CHAPTER 18

Interdisciplinarity in ethics and the ethics of interdisciplinarity

ANNE BALSAMO AND CARL MITCHAM

This chapter explores interdisciplinarity dynamics in the context of ethics. It starts by observing the origins of ethics in the predisciplinary plentitude of philosophy followed by a historical overview of ethics in terms of significant interdisciplinary formations broadly construed. Next is an extended discussion of interdisciplinarity in contemporary fields of applied ethics. A third section reverses the approach, to consider the possibility of ethical guidelines for the practice of interdisciplinarity, through reflection on the character of knowledge production in the digital age.

Ethics itself is constituted by systematic, critical reflection on human action with the aim of both increasing knowledge about and improving culturally or personally acceptable behavior. In that *ethics* involves critical reflection, it is distinct from *morality* which exists largely independent of conscious thought. Because ethics bridges knowing and doing, it constitutes a site for multiple inter- and transdisciplinary engagements. Most commonly, however, it is identified as a major branch of the discipline of philosophy—alongside logic, epistemology, and metaphysics. Yet upon closer examination, ethics can be seen as drawing on a number of disciplines that may also be described as having emerged from it; disciplines such as psychology and anthropology, as well as politics and economics, significantly influence the domain of ethics. Especially in what are called its *applied* or *practical* versions, ethics takes form as hybridizations of disciplines and specialized concerns in the cases of biomedical ethics, environmental ethics, or computer ethics—each of which depends on multidisciplinary interactions with other domains. Finally, ethics manifests strong transdisciplinary elements, insofar as it is heavily dependent on life experience. Informed by the development of multiple disciplines, implicated in the creation of new hybrid research fields, and constituted by transdisciplinary questions, ethics is an inherently interdisciplinary endeavor.

18.1 Historical overview

In its classical form philosophy was a term that referenced all learning and was thus deeply interdisciplinary. Indeed, it may be more accurate to describe philosophy as originally *pre*disciplinary, since it preceded the demarcation of disciplines. The history of the pursuit of knowledge in the European tradition unfolds as a progressive spinning off of multiple specialized forms of learning from within a nondisciplinary matrix known as philosophy. Physics, astronomy, natural history or biology, psychology—including what are now termed the human sciences and the humanities—were all once part of philosophy as exhibited in the works of Plato, Aristotle, and their followers.

The emergence of moral theory or ethics as an explicit dimension of learning exemplifies what social scientists have termed the process of structural differentiation. Over the course of human history, there has been a tendency to disaggregate many aspects of human culture that once formed a more synthetic unity. For instance, one distinctive feature of the period between 500 BCE and 500 CE, especially among those peoples inhabiting the northeastern shores of the Mediterranean Sea, was a gradual movement to distinguish among the elements of law (in Greek, *nomos*), moral custom (*ethos*), narrative story (*mythos*), rational thinking (*logos*), and nature (*phusis*).

Since the 1500s in Europe and then the Americas, this process continued, such that a plethora of structural differentiations emerged in science (where physics, chemistry, geology, biology, and more were separated out as specialized forms of knowledge), in industry (through the division of labor), in government (separation of powers), and in religion (multiple church denominations). This systole of differentiation has in turn repeatedly given rise to the diastole of counter efforts promoting relationships or interactions among the associated socio-cultural structures, thus constituting in broad if non-standard terms multiple manifestations of interdisciplinarity: interdisciplinary research in science, team management in industry, constitutional formation and civil religion in the state, ecumenism in religion, and universal human rights in culture. One basic description of philosophy today could reasonably characterize it as the most general effort to reflect on and understand these differentiations and their countermovements. This is especially the case with that structural differentiation in philosophy known as ethics.

In a broad-brush historical overview, the development of ethics took shape in five overlapping interdisciplinary interactions or formative efforts to bridge other structural differentiations in culture. The first formation took shape in Greece in the centuries preceding the common era as an orientation toward understanding certain social norms as perfecting human nature by integrating humans into natural or cosmic orders. The macrocosm of cosmic reality was thought to be mirrored in the human microcosm, as summarized in the phrase 'as above, so below'. From this perspective, study of the natural world was itself of ethical significance. Morality served to mediate not just among human beings but also between social and natural orders. This view of the relation between human behavior and non-human orders of reality that can be found articulated in related ways in classical Hinduism and Daoism.

Insofar as the social order is itself viewed as the instantiation of a cosmic order, morality could also be understood, in a second interdisciplinary formation, as mediating between

individuals and the social order. The ethics of Confucianism illustrates such an approach. Confucian ritual aims to unify not only heaven and earth but also individual persons with the present and past social fabric, and might thus be described as a practice of intergenerationality. Greek philosophy, Hinduism, Daoism, and Confucianism all emerged in what Karl Jaspers (1949) identified as the Axial Age of human history—the period between 800 and 200 BCE—which gave rise to a set of basic ethical understandings of morality as distinct from but mediating cultural formations.

A third basic formation of ethics emerged in conjunction with Judeo-Christian-Islamic notions of divine revelation, especially as articulated in Christian theology. In revealed theology, divine or supernatural infusions of knowledge from above can be variously understood as enclosing nature or opposing it. In the view of Thomas Aquinas, for instance, the natural law ethics of reason was simply confirmed by and raised to a higher level by the ethics of revelation; the natural virtues of courage, moderation, practice-wisdom, and justice were understood as complemented by the supernatural virtues of faith, hope, and love. By contrast, for Augustine, revelation functioned to relativise the importance of nature; the virtues of the ancients were no more than 'shining vices'. In both cases, however, ethics functioned as a handmaid to theology by mediating between revealed and natural knowledge. These two conceptions of ethics also manifested in the ethical theories of Judaism and Islam.

A fourth formation of ethics as interdisciplinarity has emerged opposed to the idea of ethics as handmaid of revelation. In this case, ethics functions instead as the handmaid of a new kind of science: modern natural science. During the Enlightenment, ethics became an interdisciplinary mediation not so much between nature and society as between the socio-political order and the pursuit of science in its distinctly modern form, which conceives non-human realities as devoid of moral significance except insofar as value is attributed to them by humans. In one version, ethics is cast as the protector of science. This notion of ethics argues for the autonomy of science and its support by the state because of its benefit to society. In another version, that of ethics as Romantic critique, it argues for delimitations on science in order to protect humans from dominance by science.

Finally, in a fifth formation, morality can be conceived as a practice leading to some kind of enlightenment or revelation from below. This view of morality may be interpreted as having roots in the Axial Age, through the example of Buddhism, but is also illustrated in the belief that adherence to the scientific method leads to the production of true knowledge. Additionally, modern psychology has proposed various methods, from psychoanalysis to educational techniques, as productive of knowledge. Although the enlightenments of Buddhist meditation and scientific methods are quite different, according to this formation of ethics both may be described as emerging in a natural manner from the disciplining of experience. The meaning of 'discipline' in this instance exhibits different but related meanings to those customarily associated with discussions of interdisciplinarity.

This brief historical overview of five formations of ethics as interdisciplinarity may be summarized as follows. In generalized terms, ethics as interdisciplinarity has functioned as mediation and synthesis of: (1) human and cosmic reality, (2) individual and social

orders, (3) reason and revelation, (4) science and human affairs, and (5) as a pathway to insight. Only in the first half of the twentieth century were efforts made to construct an ethics purified of all forms of interdisciplinarity in what has come to be known as 'meta-ethics'. In the face of manifest needs for ethical guidance with regard to new forms of science and technology, however, the meta-ethics project gave way in the second half of the 20th century to what has come to be called applied ethics.

18.2 Interdisciplinarity in applied ethics: bioethics and nuclear ethics

The meta-ethics project aimed to set aside substantive debates about good and bad, right and wrong, and to focus instead on analyzing the meaning of moral terms and the structure of ethical discourse or argumentation, as in a seminal text titled *The language of morals* (Hare 1952). According to American philosopher Stephen Toulmin (1982), the practical problems created by scientific and technological advances in medicine 'saved the life of ethics' in a more traditional or normative sense. He might have extended his insight to note that salvation also involved resuscitation by interdisciplinarity. For Toulmin, when ethical reasoning became engaged in clinical work and considered the actual practices of physicians, hospital ethics committees' and/or institutional or governmental bodies' linguistic analyse of theoretical conflicts tended to be superceded by practical reasoning. Conflicts between deontology, utilitarianism, and virtue ethics are sidestepped in favor of *ad hoc* constructions to deal with particular problems.

Such social consensus in the area of medicine on the basis of multidisciplinary ethical practice was initially adumbrated in the post-World War II creation of the Nuremberg Code for research on human subjects. While in earlier periods medical scientists had at times exhibited a certain weakness in exercising their responsibilities for the protection of human subjects, Nazi concentration camp experiments dramatized the need to develop universally agreed-upon guidelines for the conduct of medical research. Judges from several nations collaborated with medical experts to create protocols establishing applied ethical principles for technoscientific medicine. This transdisciplinary cooperation among legal experts and medical practitioners resulted in foundational statements about the basic rights of all medical research participants to free and informed consent. Subsequent debates about human stem cell research, cloning, and the patenting of genomic sequences have continued to depend on broad cross-disciplinary dialogues regarding what factors and kinds of knowledge are relevant to policy making.

Insofar as medicine engages with and is transformed by developments in biology and the life sciences, it becomes empirically interdisciplinary. This trajectory has turned medical ethics into the interdisciplinary fields of bioethics and biomedical ethics. In a well-cited article on the constitution of the field of bioethics' Maurice de Wachter (1982) has argued that even when its interdisciplinary character is assumed, the implications require careful attention. In particular, de Wachter argues that flourishing of interdisciplinarity calls for the suspension of all disciplinary approaches, even when formulating research questions.

In light of the points made by Toulmin and de Wachter, it is important to acknowledge that the very term 'applied ethics' has been contested. Yet regardless of the different terms used to describe this domain—such as 'practical ethics' or 'professional ethics'—all assert a notion of engagement between and among multiple disciplines as the proper course for determining moral action. Consider, for instance, the case of nuclear ethics and policy, which refers to the ethics of nuclear weapons development and deployment as well as the ethics of nuclear power generation and production. Here the engagement spans the technological disciplines of nuclear science and engineering, as well as the social sciences of economics and environmental policy, along with the health sciences and medicine. If such interdisciplinary engagements are to be fruitful, the particular issues posed for ethical analysis will need to be formulated from the beginning through dialogue among the disciplines, so that the results of analyse are not predetermined by any set of disciplinary concerns.

18.3 Interdisciplinarity in applied ethics: environmental and computer ethics

Similar observations apply to the fields of environmental and computer ethics. Indeed, the development of environmental ethics was originally informed by naturalist writers (such as Henry David Thoreau and John Muir) as well as by conservation biologists (such as Aldo Leopold and Rachel Carson), all of whom undertook to advance critical ethical reflection on human—nature interactions from different disciplinary contexts. In previous formulations, ethics had been concerned primarily with the relationship of human-to-human or human-to-divine. Wildlife biologist Leopold was the first to make an explicit case for an environmental extension of ethics to include what he called a 'land ethic'. In his words:

> All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. His instincts prompt him to compete for his place in that community, but his ethics prompt him also to co-operate (perhaps in order that there may be a place to compete for)....The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land. (Leopold 1949, p. 204)

Extending both the foundation of an ethical relationship to encompass both humans and the land required interdisciplinary collaboration to unpack the logic of this interaction. Carson's work (1962) in particular was instrumental in establishing a context for the creation of statutory laws and governmental agencies for protection of the natural environment. In turn, environmental protection has become a global discussion that now routinely engages politicians and economists on issues of sustainable development. In the early twenty-first century, environmental ethics developed into a broad interdisciplinary field that includes thinkers in the domains of literature, science, law, economics, public policy, education, and philosophy.

The formation of computer ethics unfolded in similar ways. In the early stages of the development of computer technologies, it was scientists and engineers such as Norbert Wiener who argued for the need to direct ethical attention to the implication of the use of the new machines of data manipulation and communication. Wiener, the founding figure of cybernetics, titled

his second book *The human use of human beings: cybernetics and society* (Wiener 1950). His work was from the beginning an interdisciplinary endeavor situated in the interstices between mathematics, physics, and biology (Balsamo 1996). Through the interpretation of Terrell Ward Bynum (2008), Wiener also laid the foundation for computer or information ethics.

Following this early work, discussions in the Association for Computing Machinery (ACM), the largest non-governmental organization of computer professionals, led in 1973 to the adoption of a code of ethics (Anderson 1994). Other computer professional societies formulated similar or related codes in the following decade, e.g. the British Computer Society in 1983 and the Australian Computer Society in 1987. In 1978, interdisciplinary engagement between computer professionals and philosophers led to coining the term 'computer ethics' and in 1985 to the publication of a textbook of the same name (Johnson 1985). There followed an explosion of interdisciplinary interest and collaboration among computer professionals, philosophers, social scientists, and others who shared a general recognition that the field of computer ethics could not be pursued without extensive interdisciplinary collaboration.

As illustration of the implications of interdisciplinary ethics, consider the ACM code revision of 1992. The first code emphasized professional self-promotion and discipline (for example, being competent, acting within the limits of competence, and not misrepresenting one's abilities). Only in the last of five canons did the code specify that ACM members should be concerned to use their 'special knowledge and skills for the advancement of human welfare'. By contrast, the 1992 revision elevated the principle of contributing to 'society and human well-being' to the first commitment, while professional discipline was subordinated to education and raising consciousness. In a commentary on the revised code published in the *Communications of the ACM* in 1993, the interdisciplinary team of Ronald E. Anderson (social scientist), Deborah G. Johnson (philosopher), Donald Gotterbarn (computer scientist), and Judith Perrolle (social scientist)—a subset of the code drafting committee—noted that 'a major benefit of an educationally oriented code is its contribution to the group by clarifying the professionals' responsibility to society' (p. 98).

One substantive moral commitment that stands out as a distinctive result of the interdisciplinary nature of the ACM code is an expressed respect for individual privacy. In the 1973 version of the code, this idea took the form of obligations to minimize personal data collection, to secure such data collections, and to arrange for the disposal of data when their function had been served. In the 1992 revised code, a similar respect for individual privacy is expressed in the following terms:

> Computing and communication technology enables the collection and exchange of personal information on a scale unprecedented in the history of civilization.…It is the responsibility of professionals to maintain the privacy and integrity of data describing individuals.…This imperative implies that only the necessary amount of personal information be collected in a system, that retention and disposal periods for that information be clearly defined and enforced, and that personal information gathered for a specific purpose not be used for other purposes without consent of the individual(s). (ACM code, 1.7)

According to Bynum, however, computer and information ethics, especially as grounded in the foundational reflections of Wiener, raise issues that are more transdisciplinary than interdisciplinary. As Bynum describes it:

[Wiener's] way of doing information ethics does not require the expertise of a trained philosopher.…Any adult who functions successfully in a reasonably just society is likely to be [able to contribute]. As a result, those who must cope with the introduction of new information technology – whether they are public policy makers, computer professionals, business people, workers, teachers, parents, or others – can and should engage in information ethics by helping to integrate new information technology into society in an ethically acceptable way. Information ethics, understood in this broad sense, is too important to be left only to philosophers or to information professionals. (Bynum 2008, p. 30)

In effect, Bynam suggests the possibility of an interdisciplinary ethics not simply of knowledge and technological production, but also of knowledge and technological utilization. The users of technologies should be able to draw on their own broad non-disciplinary knowledge to assess them, a view that has also been termed end-user conviviality (Mitcham 2009).

Indeed, most discussions about the ethics of information focus on the production side (of information goods or solutions to problems) rather than on the use side, where consumers and citizens take up and utilize information. Information production is admittedly difficult to thematize, analyze, and practice interdisciplinarily. But interdisciplinary use of information is a quite common phenomenon, well and easily practiced if seldom theorized. Most 'disciplinary' producers engage frequently in 'interdisciplinary' consumption. When information producers leave the design shop or academic classroom they become citizens, members of families, churches, and users of all sorts of information goods and services—most of which they engage not as disciplinary experts or specialists but simply on the basis of common experience. In short, the disciplinary historian becomes an inter- and transdisciplinary human being when going to a health care provider. A physician's diagnosis and treatment recommendation is only incidentally filtered through the historian's perspective, insofar as questions might be asked about the historical development and origin of a diagnosis or therapy. The historian *qua* patient and consumer of medical services has an ability and indeed a motivation to draw from any number of disciplines in the process of making sense of a diagnosis or prescribed therapy: an old general chemistry course from high school, a required science course in college, a novel about medical care, newspapers reports and TV programs. Interdisciplinary consumption and use is a largely undertheorized aspect of interdisciplinarity that in fact functions in almost all areas of applied ethics.

18.4 Interdisciplinarity in applied ethics: professional ethics of engineering and science

The 'disciplinarity' that characterized the mode of knowledge production of the last half of the twentieth century, into which 'interdisciplinarity' is an intervention, exhibits a historically specific character. In earlier periods, producers such as farmers, tailors, and even soldiers were both producers and consumers of their own goods: farmers ate their own food; tailors wore their own clothes; vernacular architects lived in the houses they built; soldiers fought with the weapons they designed, manufactured, and maintained. The

hyperstructural differentiation that resulted in the proliferation of disciplines with rigid boundaries did not arise until the modern period.

In the domain of professional ethics the typically modern separation of production and use is less pronounced than in other applied ethics fields. Consider, for example, the development of engineering ethics and the ethics of scientific research. In both cases, interdisciplinary work has become the norm. Engineering is a discipline that has evolved into several specialized subfields, from civil and mechanical to chemical, electrical, electronic, industrial, nuclear, computer, and more. Especially since the 1990s, the paramount commitment, across all fields of engineering, has been articulated as the protection of public safety, health, and welfare—a commitment that has become known as the *paramountcy clause*. In the 1970s, the US National Endowment for the Humanities (NEH) and the National Science Foundation (NSF), stimulated in part by widespread public concern about a series of engineering-related failures (most prominently involving automobiles and airplanes) and in an effort to deepen understanding and practice of the paramountcy clause, jointly awarded a number of grants to research teams that included both philosophers and engineers to study the ethics of engineering research and practice. The NSF even established a special Ethics and Values in Science and Technology (EVIST) grants program. This resulted in the creation of a number of interdisciplinary team-taught engineering ethics courses and the publication of engineering ethics textbooks (e.g. Unger 1982; Martin and Schinzinger 1983; Harris *et al*. 1995).

A similar interdisciplinary dynamic transformed critical reflection and practice with regard to the ethics of scientific research. Stimulated again in part by public concern about fraud and misconduct in science, including the misuse of public funds as revealed in US Congressional hearings in the 1980s, the NSF and the US National Institutes of Health (NIH) funded interdisciplinary research and course development on the responsible conduct of research. This trajectory of scholarship was also promoted by interdisciplinary professional scientific organizations such as the US National Academies of Science (NAS) and the American Association for the Advancement of Science (AAAS). A 1989 pamphlet, *On being a scientist*—produced by an interdisciplinary team of representatives from the physical sciences, life sciences, engineering, social sciences, and humanities under general direction of the Committee on Science, Engineering, and Public Policy of the NAS, National Academy of Engineering, and Institute of Medicine and published by the National Academies Press—became a standard teaching resource at both the graduate and undergraduate levels in universities. This and related texts review basic research protocols regarding notions of integrity and honesty in the reporting of research results, the avoidance of conflicts of interest, the fair treatment of subordinates and colleagues, and respect for animal welfare for the purposes of raising awareness and fostering ethically responsible scientific practice.

18.5 Applied ethics generalized

The permutations of 'applied ethics' discussed here display at least four common features. First, the distinctions between multi-, cross-, trans-, and interdisciplinarity are of

marginal concern to those who practice interdisciplinary ethics. Interdisciplinary teams engage in their work and negotiate the parameters of their interactions on the fly without feeling much need to analyze the particulars. Second, the *practice* of interdisciplinarity is often considered a transgression of proper disciplinary order. In the discipline of philosophy, for instance, those who become involved in interdisciplinary work are often professionally marginalized. Philosophers who specialize in applied ethics are seldom accepted as equal members of their departments. Sometimes they are nudged out of the discipline and into interdisciplinary units such as programs and departments of science, technology, and society (STS) studies. Julie Thompson Klein (1990, 2001) has in this regard described the character of 'interdisciplinarity' that emerges in different institutional contexts as a consequence of the movement 'out of the disciplines' by interdisciplinary researchers.

Third, the notion of interdisciplinarity often expands beyond an initial grouping comprising engineers and scientists to eventually include social scientists and humanists (Frodeman *et al.* 2001). This results, fourth, in the formation of new questions about the professional and cultural boundaries of applied ethics work. Engaging in applied ethics in the context of contemporary globalization leads researchers to ask questions about the legitimacy of, for example, standards for the responsible conduct of research developed in Europe and the United States as distinct from China, India, or South Africa (European Commission 2009).

Along with a number of different, substantive ethical ideals such as free and informed consent in bioethics, sustainability in environmental ethics, and privacy protection in computer ethics, two other commitments are often incorporated into applied ethics fields. One is that technical experts have the obligation to promote public education regarding the most relevant aspects of their work. Another is that, when appropriate, these technical experts have obligations to involve the public in decision making about technical matters. Summarizing these two ideal commitments, it has been argued that the ethical determination of boundary conditions on research and knowledge production requires co-responsible or interdisciplinary collaboration between the scientific community and the public (Mitcham 2003). This, in turn, requires ethics (in its broadest formation) to reflect upon its own unavoidable disciplinary blind spots, to shift from one frame of reference to another, in order to appreciate the specific character of different forms of knowledge, different methods of knowledge production, and different purposes of knowledge creation. Clarifying the ethical responsibility of technical experts to engage members of the public in technical decision making enacts the political adage of 'no taxation without representation'. We live in a world where scientific research and technological invention have a more significant impact on citizens than do government tax policies. This participatory principle also moves applied ethics from the realm of personal behavior into that of politics and policy (Winner 1980; Goldman 1992).

18.6 The ethics of interdisciplinarity as an ethics of shift work

The foregoing review of applied ethics indicates that it would be difficult to do such work without interdisciplinary engagements. This persistent fact in turn suggests a value: doing

interdisciplinarity in the most ethical way imaginable. Although value may not be derivable from fact, facts can stimulate reflection on relevant values. To think about the right and wrong ways of doing interdisciplinarity is to anticipate an ethics of interdisciplinarity, and in such an anticipation it would be useful to begin with a general characterization of interdisciplinarity itself. Although interdisciplinary collaboration comes in many forms—multi-, cross-, inter-, and transdisciplinarity, to name only the four most common types—uniting all forms of interdisciplinary is what may be described as the phenomenon of 'shift work', literal and metaphorical. Taking this as the starting point, a manifesto on the ethics of interdisciplinarity will itself involve a shift in rhetoric and tone. This is but one more manifestation of the dynamic movement characteristic of interdisciplinary work.

Unlike shifts that start and end with the punch clock, interdisciplinary shifts from one framework to another require the on-going crossing of boundaries. Many studies treat boundary crossing as the exception rather than the rule: 'At this historical point, however, the interactions and reorganizations that boundary crossing creates are as central to the production and organization of knowledge as boundary formation and maintenance' (Klein 1996, p. 2). Yet it can be difficult to grasp the specific dynamics of this shift work across boundaries, let alone figure out how to exercise positive influence over it. In this case, *ought* need not imply *can*, but does imply *try*.

Although interdisciplinary shift work is enabled by new technologies, it is not technologically determined. Enabled and stimulated by advancing technologies of transportation, communication, and information storage and retrieval, shift work takes form in classrooms and galleries, in virtual online worlds, in networked social spaces, and through mobile access points. The traditional spaces of cultural production and reproduction—research labs, art studios, universities, museums, libraries, galleries, theaters, and community centers—are themselves being transformed by those who inhabit them as they adopt new practices of communication, community formation, knowledge production, and technology use.

Given its dependence on, without being determined by, technological change, the shift work ethos invites cultivation of what may be called the *technological imagination*, a quality of mind that enables people to think *with* and *through* technology (Balsamo, forthcoming). This is equivalent to what Albert Borgmann calls 'real ethics': an ethics that steps beyond ideas and theories and is more expansive than that focused on personal interactions. 'Real means tangible; real ethics is taking responsibility for the tangible setting of life' (Borgmann 2006, p. 11). Real ethics rests on the recognition that even as we design the world of artifacts within which we live, those artifacts design us. Additionally, the technological imagination entails performativity and improvization, the cultivation of which rests on appreciation or understanding of: (1) the hidden character of knowledge in a digital age, (2) the multifaceted consequences of technological innovation, and (3) the development of new protocols for enacting interdisciplinary activity. The richer the technological imagination, the better the questions it will bring to these three aspects of the practice of interdisciplinarity.

(1) With regard to the hidden character of knowledge: for those now considered members of a generation 'born digital' (who came to consciousness after the emergence of the internet in the 1990s), it is obvious that data $\neq$ information $\neq$ knowledge, and that daily life is a scene of constant shifts between different networked contexts. Consequently,

they often display a transgressiveness that emerges from repeated experiences of traveling across linked information flows. Their successful navigation of media flows, distributed learning, and social environments requires the fluid mutation of interests, identities, and affiliations. Mutability becomes one of their strongest attributes. It is exactly this sensibility and fluid mutability that can serve as the foundation for a lifetime of learning.

But mutability is not easily accommodated within established institutions that govern and sanction knowledge production and which depend on specific structures, conventions, and often highly traditional rituals of production. In order to successfully navigate contemporary digital network worlds, participants must learn not only how to transform data into information, but then be able to integrate information that comes from different sources for purposes of creating knowledge. In short, they must learn how to synthesize material harvested from diverse information flows. To affect this, digital shift workers learn to produce knowledge through dialogues among disciplines, social negotiation, and collaboration with peers, experts, and multiple others. Knowledge-producing activities will thus depend on understanding how disciplinarity functions as the institutionalized practice of knowledge verification. Shift workers learn how to engage in conversations with those who hold diverse cultural values or intellectual commitments. The everyday experience of the digital generation already incorporates creative synthesis practices such as data mining, remixing, and modding. But to create knowledge, interdisciplinarians must also learn how to critique the information flows they remix. In this sense, 'critical reading' is not an outmoded text-based literacy.

(2) The multifaceted consequences of innovation can be summed up in the formula: technological innovation = social transformation. Research that produces technological innovation is socially and culturally transformative insofar as all technologies shift social and cultural arrangements. Transformation takes shape through the formation of new publics, policies, social protocols, services, cultural narratives, as well as new technological applications and devices. Innovation thus calls for multidisciplinary collaboration not just in pursuit of the creation of new technological products, but also in the formation of political alignments for interdisciplinary collaborations. In the past, such collaborations have been unnecessarily limited. As the technohumanists Cathy Davidson and David Goldberg (2004) point out in their 'Manifesto for the humanities in a technological age', those who call for interdisciplinary collaboration that focuses on applied social problems frequently disregard the participation of humanists. As an example they cite Jeffrey Sachs, as Director of the Earth Institute at Columbia University and Special Adviser to the United Nations Secretary-General on Millennium Development Goals. Although insisting 'that interdisciplinarity was the only way to solve world problems', proposed bringing together only the earth sciences, ecological sciences, engineering, public health, and the social sciences with a heavy dose of economics—leaving out the arts, culture, and philosophy. Yet complex social problems call for hybrid solutions that benefit from the incorporation of intellectually nuanced cultural analyses. The cultural aspects of technology design, use, deployment, implementation, maintenance, and disposal are fundamental to the process of forming adequate responses to variegated social problems.

(3) Having called for including a broader range of disciplinary participants, it is important to note that those who collaborate as members of interdisciplinary

shift teams must resist any facile division of labor that relegates scientists to studying conditions, engineers to designing artifacts, and social scientists and humanists left to practicing critique. While different roles are to be played by different types of participants, all must be willing—indeed, eager—to learn new skills, analytical frameworks, methods, and practices. This is the starting point for a practical ethics of interdisciplinarity. When people with different disciplinary or even interdisciplinary backgrounds come together, it is important to acknowledge that everyone has something to contribute and to learn.

The following virtues may thus be as indicative of the ethical habits appropriate to shift work interdisciplinarity:

Intellectual generosity. A genuine acknowledgment of others' work. This should be explicitly expressed to collaborators as well as mentioned via citation practices. Showing appreciation for other ideas in face-to-face dialogue and throughout a collaborative process stimulates intellectual risk-taking and creativity.

Intellectual confidence. A belief that one has something important to contribute. Confidence avoids boastfulness and includes a commitment to accountability for the quality of a collaboration. Everyone's contribution to a collaboration needs to be reliable, rejecting short cuts and guarding against intellectual laziness.

Intellectual humility. A recognition that one's knowledge is partial, incomplete, and can always be extended and revised. This is a quality that allows people to admit they do not know something without suffering loss of confidence or self-esteem.

Intellectual flexibility. The ability to change one's perspective, especially based on new insights from others. This can include a capacity for play, for suspending judgment and imagining other ways of being in the world and other worlds to be within.

Intellectual integrity. The exercise of responsible participation. Such a habit serves as a basis for the development of trust, and is a quality that compels colleagues to bring their best work and thinking to collaborative efforts.

Beyond such particular virtues, however, the practical ethics of interdisciplinarity assumes that more effective interdisciplinary production and use is a natural good. It is pragmatic in orientation, seeking only to improve interdisciplinary output—making interdisciplinarity work well rather than questioning whether interdisciplinarity should work.

At the same time, is there no need for a questioning of greater and greater productivity? Questioning is generally seen as legitimate with regard to material productivity. Why not also with interdisciplinary productivity, whether practiced in the realm of tangible or cognitive goods? Is it not possible to be overwhelmed by knowledge and innovation? Are these not the ultimate issues for any ethics of interdisciplinarity?

18.7 Conclusion

Ethics as a form of interdisciplinarity has been described in a broad-brush historical survey from the Axial Age to the twenty-first century. This survey identified five basic frameworks in which ethics has mediated interactions between human beings and other aspects of reality. This constitutes an admittedly metaphorical extension of the notion

of interdisciplinarity, but one that suggests possibilities deeper than those customarily imagined—and going beyond the commonplace of interdisciplinarity as useful for problem solving.

Beginning in the second half of the twentieth century it is also possible to identify a form of ethics—applied ethics—in which interdisciplinarity in a less metaphorical sense plays an increasingly constitutive role. A selective review of work in various applied ethics fields, from bioethics to engineering, reveals how integral interdisciplinarity is to almost any critical reflection on life in a technoscientific world.

The prominence of interdisciplinarity in ethics in turn suggests the need for an ethics of interdisciplinarity, that is, for reflections on what ethos could best guide interdisciplinary practitioners in their shift work. In a sense, of course, the whole handbook of which this chapter is a part has the same aim. But as its own special contribution to such a general goal, the ethics chapter concluded by identifying shift work as a key characteristic of all interdisciplinary activity and then ventured to explore differences between right and wrong ways to enact its ever recurring shifts in perspective and method. The result was to describe five virtues for interdisciplinary practice. One way of testing the adequacy of these virtues would be to consider their relevance to the many other analyses of interdisciplinarity that inform the present handbook.

References

Anderson, R.E. (1994). The ACM code of ethics: history, process, and implications. In: C. Huff and T. Finhold (eds) *Social issues in computing: putting computing in its place*, pp. 48–71. New York: McGraw-Hill.

Anderson, R.E., Johnson, D.G., Gotterbarn, D., and Perrolle, J. (1993). Using the new ACM code of ethics in decision making. *Communications of the ACM* **36**(2), 98-1-7.

Balsamo, A. (1996). *Technologies of the gendered body: reading cyborg women*. Durham, NC: Duke University Press.

Balsamo, A. (forthcoming). *Designing culture: a work of the technological imagination at work*. Durham, NC: Duke University Press.

Borgmann, A. (2006). *Real American ethics: taking responsibility for our country*. Chicago: University of Chicago Press.

Bynum, T.W. (2008). Milestones in the history of information and computer ethics. In: K.E. Himma and H.T. Tavani (eds) *The handbook of information and computer ethics*, pp. 25–48. Hoboken, NJ: John Wiley.

Carson, R. (1962). *Silent spring*. Boston, MA: Houghton Mifflin.

Committee on Science, Engineering, and Public Policy (1989). *On being a scientist: a guide to responsible conduct in research* [2nd edn 1995, 3rd edn 2009]. Washington, DC: National Academies Press.

Davidson, C.N. and Goldberg, D.T. (2004). A manifesto for the humanities in a technological age. *Chronicle of Higher Education* **50**(23), B7.

European Commission Expert Group on Global Governance of Science (2009). *Global governance of science*. Brussels: Directorate-General for Research; Science, Economy and Society.

Frodeman, R., Mitcham, C., and Sacks, A. (2001). Questioning interdisciplinarity. *Science, Technology & Society Curriculum Newsletter* **126–127**, 1–5.

Goldman, S.L. (1992). No innovation without representation: technological action in a democratic society. In: S.H. Cutcliffe, S.L. Goldman, M. Medina, and J. Sanmartin (eds) *New worlds, new technologies, new issues*, pp. 148–60. Bethlehem, PA: Lehigh University Press.

Hare, R.M. (1952). *The language of morals*. Oxford: Clarendon Press.

Harris, C.E., Jr, Pritchard, M.S., and Rabins, M.J. (1995). *Engineering ethics: concepts and cases*. Belmont, CA: Wadsworth.

Jaspers, K. (1949). *Vom Ursprung und Ziel der Geschichte*. Zurich: Artemis Verlag.

Johnson, D. (1985). *Computer ethics*. New York: Prentice Hall.

Klein, J.T. (1990). *Interdisciplinarity: history, theory, and practice*. Detroit, MI: Wayne State University Press.

Klein, J.T. (1996). *Crossing boundaries: knowledge, disciplinarities, and interdisciplinarities*. Charlottesville, VA: University Press of Virginia.

Klein, J.T. (2001). The interdisciplinary variable. In: B.L. Smith and J. McCann (eds), *Reinventing ourselves: interdisciplinary education, collaborative learning and experimentation in higher education*, pp. 391–418. Bolton, MA: Anker Press.

Leopold, A. (1949). *A sand county almanac*. New York: Oxford University Press.

Martin, M.W. and Schinzinger, R. (1983). *Ethics in engineering*. New York: McGraw Hill.

Mitcham, C. (2003). Co-responsibility for research integrity. *Science and Engineering Ethics* **9**(2), 273–90.

Mitcham, C. (2009). Convivial software: an end-user perspective on free and open source software. *Ethics and Information Technology* **11**(3), 299–310.

Post, S.G. (ed.) (2004). *Encyclopedia of bioethics*, 3rd edn. Detroit: Macmillan Reference.

Toulmin, S. (1950). *An examination of the place of reason in ethics*. Cambridge: Cambridge University Press.

Toulmin, S. (1982). How medicine saved the life of ethics. *Perspectives in Biology and Medicine* **25**(4), 736–50.

Unger, S.H. (1982). *Controlling technology: ethics and the responsible engineer*. New York: Hold Rinehart and Winston.

de Wachter, M.A.M. (1982). Interdisciplinary bioethics: but where do we start? *Journal of Medicine and Philosophy* **7**(3), 275–88.

Weiner, N. (1950). *The human use of human beings*. Boston: Houghton Mifflin.

Winner, L. (1980). Do artifacts have politics? *Daedalus* **109**(1), 121–36.