Chapter 2
Research Ethics Guidelines for the Engineering Sciences and Computer and Information Sciences

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Abstract This chapter presents, discusses and defends research ethics guidelines for the engineering sciences and computer and information sciences. Only very recently has there been an effort to establish research ethics frameworks and ethics committees for these two fields. Arguments are presented concerning these developments, and a specific proposal is made for ethics guidelines for the engineering sciences and the computer and information sciences. It is argued that although there are shared issues and principles for research ethics across scientific fields, all scientific fields raise unique ethical issues that require special ethical principles and guidelines. Following this discussion, the historical development of professional ethics and research ethics in the engineering science and the computer and information sciences is discussed, and special guidelines for these fields are presented that were developed as part of a CEN (European Committee for Standardization) standard for research ethics within the European Commission-funded SATORI project on research ethics and ethics assessment.

Keywords Engineering sciences · Information sciences · Research ethics · Ethics assessment · Standardization

2.1 Introduction

This chapter considers the development of research ethics guidelines for the engineering sciences and computer and information sciences. Codes of professional ethics have existed for these fields for a long time, but research ethics guidelines have been developed for them only very recently. This is likely because, until recently, research ethics committees for these fields were hardly in existence. In recent years, however, there has been a push to establish dedicated research ethics committees for

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K. Laas et al. (eds.), *Codes of Ethics and Ethical Guidelines*, The International Library of Ethics, Law and Technology 23,
https://doi.org/10.1007/978-3-030-86201-5_2

these fields, as has already happened long before that in biomedicine. More and more universities and research institutions are subjecting engineering and computer science research to ethics review, and more and more companies (e.g., Apple, Microsoft, Facebook) are also instituting research ethics committees in these fields.

The distinction between professional ethics codes and research ethics guidelines is crucial in this chapter, which is why I will elaborate. Codes of professional ethics are guidelines for ethical behavior by individual professionals in various professional fields (Martin et al. 2010). They aim to regulate professional conduct so as to ensure it exhibits high ethical standards, professional quality, and trustworthiness. Codes of professional ethics are in place not only in professions that center around research and innovation but also in many other fields (e.g., for lawyers, nurses, and journalists). In professions in which research and innovation have an important place (in fields like computer science, engineering science, social science, and medicine), professional ethics codes to some extent cover expected professional behaviors in relation to research and innovation, but much of what they cover is more general. Professionals in these fields are likely to carry out research and innovation activities, but they may do a lot of other things as well, such as managing people, interacting with clients, teaching, writing a column for a newspaper, and sitting on a review committee in their company. A large part of professional ethics is typically devoted to general virtues and professional behaviors that define professional integrity, social responsibility, and professionalism in these fields.

Research ethics guidelines typically do not apply to individual conduct but to research and innovation practices (Ipfhofen 2020). These practices often involve multiple researchers, and it is not their individual conduct that the guidelines are directed at but the overall way in which the research is conducted. These guidelines are typically not only used by researchers themselves but also by research ethics committees that ethically assess research. Research ethics committees typically do not do this during or after the research activity, but prior to it, on the basis of a research plan or proposal. They assess whether the research proposal adheres to relevant ethical standards or guidelines. These guidelines cover the research design and not individual conduct. A research ethics committee cannot determine on the basis of a research plan if individual scientists involved in the research will act honestly and with integrity.

Research ethics has for long been virtually synonymous with medical research ethics, as is evidenced by the fact that until recently, the vast majority of research ethics committees were focused on biomedicine, and the vast majority of publications in research ethics focused on the medical field. This can be explained through an account of the nature and history of both medical and nonmedical fields. Medical research and medicine generally raise many ethical issues that are difficult to ignore since they involve many decisions that can have life and death consequences and are the subject of moral and religious disagreement. Medical research ethics gained a strong foothold after the Second World War when the Nuremberg trials led to the establishment of the Nuremberg Code, which sets out research ethics principles for human experimentation.

The natural sciences never developed a strong tradition in research ethics, in part because, for the most part, they do not involve human or animal experimentation and because their impact on people and society is quite indirect. The social sciences similarly often only have an indirect impact on people and society, and only some of their research involves human experimentation (especially psychology). Finally, the engineering sciences do have an identifiable impact on society that needs to be accounted for since its designs can involve risks to health, life, and the environment. However, these risks have traditionally been mitigated through technical standards and ethics codes for individual engineers, rather than a tradition of research ethics.

In recent years, this situation has changed, and there are now strong arguments to introduce a tradition of research ethics for many nonmedical fields as well. In the next section (Sect. 2.2), I will make this case, and I will moreover argue the ethical issues in these nonmedical fields are to some extent different from those in the medical field and require partially different ethical guidelines. Having established this, I will focus the discussion on appropriate ethical guidelines for the engineering sciences (Sect. 2.3), followed by an analysis of ethical guidelines for the computer and information sciences (Sect. 2.4). In a concluding section, I will take stock of the results of the analysis. The guidelines proposed in Sects. 2.3 and 2.4 are based on a CEN (European Committee for Standardization) Workshop Agreement (CWA), a standards document for research ethics committees that was developed in the SATORI project, a European Commission-funded project on the strengthening and harmonization of research ethics within the European Union.[1]

2.2 The Need for Research Ethics for Nonmedical Fields

In the SATORI project, we performed a study in which we aimed to identify ethical principles that apply to all research fields and ones that apply to only some research fields (Shelley-Egan et al. 2015). I here report our key findings. First, let us consider ethical principles that apply to all research fields. An obvious first one is *research integrity* (or scientific integrity), but this is in large part, not a principle that can be assessed for in research ethics, as it is intended to regulate individual conduct and cannot easily be verified on the basis of research plans. It is difficult to determine based on a research plan whether the researchers involved will act honestly and collegially, will be transparent and scrupulous, and will comply with professional ethical codes. However, some aspects of research integrity may be tested for in research ethics, notably the avoidance of and openness about potential conflicts of interest. Such potential conflicts can easily be disclosed and examined as part of an ethics review process. An ethics committee could also assess whether research methods

[1] SATORI (Stakeholders Acting Together on the Ethical Impact Assessment of Research and Innovation) received funding from the European Commission's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 612231. It ran from 2014 to 2017. The website, with all project deliverables, can be found at http://satoriproject.eu/

and procedures exhibit qualities of carefulness, justification, reliability, transparency and openness, qualities that are often associated with research integrity.

A second ethical principle that applies broadly across different fields is *the protection of human research participants*. Human research participants play a role in many types of research, including not only the medical sciences and social sciences, but also the engineering sciences and computer and information sciences, for example, in stakeholder engagement and the testing of new designs. Although specific principles for the protection of human research participants will be different for different fields, since they may involve different procedures, different risks, and different specific ethical issues, there will also be commonalities, such as the need to have informed consent, to respect dignity, autonomy, and personal integrity, to avoid risks of serious physical or psychological harm, and to have special provisions and protections for children and vulnerable groups.

Social responsibility is a third universal ethical principle and implies that researchers anticipate and consider the potential consequences of the research project or activity for society, including potential future applications, and take appropriate remedial action to address potential negative impacts in their research design. Social responsibility also implies taking into account the concerns of stakeholders when planning and conducting research, communicating research results and potential societal implications of it to stakeholders, take potential misuse of research results into account, and to ensure that research carried out in lower- and middle-income countries involves benefit sharing and takes local needs and interests into account.

A fourth general ethical principle is *the protection of and respect for animals used in research*. There is already considerable international agreement on this principle and, in particular, the three R approach based on *replacement* of animal experiments with other research where possible, *reduction* of the number of animals involved, and *refinement*, which means minimizing suffering (Russel and Burch 1959).

Fifth is the protection of researchers and the research environment. This is a sometimes overlooked principle, but nevertheless important. It ensures the protection not only of human subjects and animals in research, but also of researchers themselves (their health and safety), the local community, and the local environment where experiments or fieldwork are carried out.

A sixth principle, on which there is emerging consensus, is that of responsible data management.[2] This involves the secure storage of research data, awareness of actual and potential data flows, protection of personal data, and open access to research data where possible. In relation to this principle, we reference the FAIR Guiding Principles for scientific data management and stewardship and the open access guidelines of the European Commission (European Commission 2017). Our

[2] In our report, we refer to this as "protection and management of data and dissemination of research results".

personal data principles are in line with the European Union's General Data Protection Regulation.

I hereby present the six principles, with guidelines, in an abbreviated version. The full version can be found in CEN (2017).

Research Integrity

We include nine specific guidelines that concern the following issues:

- employing appropriate research methods
- avoiding bias, avoiding manipulations and distortions
- avoiding inclusion of data or observations that did not occur in data collection and experimentation
- ensuring autonomy and freedom of research
- avoiding conflict of interest
- avoiding the representation of the work of others as one's own
- avoiding misrepresentation of one's qualifications or accomplishments

We point out that these requirements are normally not tested for by research ethics committees, except that conflicts of interest in research design can be more easily addressed than many of the other listed issues. For this reason, we include separate guidelines for avoidance of and openness about potential conflicts of interest.

Social responsibility

We include six specific guidelines:

- Anticipating potential negative consequences for society and taking remedial actions
- Consideration of potential negative impacts on individuals and groups, or the common good
- Promotion of sustainable development
- Acknowledgment of the economic and cultural value of local and traditional knowledge
- Avoidance of misuse of research materials and results
- Communicating with stakeholders and taking their interests into account

We also include five special provisions for research involving low income or lower-middle income countries, including responsiveness to special needs, benefit sharing, involving local researchers in the research, minimizing the diversion of local (human) resources, and showing respect for local culture.

Protection of and respect for human research participants

We include eight specific guidelines:

- Ensuring that research participants receive adequate information about the research
- Obtaining informed consent
- Treating human participants with respect for their dignity, autonomy, and personal integrity
- Ensure that research participants are not exposed to serious physical or psychological harm or strain
- Ensuring that risks to research participants are balanced by benefits to the participants or to society
- Ensuring that the privacy of research participants is protected
- Respecting cultural diversity and pluralism
- Ensuring adequate representation of society and social groups

We also have special provisions for the protection of children, mentally disabled persons, and other vulnerable groups as research participants.

Protection of and respect for animals used in research

We include ten specific guidelines under the following headings:

- Respect for life (three Rs – replacement, reduction, refinement): consider replacement methods, reduction of number of animals used, and ways to minimize suffering
- Respect for the welfare of animals: ensure that potential benefits outweigh harm caused to animals, provide reasonable accommodation for the animals, and limit the use of animals with genetic diseases and behavioral disorders.
- Special provisions for the protection of non-human primates and wild animals and species: avoid the use of non-human primates, and restrict the use of animals captured in the wild.
- Special provisions for the protection of animals in low or lower-middle income countries: help in building local capacity for humane animal experimentation, and only use endangered species if the research contributes to their conservation.

Protection and management of data and dissemination of research results

We include 18 specific guidelines under the following headings:

- *Management of data and open data:* secure storage of data, awareness of data flows, and ensuring access to other researchers, interoperability and reusability.

– *Protection of personal data:* ensuring that collected personal data are needed for the research, obtaining or verifying informed consent, ensuring secure storage that takes place no longer than needed, ensuring that secondary use does not take place without informed consent or proper justification, ensuring regulated access for secondary use, consideration of access to personal information on third parties.
– *Protection of personal data and ethics in Internet research:* consider whether publicly available information is sensitive personal information, ensure anonymity and pseudonymity in data merging, guarantee proper consent when needed, inform participants in open online forums about systematic registration or reporting, endure anonymity when using information from Internet sources, do not disguise one's identity when communicating with research subjects electronically.
– *Dissemination of research results:* make research results publicly available unless there are compelling reasons to do otherwise, strive for open access publications, make research results available to different audiences if possible.

Protection of researchers and the research environment

We include four specific guidelines:

– Protecting of researchers and staff from serious risk of physical or psychological harm or strain
– Taking special precautions to protect health and safety of (local) researchers and staff in low income or lower-middle income countries
– Avoiding harm to local communities
– Minimizing harm to the local environment

We found that apart from these general principles, there is a significant number of ethical principles and guidelines that do not broadly apply to different fields, and that only apply to one field, or a few fields. We hypothesize that this is not the contingent result of different traditions of research ethics, but because different scientific fields encounter different ethical issues in research, resulting in different ethical concerns. These different concerns stem from the fact that the subject matter of these fields, and the relation of researchers to this subject matter, is substantially different for each of them. I will demonstrate this by considering seven broad areas of science and the ethical issues that they raise.

- *Medical sciences:* Medical ethics has traditionally centered around the *doctor-patient relationship*, which concerns standards of ethical behaviour of doctors towards their patients. In medical research ethics, this relationship has turned into the *relationship between medical researcher and human subject*. Ethical issues therefore concern those relating to the proper treatment of human subjects

(especially in clinical trials), involving medical principles such as autonomy, informed consent, beneficence, human dignity, and justice.

- *Life sciences:* The life sciences centre around the *relationship of researchers to living biological systems, ecosystems, and the environment*. Therefore, ethical issues concern the proper treatment of living beings, impacts on ecosystems, environmental impacts, and ethical principles include animal welfare, ecosystems integrity, sustainability, health and environmental risks, naturalness, and playing God.
- *Natural sciences:* The natural sciences have, at their core, the *relation to truth*: accurate measurement and representation of natural phenomena, including criteria like exactness, objectivity, verifiability, and reproducibility. Ethical issues, therefore, concern those that threaten this relation to truth, such as data manipulation, falsification, fabrication, unintentional bias, and conflict of interest. Corresponding ethical principles include scientific integrity, data integrity, freedom from bias, and honesty. While these principles are important in other fields as well, they have received the most attention in the natural sciences and are at the core of research ethics considerations in them.
- *Social sciences:* At the core of the social sciences is the *relation between the researcher and human beings*. However, this relation differs from that in the medical sciences, since it does not involve medical interventions but instead involves behavioural experimentation with and observation of humans, collection of personal information, and the representation of and intervention into the lives of individuals, social groups, and society at large. This leads to ethical issues e.g., the proper treatment of human subjects, privacy of data, and issues such as bias and unequal treatment (in theory and intervention). It involves ethical principles such as informed consent, equality, anonymity, confidentiality, privacy, fairness, non-discrimination, human rights, avoidance of cultural and social bias, and respect. In addition to having a focus on human beings, the social sciences also have a *strong concern for proper methodology* so as to ensure the quality and objectivity of research. Therefore, there is a focus on ethical issues and principles concerning data integrity, research integrity, freedom from methodological bias, objectivity, and others.
- *Engineering sciences:* At the core of the engineering sciences *is the technological intervention into society*: engineers develop technological concepts, artefacts, processes, and systems that directly or indirectly have an impact on people, the environment, and society at large. Ethical issues, therefore, concern impacts, especially those concerning health, well-being, and harms and benefits to society and the environment, as well as corresponding risks (that harmful impacts will occur), and responsibility for these impacts. Ethical principles include social responsibility (or responsibility to the public), well-being, impacts on rights, and the precautionary principle,[3] sustainability, and the good of society, amongst others.

[3] This is the principle that uncertainty about the risks involved in developing a new technology should not be used to justify inaction in addressing them.

- *Computer and information sciences:* These are sciences that are concerned, in different ways, with the *processing, storage, and dissemination of information*. As a result, the focus is on the way in which these activities are enabled and concern issues and principles that include informational privacy, surveillance, information security, intellectual property, censorship, and freedom of information.
- *Humanities:* The humanities, finally, have as their concern *the study and expressive imagination of human culture and the human condition*. This subject's matter involves a special focus on interpretation, narrative, imagination, art, and the documentation, preservation, or augmentation of cultural heritage. Therefore, ethical issues concern the proper conduct of the interpretation and construction of narratives, the proper role of works of imagination and art in society and our evaluation of them, and our responsibilities in the preservation of cultural heritage. In addition, because the humanities may include human subjects in their research, they share ethical issues and principles concerning human subjects' research with the social sciences. Alternatively, in the arts, the relation with audiences can raise ethical issues of responsibility.

We conclude that because of these differences in ethical concerns in these seven areas of science, the ethical guidelines for them will also have to be substantially different. In our CEN Workshop Agreement (CWA) on ethics committees (CEN 2017), we have worked out specific guidelines for these seven fields. These guidelines were the result of consultation with a large number of stakeholders. In what follows, I will now turn to the ethical guidelines that the CWA resulted in for the engineering sciences (Sect. 2.3) and computer and information sciences (Sect. 2.4).

2.3 Guidelines for the Engineering Sciences

While professional engineering societies already started adopting professional ethics codes in the late nineteenth century, it is only very recently that ethics guidelines for engineering research have been developed. While professional ethics in engineering is well developed, research ethics has not been. Many engineering programs at universities include courses or modules on engineering ethics, which pays attention to ethical issues in engineering, but the focus is on professional ethics rather than research ethics. Engineering ethics is concerned with the engineer's consideration for the public, clients, employers, and the profession, and focuses on responsibilities for the health, safety, and welfare of the public, on sustainability and care for the environment, and on standards of professional integrity. Some engineering ethics textbooks cover ethical issues in engineering research, but most codes of ethics do not make specific reference to research.[4]

[4] See Brey and Jansen (2015) for more information on the current state of affairs of engineering ethics and engineering research ethics.

In understanding this state of affairs, it should be taken into account that only part of engineering work involves research. Much of it is concerned with innovation and technology development, which may include or be preceded by research activities, but which includes a creative process of making and designing that is different from scientific research. The engineering sciences highlight the fact that the concept of research ethics may be too limited for some scientific fields. Next to the engineering sciences, the computer and information sciences also have a focus on developing systems and products rather than scientific discovery. So because of the nature of these two fields, it might be more appropriate to consider a realm of *research and innovation ethics* instead of just research ethics. Research ethics committees for these sciences are actually research and innovation committees, as they assess not just research but also innovation and technology development plans.

The reason that professional ethics codes for engineers may not be enough, and we need research ethics as well, is that engineering projects are typically carried out by teams of engineers and involve ethical issues that concern the overall research and innovation design. This means that addressing such issues is a collective responsibility, and they cannot be addressed through individual action alone, but rather require a comprehensive accounting for ethical issues throughout the research and development process.

In recent years, there has been an interest in research ethics for the engineering sciences, and one sees the emergence of research ethics committees for the engineering sciences at a growing number of institutions.[5] While a full explanation for this development is beyond the scope of this chapter, we can point to two developments that may have been of influence here. First, ethical concern with the pervasive role of technology in society has resulted since the 1990s in a new field of technology ethics (Hansson 2017; Sandler 2013), which is not a form of professional ethics but rather a form of applied ethics that concerns itself with social-ethical problems surrounding technology. Ethics of technology is related to the field of technology assessment, but has a specific focus on ethical issues. It focuses on the ethical issues that society in general has to deal with regarding the introduction and use of technology in society. Examples of such issues include whether the risks of new nanotechnologies are morally acceptable, whether cloning should be allowed, and to what extent Internet users are entitled to privacy. Technology ethics potentially provides a basis for the development of research ethics for the engineering sciences, since it identifies ethical issues with the development of technology and its impact on society. It has even identified how technological design can be morally biased and includes value choices and how engineering design can be carried out in such a way that the resulting systems promote desired values and reduce undesirable biases (Van den Hoven et al. 2015; Friedman and Hendry 2019).

A second development that has stimulated research ethics for the engineering sciences has been the policy of the European Commission to have ethics review for

[5] See Koepsell et al. (2014), who, however, focus on human research ethics at technical universities.

all research in the European Union funded within research framework programmes. These are programmes with budgets of many billions of euros per year, that mostly fund research in the engineering sciences and computer and information sciences. Including ethics review, and often requiring research plans that are assessed by local ethics committees as well, has stimulated the emergence of local ethics committees in the engineering sciences and computer and information sciences in the European Union.

In spite of these developments, there is still hardly a tradition of research ethics for the engineering sciences. In fact, the only example of research ethics guidelines for the engineering sciences known to us before we developed our own in the SATORI project were the Guidelines for Research Ethics in Science and Technology by The Norwegian National Committee for Research Ethics in Science and Technology (2016). However, these guidelines had the limitation of covering both science and technology, thereby hardly covering issues that are specific to the engineering sciences. Moreover, they blend engineering ethics guidelines with research ethics guidelines, while in our view, these are best kept separate.

In what follows, I present the additional ethical principles for the engineering sciences developed in the CWA that we see as supplementing the general ethical principles of respect for scientific integrity, social responsibility, respect for human subjects, respect for animals, protection of researchers, and the research environment, and responsible data management that we earlier identified to apply to all fields. The principles are either additional provisions for these six general principles, or substantially new principles.

Starting with additional provisions, we identified a large number of specific social responsibilities involved in engineering that do not apply to (most) other fields, and also identified some additional principles regarding the protection of animals and of researchers and the research environment:

Social responsibility (additional provisions)

Respect for individual rights and liberties:

- Ensure the technology does not pose inherent risks to individual freedom, autonomy, authenticity, or identity; or to individual privacy, human dignity, or human bodily integrity.

Protection and promotion of well-being and the common good:

- Consider how the technology could potentially harm or benefit the well-being and interests of individuals and groups in society;
- Consider how the technology could help to protect and promote important social institutions and structures, democracy, and important aspects of culture and cultural diversity.

Protection and promotion of justice and equality:

- Consider how the technology could harbour biases or negative effects that disproportionally impact people in terms of age, gender, sexual orientation, social class, income, race, ethnicity, religion, culture, or disability;
- Consider how the technology could contribute to the reduction of unjust biases, stigmatization, or discrimination in society in terms of age, gender, sexual orientation, social class, race, ethnicity, religion, culture or disability;
- Consider how the technology could widen or help narrow social inequalities in terms of the distribution of opportunities, powers, and capabilities, civil and political rights, economic resources, income, risks or hazards;
- Consider how the technology could harm or benefit vulnerable, disadvantaged, or underrepresented individuals, groups, and communities in society or individuals, groups and communities in low-income and lower-middle income countries;
- Consider how the technology could harm or benefit future generations.

Protection of animals (additional provisions for technology that is intended for use around animals)

- Ensure that the technology does not pose any unnecessary risks of harm to animals;
- Respect the characteristics, needs, and behaviours of the animal species involved.

Protection of researchers and the research environment (additional provisions)

- Take special precautions to ensure that researchers and staff involved in conducting the research are not exposed to serious physical harm or strain as a result of working with harmful biological, chemical, radiological, nuclear, or explosive materials.

These guidelines were included because of the specific nature of technology: technology results in products and systems that are used in society, and as such can affect, sometimes reliably, the realization of individual rights and liberties, justice and equality, well-being, and the common good. The ethical guidelines ask technology developers to anticipate and account for this in their work. Technological products can also cause harm to animals in the context of use, separately from potential harm from animals in research, and technological research also requires special precautions for researchers and the research environments that are not needed for most other types of research.

We also identified several principles that apply specifically to engineering science: avoidance of risks of harm to the environment, dual use of engineering research and technology, and avoidance of misuse of research materials and results:

Avoidance of risks of harm to the environment

Protection of the environment:

- Anticipate and assess potential risks of harm to the (urbanised or natural) environment as a result of the applications or uses of the technology, and take appropriate measures to address them during the innovation process;
- Consider the possibility of unforeseen or long-term environmental effects of the technology;
- Take special precautions to prevent environmental harms caused by the use of biological, chemical, radiological, nuclear, or explosive materials;
- Promote a clear understanding of the actions required to restore the environment once it has been disturbed as a result of the technology.

Promotion of environmental sustainability:

- Optimize the technology for effective and cost-efficient resource recovery (recycling);
- Take responsibility to search for technological solutions that lower the potential consumption of raw materials and energy;
- Take responsibility to search for technological solutions that lower the production of environmentally harmful wastes and lessen environmental pollution;
- Be conscious of the interdependence between ecosystems and the importance of bio-diversity.

Social environmental responsibility:

- Be conscious of, and engaged with, any (local) societal concerns and interests regarding the ways in which the technology could affect the environment.

Avoidance of public health and safety risks.

- Ensure that the technology that is developed, in terms both of the production and the societal use of any goods based on it, does not pose inherent direct or long-term risks of harm to public health and safety.

Dual use of engineering research and technology

- Consider whether the technology could have military applications;
- Consider whether the technology could contribute to the proliferation of weapons of mass destruction;

- Consult proper authorities before publishing and adhere to relevant national and supra-national regulations if the technology has significant military applications or if it contributes significantly to the proliferation of weapons of mass destruction.

Avoidance of misuse of research materials and results

- Take special precautions to prevent or counter the effects of potential misuse of security-sensitive chemical, radiological or nuclear materials and knowledge (e.g. the appointment of a security advisor, limiting dissemination, classification, training for staff).

These guidelines were included for the following reasons: Avoidance of risks of harm to the environment was included because technology development results in technological solutions that can either harm or benefit the environment. The engineering sciences differ in this respect from most other types of research. Guidelines for dual use were included because these are also specific to technology and engineering. The same applies to avoidance of misuse: technological products can often be misused in harmful ways, and designers can often anticipate this and take special precautions to prevent misuse.

The complete set of guidelines for the engineering sciences, combining both general guidelines and engineering-specific guidelines, can be found on the SATORI website at http://satoriproject.eu/deliverables/.

2.4 Guidelines for the Computer and Information Sciences

In the computer and information sciences, we see a similar development to that of the engineering sciences. Professional ethics for computer scientists has been around since the field was still young, and the first code of ethics for computer scientists was developed in 1973 by the Association for Computing Machinery in the United States. Research ethics guidelines and committees have been in existence, however, only since very recently (Søraker and Brey 2015). Recent efforts may have been stimulated by the emergence, since the 1980s, of the field of computer ethics (Johnson 1985; Tavani 2015), which, like the ethics of technology did for the engineering sciences, addresses ethical issues relating to the role of computer systems in society. It may have also been stimulated by the requirement of ethics review for EU-funded research in the European Union, as happened with the engineering sciences. Since the late 2010s, moreover, there has been a strong interest in both the tech industry and in policy circles for ethics of artificial intelligence, which is believed by many to raise important ethical issues for society. Many guidelines have been generated in recent years for AI, and this interest has also stimulated the

formation of research ethics committees for AI specifically, or for computer science and information technology generally, at tech companies like Google, Apple, and Facebook, and at universities (Hagendorff, 2020). In addition, there has been a significant interest since at least the 1990s to address privacy issues with information technology, and various guidelines have been developed to specifically address issues of privacy and data protection – though in most cases, these are not aimed at the development of information technology but at its use (e.g., European Commission 2018; Wright 2012).

While plenty of guidelines have been developed that specifically address AI and privacy, very few have been developed that address the computer and information sciences in general. When we developed our own in the SATORI project, as part of the CEN CWA, only one clear example was known to us, which were ethics guidelines for information and communication technology research for the U.S. Department of Homeland Security: the Menlo report and its companion (Dittrich and Kenneally, 2012; Dittrich et al. 2013). These guidelines have a focus, however, on human subjects research only. For the reasons given in Sect. 2.2, we believe that the issues in computer science are broader in scope and cannot easily be captured by traditional human subjects research frameworks.

I now present the additional ethical principles for the computer and information sciences that were developed in the CEN CWA and that we see as supplementing the general ethical principles identified earlier. Starting with additional provisions to general principles, we identified a large number of specific social responsibilities involved in computer and information science and specific additions for the responsible data management in relation to privacy and protection of personal information:

Social responsibility (additional provisions)

Respect for freedom of expression:

- Ensure that new research concepts and innovations do not pose unjustified inherent risks to the freedom of individuals to express themselves through the publication and dissemination of information, or to their freedom of access to information;
- If research or innovation involves the use of censorship methods, strike an appropriate balance between the need for content control and the right of individuals to express themselves freely.

Respect for intellectual property:

- Ensure that new research concepts and innovations do not pose unjustified inherent risks to the intellectual property rights of individuals or organisations;
- Avoid research that could generate copyright issues, such as research involving peer-to-peer networking or file sharing and distribution.

Respect for other individual rights and liberties:

- Ensure that new research concepts and innovations do not pose inherent risks to autonomy, authenticity, or identity. In particular, ensure that information systems do not unnecessarily or unjustifiably take away control from users by limiting their choices or making choices for them that they would prefer to make themselves;
- Ensure that decisions made by information systems that have significant social impact take into account the rights, values, and interests of stakeholders, including users, and make efforts to ensure that the reasons for decisions made by information systems can be retrieved so as to make the systems accountable;
- Take into account the issue of how responsibilities and liabilities are assigned between humans and machines when information systems are involved in decision-making.

Avoidance of harms to justice and equality:

- Consider how new research concepts and innovations could widen or narrow social inequalities in terms of the distribution of opportunities, powers, and capabilities, civil and political rights, economic resources, income, risks or hazards;
- Consider how new research concepts and innovations could harbour or counter unjust bias in terms of age, gender, sexual orientation, social class, race, ethnicity, religion, or disability;
- Consider how new research concepts and innovations could harm or promote the interests of vulnerable, disadvantaged, or underrepresented groups and communities in society, including those in low income and lower-middle income countries.

Promotion of well-being and the common good:

- Consider how the research or innovation activity could harm or promote the general well-being of individuals and groups in society (e.g., effects on the quality of work or quality of life);
- Consider how the research or innovation activity could harm or promote the social skills and behaviour of individuals, and how it could harm or promote the learning or exercising of important virtues, such as patience and empathy;
- Consider whether and how the research or innovation activity could harm or promote important social institutions and structures, democracy, and important aspects of culture and cultural diversity.

Promotion of environmental sustainability:

- Optimize technologies for effective and cost-efficient resource use (including raw materials and energy), for resource recovery (recycling), and for lowering the production of environmentally harmful wastes and environmental pollution.

Protection and management of data and dissemination of research results (additional provisions)

Protection of personal data.

- Ensure that new research concepts and innovations do not pose any unjustified inherent risks to the right of individuals to control the disclosure of their personal data;
- If research concepts and innovations involve the combination of multiple data sources, carefully consider the effects on (informational) privacy;
- If research concepts and innovations involve the development of capabilities for, or the use of, data surveillance or human subject monitoring or surveillance, then invoke the requirement for informed consent, if appropriate. Strike an appropriate balance between the need to monitor and control personal information and the right of individuals to (informational) privacy and other human rights.

These guidelines were included either because they apply to all technology, and as such, correspond with specific guidelines for the engineering sciences, or because of the specific nature of information technology. For this reason, we included guidelines that address how computer science research and development (R&D) results in products and systems that are used in society and affect the realization of individual rights and liberties, justice and equality, well-being, and the common good. We also included privacy and data protection guidelines that do not so much pertain to the use of information technology, as our general guidelines for responsible data management do, but to its development.

We also identified two additional principles for the computer and information sciences: avoidance of security risks and dual use (which contains several guidelines that are identical to those for the engineering sciences).

Avoidance of security risks

- Ensure that new research concepts and innovations offer reasonable protection against any potential unauthorized disclosure, manipulation, or deletion of information and against potential denial of service attacks, e.g., protection against hacking, cracking, cyber vandalism, software piracy, computer fraud, ransom attacks, disruption of service;

- Ensure that new research concepts and innovations, by themselves or through their use in a system, do not pose inherent direct or long-term risks of harm to public health and safety, e.g., information and communications technology (ICT) innovations used in healthcare, ICT innovations used in the monitoring and control of public infrastructure, ICT innovations that could lead to addiction;
- Do not engage in research that involves attempts to make unauthorized access to telephone systems, computer networks, databases or other forms of ICT; such research is illegal and unethical, regardless of motivation;
- Treat with extreme caution the dissemination of research involving the identification of undiscovered security weaknesses in existing systems;
- Avoid practical experiments with computer viruses or perform them in a controlled environment, and exercise extreme caution in the dissemination of the results of paper-based (theoretical) computer virus experiments;
- Carry out any experiments in breach security on designated, standalone (offline) computers or on designated isolated networks of computers.

Dual use of computer and information sciences research and innovations

- Consider whether new research concepts and innovations could have military applications;
- Consider whether new research concepts and innovations could contribute to the proliferation of weapons of mass destruction;
- Consult proper authorities before publishing and adhere to relevant national and supra-national regulations if a technology has significant military applications or if it contributes significantly to the proliferation of weapons of mass destruction. Even if publication is allowed, find a proper balance between security and freedom of publication.

These guidelines were included for the following reasons: Security risks are specific risks that apply to computer systems that could cause significant harm, as well as violate individual rights. It is therefore proper to include guidelines for addressing such risks in computer science R&D. As in the engineering sciences, there are sometimes dual use issues where some civilian projects in information technology can be used for military purposes. We, therefore, include guidelines for dual use here as well.

The complete set of guidelines for the computer and information sciences, combining both general guidelines and engineering-specific guidelines, can be found on the SATORI website at http://satoriproject.eu/deliverables/.

2.5 Conclusion

In this chapter, I discussed research ethics guidelines for the engineering sciences and computer and information sciences. Only very recently has there been an effort to establish research ethics frameworks and ethics committees for these two fields. I presented arguments in support of these developments. It was argued that although there are shared issues and principles for research ethics across scientific fields, scientific fields raise unique ethical issues that require special ethical principles and guidelines. Following this discussion, I discussed the historical development of professional ethics and research ethics in the engineering science and the computer and information sciences, and I presented and discussed the special guidelines for these fields that were developed as part of a CEN CWA standard for research ethics within the SATORI project. It is my hope that the developments that I sketched will continue and that distinct research ethics frameworks and committees for these two fields will be in place in many countries in the future.

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