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).

2.6.2 Justice, access, and equality

Emerging technologies often distribute their burdens and benefits unequally; they often empower some people (or institutions) while disempowering or disadvantaging others; and there is often differential access to them. They therefore raise significant concerns about justice across a wide range of domains – e.g. economic, political, and social. This is particularly so when the technologies are introduced into contexts that already include unjust inequalities, and when the introduction is done through market mechanisms that favor access for those that are socially and economically advantaged. Justice and access issues, particularly as they pertain to class and gender, are addressed in chapters on cognitive enhancement (Garcia and Sandler, Ch. 17), intellectual property and medicine (Ravvin, Ch. 13; Allhoff, Ch. 11), agricultural biotechnologies (Shiva, Ch. 32), information and computer technologies (Himma and Bottis, Ch. 22), genetic engineering (de Melo-Martin and Gillis, Ch. 9), virtual reality (Brey, Ch. 21), and reproductive technologies (Frith, Ch. 5; de Melo-Martin, Ch. 7).

2.6.3 Individual rights and liberties

EHS considerations include concerns about human health and environmental impacts. Sometimes those impacts constitute rights violations – for example, if they displace or kill people. However, some harms and wrongs are independent from or not reducible to their EHS impacts. For example, forcibly taking someone's property without adequate authority or cause violates their property rights even if it is not harmful to their health. As discussed above, individual liberties are often appealed to in the ethics of technology as a basis for justifying innovation and access. For example, procreative liberty is thought by some to justify access to genetic enhancement and cloning technologies. However, concerns are also often raised regarding the potential for a technology to violate rights or liberties. For example, a primary concern about many information technologies is their potential to compromise the right to privacy, and concerns about violating the right to informed consent often arise in the context of testing new medical technologies. Among the chapters that address rights and liberties issues are those on information technologies (Stanley and Steinhardt, Ch. 18; van den Hoven, Ch. 19), reproductive technologies (Frith, Ch. 5; de Melo-Martin, Ch. 7), and genetic enhancement (Kass, Ch. 6; Liao, Ch. 8).

2.6.4 Autonomy, authenticity, and identity

Because technology confers or constitutes power, and shapes the conditions of human experience (including our perspectives and values), emerging technologies often raise concerns about autonomy, authenticity, and identity. One type of concern is that people can have technologies imposed on them against their will or without their consent. This could be done through authority – for example, if employers were to require employees to take pharmaceuticals in order to improve their performance. Or it could be done through social pressure – for example, if parents feel they must select the genetic traits of their children so that they will be able to "keep up." Another type of concern is that technologies will be used in manipulative ways – for example, when kids are cyber-bullied into doing things they would not otherwise do. Issues related to autonomy and authenticity are discussed in chapters on reproductive technologies (Frith, Ch. 5), stem cell research (de Melo-Martin and Gillis, Ch. 9), and virtual reality (Brey, Ch. 21). A related type of concern is that technologies could so change or alter people that their biographical identity will be disrupted. This concern primarily arises regarding technologies that impact the brain and mental functions, such as neurotechnologies, (Glannon, Ch. 12), enhancement technologies (President's Council on Bioethics, Ch. 14; Bostrom, Ch. 15; Douglas, Ch. 16), and brain–machine integration technologies (Kurzweil, Ch. 26).

2.6.5 Dual use

As mentioned above, problematic outcomes of the development and dissemination of emerging technologies are almost always unintended byproducts (for this reason they are often referred to as unintended effects, secondary effects, or collateral effects). Therefore, when analyzing and evaluating the social and ecological dimensions of a novel technology or application, one must consider unintended impacts, as well as the possibility of unintended uses. Many technologies are *dual use* technologies in that they can be effectively employed in ways other than their intended or designed use. This is frequently the case with drugs. For example, methylphenidate (Ritalin) and modifinil (Provigil) treat ADHD and narcolepsy, respectively, but they are also widely used by healthy people to enhance focus and wakefulness. Restricting a technology to its intended use once it enters the marketplace is difficult, and this needs to inform evaluations of it, particularly as it concerns technology and regulatory design. The dual use challenge of emerging technologies is discussed in chapters on synthetic genomics (Garfinkle and Knowles, Ch. 35; Bedau and Triant, Ch. 37), information technologies (Stanley and Steinhardt, Ch. 18; van den Hoven, Ch. 19), and robotics (Lin et al., Ch. 23; Wallach, Ch. 24).

Extrinsic concerns regarding emerging technologies are often cast in terms of costs and benefits. However, as the forgoing review indicates, there are in fact several varieties of extrinsic concerns. Moreover, they can carry very different normative weight or significance. For example, rights violations are often considered more serious than economic losses. As a result, thorough ethical evaluation of emerging technologies requires not only identifying extrinsic concerns, but also attending to their different normative features or logics.

Because extrinsic concerns are not to do with the technology itself, the same technology can have different extrinsic profiles in different contexts. For example, a technology might perpetuate injustice if it is introduced into an already unjust context that leads to differential access to it, but might be justice neutral if the social context were different. Therefore, addressing extrinsic concerns about emerging technologies often requires both designing the technologies in ways that minimize the likelihood of problematic effects through *value sensitive design* (Elliott, Ch. 27; van den Hoven, Ch., 19; Spinello, Ch. 20) and responding to problematic features of their social context (Sandler and Garcia, Ch. 17).

Furthermore, because the same technology (or type of technology) can have a different extrinsic profile in different circumstances, extrinsic considerations typically do not favor either comprehensive acceptance or comprehensive rejection of an emerging technology. *Discriminatory assessment* across contexts is needed, and extrinsic considerations tend to favor *selective endorsement* of them – i.e. endorsement under these or those conditions or if this or that factor is addressed. Of course, the difficult and important ethical work is determining what those conditions and factors are for a given technology, as well as the extent to which they can be met through technology design and social practices or policies.

2.7 Common concerns regarding emerging technologies: intrinsic concerns

Intrinsic concerns regarding an emerging technology are objections to the technology itself, independent of the outcomes or consequences of its creation and use. Intrinsic concerns have primarily been raised regarding bio- and eco-related technologies, though they are applicable as well to other emerging technologies, such as artificial intelligences. The primary (and often interconnected) intrinsic concerns regarding emerging technologies are these:

2.7.1 Playing God

Research on emerging technologies, particularly genetic technologies, is sometimes described as "playing God." The "playing God" language appears theological, and sometimes it is intended that way. However, it is often used non-theologically as well. The idea that "playing God" language is meant to capture is that there are types of activities that it is simply wrong for people to engage in. With respect to genetic technologies and artificial life, the idea is that people ought not to be trying to create novel species or novel life forms. With respect to human embryonic stem cell research, the idea is that embryonic stem cells are not merely material for us to use. In each case, the idea is that the activity is beyond the purview of what is appropriate for humans to be doing. Different proponents of "playing God" concerns will provide different bases for the claim that certain technologies involve extending our agency to activities that are inappropriate; and, again, some will be theological (e.g. divine prohibition) and some secular (e.g. the moral status of embryos). Among the chapters that discuss "playing God" concerns are those on genetically modified crops (Comstock, Ch. 31), synthetic genomics (Bedau and Triant, Ch. 37), and stem cells (de Melo-Martin and Gillis, Ch. 9).

2.7.2 Hubris

The central idea of hubris-oriented concerns is that those who develop and embrace emerging technologies often overestimate their ability to predict what the technologies will do when they are put into use, as well as their ability to address any problematic effects that might arise (particularly when the technologies are being introduced into complex, dynamic and inadequately understood biological and ecological systems). The hubris concern arises regarding the use of geoengineering to address global climate change (Hamilton, Ch. 29), the release of genetically modified organisms into agricultural systems (Comstock, Ch. 31), reproductive cloning (Kass, Ch. 6), and genetically engineering people for enhancement purposes (President's Council on Bioethics, Ch. 14).

The hubris involved in these activities is thought to make them intrinsically problematic (in addition to the extrinsic EHS concerns involved).

2.7.3 Respecting nature

Bio- and eco-related technologies also often are objected to on the grounds that they destroy naturalness, violate nature, or are disrespectful of the natural. The idea is that there is value or normativity in naturalness – i.e. the biological and ecological world independent of human design and control – that the technologies undermine or violate. For example, human enhancement is sometimes objected to on the grounds that it aims to modify our given, human nature (President's Council on Bioethics, Ch. 14; Liao, Ch. 8; Bostrom, Ch. 15), and synthetic genomics is sometimes objected to on the grounds that the aim is to create organisms without a natural history (Preston, Ch. 36). Naturalness concerns have also been raised about human reproductive cloning (Kass, Ch. 6), ecological restoration (Minteer and Collins, Ch. 30), and geoengineering (Hamilton, Ch. 29).

What these intrinsic concerns or objections have in common is that they are based on features of the technologies themselves. In some cases, intrinsic objections are taken to be overriding – i.e. if there is something intrinsically objectionable about a technology then it ought not to be pursued no matter what. In other cases, intrinsic objections are taken to be defeasible – i.e. they count against the development and use of a technology, but can be overridden by extrinsic considerations. Whether intrinsic objections are taken to be overriding or not often depends upon the type of ethical theory in which the objection is situated – for example, whether rightness of action is understood in terms of outcomes, adhering to rules, or acting virtuously. Thus, the normative significance of intrinsic (and extrinsic) objections depends not only on the type of objection that they are, and whether they are legitimate or reasonable concerns, but also on the ethical system in which they are located (and whether that system is well justified). I briefly discuss different types of ethical systems in Section 3.

2.8 RESPONSIBLE DEVELOPMENT

Everyone – researchers, industry, government, and citizens – is in favor of responsible development of emerging technologies; that is, promoting innovation and commercialization while also addressing legitimate social and ethical concerns. However, there are several factors that make accomplishing responsible development difficult in practice. One is the high rate of technological innovation, which frequently exceeds that of policy and regulatory processes. This difficulty is compounded by the fact that many oversight institutions lack capacity – e.g. they are underfunded or understaffed relative to their regulatory mandates – and often are not as familiar with novel technologies as are those they are regulating. Because of this, soft law and non-legislative resources are crucial to responsible development – for example, product liability, development and promotion of best practices, professional standards and licensing, codes of conduct, and training and education (Garfinkle and Knowles, Ch. 35). However, while these avoid some of the time-lag and information deficit challenges associated with hard regulation, they typically do not have the same authority and sanction behind them (market and liability incentives can be an exception).

A second challenge to responsible development is what might be called *the lure of the technological*. Technological optimism and beliefs about technological determinism favor uncritical adoption of emerging technologies. They also tend to favor technologically-oriented solutions to human health and ecological problems. After all, a technological fix holds the promise of addressing a problem – from high cholesterol to global climate change – without requiring individual sacrifices or significant institutional, cultural, or lifestyle changes (Pacey, Ch. 2; Hamilton, Ch. 29).

Yet another challenge to responsible development is that stakeholders in an emerging technology may have quite different views about what responsible development involves. For example, many non-governmental organizations (NGOs) advocate for premarket regulatory approval for all new industrial chemicals – i.e. the chemicals must be demonstrated to be safe to people and the environment before being used – whereas industry often advocates for post-market monitoring and enforcement instead – i.e. a new chemical can be brought onto market without a rigorous approval process, but if it is shown to be hazardous then it may be pulled from the market and the manufacturer will be liable for damages. Similarly, some researchers, industry and patient advocacy groups favor an expedited process for approving new medical drugs and devices on the grounds that delays to market prevent treatments from getting to those who need them (particularly when the technologies are potentially lifesaving). Others argue that it is more important to extensively demonstrate that a drug or device is safe and effective, even if this results in a longer time to market, since it is crucial that people have confidence in approved technologies and that they not cause further health problems. This issue – how much caution and confidence with which to proceed under conditions of uncertainty – applies to a great many emerging technologies (Bedau and Triant, Ch. 37; Garfinkle and Knowles, Ch. 35; Elliott, Ch. 27; Hamilton, Ch. 29).

Another area in which there are substantive disagreements about what constitutes responsible development is the role of public input in technology policy and regulation. Public consultations and citizen forums on such things as nanotechnology, synthetic genomics, and geoengineering are increasingly common. The motivation is to provide opportunities for citizens to provide input on funding priorities, research goals, and regulatory decisions. However, some argue that such forums are problematic in that many citizens lack an adequate understanding of the technologies, institutions, and political processes at issue. What this and the previous examples indicate is that, in addition to identifying social and ecological opportunities and challenges associated with particular technologies, the ethics of emerging technologies also includes characterizing what responsible development involves: What is the appropriate role of public engagement? How should public funding decisions regarding emerging technologies be made? What standards for safety ought to be met prior to dissemination? How should responsibility for oversight be allocated? And so on.

The rapid pace of technological innovation has led to a widespread call for more anticipatory and agile technology policy and responsible development processes, so that social and ecological issues can be addressed early in technology development (sometimes called *upstream*). Proactive responsible development is contrasted with reactive approaches, in which social and ecological issues are addressed only after they arise. The idea is that we have had sufficient experience with emerging technologies, and have developed sufficient responsible development capacities (e.g. laws, civic organizations, governmental institutions, codes of conduct, and market expectations), that we should now be able to identify potential issues and prevent or mitigate them before they manifest. For example, life cycle analysis is increasingly used by industry to assess the ecological impacts of industrial processes and products to determine where their impacts can be reduced. There is also increased interest in value sensitive design in engineering – i.e. designing technologies in ways that are informed by social and ecological evaluation of them (van den Hoven Ch. 19; Spinello, Ch. 20; Brey, Ch. 21; Elliott, Ch. 27). And regulators and policy makers are employing such means as citizen consultations and mandatory reporting in order to move toward more anticipatory governance.

To be sure, there remain significant challenges to proactive responsible development. Not least of these is the inherent information deficits involved (sometimes referred to as the *Collingridge Dilemma*). On the one hand, the earlier in the development process that one attempts to evaluate the social and ecological aspects of an emerging technology, the less information about the technology, its applications, and its impacts are available. On the other hand, the later one does the evaluation, the more entrenched is the technical design and the more momentum there is to the commercialization process, so the more difficult it is (and fewer opportunities there are) to address social and ecological concerns in the development process. Thus, even (or especially) in proactive responsible development, the issue of how to proceed under conditions of uncertainty and with incomplete information remains crucial.

2.9 ETHICS AND PUBLIC POLICY

A prominent issue in the ethics of emerging technologies is what role peoples' moral or religious concerns ought to play in developing policy and regulation. For example, can a ban on the use of federal funding for embryonic stem cell research be justified on the grounds that many taxpayers believe that such research is disrespectful of human life? Could a broader prohibition on conducting such research be justified?

In democratic societies committed to basic liberties, such as freedom of speech, thought and expression, government is expected to refrain from privileging one worldview over another. This is often referred to as *state neutrality*. Government should not make it more difficult for citizens to live according to one worldview than another – for example, by prohibiting particular religions. It also should not try to promote one worldview over others – for example, by requiring certain ideological commitments in order to hold public office or be part of particular professions. Not all worldviews need to be respected in this way, only those that are reasonable and consistent with basic democratic principles and liberties. Governments do not need to be neutral toward a worldview on which it is permissible to deny basic rights to women, for example. However, for all reasonable worldviews, public policies should not privilege one over others.

The implication of state neutrality for public policy regarding emerging technologies is that it is inappropriate to formulate policy on the basis of moral or theological concerns that are distinctive to particular worldviews. Instead, policies need to be based on fundamental liberal democratic values or else supported by an overlapping consensus among reasonable worldviews. For example, theologically based concerns about violating species boundaries are not a legitimate basis for restricting research on and use of genetically modified organisms (GMOs), since there are many reasonable worldviews on which species boundaries are not ethically significant. Such a ban would therefore violate state neutrality. However, it is permissible to regulate GMOs in order to protect or promote public health, since that is a value that any reasonable worldview would endorse. Moreover, respect for the autonomy of those who believe that cross-species genetic engineering is unethical may favor a policy of labeling foods that contain GMOs. In this way, citizens can make informed judgments about whether to eat them and can live according to their own values.

What the forgoing illustrates is that part of characterizing the ethical profiles of emerging technologies is determining which social and ecological considerations raised by them are policy relevant, and how they are so.

2.10 A FRAMEWORK FOR ETHICAL ANALYSIS OF EMERGING TECHNOLOGIES

Taken together, the critical perspectives and issues discussed in the previous sections (particularly 2.2–2.7) constitute a rich set of resources for analyzing, evaluating, and reflecting upon the personal, social, and ecological dimensions of emerging technologies. Indeed, a fairly comprehensive ethical analysis of an emerging technology can be accomplished by:

A. Identifying any *benefits* the technology might produce (with respect to both human and nonhuman flourishing), including how large the benefits would be and how likely they are to occur.
B. Identifying any *extrinsic concerns* (e.g. EHS, justice-oriented, or rights-based) that the technology may raise, including how likely it is to do so.
C. Conducting a *power analysis* to identify who is empowered and who is disempowered by the technology, as well as how they are empowered or disempowered.
D. Conducting a *form of life analysis* to identify how the technology might restructure the activities in which it is involved, as well as the personal, social, and ecological conditions of our lives.
E. Identifying any *intrinsic concerns* that the technology is likely to raise.
F. Identifying any *alternative approaches* to accomplishing the ends at which the technology aims, including less technologically sophisticated possibilities.

These analyses and issue identifications need to be done over the course of the technology's lifecycle and in a situated way. They need to attend to the distinctive features of the technology, how it differs from prior technologies, and the relevant features of the social and ecological contexts into which it is emerging. They also need to be informed by our experiences with relevantly similar prior technologies (van den Hoven, Ch. 19; Garfinkle and Knowles, Ch. 35; Thompson, Ch. 34).

In many cases, there will be a speculative element to the analyses. When the technologies are not yet fully developed we will not know precisely what their features are or how they work; and when they are not widely disseminated we will not know precisely what their impacts are. As discussed earlier, this information deficit is part of the challenge of responsible development. However, there is a very large difference between informed, well measured anticipation and wild speculation. Good ethical analyses will be as informed as possible about the technology – i.e. what it is, how it works, and who uses it. It will be as informed as possible about the social and ecological context of its development and use – e.g. the relevant regulations, oversight mechanisms, social inequalities, and methods of dissemination. It will be as informed as possible by the study of the social and ethical dimensions of relevant prior technologies, as well as by research on the impacts of the emerging technology (e.g. how sex selection has been used when available, toxicity data on nanomaterials, and public surveys on whether creating artificial life is "playing God").

Conducting these analyses for an emerging technology will provide a profile of the technology's potential to contribute to human flourishing, justice and sustainability, as well as the potential challenges, problems, and costs associated with it. It will also provide the full range of alternatives against which they should be evaluated, including less technologically-oriented ones (Cafaro, Ch. 28; Hamilton, Ch. 29; Thompson, Ch. 34). This, in turn, puts one in a strong position for evaluating the technology, as well as for identifying ways to optimize it (socially and ecologically) through technological design, public policy, and addressing social and cultural factors relevant to its dissemination and use.

3. ETHICAL THEORY AND TERMINOLOGY: A VERY BRIEF PRIMER

Crucial to the ethics of emerging technologies is determining not only which features or impacts of a novel technology are ethically salient, but also how they are salient. As mentioned earlier in this introduction, how a social or ecological concern should be taken into consideration is sensitive to the type of ethical theory that is operative. Ethical theories are systematic accounts of what, why and how things matter, particularly as they relate to deliberations about actions, practices, and policies. For these reasons, the ethics of emerging technologies – both in general and with respect to particular technologies – often involves discussion of ethical theory more generally. The aim of this section is to provide a very brief primer on the elements and types of ethical theories, as well as to introduce some relevant terminology.

3.1 Types of value

The things that matter are the things with value. But there are a variety of different types of value, or ways in which things can matter or have importance. One prominent type of value is *instrumental value*, or the value of something as a means to an end. Novel technologies very often have instrumental value, since they help us to do or accomplish things. They are almost always intended to enable something that is desirable – e.g. human health, security, or economic gain. However, as discussed earlier, they also often have negative unintended byproducts (e.g. pollution), or can be used for detrimental ends (e.g. privacy violations). Thus, both a technology's potential instrumental value and its potential instrumental disvalue are relevant to ethical evaluation of it.

Another prominent type of value is *final value* (or noninstrumental value). Final value, which is also sometimes referred to as intrinsic value, is the value that something has for what it is, or as an end. If something has final value, then its usefulness is not exhaustive of its value. People are commonly thought to have final value. The value of a person is not just to do with how effective they are as a means to ends. Rather, they have value as a person or in virtue of being a person.

Some things have final value because we value them as an end – i.e. they have *subjective final value*. Works of art, landscapes, mementos, religious artifacts, and historical sites are often like this. They have final value because we value them for their beauty, rarity, or history, for example, and not just because they are an effective means to a desired end. Technological accomplishments are frequently valued noninstrumentally – e.g. for their ingenuity, grandeur, or cultural significance. Concerns are also sometimes raised about emerging technologies on the grounds that they compromise something with subjective final value – for example, that a wind turbine energy "farm" would despoil a beautiful (and so valued) landscape or that genetic technologies compromise species purity (which, as discussed earlier, is valued by many people).

Other things have final value in and of themselves, independent of how they are valued by us – i.e. they have *objective final value*. This is typically thought to be the case with people – that is, people have value in virtue of what they are and independent of the valuations of others. Technology usually is not thought to have objective final value, though advances in artificial intelligence and synthetic genomics may require reconsidering this presumption (Basl, Ch. 25). However, technology is often evaluated on the basis of how it would impact entities – e.g. people, species, or nonhuman animals – or states of affairs – e.g. distributions of burdens and benefits – that are thought to have such value. Whether all final value is subjective or some is objective is a contested issue in ethical theory. However, this is not the place to address it. What is important in this context is that there is a difference between instrumental and final (or intrinsic) value, and that there are two possible bases of final value (subjective and objective).

As the foregoing discussion illustrates, there are several varieties of instrumental and final value. Being clear about which types of value are operative is crucial to the ethics of emerging technologies, just as it is in other areas of ethics. The reason is that different types of value have different normative significance. For example, instrumental values often are contingent, replaceable, recreatable, and substitutable, whereas final values often are not; and subjective final values are contingent on the evaluative attitudes of valuers, whereas objective final values are not.

3.2 Types of theories

The idea, discussed earlier, that the same consideration can matter differently depending upon the type of ethical theory in which it is located can be somewhat counterintuitive. Here is an example to illustrate the point. Suppose that the development of a novel medical technology would require extensive testing on nonhuman animals, and that the testing would cause the animals considerable and persistent pain and suffering. Further suppose that nonhuman animals are morally considerable, in that causing them suffering is an ethically relevant consideration. Should the drug's development be supported and allowed to go forward? Here is one possible response: It depends on whether the pain and suffering that is caused by the testing is outweighed by the pain and suffering that the drug would prevent. This is a consequentialist response. The rightness or wrongness of the testing depends upon the balance of the good and bad outcomes that would result (or are expected to result). Thus, it might be permissible to do the testing in a case where the benefits to be gained are sufficiently assured and great (and there is no other way to achieve them with less harm caused), but not in a case where the benefits are not so clear or large. Here is another possible response: Intentionally causing harm to animals as a means to our ends is always wrong. This is a deontological response. The rightness of the practice is determined largely by the features of it – i.e. that it involves using animals in this way – and not by the outcomes. Thus, animal testing is wrong in all cases.

This example shows that knowing that nonhuman animals have final value such that causing them suffering is ethically relevant is not sufficient for ethical evaluation. One must also know how the suffering is relevant to determining what ought to be done. According to *consequentialist* normative theories, what one ought to do, what policy ought to be adopted, or what practices ought to be developed is determined by comparing the outcomes (or expected outcomes) of the different possibilities. The better the outcomes, the more justified is the action, practice, or policy. In *deontological* normative theories, whether an action ought to be done or a policy ought to be adopted is determined by whether it conforms to the operative rules – for example, that it does not violate any human rights or basic principles of justice. In *virtue-oriented* normative theories, an action or policy is justified to the extent that it expresses or hits the target of virtue – e.g. it is compassionate, honest, efficient, and ecologically sensitive. These are the three most prominent types of ethical theories, and they are distinguished by their approaches to evaluation. (There are other types, including atheoretic views.) Consequentialist views prioritize outcomes; deontological views prioritize the features of the action or practice itself; and virtue-oriented views prioritize the character traits that are expressed. This is of course an idealized characterization, and in actuality many ethical theories are hybrids in that they incorporate elements from more than one of them.

Which account of right action and approach to decision making is most justified – i.e. deontological, consequentialism, virtue oriented, some combination, or some other alternative – is another contested issue in ethical theory. Again, it is not an issue that can be addressed here. But it is crucial background. In the discourse on emerging technologies (including in the readings in this textbook), considerations offered for or against a technology will often be situated within a particular type normative theory. For example, a deontological argument against synthetic organisms is developed (Preston, Ch. 36), as is a consequentialist argument for them (Garfinkle and Knowles, Ch. 35). Evaluating them requires not only assessing the arguments, but also considering the broader theoretical frameworks in which they are located.

4. CONCLUSION

Technology continually restructures the conditions of human experience. It shapes our relationships, values, landscapes, and expectations. It alters power relationships. It makes possible new forms of life and displaces previous ones. Moreover, technological innovation and dissemination is accelerating. Perhaps more than ever before, we need to be reflective about how to develop technologies, how to incorporate them into our lives, and how to use them. That is, we need to develop frameworks and resources for evaluating emerging technologies, as well as create spaces and opportunities, both personal and public, for doing so. That is, we need ethics and policies for emerging technologies.

Most of the chapters in this textbook focus on a type of technology or field of application – for example, nanotechnology, synthetic genomics, robotics, therapeutic technologies, agricultural technologies, and enhancement technologies. However, they often employ perspectives, advocate approaches to evaluation, and raise issues that cut across fields and technology types. The aim of this introduction was to highlight those perspectives, approaches and themes, as well as to show how, when taken together, they can provide a robust framework for ethical analysis and evaluation of emerging technologies.