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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."

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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.

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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 with-facts 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.

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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

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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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