1

The Responsibilities of Engineers

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Having read this chapter and completed its associated questions, readers should be able to:

- Describe passive responsibility, and distinguish it from active responsibility;
- Describe the four conditions of blameworthiness and apply these to concrete cases;
- Describe the professional ideals of engineers: technological enthusiasm, effectiveness and efficiency, and human welfare;
- Debate the role of the professional ideals of engineering for professional responsibility;
- Show an awareness that professional responsibility can sometimes seem to conflict with the responsibility as an employee and how to deal with this;
- Discuss the impact of social context of technological development for the responsibility of engineers.

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1.1 Introduction

Case Dieselgate

In September 2015, Volkswagen's (VW) Dieselgate was revealed. Dieselgate is one of the biggest scandals of corporate environmental violations worldwide that directly affected consumer health and safety. Volkswagen had not only run their new engine on diesel, but also on cheating software. It had implemented a software manipulation device in the 2009–2015 vehicle models with 2.0-L diesel engines that recognized when a vehicle was undergoing an emissions test and automatically adjusted emissions to the legal thresholds.

The scandal actually began in 2006, when Volkswagen decided to widely promote its diesel car in the US by capitalizing on its success in Europe. At that time, European regulations favored diesel cars over petrol cars, mainly because of their 20% lower CO_2 emissions, and provided legal and financial incentives for carmakers and car dealerships to focus on diesel cars. Therefore, dieselization emerged as a cost-effective strategy to tackle the task of CO_2 emissions reduction. Volkswagen's innovative "turbocharged direct injection" engine (TDI), developed in 1989 was a "cleaner" diesel model with improved fuel efficiency and better performance in CO_2 emission tests. This engine system placed Volkswagen in an ideal position to emerge as a market leader in Europe, and, because of a new version of the TDI, technically known as the VW EA189, introduced in 2008, Volkswagen was ready to grow the market for diesel cars in the US, aiming "to set new environmental standards in vehicles, powertrains and lightweight construction"[1], and "becoming the most innovative high-volume brand in the US"[2].

In its promotional campaign, Volkswagen had to fight against the rather negative image of diesel engines in the US: diesel engines were believed to lack technological sophistication, and consumers had a general impression that diesel fuel was dirty. The fact that diesel cars were considered "green" by Volkswagen, and that Volkswagen claimed that they meet the US Environmental Protection Agency's (EPA) stricter standards for nitrogen oxides (NO_x) reassured the American public. A key point in what would become the scandal of cheating on emissions is that the regulations in the US were much stricter and required NO_x emissions to be six times lower than allowed in the EU at the time. The difference is that CO_2 emissions have an effect on climate change, whereas the EPA was primarily concerned with emissions that are or would be harmful to people. NO_x emissions, in particular, can contribute to cardiovascular and respiratory diseases.

However, engineers were struggling to meet the regulations of the EPA given the available development budgets and engineering constraints. Meeting the regulations was necessary because Volkswagen had to have its diesel models approved by the American automobile authorities before they could be put on the road. Two obvious solutions for emission reduction technologies were rejected: lean NO_x trap and Selective Catalytic Reduction (SCR). SCR is very effective, but was considered too costly ($350 per car) since Volkswagen focused on the less affluent customer. The lean NO_x trap was much cheaper but less effective and negatively affected engine efficiency. This left the engineers with an emission problem they could not solve.

Consequently, they opted for the cheating software that they had come across when they had examined the engine for their own design process. This software recognizes when a Volkswagen is on the test bench, sets the emission cleaning regime to maximum in order to comply with the standards, and switches the cleaning back to low as soon as it has left the test bench. This cheating software was already developed in 1999 by Audi. Audi developed a tweak to the engine control system in its diesel engines that made the engines run more quietly. They referred to the tweak as "acoustic function," but it had a problem: it increased NO_x emissions. As a way out, they developed software that would only omit the extra fuel injection during the test.

In November 2006, a software engineer was tasked with adopting the acoustic function for the VW EA189 under development. Under the responsibility of Rudolf Krebs, the head of the engine development department, a meeting was held in the same month to decide on the fraud with the people responsible for engine development and engine electronics, some 15 in total. This led to intense debate: some attendees morally objected to the cheating software, which was clearly in violation of the law, whereas others expressed fears of getting caught. In the end, Rudolf Krebs ordered the cheating software to be built, but he strongly advised not to get caught.

Despite the described problems with meeting the regulations of the EPA, Volkswagen marketed "clean," "green" diesel models, with the new slogan "Clean Diesel," that supposedly complied with US regulations on NO_x emissions. Sustainability was central to the communication of company policy and strategy.[3] This marketing strategy was very successful, leading to, for example, the Volkswagen Passat TDI Clean Diesel being selected as a "2012 Clean Car of the Year" Finalist. In 2014, 40% of the US consumers considered purchasing a diesel car, up from only 13% in 2005.

However, Volkswagen's success in the US market did raise some concerns. In 2012, a group of American environmentalists questioned why VW's diesel car models driving on US roads would cause less pollution than in Europe. The International Council on Clean Transportation (ICCT), an environmental NGO, began testing the performance of diesel cars on the road in 2013. The results showed that NO_x emissions from the cars tested were about 35 times higher than the legal limit set by the EPA. However, when the cars were tested under laboratory conditions, the results met the EPA standards.

In 2014, ICCT shared its results with both Volkswagen and the EPA for verification. The subsequent EPA investigation took more than a year. Due to the sensitivity of the issue, the EPA was reluctant to make a public statement about the "incident" without hard evidence. However, in August 2015, the EPA obtained incontrovertible proof of the company's deliberate cheating in emissions testing from whistleblower Stuart Johnson, Volkswagen's head of engineering and environmental office. Johnson revealed that software was installed on certain VW diesel cars that could detect laboratory tests and instruct the cars to enter a special laboratory mode in which they produced lower emissions. This type of software is known as a "defeat device." Volkswagen officially acknowledged their illegal software to the EPA on September 3, 2015, and the EPA made this finding public on September 18.

As a result of the investigation, the EPA ordered the recall of 482,000 diesel vehicles sold in the US that were equipped with the defeat device, dating back to the 2009 model. In Europe, an estimated 8.5 million Volkswagen diesel cars had the

defeat device installed. To date, the legal costs, fines, repairs, and product buybacks associated with the scandal have cost Volkswagen more than 30 billion euros. In addition, it is estimated that this scandal has led to 1,200 premature deaths in Europe, with an associated cost of 1.9 billion euros.

Source: Based on Zang et al. (2021), Spapens (2018), and Ewing (2017).

In this case, we see how the Dieselgate scandal was caused by the company's decision to install secret software to cheat emission tests. For the company, the scandal had huge legal implications. For example, Volkswagen pleaded guilty in 2017 to fraud, obstruction of justice, and falsifying statements as part of a $4.3 billion settlement reached with the US Justice Department. Besides the company, also some persons have been charged by US prosecutors. Among them were two former VW executives, the US-based VW executive, and engineer Oliver Schmidt, who oversaw emissions issues, and Martin Winterkorn, who was Volkswagen CEO between 2007 and 2015. Schmidt was sentenced to seven years in prison and fined $400,000 after admitting to charges of conspiring to mislead US regulators and violate clean-air laws. The same charges have been made against Winterkorn in a still-ongoing trial. Winterkorn denied any knowledge of the rigged emissions test, and that he is "not aware of any wrongdoing" on his part.[4] Engineer James Robert Liang, was the first company employee to be send to prison. He was sentenced to 40 months in prison and a $200,000 fine. According to federal judge Cox, Liang was an important member of a "massive and stunning fraud": "[b]eginning in about 2006, he and his co-conspirators began to design the new 'EA 189' diesel engine for sale in the US. When Liang and his co-conspirators realized that they could not design a diesel engine that would meet the stricter US emissions standards, they designed and implemented software to recognize whether a vehicle was undergoing standard US emissions testing on a dynamometer, versus being driven on the road under normal driving conditions (the defeat device), in order to cheat US emissions tests."[5]

The Dieselgate case raises questions about the responsibility of engineers (Davis, 2019). While some of the involved engineers acted clearly irresponsibly, others – like the whistleblower – may have acted more responsibly. But what do we exactly mean by responsibility and what is the responsibility of engineers? As we will see responsibility is not only about blame for things that have gone wrong, but also about avoiding harm in the future and doing good.

This chapter first investigates what exactly responsibility is (Section 1.2), distinguishing between passive responsibility for things that happened in the past (Section 1.3) and active responsibility for things not yet attained (Section 1.4). The final two sections discuss the position of engineers vis-à-vis managers, which was obviously important in the Dieselgate scandal, the wider context of technological development, and examine the consequences for the responsibility of engineers in this wider context.

1.2 Responsibility

Whenever something goes wrong or there is a disaster or scandal like that of Dieselgate, the question of who is responsible for it often quickly arises. Here responsibility means in the first place being held accountable for your actions and for the effects of your actions. The making

of choices, the taking of decisions, and also failing to act are all things that we regard as types of actions. Failing to save a child who is drowning is therefore also a type of action. There are different kinds of responsibility that can be distinguished. A common distinction is between active responsibility and passive responsibility. Active responsibility is responsibility before something has happened. It refers to a duty or task to care for certain states of affairs or persons. Passive responsibility is applicable after something (undesirable) has happened.

Responsibility (both active and passive) is often linked to the role that you have in a particular situation. In the case described here, James Robert Liang fulfilled the role of engineer and not that of, for example, a family member. You often have to fulfill a number of roles simultaneously such as those of friend, parent, citizen, employee, engineer, expert, and colleague. In a role you have a relationship with others, for instance, as an employee you have a relationship with your employer, as an expert you have a relationship with your customers and as a colleague you have relationships with other colleagues. Each role brings with it certain responsibilities. A parent, for example, is expected to care for their child. In the role of employee, it is expected that you will execute your job properly, as laid down in collaboration with your employer; in the role of expert, it will be presumed that you furnish your customer with information that is true and relevant, and in the role of colleague you will be expected to behave in a collegial fashion with others in the same work situation. An engineer is expected to carry out their work in a competent way. Roles and their accompanying responsibilities can be formally laid down, for instance legally, in a contract or in professional or corporate codes of conduct (see Chapter 2). In addition, there are more informal roles and responsibilities, like the obligations one has within a family or toward friends. Here, too, agreements are often made and rules are assumed but they are not usually put down in writing. We will call the responsibility that is based on a role you play in a certain context **role responsibility**.

Role responsibility The responsibility that is based on the role one has or plays in a certain situation.

Since a person often has different roles in life they have various role responsibilities. One role may come with responsibilities that conflict with the responsibilities that accompany another role. Liang, for example, in the Dieselgate scandal had both, the role as an employee and as an engineer. As an employee, he was expected to be loyal to his company and to listen to his superiors, who eventually ordered the cheating software to be built. As an engineer, he was expected not to develop technologies that can pose unacceptable human and environmental risks, and to avoid deceptive acts. This would imply a refusal to design and implement the defeat software.

Although roles define responsibilities, **moral responsibility** is not confined to the roles one plays in a situation. Rather it is based on the obligations, norms, and duties that arise from *moral* considerations. In Chapter 3, we will discuss in more detail what we mean by terms like morality and ethics, and what different kinds of ethical theories can be distinguished. Moral responsibility can extend beyond roles. In the Dieselgate scandal, it was part of Liang's moral responsibility to care for the consequences of the used cheating software for consumers and environment. Moral responsibility can, however, also limit role responsibilities because with some roles immoral responsibilities may be associated. (Think of the role of Mafioso.) In this and the next chapter, we are mainly interested in the **professional responsibility** of engineers.

Moral responsibility Responsibility that is based on moral obligations, moral norms or moral duties.

Professional responsibility The responsibility that is based on one's role as professional in as far it stays within the limits of what is morally allowed.

Professional responsibility is the responsibility that is based on your role as a professional engineer as far it stays within the limits of what is morally allowed. Professional responsibilities are not just passive but they also contain an active component. We will examine the content of the professional responsibility of engineers in more detail in Section 1.4, but first, we turn to a more detailed description of passive responsibility.

1.3 Passive Responsibility

Typical for **passive responsibility** is that the person who is held responsible must be able to provide an account why they followed a particular course of action and why they made certain decisions which have led to the undesired outcome. In particular, the person is held to justify their actions toward those who are in a position to demand that the individual in question accounts for their actions. In the case of the Dieselgate scandal, Volkswagen had to be able to render account for its actions to customers, to society, and to the sitting judge. We will call this type of passive responsibility **accountability**.

Passive responsibility Backward-looking responsibility, relevant after something undesirable occurred; specific forms are accountability, blameworthiness, and liability.

Accountability Backward-looking responsibility in the sense of being held to account for, or justify one's actions toward others.

Blameworthiness Backward-looking responsibility in the sense of being a proper target of blame for an undesired outcome. In order for someone to be blameworthy, usually the following conditions need to apply: causal contribution, wrong-doing, foreseeability, and freedom.

Passive responsibility often involves not just accountability but also **blameworthiness**. Blameworthiness means that it is proper to blame someone for an undesired outcome (partially) caused by their actions. To decide whether someone is blameworthy, four conditions need to apply: causal contribution, wrong-doing, foreseeability, and freedom. The extent to which you can be blamed is determined by the degree to which these conditions are fulfilled. The four conditions will be illustrated on the basis of the Dieselgate scandal.

Causal contribution

The first criterion is that the person who is held responsible must have made a causal contribution to the undesired outcome for which they are held responsible. Two things are to be kept in mind when judging whether someone made a causal contribution to a certain outcome. First, not only an action, but also a failure to act may often be considered a causal contribution, like in the case of the Dieselgate scandal: the failure to prevent Volkswagen from cheating on emissions testing. Second, one causal contribution is usually not a sufficient condition for the occurrence of the outcome under consideration. Often, a range of causal contributions will have to be present for the outcome to occur. A specific causal contribution will often be a necessary ingredient in the actual chain of events that led to the undesired outcome, that is, without the causal contribution the outcome would not have occurred.

Both the head of the engine development department and the engineers designing and implementing the cheating software made a causal contribution to the company's emissions cheating because both could have averted the scandal. The head of the engine department could have decided not to build the cheating software, and the engineers could have refused to build the software. Some engineers initially objected to the cheating software, but they

did persist or lacked the power to prevent the scandal. In retrospect, they could possibly have gone public by informing the press. Perhaps, they could also have intervened earlier on in the process – before the decision had to be made about the cheating software – to ensure that the emission problem had been better tackled.

Wrong-doing

Whenever one blames a person or institution, this person or institution must have performed an action – which has contributed to the undesired outcome – that is in breach of a norm. This can be a norm that is laid down in the law. In the Dieselgate scandal, for example, Volkswagen violated the US Clean Air Act, the primary federal air quality law intended to reduce and control air pollution nationwide, and engineer James Robert Liang was guilty of fraud and conspiracy charges. In this book, we are not just interested in legal norms, but also in moral ones. We will therefore investigate different kinds of ethical frameworks that can be applied in judging the moral rightness or wrongness of actions and their consequences. This includes ethical frameworks such as your own conscience and moral beliefs but also codes of conduct (Chapter 2) and ethical theories (Chapter 3). Together these frameworks form a means of thinking about how one can arrive at what is good, how one can act in the right way. For example, the engineers who contributed to the design and implementation of the cheating software violated the rule stating that engineers shall not aid or abet the unlawful practice of engineering by a person of a firm, often mentioned in codes of conduct for engineers.

Foreseeability

A person who is held responsible for something must have been able to know the consequences of their actions. The consequences are the harm actually arising from transgressing a norm. People cannot be held responsible if it is totally unreasonable to expect that they could possibly have been aware of the undesired outcome. What we do expect is that people do everything that is reasonably possible to become acquainted with the possible consequences of their actions.

In the Dieselgate scandal, the head of the engine development department and the engineers designing and implementing the cheating software knew, or at least could have known, that the software was likely to be used in the coming VW vehicles model with diesel engines for the US market, so violating the law. They also knew, or could have known, that this might lead to additional health risks.

A question that still remains is whether former Volkswagen CEO Martin Winterkorn could have known about the cheating software. He has repeatedly denied any knowledge of the software, but according to an investigation, he failed to respond properly to signs that the company may have been using cheating software, and therefore his claim to have known absolutely nothing about irregularities is doubtful. Moreover, the relevant question is not whether he did not know but whether he reasonably could and should have known it.

Freedom of action

Finally, the one who is held responsible must have had freedom of action, that is, they must not have acted under compulsion. Individuals are either not responsible or are responsible to a lesser degree if they are, for instance, coerced to take certain decisions. The question is, however, what exactly counts as coercion. A person can, for example, be "forced" or manipulated to work on the development of a particular technology under the threat that if they do not cooperate they will sacrifice their chances of promotion. In this case, this

person is strictly speaking not coerced to work on the development of the particular technology, they can still reasonably act differently. Therefore, the person remains responsible for their actions. However, since they are is also not entirely free we could say that their responsibility is somewhat smaller than in the case where they had freely chosen to be involved in the development of this technology.

The engineers of Volkswagen were under high pressure because of the corporate culture. Volkswagen's corporate culture was the old fashioned "command and control" model by overly demanding, and by rule of fear. A former VW employee pointed out that the pressure on the engineers was enormous: "Do what you are told. If you fail, expect being yelled at by your manager, or worse, getting fired."[6] So, the engineers working on the cheating software chose to look to the other side, because they feared they might lose their job otherwise. And they might if they spoke up, so the possibilities open to the engineers were limited. The only thing they could have possibly done to prevent the emission cheating was informing the press but that would have had negative consequences (e.g., dismissal) for the engineers and their families. In this case, you could argue that the potential negative personal consequences the engineers faced diminishes their responsibility.

1.4 Active Responsibility and the Ideals of Engineers

Google employees: Google should commit to not weaponizing its technology

In April 2017, Google launched a pilot program with the Department of Defense's Project Maven to develop and integrate "computer-vision algorithms needed to help military and civilian analysts encumbered by the sheer volume of full-motion video data that DoD collects every day in support of counterinsurgency and counterterrorism operations."[7] A year later, in April 2018, Over 3,000 Google employees, including many senior engineers in the area of artificial intelligence research, signed a petition in protest against this Artificial Intelligence project. In an open letter, originally published in the New York Times, addressed to CEO Sundar Pichai, Google employees expressed concern that the US military could weaponize AI and apply the technology toward refining drone strikes and other kinds of lethal attacks:

> We believe that Google should not be in the business of war. Therefore we ask that Project Maven be cancelled, and that Google draft, publicize and enforce a clear policy stating that neither Google nor its contractors will ever build warfare technology. (…)
>
> We cannot outsource the moral responsibility of our technologies to third parties. Google's stated values make this clear: Every one of our users is trusting us. Never jeopardize that. Ever. This contract puts Google's reputation at risk and stands in direct opposition to our core values. Building this technology to assist the US Government in military surveillance – and potentially lethal outcomes – is not acceptable. Recognizing Google's moral and ethical responsibility, and the threat to Google's reputation, we request that you:
>
> 1 Cancel this project immediately
> 2 Draft, publicize, and enforce a clear policy stating that neither Google nor its contractors will ever build warfare technology.[8]

Google announced on June 1, 2018 – after mounting pressure from its employees – that it would not renew its contract with the Pentagon's Project Maven when it was to expire in 2019. It also stepped out of the running for DOD's JEDI (the gratuitous Star Wars reference stands for Joint Enterprise Defense Infrastructure) cloud contract around the same time, because of ethical concerns centering on the use of artificial intelligence.

Google had also accommodated the second request of its employees. It released in June 2018 an ethical code for AI. Part of this code "Artificial Intelligence at Google: Our Principles" reads as follows:

> [W]e will not design or deploy AI in the following application areas:
>
> 1 Technologies that cause or are likely to cause overall harm. Where there is a material risk of harm, we will proceed only where we believe that the benefits substantially outweigh the risks, and will incorporate appropriate safety constraints.
> 2 Weapons or other technologies whose principal purpose or implementation is to cause or directly facilitate injury to people.
> 3 Technologies that gather or use information for surveillance violating internationally accepted norms.
> 4 Technologies whose purpose contravenes widely accepted principles of international law and human rights.
>
> We want to be clear that while we are not developing AI for use in weapons, we will continue our work with governments and the military in many other areas. These include cybersecurity, training, military recruitment, veterans' healthcare, and search and rescue. These collaborations are important and we'll actively look for more ways to augment the critical work of these organizations and keep service members and civilians safe.[9]

In the previous section, we have considered questions of responsibility when something has gone wrong. Responsibility is also something that comes into play beforehand, if nothing has yet gone wrong or if there is the opportunity to realize something good. We will refer to this as **active responsibility**. If someone is actively responsible for something they are expected to act in such a way that undesired consequences are avoided as much as possible so that positive consequences are realized. Active responsibility is not primarily about blame but requires a certain positive character trait in dealing with matters. Philosophers call such positive character traits virtues (see Chapter 3). Active responsibility, moreover, is not only about preventing the negative effects of technology, such as illustrated by the Google employees (see box), but also about realizing certain positive effects.

Active responsibility Forward-looking responsibility referring to a duty or task to care for certain state-of-affairs or persons.

Active Responsibility

Mark Bovens mentions the following features of active responsibility:

- Adequate perception of threatened violations of norms;
- Consideration of the consequences;

- Autonomy, that is, the ability to make one's own independent moral decisions;
- Displaying conduct that is based on a verifiable and consistent code; and
- Taking role obligations seriously. (Bovens, 1998)

One way in which the active responsibility of engineers can be understood is by looking at the **ideals** of engineers. Ideals, as we will understand the notion here, have two specific characteristics. First ideals are ideas or strivings which are particularly motivating and inspiring for the person having them. Second, it is typical for ideals that they aim at achieving an optimum or maximum. Often, therefore, ideals cannot be entirely achieved but are strived for. In the course of practicing their profession engineers can be driven by several ideals. Those can be personal ideals such as the desire to earn a lot of money or to satisfy a certain degree of curiosity but they can also be social or moral ideals, such as wanting to implement technological ends to improve the world. Those are also the types of ideals that can spur people on to opt for an engineering field of study and career. Some of these ideals are directly linked to professional practice because they are closely allied to the engineering profession or can only be aspired to by carrying out the profession of engineer. We call such ideals **professional ideals**. As *professional* ideals, these ideals are part of professional responsibility in as far they stay within the limits of what is morally allowed. Below, we shall therefore discuss three different professional ideals of engineers and we shall establish whether these ideals are also morally commendable.

Ideals Ideas or strivings which are particularly motivating and inspiring for the person having them, and which aim at achieving an optimum or maximum.

Professional ideals Ideals that are closely allied to a profession or can only be aspired to by carrying out the profession.

1.4.1 Technological enthusiasm

Technological enthusiasm pertains to the ideal of wanting to develop new technological possibilities and take up technological challenges. This is an ideal that motivates many engineers. It is fitting that Samuel Florman refers to this as "the existential pleasures of engineering" (Florman, 1976). One good example of technological enthusiasm was the development of Google Earth, a program with which, via the Internet, it is possible to zoom in on the earth's surface. It is a beautiful concept but it gives rise to all kinds of moral questions inherent in the use of remotely sensed images, "as Google Earth might be seen as a panoptic viewing technology that leaves no voice to those being viewed" (Myers, 2010, p. 455). For instance, in the area of privacy, you can study the opposite neighbor's garden in great detail, and in the field of security, terrorists could use it to plan attacks. In a documentary on the subject of Google Earth one of the program developers admitted that these are important questions.[10] Nevertheless, when developing the program these were matters that the developers had failed to consider because they were so driven by the challenge of making it technologically possible for everyone to be able to study the earth from behind their computer.

Technological enthusiasm The ideal of wanting to develop new technological possibilities and taking up technological challenges.

Technological enthusiasm in itself is not morally improper; it is in fact positive for engineers to be intrinsically motivated as far as their work is concerned. The inherent danger

of technological enthusiasm lies in the possible negative effects of technology and the relevant social constraints being easily overlooked. This has been exemplified by the Google Earth example. It is exemplified to an extreme extent by the example of Wernher von Braun (see box).

Wernher von Braun (1912–1977)

Wernher von Braun is famous for being the creator of the space program that made it possible to put the first person on the moon on July 20, 1969. A couple of days before, on July 16, the Apollo 11 spaceship used by the astronauts to travel from the earth had been launched with the help of a Saturn V rocket and Von Braun had been the main designer of that rocket. Sam Phillips, the director of the American Apollo program, was reported to have said that without Von Braun the Americans would never have been able to reach the moon as soon as they did. Later, after having spoken to colleagues, he reviewed his comment by claiming that without Von Braun the Americans would never have landed on the moon full stop.



Figure 1.1 Wernher von Braun. Photo: NASA/Wikimedia Commons/Public domain.

Von Braun grew up in Germany. From an early age he was fascinated by rocket technology. According to one anecdote Von Braun was not particularly brilliant in physics and mathematics until he read a book entitled *Die Rakete zu den Planetenraümen* by Hermannn Oberth and realized that those were the subjects he would have to get to grips with if he was later going to be able to construct rockets. In the 1930s Von Braun was involved in developing rockets for the German army. In 1937 he joined Hitler's National Socialist Party and in 1940 he became a member of the SS. Later he explained that he had been forced to join that party and that he had never participated in any political activities, a matter that is historically disputed. What is in any case striking is the argument that he in retrospect gave for joining the National Socialist Party which was this: "My refusal to join the party would have meant that I would have had to abandon the work of my life. Therefore, I decided to join" (Piszkiewicz, 1995, p. 43). His life's work was, of course, rocket technology and a devotion to that cause was a constant feature of Von Braun's life.

During World War II Von Braun played a major role in the development of the V2 rocket, which was deployed from 1944 onwards to bomb, among other targets, the

city of London. Incidentally more were killed during the V2-rocket's development and production – an estimated 10 000 people – than during the actual bombings (Neufeld, 1995, p. 264). The Germans had deployed prisoners from the Mittelbau-Dora concentration camp to help in the production of the V2 rockets. Von Braun was probably aware of those people's abominable working conditions.

There is, therefore, much to indicate that Von Braun's main reason for wanting to join the SS was carefully calculated: in that way he would be able to continue his important work in the field of rocket technology. In 1943 he was arrested by the Nazis and later released. It was claimed that he had allegedly sabotaged the V2 program. One of the pieces of evidence used against him was that he had apparently said that after the war the V2 technology should be further developed in the interests of space travel – and that is indeed what ultimately happened when he later started to work for the Americans. When, in 1945, Von Braun realized that the Germans were going to lose the war he arranged for his team to be handed over to the Americans.

In the United States, Von Braun originally worked on the development of rockets for military purposes but later he fulfilled a key role in the space travel program, a program that was ultimately to culminate in man's first steps on the moon. Von Braun's big dream did therefore ultimately come true.

Source: Based on Stuhlinger and Ordway (1994), Neufeld (1995), and Piszkiewicz (1995).

1.4.2 Effectiveness and efficiency

Effectiveness The extent to which an established goal is achieved.

Efficiency The ratio between the goal achieved and the effort required.

Engineers tend to strive for effectiveness and efficiency. **Effectiveness** can be defined as the extent to which an established goal is achieved; **efficiency** as the ratio between the goal achieved and the effort required. The drive to strive toward effectiveness and efficiency is an attractive ideal for engineers because it is – apparently – so neutral and objective. It does not seem to involve any political or moral choices, which is something that many engineers experience as subjective and therefore wish to avoid. Efficiency is also something that in contrast, for example, to human welfare can be defined by engineers and is also often quantifiable. Engineers are, for example, able to define the efficiency of the energy production in an electrical power station and they can also measure and compare that efficiency. An example of an engineer who saw efficiency as an ideal was Frederick W. Taylor (see box).

Frederick W. Taylor (1856–1915)

Frederick Taylor was an American mechanical engineer. He became known as the founder of the efficiency movement and was specifically renowned for developing scientific management also known as Taylorism.

Out of all his research, Taylor became best known for his time-and-motion studies. There he endeavored to scientifically establish which actions – movements – workers



Figure 1.2 Frederick Taylor. Photo: Bettmann/Bettmann/Getty Images.

were required to carry out during the production process and how much time that took. He divided the relevant actions into separate movements, eliminated all that was superfluous and endeavored, with the aid of a stopwatch, to establish precisely how long the necessary movements took. His aim was to make the whole production process as efficient as possible on the basis of such insight. Taylorism is often seen as an attempt to squeeze as much as possible out of workers and in practice that was often what it amounted to but that had probably not been Taylor's primary goal. He believed that it was possible to determine, in a scientific fashion, just what would be the best way of carrying out production processes by organizing such processes in such a way that optimal use could be made of the opportunities provided by workers without having to demand too much of them. He maintained that his approach would put an end to the on-going conflict between the trade unions and the managerial echelons, thus making trade unions redundant. He was also critical of management which he found unscientific and inefficient. To his mind having the insight of engineers and their approach to things would culminate in a better and more efficient form of management.

In 1911 Taylor published his *The Principles of Scientific Management* in which he explained the four principles of scientific management:

- Replace the present rules of thumb for working methods with methods based on a scientific study of the work process;
- Select, train, and develop every worker in a scientific fashion instead of allowing workers to do that themselves;
- Really work together with the workers so that the work can be completed according to the developed scientific principles;
- Work and responsibility are virtually equally divided between management and workers. The management does the work for which it is best equipped: applying scientific management principles to plan the work; and the workers actually perform the tasks.

Though Taylor was a prominent engineer – for a time he was, for instance, president of the influential American Society of Mechanical Engineers (ASME) – he only had a limited degree of success when it came to the matter of conveying his ideas to people. They were not embraced by all engineers but, thanks to a number of followers,

they were ultimately very influential. They fitted in well with the mood of the age. In the United States the first two decades of the twentieth century were known as the "Progressive Era." It was a time when engineers clearly manifested themselves as a professional group capable of promoting the interests of industry and society. It was frequently implied that the engineering approach to social problems was somehow superior. Taylor's endeavors to achieve a form of management that was efficient and scientific fitted perfectly into that picture.

Source: Based on Taylor (1911), Layton (1971), and Nelson (1980).

Though many engineers would probably not have taken things as far as Taylor did, his attempt to efficiently design the whole production process – and ultimately society as a whole – constituted a typical engineering approach to matters. Efficiency is an ideal that endows engineers with authority because it is something that – at least at first sight – one can hardly oppose and that can seemingly be measured objectively. The aspiration among engineers to achieve authority played an important part in Taylor's time. In the United States the efficiency movement became an answer to the rise of large capitalistic companies where managers ruled and engineers were mere subordinate implementers. It constituted an effort to improve the position of the engineer in relation to the manager. What Taylor was really arguing was that engineers were the only really capable managers.

From a moral point of view, however, effectiveness and efficiency are not always worth pursuing. That is because effectiveness and efficiency suppose an external goal in relation to which they are measured. That external goal can be to consume a minimum amount of non-renewable natural resources to generate energy, but also war or even genocide. It was no coincidence that Nazis like Eichmann were proud of the efficient way in which they were able to contribute to the so-called resolving of the Jewish question in Europe which was to lead to the murdering of six million Jews and other groups that were considered inferior by the Nazis like Gypsies and mental patients (Arendt, 1965). The matter of whether effectiveness or efficiency is morally worth pursuing, therefore, depends very much on the ends for which they are employed. So, although some engineers have maintained the opposite, the measurement of the effectiveness and efficiency of a technology is value-laden. It presupposes a certain goal for which the technology is to be employed and that goal is likely to be value-laden. Moreover, to measure efficiency one needs to calculate the ratio between the output (the external goal) and the input, and also the choice of the input may be value-laden. A technology may, for example, be efficient in terms of costs but not in terms of energy consumption.

1.4.3 Human welfare

A third ideal of engineers is that of contributing to or augmenting human welfare. The professional code of the American Society of Mechanical Engineering (ASME) and of the American Society of Civil Engineers (ASCE) states that "engineers shall use their knowledge and skill for the enhancement of human welfare." This also includes values such as health,

the environment, and sustainability. According to many professional codes that also means that: "Engineers shall hold paramount the safety, health and welfare of the public" (as, for example, stated by the code of the National Society of Professional Engineers, see Chapter 2). It is worth noting that the relevant values will differ somewhat depending on the particular engineering specialization. In the case of software engineers, for instance, values such as the environment and health will be less relevant while matters such as the privacy and reliability of systems will be more important. One of the most important values that falls

Johan van Veen (1893–1959)



Figure 1.3 Netherlands. Viewed from a US Army helicopter, a Zuid Beveland town gives a hint of the tremendous damage wrought by the 1953 flood to Dutch islands. Photo: Agency for International Development/Wikimedia Commons/Public domain.

Johan van Veen is known as the father of the Delta Works, a massive plan devised to protect the coasts of the South-western part of the Netherlands which materialized after the flood disaster of 1953 (see Figure 1.3). During the disaster 1835 people died and more than 72,000 were forced to evacuate their homes.

Before the disaster occurred there were indications that the dykes were not up to standard. In 1934 it was discovered that a number of dykes were probably too low. In 1939 Wemelsfelder, a Public Works Agency employee working for the Research Service for the Estuaries, Lower River Reaches and Coasts sector, was able to support that assumption with a series of models. Even before the big disaster of 1953 Johan van Veen had emphasized the need to close off certain estuaries.

Van Veen studied civil engineering in Delft before then going on, in 1929, to work for the Research Service which he was later to head. On the basis of his interest in the history of hydraulic engineering and his activities with the Public Works Agency, he gradually became convinced that the danger posed by storm-driven flooding had been vastly underestimated and that the dykes were indeed too low. Van Veen was quite adamant about his beliefs which soon earned him the nickname, within the service, of "the new Cassandra" after the Trojan priestess who had perpetually predicted the fall of Troy. He even adopted the pseudonym Cassandra in the epilogue to the fourth edition of his book *Dredge, Drain, Reclaim* which was published in 1955. According to Van Veen, Cassandra had been warning people about the too-low state of the dykes since 1937. In the fifth edition of his book, which appeared in 1962, Van Veen revealed that he was in fact Cassandra (Van Veen, 1962). Van Veen's reporting of the lowness of the dykes was not something that was welcomed. In fact, it was deliberately kept secret from the public. It is even said that Van Veen was sworn to silence on the matter.

In 1939 Van Veen became secretary of the newly created Storm Flood Committee. In that capacity, he was given the space to elaborate several of his plans for the further defense of the Netherlands. In public debates, he consistently based his arguments for those plans on the need to combat silting up and the formation of salt-water basins. Undoubtedly that was because even then he was unable to publicly air his views about safety.

Even though pre-1953 there was growing doubt within the Public Works Agency as to the ability of the existing dykes to be able to withstand a storm-driven flood that was not a matter that became publicly known. It was not only the Public Works Agency and the relevant minister that kept quiet about the possibility of a flood disaster. At that time the press was not keen to publish such doom and gloom stories either. As there was little or no publicity about the inadequacy of the dykes the inhabitants of Zeeland were thus totally surprised by the disaster. There are no indications that in the period leading up to 1953 steps were taken to improve the storm warning systems and the aid networks. If that had happened, then undoubtedly considerably fewer people would have lost their lives.

Source: Based on Ten Horn-van Nispen (2002), Van der Ham (2003), and De Boer(1994).

under the pursuit of human welfare among engineers is safety. One of the engineers who was a great proponent of safety was the Dutch civil engineer Johan van Veen (see box).

From a moral point of view, the professional ideal of human welfare is hardly contestable. One could maybe wonder whether serving human well-being is a moral obligation for engineers, and whether they have a social responsibility. There are some elements of these engineering social responsibilities that are widely agreed upon, as we already mentioned: human health and safety, protection of the environment, and sustainability. Other engineering social responsibilities have less consensus across countries and disciplines, such as the mandate to participate in pro bono work; to strive for social justice, relating to the distribution of wealth and privileges in society, as well as issues related to poverty and development; and to embrace diversity (Bielefeldt, 2018). But if engineers choose to have these latter engineering social responsibilities, this seems certainly

laudable. Therefore, from a moral angle, this ideal related to social responsibility has another status than the other two ideals discussed above. As we have seen technological enthusiasm and effectiveness and efficiency are ideals that are not necessarily morally commendable, although they are also not always morally reprehensible; in both cases much depends on the goals for which technology is used and the side-effects so created. Both ideals, moreover, carry the danger of forgetting about the moral dimension of technology. On the other hand, the ideal of human welfare confirms that the professional practice of engineers is not something that is morally neutral and that engineers do more than merely develop neutral means for the goals of others.

1.5 Engineers versus Managers

Engineers are often salaried employees and they are usually hierarchically below managers. Just as with other professionals this can lead to situations of conflict because they have, on the one hand, a responsibility to the company in which they work and, on the other hand, a professional responsibility as engineers, including – as we have seen – a responsibility for human welfare. We will discuss here three models of dealing with this tension and the potential conflict between engineers and managers: separatism, technocracy, and whistleblowing. These three models are positions that engineers can adopt versus managers in specific situations, but they also reflect more general social frameworks for dealing with the potential tension between engineers and managers.

Case Challenger

When, on the morning of January 28, 1986, the mission controllers' countdown began for the 25th launching of the space shuttle, it was almost four degrees Celsius below freezing point (or about 25 degrees Fahrenheit). After 73 seconds the Challenger space shuttle exploded 11 kilometers above the Atlantic Ocean. All seven astronauts were killed. At the time it was the biggest disaster ever in the history of American space travel.

After the accident an investigation committee was set up to establish the exact cause of the explosion. The committee concluded that the explosion leading to the loss of the 1.2 billion dollar spaceship was attributable to the failure of the rubber sealing ring (the O-ring). As the component was unable to function properly at low temperatures the flame burnt through the joint of the booster rocket. This led to the separation of booster rocket, which then crashed into the external tank, which caused a structural failure of the external tank and an explosion.

On the day of the fatal flight, the launching was delayed five times, partly for weather-related reasons. The night preceding the launching was very cold; it went down to minus 10 degrees Celsius (or 14 degrees Fahrenheit). NASA engineers confessed to remembering having heard that it would not be safe to launch at very low temperatures. They, therefore, decided to have a telephone conference on the eve of the launching between NASA and Morton Thiokol (a NASA

supplier) representatives. Roger Boisjoly, an engineer at the Morton Thiokol also participated with some of his colleagues, and they underlined the risk of the O-rings eroding at low temperatures. The O-rings had never been tested in subzero conditions. The engineers recommended that if the temperature fell below 11 degrees Celsius (or 52 degrees Fahrenheit) then the launch should not go ahead. The weather forecast indicated that the temperature would not rise above freezing point on the morning of the launch. That was the main reason why Morton Thiokol initially recommended that the launch should not be allowed to go ahead.



Figure 1.4 Challenger Space Shuttle. Photo: Bob Pearson/AFP/Getty Images.

The people at NASA claimed that the data did not provide sufficient grounds for them to declare the launching, which was extremely important to NASA, unsafe. A brief consultation session was convened so that the data could once again be examined. While the connection was broken for five minutes the General Manager of Thiokol commented that a "management decision" had to be made. For Morton Thiokol it was too much of a political and financial risk to postpone the launch, since after the launching NASA would make a decision regarding a possible contract extension with the company. It was at least the case that Boisjoly felt that people were no longer listening to his arguments. After discussing matters among themselves the four managers present, the engineers excluded, put it to the vote. They were reconnected and Thiokol, ignoring the advice of Boisjoly, announced to NASA its positive recommendations concerning the launching of the Challenger. Several minutes after the launch someone from the mission control team concluded that there had: "obviously been … a major malfunction."

Several months after the Challenger disaster, Roger Boisjoly said the following: "I must emphasize, I had my say, and I never [would] take [away] any management right to take the input of an engineer and then make a decision based upon that input … I have worked at a lot of companies … and I truly believe that … there was no point in me doing anything further [other] than [what] I had already attempted to do" Goldberg (1987, p. 156). It is a view that fits into what might be termed separatism.

Source: Based on Vaughan (1996), and the BBC documentary *Challenger: Go for Launch* of Blast!Films.

1.5.1 Separatism

Engineer James Robert Liang who was involved in developing the cheating software in the Dieselgate scandal said in his defense that he was just doing what he was told while trying to be a loyal worker.[11] Just as in the Challenger case (see box) **separatism** is involved: "the notion that scientists and engineers should apply the technical inputs, but appropriate management and political organs should make the value decisions" (Goldberg, 1987, p. 156). Separatism is well illustrated by the **tripartite model**.

Separatism The notion that scientists and engineers should apply the technical inputs, but appropriate management and political organs should make the value decisions.

Tripartite model A model that maintains that engineers can only be held responsible for the design of products and not for wider social consequences or concerns. In the tripartite model three separate segments are distinguished: the segment of politicians; the segment of engineers; and the segment of users.

In the tripartite model three separate segments are distinguished (Figure 1.5). The first segment contains politicians, policy makers, and managers who establish the objectives for engineering projects and products and make available resources without intervening in engineering matters. They also stake out the ultimate boundaries of the engineering projects. The second segment relates to the engineers who take care of the designing, developing, creating, and executing of those projects or products. The final segment, the users, includes those who make use of the various technologies. According to this model engineers can only be held responsible for the technical creation of products.

The tripartite model (see, for example, Van de Poel (2001); originally based on Boers (1981)) is based on the assumption that the responsibility of engineers is confined to the engineering choices that they make. The formulation of the design assignment, the way in which the technology is used and the consequences of all of that are not thus considered to be part of the responsibility of engineers. According to this view, the responsibility of engineers limits itself to the professional responsibility that they have to their employer, customer, and colleagues, excluding the general public. The case of Werner von Braun illustrates this well. Von Braun was reconciled to the subordinate role of engineers but perpetually sought ways of pursuing his technological ideals and, in doing so, displayed a degree of indifference to the social consequences of the application of his work and to the immoral intentions of those who had commissioned the task. His creed must have been: "In times of war, a man has to stand up for his country, as a combat soldier as a scientist or as an engineer, regardless of whether or not he agrees with the policy his government is pursuing" (Stuhlinger and Ordway, 1994, p. xiii). It is a role that might alternatively be described as being that of a "**hired gun**." The dangerous side of this role can perhaps best be summed up in the words of the song text of the American satirist Tom Lehrer:[12]

"Hired gun" Someone who is willing to carry out any task or assignment from their employer or client without moral scruples.

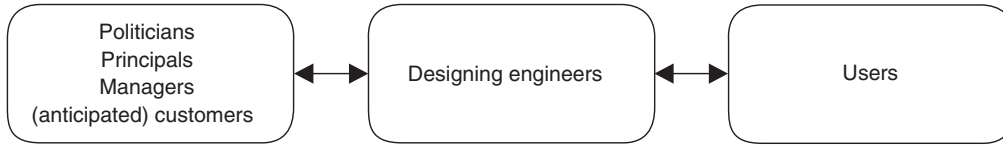


Figure 1.5 The tripartite model.

Once the rockets go up
Who cares where they come down
"that's not my department,"
said Wernher von Braun.

According to Deborah Johnson (2020), hired guns are the antithesis of professionals: "[e]ngineering is a profession, and members of a profession have responsibilities that go beyond their own short-term self-interest and the interests of their clients" (Johnson, 2020, p. 91). In a letter of the US-based VW executive and engineer Oliver Schmidt to judge Cox, it became clear that he had acted as a hired gun. Schmidt had agreed to follow a script, or talking points, agreed by Volkswagen management and a high-ranking lawyer, to conceal from regulators the existence of the defeat device, at a meeting with Alberto Ayala, a California Air Resources Board executive. In the letter he admitted his mistake and that he should have taken his professional responsibility:

> In hindsight, I should never have agreed to meet with Dr Ayala on that day. Or better yet, I should have gone to that meeting and ignored the instructions given to me and told Dr Ayala that there is a defeat device in the VW diesel engine vehicles and that VW had been cheating for almost a decade. I did not do that and that is why I find myself here today.[13]

1.5.2 Technocracy

An alternative for the engineer as a "hired gun" is offered by Frederick Taylor. He proposed that engineers should take over the role of managers in the governance of companies and that of politicians in the governance of society. This proposal would lead to the establishment of a **technocracy**, that is, government by experts. Accordingly, the role of engineers would be that of technocrats who, on the basis of technological insight, do what they consider best for a company or for society. The role of technocrats is problematic for a number of reasons. First, it is not exactly clear what unique expertise engineers possess that permits them to legitimately lay claim to the role of technocrats. As we have seen, concealed behind the use of apparently neutral terms like efficiency there is a whole world of values and conflicting interests. Admittedly engineers do have specific technological knowledge and they do know about, for example, the risks that may be involved in a technology. When it comes to the underlying goals that should be pursued through technology or the acceptable levels of risk they are not any more knowledgeable than others. A second objection to technocracy is that it is undemocratic and paternalistic. We speak of **paternalism** when a certain group of individuals, in this case, engineers, make (moral) decisions for others on the assumption that they know better what is good for them than those others themselves. In that way, paternalism denies that people have the right to shape their own lives. That clashes with the people's moral autonomy – the ability of people to decide for themselves what is good and right. Moral autonomy is often considered an important moral value.

Technocracy Government by experts.

Paternalism The making of (moral) decisions for others on the assumption that one knows better what is good for them than those others themselves.

1.5.3 Whistle-blowing

Case Inez Austin

Inez Austin was one of the few female engineers at the company Westinghouse Hanford, when in 1989 she became senior process engineer for that company at the Hanford Nuclear Site, a former plutonium production facility in the state of Washington in the United States. In June 1990, she refused for safety reasons to approve a plan to pump radioactive waste from an old underground single-shell tank to a double-shell tank. Her refusal led to several retaliatory actions by her employer. In 1990 she received the lowest employee ratings in all her 11 years at the company. Doubts were raised about the state of her mental health and she was advised to see a psychiatrist. In 1992, Austin received the Scientific Freedom and Responsibility Award from the American Association for the Advancement of Science (AAAS) "for her courageous and persistent efforts to prevent potential safety hazards involving nuclear waste contamination. Ms. Austin's stand in the face of harassment and intimidation reflects the paramount professional duty of engineers – to protect the public's health and safety – and has served as an inspiration to her co-workers." Nevertheless, after a second whistle-blowing incident, relating to the safety and legality of untrained workers, her job was terminated in 1996.

Source: Based on https://onlineethics.org/cases/engineers-and-scientists-behaving-well/inez-austin-protecting-public-safety-hanford-nuclear, accessed November 17, 2022.

A third role model is offered by Van Veen. He accepted, to an important extent, his subordinate role as engineer but he did endeavor to find channels, internally and externally, to air his grievances on safety. Though he never went public as such his role verges on that of whistle-blower as they report internal wrongs externally in order to warn society. An example of a whistle-blower is given in the boxed case on Inez Austin. The term **whistle-blowing** is the act of publicly disclosing information by someone about serious wrongdoing within their organization. Serious wrongdoing does not only include the endangerment of public health, safety, or the environment but also indictable offences, violation of the law and of legislation, deception of the public or the government, corruption, fraud, destroying or manipulating information, and abuse of power, including sexual harassment and discrimination. As the box shows whistle-blowing may well lead to conflicts with the employer. In fact, whistle-blowing can be severely detrimental to the whistle-blower, facing expensive court cases and even being jailed (Kenny, 2019). A study showed that two-thirds of identifiable whistle-blowers experienced physical and/or mental health issues, and three-quarters felt stigmatized (Redman and Caplan, 2015). While many countries and organizations have laws and policies to encourage and protect whistle-blowers (see Chapter 2), in practice these laws and policies are weak and are often simply ignored. So, it is not surprising that

Whistle-blowing The act of publicly disclosing information by someone about serious wrongdoing within their organization.

the fear for the consequences of whistle-blowing stops people from blowing the whistle. This was also the case in the Dieselgate scandal, and that was the reason that it took so long before Stuart Johnson, the head of Volkswagen's Engineering and Environmental Office, revealed the existence of the cheating software in 2015. After Johnson, more engineers admitted this when they were questioned about irregularities in the emissions data. As we already mentioned the company's culture was one that was ruled by fear, especially when Winterkorn became CEO. Winterkorn expressed himself "loudly, yelling at anything that displeased him and he was also physically intimidating" (Spapens, 2018, p.100), and often "top VW managers received relentless criticism from Winterkorn in front of their peers" (ibid., p. 100). Through this culture, engineers and managers were left in constant uncertainty about their jobs. This was the main reason that, in spite of the fact that they had plenty of opportunities to protest or blow the whistle, they decided to choose obedience over professional responsibility.

Guidelines for Whistle-blowing

Business ethicist Richard De George has proposed the following guidelines, for when whistle-blowing is morally required:

1. The organization to which the would-be whistleblower belongs will, through its product or policy, do serious and considerable harm to the public (whether to users of its product, to innocent bystanders, or to the public at large).
2. The would-be whistleblower has identified that threat of harm, reported it to her immediate superior, making clear both the threat itself and the objection to it, and concluded that the superior will do nothing effective.
3. The would-be whistleblower has exhausted other internal procedures within the organization (for example, by going up the organizational ladder as far as allowed) – or at least made use of as many internal procedures as the danger to others and her own safety make reasonable.
4. The would-be whistleblower has (or has accessible) evidence that would convince a reasonable, impartial observer that her view of the threat is correct.
5. The would-be whistleblower has good reason to believe that revealing the threat will (probably) prevent the harm at reasonable cost (all things considered). (De George, 1990)

Whistle-blowers are often seen as people who are morally to be commended and are heroes (see box about Frances Haugen), however, some authors argue that the potential whistleblower has a duty to blow the whistle. Ceva and Bocchiola, for example, argue that whistle-blowing is an issue neither of personal morality nor professional duty, and challenge the notion of whistle-blowing as heroic: "[t]o see whistleblowing as a supererogation has the effect of reducing any such report of organizational wrongdoing to a one-shot game in which an individual sacrifices her life and career for the sake of higher moral ideal and goals" (Ceva and Bocchiola, 2019, p. 49).

Frances Haugen, "21st century hero"



Figure 1.6 Frances Haugen Michael Morgernstern.

Beginning in September 2021, The Wall Street Journal published The Facebook Files, a series of news reports "based on a review of internal Facebook documents including research reports, online employee discussions and drafts of presentations to senior managers".[14] These documents indicate that Facebook was aware of various problems caused by its apps, ranging from its impact on teens' mental health and the extent of misinformation on its platforms, to fomenting ethnic violence in countries such as Ethiopia and human traffickers' open use of its services. For example, with regard to the impact on teens' mental; health, statistics from Facebook showed that one-third of the teen girls said that when they felt bad about their bodies, Instagram (one of the companies owned by Facebook) made them feel worse.

Frances Haugen's identity as the Facebook whistle-blower was revealed on *60 Minutes* on October 3, 2021.[15] Haugen is a data scientist from Iowa with a degree in computer engineering and a Harvard master's degree in business. In 2019, she was recruited by Facebook, and she wanted to work on issues around misinformation, since she was motivated by the loss of a friendship due to online conspiracies. She became a product manager within Facebook's Civic Integrity team, the unit tasked with monitoring and limiting misinformation. She and her team had lots of ideas for how to make Facebook less harmful, but her optimism that she could make a change from inside was short-lived. The team was, for example, understaffed, and the concerns she raised were repeatedly discounted by the managers. The Civic Integrity team played a key role in the company's efforts to get through the presidential election in 2020 relatively unscathed by tweaking the algorithm such that polarizing political content was given lower priority. After the election, Facebook removed these so-called safeguards, an action Haugen believes was at least partially responsible for the riots at the Capitol in Washington on January 6, 2021, and disbanded the misinformation team. It was the last straw for Haugen. She resigned, but still had access to the intranet and started secretly collecting documents about the strategy of Facebook. She passed these documents on to the Wall Street Journal, leading to The Facebook Files.

In her opening statement to the US Senate Commerce Subcommittee on Consumer Protection on October 5, 2021, Haugen, hailed as "21st century hero" by the Senate, said

> I joined Facebook because I think Facebook has the potential to bring out the best in us, but I'm here today because I believe Facebook's products harm children, stoke division, and weaken our democracy. The company's leadership knows how to make Facebook and Instagram safer, but won't make the necessary changes because they have put their astronomical profits before people.[16]

Haugen's main concern was Facebook's "engagement-ranking" system, more commonly known as "the algorithm," that chooses which posts, out of thousands of options, to rank at the top of users' feeds, which according to Haugen is doomed to amplify the worst in us. This system is essentially designed to keep people on the site/app for as long as possible, and it is this time and the data thus collected that is ultimately monetized:

> One of the things that has been well documented in psychology research is that the more times a human is exposed to something, the more they like it, and the more they believe it's true. One of the most dangerous things about engagement-based ranking is that it is much easier to inspire someone to hate than it is to compassion or empathy. Given that you have a system that hyperamplifies the most extreme content, you're going to see people who get exposed over and over again to the idea that [for example] it's O.K. to be violent to Muslims. And that destabilizes societies.[17]

Haugen came forward because she realized a "frightening truth": "almost no one outside of Facebook knows what happens inside Facebook. As long as Facebook is operating in the dark, it is accountable to no one. And it will continue to make choices that go against the common good."[18] Haugen's disclosure has prompted policymakers not only in the US, but also around the world, to intensify their calls for regulation of social media platforms to tackle harmful online content and regulate the social media giant Facebook. Besides the testimony before the US Senate Commerce Subcommittee on Consumer Protection, Haugen was invited for a hearing by the Parliament of the United Kingdom and by the European Parliament. After the meeting with the European Parliament, Chair Anna Cavazzini said:

> Whistleblowers like Frances Haugen show the urgent need to set democratic rules for the online world in the interest of users. Her revelations lay bare the inherent conflict between the platform's business model and users' interests. It shows that we need strong rules for content moderation and far-reaching transparency obligations in Europe. It also shows that corporate self-regulation has not worked. (…) All allegations in the 'Facebook Files' must be investigated. As the Internal Market Committee is currently negotiating the Digital Services Act and the Digital Markets Act, a public hearing with Frances Haugen will enrich the democratic discourse and our current legislative work in the committees concerned.[19]

It does not seem desirable to let the professional ethics of engineers – or people of any other profession – be exclusively dependent on such practices. Although whistle-blowing may sometimes be unavoidable, as a general social framework for dealing with the potential tension between engineers and managers, it is unsatisfactory. In the first place, whistle-blowing usually forces people to make big sacrifices and one may question whether it is legitimate to expect the average professional to make such sacrifices. In the second place, the effectiveness of whistle-blowing is often limited because as soon as the whistle is blown the communication between managers and professionals has inevitably been disrupted. It would be much more effective if at an earlier stage the concerns of the professionals were to be addressed but in a more constructive way. This demands a concept of the engineer's role in which the engineer as professional is not necessarily opposed to the manager. It means that engineers have to be able to recognize moral questions in their professional practice and discuss them in a constructive way with other parties.

1.6 The Social Context of Technological Development

Engineers are not the only ones who are responsible for the development and consequences of technology. Apart from managers and engineers, there are other actors who influence the direction taken by technological development and the relevant social consequences. We use the term **actor** here for any person or group that can make a decision on how to act and that can act on that decision. A company is an actor because it usually has a board of directors that can make decisions on behalf of that company and is able to effectuate those decisions. A mob on the other hand is usually not an actor. A variety of actors can be distinguished that usually play a role in technological development:

Actor Any person or group that can make a decision on how to act and that can act on that decision.

- Developers and producers of technology. This includes engineering companies, industrial laboratories, consulting firms, universities, and research centers, all of which usually employ scientists and engineers.
- **Users** who use the technology and formulate certain wishes or requirements for the functioning of the technology. The users of technologies are a very diverse group, including both companies and citizens (consumers).
- **Regulators** such as the government, who formulate rules or regulations that engineering products have to meet such as rulings concerning health and safety, but also rulings linked to relations between competitors. Regulators can also stimulate certain technological advances by means of subsidies.

Users People who use a technology and who may formulate certain wishes or requirements for the functioning of a technology.

Regulators Organizations who formulate rules or regulations that engineering products have to meet such as rulings concerning health and safety, but also rulings linked to relations between competitors.

Also other actors may be involved in technological development including, for example, professional associations, educational institutes, interest groups, and trade unions

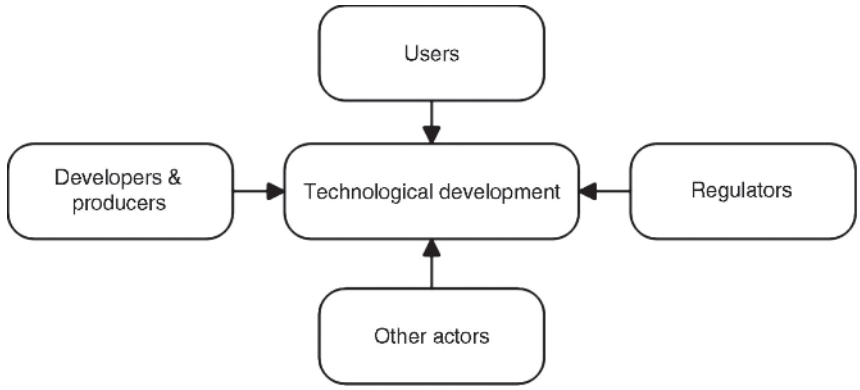


Figure 1.7 Technological development map of actors.

(see Figure 1.7). All these actors have certain **interests**, – things they strive for because they are supposed to be beneficial or advantageous for them. The interests of the various actors will often conflict, so that there is no agreement on the desirable direction of technological development.

Interests Things actors strive for because they are beneficial or advantageous for them.

Stakeholders Actors that have an interest ("a stake") in the development of a technology.

In addition to actors that influence the direction of technological development we distinguish stakeholders. **Stakeholders** are actors that have an interest ("a stake") in the development of a technology, but who cannot necessarily influence the direction of technological development. An example is people living in the vicinity of a planned construction site for a nuclear plant. Obviously these people have an interest in what type of reactor is built and how safe it is but they may not be able to influence the technology developed. Of course, such groups may organize themselves and try to get a say in technological development and they may do so more or less successfully. Stakeholders are not only relevant because they may become actors that actually influence technological development, they are also important from a moral point of view. As we have seen, stakeholders are actors whose interests are at stake in technological development. It is often assumed that morality and ethics require that we do not just neglect the rights and interest of those stakeholders because they are powerless but that we should somehow take them into account.[20]

The possibility of steering technological development is not only restrained by the fact that a large number of actors are involved in the development of technology but also

Case The Invention of Teflon

Roy Plunkett – a 28-year-old chemist at Du Pont – was requested in 1938 to develop a new, non-poisonous coolant for fridges. He, therefore, filled a metal tube with a little-used mixture and with tetrafluorethylene that would perhaps possess cooling qualities. When he went to get the mixture out of the tube nothing came out but the tube was 60 grams heavier than normal. There, therefore, had to be something in it. After having sawn open the tube it was discovered that a pale and fatty, wax-like, white

powder was stuck to the side. Nobody knew what it was so they began to experiment with the substance which turned out to be completely unique. It was given the name Teflon, after "tef" – the nickname given by chemists to tetrafluorethyleen – followed by "lon" – a suffix that Du Pont frequently used for its new products.

Du Pont devoted a great deal of time and money to discovering the exact characteristics of Teflon. It turned out to be complicated and expensive to produce Teflon. The first time that it was ever used was during World War II in order to reinforce the closing rings of the atom bomb. Teflon thus remained a state secret. It was not until 1946 that it was introduced to the general public.

Teflon has nowadays a wide range of uses. It is maybe best known as coating for non-stick frying pans. Although Teflon was long seen as a wonder material, it has recently come under some suspicion. In 2005, the Scientific Advisory Board of the Environmental Protection Agency (EPA) in the US found that perfluorooctanoic acid (PFOA), a chemical compound used to make Teflon, is "likely carcinogenic."[21] In 2005, scientists of US Food and Drug Administration (FDA) found small amounts of PFOA in Teflon cookware (Begley et al., 2005), while DuPont scientists did not detect PFOA in such pans (Powley et al., 2005). In 2004, Du Pont still maintained that "evidence from 50 years of experience and extensive scientific studies supports the conclusion that PFOA does not cause adverse human health effects."[22]

Nevertheless, in 2006 Du Pont committed itself to eliminating the release of PFOA to the environment (Eilperin, 2006).

Source: Adapted from Grauls (1993, pp. 123 ff).

Technology Assessment (TA)
Systematic method for exploring future technology developments and assessing their potential societal consequences.

Collingridge dilemma This dilemma refers to a double-bind problem to control the direction of technological development. On the one hand, it is often not possible to predict the consequences of new technologies already in the early phases of technological development. On the other hand, once the (negative) consequences materialize it often has become very difficult to change the direction of technological development.

because technological development is an unpredictable process (see Teflon box). In the course of time, a variety of methods and approaches have been developed to deal with this unpredictable character of technology development. This is done by a discipline known as **Technology Assessment (TA).** Initially TA was directed at the early detection and early warning of possible negative effects of technological development. Although such early detection and warning is important, it became increasingly clear that it is often not possible to predict the consequences of new technologies already in the early phases of technological development, as is also underscored by the Teflon example. On the other hand, it appeared that once the (negative) consequences materialize it has often become very difficult to change the direction of technological development because the technology has become deeply embedded in society and its design is more or less fixed. This problem is known as the **Collingridge dilemma**, after David Collingridge who first described it (Collingridge, 1980). Various approaches have been developed to overcome the Collingridge dilemma,

one is **Constructive Technology Assessment (CTA)**. The idea behind CTA is that TA-like efforts are to be carried out parallel to the process of technological development and are fed back to the development and design process of technology (Schot, 1992; Schot and Rip, 1997). CTA aims at broadening the design process, both in terms of actors involved and in terms of interests, considerations and values taken into account in technological development. Among other things, this implies that stakeholders get a larger say in technological development.

There are also more recent approaches that aim at broadening the design process of technological development, such as **Design for Values** and **Responsible Innovation**, which will be discussed in Chapters 5 and 9. The approach of responsible innovation is to encourage innovators to work together with stakeholders during the research and innovation process, to better align the (expected) outcomes of innovation with the values, needs, and expectations of society. **Design for Values** is a systematic approach to addressing values of moral importance in (engineering) design. Both Responsible Innovation and Design for Values are in line with the demands for active responsibility, discussed in this chapter.

Constructive Technology Assessment (CTA) Approach to Technology Assessment (TA) in which TA-like efforts are carried out parallel to the process of technological development and are fed back to the development and design process.

Responsible Innovation Approach that stimulates innovators to work with stakeholders during the research and innovation process, to better align the (expected) outcomes of innovation with the values, needs, and expectations of society.

Design for Values Approach that aims at integrating values of ethical importance in a systematic way in (engineering) design.

What are the implications of the social context of technological development for the responsibility of engineers? In one sense, it diminishes the responsibility of engineers because it makes clear that engineers are just one of the many actors involved in technology development and cannot alone determine technological development and its social consequences. In another sense, however, it extends the responsibility of engineers because they have to take into account a range of stakeholders and their interests. Engineers cannot just as technocrats decide in isolation what the right thing to do is, but they need to involve other stakeholders in technological development and to engage in discussions with them.

1.7 Chapter Summary

In this chapter, we have discussed the responsibility of engineers. The notion of responsibility has different meanings. One sense of responsibility, accountability, implies the obligation to render an account of your actions and the consequences of these actions. If you are not able to give a satisfactory account, you are blameworthy. Usually four conditions need to apply in order to be blameworthy: causal contribution, wrong-doing, foreseeability, and freedom. In addition to accountability and blameworthiness, responsibility has an active component relating to preventing harm and doing good.

There are two main grounds of responsibility: the roles you play in society and moral considerations. Engineers have two main role responsibilities, one as engineers, the other as employees. As engineer you have a professional responsibility that is grounded in your role as engineer insofar as that role stays within the limits of what is morally allowed. Three professional ideals of engineers were examined as potential parts of the professional

responsibility of engineers: technological enthusiasm, effectiveness and efficiency, and human welfare. The first two ideals are not always morally commendable and can in fact even become immoral when pursued in the light of immoral goals. The third ideal is morally laudable and, therefore, part of the professional responsibility of engineers.

Your professional responsibility as an engineer may sometimes seem to conflict with your responsibility as an employee. We have discussed three models for dealing with this apparent conflict: separatism, technocracy, and whistle-blowing. Separatism implies that the professional responsibility of engineers is confined to engineering matters and all decisions are made by managers and politicians. The disadvantage of this model is that engineers may end serving immoral goals and lose sight of the engineering ideal of public welfare. Technocracy means that engineers take over the decision power of managers and politicians. One disadvantage of this model is that engineers do not possess the expertise on which to decide for others what human welfare is or what is safe enough. Another disadvantage is that this model is paternalistic. Whistle-blowing means that you, as an engineer, speak out in public about certain wrong-doing or dangerous situations in a company. Although whistle-blowing may sometimes be required it is not a very attractive model for the relation between engineers and managers. Instead of any of the three models, it might be better to work on a relation between engineers and managers that is more cooperative and mutually supportive, such as a model in which engineers think about broader issues than just engineering decisions but do not decide on these issues alone.

The responsibility of engineers is further complicated by the social context of technological development. Apart from engineers, a whole range of other actors is involved in technological development. This diminishes the responsibility of engineers as their causal contribution to technology and the foreseeability of consequences is diminished. At the same time, it introduces additional responsibilities, because engineers also need to take into account other stakeholders and their interests in the development of new technologies.

Study Questions

1 What are the five features of active responsibility according to Bovens?
2 What is the difference between passive and active responsibility?
3 What criteria (conditions) are usually applied when deciding whether someone is passively responsible (blameworthy) for a certain action and its consequences?
4 According to Udo Pesch (2015), Constructive Technology Assessment (CTA) and Design for Values are methodologies that can be used to identify the contours of a framework for active responsibility of engineers. Explain why the methodologies CTA and Design for Values can help foster active responsibility.
5 Suppose one person's actions have led to the injury of another person. What additional criteria must be satisfied in order to imply that the first person is passively responsible for the injury?
6 Consider the following situation: An engineer who has been involved in the design of a small airplane for business travel, type XYZ, finds out that they used the wrong software to calculate the required strength of the wing. They have used a standard software package but now realize that their package was not fit for this specific type of airplane. The very same day they find this out, a plane of type XYZ crashes and all four passengers die. The investigation shows that the plane has crashed due to an inadequate design of the wing.

Do you consider this engineer responsible for the plane crash and the death of four people? (If you think there is not enough information to arrive at a judgment, indicate what information you would need to make a judgment and how this information would affect your judgment.)

7 In general, nobody will want to deny that engineers have an active responsibility for technologies they design and/or work with. In practice, however, many engineers find it problematic to act on this responsibility. Describe three problems for the idea that engineers should take responsibility for technologies and give a concrete example of each problem from engineering practice.
8 Explain what is meant by "separatism," and explain why the tripartite model illustrates separatism so well.
9 Why is it so difficult to steer technological development?
10 Explain why the ideal "public welfare" in professional ethics is the most important one for engineers from a moral perspective.
11 Look for an example of technological enthusiasm in your own field of study. Would you characterize this enthusiasm in this case as morally commendable, morally reprehensible, or just morally neutral? Argue your answer.

Discussion Questions

1 How serious does a wrongdoing have to be that it creates a moral obligation for an engineer to blow the whistle in spite of the very negative consequences for the engineer, such as dismissal?
2 Do you agree with Ceva and Bocchiola (2019) that whistle-blowing is an issue neither of personal morality nor professional duty, and that whistle-blowing isn't something that is heroic?
3 Can companies, as contrasted to people, be morally responsible? In what sense are companies different from people and is this difference relevant for moral responsibility?
4 What would you, as an engineer, have done if you had participated in the meeting in 2006 where the decision had to be made whether to use the cheating software in the Dieselgate scandal?
5 Give an example in engineering practice, and explain what is meant by "moral responsibility" in that example and how it extends beyond role responsibility.
6 As was already mentioned in the case Challenger (see subsection 1.5.1), Roger Boisjoly said – several months after the disaster – the following: "I must emphasize, I had my say, and I never [would] take [away] any management right to take the input of an engineer and then make a decision based upon that input … I have worked at a lot of companies … and I truly believe that … there was no point in me doing anything further [other] than [what] I had already attempted to do" Goldberg (1987, p. 156). Explain why this fits the term "separatism", and do you think Boisjoly's separatist argument is sound?

Notes

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12 Text from the number "Wernher von Braun" by Tom Lehrer that featured in his album *That was the year that was* (1965).
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21 We will discuss the reasons for this assumption in more details in later chapters.
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