people to accomplish their goals. It is also often thought to be value neutral – the idea is that the goodness or badness of a technology depends entirely upon the goals or ends for which it is used. There is some truth to this *technology as tool* view, since technology certainly helps people to accomplish things they would

not otherwise be capable of doing. In fact, engineering is often described as the creative application of scientific principles to design processes and structures in order to solve problems and overcome barriers. Drugs are engineered to address diseases; crops are engineered to increase food productivity; networking software is engineered to facilitate communication; solar panels are engineered to produce energy; manufacturing processes are engineered to produce reliable products at high volumes and low costs. Moreover, many technologies can be used for both good and bad ends. Synthetic genomics can be used to develop pharmaceuticals or for bioterrorism; GPS technologies can be used to improve supply chain efficiency or to track people without cause and without their knowledge; autonomous military robotics can be used for self-defense or for unjust attacks.

However, the technology as tool view is only part of the story about the complex relationships between technology, society, and ethics. The reason for this is that technologies, in addition to being means to ends, are also complex social phenomena.

Some technologies are encouraged by society through social demand or public funding. This is often the case with medical technologies, for example. Other technologies are opposed or rejected by society (or at least by some members of society). For example, genetically modified crops have been resisted in parts of Europe and Africa, and many countries have passed laws banning human reproductive cloning. Technologies are always implemented in and disseminated through society. Sometimes they help us to solve social problems. For example, vaccines, medical databases and analytical tools help us to respond to disease epidemics and generally improve public health. Sometimes technologies create social problems. For example, many mining technologies have caused tremendous environmental pollution and degradation. In no cases are technologies separate from social context. They are all, always, socially situated. Every instance of technology creation and use is historical. It occurs in a particular place, time, and circumstance (Pacey, Ch. 2). As a result, technologies are in constant interaction with social systems and structures. They are not merely tools to be used by us. *Technology shapes us and our social and ecological world as much as we shape technology.*

Technology shapes the spaces we inhabit. In our homes, businesses, and public buildings almost every aspect of the physical space is structured by technology. This has social implications. It influences who we see and interact with, as well as the conditions under which those interactions occur. Technology also shapes broader spaces – for example, many cities and towns are organized in ways that accommodate themselves to car travel. Entire geographical areas – e.g. the Midwestern United States – have been transformed by technology. Where there were once vast prairies and woodlands, there are now vast farmlands. This impacts who lives there, what they do, how they relate to each other, and what they value. Social interactions and perspectives are structured by the types of places we inhabit, and the places we inhabit are shaped by technology.

Technology also shapes our conceptions of sociability – i.e. how we conceive of social life and what constitutes social relationships. Perhaps the clearest example of this is the impact of information technologies on social interactions. Cell phones, web chatting, social networking, massively multiplayer online gaming, and virtual realities have opened up new forms of social interaction and new types of social

relationships. As a result of these technologies, physical proximity is less and less a crucial component of meaningful social interaction. We also are almost always able to reach our friends and family, and plans are made in real time (as opposed to being set in advance). These technologies have extended space and compressed time with respect to social interaction. They have altered how we spend time with people, as well as who we can spend time with. They have transformed social worlds.

Information technologies have also transformed social institutions and organizations. For example, college students and faculty interact with each other and access and exchange information much differently than they did 25 years ago, before email, the internet, personal computers, and PowerPoint. News agencies operate and disseminate information dramatically differently. Government services are accessed and delivered differently. The examples could go on and on.

All of this alters our expectations. We expect to access information quickly and easily. We expect to be able to reach people at any time. We expect government to make information available and to be transparent. We expect that people will be able to learn more about us (and to do so more quickly) than before. We expect to be able to rapidly travel large distances. We also expect to live longer, healthier, more comfortable lives than people have previously. Life expectancy has increased by over a third in technologized nations over the past 100 years, and people expect to be healthy, comfortable and active until the end of life. These are just some of the diverse ways in which technology impacts values and valuing.

Finally, technology shapes our daily lives and activities. From the moment we wake up, we are dealing with technology and moving through a world configured by technology. Many of us spend large amounts of our days looking at a monitor and punching buttons. Others spend it driving vehicles, or using manufacturing technologies to produce still more technologies. Many of us take our recreation in ways that involve technology – e.g. television, video games, off-road vehicles, and geocaching. As already discussed, technology impacts how we interact with each other and the natural environment, as well as our perspectives and expectations. All of us, almost all the time, are interacting with technology in myriad and significant ways. For all of these reasons, technology is much more than a value neutral tool (Pacey, Ch. 2; Winner, Ch. 4).

1.2 The technological animal

Technology is so socially and ecological significant because it is fundamental to and inseparable from our cultural way of life. Our capacity as cultural animals distinguishes us from all other species. Many species, such as starlings and dolphins, have complex communications systems. Many species, such as honey bees and meerkat, have elaborate social systems. Many species, such as elephants and octopi, exhibit social learning and tool use. However, no other species that we are aware of innovates, accumulates, and transmits ideas, information and practices on the scale or at the rate that we do. A thermostat is a far more complex tool than anything found in the nonhuman world – let alone a smart phone or a space shuttle. A university is far more complex than any social structure found in nature – let alone a democratic state or the Catholic Church. Moreover, our

social systems and tools change much more rapidly than does anything found in the nonhuman world. For example, the way universities function today – online libraries, smart classrooms, distance learning – is much different from how they functioned prior to widespread personal computing, digitization of information, and the internet. In comparison, the social systems of wolves and the tool use of chimpanzees – two of the most psychologically complex nonhuman species – have changed very little over that time.

We, members of the species *Homo sapiens*, have a characteristic way of going about the world, and that is the cultural way. We have the capacity, far greater than that of any other species, to imagine how the world might otherwise be, to deliberate on whether we ought to try to bring those alternatives about, to devise and implement strategies for realizing those alternatives we judge to be desirable, and to disseminate them (through teaching and learning) if they prove to be successful. Our way of life is characterized by our comparatively large capacity for gathering information, social interactions, moral agency, and technology: *we are the cultural animal.* In fact, our life form is only possible because of our capacity for culture. A human being alone, without social cooperation and without technology, would have difficulty surviving very long in any environment.

The basis for our comparatively large cultural capacity is our biology. The robust psychological and cognitive abilities that make culture possible arise from the features of our brains, and we have the brains that we do (and not the brains of rattlesnakes or chickadees) because of our DNA. Indeed, the DNA that "codes" for brains like ours evolved, in part, because our increasingly large capacity for culture was fitness enhancing under obtaining environmental conditions, and other parts of human biology (such as skull size and language capabilities) co-evolved with the cultural capacities.

Although culture is made possible by our biology, the content of culture is not determined by biology. Cultural diversity is not the product of biological differences between groups of people, but the result of the development of language, social systems, and technology by (relatively) independent populations over time. Cultural evolution is influenced by the environments in which populations live, the resources available to them, and their interactions with other populations (e.g., trade and conflict). Cultural innovation and dissemination is much more rapid than is biological evolution, so since robust culture has emerged, cultural evolution has accounted for most of the changes in the way people live. Indeed, the "ages" of human history – stone, bronze, iron – are often marked by the technologies in use; and the great "revolutions" in human history – agricultural, Copernican, industrial, Darwinian, information – refer to cultural innovations in techno-social and conceptual systems, rather than biological transitions.

Due the pace of technological innovation since the industrial revolution, as well as other factors such as globalization (which is itself enabled by technological innovation), technological change is arguably now the most significant driver of cultural change (Kurzweil, Ch. 26). To be sure, technological innovation is shaped by social systems and ideas (just as social systems and ideas are shaped by technology). But there can be no doubt that technology is restructuring our social, ecological, and personal worlds at an increasingly rapid rate.

2. THEMES IN THE ETHICS OF TECHNOLOGY

As we have seen, technology is inseparable from human life. It structures and mediates our social and ecological worlds. It increasingly drives social and ecological change. However, technology is not one thing. There are different types of technologies and applications. The ethics of emerging technologies is not about whether to have technological innovation at all. It is about which technologies to promote, which to discourage, and how to develop and disseminate them to promote human flourishing in just and ecologically sensitive ways. Determining this requires being able to analyze the quite divergent social and ecological profiles of emerging technologies. We cannot make informed decisions regarding which technologies and applications to encourage, how to optimize their designs (from a social and ecological perspective), or how to regulate them unless we characterize their social, ethical, and ecological dimensions.

In this section, I review prominent themes in the ethics of emerging technologies. Among them are several critical perspectives and concerns that, taken together, constitute a robust set of resources for analyzing and assessing emerging technologies.

2.1 The innovation presumption: liberty, optimism, and inevitability

Ethical evaluation of emerging technologies tends to focus on what might be problematic about them. The reason for this is typically not luddism (i.e. a general opposition to new technologies), but rather that there is a presumption in favor of new technologies. Given this presumption, the question is not 'Why should we pursue or permit this new technology?', but rather 'Are there any good reasons not to develop it?' and 'Are there any concerns that need to be addressed in its development and dissemination?'

There are three considerations that provide the basis for the presumption in favor of invention, adoption, and use of emerging technologies (the *innovation presumption*). The first is *liberty*. This is the idea that people ought to be permitted to do as they like, so long as it is not harmful to others or otherwise socially or ecologically problematic.

The second basis for the innovation presumption is *technological optimism*. Technological innovations have, in general, increased the longevity, health, comfort, and opportunity in the lives of those who have access to them. This is why people are so keen to adopt new technologies. Given this, it seems as if we ought not only allow, but also encourage technological innovation and adoption. The fewer impediments to invention and dissemination, the sooner further technological innovations can improve human lives.

The third basis for the innovation presumption is *technological determinism*. As discussed earlier, technological innovation is crucial to our cultural way of life. Moreover, the rate of technological innovation has continually accelerated, and there are historically very few cases of relinquishment – i.e. societies that have forgone technological innovation. If this is right, then it makes little sense to ask whether we should support or restrict technological innovation, since it is inevitable.

Taken together, appeals to liberty, technological optimism, and technological determinism provide some support for an innovation presumption. However, it is critical to the ethics of emerging technologies that their significance not be overstated, since doing so closes off rather than advances ethical analysis and evaluation.

As indicated above, liberty is not the right to do whatever one likes. Appeals to liberty do not justify human rights violations or ecological degradation, for example. Moreover, governments, particularly those that are democratically elected, are empowered to limit individual choices in order to promote the public good. (There is reasonable disagreement about the extent to which governments ought to have that power.) So, while liberty does support an innovation presumption, it is still necessary to determine whether technological research programs or applications are problematic in ways that justify restrictions or regulations.

Furthermore, the fact that a person has a right to do something does not imply that she ought to do it. People have the right to play massively multiplayer online games for eight hours each day, but doing so is not good for them. In fact, people often have the right to do things that are morally problematic. Parents have the right to install spyware on their children's computers, while telling them that they are not doing so. But it would nevertheless be dishonest, untrusting, and a privacy violation for them to do so (unless special circumstances obtain). Again, liberty only goes so far, and it is not always an overriding consideration when it comes to the ethics of emerging technologies (Kass, Ch. 6; de Melo-Martin, Ch. 7; Liao, Ch. 8).

The view that technological innovation and dissemination improves people's lives also must be qualified. It is true that people live longer, healthier, more comfortable lives today in highly technologized countries than they have at any other point in human history. However, this is not just the product of technology. Ideas, such as democracy and human rights, and social institutions, such as universities and governments, have also played a significant role. Moreover, technological innovations often have had very serious problems and costs that social institutions have had to address. In the United States, for example, an environmental movement, a host of environmental laws, and an Environmental Protection Agency have been needed to address the detrimental ecological and human health effects of technological development – e.g. pollution, resource depletion, and biodiversity loss. Similarly, a labor movement, labor laws, and Labor Department continue to be needed to promote workplace safety and prevent workplace abuses. The United States is not exceptional in these respects; most highly technologized countries have had similar social movements and have institutions with similar responsibilities. It is often only after tremendous effort, sacrifice, and social innovation that the detrimental aspects of technology are addressed.

Moreover, it is not clear that our current levels of consumption are sustainable or just given the finitude of planetary resources and a global population that is now over seven billion (Cafaro, Ch. 28). Strong technological optimists are confident that further technological innovations will help us to address our natural resource challenges, but so far that optimism is unsupported. We have not seen safe and effective solutions to climate change, top soil degradation, desertification, and fresh water shortages, for example. And the three billion people in the world who

live on less than $2.50US ppp/day ('ppp' stands for 'purchasing power parity', that is the equivalent of what $2.50 can purchase in the United States) have not benefitted nearly so much from modern technological innovations. In many cases, they have suffered from them – for example, by having their labor and natural resources exploited. These considerations demonstrate that technological innovation and dissemination is not inevitably conducive to human and nonhuman flourishing. Consideration of and responsiveness to the social and ethical challenges of emerging technologies is therefore crucial, even given the very large potential for new technologies to improve human lives.

As with liberty and technological optimism, claims about technological determinism have a kernel of merit but must also be highly qualified. The historical record and a proper understanding of the role of technology in our way of life does support the view that technological innovation and dissemination will continue. However, what the particular innovations will be, who will have access to them, and how they will be used is not at all determined. For example, it may have been largely inevitable that countries with the capacity to do so would begin to develop space programs. But the decision to have the United States Space Program be run by a civilian, scientific organization, rather than by a military one has been crucial to which space technologies have been developed, not to mention the geopolitical implications of their development. Ethically informed policies, regulations, and designs can and do shape the development of emerging technologies.

It should also be noted that ethical concerns do sometimes result in restricted use of technologies. This is the case with genetically modified crops having only limited adoption in Europe, with ozone depleting chemicals being phased out under the Montreal Protocol, and with national prohibitions on human reproductive cloning, for example. Technological innovation and dissemination is not going to be relinquished on a large scale (there are, of course, particular societies that do forgo it to some extent, such as the Amish), but particular technologies often are prohibited or severely restricted. The truth of technological determinism is in historical trajectories and generalities. It in no way undermines the importance of social and ethical evaluation of particular emerging technologies (Winner, Ch. 4; Kass, Ch. 6).

The foregoing shows that, while there might be a presumption in favor of technological innovation and dissemination, it is not nearly as strong as is often supposed. Moreover, it does not at all diminish the importance of thorough ethical evaluation of emerging technologies in order to inform judgments about which technologies to promote, which to discourage, and how to develop and disseminate them.

2.2 Situated technology

As discussed in Section One, technology is always historically situated. It is always located at a time, in a place, and within a set of practices and institutions. As a result, it is not possible to identify the full range of social and ethical issues raised by a technology merely by reflecting on the technology as such, or the distinctive features of the technology, abstracted away from its context. For example, there is no way to determine, just by considering the distinctive features of human

enhancement technologies, whether they are likely to exacerbate or diminish social injustices. One must also know about the social structures and systems that will enable or frustrate access to the technologies, as well as what sorts of competitive advantages access to the technologies are likely to impart (Garcia and Sandler, Ch. 17). Similarly, one cannot know how a particular information technology, such as internet browsers, RFID chips or cell phones, might challenge people's privacy without knowing what laws and institutions are (or are not) in place to prevent capture, dissemination, and use of the information (Stanley and Steinhardt, Ch. 18; van den Hoven, Ch. 19). It is, of course, crucial to know what the technologies are, and how they work, but that is not enough. Developing and implementing emerging technologies in ways that are just and sustainable can only be accomplished if the institutional, cultural, and ecological contexts of the technologies are carefully considered (Pacey, Ch. 2).

Attending to the social and ecological situatedness of a technology is also crucial to designing effective technology (Pacey, Ch. 2; van den Hoven, Ch. 19; Spinello, Ch. 20). Consider, for example, the One Laptop Per Child initiative, which had the goal of producing inexpensive laptops (around $100 each) "to empower the children of developing countries to learn" and to "create educational opportunities for the world's poorest children" (http://laptop.org/en/vision/index.shtml). Given this goal, producing a $100 laptop was not sufficient for success. Not only did the laptop need to come close to the target price point, it needed to function well in the conditions in which the children live, which often include unreliable or no access to electricity, unreliable or no internet access, and little if any technical support. As a result, the computers were designed so that they could be charged on alternate power sources, such as car batteries. They have no hard drive and only two internal cables. Their software is open source. They have a long range antenna. And the keyboards are sealed with a rubber membrane to protect them from humidity.

When cultural and ecological context is not adequately attended to, technologies are much more likely to be ineffective or to have detrimental social and ecological impacts (Shiva, Ch. 32). Moreover, it will often be necessary to address aspects of the social context – for example, by providing training or support – into which a technology is being introduced in order for it to be successful (Pacey, Ch. 2). Careful attention to social context might also reveal that the goal a technology aims to accomplish – e.g. educational, public health, or ecological improvement – can be more easily and efficiently accomplished by less technologically sophisticated means, such as implementation of best practices, institutional reform, education, or providing access to already established technologies (Cafaro, Ch. 28; Hamilton, Ch. 29; Thompson, Ch. 34).

2.3 Lifecycle (or Cradle to Grave)

When evaluating an emerging technology or application it is crucial to consider its entire lifecycle, from extraction of the natural resources that are used in its production to where it ends up when it is no longer used. The reason for this is that a technology might appear socially or ecologically benign, or even beneficial, when one focuses only on the use portion of its lifecycle, when in fact it raises

significant socially and ecologically issues when one looks at its production or end of life disposal. For example, a comprehensive ethical analysis of cell phones involves considering not only how mobile communication has impacted users and the social institutions (e.g. the workplace) and practices (e.g. social networking) they participate in. It also includes attending to the materials that are used in cell phone production, some of which are relative scarce minerals the control of which has contributed to violent conflicts in parts of Africa. It includes attending to the manufacturing conditions where the phones are assembled, which in some cases have involved human rights violations. It includes attending to the fate of hazardous components when the phones are discarded, which in some cases has involved environmental release and human exposure.

There is nothing distinctive about mobile phones that gives rise to the need for comprehensive lifecycle evaluation. All technologies are made of raw materials that must be extracted, transported, and processed or refined into a usable form. All technologies must be manufactured or constructed, which involves energy and other inputs (e.g. chemicals). All technologies must be transported to consumers. And all used technologies must be disposed of in one way or another. Thus, the use stage of technology constitutes only part of its ecological and social profile. Worker health and safety, environmental impacts of production, greenhouse gases emitted in transportation, effects of extraction activities on local communities, and technological displacement of prior practices must also be considered, for example (Elliott, Ch. 27). Ethanol might burn more cleanly and with fewer greenhouse gas emissions than gasoline; however, this does not tell us anything about the biodiversity losses associated with clearing forests to grow oil palms for ethanol, the impacts on food availability and food prices of using agricultural lands for ethanol inputs rather than food crops, how much energy is used in the production of ethanol (and what the sources and so associated emissions of that energy are), or the effects of ethanol production on farming communities.

The point of the foregoing is not that ethanol and mobile phones are overall objectionable or should be eliminated. It is that optimizing these technologies from a social and ecological perspective (as opposed to a bare technical one) requires evaluating them in a situated way and over their lifecycles. Only then can the full range of challenges and opportunities associated with them be identified, evaluated and addressed. It may be that some emerging technologies are sufficiently risky, ethically objectionable, or otherwise problematic that relinquishment of them is the most justified course of action (Kass, Ch. 6; Hamilton, Ch. 29; Shiva, Ch. 32). But in most cases, the ethical challenge is how to develop them responsibly – i.e. in ways that respect rights, are consistent with principles of justice, and promote human and nonhuman flourishing. Situated lifecycle analysis is crucial to this.

2.4 Power

Technology affords power to those who have access to it. This is perhaps clearest with respect to what we might call *efficient power*, or the power to do or accomplish things. Guns increase the capacity to kill or injure. Washing machines increase the capacity to clean clothes. Steam-shovels increase the capacity to clear land.

Internet access increases the capacity to gather information and communicate with others. Synthetic genomics increases the capacity to modify organisms. Magnetic resonance imaging (MRI) increases the capacity to visualize structures internal to the body. Technology enables individuals, groups of people, and organizations to do things that they would otherwise be capable of doing. It empowers by increasing the scope of our agency (Jonas, Ch. 3). A prominent theme in the ethics of emerging technologies is the need to take responsibility for the power that modern technology provides and to develop ethics appropriate for that power. For example, it is our technologically enabled capacity to impact the natural environment and distant people (spatially and temporally) that makes environmental ethics, global ethics, and future generation ethics so important (Jonas, Ch. 3).

Efficient or material power often translates into *social or political power* (Lin et al., Ch. 23; Shiva, Ch. 32). Social and political power is relational. It is power relative to others within a particular domain or activity. For example, possessing a technologically sophisticated military or nuclear weapon capability empowers a nation in the domain of international negotiations. A more efficient water pump empowers a farmer in the domain of resource competition (particularly if the farmer's neighbors lack the technology). Here is a slightly more detailed example. Among the distinctive feature of digital media is that it can be easily, inexpensively, and reliably copied and disseminated, without loss of quality. It materially empowers consumers to share music and videos online. As a result, their social or political power is increased relative to music distribution companies and record labels. Although record companies have tried to mitigate consumers' power with legal and technological measures (for example, anti-piracy legislation and digital rights management), the power provided to consumers (and musicians) by digital media has caused tremendous change in the music industry (Spinello, Ch. 20).

As the digital media example illustrates, the increase in social and political power provided by a novel technology often comes with a correlative decrease in the power of others. The fact that one farmer can bring water up more quickly or from greater depths than can another farmer disempowers the farmer that does not have access to the technology and so cannot irrigate as reliably or extensively. The fact that Google is able to track individual browsing histories disempowers advertising companies that do not have access to personalized data, and so cannot as effectively target advertisements.

Because technology provides material power that often translates into differential social and political power, a comprehensive assessment of the social and ethical dimensions of an emerging technology requires conducting a *power analysis* of the technology (and constitutes another reason that technology is not value neutral). One must try to determine, given the features of the technology and its situatedness: Who is likely to control and/or have access to the technology? Who is likely to be empowered or disempowered by the technology? How are they likely to be empowered or disempowered? Whose interests are promoted by the technology and whose are not (and whose may be compromised)?

As with lifecycle analysis, the point of a power analysis is not primarily to determine whether a technology should be pursued or permitted at all. It is crucial to identifying how to design technologies and address aspects of their social

and ecological context in order to ensure that they contribute to, rather than undermine, justice, autonomy, sustainability, and flourishing.

2.5 Form of life

As we have seen, technology shapes us and our relationships by configuring our social and ecological worlds. As a result, new technologies often involve a change in *form of life*. When we adopt a technology (or have one imposed on us, as is often the case) it provides not only possibilities and power, but also responsibilities, requirements, incentives, perspectives, relationships and constraints (Winner, Ch. 4). This is yet another respect in which technology is value laden, rather than value neutral.

Here is a non-technological example to help illustrate the idea of a form of life: adopting a dog. When a person adopts a dog, she does not merely get a furry four-legged canine. She also adopts a set of responsibilities, to provide care for the dog and to ensure that it does not harm others. As a result, she must organize her life in certain ways – for example, adjusting her schedule so that the dog is not at home alone too long. It also places constraints on her – for example, she cannot live in places that do not allow dogs and must make arrangements for others to take care of the dog if she is travelling. Having a dog is also likely to result in her going to new places (such as dog parks), meeting new people (such as other dog owners), and learning and caring about new things (such as Lyme disease and leash laws). In these and many other ways, the decision to adopt a dog is a decision to adopt a form of life, with economic, lifestyle, relationship, perspectival, responsibility, and opportunity dimensions.

Technology adoption also often has form of life implications, at both the individual and societal levels. A classic example of this is the widespread adoption of cars (Winner, Ch. 4). It required cities to be designed in order to accommodate them, homes constructed with places to park them, and roads laid where people wanted to take them. An infrastructure to support them was also necessary – e.g. refineries, filling stations, repair shops, traffic laws, and licensing systems. Moreover, experiencing the world from a moving automobile is quite different from doing so as a pedestrian. It alters what you perceive, who you interact with (and how you do so), what you are attentive to, and what you care about. The automobile brought with it a form of life, with enormously significant spacial, perspectival, economic, geopolitical, and lifestyle dimensions.

We find the same thing with many more recent and emerging technologies – though of course not always to so profound an extent as automobiles. Mobile computing has changed where and how we can work; it has required a supporting infrastructure (e.g. internet access and electrical outlets); it has increased vulnerability to privacy and security violations; it has altered personal and professional interactions; and it has changed how we take our recreation. The genomics revolution has changed the types of research questions that can be asked, how diagnosis of diseases and illnesses takes place, how health and sickness are conceptualized, the types of treatments that are possible, and the structure of patient–provider interactions and relationships. Genetically engineered organisms in agriculture have promoted a particular type of agricultural practice (industrial, high-input

monoculture), increased the power of transnational seed companies, and displaced traditional farming practices, technologies, and traditions (Shiva, Ch. 32).

When a person, community or culture chooses to adopt a new type of technology, or when it is imposed on them by social or economic pressures or authorities, they very often are adopting a new (or modifying a prior) form of life as well. Therefore, when analyzing an emerging technology it is necessary to consider how it might impact such things as how we spend our time, who we interact with (and how we do so), our dependencies and vulnerabilities, what values we attend to (e.g. aesthetic, cultural, efficiency, or economic), and our perspectives more generally. Only then are we able to discuss in an informed way whether the changes in how we live that the technology will bring about are desirable, and how to incorporate them into our lives so that they are so. This applies to everything from whether to join Facebook to whether to genetically enhance one's children (President's Council on Bioethics, Ch. 14).

2.6 Common concerns regarding emerging technologies: extrinsic concerns

Ethicists working on emerging technologies often make a distinction between extrinsic and intrinsic concerns regarding them (Comstock, Ch. 31; Preston, Ch. 36; Bedau and Triant, Ch. 37). *Extrinsic concerns* refer to concerns about possible problematic outcomes or consequences of a technology – for example, that its widespread adoption would result in human health problems, ecological degradation, unjust distribution of risks and benefits, or human rights violations. *Intrinsic concerns* refer to objections to the technology itself, independent of what its impacts might be. For example, some people are opposed to transgenic organisms on the grounds that their creation involves crossing species boundaries; and some people are opposed to embryonic stem cell research on the grounds that it violates the moral status of stem cells or is disrespectful of human life.

Extrinsic and intrinsic concerns regarding particular technologies are addressed at length in the readings. Here I just briefly introduce the most prominent types of concerns, and indicate the chapters in which they are discussed. The primary extrinsic concerns are these:

2.6.1 Environment, Health, and Safety (EHS)

EHS concerns are those to do with the possible negative impacts of technology on human welfare and the nonhuman environment. They are frequently raised in connection with pollutants, as well as biotechnologies. Workplace safety, consumer safety, public health, and ecological integrity (including concerns about biodiversity) all fall within EHS. The negative EHS impacts of an emerging technology are typically unintended and unwanted, though there are exceptions (e.g. bioterrorism). EHS concerns are addressed in chapters on nanomaterials (Elliott, Ch. 27), nanomedicine (Allhoff, Ch. 11), genetically modified crops (Comstock, Ch. 31), synthetic genomics (Garfinkle and Knowles, Ch. 35; Bedau and Triant, Ch. 37), neurotechnologies (Glannon, Ch. 12), global climate change (Cafaro, Ch. 28), geoengineering (Hamilton, Ch. 29), and Robotics (Lin et al., Ch. 23; Wallach, Ch. 24).