Ethics in engineering and research

Applying ethics in fields like engineering and research poses new challenges. In this chapter, we'll take a look at what specific challenges this actually poses, and how they can be solved.

1 Ethics in engineering practice

Although some people may believe otherwise, technological developments raise a whole range of ethical issues. (Think, for example, of the cloning of people, and privacy issues related to surveillance systems.) Therefore, engineers need to be able to make ethically responsible decisions. And, no matter what some people might say, engineers will always be (at least partly) responsible for what is done with technologies that they have developed.

1.1 Ways for engineers to influence effects of technology

Some engineers think that they are relatively powerless in influencing the eventual effects of the things they develop. But the truth is that engineers make a lot of smaller choices that do matter from an ethical point of view. Let's take a look in what ways engineers can influence the effects of technology.

The first way in which engineers can influence the effects of technology, is through **requirements**. This is because requirements form the foundation of the design of a system. By setting the right requirements, engineers will be able to influence the effects of the developed product/technology. Important requirements related to moral issues concern safety, human well-being, animal well-being, welfare, privacy, justice, sustainability, environmental care, and so on.

A second way to apply influence is through engineering design. **Engineering design** is defined as the process in which certain goals/functions/requirements are translated into a blueprint/artefact/system/service that can fulfill these functions. A design often has several (partially) conflicting requirements. During the design process, decisions are made about the relative importance of these requirements. (For example, do we add extra mass to a car to increase safety, thus reducing its sustainability?) Again, the engineer will be able to influence the effects of the developed technologies.

The third topic we will look at is the **trade-off**. Engineers usually have to choose between different alternatives that fulfil the same or similar functions. In engineering practice, there are several ways to choose between alternatives. Let's look at a few options.

- The **cost-benefit analysis** is a utilitarian method. The social costs and benefits of all options are compared, and the option with the largest net social benefit is chosen.
- When using a **multi-criteria analysis** we give scores to all alternatives on a set of criteria. These criteria theirselves also may have different weights. Eventually, the option with the highest overall (weighted) score is chosen.
- We could **set a threshold** (or a minimum value) for every criteria. Each design that meets all the thresholds is considered satisfactory. Although no trade-offs have to be made, it may now occur that the analysis will result in multiple options, or no options at all.
- An alternative to the above three options is to simply **look for new alternatives** that perform better on all design criteria. This method does require a lot of creativity though.

Which of the above method is best suited depends on the situation.

1.2 Risks

Technologies often have unintended and undesirable side-effects. If such a hazard is known beforehand, we usually speak of a **risk**. In fact, risk is usually defined as the product of the probability of an undesired event and the effect of that event. Making safe technologies, by reducing hazards/risks, is an important ethical duty of engineers. So how can we reduce risks?

- We can make an **inherently safe design** that avoids dangers. Sadly, this is not always possible.
- We can apply **safety factors**.
- We can use **negative feedback**. When a device fails or an operator loses control, a negative feedback mechanism can make sure that the system is shut down, thus preventing it from doing serious damage.
- We can install **multiple independent safety barriers**.

In general, risks should be as small as possible. But, reducing risks is not always feasible or desirable. If the cost of a small risk reduction is, for example, very high, then it may not be worth while.

It must also be kept in mind that risks are hard to compare. First of all, not all risk assessments are equally reliable. Secondly, risks are often multidimensional. (Although a risk can be expressed in a one-dimensional number, the consequences may concern several fields, like human fatalities, property damage, environmental damage, etcetera.) Thirdly, the question is whether people voluntarily take risks. Next to this, also the benefit of taking the risk matters. Finally, it is important to check whether there are any available alternatives.

1.3 Scripts

Scripts are certain prescriptions that are built into technical products. These prescriptions influence how people behave and/or how they perceive the world. Some scripts may **exclude** groups of people from using the product. This is often the case when certain presuppositions about the users of the product have been made. (For example, in the case of a can opener, a presupposition about the strength of the user is made. Elderly people might not satisfy this presupposition and can thus not use the product.) This actually may become problematic when people are excluded from a certain vital service/product for which no affordable alternatives are available.

Scripts can also be used to **moralize users**. (An example here are automatic seatbelts. A car will not start, until the automatic seatbelts are used.) Such scripts have a positive effect: they may improve, for example, the safety of a product. However, they also limit the freedom of the user. When choosing to apply a script, the engineer has to wonder whether the advantages outweigh the disadvantages.

2 Responsibilities for research integrity

2.1 Responsible scientific research

To improve our technologies, we have to do research. Performing research in an integer way is very important. In fact, every researcher has the responsibility of **research integrity**. Research integrity encompasses several things: deal fairly with others, be honest about your methods and results, protect the welfare of research subjects, ensure laboratory safety, protect the health/safety of the public, and so on.

Still, things occasionally tend to go wrong in research. Only in very rare cases is this caused by **deliberate wrongdoing**. Instead, **honest mistakes** are much more common. To prevent such mistakes, often peer reviews are held before scientific work is published. Also, some researchers like to replicate their results, to make sure no errors have been made. However, this is of course not always possible.

2.2 Research misconduct and fraud

Let's suppose that we are dealing with **research misconduct**: research has been done in a non-integer way. First, we have to ask ourselves, what actually counts as research misconduct? Research misconduct only covers wrongdoing related to scientific research. Three main acts can now be distinguished.

- **Fabrication** is the making up of data or experiments. This is often done by people who believe to know what the outcome of experiments will be, but (for some reason) can't wait for the results. Only in very rare cases does one use fabrication to support a conclusion which he himself doesn't believe to be true.
- **Falsification** is the changing or misrepresenting of data or experiments. This is often caused by **data selection**. In scientific research, certain experiments often need to be discarded. (For example, when measurement inaccuracies have occurred.) This data selection should be done legitimately: the method of selection should be clear and objective. If, on the other hand, the researcher only takes the measurements that support his hypothesis, he is **'cooking the data'**. The goal of this generally is to improve the strength of the evidence of the researcher.
- **Plagiarism** is the representing of the work or ideas of another person as one's own.

There are often discussions whether other serious deviations from accepted practices should also be considered as research misconduct. However, if this would be the case, then any novel/unorthodox research would be considered as research misconduct. Thus, innovation is suppressed. And this is undesirable. As such, research misconduct generally only consists of the above three acts.

Next to research misconduct, there is also **fraud**. Although fraud is often used to describe research misconduct, there is a difference. For fraud to be present, there should first be a person that intends to deceive others. Next to this, damage also has to be caused by this deception. Only when there is both deception and damage, do we speak of fraud.

Another method of deception is a **hoax**. The goal of a hoax is to deceive others only for the sake of deceiving them. However, hoaxes are rare in engineering and science.