1 Ethics and Engineering

An Ethics-Up-Front Approach

1.1 The Dieselgate Scandal: Who Was Responsible?

In September, 2015 the US Environmental Protection Agency (EPA) discovered irregularities with certain software in the board computer of Volkswagen diesel cars. The software enabled the car to detect when it was running under controlled laboratory conditions on a stationary test ring and to respond to that by switching to a mode of low engine power and performance. As a result, the emissions detected under laboratory conditions (or while the car was being tested) were substantially lower than the actual emissions when the car switched back to the normal mode on the road. This resulted in Volkswagen vehicles emitting up to forty times more nitrogen oxide pollutants than the levels allowed under US regulations.

In what later came to be popularly known as the "Dieselgate" scandal, Volkswagen admitted that 11 million of its vehicles – including 8 million in Europe – had this software problem. In a Congressional hearing in the US, the CEO of Volkswagen's American division, Michael Horn, apologized for this "defeat device" that served to "defeat the regular emission testing regime"[1] but denied that the decision to incorporate the deceptive device was a corporate one. When he was asked whether he personally knew about the practice, he responded, "Personally, no. I am not an engineer." Horn continued to blame a few rogue engineers.[2] As this book goes to the press, several executives have been imprisoned for their role in the scandal; a larger group of executives have been charged for their involvement.[3]

[1] Horn, Testimony of Michael Horn, 1.

[2] O'Kane, "Volkswagen America's CEO Blames Software Engineers for Emissions Cheating Scandal."

[3] O'Kane, "VW Executive Given the Maximum Prison Sentence for His Role in Dieselgate."

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The Dieselgate scandal provides an important case study in engineering ethics for several reasons. First, deception is clearly a breach of anethically acceptable practice in engineering; Volkswagen first claimed that the problem was due to a technical glitch,[4] but the "defeat device" was later admitted to have been intentionally included. Yet it remained unclear where and at which level of the organization the responsibilities lay. This brings us to the second issue, namely the responsibilities of engineers. In his original testimony to the House Committee on Energy and Commerce of the US Congress, Horn wholeheartedly accepted responsibility – "we at Volkswagen take full responsibility for our actions"[5] – but in the questions and answers that followed with the members of Congress, he blamed a "few rogue engineers." He did not feel any personal responsibility because – he claimed – as the CEO, he could not have known about the software problem. He further pointed out that the software was designed by engineers in Germany and not in the US, where he was the boss: "I feel personally deceived."[6] On the one hand, this pinpoints an interesting question regarding the responsibilities of different engineers in an organization versus those in the higher echelons of the organization. On the other hand, another question pops up: whether such a big fraud in the automotive industry could be the work of only a few rogue engineers. Horn's stark distinction between engineering and management choices was also doubted by car industry veterans. As Joan Claybrook, former administrator of the US National Highway Traffic Safety Administration, said in an interview with the *Los Angeles Times*, rogue engineers cannot "unilaterally decide to initiate the greatest vehicle emission fraud in history. . . . They have teams that put these vehicles together. They have a review process for the design, testing and development of the vehicles."[7] The fact that several executives have been charged for fraud also stresses the lack of such a sharp division between engineering and management.

The third important feature of this example is this: Engineering choices are often collaborative choices made by different people at different

[4] See Ewing and Mouawad, "Directors Say Volkswagen Delayed Informing Them of Trickery."

[5] Horn, Testimony of Michael Horn, 2.

[6] Kasperkevic and Rushe, "Head of VW America Says He Feels Personally Deceived."

[7] Puzzanghera and Hirsch, "VW Exec Blames 'a Couple of' Rogue Engineers for Emissions Scandal."

organizational levels, for instance by engineers in Germany and the US, as Horn stated in his testimony. This is sometimes referred to as "the problem of many hands."[8] Fourth, and somewhat related to the previous issues, the scandal reveals broader issues of responsibility in engineering. Horn's testimony before the Congressional committee could be seen as an attempt to restore the trust of "customers, dealerships, and employees, as well as the public and regulators."[9] Engineering corporations operate in broad societal contexts, and they deal with large groups of stakeholders, to whom they have certain responsibilities. Likewise, engineers have broad social responsibilities that extend beyond their direct answerability to their employers; more about this will be said later in the chapter. Fifth, this case emphasizes that many engineering choices made in the process of design – both intentional and unintentional – are not easily reversed afterward. These choices often have ethical implications.

The Dieselgate scandal is an extreme example of ethically questionable decisions. Many ethical choices in engineering and design practice are implicitly made. Moreover, in many such situations there are no clear right and wrong options. In contrast to the Dieselgate affair, there may be a large gray area in which many ethically relevant questions reveal themselves. While we need to realize that engineering ethics is often about less extreme situations and examples, the example of Dieselgate does help me to introduce two different aspects of the field of ethics and engineering, namely "ethics and the engineer" and "ethics and the practice of engineering." I will focus on the former in the remainder of this chapter. Various issues will be discussed relating to the responsibility of an engineer in general and within organizations, including corporate social responsibility (CSR) and codes of conduct (such as professional engineering codes, company codes, and other important international codes). While discussing these issues I shall highlight the concepts that have to do with the role of engineers in their practice.

In the last part of this chapter, I will introduce the concept of *ethics up front* and the forward-looking responsibility of an engineer. The other chapters of this book expand this ethics-up-front approach. Before focusing more on discussions about the first approach – ethics and the engineer – let me first clarify what the field of engineering ethics is *not* about.

[8] Van de Poel, Royakkers, and Zwart, *Moral Responsibility and the Problem of Many Hands*.

[9] Horn, Testimony of Michael Horn, 2.

1.2 Three Biases about Engineering and Engineering Ethics

There are persistent biases about ethics, engineering, and how the two fields relate to each other. In some instances, these are misunderstandings about what the role of ethics is in engineering practice, and in other instances, they represent only a narrow or incomplete view of ethics. It may be unconventional to introduce a field by first saying what it is not about, but because these biases often stand in the way of a better understanding, I will discuss them explicitly. This can help us to demarcate the boundaries of this academic field and – perhaps more importantly for the purposes of this book – establish what will be discussed in the book.

1.2.1 Isn't Engineering Based Only on Facts and Figures?

A commonly heard argument is that engineering deals predominantly withfacts and figures that are based upon the formulas and methods commonly accepted in engineering. These are also where the authority of engineering stems from. There is thus no room for ethics! However, ostensibly unbiased and objective issues in engineering often encompass important moral assumptions and choices. Take, for example, the probabilities assigned to the occurrence of major accidents, which often rest on a range of ethical assumptions.

At times, the moral issue is not labeled or recognized as such. For instance, the question of "how safe is safe enough" when new nuclear power plants are designed is not only a legal and regulatory one. Nor can economic optimization models straightforwardly answer this question. Chapter 2 will extensively discuss this issue in the context of the Fukushima Daiichi nuclear disaster by focusing on the risk assessments that were made and, more importantly, on how such a major accident could fall through the cracks of such risk assessments. Chapter 3 will discuss the quantifications that are often used for comparing the costs and benefits of certain engineering projects, focusing not only on the underlying assumptions but also on the ethical implications of such quantifications. To sum up, seemingly exact issues in engineering may contain several assumptions of great ethical relevance.

1.2.2 Isn't Engineering Ethics about Abiding by the Law and Engineering Norms?

Another misconception, related to the previous one, is that engineering ethics is particularly (or even solely) about abiding by laws and regulations.

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Thus, an engineer needs to comply with various laws, regulations, and standards, for instance, those regarding safety. As the bias goes, ethics is about successfully complying with those standards or simply *not cheating* in relation to the standards. This might well be seen as an interpretation of ethics but perhaps in its most basic and least demanding form. Ethics in engineering aims to go further than this basic demand and to explore the responsibilities of engineers, which are certainly not confined to merely abiding by their legal obligations.

Ethics and law are unquestionably intertwined. Laws usually stem from what is commonly morally accepted in society; however, saying that something is legal does not necessarily mean it is ethically correct. Slavery, apartheid, and gender inequality might be part of the legal system of a country, but their ethical rightness might be very much questioned. Likewise, saying that something is ethically sound does not necessarily mean that it is embedded in the legal system. The latter has particular relevance in engineering because the law generally tends to lag behind technological innovations. In this regard, a typical example that various engineering ethics books mention concerns the development of the Ford Pinto. In the 1970s Ford started developing a new two-door car, the Pinto.[10] The development of this model went at an unprecedented pace, but the final result had a technical error: The gas tank was situated behind the rear axle, which meant that a rear-end accident (at speeds as low as 35 km per hour) could rupture it. This could easily lead to a fire, which is particularly worrisome in a two-door vehicle. The company was made aware of this problem by its engineers prior to the first release but decided to continue with the release. Legally speaking, Ford was meeting all the requirements because the crash tests in the US at the time did not require rear-end testing. This was clearly a situation in which ethical responsibility was not legally defined, especially because in this respect legislation was lagging behind, and the only people who were aware of the error were the engineers involved in developing and testing the Ford Pinto. Such a situation creates certain responsibilities for engineers, because they are often at the forefront of technological development and will – in principle – know before anyone else when laws are outdated or have become otherwise inappropriate or inadequate to deal with the engineering issues at hand.

[10] Van de Poel and Royakkers, *Ethics, Technology and Engineering*, 67–69.

It was shortly after Ford released the Pinto that the problematic crash tests were modified and a rear-end crash test without fuel loss was made obligatory. In this example, it was certainly not the engineers who decided to proceed with the release of the model. That was decided at executive level, which again shows that determining who is responsible in a large organization is a rather complex matter.[11]

1.2.3 Isn't Engineering Ethics a Moral Brake on Innovation?

In engineering and technological innovation, ethics is sometimes considered to be a moral yardstick that can pass yes/no judgments on development.[12] Indeed, it may sometimes be the case that moral considerations can urge engineers to stop developing a new technology altogether. The *Precautionary Principle* has now reverberated throughout engineering design for over two decades, since lack of scientific knowledge about potential risk cannot provide sufficient reason for further development.[13] The Precautionary Principle is perhaps one of the most misunderstood principles in engineering, as it can do much more than give a dichotomous yes/no verdict about a technological development.

Indeed, sometimes it might be recommendable categorically to say no to a certain development. A good example is the recent campaign to "Stop Killer Robots," in which over 1,000 artificial intelligence (AI) scholars, philosophers, and other professionals pleaded for a ban on the development of fully autonomous weapons that are capable of engaging targets without

[11] This case study is often used in ethics and engineering textbooks for another purpose. When Ford was later sued for the many losses and serious injuries attributable to technical failure, the company justified its choice not to modify the design before release by using a Cost–Benefit Analysis (CBA). Ford had two modification methods, and even the more expensive method would have cost $11 per vehicle. However, Ford had decided not to modify, and this decision was justified in court using a CBA. I will briefly return to this CBA in Chapter 3. For more details about the Ford Pinto case, see Van de Poel and Royakkers, *Ethics, Technology and Engineering*.

[12] Van den Hoven, Lokhorst, and Van de Poel, "Engineering and the Problem of Moral Overload."

[13] The definition of the Precautionary Principle, according to the Wingspread Statement, emphasizes that (1) lack of *fully scientifically established* risk is no reason to assume that there is no risk and (2) it is the proponent of a new activity that should bear the burden of proof to show no risk. See www.gdrc.org/u-gov/precaution-3.html.

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human intervention.[14] Nowadays such campaigning is, however, more the exception than the rule.

Modern approaches to applied ethics, however, often reflect on technology within its societal boundaries. Let me elucidate this by describing an example of ethics of nuclear energy that has long been associated with yes/no dichotomies. In view of the reality of the energy demands and consumption levels of the twenty-first century, our societies cannot afford the luxury of holding an isolated binary opinion about nuclear energy. Rather, we must investigate all the different paths for nuclear energy production and consider the future promises and possibilities afforded by these technologies while bearing in mind the burdens and benefits that each path creates for present and future generations. It is only after such moral analysis that we can compare different types of nuclear energy with other energy sources in order to reach conclusions on whether nuclear energy should have a place in the desirable future energy mix and on whether, if we are to deploy it, what type of nuclear energy should be further developed.

1.3 Ethics and the Engineer

The first – and perhaps best-known and best-established – approach to engineering ethics focuses on the engineer and their roles and responsibilities from a broad societal perspective; this approach has also been referred to as professional engineering ethics. In this section, I will first discuss the question of whether engineering is to be considered a profession and, if so, what that means for the associated professional responsibilities. I will then present three different categories of responsibilities, namely the responsibilities of (1) an engineer to society, (2) an engineer in an engineering organization, and (3) engineering corporations toward society.

1.3.1 Is Engineering a Profession?

This question is not, of course, applicable only to engineering. In several other professions, such as medicine, the question has been addressed for much longer. The consensus there seems to be that a profession must be "based upon the mastery of a complex body of knowledge and skills" and "used in the service of others," while members of the professions must

[14] See www.stopkillerrobots.org/.

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accept “a social contract between a profession and society, which, in return, grants the profession a monopoly over the use of its knowledge-base [and] the right to considerable autonomy in practice.”[15] Thus, society grants certain rights to a profession, which – in turn – bring certain responsibilities. Michael Davis, a pioneer in engineering ethics, identifies a similar distinction between an occupation and a profession, stating that the exercise of an occupation does not require society’s approval and recognition, while the profession itself aims to serve ideals upheld by society.[16] Thus, society “has a reason to give it special privileges.” Members of an occupation therefore serve their own interests, while members of a profession must primarily serve the interests of others.

When investigating whether engineering is considered a profession everywhere in the world, Davis distinguishes between the economic and political traditions underlying the definition of a profession.[17] The economic tradition sees a profession as “a means of controlling market forces for the benefit of the professionals themselves,” whereas the political tradition considers professions to carry legal conditions that “set standards of (advanced) education, require a license to practice, and impose discipline upon practitioners through formal (governmental) structures.”[18] Both definitions fall short in that they fail to include reflections on the moral rightness or wrongness of professions. That leads Davis to his own philosophically oriented definition of a profession as an occupation that is organized in such a way that the members can “earn a living by openly serving a moral ideal in a morally-permissible way beyond what law, market, morality, and public opinion would otherwise require.”[19] It is thus emphasized that the professions should both serve a moral ideal and strive to achieve that ideal in a morally permissible way. It is on this definition that the rest of this book is based as far as the morally relevant questions of engineering practice are concerned.[20]

[15] Cruess, Johnston, and Cruess, “Profession,” 74.

[16] Davis, “Thinking Like an Engineer,” 154.

[17] Davis, “Is Engineering a Profession Everywhere?”

[18] Ibid., 213–14. When defining a profession, Michael Davis also distinguished a third tradition, namely the anthropological tradition.

[19] Ibid., 217.

[20] Several authors have identified the characteristics of the engineering profession. Perhaps the most notable examples are provided by Van de Poel and Royakkers and by Harris

1.3.2 What Are the Responsibilities of Individual Engineers to Society? Professional Codes of Conduct

If we accept the reasoning above, that is, that engineering is a profession, then the following two questions arise: (1) what is the moral ideal that engineering should serve and (2) what are the professional responsibilities of individual engineers? Both questions have frequently been addressed in the ethical standards that govern this profession, as reflected in codes of ethics or codes of conduct. Again, the desire to formulate such ethical standards is not unique to engineering. Many other professions have already formulated such standards in their professional codes of ethics. Undoubtedly, the most familiar example is to be found in the field of medicine, where the roots of the first codes of conduct are found in the Hippocratic Oath, which derives from Ancient Greece. Modern medicine has extended and modernized this ancient code into codes of conduct that serve to govern the present-day profession of medical doctors.

Important discussions of codes of conduct in engineering go back to the questionable role that many scientists and engineers played in the Second World War. One of the most famous examples emerged from the "Engineers' Creed" that the American National Society of Professional Engineers (NSPE) adopted in 1954. In this pledge – based on the doctors' oath – issues such as respecting and maintaining the public interest as well as upholding the highest ethical standards were emphasized: "As a Professional Engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare."[21] Similar pledges were drawn up by the German Engineering Association in the 1950s, and they emphasized, among other matters, that engineers should not work for those who fail to respect human rights. This was a reference to the highly problematic role that many engineers had played in Nazi Germany.[22]

Pledges such as the Engineers' Creed have been criticized for encompassing predominantly self-serving functions such as "group identification and self-congratulation" rather than addressing "hard decisions about how to

et al. See Van de Poel and Royakkers, *Ethics, Technology and Engineering*, 35; Harris et al., *Engineering Ethics*, 13–14.

[21] NSPE, *NSPE Ethics Reference Guide*, 2.

[22] Van de Poel and Royakkers, *Ethics, Technology and Engineering*, 38.

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behave in difficult situations."[23] Indeed, such pledges are too general to have a meaningful impact on behavior, and they can, at most, serve to remind engineers of their social responsibilities. Later attempts to formulate professional engineering codes were much more detailed, such as the NSPE's "Code of Ethics for Engineers."[24] Like many other engineering codes, these code was the upshot of discussions between members of professional organizations who sought to formulate ethical standards for the profession of engineering. The code was presented as a dynamic document that should "live and breathe with the profession it serves" and should be constantly reviewed and revised to "reflect the growing understanding of engineering professionalism in public service."[25]

Of course, this approach does not necessarily eliminate all the objections to codes. One may consider, for instance, the fact that ethics cannot always be codified and that forming a proper judgment about a situation (and thereby a potentially serious impact on decision-making in engineering) requires an understanding of the specifics of that situation.[26] However, the purpose of such codes is not necessarily to point to unequivocal answers in ethically problematic situations. Instead, they mainly serve to emphasize the place that the profession of engineering has in society. Thus, society has granted engineers certain rights to exercise their profession, and with those rights and privileges come certain responsibilities; or, conversely, one may talk of the social contract that engineers have not only with society but also among themselves. This social contract is reflected in professional codes of conduct.

The NSPE code is a general code applicable to engineering. Sometimes, in an attempt to bring the codes closer to actual practice, particular engineering fields formulate their own codes, such as those of the American Society of Civil Engineers (ASCE) and the American Society for Mechanical Engineering (ASME). Furthermore, professional engineering organizations in many other countries have adopted their own codes of conduct. Professional codes – both general engineering codes and specific codes related to individual

23 Kultgen and Alexander-Smith, "The Ideological Use of Professional Codes," 53.

24 NSPE, *NSPE Ethics Reference Guide*.

25 Ibid., 1.

26 Ladd, "The Quest for a Code of Professional Ethics." For an overview of the scope and limitations of codes of conduct, see Van de Poel and Royakkers, *Ethics, Technology and Engineering*, section 2.3.

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engineering fields – can be found in Australia, Canada, Chile, China, Iran, Japan, Hong Kong, and Finland, to name but a few countries.[27] While some countries of the world do not have formal written codes of ethics, that does not mean to say that they do not have the same social contract or uphold the same ideals that exist in those countries. As Davis correctly argues, in many countries the technical standards serve the same purpose as the code of ethics, in that engineers expect each other to abide by the same standards.[28]

In discussions of the responsibilities of engineers, there is a potential tension between individual and collective responsibilities. Engineering practice often involves several engineers, often from different organizations. This makes the attribution of individual responsibilities in collective action a rather daunting task. As already mentioned, this is referred to as the "problem of many hands." The notion was originally developed by Dennis Thompson with regard to the assigning of responsibilities to public officials when "many different officials contribute in many different ways to decisions and policies in the modern state."[29] Ibo Van de Poel, Royakkers, and Zwart have extended the notion to the realm of engineering, where there are also often very many "hands" involved in certain decisions and activities.[30] Discussing the Deepwater Horizon disaster in the Gulf of Mexico in 2010, these authors argue that "it is usually very difficult, if not impossible, to know who contributed to, or could have prevented a certain action, who knew or could have known what, etc."[31] This is problematic because it implies that nobody can be reasonably held morally responsible for a disaster.

1.3.3 What Are the Responsibilities of an Engineer in an Organization? Corporate Codes of Conduct

In addition to their responsibilities to society, engineers also have certain responsibilities to their employers. Engineers often work in organizations that understandably expect them to abide by certain rules and regulations.

[27] The Illinois Institute of Technology has listed the internationally known codes. See for an overview of all the countries and fields http://ethics.iit.edu/ecodes/ethics-area/10.

[28] Davis, "Is Engineering a Profession Everywhere?," 223.

[29] Thompson, "Moral Responsibility of Public Officials," 905.

[30] Van de Poel, Royakkers, and Zwart, "Introduction." [31] Ibid., 4.

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Often they have a special role in these organizations because they are at the forefront of technological development. This is, on the one hand, justification enough for professional codes to emphasize the broader responsibilities of engineers to society at large. On the other hand, it is also particularly important for an organization to secure an engineer's loyalty, to ensure that the same engineer shares the organization's most sensitive information will not jeopardize the interest of that organization. This could otherwise give rise to dilemmas in which professional codes and organizational codes might require different courses of action.[32] Naturally, this argument does not render codes of conduct redundant. Instead, it emphasizes the need to acknowledge the potentially conflicting duties that engineers may have in such situations, thereby highlighting the need for a broader understanding of the socio-ethical questions of engineering. Of course, there is no one-size-fits-all solution, and so all situations need to be considered in the light of their specific circumstances.

Whereas professional codes of conduct explicate engineers' responsibilities as members of the profession, organizational codes of conduct (in the case of corporations they are called corporate codes) spell out, for instance, engineers' responsibilities to their organization as well as their responsibilities as members of that same organization to the organization's stakeholders.[33] This brings me to the broader issues of the responsibilities of engineering corporations.

1.3.4 What Are the Responsibilities of Engineering Corporations? CSR

Let me elaborate on this issue by returning to the case discussed at the beginning of this chapter, because an interesting development seems to have taken place at Volkswagen. Presumably in response to Dieselgate, the Volkswagen Group has updated and expanded its codes of ethics. These codes, like many other corporate codes, deal with the broader issues of the

[32] See for an extensive discussion of this issue Van de Poel and Royakkers, *Ethics, Technology and Engineering*, 46–47.

[33] The terminology can be a bit confusing here. Sometimes professional codes also discuss engineers' responsibilities to employers or to clients (e.g., the NSPE code). These codes do not, however, replace organizational codes such as corporate codes.

responsibilities of the corporation. More specifically, they discuss the corporation's responsibilities (1) as a member of society, (2) as a business partner, and (3) in the workspace (and toward employees):[34] "Every employee in the Volkswagen Group must be aware of their social responsibility, particularly as regards the well-being of people and the environment, and ensure that our Company contributes to sustainable development."[35]

What is particularly striking about these renewed codes is the fact that they attempt in several ways to assist employees to arrive at ethically justifiable decisions in their own practice. First, there are a number of hands-on questions that encourage self-testing, including a "Public Test" ("do I still think my decision is right when my company has to justify it in public?"), an "Involvement Test" ("would I accept my own decision if I were affected?"), and a "Second Opinion" test: "What would my family say about my decision?"[36] Furthermore, there are clear and detailed procedures included for "whistle-blowers": "If we suspect a violation of the Code of Conduct or any other misconduct in our work environment, we can use the Volkswagen Group whistle-blowers system to report this – either giving our name or making our report anonymously."[37] Further provisions are included to protect whistle-blowers, who are presumed innocent until convicted of an offense. What is also interesting in these Volkswagen codes is the explicit reference to a lengthy list of other voluntary commitments, such as the UN Declaration of Human Rights, the guidelines of the Organization for Economic Cooperation and Development (OECD), the International Labour Organization's Declaration on Fundamental Principles and Rights at Work, and the Ten Principles of the UN Global Compact.[38]

In general, corporations' broader societal responsibilities are often subsumed under the heading of CSR. CSR (along with corporate codes of conduct) became important toward the end of the last century, the assumption being that they could "enhance corporations' social and environmental commitments by articulating the norms and standards by which they profess to be bound."[39] Such corporate codes, as well as CSR measures, often

[34] Indeed, corporate codes discuss not only issues such as confidentiality and the employee's responsibility to the employer but also the employee's rights in the workplace and, hence, the responsibilities of employers.

[35] Volkswagen, *Volkswagen Group Code of Conduct*, 6. [36] Ibid., 65. [37] Ibid., 62.

[38] See www.volkswagenag.com/en/sustainability/policy.html#.

[39] Rosen-Zvi, "You Are Too Soft," 537.

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emphasize the need to respect human rights, environmental protection and, more recently, problems associated with climate change and the much-needed global greenhouse emission cuts to which large multinational corporations can substantially contribute. Two important organizations to which the updated Volkswagen codes of conduct also refer are the OECD and the UN. The OECD has developed principles that build on the notion of transparency, including the OECD Principles of Corporate Governance and the OECD Guidelines for Multinational Corporations.[40] The UN Global Compact is perhaps the most recognizable initiative for the collection and disclosure of CSR-related information.[41] It lists ten conduct-oriented principles covering subjects such as "human rights, labour, environmental and anticorruption values," all of which aim to create a framework for corporate accountability.[42]

Before moving to the next section, let me make three brief remarks about CSR. First, CSR and corporate codes do not, of course, relate only to engineering firms, but given the role that engineering firms play in various CSR-related issues, such as the environment, it is becoming increasingly important to consider them in relation to engineering corporations. Second, in discussions of CSR, there is an inherent assumption that a corporation aims and wishes to go beyond merely meeting legal requirements. CSR also covers issues that are not fully regulated and that are not regulated at all. In that sense, it is comparable to what we call "engineering ethics" in this book, that is, principles that go beyond what is legally required. Third, and in conjunction with the previous issue, committing to CSR-related requirements and having corporate codes is one thing, but acting upon them is another. The implied criticism here is that some such initiatives can easily be seen as window-dressing,[43] or – in the case of environmental restrictions that corporations voluntarily impose on themselves – as greenwashing.[44] It is therefore important to understand that the added value of CSR and corporate codes often lies in the way in which they are monitored, for instance in

[40] OECD, *OECD Principles of Corporate Governance*; OECD, *OECD Guidelines for Multinational Enterprises.*

[41] Akhtarkhavari, *Global Governance of the Environment*.

[42] Backer, "Transparency and Business in International Law," 115.

[43] Amazeen, "Gap (RED)."

[44] Laufer, "Social Accountability and Corporate Greenwashing."

external and independent audits,[45] and in whether the outcome of such audits is publicly available and could, for instance, lead to naming and shaming, all of which could incentivize changes of behavior among corporations.[46]

1.4 Ethics and the Practice of Engineering: Ethics Up Front

In the remainder of this book, I will focus on this ethics-up-front approach in the practice of engineering. Let me clarify what I mean by both notions while introducing how ethics up front features throughout the book. In their practice, engineers employ and engage in a variety of activities including the assessment and evaluation of risks, costs, and benefits, and the design and development of artifacts and systems, such as energy systems. At every turn in those activities, values are expressed either explicitly or implicitly, and choices have ethical ramifications, whether recognized or not. It is my aim to help engineers to better understand this aspect of their practice and think more intentionally about the ethical issues associated with their work.[47] By "ethics up front" I mean proactive thinking about ethical issues. Rather than dwelling on ethical reflections in retrospect, this approach aims to facilitate the proactive involvement of ethics in engineering practice in order to identify the ethical problems at hand and to provide tools and frameworks to address those problems.

It should be clear that I claim no originality for this approach. What I call ethics up front in this book builds on a tradition of ethics in technology and engineering that aims to include ethical reasoning and thinking as early as possible in a project. It neatly fits a number of approaches and methodologies discussed in this book, including value-sensitive design (VSD) and responsible innovation.[48] The ethics-up-front approach features in all three parts of this book, as outlined below.

[45] Morimoto, Ash, and Hope, "Corporate Social Responsibility Audit."

[46] Jacquet and Jamieson, "Soft but Significant Power in the Paris Agreement"; Taebi and Safari, "On Effectiveness and Legitimacy of 'Shaming' as a Strategy for Combatting Climate Change."

[47] I thank an anonymous reviewer for helping me to better determine the scope of what I mean by "practice" in this book.

[48] In presenting this term, I am building on the work of Penelope Engel-Hills, Christine Winberg, and Arie Rip, who present ethics up front as necessary for proactive thinking

Part I: Ethics and Assessment and Evaluation in Engineering

In Chapters 2 and 3 of the book, I will focus on engineering assessment and the evaluations that often take place prior to the start of an engineering project and, hence, can facilitate an ethics-up-front approach. Chapter 2 will examine risk analysis from the perspective of the broader societal aspects of risk and ethics of risk. Risk is a crucial aspect in any engineering practice. The introduction of new technology to society often brings great benefits, but it can also create new and significant risks. Serious efforts have been made to assess, map, understand, and manage such risks. For instance, in the chemical industry, risk assessment methods have been proposed for describing and quantifying the risks associated with hazardous substances, processes, actions, and events. Perhaps the most notable example is the probabilistic risk assessment approach, originally developed in order to determine and reduce both the risk of meltdown in nuclear reactors and the risk of crashing in aviation. However, these and other risk analysis methods have limitations. By reviewing how the Fukushima Daiichi nuclear accident could fall through the cracks of risks assessments, I will discuss some of these limitations. Naturally, this is not intended to dismiss risk assessment but rather to make engineers more aware of what risk assessments can, and in particular cannot, do. Moreover, risk assessment methods have been criticized for ignoring the social and ethical aspects of risk. I will discuss in detail the ethical issues associated with risk analysis, distinguishing between individual-based approaches to ethics of risks (e.g., informed consent) and collective and consequence-based approaches. I will finish the chapter by reviewing several methods for dealing with uncertainties in engineering design and applications. In assessing technological risks, we will inevitably run into the problem of the social control of technology, also known as the Collingridge dilemma; that is, the further we progress in the development of new technology, the more we learn about the associated risks and the less we can control those risks.[49] I will discuss approaches such as redundancies, barriers, and safety factors, as well as the Precautionary

about ethical issues in an organizational setting when building a university; see Engel-Hills, Winberg, and Rip, "Ethics 'Upfront.'" My understanding of this idea is that ethics can also be front-loaded in thinking about the practice of engineering.

[49] Collingridge, *The Social Control of Technology*.

Principle and more modern approaches that take safety to the core of engineering design, specifically Safe by Design.

In Chapter 3, I will discuss other engineering assessment methods that are focused on balancing costs, risks, benefits, and environmental impacts. More specifically, I will review Cost–Benefit Analysis (CBA) as one of the most commonly applied assessment methods, both when private money is to be invested in engineering projects and when choices are to be made between public policy alternatives. It is often wrongly assumed that a CBA is an objective way of assessing costs and benefits and that the result unequivocally presents the best outcome. CBA is rooted in consequentialist thinking in ethics, which argues that moral rightness depends on whether positive consequences are being produced. A specific branch of consequentialism is utilitarianism, which aims to not only create but also maximize positive consequences. Classically, a CBA aims to judge alternatives on the basis of which can maximize any positive consequences, by first tallying all the positive and negative consequences and then assigning a monetary value to each one. CBA and its underlying ethical theory have been abundantly criticized in the literature; can we assess moral rightness only in terms of consequences? And even if we assume that the latter is possible, can we objectively assign monetary values to those consequences? While these are essentially valid objections, the chapter is not intended to criticize and dismiss CBA. Instead, following the reasoning that formal "analyses can be valuable to decision-making if their limits are understood,"[50] the chapter aims to show what a CBA can and cannot do, the aim being to make it maximally suitable for assessing the risks, costs, and benefits of an engineering project. Thus, the chapter provides several ways of circumventing some of the ethical objections to a CBA by amending, adjusting, or supplementing it, or – when none of these can help – rejecting and replacing the CBA as a method. This approach accommodates ethics-up-front thinking about the consequences of engineering projects.

Part II: Ethics and Engineering Design

The Volkswagen Dieselgate scandal has drawn much media attention to the foul play seen in the automotive industry, but another aspect has also come

[50] Fischhoff, "The Realities of Risk–Cost–Benefit Analysis."

to the fore. The scandal has reminded us that already in the design phase, engineering involves certain moral values and choices. Part II of the book will focus on ethical issues in the design of technology. It will build upon the argument that technological developments are not morally neutral. Especially in the design of new technologies, there are many implicit ethical issues. We should therefore be aware of, and proactively engage with, those ethical issues at a early stage of development.

In Chapter 4, I will show how different values including security, privacy, and safety have been at stake in the design of whole-body scanners at airports. VSD and Design for Values will be discussed as two approaches for proactively identifying and including values in engineering design.[51] When designing for values, one can run into conflicting individual values that cannot all be accommodated at the same time. Different strategies for dealing with value conflicts will be discussed, including designing out the conflict and balancing the conflicting values in a sensible and acceptable way. The chapter does not claim to offer the holy grail of design for ethics; indeed, complex and ethically intricate situations will emerge during the actual process of design. Instead, it offers a way to become more sensitive to these conflicts when they occur and to be equipped as far as possible to deal with them. The chapter will further discuss responsible research and innovation in proactive thinking about technological innovations. In so doing, it will extend the notion of design beyond simply technical artefacts and focus on the process of innovation.

In the twenty-first century, we are moving at a fast pace toward the era of machines that are in charge of moral decisions, such as self-driving cars. In reviewing the Uber self-driving car accident in Arizona in 2018, Chapter 5 will first discuss the complexities associated with assigning responsibilities when such an accident occurs. This is a typical problem of "many hands" because it is difficult, if not impossible, to say precisely whose hands caused the accident. The problem is made even more complicated by the fact that one of the pairs of "hands" involved is that of a machine, and it raises the question: Who is responsible for the accident? Can we ascribe any form of responsibility to the car, or is the responsibility solely with the car designer or manufacturer? Who else might have contributed to the accident? I will

[51] See, e.g., Friedman, Kahn, and Borning, *Value Sensitive Design*; Van den Hoven, Vermaas, and Van de Poel, *Handbook of Ethics and Values in Technological Design*.

review how crash optimization programs include ethical considerations while focusing more broadly on the ethics of self-driving cars. More broadly, I will discuss the ethics of AI, focusing specifically on the problems of agency and bias. If we are to assign any responsibility to an autonomous system, we must assume that it can exercise agency, that is, it can independently and autonomously decide how to act. This is problematic for fundamental and practical reasons.

Part III: Engineering Ethics, Sustainability, and Globalization

This part of the book will focus on intergenerational and international thinking about engineering and engineering ethics. Engineering practices produce not only benefits but also risks that clearly extend beyond generational and national borders.

Chapter 6 focuses on sustainability and intergenerational justice in energy production and consumption. Sustainability is perhaps one of the most frequently misused and abused concepts, and what exactly it means has often been interpreted in a rather binary fashion. In this chapter, I will argue against the use of sustainability in a dichotomous mode. Two extreme examples of energy technologies are discussed: biofuel and nuclear energy. In a binary view, a desire for sustainability is likely to lead to excessive haste in dismissing or endorsing an energy system without understanding its technical specificities. This is unsatisfactory because one needs to first be aware of the technological possibilities, such as the different existing and future production methods of energy production, and of the social and ethical implications of each method. If we ignore the complexity associated with sustainability, it can easily be (mis)used for greenwashing and window-dressing purposes, leading to potential ideological and political manipulation.

Engineering is becoming increasingly globalized, and this raises the question of how to consider the ethical considerations of engineering in the international context. In Chapter 7, I will first explore two existing strands in the literature, namely the ethical issues associated with technology transfer from Western to non-Western countries and, somewhat related, the dilemmas that a Western engineer may encounter when working in non-Western countries with other ethical standards. I will argue that discussions of international approaches deserve to be much broader than only these two strands. Engineering ethics should not be predominantly considered a Western phenomenon; nor should we take only the Western perspective as the point of departure for discussions of engineering ethics. I will review the "why" and the "how" questions of international thinking in engineering ethics. I will also distinguish between the two approaches of globalization and diversification of engineering ethics. While the idea of globalizing engineering ethics is intuitively compelling, it must go forward in ways that do not damage the interests of newcomers to engineering fields. That is, in order to be recognized in this "global" engineering community, engineers in developing countries might be expected to adopt the global standards and their underlying values that are already established in the West. Diversification focuses on acknowledging the cultural and contextual differences between countries when dealing with questions of engineering ethics, but it can be easily misinterpreted as ethical relativism. Diversification is most helpful if we manage to facilitate a cross-cultural exchange and reflection. This can increase mutual understanding and respect among engineers and can help to educate culturally sensitive engineers.