What can be done to improve the ethical decisions made by engineers?

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Abstract

We can improve the ethical decisions made by engineers by altering what information they perceive as relevant when making their decisions. If we want engineers to make better ethical decisions it is essential that they can “see” ethically pertinent information. We can think of how engineers view the world as shaped in two ways; the narratives that they use to define the world and the metaphor of photographic vision. Narratives shape engineers’ thinking and decision making by suggesting that certain roles and beliefs about the world are true. This can lead to filtering - as a result of the narrative the engineer believes that certain information can be safely ignored. Photographic vision (metaphorically viewing the world through a camera) demonstrates that with the limited human ability to perceive information we lose potentially important information as a result zooming past it, zooming too far out to see the detail and by filtering out particular types of information, or by focussing on the wrong parts.

Engineers’ perception of what information is pertinent is influenced by their view on what an engineer is, or should be, along with their experience as an engineer and their engineering education. We can alter this perception by changing the environment they experience (professional and educational), by providing them with new information, highlighting information they already have, and by encouraging personal reflection. Encouraging engineers to develop narratives of engineering as a profession, with an awareness of their role as risk imposers and as constituents of professional bodies can alter how they approach their decision making. Developing new ways to describe what an engineer does will provide educators with a different understanding of their role which can influence how future engineers are taught.

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1 Introduction

In this thesis I argue that we can encourage engineers to make better ethical decisions by influencing what they see when they are making those decisions. We do not consider all the information that is potentially available to us when making decisions. Some of the information is "invisible" to us. If we want engineers to make better ethical decisions, it is essential that they can see the ethically pertinent information.

1.1 Why ask this question?

Over recent years the profile of ethics in engineering has been steadily rising, as can be viewed by the formulation of a "Statement of Ethical Principles" by the Royal Academy of Engineering and the Engineering Council UK in 2005 (Royal Academy of Engineering, 2007). The Engineering Council UK now requires that engineering courses teach "economic, social, and environmental context" including environmental and legal considerations, and the "understanding of the need for a high level of professional and ethical conduct in engineering." (Engineering Council UK, 2008, p. 13) in order to be accredited. Accreditation is important because an accredited qualification is necessary in order to become a chartered engineer.

Despite this recognition of the importance of ethics in engineering, anecdotal evidence suggests that there are engineers and engineering students who are resistant to ethics being taught to engineers, offering reasons like; ethics is not a consideration in their field; it is just "common sense"; ethics cannot be taught; or that ethics is not for engineers to consider.

Engineering ethics textbooks seek to illustrate the ethical issues being discussed by reference to case studies. These case studies often tend to be examples of wrong doing. One example is the Challenger accident discussed further on. This focus on engineers "getting it wrong" could lead one to think that engineers are generally making very poor ethical decisions, but this is not a fair or justified conclusion. We look to improve a situation, not because it is dire, but because we can appreciate that better might be possible.

Engineering projects can have a wide-ranging impact, as some of the case studies in the thesis will demonstrate, and the implications of poor engineering decision making can be devastating. If we can improve the ethical decisions made by engineers then we can avoid potential future disasters. But more than that, improved engineering decisions can contribute to the enhancement of people's lives both by improving recognisably poor conditions (e.g. lack of clean drinking water) and as we respond to new and unfamiliar challenges (e.g.

climate change). The approach that this thesis takes suggests that improvement can come in light of reflection on what engineers do, can do, and how they can and should do it. This in turn may open opportunities for engineers to appreciate the possibility of their work in new and powerful ways.

1.2 Approaches to the thesis question

Not all poor decisions are the same. For example, some decisions are poor because they are made without important information, some are poor because they do not treat the information appropriately and some are poor because the decision maker is unduly influenced by other factors (e.g. personal gain).

Different causes of poor decisions may require different approaches to create improvement. The focus of this thesis is the way that engineers view the world and their role in it. By altering engineers' vision so that they can see ethically pertinent information we can improve those decisions where key ethical information was not considered.

In chapter two I argue for an approach to improving decisions that does not need to result in the improvement of all poor decisions. Instead of a universal approach to all types of poor decision making I am offering one specific approach to one particular problem.

1.3 Photographic vision

Michael Davis describes specialists as having "microscopic vision" (Davis, 1998). As I will explain in chapter two, the view that they have of the world when working as a specialist is like looking down a microscope. They can see a small amount of information in great detail, but run the risk of missing all information that could be seen by looking up from the microscope. I expand this analogy by considering a camera, (the corollary to 'microscopic vision' being "photographic vision"). From the normal vision of 1:1 scale we can zoom in (as with a microscope) and we can zoom out to see a whole city, country or continent (macroscopic vision). Recognising this means that we acknowledge that we could be functioning at any level of magnification (rather than the two Davis discusses – down the microscope or looking up from it).

In addition we can also filter potential information (think of a colour filter that limits the colours that reach the camera film). This metaphor emphasises that we do not see all the information that is there to be seen[1]. When it is used well we can see the useful bits very clearly and it allows us to make decisions quickly and accurately. When it is used poorly,

[1] An introduction uses macroscopic vision, we can review the whole thesis in a single chapter. Doing so allows us to appreciate all the elements involved and how they inter-relate but by doing so we lose the detailed argument.

important information that was relevant to the decision at hand can be lost, with significant and sometimes devastating consequences. We can lose information because we were operating at a scale that rendered it invisible (either by making it too small to see, or zooming in so much that the particular piece of information is no longer in our field of view). We can also lose information by filtering it out, or by focussing so much in one place that we fail to consider other relevant information. (For my purposes focussing is also a form of filtering, but not necessarily one we would consider when describing “filtering out” information). In both cases (scaling and filtering) photographic vision is constant. We would find it odd to think that we were operating ‘without scale’; we recognise that we are working on a 1:1 scale when viewing the world with our ‘naked’ (or vision-corrected) eyes. I will argue that filtering is an equally constant state by suggesting that the absence of filtering can be described as the information overload which can be experienced by people with autism.

I will demonstrate that we can use the metaphor of photographic vision to explain some engineering decision failures by recognising that the decision maker made their choice without considering one or more key pieces of information. The information was theoretically available to them (they could have known it etc.) but they did not perceive it as relevant to the decision at the time. By identifying poor photographic vision as a mode of engineering failure I argue that improving photographic vision can lead to improved ethical decisions. Some methods for increasing the likelihood of engineers recognising the right information at the right moment are discussed and evaluated in chapter five.

In chapter three I will focus on Gary Klein’s description of the role of expertise in decision making (Klein, 1998). The distinction between an amateur photographer and an expert is that an expert knows what lenses and filters to use. Within the context of the photographic vision metaphor this translates as knowing information can safely be left out (which filters to use) and what scales will clearly reveal the necessary and relevant information (the correct magnification lens and zoom). I will argue that we develop our filters and scales in response to our environment and are likely to struggle to appreciate what is and is not relevant when we are faced with a new situation. From this I will say that in supporting engineers to develop photographic vision that includes ethical considerations our focus is on helping them to develop the skills to choose the right filter and scale. I will also argue that we can safely filter certain information out by making assumptions about our environment. But this carries with it a risk, because the environment may change, and the view through the camera may look no different. I argue that engineers have an obligation to double check that their working environment has not changed in order to avoid missing potential ethical concerns.

1.4 Understanding alters an engineer's specialist vision

I will also argue that in addition to the photographic vision metaphor we can consider engineers' vision as enhanced in particular ways beyond that of a layperson. I will use a comparison with reading a foreign language to suggest that specialist understanding can enhance what information we can see as well as informing us which filters to use. Unlike the filtering case, this implication of specialist vision is that there are additional forms of specialist sight that do not imply a sacrifice of other information.

I will also argue, in chapter six, that the role of the engineer is important to determining what information the engineer should reliably and consistently see because the engineer has duties to others and the public that affect what is important to their decision making.

1.5 Metaphors structure our understanding and actions

Lakoff and Johnson argue that our thoughts, language and action are significantly structured by metaphors (Lakoff & Johnson, 1980). The metaphors that we use to describe a role influence how we perform in that role. Metaphors hide and highlight particular pieces of information. The photographic vision metaphor highlights the limitations of information perception and the possibility of losing key information.

If the current narratives of engineers (how they describe their role) contain metaphors that do not highlight ethical information, but rather hide it from view, engineers will find it very difficult to realise that there are ethical implications that they should be considering in their work.

1.6 Narratives

We use narratives to make sense of the world around us. We recognise that we fulfil particular roles with particular actions and duties that are associated with them. We expect these roles to progress in particular ways. There are life narratives (or narratives that cover part of life) that are so well known that to name them is to recognise the narrative – rags to riches, the gold digger, the American dream (Lakoff, 2008).

I will argue that we use narratives to make sense of the world and our place within it. We use different types of narratives for different purposes, some to describe and judge the value a life, some to enable us to consider the implications of information and evaluate potential courses of action ("how did this happen and what might happen next") (Klein, 1998) and others to evaluate the desirability of future courses of action (Beach, 2010).

Understanding the world through narratives is an empirical statement about how our brains work (Lakoff, 2008). We are limited by our computational ability, by our access to information and by the time that we have to make decisions. Proponents of bounded rationality (Gigerenzer & Selten, 2001; Simon, 1990) support the claim that we can make good decisions in these circumstances because we can develop strategies that allow us to look at a much smaller number of key pieces of information when decision making in an established and familiar environment.

Because we are already working with an understanding of the world that is shaped by our existing narratives we can improve the ethical decisions that engineers make by developing narratives that help them to recognise when ethical content is pertinent to their decision making. Rather than attempting to suggest that engineers should not think in narratives, I propose that we acknowledge this pattern of thinking and find ways to ensure that the ethical ideas we wish engineers to be familiar with are compatible with the structure of narrative thought.

Our narratives influence our photographic vision, because our narratives also serve to hide and highlight particular information. We can improve the information available to the engineer metaphorically looking through the camera by emphasising particular pieces of information as particularly important (such as the “think bike” campaign designed to raise car drivers awareness of motorbikes), or by developing a different narrative of what it is to be an engineer and how the world works, which will bring with it a change in photographic vision.

As I will discuss in chapter three, determining which narratives an engineer currently holds can be hard, because people aren’t always aware of their own narratives. In chapter five, I will look at some of the beliefs that can be imbedded in narratives that make it difficult for the engineer to understand why studying ethics is a valid and useful thing to do (I will refer to these beliefs as “roadblocks”). In chapter seven, I will consider an additional challenge that students face when studying ethics because they struggle not only to engage with something that looks so different from engineering science, but also because they are operating without a full awareness of what an engineer does.

1.7 Improving the ethical decisions made by engineers

I will argue that we can approach altering photographic vision and narratives in similar ways and that improving either can improve the ethical decisions that engineers make, that narratives and photographic vision are linked and that improving one may also lead to improvements in the other. In chapter five, I will propose that we can alter narratives and photographic vision by (1) changing the engineering environment (e.g. policies and assessment criteria), (2) presenting new information (or presenting existing information so that it highlights something new) and (3) encouraging the engineers to engage in personal reflection and we do this by debating, discussing and engaging with the public.

Chapter five also includes a discussion on the importance of engineer engagement, which is necessary for stimulating individual reflection. Engagement can be challenging to achieve where the engineer's pre-existing filters and narratives make it hard for the engineer to see the value of ethical discussion. I suggest some practical considerations that we need to consider when encouraging engagement with engineers, including an awareness of their existing views and narratives, the importance of well-rooted engineering examples and a progressive focus that places more engaging topics earlier in the process.

In chapter five I will also consider some roadblocks to engagement; arguments (primarily given by students) that act as strong filters which hide the ethical considerations that we want to discuss. E.g. "Ethics is just opinion", "ethics has nothing to do with engineering", "talking about ethics is pointless". They are roadblocks because they prevent any further ethical engagement until they have been considered. As I note below, establishing the intended argument of the speaker is not always easy because the statements can often carry unexplained implications. For each roadblock I offer a counter-argument and in some cases where the implications are unclear more than one. But as I note in the chapter, sometimes it is possible to pre-empt to the roadblocks before they arise.

1.8 Understanding leading to improved decision making

Understanding changes what we see because it enriches the information that is available to us. If we have now passed the roadblocks to ethical discussion we can provide engineers with some understandings that will enhance their perception of the ethical components of their decisions.

In chapter six I offer three descriptions of engineering and engineers that could alter how engineers perceive their role and actions (which have implications for their choice of narrative). (1) Engineering is a profession because of what engineers do and how it affects the public and this implies that there are duties for an individual engineer. (2) Engineers are risk imposers whose decisions impose risk and benefits on the public and that this can be characterised as social experimentation without the ability to gain informed consent. (3) Engineers can be members of professional bodies and that this is a way to respond to some of the ethical duties and issues an engineer should consider. In this last section I will also consider different approaches to engaging with the profession, examining the case of Albert Speer.

1.9 Implications for Engineering Education

During their time at university, students are gaining the expertise that they will use as practising engineers. That expertise includes the form of photographic vision appropriate to their specialisation (by the end of their course they should be familiar with the type and level of information that they need to include, as well as that which can safely be left out. We can characterise this using the camera metaphor as knowing which scales and filters clearly show them the information that they require).

In chapter seven, I argue that there are occasions the the engineer’s photographic vision should show ethical considerations because they could significantly alter the course of action chosen and that this should be taught at the same time as they are developing their expert photographic vision. The alternative to including ethical considerations in teaching is one I call ‘teaching by omission’, where an absence of ethical discussion could be taken by the student as indicating that ethical considerations can appropriately be filtered out before making a decision.

In chapter seven I also discuss the implications of narratives of what it is to be a student, the non-exclusive nature of engineering training in the UK, and the initial narratives students have about what an engineer does.

1.10 The Contribution of the Thesis

Davis’ microscopic vision offers us an intuitive metaphor for understanding the effects that specialist knowledge and skills have on the way that we see the world. The metaphor highlights the information sacrifice that can occur when functioning in a specialist area and the implication that poor ethical decisions can be made if one fails to look up from the microscope.

I have expanded on Davis' idea of microscopic vision, to include a wider range of metaphors, including scaling, focussing and filtering. This allows us to appreciate how it is that engineers can lose information that is important. Recognising the previously implicit distinction between scaling and filtering shows us that there are different failure modes within our limited vision and that there are multiple checks that might need to be performed to determine that all the relevant information has been considered.

I have identified several different narratives that can be used to describe what an engineer is and what he or she does. Supporting particular narratives and challenging others not only alters how engineers see the world and their place in it, but also alters how they approach the tasks of engineering and will affect the way potential future engineers view the profession and evaluate it as an appropriate career choice. Included in some of these narratives is an awareness of what it means to belong to a profession and be a professional. The narratives also serve to highlight the impact that engineers have on the world in a way that can cause them to alter their photographic vision.

The characterisation of engineering education as specialist vision formation is itself vision altering. It offers us an additional perspective from which to consider engineering education. Because metaphor affects our actions, it also offers educators a new way of understanding and performing their role.

2 Fox and Hedgehog

The purpose of this chapter is to establish and justify the approach taken to answer the thesis question; “What can be done to improve the ethical decisions made by engineers?”

I will consider two possible approaches to resolving it, a unified moral theory approach and a case by case approach. I reject the unified theory approach, not as impossible, but as poorly suited to the requirements of the thesis question that focuses on producing practical outcomes that can be employed by engineers. This is because there are a number of questions that remain unanswered in producing a single unified moral theory, given where moral theories currently stand, and the separate but related issues of then applying that theory correctly (especially given the limited ethics knowledge of many engineers).

The case by case approach, where individual cases or ethical issues that are faced by engineers in their professional capacity are considered and resolutions and improvements suggested, is better suited because it leads more directly to the type of action required. It is, however, a more limited approach because it can offer no improvement to some causes of poor decision making.

2.1 Two approaches to the thesis question

In considering possible approaches to answering the thesis question we can use a distinction made by Tony Hope.

> The philosopher and cultural historian, Isaiah Berlin, begins an essay on Tolstoy with the following words:
>
> > There is a line among the fragments of the Greek poet Archilocus which says: “the fox knows many things, but the hedgehog knows one big thing”.
>
> Berlin goes on to suggest that, taken figuratively, this distinction between the fox and the hedgehog can mark “one of the deepest differences which divide writers and thinkers, and it may be, human beings in general.” The hedgehog represents
>
> > those who relate everything to a central vision, one system less or more coherent or articulate, in terms of which they understand, think and feel – a single, universal, organizing principle in terms of which alone all that they are and say has significance.

The fox represents

> Those who pursue many ends, often unrelated and even contradictory, connected, if at all, only in some de facto way... [who] lead lives, perform acts, and entertain ideas that are centrifugal rather than centripetal... seizing upon the essence of a vast variety of experiences... without... seeking to fit them into... any one unchanging, all-embracing... unitary inner vision. (Hope, 2004, pp. 4-6)

The two alternatives that Hope puts forward for solving different problems in his field (medical ethics) are a “single moral theory” (hedgehog) or a case by case approach (fox). I intend to consider the value of both approaches in answering my thesis question, arguing that the case by case approach is better suited to my ends.

2.2 Moral theory – ‘the hedgehog approach’

One could approach the thesis question by establishing a single moral theory and using that to determine what can be done to improve the ethical decisions made by engineers. Let us first consider the possibility of creating a single moral theory[2].

> A moral theory is “a comprehensive perspective on morality that clarifies, organizes, and guides moral reflection. If successful, it provides a framework for making moral choices and resolving moral dilemmas – not a simple formula, but rather a comprehensive way to identify, structure and integrate moral reasons” (Martin & Schinzinger, 2005, p. 54).

A successful theory would then lead us closer to an answer to the thesis question by determining not only the correct course of action an individual should take on any given occasion, but also what approach should be adopted in seeking improvements in a given field of action. For example, establishment of a form of utilitarianism[3] could suggest the answer on how to improve engineering ethical decisions to be whichever combination of outcomes leads to the greatest increase in utility. So that the moral theory not only covers the questions of “what should I do now” but the more general questions of “what is the best way to approach engineering ethical decisions” and “what should be done to improve engineering ethical decisions”.

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[2] The moral theories mentioned in the textbooks are all examples of moral theories. The reason that I talk of a “unified moral theory” is that there is wide-ranging disagreement on which theory is right.
[3] See Section 2.4 for a definition and discussion of utilitarianism.

2.3 Moral theory and engineering ethics textbooks

Some introductory engineering ethics textbooks directly mention moral theories[4], both generally and specifically outlining several different theories and the approach that they take to determining right action. However, having mentioned these theories briefly[5] they are rarely referenced again throughout the rest of the book. This suggests that it is possible to consider engineering ethics without explicit reference to or consideration of moral theories, but is this the right approach to take?

I will argue that it is, and that for the purpose of this thesis the moral theories do not constitute the best approach to answering the thesis question. As they currently stand moral theories are difficult to apply and it is difficult to be sure that one has applied them correctly. This section seeks to delineate the challenges that would be faced in an attempt to answer the thesis question using the unified moral theory approach.

Fledderman's "Engineering Ethics" (Fleddermann, 2004, pp. 34-38) is a typical example of how moral theories are introduced in engineering ethics text books. Fleddermann divides moral theories into the following groups:-

- Utilitarianism
- Cost-Benefit Analysis
- Duty and Rights Ethics
- Virtue Ethics

By comparison, Martin and Schinzinger's "Ethics in Engineering" (Martin & Schinzinger, 2005, pp. 54-72) offers a more detailed description.

- Utilitarianism
    - Act-Utilitarianism and Rule Utilitarianism
    - Theories of Good
- Rights Ethics and Duty Ethics
    - Human Rights
    - Two versions of Rights (liberty rights and welfare rights)

[4] Some mention ethical ideas more vaguely without specific reference to moral theories e.g. "What every engineer should know about ethics" (Humphreys, 1999) which has 5 pages on "Ethical Terms and Definitions". A few books contain no reference to moral theories in this form e.g. "Engineering Ethics" (Harris, et al., 1995).

[5] In "Engineering Ethics" (Fleddermann, 2004) moral theories occupy 8 of 134 pages; "Ethics in Engineering" (Martin & Schinzinger, 2005) 23 of 325 pages; "Engineering Ethics: An Industrial Perspective" (Baura, 2006) 6 of 213 pages and "The decision makers: Ethics for engineers" (Armstrong, et al., 1999) 1 page on moral theories and 16 other pages on "general principles" of 156 pages.

    - Duty Ethics
    - Prima Facie Duties
- Virtue Ethics
    - Virtues in Engineering
    - Florman: Competence and Conscientiousness
    - Aristotle: Community and the Golden Mean

I appreciate that these terms may be very unfamiliar to engineers. Where a theory is mentioned in any detail further into the chapter an explanation is included. What I wish to observe here is that whilst Martin and Schinzinger present some degree of consideration of the different theories under each “umbrella” term, both these descriptions are relatively simple versions of complex differences in theories.

The brevity of these descriptions will mean that a notable degree of nuance of understanding must be absent. I suggest that these broad definitions mean that they are not very useful to particular engineering decisions. This appears to be corroborated by the scarcity of references to these theories in the textbooks; the textbooks proceed to discuss individual cases and issues without referencing the theories again.[6] I will argue that direct application of a moral theory is not the best approach to answer my thesis question. However, since one could reasonably argue that all this demonstrates is that for theories to be useful they require detailed definition, all I wish to observe for the textbooks is that the broad definitions of the textbooks make it difficult to apply the theories to engineering decisions. Whilst it is possible to draw some value from this level of description (I might be able to say, “What might a utilitarian think was relevant in this decision?”) the broad nature of the descriptions of the theories as presented means that it is very difficult to apply them to an actual decision. (An engineer is unlikely to be able to say from these descriptions, “in this situation, a virtue ethicist would do X, a deontologist would do Y”.) If the value of an ethical theory is that it can be used as a decision tool, then these descriptions offer an engineer little to work with.

As an example of these difficulties, let us consider the description of virtue ethics provided by Fleddermann.

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[6] In “Engineering Ethics” (Fleddermann, 2004) an index search returns the following number of references for each term: utilitarianism – 4; cost-benefit analysis – 6; duty ethics – 4; rights ethics – 4; virtue ethics – 3.
In “Ethics in Engineering” (Martin & Schinzinger, 2005) the index search is as follows: utilitarianism – 15; rights ethics – 15; duty ethics – 10; virtue ethics – 19.
“Engineering Ethics: An Industrial Perspective” (Baura, 2006) has no index entries for any of the four terms.
“The decision makers: Ethics for engineers” (Armstrong, et al., 1999) does not have an index.

> "Fundamentally, virtue ethics is interested in determining what kind of people we should be. Virtue is often defined as moral distinction and goodness. A virtuous person exhibits good and beneficial qualities. In virtue ethics, actions are considered right if they support good character traits (virtues) and wrong if they support bad character traits (vices) (Schinzinger & Martin, 2000). Virtue ethics focuses on such words as responsibility, honesty, competence, and loyalty, which are virtues; and dishonesty, disloyalty, and irresponsibility, which are vices. As you can see, virtue ethics is closely tied to personal character. We do good things because we are virtuous people and seek to enhance these character traits in ourselves and in others." (Fleddermann, 2004, p. 38)

In the following three paragraphs Fleddermann mentions that although this may appear to be a theory better suited for business ethics, one should not separate engineering and business ethics in this way. He states that virtue ethics can be used in engineering "by answering questions such as: Is my action honest? Will this action demonstrate loyalty to my community and/or my employer? Have I acted in a responsible fashion?" Finally he considers that there is a possibility of misunderstanding what a virtue is, "it is important to ensure that the traits you identify as virtues are indeed virtuous and will not lead to negative consequences."

Let us take what this description says about ethical behaviour and apply it to an engineering decision.

> As a new engineering graduate you are offered a job with ABC Defence Company, in a unit developing new radar to target enemy soldiers and vehicles on the battlefield. You must decide whether or not to accept the job.
>
> Adapted from (Fotheringham, 2007)

In order to decide whether or not to accept the job, consider the virtues that you should display in this situation. These may include justice, truthfulness, loyalty, responsibility and compassion. In this case, if you choose to take the job, you should then be demonstrating loyalty and responsibility to your employer, such that you seek to do your job well. If you do not think that you could do the job well then you should not accept it. However, compassion is also a virtue, and here the question is, towards whom should you be compassionate? If you are compassionate towards enemy soldiers it is unlikely that you would accept a job that brings harm to them, if you are compassionate towards your own soldiers you might want to do all you can to help keep them safe. In terms of responsibility, you may also have responsibilities towards people outside of the company or military, you may have a responsibility to support a family for example.

As can be seen, this application does not lead us to a definite answer, to a process that engineers can apply consistently and produce consistent results, different engineers could read the descriptions above and reach different conclusions about the right thing to do. As discussed below, this does not suggest that ethical theories are without value in engineering, but does suggest that this simplified presentation of them is not of much support to engineers in assisting with their decisions.

2.4 Achieving a usable theory

There is an obvious objection to giving the type of list above of ethical theories to engineers as a way of improving their ethical decision making, which is that there is no attempt to determine which of these approaches to determining right action the engineer should adopt.

If broad definitions, such as that given above, do not offer us a detailed guide to correct moral action, this does not mean that such a guide is not achievable. My purpose is to suggest some of the distinctions that are not considered in engineering ethics text books which would need to be to some degree determined before a clear moral theory emerges.

These broad terms are sufficiently wide and used to refer to so many different theories that even establishing one of them as the correct approach does not offer us a single theory. For each of these "umbrella" terms (e.g. utilitarianism, virtue ethics etc.) there are distinct theories, which can be at odds with each other. As an example, let us consider just the brief reference made by Fleddermann to "Utilitarianism". Fleddermann defines Utilitarianism as 'hold[ing] that those actions are good that serve to maximise human well-being' (Fleddermann, 2004, p. 34)

Firstly, utilitarianism is a form of consequentialism. By not making reference to consequentialism, Fleddermann dismisses a number of possible forms of consequentialist theory (roughly put, that an action is right or wrong based on the consequences of that action, whereas utilitarianism is defined more specifically as holding that an action is right as it tends to maximise human well-being. But a consequentialist theory could be to maximise freedom rather than well-being). Let us assume that we have now accepted that some form of consequentialism is the correct moral theory (in order to move us past the first concern of which "umbrella" term is correct). We are now faced by a number of possible theories, which may in different circumstances suggest that different actions are the right ones for a given situation.

Pettit defines consequentialism as "the view that whatever values an individual or institutional agent adopts, the proper response to those values is to promote them" (Pettit, 1991, p. 231). Working with Pettit's definition there are a number of further questions that must be answered before we are in a position to determine the right course of action associated with a given decision.

Firstly, as seen above it is necessary that we establish which value we ought to promote. Let us consider for the moment that it is utility in order to illustrate the issues to be resolved in the case. Even if we agree on utility we must still do a little more work to understand our value. Even having ignored all other possible values, we are still left with disagreement as to what exactly utility is. Is well-being the same as pleasure? Are all forms of pleasure equal? Bentham argued that utility is "that property in any object, whereby it tends to produce benefit, advantage, pleasure, good, or happiness (all this in the present case comes to the same thing)" (Bentham, 1989, p. 92). Whilst recognising that pleasures vary in intensity, duration, certainty and proximity Bentham argues that no pleasure is better than another, except that it is greater than another (for example it lasts longer, or is more likely to lead to further pleasure). In contrast Mill argues that different types of pleasure should be valued differently, that there are higher and lower pleasures and that we should aim for the higher, "it is better to be a human being dissatisfied than a pig satisfied" (Mill, 2004).

Another common objection to consequentialism is that it is extremely difficult to produce a system of accounting that would allow us to implement this theory. How are we to determine exactly how much utility a given option would create, and how are we to relate the utility of different types of action? (How many people would need to experience how much happiness before this outweighs the suffering of a particular individual?). Resolving this objection is an important part of understanding utility because utility becomes a currency that we can use to compare very different ideas[7].

If we then establish the correct value to promote, we must establish how we are to promote it.[8] We could decide that we wish to promote the value by considering every action independently, weighing the degree to which the value is promoted by all the available options, and then adopting whichever option most promotes (or least fails to promote) our chosen value. However, this may appear to be burdensome, or possibly even counter-productive if the application of the theory in this manner would actually reduce the value we

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[7] For example, utility becomes the currency that allows us to compare the value of a natural environment and the species it contains with the value of access to water created by building a dam.

[8] Fleddermann does make a brief reference to this problem, in that he distinguishes between Act-utilitarianism (where the right action is that which maximises utility in each individual case) and Rule-utilitarianism (where right action is to follow a set of rules which general maximise utility, but may not in an individual case).

seek to promote (if I value utility, I do not necessarily find great utility in time-consuming decisions over how to promote utility). Maybe therefore I would prefer to adopt a rule-based approach, where I establish a list of rules, chosen because in most circumstances they seek to promote utility and act by that approach (generally called Rule Utilitarianism). Alternatively, Pettit suggests that the approach to adopt may be one he calls "virtual consequentialism":

> "Agents are not expected to inspect their behaviour continually, or guide their decision-making, by reference to how well it promotes the neutral values that they countenance. But agents are expected always to be ready to go over to such a self-examining, and potentially such a self-reforming, mode." (Barron, et al., 1997, p. 160)

Having established which value to promote, and what approach to adopt in promoting it, there is at least one stage further that we must go through before we have a theory that we could apply as required. We must now consider maximising versus non-maximising consequentialism. Essentially, this is a definition of "how far" one ought to go in promoting the chosen value. A maximising approach would determine that one should always do that which maximises the value and correspondingly any choice less than this one is not a good choice by that ethical theory. So that, if human well-being (my temporarily chosen value for the purpose of illustration) is maximised by my giving 98% of my income to charities that use it in poorer countries, it is not morally sufficient that I donate only 90% of my income. Non-maximising consequentialism is the view that right action is that which promotes the value, but does not place the stringent requirement that the only right action is that which maximally promotes the value. This leaves the possibility of supererogation – the performance of a morally praiseworthy act that is beyond that which would be expected – under this view if I give 90% of my income to charity I have not only performed a morally praiseworthy act but I have gone beyond what would have been required for a morally right action[9].

As a final obstacle on our path to a correct moral theory, even when we have agreed on the exact form of the moral theory we may still disagree on its interpretation (what does this theory mean and how should I apply it). As an example, in his paper on 'Kant's Normative Ethics', Brad Hooker (Hooker, 2002) discusses Robert Audi's interpretation of Kant's principle of treating others as ends.[10] In response to a contractualist approach (according to

[9] See Michael Slote (Slote, 1989).

[10] The point I am wishing to consider is that it is possible for two people who hold the same moral theory as correct to disagree about what it means. It is not necessary to have a detailed understanding of Kant's theories, but briefly put, Kant formulated what he called the "Categorical Imperative". Which "tell[s] us what to do regardless of our desires" (Hooker, 2002). In its second form it is an

which we should treat people as ends when we treat them in ways to which they do consent, or would consent under appropriate conditions), Audi suggests that it is not obtaining an individual's consent that treats him as an end rather than a means, but a consideration of his well-being. Where something has only instrumental value we are not concerned if the instrument is damaged, provided that it has performed the required task. Audi thinks that "treating someone as a means consists in treating that person *as if his or her well-being doesn't in itself matter at all"* Hooker says that this could lead to a minimal weighting of the well-being of others and argues "[that] what is needed is *not* just I treat you as if your well-being matter in itself to *some degree*, but that I treat you as if your well-being matters in itself *a lot*" (Hooker, 2002, p. 6).

In this case the problem is not whether Kant's theory of a Categorical Imperative is correct or not, or even if he has formulated the Categorical Imperative correctly. The problem is rather, agreeing about the Categorical Imperative, when would I be treating others as means rather than ends? In fact, in this example there are two levels of interpretation, firstly, whether or not to treat someone as an end I need to gain their consent (or believe that they would give consent) or whether I need to value their well-being. If I value their well-being there are still varying interpretations as to how much I must value their well-being. So, our quest to find the correct moral theory and apply it is not finished until we have a theory that can be understood through an agreed interpretation.

None of these criticisms is fatal to the establishment of any of the theories discussed above. However, what I highlight is that the path to a unified moral theory is a long and complex one in its own right and with little hope of immediate consensus. To say that resolving all the objections discussed above would guarantee an answer to my thesis question is too strong a claim, but that these objections need to be answered or circumnavigated in order to achieve a thesis answer by this route seems plausible. For this reason I suggest that if an alternative method to achieving an answer to the thesis question exists, it may be preferable, as attempting to answer the question by finding a unified moral theory is liable to result in an unfinished thesis.

2.5 The value of hedgehogs

To say that moral theories do not necessarily offer us clear advice in particular circumstances does not undermine the project of searching for a moral theory. The purpose of moral theory might not be to provide a rule book for conduct, but rather to provide a means of reflecting on what we think is right and wrong in a systematic manner. Rather than

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injunction "never to treat rational agents merely as means but rather always to treat them as ends in themselves" (Hooker, 2002).

ask what I should do in situation X, it might instead answer the question, what makes an action right? Nor should what I have said above be taken to suggest that moral theories have no further place in the course of this thesis. I will reference particular ideas drawn from moral theory discussions as they are relevant to the topic at hand.

As will be discussed in chapter four, when we have expert understanding we can see things that are invisible to those without the expertise. Studying moral theories is one way to develop an expert vision that means that you can now see distinctions that are ethically significant that you would not have appreciated before. But, as I discuss in chapter five, developing improved photographic vision sometimes requires the engineer to engage in person reflection. Moral theories are not necessarily instantly understood, or instantly applicable to engineering situations. They represent a source of expert distinctions and some of those distinctions are about recognising the complexity of the subject. The time it takes to understand those complexities and why they are significant can be a barrier to the engineer's willingness to engage.[11]

I propose that a good way to think about the use of moral theories is as a source of language that can be given to engineers as their photographic vision improves to explain and clarify the new information for which they have no previous specialist language. I do not mean by this just an extended vocabulary (we could ask engineers what virtues they should display, what duties they have and what sort of consequences they wish to create), although I realise that these questions might be part of a process of developing ethical thought. The practise of philosophy has been referred to as conceptual engineering, "just as the engineer studies the structure of material things, so the philosopher studies the structure of thought" (Blackburn, 1999, p. 2) and comes with a set of conceptual tools unfamiliar and possibly useful to an engineer. Among these is a rigorous approach to the use of a type language unfamiliar to engineers. Engineers are accustomed to being rigorous in their technical language but complex ethical issues such as duty, moral obligation or informed consent are not typically part of engineer's detailed language. Deeper than the "vocabulary" idea mentioned above this view of language includes concepts of grammar and syntax, that it is possible to create an argument that follows to a conclusion or one that does not.

Along with this language comes a culture, or cultural approach, also potentially valuable to engineers, with its own set of views and expectations, which may focus on considerations (such as societal value) not normally a standard part of engineering decisions. This language

[11] For an argument against the use of moral theories in teaching applied ethics see Rob Lawlor's "Moral theories in teaching applied ethics" (Lawlor, 2007).

and culture, notably different to that of engineering, offers insights that I believe are essential to the development of good ethical decision making.

I suggest that the place of moral theories comes further into the study of ethics than most engineers reach. If one studies enough ethics one will eventually come across moral theories, but given the relatively limited amount of ethics taught to engineers[12] focussing on the distinctions and language we can draw from moral theories are most valuable when time is so limited.

Another hedgehog-like approach, although not one that seeks to create a moral theory as outlined above, is presented by Bowen (Bowen, 2009). He outlines what he describes as an "aspiration approach" to engineering, which highlights the positive and essential role that engineers play in society. He seeks to describe what engineering can be at its best, and what he believes engineers and the engineering profession should be working towards, and believes that focussing on the role and purpose of engineering would lead to a clearer understanding of how engineers should act in response to different ethical issues. (If your analysis determines that the value of engineering lies in its ability to improve human lives, you may find it more difficult to accept a job building weapons.) Engaging in this kind of discussion can open engineers up to ethical concepts, considerations and ideas in a very different way to that which emerges from considerations of case studies. I will consider the narrative of the engineer presented by the aspiration approach in chapter three.

2.6 The fox perspective: a case by case approach

In comparison to the "unified moral theory" approach, it is possible to adopt a case by case approach to solving ethical concerns and issues. Simply put, this is a discussion of an ethical decision or issue without reference to a moral theory. Much ethical debate, particularly in applied ethics, does occur this way. An example of this approach is Singer's argument in his article "Famine, Affluence, and Morality" (Singer, 1972). Singer contrasts one's willingness to save a drowning child at the risk of damaging ones clothes and the general unwillingness to make a similarly small sacrifice to assist people in other parts of the world. In choosing to rescue the drowning child, but not to give aid to poorer countries at similar cost to ourselves we are acting inconsistently, and Singer goes on to reject attempts to explain away the inconsistency. In this case, an argument for a change in attitude towards aid to poorer countries is formulated without obvious reference to a moral theory[13].

[12] A suggestion at the University of Leeds is to aim for the equivalent of 10 credits worth of teaching over four years – roughly equal to 20 lecture hours.

[13] Although Singer is a known consequentialist, most of the arguments in this paper are formulated without reference to the consequentialist position.

Whilst engineering ethics is still a relatively young field of study, there are already examples of engineering ethics being developed on a case by case approach. In fact, this is how the majority of engineering text books approach the issue. There are two major approaches, within the case by case approach available in engineering ethics literature. These are a case-study approach, in which one or more similar case studies are examined in detail and the issue-study approach, where an issue that is commonly recognised as troubling is discussed.[14] I will use Davis as an example of the former, and Martin and Schinzinger as an example of the issue-based approach, both discussed below.

Michael Davis (Davis, 1998) takes a number of cases where engineers have made poor ethical decisions (price fixing, insider trading and the Challenger case where the decision resulted in deaths) and then considers what the problem was - what it was that lead to these decisions. Then he considers what could be done to remove or mitigate the given problem, perhaps changes in the functioning of a particular engineering company, changes in engineers' education etc. All this can be considered without an appeal to moral theory. In fact, Davis' approach is doubly interesting, not only is it a case by case approach, but Davis actually identifies an underlying cause that he claims if solved would reduce the instances of all three kinds of wrongdoing (see below for an explanation of "microscopic vision"). Here the use of case studies in combination not only reveals a common[15] problem but suggests that if this problem is common to these cases then resolving it might bring about changes that would also improve other ethical decisions.

Martin and Schinzinger (Martin & Schinzinger, 2005) consider a wide range of issues that are recognised as part of engineering ethics, including safety, honesty, workplace responsibilities and global issues, among many others. As a specific example they consider the dilemma facing an engineer who is concerned that there is a serious risk (perhaps a safety risk) and that those in more senior management positions are not choosing to act. This engineer is in a whistle blowing situation. The idea of whistle blowing is not a specific case study but rather an issue, most specifically the issue is, what can be done to make sure that this type of information (e.g. where there is a serious risk) is dealt with appropriately, this may manifest itself as concerns about the well-being of whistle blowers (so that people would be willing to blow the whistle) or about how to prevent the need for whistle blowers. This is the approach that I refer to as issue-based, in that it is not primarily the result of the

[14] Issue-based work e.g. whistle blowing, or environmental considerations, often use case studies to illustrate the issue. The distinction is that the analysis is not of the case study directly ("What would be the right thing for Bob to do in this circumstance" but of the general issue "How do we design organisations where whistle blowing is not necessary". Often, the two approaches can reach the same or similar conclusions.

[15] "Common" as in "common to all these case studies" rather than common throughout engineering.

consideration of one or a number of case studies, but of a whole issue, already recognised as such. Although, on occasion, the best way to explore a particular issue is through a case study (e.g. Albert Speer in chapter six).

My thesis will be concentrating on one facet of decision making; the information that the engineer can ‘see’ when they are making their decisions. This is not the only facet of decision making, there are other potential failure modes that I will not be considering, and as such it fits the fox approach outlined here. In focussing on this area of decision making there are several issues that we can consider, including what we want the engineer to see, and how we can influence what it is that he or she does see, so the chapters that follow are not case by case to the extent that they are not intended to be totally independent arguments, but to be interrelated. Nonetheless, the implications for education considered in chapter seven can be implemented independently of any recommendations made to the professional bodies in chapter six.

2.7 Microscopic vision

In “Thinking like an Engineer” Davis considers a number of specific cases where engineering ethical decisions are viewed as flawed and discusses not only why the decisions occurred, but what can be done to improve the situation, such that these decisions would not occur again. One of the cases he considers is the Challenger explosion, outlined below.

> “On the evening of January 27, 1986, Robert Lund, vice president for engineering at Morton Thiokol, had a problem. The Space Center was counting down for a shuttle launch the next day. Earlier that day, Lund presided at a meeting of engineers who unanimously recommended against the launch. He concurred and informed his boss, Jerald Mason. Mason informed the Space Center. Lund expected the flight to be postponed. The Space Center had a good safety record. It had achieved it by not allowing a launch unless the technical people approved.
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> ... Lund was worried about the O-rings that sealed the boosters’ segments... the O-rings were not perfect. If one failed in flight, the shuttle could explode. Data from previous flights indicated that the rings tended to erode in flight, with the worst erosion occurring at the coldest temperature preceding lift-off... Unfortunately, almost no testing had been done below 40°F. The engineers had had to extrapolate. But, with the lives of seven astronauts at stake, the decision seemed clear enough: safety first.

> Well, it had seemed clear earlier that day. Now Lund was not so sure. The Space Center was "surprised" and "appalled" by the evidence on which the no-launch recommendation was based. The Space Center's senior managers wanted to launch, but they could not launch without Thiokol's approval. They urged Mason to reconsider. He re-examined the evidence and decided the rings should hold at the expected temperature. Joseph Kilminster, Thiokol's vice president for the shuttle programs, was ready to sign a launch approval, but only if Lund approved. Lund's first response was to repeat his objections. But then Mason said something that made him think again. Mason asked him to think like a manager rather than an engineer. (The exact words seem to have been, "Take off your engineering hat and put on your management hat.") Lund did so and changed his mind. On the next day the shuttle exploded during the lift-off, killing all aboard. An O-ring had failed." (Davis, 1998, pp. 43-44)

Davis considers a number of possible reasons for Lund making the decision that he did. In combination with a consideration of several other cases, Davis identifies a phenomenon he calls "microscopic vision". This name comes from the idea of looking down a microscope. By looking through a microscope one can see all sorts of things that are not visible to the naked eye, but in the process of looking through the microscope, one cannot at the same time be looking up from it. Either way, one risks missing information that was visible in the other view. Microscopic vision is an essential part of what it is to be a professional, and much of the training to become a professional is to develop appropriate microscopic vision to that field[16]. Davis offers an example of microscopic vision "A shoemaker, for example, can tell more about a shoe in a few seconds than I could tell if I had a week to examine it... But the shoemaker's insight has its price. While he is paying attention to people's shoes he may be missing what the people themselves are saying or doing" (Davis, 1998, p. 66).

In the Challenger case the problem is not the microscopic vision. In fact, microscopic vision is part of being an engineer, and it is difficult to see how engineering could exist without it[17]. "Microscopic vision is enhanced vision, a giving up of information not likely to be useful under the circumstances for information more likely to be useful" (Davis, 1998, p. 65). The

[16] Davis's "microscopic vision" fits well with the decision making theory of Bounded Rationality – that we use relatively few values (e.g. time, ease, cost) to make most of our decisions and that this approach generally yields good results (Gigerenzer & Selten, 2001). When a professional is working in their field the pieces of information that they use to make decisions could be very different to how they would make decisions outside their professional expertise. As an imperfect but suggestive analogy we can appreciate that a doctor might make decisions based on different values as a professional and as a patient. I discuss bounded rationality in greater detail in chapter three.

[17] This relates back to the idea of "language" discussed before. We could call this "microscopic language" and suggest generally that engineering microscopic language lacks many of the terms useful for ethical discussions.

problem, as Davis notes, is that the danger of this type of vision, essential as it is in order to perform a technical role well, is that you might not look up from the microscope at the appropriate moment.

It was this inability to choose well when to employ this microscopic vision that Davis feels led to the Challenger disaster and the other case studies he considers. From this understanding, he draws together a set of actions that could improve the situation:

> "The problem as I described it is that normal processes can lead to important information going unused at a decisive moment. Lund's training as a manager would not prepare him to see how special his role was... Though microscopic vision is not a flight from reality, it does involve a sacrifice of one part of reality to another. Usually, the sacrifice is worth it. Sometimes it is not. When it is not, we need to change the microscopic vision of those working in the environment in question or change the environment. Sometimes we need to change both. Often, changing one changes the other too.
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> ...One way [to change the environment] is simply to talk openly and often about what we want people to notice. For example, Lund would probably have refused to do as Mason suggested if the people back at Morton Thiokol's headquarters in Chicago regularly reminded him that he was no ordinary manger: "We are counting on you to stand up for engineering considerations whatever anyone else does." Indeed, had Mason heard headquarters say that to Lund a few times, he could hardly have said what he did say. He might well have deferred to Lund's judgement even though NASA was pressuring him. "Sorry," he could have said, "my hands are tied" (Davis, 1998, p. 71).

Davis goes on to consider how managers could change the environment, as well as the impact that this kind of microscopic vision may have on how we educate engineers. By working from a number of specific incidences of microscopic vision he creates suggestions for more general improvement. So, in the Challenger case, he offers the suggestion that it is necessary for organisations and companies to discuss exactly what it is that they want from their employees, and implicitly encourages clarity about the appropriate use of microscopic vision. So Davis suggests that here Lund should have made use of the microscopic vision where the primary concern was the safety of the astronauts and an understanding of the lack of data at appropriate temperatures, both of which would have supported delaying the launch.

In regard to educating engineers, the microscopic vision developed by engineers is certainly honed by their educational experience. (It is interesting to consider the extent to which individuals choose a profession because they already have a tendency to that type of microscopic vision, but that lies beyond what we are considering here.) Davis suggests that learning the microscopic vision of a profession is as much about learning what we can leave out from our specialised vision as what we can include[18]. There is therefore a need to include specific references to ethical content (Davis focuses on the codes of conduct from professional bodies) as silence could lead students to the conclusion that this is not part of what it is to be an engineer otherwise.

Davis uses the Challenger case across two chapters of his book. In addition to developing the concept of "microscopic vision" he also considers how Lund should have acted in the light of codes of ethics from various engineering institutions. In this sense he is also engaged in the issue-based approach mentioned above, where the issue is the role of the code of ethics. He highlights two considerations; firstly, that a strong code of ethics can act as back-up to engineers when they find themselves pressurised, and that secondly, from this point it is wise for engineers to support the code and ensure that they are familiar with it.

The case by case approach (which includes both case-study and issue-study) that Davis employs here is used to identify what led to a poor decision. It was not that Lund was weak-willed, or that a clearer decision-making procedure would necessarily have changed the decision. Rather, the underlying cause was the environment in which Lund worked, and the nature of what it is to be a professional ("microscopic vision"). By identifying how Lund reached the decision he did, and what was wrong in that process, Davis offers a solution that can improve engineering ethical decisions generally. What this approach suggests is that when a problem has been clearly identified, the solution that would lead to improvement can be relatively straightforward. The consideration of the code of ethics adds another dimension to the solution, in that whilst much of what would improve the misapplication of microscopic vision may lie outside the purview of the engineer, professional codes of ethics are directly accessible to the engineer.

Martin and Schinzinger provide us with another example of the issue-based approach to engineering ethics. In "Ethics in Engineering" they consider a number of issues commonly held as ethical dilemmas in engineering. As an example, one of the issues that they consider

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[18] Anecdotally, as an electronic engineering student I would have said that it wasn't my "job" to think about how a finished product would look – there are designers to resolve this, my job was to make sure the internal components and circuitry worked. No one ever told me that I should not consider external design, but no one ever told me that I should, and so I selected it out as information that was not relevant to my task.

is whistle blowing. In particular, recognising that whilst it would be better that whistle blowing were not required, they acknowledge that there are cases where it is the best choice of action but that engineers choose not to do so because they are concerned that they will suffer as result. In addition to offering advice to engineers considering whistle blowing, they also suggest that law-makers and other organisations can improve the situation.

> "Laws, when they are carefully formulated and enforced, provide two types of benefits for the public, in addition to protecting the responsible whistleblower: episodic and systemic. The *episodic* benefits are in helping to prevent harm to the public in particular situations. The *systemic* benefits are in sending a strong message to industry to act responsibly or be subject to public scrutiny once the whistle is blown.
>
> Laws alone will usually not suffice. When officialdom is not ready to enforce existing laws – or introduce obviously necessary laws – engineering associations and employee groups need to act as watchdogs ready with advice and legal assistance. Successful examples are the Government Accountability Project (GAP) and some professional societies that report the names of corporations found to have taken unjust reprisals against whistleblowers." (Martin & Schinzinger, 2005, p. 177)

Although, like Davis, Martin and Schinzinger refer to case studies to describe the problem they are discussing they are referring to a widely-recognised problem. There have been numerous cases where individuals knew that there were serious concerns about an engineering project and yet chose not to blow the whistle, because they were concerned that they would suffer if they did. In this case the problem is well identified, but the solution has not yet been agreed upon.

What both these approaches have in common is that they work from identified cases of problems; circumstances where poor engineering ethical decisions were made, and then offer solutions that would work to mitigate the problem. In these cases there is a degree of consensus that the ethical decision was poor. Whilst this does not necessarily assist in the resolution of cases where an action is controversial, notable improvement can be made by considering these clearer cases. Davis does not claim that the solutions that he puts forward can guarantee that an engineer will in future consider whether or not now is an appropriate moment for "microscopic vision", but that generally better decisions will result, entirely in keeping with the intention of this thesis.

Consider instead, how the hedgehog approach would have been used in these cases. Instead of starting from a position that suggested that a given decision was poor (e.g. Lund's decision to approve the Challenger's launch), we must first establish what the correct action would have been in light of our theory (having first overcome the difficulties of such a theory described in an earlier section of this chapter). Where poor decisions are then observable (as deviations from the correct action) the resolution must spring from the theory (for example, it could be that the resolution would be that the theory would be taught, or that theory would prescribe the actions required to improve the situation). Alternatively, depending on the nature of the theory, it is possible that it would have little to say about an individual case, which would leave us no further on in our desire to prevent a recurrence of the incident.

The theory approach can be used to determine what the correct actions are for protagonists other than engineers, but each must be considered separately. So, one must now consider, what does the theory say that the legal institutions should have done? What about the professional societies? What about the company and its directors and managers? How does the right action, or lack of it, affect each of the other parties and what they in turn should or should not do?

Even allowing for an accurately crafted theory that allows for consideration of the complex interplay with individuals and institutions, it seems uncertain that we would get such a clear and usable prescription. Or that we would get a prescription that would be so easy to define and explain to engineers in a manner that they are likely to grasp the relevance of.

None of these observations are intended to raise new objections to the unified moral theory approach in addition to those listed above, but merely to highlight that where there is a clearly identified moral issue or case, referring to a unified moral theory seems the longer route to take and it is not clear what the advantages would be.

Also, as a final observation, I think it likely that engineers would be content that the defining difference between the hedgehog and the fox lies in the speed and ease with which recommendations can be achieved. Davis takes relatively few steps from the initial case to reaching a workable recommendation.

2.8 Narratives and photographic vision

In the following chapters I will expand on the work of Davis and others. The presentation of the ideas here is given by explaining the consistent themes, and then describing their implications for specific cases, rather than explaining the cases and then identifying the common themes between them. Nonetheless this approach fits within the fox case by case approach as I am not attempting to do what Berlin says the hedgehog does and "relate everything to a central vision, one system less or more coherent or articulate, in terms of which they understand, think and feel – a single, universal, organizing principle in terms of which alone all that they are and say has significance" (Hope, 2004). The implications of characterising engineering decision making as occurring within the context of specialist vision does has implications for several different case studies. However, there are other ways of making poor decisions (e.g. weakness of will) that I will not be discussing.

2.9 Interviewing engineers

During my time working on the PhD, I worked with academics with expertise in philosophy, engineering, decision theory and sociology. The thesis was always going to be interdisciplinary, and many approaches for the thesis were considered and discarded. One such approach deserves special mention because it contributed to the final thesis in an important but mostly invisible way.

Early in the PhD process I decided to interview practising engineers about their views and experiences of ethics. The purpose of the interviews was to contrast the views of practising engineers in regard to ethical decision making with those in the decision making and engineering literature. The initial key questions were; what types of consideration form part of the decision making process? What concerns are there with how engineers make decisions? Do engineers feel well-informed and capable of making decisions with complex ethical components?

The intention was that the interviews would be fully transcribed and anonymised and then analysed using framework analysis to draw out common themes and ideas. It was recognised that the scale of the study would not be large enough to create a representative sample that would allow us to draw conclusions about engineers in general. However, it might offer us a small number of data points that we could use to compare the views expressed by engineers with views stated (implicitly or explicitly) in the engineering ethics literature. (If all the literature assumed something that one a number of engineers disagreed with then we could say that the assumptions about engineering present in some of the literature may be questionable).

Although I wasn't claiming to have a representative sample, I did attempt to avoid interviewing only engineers who were likely to be already sympathetic to the project, by using existing contacts and friends of friends to expand the range of ethical views I would encounter. This meant, that rather than only have engineers who already through that ethics was sufficiently important to donate their time, I also interviewed engineers who agreed to be interviewed for other reasons, such as a willingness to assist a friend. I also made sure that I had a variety to ages and specialisms, and included engineers of both genders (although only one woman, I found that most of the engineers I could access were men).

As the interviews progressed I discovered that the information that I was gaining, although interesting, did not lead towards an answer to the thesis question. I found that it was more challenging that I had expected to find questions that would prompt ethical reflection without suggesting that I was looking for a particular kind of answer. It may be that the engineers I interviewed particularly struggled with articulating their ethical views, or it may have been that I did not choose engineers whose specialisms clearly highlighted ethical issues in a manner that meant that they could articulate them easily.

As the thesis progresses, the idea of limited expertise and the ability to see things clearly within a limited field will be one that is repeated. In this case, the engineers may well not have the type of specialist vision that I was asking for in questioning them on how their ethical decision making and that of their colleagues could have been improved.

As I became more aware of the amount of time required to complete each transcription, necessary before the analysis could begin, and as I became less optimistic of the chances of it being productive, I chose to move away from an interview-based approach to one that adopted a more traditional philosophical methodology that focussed on a synthesis of literature, analysis, moral intuition and argument. As a result, I stopped interviewing after ten participants. Rather than completing the transcription[19] I chose to move to a different line of work, designed to stand complete without reference to the interview data.

Nonetheless, the interview process was significantly useful, and I want to reflect its formational role in this work. Firstly, I had not realised the extent to which my view of how engineers thought and acted was based on my own experiences as an undergraduate engineering student. Spending time with practising engineers widened my perspective and enabled me to realise that views that are common among engineering students are not necessarily common among practising engineers.

Second, the engineers I interviewed were willing to give up their time to talk to me, and expressed views that suggested that they considered it important to act ethically. Without wanting to suggest that this is how all engineers are, it strengthened my intuition that I

[19] I have not included the transcripts in this thesis. As I say later in this section, the thesis developed into a different form that did not require the data. Not only are the transcripts not required, but they would require significant additional work in order to ensure that they were properly anonymised. This section shows that the value of the interviews to this thesis is experiential, rather than based in the data.

should look for an account of engineering ethical decision making that could allow for positive motivation and yet result in poor decision making. Critically, it became increasingly clear to me that my approach needed to account for the fact that, as I read the literature and listened to the engineers, I often found myself sympathetic and understanding of the engineer's decision making, even when I recognised that it was wrong. I could see why Bob Lund might change his opinion, and I cannot say for sure that in the same circumstances I would necessarily have recognised the moral importance of continuing to think like an engineer.

Thirdly, it highlighted the importance of the challenge presented by the "obvious" that is discussed in chapter four. When we can see something clearly we can struggle to recognise that the same information is not necessarily available to others. Throughout the interviews I found that there were no standard questions that all the interviewees would find interesting, or respond to in detail. Their views on what was obvious and what required explanation varied widely.

I am grateful to those engineers who gave up their time to provide me with experiences that founded the direction of thesis development.

2.10 Conclusion

I have considered two approaches towards answering the thesis question and have argued that we can improve engineers' ethical decisions without focussing on relating the ideas on discussion to one central moral theory. This does not mean that moral theories should be rejected as having no place in the thesis but that they are not the initial or primary approach that will be used.

I have introduced Davis' microscopic vision as a way of describing how engineers see the world, that they see small parts in great detail but in doing so they sacrifice information that is now invisible to them. I have suggested that Davis' approach to engineering ethics can provide an example of an approach to engineering ethics that is case study rather than moral theory led.

3 Decision Making and Narratives

This chapter argues that we can improve the ethical decisions that engineers make by altering the narratives that they use to define their role, their work and the world around them. Narratives shape should we understanding the world, and by changing our narratives we change how we see the world.

3.1 Altering narratives can improve the ethical decisions made by engineers

Chapters three and four together build up an understanding of our decision making that is based in our limited human capacities. We are limited in what we perceive and how we perceive the world. Given that this is the case, we can focus on improving ethical decisions by encouraging engineers to ensure that appropriate ethical considerations are included in their perceptions of themselves, their world and the world around them.

The next chapter will build a metaphor of how we see the world by considering that we look at the world through a camera (photographic vision). This chapter says that we make sense of the world and what happens by thinking in narratives. Both these chapters suggest that whilst our view is limited we can alter what it is that we see, in this chapter by altering the narratives that we are using.

The narratives that we use to describe the world and our role in it render certain decisions and actions as natural and obvious, and others as clearly inappropriate or unusual. As a simple example consider this story of a quiet subway journey on a Sunday morning:-

> Then suddenly, a man and his children entered the subway car. The children were so loud and rambunctious that instantly the whole climate changed.
>
> The man sat down next to me and closed his eyes, apparently oblivious to the situation. The children were yelling back and forth, throwing things, even grabbing people's papers. It was very disturbing. And yet, the man sitting next to me did nothing.
>
> ...I turned to him and said, "Sir, your children are really disturbing a lot of people. I wonder if you couldn't control them a little more?"
>
> The man lifted his gaze as if to come to a consciousness of the situation for the first time and said softly, "Oh, you're right. I guess I should do something about it. We just came from the hospital where their mother died about an hour ago. I

> don't know what to think, and I guess they don't know how to handle it either. (Covey, 1999, p. 30)

The narrator is predisposed to think that the world should be a certain way, and that certain things are or are not acceptable. Changing the narrative about the children's behaviour renders their behaviour as appropriate and changes the narrators view towards them. Instead of blaming the children for their behaviour, the narrator then seeks to provide support in a difficult time.

At the end of this chapter I will describe and name some narratives that could be used to describe the role of the engineer. Chapter five will discuss some beliefs to contribute to particular versions of the engineer narrative and chapter six contains discussions and concepts that might influence which narrative an engineer holds about their role and work.

3.2 Limited perception

Inherent to Davis's microscopic vision discussed in the previous chapter, is the recognition that we have limited perception. We do not perceive all that it is potentially possible for us to perceive. Instead, of the almost endless array of potential information, we interact with a subset of perceptions. Of all the things that we could potentially observe, when we chose to look down the microscope of expertise we see only a small amount but in great detail. Implied in this metaphor is the idea that we have limited perception – that we cannot see everything at every level of detail all at once.

I will return to this idea in chapter four, when we look at the metaphor of photographic vision. But in considering how we view the world, which this chapter discusses in terms of narratives, we need to remember that at its core we view the world *partially*.

3.3 Bounded Rationality – understanding decision making in context

Bounded Rationality is an approach to decision making theory that states that our everyday decisions can be understood as rational given the limitations of time, computational ability and information availability. Bounded Rationality is significant for what will follow because it demonstrates that we make decisions without considering all the available information and that we can make good decisions in this way. Since we look for key cues to make certain decisions, it is important that ethical considerations are amongst the first things that are considered when they will influence decision making because otherwise they may not be considered at all. It will also show us that our approaches to decision making depend on an awareness of our environment, and that we are less likely to make good decisions when in novel situations.

There are many different understandings of what it is to be rational, and there is a divide between rationality as discussed in the literature of philosophy and that of decision making theory. A recurring theme when introducing ideas in this chapter is that they are introduced by considering different versions of rationality as the background against which they define themselves.

Bounded Rationality is perhaps best understood as a response to a view of decision making theory based on subjective expected utility (SEU). SEU theory states that the best way to make a decision is to consider the utility[20] that each option offers and choose the option that maximises utility. But as Gerd Gigerenzer puts it;

> Logic and probability are mathematically beautiful and elegant systems. But they do not always describe how actual people – including the authors of books on decision making – solve problems, as the subsequent story highlights. A decision theorist from Columbia University was struggling whether to accept an offer from a rival university or to stay. His colleague took him aside and said, "Just maximize your expected utility – you always write about doing this." Exasperated, the decision theorist responded, "Come on, this is serious." (Gigerenzer, 2008, p. 20)

Bounded Rationality's response to subjective expected utility is that SEU relies on an unrealistic access to information and an unachievable computational ability. It might be a tool that people could use for making decisions (particularly with computers to support the computational load), but it does not provide a model of how people make decisions in practice. Bounded Rationality, as its name implies, a theory based on how humans make rational decisions when bounded by constraints (including those of time and information availability).

> "Bounded Rationality is not irrationality. A sharp distinction should be made here. The theory of bounded rationality does not try to explain trust in lucky numbers or abnormal behaviour of mentally ill people. In such cases, one may speak of irrationality. However, behaviour should not be called irrational simply because it fails to conform to norms of full rationality. A decision maker who is guided by aspiration adaption rather utility maximization may be perfectly rational in the sense of everyday language use". (Selten, 2001, p. 15)

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[20] Utility is a term used by both engineers and philosophers but without a common meaning. Since we are only mentioning utility in order to explain how it differs from Bounded Rationality we can leave it with the vague definition of "the value that an option holds to an individual".

Bounded Rationality leaves us with the ability to judge particular decisions as irrational, and to criticize individuals in terms of failures in their decision making process. However, it suggests that we need to understand rationality in the context of human limitations in order to determine what constitutes good decision making, and that we would be wrong to label a decision as "irrational" because it does not choose the outcome that subjective expected utility would suggest is optimal.

H.A. Simon, who coined the term "Bounded Rationality", explains that decisions can be understood in light of two different factors, environment and capabilities.

> "We have developed these approaches to decision making in light of the environments in which we have found ourselves. Human rational behaviour is shaped by a scissors whose two blades are the structure of task environments and computational capabilities of the actor." (Simon, 1990, p. 7)

Several different proponents of Bounded Rationality have suggests different approaches that someone might use to make decisions. The "aspiration adaption" quoted above is the process by which we evaluate available options against our preferred criteria. In the absence of an available option we can then adapt our criteria and re-evaluate until such point as an option now fulfils our revised criteria.

Expanding on Simon's work Gigerenzer states that there are two key concepts (the two blades of the scissors) which are (1) the adaptive toolbox and (2) ecological rationality.

> The adaptive toolbox contains the *building blocks* for *fast and frugal heuristics.* A heuristic if fast if it can solve a problem in little time and frugal if it can solve it with little information. Unlike as-if optimization models, heuristics can find good solutions independent of whether an optimal solution exists. As a consequence, using heuristics rather than optimization models, one does not need to "edit" a real-world problem in order to make it accessible to the optimization calculus (e.g., by limiting the number of competitors and choice alternatives, by providing quantitative probabilities and utilities, or by ignoring constraints). Heuristics work in real-world environments of natural complexity, where an optimal strategy is often unknown or *computationally intractable*...[21]

[21] "A problem is computationally intractable if no mind or machine can find the optimal solution in reasonable time, such as a life time or a millennium. The game of chess is one example, where no computer or mind can determine the best sequence of moves. In order to be able to compute the optimal strategy, one could trim down the 8x8 board to a 4x4 one and reduce the number of pieces accordingly. Whether this result tells us much about the real game, however, is questionable." (Gigerenzer, 2008)

> The study of ecological rationality answers the question: In what environments will a given heuristic work? Where will it fail? Note that this normative question can only be answered if there is a process model of the heuristic in the first place, and the results are gained by proof or simulation. (Gigerenzer, 2008, p. 7)

Bounded Rationality is significant to us because it offers us a descriptive model of how people make decisions. Understanding how we make decisions, and the limitations that we have in practical decision making, is necessary to appreciate the role that narratives play in our decision making and the extent to which altering narratives can influence decision making, which are discussed below.

Gigerenzer's "Ecological Rationality" (that heuristics work in particular environments to produce good decisions) is also significant.[22] Our interest lies in the idea that heuristics can arise from familiarity with the environment. This seems intuitively plausible, because experience means that we tend to make better decisions and we allow people with more experience more responsibility in light of what we view to be their better decision making ability. This will be a recurring theme of this chapter that our environment influences the way that we make decisions and the types of information and ideas that we consider when making those decisions.

3.3.1 Fast and frugal heuristics

"A fast and frugal heuristic is a strategy, conscious or unconscious, that searches for minimal information and consists of building blocks that exploit capacities and environmental structures." (Gigerenzer, 2008, p. 22) Gigerenzer asks how it is that a baseball outfielder catches a fly ball. After considering the possibility that the outfielder is working through the parabola the ball will take, factoring in wind speed, direction etc. he suggests that the actual solution is much simpler: the outfielder uses this heuristic, "Fixate your gaze on the ball, start running, and adjust the speed so that the angle of gaze remains constant".

As Gigerenzer notes this heuristic works if the ball is high in the air. The gaze heuristic works if the ball is falling. It would be possible to misapply this heuristic to situations where the ball is still rising – the heuristic is only valid after a certain point in the throw. Gigerenzer also observes that using this heuristic allows the outfielder to be where the ball is when it lands. It does not allow the outfielder to predict where the ball will land, but to

[22] It opens up an avenue that we do not take, in considering that it might be possible to adapt our environments to better suit our existing heuristics, and thereby improve decision making by making existing heuristics more widely applicable.

respond to the situation so that he or she can catch the ball. This highlights a necessary distinction for considering discussions with engineers, engineers may be using heuristics appropriately and effectively (let us for the moment exclude cases where the engineer misapplies a heuristic) but heuristics can be very specific and do not necessarily mean than an engineer can discuss the heuristic (not all outfielders are conscious that they are maintaining their gaze at a fixed angle) nor does the ability to fulfil the task accurately necessarily give an individual the ability to speak about it easily.

Heuristics are not narratives, and the distinction between the two is discussed below when examining the differences between narratives and rules of thumb. However, understanding our use of heuristics allows us to appreciate the extent to which we use relatively limited information to make many decisions and that provided that the heuristic is being used in the correct environment this does not constitute bad decision making. Gigerenzer suggests that we have a “toolbox” of these narratives, that are each used for different occasions and specialised for the decision type (in the same way that we don’t use a screwdriver to hammer a nail).

One more general example of fast and frugal heuristics is satisficing.

> [S]atisficing – using experience to construct an expectation of how good a solution we might reasonably achieve, and halting search as soon as a solution is reached that meets the expectation.
>
> Picking the first satisfactory alternative solves the problem of making choice whenever (a) an enormous, or even potentially infinite, number of alternatives are to be compared and (b) the problem has so little known structure that all alternatives would have to be examined in order to determine which is optimal. Satisficing also solves the common problem of making choices when alternatives are incommensurable, either because (a) they have numerous dimensions of value that cannot be compared, (b) they have uncertain outcomes that may be more or less favorable or unfavorable, or (c) they affect the values of more than one person. Then a satisficing choice can still be made as soon as an alternative has been found that (a) is satisfactory along all dimensions of the value, (b) has satisfactory outcomes for all resolutions of uncertainty , or (c) is satisfactory for all parties concerned, respectively. (Simon, 1990, p. 10)

I propose that there are engineering decisions that fit the desciption given by Simon - where large number of alternatives are available and not all parameters that could be used to examine the quality of the decision will be considered. This is particularly true when we consider that engineers consider themselves to make decisions with limited time (see section 3.7 for more on making decisions under time pressure). Even when this is the case, not all decisions will be made using satisficing – there are other decision tools in the toolbox. But in cases where it is used, we can understand that if the ethical considerations are not part of the limited criteria used to make a decision they may end up not being considered at all.

3.4 Lakoff: narratives and understanding the brain

Bounded Rationality says that we make decisions without considering all the possibly available alternatives and compares itself to subjective expected utility. George Lakoff describes human decision making by framing it within the limitations of the human brain, his particular focus being on the function of the brain and how that functioning is related to the use of language. Lakoff includes in his approach the explaination that it is in contrast to the enlightenment view of man as a rational being, who presented with rational argument will alter his opinion.

> The brain is not neutral; it is not a general purpose device. It comes with a structure, and our understanding of the world is limited to what our brains can make sense of. Some of our thought is literal – framing our experience directly. But much it is metaphoric and symbolic, structuring our experience indirectly but no less powerfully. Some of our mechanisms of understanding are the same around the world. But many are not, not even in our own country and culture...
>
> Language gets its power because it is defined relative to frames, prototypes, metaphors, narratives, images, and emotions. Part of its power comes from its unconscious aspects: we are not consciously aware of all that it evokes in us, but it is there, hidden, always at work. If we hear the same language over and over, we will think more and more in terms of the frames and metaphors activated by that language. (Lakoff, 2008, p. 14)

Lakoff describes the complex narratives that we recognise from our own lives as well as fairy tales, novels and dramas as being made up of basic simple structures he refers to as "frames". He quotes the work of Erving Groffman who discovered that all institutions are structured by frames (Groffman, 1974). So there is a frame (or possibly several) that we use to understand what a hospital is – as a place where there are doctors, nurses, sick people, medicine etc. Complex frames allow us to combine simple frames, so that frame "field-hospital" would combine the frames of "hospital" and "military" (Lakoff, 2008). These frames coming together create what Lakoff calls narratives. Since several different authors use the term narrative with different nuances, I will refer to Lakoff's narratives as *descriptive* narratives – narratives that describe a life (or significant parts of it).

Lakoff uses the example of the life of Anna Nicole Smith to explain the significance of narratives. Well-known in the media, Smith dropped out of High School at 15, was separated from her first husband at 19 (leaving her with a one year old child), modelled for Playboy, married her second husband millionaire J Howard Marshall when she was 26 (Marshall was 89), was involved in a high profile court case against Marshall's children as a result of his will, and eventually committed suicide aged 39.

Lakoff is interested in Smith because he argues that her life can be told using several different narratives;

- Rags to Riches – the hero or heroine overcomes difficult initial circumstances and various trials before an extraordinary act leads to success, respect, fame and wealth.
- Reinvention of self – an extension of Rags to Riches in which the protagonist reinvents his/her self.
- American Redemption Story – the hero/ine initially makes bad mistakes or failures and looks like a looser but is redeemed by later successes.
- Gold digger – heartless, ruthless, manipulative young woman who marries an older man in the hope that he will die and leave her rich.
- How to marry a millionaire – a naive sexpot with a heart of gold that the millionaire recognises and respects.
- Woman's Lot Narrative – a woman trying to succeed in a man's world without education or money: her sexuality and her determination are her main resources.

In addition, he mentions several smaller narratives, the Innocent Ingénue, the Victim, the Girl with Pluck and Determination, the Calculating Bitch, the Nice Family, the Glamorous Star, the Hard-Driving Businesswoman and the Rich Man's Mistress. Lakoff feels no need to identify all these narratives in great detail, and his point serves to illustrate that certain narratives are highly prevalent in society. So that when they are named, we understand the type of narrative that is being referenced without the need for a detailed explanation.

The narratives that Lakoff identifies clearly highlight the same highlighting and hiding phenomena that we will see when examining metaphors (see section 3.5). Different pieces of Smith's story are bought into prominence depending on which metaphor you are considering. The idea that only certain information is available to the engineer is discussed in detail in chapter four. The significance of raising the idea in relation to narratives is that an engineer's views on what he or she does, and how the world functions will influence what information he or she is likely to perceive.

It is important for this work that the different narratives that Lakoff presents contain different moral views. If I say that Smith best fits the Calculating Bitch narrative, I have also told you that I do not approve of her actions – because the moral view is part of the narrative and having chosen the narrative I have defined my moral view of her actions. If I view her as a Victim my view on her behaviour, and my emotional response towards her story, are very different.

If views on what is right and wrong are imbedded into narratives in this way it becomes clear why someone might say, "It's obviously wrong to do X" (with the implication that questioning the appropriateness of X is an odd thing to do). To those functioning using a particular narrative, the narrative has highlighted the wrong doing so clearly that they may struggle to articulate why because it is just a part of the narrative that they are using to process action X. Pressing them to consider why action X is wrong causes them to examine their narrative, and to begin to articulate the values that are an ingrained part of it.

3.4.1 Accessing engineers' narratives

It can be challenging to identify which narratives engineers hold. We can ask engineers about what they think is right and wrong, and what constitutes good decision making. But we are only accessing narratives where those ideas are clearly highlighted, not the ones where they form part of the background assumptions.

Also, we can begin to realise that because these are underlying assumptions that are part of narratives we may have to do some work to accurately unpick the narrative to work out which key "frames" are in play. Several examples of this have arisen during casual conversations with engineers at conferences etc. When asked "what can be done to improve the ethical decisions made by engineers" they would provide specific actions. When I considered their answers I realised that the most telling information was not what suggestion they made, but their implicit characterisation of the underlying problem, what their narrative was about the current approach that engineers have to ethics. One suggestion was "insist upon an ethics exam as part of chartership". This was a solution to their narrative of the problem with the current state of engineering ethics. It could be that they think what was lacking was a universal system for ensuring ethical understanding. Alternatively, it could be that they felt that problem was that engineers need to be able to express ethical ideas more clearly. The narrative that defined the problem wasn't clear, but it was powerful in presenting certain options as better than others.

As Beach observes below (see section 3.8), some of the narrative concepts (in his description, "values") that we are seeking to understand are at best, "fuzzy" and can be understood by the descriptors that we use to when considering various courses of action. Also, as Klein (see section 3.7) points out the expertise to perform an action well does not necessarily encompass the expertise to explain it clearly. Both of these factors make accessing the narratives that engineers use challenging. I will return to Lakoff's descriptive narratives towards the end of the chapter when I consider some of the potential narratives that could be formed about the role of the engineer.

3.5 Lakoff and Johnson: metaphors

Lakoff and Johnson argue that metaphors are the building blocks of our conceptual system. "Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature" (Lakoff & Johnson, 1980, p. 3). As an example they consider the metaphor "ARGUMENT IS WAR". (Lakoff and Johnson use capitals to indicate concepts and conceptual metaphors – I have maintained the same system to aid clarity when discussing their ideas.) Not all the narratives that I consider will take the form of metaphors, but they are a clear example of the implications that narratives have on our thinking and actions.

Lakoff and Johnson describe their view on metaphor in the following manner:

> *The essence of metaphor is understanding and experiencing one kind of thing in terms of another…*
>
> Metaphors as linguistic expressions are possible precisely because there are metaphors in a person's conceptual system. Therefore, whenever… we speak of metaphors, such as ARGUMENT IS WAR, it should be understood that *metaphor* means *metaphorical concept*. (Lakoff & Johnson, Metaphors we live by, 1980, pp. 5-6) (Emphasis in the original)

Metaphor, as Lakoff and Johnson describe it, is not just a poetic way of relating two ideas, but a linguistic expression of a conceptual link between two ideas that are related. Lakoff explains in a later work:

> The word *metaphor* was defined as a novel or poetic linguistic expression where one or more words for a concept are used outside of its normal conventional meaning to express a *similar* concept…
>
> [But e]veryday metaphor is characterised by a huge system of thousands of cross-domain mappings, and this system is made use of in novel metaphor…

> the word *metaphor* has come to be used differently in contemporary metaphor research. The word *metaphor* has now come to mean *a cross-domain mapping in the conceptual system.* (Lakoff, 1993)

It is this sense of cross-domain mapping that is generally intended by the term metaphor in this thesis, and can generally be formulated as suggested above by Lakoff and Johnson in the form A IS B. Where this metaphor has been recently stated it may be referred to as the B metaphor. So the metaphor ARGUMENT IS WAR may be referred to as the “war metaphor” when the context makes this clear. (In this case, the “war metaphor” can be considered the name of the metaphor, not actually the metaphor.)

Gary Klein uses the term metaphor in a different but compatible way, which is discussed when introducing his work later on in this chapter.

3.5.1 ARGUMENT IS WAR

Before examining the effect of metaphors on our thinking let us first elaborate upon the example that they given. In defining the conceptual metaphor ARGUMENT IS WAR Lakoff and Johnson make three significant points.

1) The metaphor is present in a wide variety of expressions: “Your claims are *indefensible*”. “He *attacked every weak point* in my argument.” “His criticisms were *right on target.*” (Emphasis in the original).
2) Our actions are partially structured by the concept of war, “We can actually win or lose arguments. We see the person we are arguing with as an opponent. We attach his positions and we defend our own. We gain and lose ground. We plan and use strategies. If we find a position indefensible, we can abandon it and take a new line of attack.”
3) Metaphor can define our understanding so that we would view certain actions, circumstances etc. differently as a result. “Try to imagine a culture where arguments are not views in terms of war, where no one wins or loses, where there is no sense of attacking or defending, gaining or losing ground. Imagine a culture where an argument is viewed as a dance, the participants are seen as performers, and the goal is to perform in a balanced and aesthetically pleasing way. In such a culture, people would view arguments differently, experience them differently, carry them out differently and walk about them differently. But *we* would probably not view them as arguing at all: they would simply be doing something different. It would seem strange even to call what they are doing “arguing”.” (Lakoff & Johnson, 1980)

The first two points are a justification of the existence of the metaphor; we use similar concepts in discussing and describing arguments and war. The third point is of more interest to us here, because it begins to allow us to understand that metaphors contribute to determining how we view certain concepts. This is perhaps best considered in reverse, if an engineer tells me “that is not part of engineering” they are telling me something about the metaphor(s) he or she is associating with engineering.

3.5.2 Metaphors partially structure the actions associated with a concept

The metaphor contributes to our experience of the concept. “Arguments and wars are different kinds of things – verbal discourse and armed conflict – and the actions performed are different kinds of actions. But ARGUMENT is partially structured, understood, performed and talked about in terms of WAR”. (Lakoff & Johnson, 1980)

By partially framing our understanding of a concept, the metaphor then also partially frames the actions that we take. If we view argument as war then we are more likely to look for ways to *attack* someone’s position, or *defend* our own views, our actions are affected by the metaphors that we use. If we viewed argument as dance we might well think more of stillness and movement, of harmony and discord of shape and form than we do when viewing argument as war.

3.5.3 Hiding and highlighting conceptual content

Lakoff and Johnson point out that metaphors highlight and hide conceptual content. “In allowing us to focus on one aspect of a concept (e.g. the battling aspects of arguing), a metaphorical concept can keep us from focusing on other aspects of the concept that inconsistent with that metaphor. For example, in the midst of a heated argument when we are intent on attacking our opponent’s position and defending our own, we may lose sight of the cooperative aspects of arguing.” (Lakoff & Johnson, 1980) This idea of hiding and highlighting, which I discuss further elsewhere in this chapter when examining the importance of filtering, explains why altering narratives could improve decision making. We do not treat all information as equally relevant, and as a result we have a tendency to treat certain information in habitual ways. If we can change the narratives that an engineer holds we may be able to highlight aspects on particular narratives that are currently hidden. This idea is particularly relevant when considering the metaphors that engineers and engineering students may use to consider the engineering profession and the beliefs that are embodied in their narrative of what it is to be an engineer.

This highlighting and hiding can also change our view on the morality of an action. Changing what facets of the action we can see might alter our view of whether an action is right or wrong. As was demonstrated above, the narratives that Lakoff used to describe Anna

Nicole Smith highlighted different facets of her life. Some of those were narratives that we would see as commendable, and others were ones that we would see as lamentable. Within each narrative we might struggle to define precisely what was good or bad about her actions, because highlighting means that it is now so "obvious" that it can be hard to explain.

Metaphor is very deeply entrenched in our understanding and we perhaps do better by changing our language rather than our metaphors. If ARGUMENT IS WAR, then maybe rather than try and change that we instead look at "reasoning", "decisions" or "justifications" rather than attempt to alter a strongly held description of the dynamics of argument.

3.6 Filtering by the questions we ask and the words we use

During the interviews, the engineers consistently responded when asked that they believe that morality and ethics are distinct concepts. There was, however, no consistent distinction made by them between the two terms. The important point to note is not a concern over whether or not the terms are applied accurately, or with philosophical rigour, but rather that using one term over the other may elicit a different response from the engineer. Asking an engineer to consider the moral implications of a course action may get a different response to asking the engineer to consider the ethical implications[23].

This is important for two reasons. The first is that sometimes the narratives that we use in decision making are not the ones that we think of first when engaged in discussions, particularly depending on how the questions are asked. But if we do use them, then to challenge them we first need to be able to access them. Finding the right triggers enables us to access narratives that might otherwise be untouchable.

The second reason is that the questions that we ask ourselves may hide or reveal certain narratives. If an engineer asks "what should I do in this situation" this might yield a different response to "what is the right thing to do in this situation" or "what is the moral thing to do in this situation".

3.7 Recognition-Primed Decision making

Gary Klein uses the term 'narrative' in a different way to that of Lakoff. Klein's work is significant because it shows us that there is a relationship between how we describe events, how we make decisions and how we develop expertise.

[23] It would be interesting to see if as a result engineers could conclude that an action was morally justified but ethically unacceptable (or visa versa) and how they would seek to resolve these two views of the same action.

Gary Klein's recognition-primed decision (RPD) model "fuses two processes: the way decision makers size up the situations to recognize which course of action makes sense, and the way they evaluate that course of action by imagining it." (Klein, 1998, p. 24)

The first step is to consider whether or not a situation is typical. This was a major feature of experience, fire fighters, nurses and engineers all demonstrate an ability to make accurate predictions based on their appreciation of the similarities between the current case and previous cases. This has implications for how ethics should be taught to engineers, if engineers then use their experience as a basis for determining what is typical. This will be covered in chapter seven.

In situations that are considered typical, there may then seem to be an obvious next step. Klein uses the decisions made by a fire commander to illustrate this.

> There are no signs of smoke anywhere. He finds the door to the basement, around the side of the building, enters, and sees flames spreading up the laundry chute. That's simple, a vertical fire that will spread straight up. Since there are no external signs of smoke, it must just be starting.
>
> The way to fight a vertical fire is to get above it and spray water down, so he sends one crew up to the first floor, and another to the second floor.

Once the commander had established that the fire was typical, he then assumed a particular course of action. There was no need for him to consider a range of possibilities, as Klein puts it, it follows an "if... then..." form. If it is a vertical fire then spray water from above.

This case also demonstrates another feature of the RPD model, that having established that a case is typical; the decision maker still looks for feedback that corroborates or disproves the identification. The lack of external smoke is confirmation that the correct diagnosis has been made. However, further information proves that the identification was incorrect.

> Both [crews] report that the fire has gotten past them. The commander goes outside and walks around to the front of the building. Now he can see smoke coming out from under the eaves of the roof. It is obvious what has happened: the fire has gone straight up to the fourth floor, has hit the ceiling there, and is pushing smoke down the hall. Since there was no smoke when he arrived just a minute earlier, this must have just happened.
> It is obvious to him how to proceed now that the chance to put out the fire quickly is gone. He needs to switch to search and rescue, to get everyone out of the building, and he calls in a second alarm.

In this case the additional information changes the diagnosis of the situation, but again, the commander does not have to consider multiple options, the new identification now suggests a single course of action. This variation Klein refers to as “if(???)... then”. In another case a different fire commander orders a crew out shortly before the floor of the living room they were in caves in. In that case Klein identifies that the commander was responding to a lack of supporting expectancies causing the commander to realise that his initial recognition must have been mistaken.

The third case that Klein identifies within his model is “if... then(???)”. In this case the recognition is correctly made, but that recognition does not lead to a clear course of action as it did in the first two cases.

> [A woman] either fell of jumped off a highway overpass... she lands on the metal supports of a highway sign and is dangling here when the rescue team arrive...
> At any moment, she could fall to her death on the pavement below. If he orders any of his team out to help her, they will be endangered because there is no way to get a good brace against the struts, so he issues an order not to climb out to secure her... Now the question is how to pull the woman to safety. First, the lieutenant considers using a rescue harness, the standard way of raising victims. It snaps onto a person’s shoulders and thighs. In imagining its use, the realizes that it requires the person to be in a sitting position or face up. He thinks about how they would shift her to sit up and realizes that she might slide off the support.
>
> Second, he considers attaching the rescue harness from the back. However, he imagines that by lifting the woman, they would create a large pressure on her back, almost bending her double. He does not want to risk hurting her.
>
> Third, the lieutenant considers using a rescue strap – another way to secure victims, but making use of a strap rather than a snap-on harness. However, it creates the same problem as the rescue harness, required that she be sitting up, or that it be attached from behind. He rejects this too.
>
> Now he comes up with a novel idea: using a ladder belt – a strong belt that firefighters buckle on over their coats when they climb up ladders to rescue people. When they get to the top, they can snap an attachment on the belt to the top run of the ladder. If they lose their footing during the rescue, they are still attached to the ladder so they won’t plunge to their death... He thinks it through

> again and likes the idea, so he orders one of his crew to fetch the ladder belt and rope, and they tie it onto her...
>
> ... ladder belts are built for sturdy firefighters, to be worn over their coats. This is a slender woman wearing a thin sweater. In addition, she is essentially unconscious. When the lift her up, they realize the problem. As the lieutenant put it, “She slithered through the belt like a slippery strand of spaghetti.” Fortunately [the recently arrived hook-and-ladder truck operator] is right below her. He catches her and makes the rescue. There is a happy ending. Now the lieutenant and his crew go back to their station to figure out what had gone wrong. They try the rescue harness and find that the lieutenant’s instincts were right: neither is usable.
>
> Eventually they discover how they should have made the rescue. They should have used the rope that had tied to the ladder belt. They could have tied it to the woman and lifted her up. With all the technology available to them, they had forgotten that you can use a rope to pull someone up. (Klein, 1998)

This time the lieutenant correctly recognised the situation and no revision was necessary, but the novel nature of the problem meant that the first few techniques he considered would not allow him to solve it. As Klein observes, this decision process is an example of Simon’s *satisficing*. The lieutenant is looking for the first solution that he can find that will result in a safe rescue and he acts when he believes that he has such a solution. Considering Gigerenzer’s *ecological rationality* the situation has to be novel before this type of decision making is required – the more frequently experienced situations are viewed as having a single simple solution because they have been exposed to these situations frequently throughout their careers. This type of prolonged decision making is used in a novel situation.

Klein’s model uses narratives in both checking that the recognition is correct, and in evaluating potential courses of action. When the commander thought he had a vertical fire he was aware that vertical fires come with an explanatory narrative, they portray certain features, develop in certain ways, and firefighters deal with them using particular methods. When the feedback didn’t fit the vertical fire narrative, the commander reconsidered the recognition, and chose a search and rescue narrative instead.

When the lieutenant considered possible ways of rescuing the dangling woman each option took the form of an explanatory narrative where the lieutenant considered what the implications of the options would be and made a forecast about the likely outcome. Although it wasn’t listed as a choice that was dismissed, the first option that was presented was sending firefighters to secure the woman. When he had the opportunity to double-check his forecasts were mostly correct (he correctly identified that neither the rescue harness nor the rescue strap would have been able to lift the woman safely) but he failed to consider the relative different in size. His least accurate narrative was the most novel one.

But more widely the lieutenant's narrative of the likely options to consider did not include the most basic option of the rope. His narrative did not highlight that as an option and as a result it was hidden from his decision making.

Whilst these examples are focussed on the decisions of fire fighters, Klein states that the model holds good for design engineers[24]:

> "We get the same findings with design engineers who may have weeks or months to finish a project. They insist that they are working under extreme time pressure relative to their tasks, but in comparison to the fireground commanders and chess players, they are almost on vacation." (Klein, 1998, p. 4)

The RPD model and the heuristic of *satisficing* suggest that if you want an option to be considered then you need to ensure that it is something that an engineer is likely to consider, since they may well pick one of the first few options that they think of, if it appears to meet all their essential criteria. This is not the case for all decisions, since we do not always use satisficing to make decisions, but it is more likely to be the case when decisions are made under time pressure. As Klein describes above, engineers believe that many of their decisions are made with limited time. This is particularly significant in cases where the negative effects may not be experienced until sometime later. If an engineer makes a decision, and the immediate impacts are all positive, the engineer will file that experience as a successful one, and be likely to use it as a typical example of how to perform the task in the future. If the negative impacts do not emerge for some time, it may be harder for the engineer to associate them with the original decision.

3.7.1 Klein on metaphor and analogues

Gary Klein has a description that when we are performing difficult tasks we seek similar previous experiences to serve as a base for our current decision making. So our past experience acts as a metaphor that structures our understanding of how we should approach a current problem.

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[24] Not all engineers are design engineers; many engineers are involved in implementing, operating and maintaining technology. However, I see no reason to assume that the decision structures that are used by firefighters and design engineers are not equally likely to be used by other engineers as well.

> People use analogues and metaphors to perform a variety of difficult tasks: understanding situations, generating predictions, solving problems, anticipating events, designing equipment and making plans. An analogue is an event or example drawn from the same or a related domain as the task at hand; a metaphor comes from a markedly different domain. Each experience that we have, whether it is our own or one we have heard about from someone else, can serve as an analogue or a metaphor. Each time we take on a task, we can draw on this vast knowledge base, this bank of experiences and stories and images. We may overlook an analogue, select a misleading one, or fail to interpret one correctly. Usually our experience bank works smoothly, providing us with structure and interpretation even for tasks we have not been faced with before. (Klein, 1998, p. 197)

Lakoff and Johnson noted that metaphors of concept partially structure the associated action so ARGUMENT IS WAR encourages actions in argument that we associate with war such as attacking and defending. When Stephen Jobs and Steve Wozniak were designing the Macintosh computer their metaphor was THE INTERFACE IS A DESKTOP and used actions that were already familiar (such as moving a folder[25]) (Klein, 1998, p. 198).

> [E]ffective metaphors were the ones helping to organize action. They were trading in on well learned behaviours, such as flying formation, driving on a highway, or moving folders on a desktop, so that the new task could be performed smoothly using coordination skills that had already been developed. (Klein, 1998, p. 200)

Klein tells us that we can use analogues and metaphors to help us perform difficult tasks (particularly new or novel tasks). When we are unsure how to approach a problem, we might well do so in light of what has worked in other similar situations, where the similarity of "domain" distinguishes analogue from metaphor but similarity of salient features allows for a useful addition to understanding.

In drawing on what we already know to help us solve something new we can carry features of the metaphor with us without realising that that is what we do. Consider the student who has just left school and is starting university. The student's metaphor could be UNIVERSITY IS SCHOOL and certainly there are shared features of learning and testing.

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[25] When I taught basic computer literacy classes in Gambia file structures and folders were the hardest concept to teach because the students weren't familiar with filing systems. The computer architecture was using a metaphor that had no meaning for the students. Metaphors are successful where the original idea (e.g. WAR) is common to all those using the metaphor.

But university is not school, there is an expectation of a higher ability for independent study and a greater emphasis on academic rigour (e.g. the correct use of citations) among many other features. For the student using the metaphor UNIVERSITY IS SCHOOL as a way of understanding their role in a new setting, they may not see as quickly the distinctions between the two learning environments, because as Lakoff and Johnson have shown earlier, the metaphor hides some information and highlights others.

In the same way that a heuristic that works well in one environment may not hold in another, so not all metaphors and their resultant actions are equally strong, and a poorly used metaphor can lead to a poor outcome. This, then, represents another point at which we can see a potential weakness in how engineers make decisions. Just as they could use a heuristic inappropriately, so they could use a poor metaphor. This does not mean that they are using metaphor is a bad way to make decisions, indeed we are not going to explore whether or not there is an alternative. But rather we can suggest that exposure to certain types of metaphor will encourage engineers to consider them in their ethical decision making, by having these metaphors in the bank of experience they can turn to.

This process is interesting, because it is similar in form, but opposite to how metaphors are often used by philosophers considering ethical questions. There, metaphors of action (two cases that are considered similar in the significant aspects) are often used to demonstrate how two situations are not analogous (by comparing our ethical intuitions in different cases) and to establish what the ethical importance of the distinctions between the situations are.

This concept of seeking metaphors and analogues when approaching novel situations also relates to our ability to accurately appreciate risk, something that we will return to when re-examining Bob Lund's decision to green light the Challenger launch, and when considering the types of narratives that which we wish engineers to develop. But for now, let us note that if we are hunting for analogues or metaphors when considering a new problem and we don't have experience of things going wrong, the analogue we pick might well hide particular risk issues.

When Klein talks about metaphors, he is describing how, when faced with a novel decision, we look for examples from the same domain to help us determine how we should approach the novel decision. This is not a linguistic metaphor, and if we are thinking of a metaphor in a linguistic sense then it might not look like a metaphor. However, if (like Lakoff) we recognise that a metaphor is "a cross-domain mapping in the conceptual system" (Lakoff, 1993) then we can understand Klein's idea of cross-domain mapping of the old situation onto the new one. We can write Klein's idea in Lakoff and Johnson's form THIS SITUATION IS THAT SITUATION. In the same way that argument is not the same as war, so the novel situation is not the same as the previous situation, but the novel situation can be understood in similar terms and we can use the previous situation to partially understand the current situation and guide our decision making.

3.7.2 Stories leading to expertise

Klein offers another way that we can use narratives, in this case, actual stories. He observes that telling stories can contribute to expertise, to the bank of experiences that we can use as future decision aides.

> After a day of flying, military pilots gather to discuss their adventures. Perhaps a radar system was malfunctioning and after several tries, the pilot figured out a workaround, to bypass the usual procedures. So he or she tells that story because it is the type of story that you want to tell a few times while its implications are sinking in, and the other pilots want to listen because it might happen to them sometime. They want to gain a vicarious experience...
>
> In the story telling of the pilots... experiences are being crystallized into expertise. Tricks of the trade are being discovered. (Klein, 1998, p. 183)

If we use experiences as a bank of metaphors and analogues, then it follows that we can expand that bank deliberately, by experiencing more stories, and we can gain “vicarious experience” by familiarizing ourselves with the stories of others. This has implications for education and training. We can “speed-up” the process of becoming expert by providing engineers and students with access to more stories. But as Klein points out, stories are beneficial to the teller as well as the listener and a way of improving expertise may be to provide engineers and students with more opportunities to tell stories.

Part of expertise is knowing what information is necessary and what can safely be left out – this ties to filters in chapter four, and changing photographic vision in chapter five and we shall return to storytelling in chapter eight.

3.8 Beach: Forecasting, values and narrative validity

Lee Roy Beach contributes an additional view of narratives. Whilst the narratives that Klein considers are used to determine whether a particular option will lead to a successful outcome, Beach also considers how we view our own and others narratives. From which we can begin to consider what is likely to challenge a narrative and what types of response we might expect to such challenges.

> The elements of narratives are symbols that stand for real or imagined events and actors, where the latter is animate beings or inanimate forces. The glue that binds the events and actors are causality and implied purpose. A narrative consists of a temporal arrangement of events that are purposefully caused by animate beings or are the result of inanimate forces... The narrative's story line is the emergent meaning created by arranging the events and actors in terms of time, purpose and causality. That is, just as arranging words into sentences creates emerging meaning that the unarranged words do not have, and arranging sentences into larger units creates even more emergent meaning, arranging events, actors, time, purpose and causality into a narrative creates meaning that is the narrative's story line or plot. (Beach, 2010, p. 26)

Beach distinguishes between narratives about our current state from narratives about our past and future states. We use narratives to work from our current state to create a forecast of what we think will happen in the future, which we then judge to be desirable or not.

> Your current narratives plus your extrapolated forecast constitutes a story about how you expect the past and present to evolve into the future. If the forecasted future is desirable, because it satisfies your values, you can simply keep doing whatever you're doing and let it happen.
>
> If, however the, the forecasted future is not desirable, you must do something different. You can start by reevaluating your forecasted future to see if it really is as undesirable as you at first thought. If it is, you can try to escape it, you can simply hunker down and endure it, or you can actively intervene to change it. (Beach, 2010, p. 59)

This description fits with the recognition primed decision model. If the forecasted future is desirable then you use the option under consideration. So the commander having recognised the vertical fire forecasts that the fire can be stopped, views this as desirable and acts accordingly, without considering any other forecasts or options. However, the lieutenant that is responsible for rescuing the dangling woman safely considers and rejects several forecasts before choosing an option that is considered desirable.

Beach offers four ways that we can respond to an undesirable forecast; we can reevaluate to determine if it is actually undesirable (which may, in certain cases, be a form of aspiration adaption), attempt to escape it, hunker down or actively intervene. When engineers face decisions (including the simulated decisions of case studies) these are the options that are available to them. The standards by which they determine whether or not a forecast in undesirable are their values.

> Because they are frequently so fuzzy, most of us have difficulty describing our values. But because they're crucial to what we do so, they are reflected in our behavior. By watching what you and others do and say, it is possible to infer the underlying values. (Beach, 2010, p. 53)

Beach suggests three cues for inferring values based on how they are described.

1. Expressions of obligation: "ought", "should", "guilt", "shame".
2. Expressions of approval; including acceptance and praise.
3. Expressions of fear: anxiety, terror, distress, rage, anticipated regret.

Beach also notes that values and virtues are not synonymous and "[j]ust as values aren't always virtues, they also don't always prevail. You like to think that your primary values are rock solid, but you know full well that you have failed to live up to them in the past and are likely to do so again. The big problem isn't that you don't have values or that you hold them so lightly that they don't influence your behaviour; it is that you sometimes fail to realize (or perhaps acknowledge) that they apply in a particular situation." (Beach, 2010, p. 54)

Beach's values are intended to be descriptive; they are the things that you actually value, rather than the things that you should value. The first of Beach's four responses to an undesirable forecast could be a consideration of your values. Our expressions of value can change in the face of narratives that seem undesirable[26]. So one way that we can challenge a narrative (used here in Lakoff's sense e.g. long term description of what an engineer is and does) is to provide forecasts based on that narrative that we would view as undesirable. The danger with that approach is that the engineer may not respond to the forecast by reevaluating the narrative but respond by hunkering down. They accept that the forecast is undesirable, but view it as unavoidable and accept what we hope should be the unacceptable.

Beach's "big problem" is the issue of highlighting and hiding that Lakoff and Johnson identify. It is not that in a given situation your values change, but that you do not recognise them as relevant to this decision. Lakoff's view on narratives is then perhaps best thought of as the bubble that surrounds Beach's forecasting narratives. How we forecast the future, and how we judge whether or not that is desirable is based within a wider narrative structure.

[26] Consider the classic objection to Kant's view that it is never permissible to tell a lie; that this would obligate us to tell the murderous axe man that his intended victim is indeed hidden in our house. By forecasting this outcome, and considering it undesirable, we might alter our expression of our values to state that it is *normally impermissible* to lie.

This view puts the decision maker as central to the narrative, we are considering what values they use and how they forecast the future. But we also use narratives to evaluate the actions of others. We may then use this as a basis for forecasting and evaluating our own further actions (e.g. "it's acceptable to harm this individual because they did something that made them liable, e.g. incarcerating murderers").

This might impact on how we approach altering the narratives of engineers. I present an alternative narrative or a variation on a narrative that I believe that you might hold. You have to consider whether or not you think that this is a valid narrative. If it is not, then you can ignore it. If it is a valid narrative then you have to consider how to respond.

> [T]here are two kinds of narrative validity, conceptual and empirical, both of which inform narratives by affirming them or by prompting their revision. Narratives are conceptually valid insofar as they are plausible and coherent; a good narrative "feels right" and, therefore, is believable. Narratives are empirically valid insofar as they successfully predict the future (including the results of actions that are based upon them) and the degree to which they are consistent with other, closely related, narratives. Similarly, other people's narratives are regarded as conceptually valid if they are plausible and coherent, in and of themselves, and if they are consistent with your own narratives. You regard their narratives as empirically valid if they successfully predict the future. (Beach, 2010, p. 27)

In the next section I will discuss the difference between narratives and rules of thumb, one of the differences being that we often have an emotional attachment to our narratives. Beach offers us a reason for being attached to our narratives, we hold them because they have been tested and been found to be useful (not all narratives of the sort Lakoff proposes fit into Beach's use of narratives as forecasting tools, but those that do have been tested and found useful). Beach suggests two grounds on which we would reject a forecasting narrative, either that it does not fit with our current narratives (it "feels" wrong). Or because we do not think that it would successfully predict the future. If we wish to alter the forecasting narratives that engineers hold we then have two standards which could both help and hinder us. We can demonstrate that an existing forecasting narrative is inadequate because either if fails to predict the future (we can approximate the future by the use of future expressed case studies – what would you do if) or because it requires the individual to hold an incoherent position in relation to their other narratives. But, just because a narrative failed to predict that a particular outcome would occur does not mean that the narrative should be abandoned. Whilst in some cases demonstrating that a narrative will lead to undesirable outcomes might encourage the engineer to change their position, we should not expect that this will always be the case. This approach to altering narratives is one item in the tool box of ethics education.

Lakoff's descriptive narratives are not always forecasting (although they may be used in this way e.g. an engineer who decides to blow the whistle may be adopting a variant of a David and Goliath narrative where they are taking on a might organisation, will suffer but will ultimately triumph because of the justice of their cause). But the beliefs that form the background of Lakoff-style narratives about the engineer (e.g. the belief that the public are ill-informed and have a poor understanding of risk) will also be present in forecasting narratives, and challenging the forecasting narratives may also challenge these beliefs.

3.9 Differences between narratives and rules of thumb

There are several similarities between Klein's predictive narratives and Beach's forecasting narratives (treated together in this section) and rules of thumb; we use them to evaluate decisions, to check data and to limit the number of useful options that are available to us. Engineers are familiar with rules of thumb as part of teaching and practising engineering. Highlighting the differences between the two concepts can show us why altering an engineer's narratives can have a more powerful influence in changing their ethical decisions than providing them with rules of thumb used to approach ethical considerations.[27]

Engineers are familiar with the concept of "rules of thumb" which Donald Woods describes as;

> Rules of thumb are numerical values and suggestions that are reasonable to assume based on experience. They are based on the application of fundamentals and practical experience. They do not replace fundamentals but rather they enrich the correct use of fundamentals to solve problems. Rules of thumb:
>
> - Help us to judge the reasonableness of answers;
> - Allow us to assess quickly which assumptions apply;
> - Are used to guide our better understanding of complex situations; and
> - Allow us to supply rapid order-of-magnitude estimates. (Woods, c2007, p. 1)

Rules of thumb are similar to several ideas that we have already considered in this chapter. Gigerenzer compares the heuristics of bounded rationality decision theory and biological rules of thumb, which are observations of the behaviours that animals use to make certain decisions e.g. ant search patterns in determining appropriate nesting sites. Gigerenzer views

[27] This is not to say that rules of thumb might not be useful in engineering ethical decision making in some cases.

some biological rules of thumb as human heuristics, “biology considerably broadens the range of examples of heuristics, some of which will turn out to be shared between animals and humans” (Gigerenzer, 2008, p. 64). Some rules of thumb are heuristics that tell us how to do something. They could be described in the form used when considering the baseball example above; to catch the ball, maintain a constant angle of gaze.

Wood’s description of rules of thumb suggests that that they can aid our decision making when our intuition does not produce a strong response to a situation. As Klein’s work on expertise shows, if we have experience in a field we can construct a narrative that allows us to easily identify whether or not a particular mathematical result or machine response is typical or atypical for the situation. In the absence of such a response, the rules of thumb that Wood proposes would allow us to perform a quick mental calculation and determine whether or not the outcome is more likely to be typical or atypical.

So we can use rules of thumb to check our understanding (if(???)... then situations) and use rules of thumb to suggest courses of action (if... then(???)). We will consider the role of expertise in relation to decision making in chapter four. However, we can understand rules of thumb as being most useful in the absence of expertise. Klein offers a clear description of Hubert Dreyfus and Stuart Dreyfus’ explanation of this;

> “Hubert Dreyfus and Stuart Dreyfus (Dreyfus & Dreyfus, 1986) have described how people move from the level of novices to experts. They claim that novices follow rules, where experts do not. We would be mistaken to think that the experts had learned the rules so well they did not have to refer to them. Hubert Dreyfus uses the example of learning to ride a bicycle by using training wheels. As adults, we do not believe we learned to use those training wheels so well that they became an ingrained part of our bicycle riding perspective. We outgrew the need for training wheels. We developed a sense of bicycle dynamics.” (Klein, 1998)

Implicit in the idea of the rule of thumb is the awareness that it is an approximation, a rough rule that generally works but does not universally hold true. Part of developing expertise is knowing how and when rules of thumb will become inappropriate. It is not a requirement that all rules of thumb are consciously considered (we are not aware of all our decision heuristics). Our narrative understandings are taken more seriously and are often held to be important and universal. The distinction that I have presented here is one that is the result of increased experienced. If I have tested and refined my narratives over years and found them to be consistently successful, and if they are part of the standard by which I judge something to be typical or atypical, then if I find something challenges my narratives I am likely to trust my narrative and think that this case is atypical, rather than that my narrative is wrong.

Let us consider a case where two ideas I hold are challenged. The first is a rule of thumb, and someone suggests to me that upon this occasion following the rule of thumb would be a bad idea. I will probably find it to be relatively easy to recognise that this is the case and acknowledge that a rule of thumb isn't always applicable. By contrast, if someone suggests that my narrative is flawed I am more likely to become defensive; because I believe that my narrative is stronger than a rule of thumb. It is possible to challenge my narrative (and so elicit my defensive response) without ever identifying or recognising it specifically, because we have emotional responses to things that touch on our narrative views. We will consider the implications of attachment to our current views in chapter five.

The distinction between narratives and rules of thumb that I have raised are the distinctions of expertise vs. rule following and the level of trust that we place in our views. The relationship between these two ideas highlights a distinction between teaching engineering ethics and teaching some other elements of engineering. Students are more willing to consider rules of thumb and want to check for validity of information when they are engaged in activities in which they do not consider themselves to be experts. Since ethical reasoning as an individual is something that we do well before university, engineering students may not recognise themselves as beginners at ethical decision making, even though the engineering context is new to them. I will return to this in chapter seven.

Finally, rules of thumb and narratives are not necessarily always distinct. Rules of thumb can become narratives, and this process is a place where we might have concern, because what might be 'generally true' can be problematic if it is taken as universally true. So, it is plausible that as an engineer you do not have to consider ethics as a significant issue in your day to day work. If you work in an industry you consider morally acceptable, in a company whose general practises and policies are morally sound with people whose moral judgements you trust then your primary concerns could well be technical. In this case it seems that there is a perfectly valid rule of thumb that goes "I do not normally have to think about ethics". In order to make this more defensible we might we require that the engineer add a description of the context, "I do not normally have to think about ethics because I work in an environment where unethical practice is very rare". However, if this solidifies into a narrative that is "I don't have to think about ethics" then we become concerned. In the first case it seems to be true that ethics isn't a significant consideration on a day to day basis but in the second the narrative now filters out any possibility that ethics could be a significant consideration in making a decision. We shall come across similar examples in chapter four and also when considering teaching by omission in chapter seven.

3.10 Narratives of "the engineer"

Just as Anna Nicole Smith's life could be described in several ways, so there are multiple ways of viewing what an engineer is. Not all the narratives that might be considered will be found to be valid or appropriate, and particular narrative elements are considered in greater detail in chapters five and six. But, just as altering the narrative of Anna Nicole Smith's life changes the information that is highlighted and whether we consider it to be praiseworthy or not, altering the narrative of what it is to be an engineer will highlight different aspects of the role which in turn may highlight different moral issues. I will return to the idea of narratives in the next chapter once I have discussed the idea of photographic vision.

As a start point, we can consider some of the potential engineer narratives. Not all of these will be considered again in this work and the purpose of this list is to demonstrate that there is a range of possible narratives, and these narratives, whether justifiable or not, may be held by engineers and engineering students. This list is offered to demonstrate the concept of "narratives of the engineer". It is not complete and the narratives that are listed here are not all mutually exclusive.

- Ends Neutrality – engineering is about process, the reasons for the specification and the value of the outcome should not concern engineers. The role of the engineer is to focus only on how to best complete the task at hand.

- Pure Technician – the engineer's task is not a political one, and engineers should only be judged by practical accomplishments (Speer, 1970)

- Ethical Rebel – engineers should think about the ethical implications of their work by distancing themselves for their professional role and thinking like laypeople (Sammons, 1993)
- Integral Professional Engineer – making ethical decisions is an essential and unavoidable part of what it is to be an engineer and engineers can look to their profession as a source of ethical values (Sammons, 1993)
- Aspirational Engineer – Engineers have the opportunity to make the world a significantly better place by choosing what projects they focus on. Encouraging engineers now to express their work in this way will encourage more ethically-aware students to choose engineering in the future. (Bowen, 2009)
- Engineer knows best – engineers have expert knowledge and skills and understand the implications of their decisions better than the public. The role of the engineer is

to make the decisions for the public because the engineer is the best placed person to make the decision.

- Facilitative engineer – the public's ability to perform many types of action is limited by the technological options that are available to them. The role of the engineer is enable others to perform the types of action that they wish to perform
- Technological pioneer – engineering is about creating things that are faster, bigger and more impressive than ever before. Engineering is exciting because it is about pushing the boundaries of human knowledge and creating novel and exciting technology. The role of the engineering is to produce the best technology possible.

The narratives do not only include background beliefs on what an engineer does (and should do) but also views on what a profession is, the place that engineers have in the world and how they should act towards those who do not have the engineering knowledge that they do. Influencing these beliefs will affect the narratives that engineers have about their role, which in turn will influence their actions. The relationship between narratives and decisions will be considered further in chapter four, and a discussion of the validity of elements of the narratives listed here will be covered in chapter six. . In section 6.3, a subset of this list will be considered which focusses on how engineers should respond to their professional role.

3.11 Using narrative shifts to improve decisions

An engineer's narrative about what their role is, and how they should act, hides and highlights particular information, making it easier or more challenging for him or her to appreciate certain types of information, including ethical information. A shift in narrative would mean that the engineer could easily see information that was previously hidden, with access to different information their decisions may change.

3.11.1 Narrative shifts: An example

An example of a suggested narrative shift is given by Richard Bowen in Engineering Ethics: Outline of an Aspirational Approach. Bowen uses Buber's descriptions of human activities as *I-It* and *I-Thou* (Buber, 2004). Bowen characterises current views on engineering as *I-It* relationships that focus on experiencing and using, "[including] the world in which the engineer would usually be seen as carrying out his or her professional tasks, the world of mathematical analysis and physical exploitation of materials and processes" (Bowen, 2009, p. 71). In contrast *I-Thou* "is characterised by *meeting*" (emphasis in the original).

> Engineers would certainly recognise I-Thou experiences in their interpersonal relationships and most likely in their interaction with the natural world. However, they may not have considered such I-Thou experiences as being part

> of their engineers activities. This vocabulary and approach should encourage engineers to re-evaluate their attitudes to the ethics of their professional activities. (Bowen, 2009, p. 73)

Bowen is offering two narratives here about how engineers view their work, as interacting with things or interacting with people. These two narratives might imply different ethical obligations and the switch from an *I-It* focussed approach to an *I-Thou* approach could be a narrative change that would improve the ethical decisions made by engineer by increasing the likelihood of the engineer including considerations not previously included in their decision making.

This is not to suggest that engineers are currently characterising their deliberations and narratives in this way. We can make a distinction between the content of the narrative and the process that we require to change it. It may be, in the case that Bowen considers the dialogue he creates can actually do both, it can inform us of a narrative and by that information process can persuade us that one narrative is better than another. Chapter five will examine changes in photographic vision and narratives in more detail.

3.12 Conclusion

Engineer's narratives about themselves, their role and how the world works shape their vision of the world and influences what information they can easily see and process and the first places that they will look for answers when considering decisions. Some narratives make it more challenging that others for engineers to perceive the potentially ethically significant elements of their decision making. Narrative shifts can alter how engineers make decisions, including the value of considering ethics.

4 Improving decision making: using our lenses better

4.1 Introduction

The previous chapter established that different people view the same information differently. In this chapter I build on Michael Davis' 'microscopic vision' described in chapter two, to suggest that engineers (and others) have 'photographic vision' – that we view the world as if through the lenses and filters of a camera.

Davis gives the name of microscopic vision to his metaphor, the metaphor itself can be described in the form used by Lakoff and Johnson as SPECIALIST VISION IS THE VIEW DOWN A MICROSCOPE. In a similar manner I propose a metaphor to understand specialist vision is HUMAN PERCEPTION IS THE VIEW THROUGH A CAMERA and I call this metaphor "the photographic vision metaphor".

The metaphor suggests that there are two major ways that information is hidden; as a result of changing magnification (scaling) and by removing information from the picture even when in the field of view (filtering). A special form of filtering can result from a concentrated focus on part of the picture, where other information is unintentionally lost as a result. We can use this metaphor to consider some cases of wrong doing within engineering and offer an explanation for decision making that does not rely on poor decision making or weak willpower. In this sense poor decision making would be when one uses the available information poorly, as opposed to having poor information but making what would be a good decision if the information were correct.

Which information can be safely removed from the picture is dependent on the decision maker's circumstances, and I consider the implications of changing circumstances on photographic vision.

In addition to photographic vision there appear to be cases that do not fit the metaphor in so far as there is no corresponding sacrifice of information to go with the gain of information that an expert has. These cases are acknowledged and dealt with separately from the camera metaphor. Another important idea also not covered metaphor (the importance of professional obligations) is acknowledged. Finally I argue that one way to improve decisions is to focus on improving how engineers use their photographic vision (by using the correct scale and appropriate filter).

4.2 Metaphor: photographic vision

The review of the work of several authors writing on "narratives" in the previous chapter highlighted a commonality which is that different people, presented with the same information will see different narratives, with different implied ethical views. We do not all view the world the same (or hear, smell, taste or feel it the same either).

This distinction is one that is central to the idea of microscopic vision created by Michael Davis (see chapter two for an explanation of microscopic vision). Davis introduces the idea of microscopic vision by considering a shoe maker. As Davis points out, a shoe maker and I might be looking at the same pair of shoes in a shoe makers shop, but what we see and what we are able to conclude from that information is radically different. This has a significant impact upon our decision making because what we perceive limits what is available for us to consider when making decisions. Also important is the idea that we have a limited field of vision - we cannot see everything that there is to be seen at once. We may need to move the slide back and forwards under the microscope in order to examine everything we wish to look at.

In order to encapsulate some important distinctions in how we see information I will expand Davis' metaphor, and suggest that instead of considering only a microscope we might be able to clarify further distinctions if we consider a camera, showing that 'microscopic vision' is a form of 'photographic vision', both literally and metaphorically. They share some important common features; that there is a lens between the object and the eye seeing it (or the film capturing it); that altering the lens alters what is seen; and that the lens limits the field of vision to a fixed size.

4.3 Scaling

Microscopes are valuable to us because we can see things under the microscope that are invisible to the naked eye. When we zoom in and increase the magnification we reduce the area that we can see, but we can now see greater detail than we could previously. There are objects that we can only see when we use magnification. We can take this idea further than Davis by suggesting that there are not two distinct views (down the microscope and looking up from it), but rather an infinite range of possible degrees of magnification. As an example, let's consider maps. If I want to find out where another building on my university campus is, I will not use the same map that I would use to plan my driving route from London to Edinburgh, which in turn might well be different to the map that I would use to check how close Argentina is to Mexico. Each of these maps shows us something different and allows us to see things that are not visible on the other maps. It might be possible to use walking-scale maps to plan my journey from London to Edinburgh, but it will be difficult to see the whole journey if I do so. As Davis observes in relation to microscopic vision we can view each map scale as sacrificing some elements of information present on the other maps with the benefit of more useful information at the required scale.

This concept of scales of magnification is useful because it allows us to think not only of the gradations between microscopic and naked eye vision, but also to consider the macroscopic as well. This is especially important when considering engineering ethics, because the scale at which the ethical implications of an action become apparent may be neither the microscopic scale nor the naked eye view, nor any point in between, but rather by changing our magnification and considering the large human scale on which many engineering projects are conducted. So an engineer could be working on a crematorium, and at the detailed level of his design decisions not see that there are significant ethical concerns that might apply to his work. He might well look up from that microscopic vision to consider the organisation of the business and his interactions with clients and colleagues and not see any significant ethical concerns. It may be that he is required to consider the macroscopic position that the crematorium he is designing will be used in a Nazi death camp for the genocide of hundreds of thousands of people before the ethical concerns become clear. (We will return to this example later in the chapter in more detail.)

So we can imagine an engineer who, looking down a microscope, or looking up from it, can equally well say that they do not think that there are significant ethical points that they should consider in their decision making, but who might change their minds when considering the scale of the impact of their work.

We can use this understanding of scaling to explain some types of poor decision making, "Engineer X was functioning at the wrong scale". In terms of a camera, we can imagine that someone was using a lens with the wrong magnification. (Normally we tend to use magnification to mean a lens such that the photograph is larger than the original object, but in our case we are also using it to include cases where the picture is smaller than the original object, e.g. a map.) At the extreme, this poor decision making might mean using a telephoto lens when a wide angle lens would have been more appropriate. Or it might mean using a telephoto lens with a different degree of magnification. We would not say that the photographer is using a "bad lens" but that they are using the wrong lens for the situation.

4.3.1 Ways information is hidden through scaling

Figure 4-1and Figure 4-2 show us two photos of the same view, where one is using a wide angled lens and the other a telephoto lens. In Figure 4-1 we can see a wide area of the playground, but it is not easy for us to say much about the cars parked on the far side of the field. The information is hidden from us because the scale is one that does not make it easy for us to see it.

In Figure 4-2 we can see the cars much more clearly, but the church tower that was visible in the top left hand corner of Figure 4-1 has now disappeared from view as had the playground shelter straight in front of us – they have become hidden because the change in scale means that we are now seeing a smaller area in greater detail.

Information can become hidden when there is insufficient magnification to reveal it clearly, or when a reduction in the field of vision means that it is no longer in the picture. Imagine that we wanted to count the number of panes of glass in the large church window. Neither of these photographs will enable us to do this, so in order to capture the right information we need to be functioning at the correct scale, and have the camera aiming in the right direction. We may need to do more than zoom out in order to see a new piece of information, we may also need to zoom in on a different area.

Figure 4-1 Photo using wide angle lens[28]

[28] With thanks to Rob Lawlor for providing the photographs used in this chapter.

Figure 4-2 Photo using telephoto lens

Later in the chapter I will discuss the role that expertise plays in altering our photographic vision, but for now understanding scaling already shows us something important. A group of engineers will not all be working at the same scale, and of those that are, they will not all be looking at the same part of the picture. This is important because it suggests that each engineer may be in a position to see something that no one else can see, because they are the only one looking at a particular part of the picture at that level of detail. Recognising that they might hold a unique view means that the engineer cannot assume that information that is obvious to them is visible to others. It makes it more challenging to hold the view, "surely if this is important someone else will see it". There is a further discussion of scaling in chapter six.

4.3.2 Hyatt Regency Kansas City walkway: a possible example of scaling

The Hyatt Regency Kansas City hotel started development in 1976. The design included a walkway running across the full height of the hotel atrium and was a double level walkway suspended from the ceiling. The original designs called for rods to connect to the ceiling which connected to both the upper and lower levels of the walkway, each walkway being held by nuts beneath the walkway floor. The general contractor (Eldridge Construction Company) hired a subcontractor, Havens Steel Company, for fabrication and erection of the atrium steel. The long rods had to be threaded for most of their length, so that the nuts used to hold the upper walkway in place could be put onto the rod. The extensive threading significantly increased the cost of the rods. Havens suggested altering the design so that there would now be two shortened rods. The upper rod would run from the ceiling to the upper walkway and the lower rod would run from the upper to lower walkways.

What appears not to have been considered in this change was that the nuts attaching the upper walkway to the rod had been designed only to carry the weight of walkway and guests using it. Now in addition the upper walkway nuts also had to carry the weight of the supports down to the lower walkway, the lower walkway itself and guests using the lower walkway. In 1979 part of the atrium roof collapsed. The structural engineers overseeing the project investigated and reported that the atrium design was safe. In July 1981 there was a dance, with a large number of people dancing on the walkways. The large load of people and possibly the swaying movement from the dancing led to the nuts on the upper walkway failing. 114 people died and 185 were injured. (Fleddermann, 2004)

> Two factors contributed to the collapse: inadequacy of the original design for the box beam-hanger rod connection and a change in hanger rod arrangement during construction that essentially doubled the load on the box-beam hanger rod connections at the fourth floor walkway. (Pfrang & Marshall, 1982)

Case studies of this sort are often messy for us to think about, because there are several different things that are happening in the same case study. The inclusion of different companies with different responsibilities complicates the case here. Issues around the involvement of multiple groups or individuals in failures will be considered when discussing risk in chapter six. However, we can create an account of what happens that says that the failure was overlooked in part as a result of scaling.

We do not know what the individuals involved were thinking, nor do we know how the decision process was divided up within Havens, but it is plausible that there was an engineer who was concentrated on answering the question, "how can we cost effectively produce threaded rods of the required length?" Their solution did produce threaded rods of sufficient length to meet the original specification. The impact of the design changes on the nut load was outside their field of vision, because their level of magnification meant that they were intently viewing the information concerned with the manufacture of threaded rods (the nuts were not too small to see, rather they are not outside the engineer's field of vision, because he is seeing a small amount of the design in great detail). Equally, the engineer who was considering the specification for the nuts, might not have had within his highly magnified field of vision considerations relating to how the threaded rods would be manufactured.

Understanding the role that scaling plays in an engineering failure is not the same as excusing that failure; but it might suggest part of how we prevent such failures in the future.

Understanding the idea of scaling means that we can now say that there should have been someone who had in their field of vision the impact of changing the rod design on the nut load.

4.3.3 Scaling and the "Silo Mentality"

Schinzinger and Martin mention briefly the concept of "Silo mentality" (Schinzinger & Martin, 2000), and suggest that this may be partially responsible for the failure to notice the implications of the change in design in the Hyatt-Regency Walkway case. The Silo Mentality "makes engineers disregard or hold in low esteem the work carried out by groups other than their own" (Schinzinger & Martin, 2000, p. 4).

By considering the concept of scaling we can appreciate the silo mentality as an understandably natural occurrence. Different engineers within an organisation are operating at a range of different scales, and focussing on different parts of the picture (corresponding with their different areas of competency). This means that the information that is revealed by the working scale of one engineer is hidden at the working scale of another engineer. If you work with details that are hidden from me at my operating scale it will be hard for me to appropriately value the work that you do. I may not seek to deliberately undervalue it, but it is hard for me to create value for it within my current frame of reference.

To say that it is an understandable occurrence is not to suggest that we should not work to prevent it happening. If the silo mentality means that one group of engineers fail to share information with others, thinking that they wouldn't think it was relevant, we leave ourselves open to a Hyatt-Regency style failure. Rather, having an understanding of the concept of scaling on our ability to appreciate information outside of our expertise might provide us with better ways to minimise the associated risks.

4.4 Filtering

Davis' microscopic vision is about more than just scaling, it includes the idea that when we are functioning in an area of expertise we have a heightened ability to distinguish between key features that are potentially important. Consider the shoemaker that Davis uses as his original example. This is not just a case of scaling, although the shoemaker may be closer to the shoe and looking at it in more detail than I am. When the shoemaker looks at the shoe in my hand he can distinguish potentially relevant features that are completely hidden to me. But Davis observes that this comes at a cost, "[w]hile he [the shoemaker] is paying attention to people's shoes he may be missing what the people themselves are saying or doing" (Davis, 1998, p. 66). As Davis presents the case, the shoemaker is filtering out information on person's actions in order to gain clarity of information about their shoes.

So an experienced maintenance engineer when faced with a malfunctioning machine can quickly test and rule out multiple possible problems because he can distinguish the key information that is relevant. If I were to go to the same machine and examine the failure logs it might take me days to determine if there is a fault, never mind the type of fault that there is. This though is not an issue of scale - we are looking at the same information with the same available level of detail - but rather an issue of filtering. As we saw in chapter three when considering Bounded Rationality, filtering is part of how humans make decisions. This idea of filtering is implicit in Davis' description of Bounded Rationality, but is perhaps more intuitively understood when considering a camera filter.

We can use filters to limit the colours that reach the camera. So a red filter allows through red light, a green filter allows through green light etc. Filters can be useful because information that is unclear without the filter can become much easier to recognise with a filter in place. For example, consider the Figure 4-3 and Figure 4-4. These are both examples of an Ishihara Plate used to diagnose colour blindness. Figure 4-3 shows the plate as it is normally seen. If you have normal colour sight then you will see a number "42" made of red dots in a circle of green dots. Figure 4-4 shows the same image with a red filter applied. Now we can only see the red parts of the original image more clearly, and the number becomes much more visible. This clarity of what is left is important. The extraneous information is not just unnecessary but can be an actual hindrance to our ability to understand the useful information.

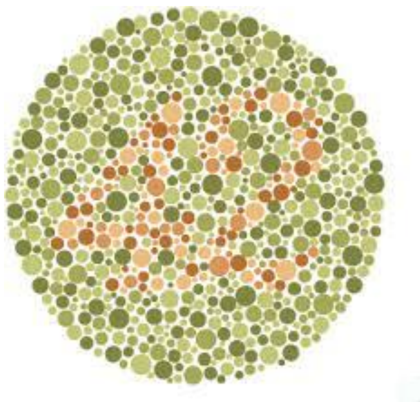

Figure 4-3 Number plate used to test for colour blindness (Waggoner, 2014)[29]

[29] With thanks to T.J. Waggoner and Konan Medical for use of this image.

Figure 4-4 Figure 4-3 with a red filter applied

This kind of filtering also involves the same information sacrifice that Davis talks about in microscopic vision because although we can now see the number more clearly, we no longer know what the original colours were. In fact we can imagine a case where the “4” is red and the “2” is in blue. If I look at it through a red filter I see the “4”, you look at it through a blue filter and see the “2”. Neither of us sees all the information but we can each see part of it clearly. Without an understanding of the filtered nature of our vision I might struggle to understand why you are not seeing the same thing that I am, and I might form incorrect judgements about how well you can see things as a result.[30]

In the next section I will argue that filters are not something that we remove so that we can see an image without them. We can swap between filters but not remove them completely. Figure 4-5 and Figure 4-6 are photographs of the same subject taken with the polarising filter in two different positions. The filter only allows light with polarity matching that of the filter through, and as the photographs clearly show, altering the filter significantly changes the information that is available in the final image.

[30] This might also contribute to the ‘silo mentality’ discussed earlier.

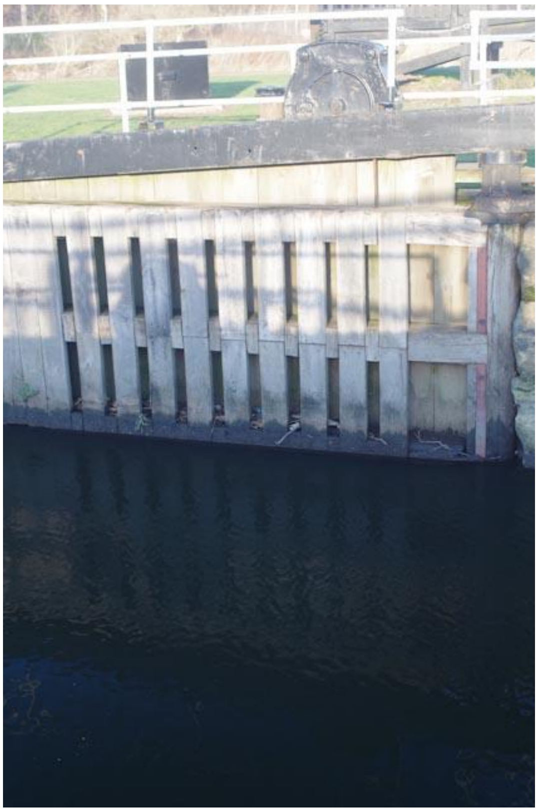

Figure 4-6 Photo with polarising filter in position A

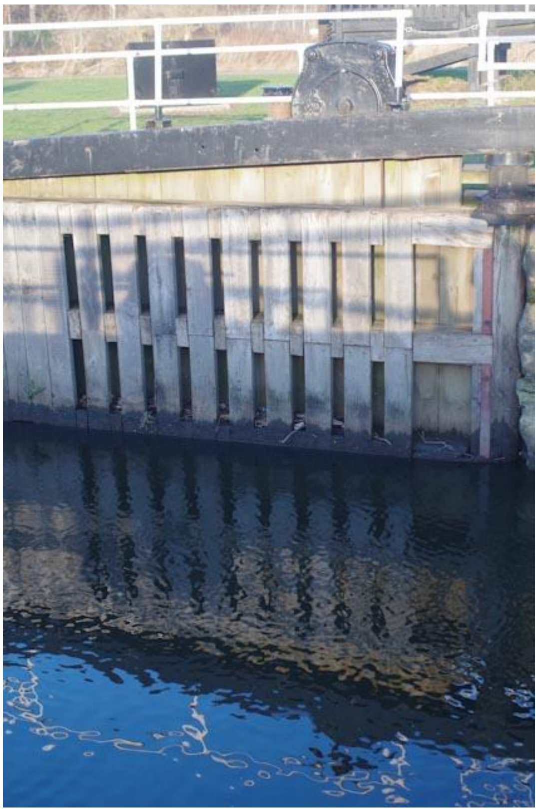

Figure 4-5 Photo with polarising filter in position B

4.4.1 Filtering as a constant state

In relation to scaling we can imagine a neutral point between the microscopic and the macroscopic, what we see when we just look at something with the naked eye, and we have a common sense view of the types of things that we can and can't see at this level. We acknowledge that we are still working at a particular scale. We do not think that using our eyes without any other magnification rather than a microscope means that we are operating "without scale". It is less obvious, but in the case of filters the same holds true. We never look at all the potential information that is there for us to see. We are always filtering information. We may have the ability to change the filter that we are using, but we cannot remove all filters completely. However, unlike in the scaling case this might appear more challenging to accept, because we can imagine the camera metaphor without a filter. Plenty of photographs are taken where no filter is used.

A good example of unfiltered information perception is the explanation given by in Mark Haddon's novel "The Curious Incident of the Dog in the Night-time". The narrator has Asperger's Syndrome and is describing how he experiences new places.

> [W]hen I am in a new place, because I see everything, it is like when a computer is doing too many things at the same time and the central processor

> unit is blocked up and there isn't any space left to think about other things. And when I am in a new place and there are lots of people there it is even harder because people are not like cows and flowers and grass and they can talk to you and do things that you don't expect, so you have to notice everything that is in the place, and also you have to notice things that might happen as well. And sometimes, when I am in a new place and there are lots of people there it is like a computer crashing and I have to close my eyes and put my hands over my ears and groan, which is like pressing CTRL + ALT + DEL and shutting down programs and turning the computer off and rebooting so that I can remember what I am doing and where I am meant to be going.
>
> And that is why I am good at chess and maths and logic, because most people are almost blind and they don't see most things and there is lots of spare capacity in their heads and it is filled with things that aren't connected and are silly, like, 'I'm worried that I might have left the gas cooker on.' (Haddon, 2003, p. 177)

Haddon's character is describing a situation where he is not filtering, and the result in overwhelming. In the book Haddon describes the difficulties the narrator has managing to catch a train to London, the lack of filtering makes it harder for him to appreciate the patterns and ways of working that appear obvious to others. Filtering is both valuable and unavoidable.

That we don't always recognise that we are using a filter shows why understanding the metaphor can be powerful. It allows us to recognise that we don't have all the information, in the same way that recognising that we are working at a particular scale may help us intuitively understand that we cannot see everything that there is to be seen.

If we filter all the time, then students that are studying to become engineers do not enter the profession filter-free. They already have filters that they have developed. This has implications for how we approach education that we will consider in chapter seven.

Scaling hides information because as we zoom in certain pieces of information are now out of sight given a limited field of vision (we might be able to move the microscope around to find some of the information again, but if we zoom in on a fixed point we will see information disappear off the edge of our field of view, and as we zoom out again we will see it reappear). Filtering hides information by preventing it reaching us. Sometimes part of the information on an object can get through, and part is lost. In Figure 4-4 we can still see that there are dots around the number 42 but their original colour has now been lost. This is potentially problematic if we are unaware that we are filtering. If I am looking at Figure 4-4 and you tell me that there are green dots around the 42, I would believe that you are mistaken. I can clearly see that that there are dots and that they are not green. Unless I understand that the filter I am looking through has removed some information I will struggle to understand that you can actually see green dots (rather than are lying or mistaken about their colour). This is significant because it means that people could disagree about the ethical value of something that they think that they can both see. We can now imagine an engineer who has a filter influenced by the belief, 'the public are stupid'. Any idea that we should involve the public in engineering decision making is filtered out as a result of this belief. If we have a project where we want to be able to include the public, it is not that the engineer cannot see the project or the decision that needs to be made, but the value of public involvement has been filtered out, so that the engineer does not recognise that it is there.

4.4.2 Understandable Failures

These two ideas (scaling and filtering) allow us to explain failures in ethical decision making in a way that allows us to empathise with, and understand, the decisions that engineers have made that led to failures, disasters or just recognisably poor decisions. I do not intend to claim that all poor decisions made by engineers can be explained in these terms. There may be cases where someone makes a poor decision on spurious criteria or makes the right decision but then fails to follow that through into action, and doubtless other cases as well.

But, for some cases, we now have a richer vocabulary to discuss incidents and encourage engineers to reflect on their practise. Recognising that colleagues may well be functioning at different scales can allow engineers to realise that they hold a potentially unique view of circumstances that may be invisible to everyone else in the decision process. Filtering allows us to understand that we rarely have the "full" picture, because that is not normally what allows us to work well, but that realising this might encourage us to consider whether or not our filters are appropriate for a particular situation.

4.4.3 Focussing

Filtering implies an intentional choice to disregard certain information, and in many cases there is information that can indeed be appropriately disregarded. In addition, we can also fail to perceive information as a result of our focus on a particular object. An example of how focussing causes us to lose information can be seen in the experiments conducted to test for inattentional blindness. Participants in the study were asked to watch a video of a group of people playing basketball and count the number of times that the basketball was passed amongst the group. During the video a person dressed in a gorilla costume comes into view, moves through the group on screen and then leaves from view. Study participants were asked if anything out of the ordinary had taken place and across most groups roughly 50% had not noticed the gorilla (Simons & Chabris, 1999). Their attention was focussed on particular information which meant that other aspects of the picture were not being considered.

Unfortunately we need to use the term focus in two different senses. In an everyday sense when we look at something we say that we are focussing on it. The participants in the study were focussing on the ball, not on the gorilla. We could say that two engineers with different specialisations (e.g. structural calculations and steel manufacturing processes) might look at the same design differently and say that they have different focuses. In this case we are using the term in the everyday sense.

In photographic terms the focus is the part of the picture that we want to see clearly, which is the bit that you make sure is clear when you take the photograph. Compare Figure 4-7 and Figure 4-8. The camera is in the same position both times, but in Figure 4-7 the gate is in focus and in Figure 4-8 the distant cars and houses are in focus.

Figure 4-7 Near focus photograph

Figure 4-8 Distant focus photograph

This second sense, photographic focus, gives us another way that potential information is reduced from the final picture that an engineer considers. In this case, their focus (in the everyday sense) on a particular point, goal or detail, renders the rest of the picture out of (photographic) focus to them. This is not literal filtering, there is nothing that has been removed or kept back such that it is no longer there. However, it is metaphorical filtering; the end picture contains less information than was originally visible. So we can think of focussing as a form of unintentional filtering, and the implications of filtering discussed throughout the work hold true for focussing too.

It would seem unusual to say that they had "filtered the gorilla out" since this might imply a conscious action that would require them to recognise that the gorilla was there. But their focussing on the basketball meant they did not see the gorilla – which is filtering of their photographic vision, in that available information did not make it to the perceiver.

There are two ways that recognising the impact of focussing is helpful to us. Let us imagine there are two engineers. As a result of discussion it becomes apparent that the first engineer has a filter, "ethics is not relevant to engineering". Any exclusively ethical considerations are filtered out, and those considerations that have an ethical component appear to the engineer with that component lacking (as the green dots are still visible through a red filter but in an altered state). The second engineer has a focus so that ethics is part of a very blurry background to a photo. Both engineers might say "I can see no ethics in my engineering". But in the second case we can point to an object that is still in view, and by encouraging the engineer to concentrate on it, bring it into clearer focus. For the first engineer we do not have that option. The filter must be in some way altered or replaced if the engineer needs to be able to see something that they are not currently considering.

The second way that it can help us is because it gives us another way of describing cases of poor use of photographic vision. Explaining to someone that changing their focus would allow them to perceive more ethical considerations than they currently do might be less threatening than explaining that they have used the wrong filter for the occasion.

It is also plausible that what starts as a focus could turn into a filter over time. So if, in my career, I never have any need to bring a particular consideration into focus, it is possible that I will believe that that is something that I can safely filter out of my thinking. This has particular implications for education that will be considered in chapter seven. In judging the actions of an engineer (where we do not know what the engineer was thinking) it’s not always clear whether a particular piece of information was not considered because it was filtered out or because it was out of focus – or even if it was actually considered, but rejected.

4.4.4 Focussing and rules of thumb

In the previous chapter I rejected the view that rules of thumb are narratives, and suggested that we might use rules of thumb in situations where we lacked the richness of understanding to form narratives. We have discussed the role of expertise in relation to filtering, and focussing as a form of unintentional filtering, in that we select information to put in and leave out. Rules of thumb act as a way for us to choose what we should make sure is in focus and what we can allow to blur out of sight when we lack the more complete understanding that comes with expertise. Rules of thumb are a part of the decision process by highlighting what is important in a given situation.

4.5 Scales, filters and expertise

Different scales reveal and hide different types of information and it is sometimes necessary to change between scales in order to appreciate the ethical implications of a decision.[31] But just looking through a telephoto lens or changing to a wide-angle view does not necessarily mean that the information is now clear. Each level of magnification may contain more information than we can easily process. So we combine the two approaches, filtering and scaling, in the work that we do.

As an example, imagine that a shoe maker and a fashion designer are looking at the same pair of shoes. They are looking at the same scale in this case. But how they would describe

[31] It may also be necessary to change between different scales in order to adequately consider other aspects of engineering decision making, not just ethical considerations.

the shoes, what they will recognise and the implications that that they can infer will be different because their expertise highlights and hides different information as being important. Presented with the same information, each will filter out the bits that they do not consider to be useful or relevant. This is not necessarily problematic, but if they think that they are doing the same thing in the same way they might be surprised and confused or make inaccurate assumptions about the other's professional abilities.

One distinction between the freshman undergraduate and the qualified professional is that their developed expertise allows them to filter for the pertinent information at the scale they are functioning at. If a freshman lacks the filters to appreciate what is important and the professional engineer has them, whilst the professional biologist has different filters, then it follows that the process between freshman and professional includes the formation of new filters, which are scale and focus specific (so a filter developed to diagnose faults in a shoe doesn't necessarily help us design a shoe that will be popular with consumers).

4.6 Focussing, filtering and scaling across time

Sacrificing information that is not relevant for information that is of use, given our limited perception, is part of the process of gaining specialist expertise and that expertise can be valuable to others. In our considerations so far we have thought of the loss of information as an instantaneous process. If I focus on the cars in Figure 4-2 I lose the ability to see the church tower we can see in Figure 4-1. This is problematic for ethical decision making if the church tower was an ethically significant consideration. Likewise, if I filter out a piece of information that was ethically significant and should have been included in my decision making this is problematic.

There is a way that ethically significant information can become lost over time. In this case were we correct in our initial assessment that a certain piece of information could be appropriately filtered, we did not need to be able to see the church tower and our time was well spent focussing on the cars. However, over time relying on this initial assessment can cause us to lose information that has now gained significance as a result of changing circumstances.

The following example is based on the work of Katz (Katz, 2011). Consider an engineer who works for a company that produce and maintain crematoria ovens. The engineer has significant experience (i.e. is not a recent graduate) and this is not his first employer. Having examined the company, and being familiar with the nature of the work and the industry he develops a filter which includes the background assumption "My boss is a good guy and will give me good instructions". ("Good" in this case is meant to suggest morally good, as opposed to, say, instructions that would be a "good" way of approaching the engineering task.)

This would enable that filter to highlight information that enabled the engineer to follow the instruction, and hide information that related to the moral appropriateness of the instruction. Let us assume that this lens developed in response to experience when this was actually the case. (So we are not considering cases where the engineer's boss was delivering bad instructions but nobody noticed.) It would be odd for the engineer to consider "is this an appropriate instruction to follow", every time his boss asked him to do something. We would consider it to be a well developed filter that allowed the engineer to concentrate on performing the task, rather than questioning its validity when the situation remains unchanged.

Now imagine that circumstances change. The engineer's boss starts to give unusual requests – including the development of crematoria plans that include no front side facilities (e.g. spaces for relatives to grieve and say goodbye) and the engineer is now being told that the integrity of the ashes is no longer important. (This is normally considered critical, because grieving relatives value the disposal of the ashes as part of showing respect to the dead e.g. by spreading them somewhere special.) If the engineer continues to use the same lens as before, he might not see that these changes could be significant. He might now continue to follow instructions when it is no longer appropriate to do so without questioning. His filter is now imperfect because it is being used in a situation where it does not highlight and hide in a way that allows him to consider pertinent ethical content. This is the personal side of the case that we considered in section 4.3. From this perspective it is chilling to see how possible it is for the engineer to struggle to recognise that the crematorium is being used to facilitate genocide. We will return to this case study in chapter five.

Using the camera metaphor framework, we can criticise the engineer by saying that he used the wrong filter for the task (not that the filter was bad). The filter has become the wrong one, where it was a perfectly good filter for the situation previously (the engineer has not changed jobs, nor has the supervisor been replaced). This example highlights the importance of continuing critical reflection on the part of professional engineers. In the face of rapidly developing technologies engineers are familiar with the need to remain current in their fields. It is not too much of a leap to recognise that that the need to critically reflect on their work and actions is not a process that can be completed once and remain good for all time. We will return to this idea as one that can be used to explain the value of continued critical reflection in chapter six.

4.7 Expertise and Understanding

In section 4.5 expertise was recognised as a source of new filters, that allow us to determine what is relevant and not within our area of specialisation and to filter out things that are irrelevant. This is not all that expertise is. Expertise also alters what we see by adding levels of distinction and clarity as a result of improved understanding. An expert can appreciate distinction and variation in relation to their specialism in a way that a ‘layperson’ (one who does not have the expertise) cannot. This is different from scaling, filtering and focussing in that there is not an obvious corresponding sacrifice of other information. The addition of understanding does not necessarily carry with it any corresponding automatic loss.

Arthur is a native English speaker and has never learnt another language. If Arthur attempts to read some Mandarin Chinese then he might well be able to tell if two characters are different in the same way that he can tell that two pictures are different, but he may have to look at them fairly closely in order to do so. Arthur’s lack of understanding doesn’t mean that he cannot see and draw some distinctions from the information in front of him. But if we show him three characters and then one minute later show him another three characters Arthur will struggle to tell you if they are the same as the first set because he lacks expertise. If you can read Mandarin you will say “no the first page reads ‘red, square, monkey’ and the second page reads ‘amazing, sour, electricity’ they are obviously completely different”. Your expertise in Mandarin means that you can clearly see distinctions that Arthur cannot see easily, but he can acquire that ability as a result of study and experience. It is not apparent in this case that there is any sacrifice of information. You and Arthur can both look at a pile of Chinese Books. It is not that Arthur is seeing something that you are missing because you are reading Mandarin and he is not. Rather you can see more than he can.

This understanding is part of what enables an expert to formulate Klein’s predictive narratives discussed in the previous chapter. Consider the difference between a rookie fire fighter and an experienced lieutenant. Both examine a fire. The lieutenant quickly identifies a likely cause and the right way to approach putting the fire out. The rookie is looking at the same fire but cannot suggest what caused it or how to respond to it. The information is present but the rookie isn’t able to formulate a narrative about how the flames started, what will happen next or the impact of alternative courses of action because he does not know what he is looking for or what is means.

Because understanding can add richness to the picture that the engineer sees, without a corresponding sacrifice of information, it does not have a strong counterpart in the camera metaphor. It is important to note it, however, because it does alter the picture that the engineer sees. The ability to see more clearly which distinctions are significant means that the expert has a different view of the information to the layperson.

4.8 Engineering Sub-disciplines and photographic vision

In section 4.5 I illustrated the role of expertise in filter choice by comparing an engineer and a biologist. Although working at the same scale they could not easily understand each other's work because they lacked the expertise necessary to recognise what information was important. The same can also occur with two engineers from different sub-disciplines. A civil engineer may be little better placed than a biologist to identify the information necessary to an electronic engineer and vice versa. Different types of engineers work on projects where there are very different considerations and their different expertise will be reflected in their differing photographic vision. For instance, we might well expect that an engineer working on improving error correction coding for Japanese digital television to have a different view on what information is important and a different attitude on the role of safety, compared with an engineer working with a live nuclear reactor.

I have previously discussed the limited capacity for human perception in the previous chapter when discussing bounded rationality. If humans have a limited capacity for perception then it is natural that people will different specialisms will view the same information differently. If humans could perceive infinite amounts of information then we could suggest that all engineers (and biologists and doctors) should use the same range of scales and filters. But given that this is not the case, we want engineers who are attuned to the information that is most relevant to the types of decisions that they make, and who are able to appreciate the limits of their competency.

In saying that different sub-disciplines of engineering will use different scales and filters, and that there is value in recognising this as an explanation of a limit of competency, I am not suggesting that there is no such thing as "an engineer" or that there are only many different varieties of specialist who happen to share the same name. Although there will be differences in photographic vision between, for example, mechanical engineers and civil engineers, there are also similarities between their roles and work that are stronger than between a civil engineer and a doctor[32]. The dual system of engineering wide professional institutions, such as the Royal Academy of Engineering and the Engineering Council UK, and discipline specific professional institutions such as the IMechE and IChemE may well

[32] There may be engineers who have photographic vision closer to a doctor than a civil engineer, for example, an engineer who specialises in designing heart valves or hip replacements. Those working at the border between professions in this way doubtless have great similarities with the doctors who are also working at the border of their profession. But generally, I would still suggest that engineers and doctors have been trained differently and have different forms of photographic vision, even these types of case.

reflect that there are some common issues that are well dealt with across the profession as a whole, and some that are better considered within the narrower bounds of a particular engineering discipline.

The specialist ability to recognise appropriate information can apply to a narrow range of applications. In his book "Bounce: The myth of talent and the power of practise" Matthew Syed (a world class table tennis player) describes trying to return a lawn tennis serve from former Wimbledon champion Michael Stich.

> I crouched down and focused hard, coiled like a spring. I was confident I would return the serve, although I was not certain it would be much more than a soft mid-court lob. Stich tossed the ball high into the air, arched his back, and then, in what seemed like a whirl of hyperactivity, launched into his service action. Even as I witnessed the ball connecting with his racquet, it whirred past my right ear with a speed that produced what seemed like a clap of wind. I had barely rotated my neck by the time it thudded against the soft green curtains behind me…
>
> Most people would conclude from this rather humbling experience that the ability to connect with, let alone return, a serve delivered at more than 130 mph must belong exclusively to those with innate reaction speeds – what are sometimes called instincts – at the outer limits of human capacity…
>
> But I was forbidden from reaching any such conclusion. Why? Because in different circumstances, *I have those extraordinary reaction speeds.* When I stand behind a table tennis table, I am able to react to, and return, smash-kills in a blink of an eye. The time available to return a serve in tennis is approximately 450 milliseconds; there are fewer than 250 milliseconds in which to return a smash-kill in table tennis. So, why could I return the latter and not the former? (Syed, 2011, pp. 26-28) (Emphasis in the original)

Syed then finds Mark Williams, professor of motor behaviour at Liverpool John Moores, who watched Syed in a lab.

> "You were looking in the wrong place," says Mark. "Top tennis players look at the trunk and hips of their opponents on return in order to pick up the visual clues governing where they are going to serve. If I was to stop the picture in advance of the ball being hit, they would still have a pretty good ideas about where it was going to go. You are looking variously at his racquet and arm,

> which give very little information about the future path of the ball. You could have had the fastest reactions in history, and you still would not have made contact with the ball."
>
> I ask Mark to [run the test again] and adjust my focus to look at the places rich in information, but it makes me even more sluggish. Mark laughs. "*It is not as simple as just knowing about where to look; it is also about grasping the meaning of what you are looking at*. It is about looking at the subtle patterns of movement and postural clues and extracting information. (Syed, 2011, p. 30) (Emphasis added)

Matthew Syed's example shows that even skills that we think are non-specific, such as quick reaction times, rely on our ability to recognise what information is important.

> Top tennis players make a small number of visual fixations and 'chunk' the key information." (Syed, 2011, p. 30)

Here is another example of photographic vision, and how similar disciplines can have distinct scales and filters. Humans cannot process all the possible information that could be used to determine which way that tennis player will send the ball, *but they don't need to.* They can use a small subset of the potentially available information to predict which way the ball will go. They choose a scale that allows them to see the key cues, and filter out other information so that they can see clearly and quickly the key cues. When Matthew Syed tried to return a tennis serve, he filtered out the wrong information and was unable to predict or respond appropriately.

The Institution of Mechanical Engineers Code of Conduct states that their members "shall perform services only in areas of current competence" (see Appendix A, CR3), as do many of the other Institutional codes. We can see the dangers of an engineer acting outside of their competence; the engineering work may be done poorly and dangerously. The requirement to act within one's current competence implies that an engineer is able to identify the limits of their competence and recognise that these will change with time.

Sometimes we do not recognise when we have moved outside our competence – as Matthew Syed did not recognise that his skills in table tennis did not mean that he was competent to return a tennis serve. We can think of these as "false positives". Occasions when we mistakenly respond to the question "can I do this well" by believing that we can, rather than recognising that we are not competent. Discussing photographic vision and its relationship to be competence can be vision altering, because it allows us an intuitive way of understanding that we might not always recognise the limits of our competence and mean that engineers might be more likely to double-check, to ask themselves “am I competent to do this task”.

4.9 Photographic vision and narratives

The rookie fire fighter example in the previous section showed us that there is a link between Klein’s predictive narratives and photographic vision; they are both influenced by understanding. There is also a link between photographic vision and Lakoff’s descriptive narratives.

As we discussed in the previous chapter, narratives hide and highlight particular information. In chapter three we looked at the different descriptive narratives that it is possible to fit to the life of Anna Nicole Smith. These different narratives hid and highlighted different facets of her story. This is not scaling, because the different narratives consider her actions on the same scale (rather than, for example, each narrative looking at a different portion of her life, or one only considering a six month period and another a five year period) so it is rather that at the same scale different narratives result in different pictures of her life. Our photographic vision is affected by the narratives that we hold in relation to the circumstances.

There is a link between descriptive narratives and our choice of scale and filters (including our choice of focus). The narratives that we hold unconsciously influence the filters and scales that we use. We can imagine a narrative that we will call the “Pure Technician” (the term is borrowed from Albert Speer, see chapter six). The Pure Technician narrative could say that one works to become an engineer by studying hard at science and mathematics. Having gained a good degree one works steadily for an engineering company, possibly several, and rises up the managerial ladder as a result of diligent hard work and use of one’s excellent mathematical, scientific and problem solving skills. This narrative might have something to say about how the pure technician acts and dresses, what place he has in society and the type of house he owns. Implicit in this view are a number of beliefs. Some of them we might applaud. The Pure Technician would be willing to consider the work others have done, and strive to be efficient in his work. He values accuracy and making sure that the job is done. But the Pure Technician narrative also includes some troubling beliefs; that the role of an engineer is to think only about practical accomplishments; that engineers are unpolitical and should not be judged in political terms. These beliefs influence the professional filters that are available to the Pure Technician. If the engineer’s role is an unpolitical one, concerns about the impact of the technology on the public will be filtered out because they would be in conflict with the narrative of what it is to be an engineer.

Speer's story will be mentioned again in chapter five and discussed in detail in chapter six. Briefly, Speer claimed that he was relying on the blind devotion of the Pure Technician to enable him to do his job. Speer's job included oversight for the transport links that led to the Concentration Camps in Nazi Germany during the Second World War and his work facilitated the genocide of millions of people. The Pure Technician narrative contributed to a state where engineers were able to filter out ethical concerns of the nature of the work that they were undertaking.

The effect of descriptive narratives on the engineer's filters might go further and suggest that there are particular scales (e.g. concerns about society as a whole) at which it would be wrong for an engineer to operate because engineers are unpolitical.

This example shows us the important link between the narratives of the last chapter and the scales and filters we are discussing in this chapter. The narratives influence the available lenses and filters and may limit what is considered valuable in engineering.[33]

The photographic vision metaphor explains not only that we sometimes fail to see important information, but also that there is information, that although we see it, we fail to recognise it as valid or important to a particular decision. We use our recognition of the world around us to form and revise our beliefs, including beliefs about how the world is, our personal identity, correct moral action etc. I will use the concept of recognition in discussing the relationship between photographic vision, professional expertise and narratives.

In the rest of this section, I will propose a relationship between these three ideas. To start I want to offer two cases that suggest that whilst narratives and photographic vision are related, they are not identical. Both cases involve drivers.

In the first case, two drivers have the same belief as part of their narrative, "my role as a driver includes identifying and avoiding potential hazards", and hazard awareness is part of the UK driving theory test. But what they recognise as hazards is different, because they drive in different places with different hazards to consider. Let us say that one normally drives on a small island where the roads are predominantly single track with passing places. Hazards in this setting include animals on the road, large number of cyclists and all other cars (because unless you time it right, one of you will have to reverse to get to a passing place). The second driver drives in a big city, and regularly uses motorways. In this context, hazards are the unusual behaviour of other drivers, rather than all vehicles, and away from

[33] See chapter six for a discussion of different characterisations of engineering. Holding a narrative of "engineering is technical problem solving" might result in using different filters from holding the narrative "engineering is enhancing the human condition".

motorways will also include pedestrians choosing to cross the road at odd places. We would expect, that although the belief is the same, and the recognition criteria of a driving hazard is the same, they to recognise very different things as being hazards. Were the two drivers each to drive in other's location we would expect them to be hesitant, and have a sense of the uncomfortable and unfamiliar.

But we can also imagine a case in which two individuals see exactly the same thing, but their narratives mean that they interpret the information differently. Imagine two car drivers, both of whom are waiting for a gap in the traffic to join a main road. Both see a motorcyclist coming towards them. Key for this example is that they both clearly see the motorcyclist. The first driver has a narrative that includes the belief "I make sure that motorcyclists are safe", who waits before pulling out. The second driver has a narrative that includes the belief "motorcyclists should avoid me" and pulls out because the motorcyclist is the one who has the duty to stop. There is no difference in photographic vision between these cases, but there is obviously a difference in the decision that they choose to take as a result of differing beliefs. These beliefs contribute to the narratives that they have about themselves and about the right way to drive, as I will discuss below.

The figure below shows that there are two stages between sensory input (that which could have been seen) and recognition (what I saw). (1) The choice of scale, with its elimination of data outside of the field of view and data too small to be seen, and (2) passing through a set of filters. These two stages I call photographic vision.

If a student is looking for things to recycle, and has a filter that says "the only recyclable material is paper" she will miss the plastic bottle straight in front of her, because she will not recognise it as being one of the things that she is looking for. Note that in this case, she may be still literally looking at the bottle, so the filter is a block on recognition, not on literal sight. In the same way that the table tennis player described above takes the same image of a tennis serve as a professional tennis player, but zooms in on different parts of the serving player's body and filters for different information.

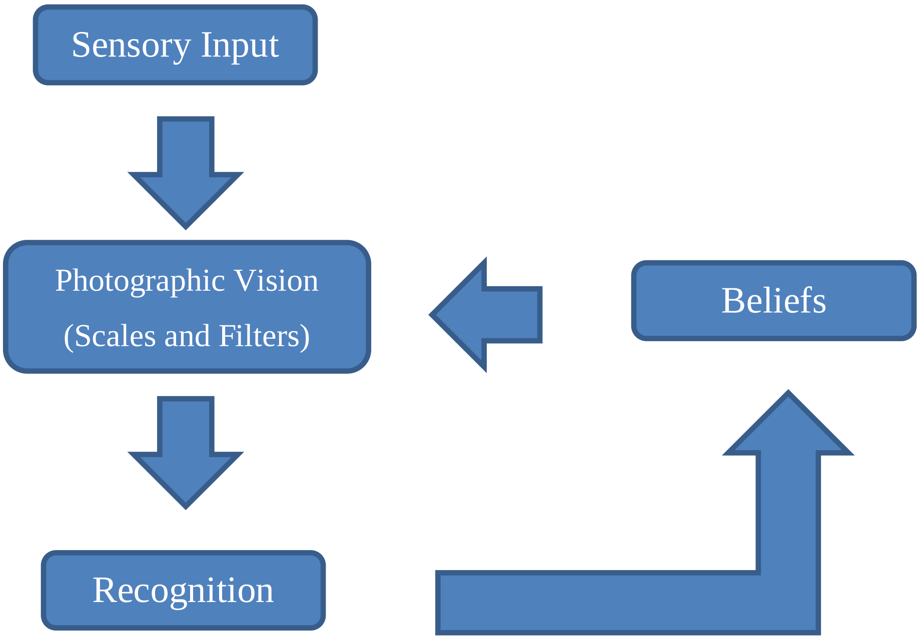

Figure 4-9 Diagram linking photographic vision, recognition and beliefs

What we recognise influences and helps form what we believe about the world. Beliefs are important to this thesis because they act as boundary conditions to the narratives that we can form, we form narratives about ourselves and the world that are plausible given what we believe. These beliefs are wide ranging and include views on our own identity, the way the world is, they way other people behave and what is right and wrong. This then feeds back in to our photographic vision. We alter what we will recognise based on what we believe. This is the phenomena of confirmation bias, that we will unconsciously select information that will potentially support our views and reject or fail to see information that could demonstrate that our views are wrong.

The scaling and filtering of photographic vision lets us pick out the important and useful information out of a sea of information potentially available to us. This limiting of information allows us to see the patterns of information more clearly, and supports us in recognising and characterising the information so that we can make an appropriate decision.

The ability to correctly recognise the key information is part of what it is to be able to competently make particular decisions. So most people in the UK are competent at crossing the road. They know that certain information is relevant and that other information can be appropriately ignored. They can use this information to recognise threats, and decide whether to cross the road or wait. Because they are competent they are also aware that factors like loud construction noise may mean that they cannot rely on audio cues to determine safety in the way that they normally would.

The acquisition of the competence requires experience, and the resultant competence is specific to the range of experiences that formed it. When I moved to Gambia, I discovered that I was not competent to cross the road when I arrived. I would look in the wrong place for information, and make mistaken judgements about when it safe to cross the road (I would look right, decide it was safe and move to cross the road without realising that the traffic was coming from the other direction). I didn't know the conventions of road usage (pedestrians have right of way and drivers are expected to brake to avoid them) and some of my default approaches were invalid – I might be used to looking for a pedestrian crossing or underpass in busy built up areas, but there were none. So my competence to cross the road wasn't a universal competence, but a region-specific one.

If, before I had tried to cross the road for the first time in Gambia, I had said "of course I know how to cross the road", my remark would have been understandable, but not correct to my new circumstances. Recognising that competence is domain-specific means that we can recognise why new engineering students would say "I am competent to make moral decisions" and still hold that they might not be competent to make engineering decisions that have a significant ethical component because they have, possibly unconsciously, crossed into a domain where they are not yet competent.

Earlier in this chapter I described expertise as an interesting case, because expert understanding can result in increased recognition without the corresponding loss of other data that forms part of the description of photographic vision. In chapter six, we will come across the idea that an expert views the world differently to the view of a layperson. It is this distinction that forms the basis of the concept of expertise as I use it, that there are distinctions between an expert and lay person, particularly in how they treat types of information relating to the field of expertise. For my purposes I can use a working definition of expertise being uncommon competences. We wouldn't talk of people being experts at crossing the road, because it is fairly common competence.

In chapter six, the discussion will be around professional expertise. Not all expertise is professional, if my friend is trying to do some DIY and is obviously failing at plumbing his kitchen, I might say "it's time to bring in an expert" (meaning a plumber) without suggesting that plumbing is a profession, in the sense that engineering and medicine are. I will argue that part of what makes something a profession is the level of acceptable risk that the professional activities can impose upon others. Professional expertise requires that the professional is competent to recognise the information that is key to their decision making, given that their decisions can impose risk on others. The link between professional expertise and photographic vision is that the expert competently uses the correct scales and filters to recognise the information that is relevant and important to their decision making.

From our instances of recognition we build up beliefs, these can be about ourselves, about others, about the world, about morality etc. These beliefs can then influences the scales and filters that we use to in the future. Imagine that the only doctors I have ever seen have all been white. I have recognised that they are doctors, and I have built up an unconscious belief that doctors are white, which now acts as a limit on what I will recognise. As a result of this belief, which filters the information I perceive, if I see a black man in a hospital uniform I might think "he's a porter or a nurse". I may be unlikely to think that he is a doctor, if that possibility has been unconsciously filtered out. This relationship between our filters and scales, our recognition and our beliefs, means that it is hard for us to recognise when one of our beliefs is wrong. If I already have a belief, this influences what I will "see", which means that the instances that fit the recognition (the people I would think are doctors) will conform to the belief and strengthen it. Whilst information that could challenge the belief goes unrecognised, or is explained away.

Recognition is important in this case. When I talk about not "seeing" something as a result of filtering, in some cases it can be that I did not recognise what I was seeing, rather than that something was actually hidden from my view. It is not that I did not see the black man in the hospital, that he had somehow become invisible to me, but rather that if you had asked me to point out all the doctors that I could see, I would not have pointed to him because I did not recognise him as a doctor.

The beliefs that we have about the world form the boundary conditions for the narratives that we can hold. Our beliefs do not necessarily fully determine our narratives, but they significantly constrain them. If we believe that something is impossible, we might "day-dream" about it happening, but we do not have an expectation that it will happen, we do not have a narrative about ourselves or the world that includes it as a real possibility. If an engineer believes that his role is that of the Pure Technician, who believes that his task is an unpolitical one, he isn't going to have a narrative that says that he will challenge the moral appropriateness of the task he is asked perform.

The reinforcement of our beliefs through repeated recognition means that we are unconsciously confident in our accuracy of our narratives in many cases. As I mentioned in chapter three this means that our narratives can be deeply held, and that we may well reject attempts to suggest that our narratives are false, because we have so many easy to access examples of cases where those beliefs have been confirmed by our experiences (remembering that our experiences have been limited by scales and filters that will in turn have been influenced by our existing beliefs). I do not mean to suggest that we hold all narratives firmly and view them all as unchangeable, but rather, the narratives that have been reinforced over time are more likely to be firmly and tenaciously held.

In chapter five, I will propose some ways in which we can improve photographic vision and narratives. One way in which considering both narratives and photographic vision is valuable is that it provides us with more than one way of suggesting improvement to engineers ethical decisions, because the two concepts highlight different elements of decision making and may be amenable to different methods of change.

In relation to approaches to improvement, what we can say based on the current discussion is that, because of confirmation bias, some attempts to alter photographic vision or narratives might be filtered out and therefore not recognised. If you want to show me that my narrative "all doctors are white" is mistaken, taking me to a hospital with black doctors and allowing me to wander the corridors might not be enough, because I may not recognise that that black man is a doctor. Introducing me to him, clearly stating his title and job, is a stronger way of challenging my belief.

Another way that we can challenge narratives is to highlight that some of the beliefs do not hold together. Either because they are factually inaccurate (like the student who mistakenly believes that plastic cannot be recycled, or the engineering student who believes that all engineering is exclusively technical), because they are inconsistent with other held beliefs (for example believing that engineers are professionals and believing that they have no duty to the public) or because the beliefs are internally inconsistent (see moral relativism in chapter five). Challenging these beliefs will feed back in to the system of filters and scales that an engineer holds. This will be discussed in more detail in chapter five.

4.10 Professional obligations

I will be discussing professionalism, and what it means to belong to a profession, in chapter six. However, at this stage there are two points that are important to note in relation to the camera metaphor. The first is that the implications of a poor choice of magnification or filter might result in a poor picture for our purposes in that does not show us what we wish to see.[34] The implications of not seeing important considerations in an engineering context can be catastrophic.

[34] This is not necessarily a bad picture, it might be a great picture for some other purpose, but it is a poor picture in these circumstances.

Secondly, determining what information can be appropriately hidden (because the scale means that we cannot see it or because it has been filtered out) is not a task that falls to the individual engineer alone. This is not a point that is clear when considering the camera metaphor by itself. A photographer can choose to take a photograph and decide which elements to hide and highlight and we very rarely have any objection on moral grounds. However, there are things (e.g. safety) that the profession and the public would want to insist are not filtered or hidden by the engineer. So engineers have an obligation to include certain elements in their photographic vision that a photographer does not. This has implications for the profession and the role of the public in engineering decisions that will be considered in chapter six, and implications for how engineers are educated that will be considered in chapter seven.

4.11 Incremental improvement to decision making

From what we have discussed we can now use the model of filters and scaling to answer the thesis question. One way we can improve the ethical decisions made by engineers is if we increase the occasions on which engineers use an appropriate filter at an appropriate scale for the decision that they are making[35]. Filters and scaling are helpful in making decisions because they reduce the information required to a manageable level, and I am not proposing that we reject them. We can however recognise that there are particular cases where the filtering and scaling results in morally important information being left out, and if we can reduce the number of occasions when that happens then the ethical decisions made by engineers will improve. The focus of the next chapter is on what we can do to improve the use of scales and filters.

4.11.1 Amateur vs. professional photographer

As the examples above have demonstrated, we can think of cases where an engineer has used a filter poorly – the filter was not appropriate to the situation. But in these cases we can also appreciate that the filter is an appropriate one for another situation. Think of the engineer who develops a filter which says “my boss gives good instructions”. That filter was appropriate when it was first created although it later proved problematic in light of changing circumstances. The focus is not on the type or nature of the filter, but on the use of the filter in a particular situation.[36]

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[35] Not all poor decisions result from incorrect scaling or poor use of filters, so there are individual poor decisions that would not be affected by this approach. But of the poor decisions that are made, some will be improved as a result of improving engineers’ use of scaling and filtering.

[36] Gigerenzer has noted that there are many cases of what initially appeared to be cognitive illusions (“systematic deviations from rationality”) where “an unbiased (not omniscient) mind plus a specific environmental structure (such as unsystematic error, unequal sample sizes, skewed distribution) is *sufficient* to produce the phenomenon” (Gigerenzer, 2008, p. 14) (Emphasis in the original). The

A useful way to think about the difference between poor and good use of filters and lenses is to consider the distinction between a rich amateur photographer and a professional photographer. In this case it is not that the amateur has poor filters and lenses and the professional has good ones, we can say that in our case they both have exactly the same high quality equipment. The distinction is that the professional knows which lenses and filters will produce the desired results in given situations where the amateur may not. Not only does the professional know which lenses will work for which photographs, but he also has an increased degree of self-knowledge: he knows which filters and lenses he can use well, what types of photographs he can take well and what work his skills are not suited for.

So we can improve the ethical decisions made by engineers by increasing the occasions on which engineers use a good filter and the right scale for the decision that they are making. Upon occasion this may mean that they will realise that they are not appropriately skilled for the decision and decide not to make it (the implications of this will be discussed in chapter six). We can do this by helping engineers develop the skill of appropriate filter use and scale choice. This metaphor highlights an important point, which is that appropriate information selection (on the level of scale and filter choices) is a skill which can be improved. Like many skills, someone who has mastered it well will develop habits that enable them to undertake the task well. But just as an amateur photographer can become a professional, we can develop better filters for a particular role. In the examples of wrong doing that we have considered so far, scaling and filtering allow us to understand how the individuals involved might have made the decisions that they did. But in those cases we can also recognise that it was possible for them to recognise other information as significant that would have altered their decision making. This is a necessary point, because unless we have the skill to improve our information selection then all that can be done is to limit those who are allowed to become engineers to people who can select the morally pertinent information. This way we have the ability to support skill development rather than just screen for it.

Police-run Speed Awareness Courses provide a good example of training that leads to improved information selection. Several police forces in England offer Speed Awareness Courses as an alternative to points on a driving license when a driver has been caught speeding. Courses may vary depending on the particular force, but the idea is to present information in such a way that at the end of the process driver's view speeding in a different manner. This might include meeting the relative of a traffic accident victim, advice on the correct gear for particular speeds, listening to a audio recording of emergency workers responding to a road traffic accident, stories about drivers who survived or were injured in

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heuristics that we use to assist decision making are not universally irrational, but can be used inappropriately.

various accidents and a discussion of statistics including the risk of injury to drivers and pedestrians at different driving speeds. This presentation of information in an immediate and personal way (meeting a victim's relative, as distinct from watching an interview on television) can be a powerful way to change an individual's view on a particular issue.

I will discuss some methods we can use to improve scale and filter selection in the next chapter, as well as some pragmatic concerns associated with those methods.

4.12 Conclusion

By developing Davis' 'microscopic vision' to include gradations between microscopic and normal vision and allow for the possibility of macroscopic vision, photographic vision can show us how there are a wide variety of scales at which an engineer can be working. Each scale can hide and reveal certain types of information just as different scales of a map can be useful for different purposes and highlight different features of the geographical area. Filtering (including focussing) as a constant state allows us to appreciate that even when two people view the same information at the same scale they will not necessarily see the same picture. Understanding can also add clarity and make information easy to see as well as allow us to remove information that we know is extraneous.

The appropriate scale and filter are dependent on the situation, which may change without the engineer realising it, and scale and filter revision may be required over time. The descriptive narratives that we hold (from chapter three) influence our photographic vision.

Engineers have an obligation to include certain considerations in their work, and those considerations should not be hidden or filtered out such that they cannot be considered.

Improvements to decision making where the decision error relates to perception of ethical information can be achieved by concentrating on improving the skills of engineers to choose appropriate scales and filters.

5 Improving Engineer's Photographic Vision

In chapter three I argued that the narratives that an engineer has about their role and world shape their vision. In chapter four I argued that we can understand how engineers view the world as the view through a camera, and that their narratives influence their photographic view. In this chapter I will consider ways that we can improve engineers' narratives and photographic view, and thereby improve the ethical decisions that they make. In addition, I will discuss considerations that will influence how we approach narrative and photographic vision improvement. Finally, I will present and consider some views that can act as roadblocks to ethical discussions.

5.1 Response to our current circumstances

5.1.1 New environments may require new filters and scales

How we use our filters and scales, and which ones we have available to us, develops in response to our perceived environment. When we find ourselves operating with new information, in a different field or a changed environment we may need to develop a new filters or magnification lenses to be able to accurately assess what information is important (because the lenses and filters available to us do not show us what need, because that not required in our previous environments).

This has two significant implications. The first is awareness that entering a changed environment might place us at a temporary disadvantage because we do not necessarily have a well-developed filter suitable for the new environment (this might include situations such as starting a new job, or being promoted). This has implications for our ability to operate with competence and will be considered in relation to professionalism in chapter six.

The second is that if we wish to encourage engineers to develop new filters and scales we can do so by exposing them to new environments. This might be by changing company policy or with students by creating teaching and assessment that mimic experiences that engineers encounter in their daily work. We can change the environment to encourage filter development and revision. We will pick up on this in chapter seven when discussing education.

5.1.2 Prompting photographic vision revision

As we discussed earlier when considering the engineer designing crematoria, filters that were appropriate can cease to be so as a result of changing external circumstances that were not recognised by the engineer.

On an individual level it can be very difficult to recognise when the view available through the camera becomes inappropriate, because the situational changes that render it inappropriate can be hidden from view. Davis says that engineers have an obligation to look up from the microscope, and certainly doing so might increase the number of ethical issues that an engineer recognises as relevant to their work.

But it can be more complicated than this. It could be that the ethical issue is actually most clearly visible when the engineer is looking down the microscope. If George checks Bob's work and discovers he has made an error in his report that has been sent to a customer then George does not need to look up from the microscope. The lack of accuracy in the report is right there for him to see using his specialist vision. Also, as was discussed when considering scaling, looking up from the microscope might not be enough. There might be any number of other scales, from the microscopic to the macroscopic, that we might need the engineer to look at in order to be able to recognise the importance of a particular ethical decision.

Looking up from the microscope can be difficult and seem counter intuitive. The crematoria-designing engineer might also have looked up from the microscope in his early career. If, every time he looked up there were no significant issues to recognise, it might seem an odd habit to maintain. "I've examined the possible ethical considerations; they haven't changed from last time or the time before". It would be very easy for this engineer to develop a filter that says, "I don't need to look up from the microscope. Maybe other engineers working in different circumstances do need to look up, but every time I have done it there was nothing I needed to see. It's better that I focus on the things that do require my attention". It doesn't seem that telling the engineer to look up from his microscope regularly by itself would necessarily have been effective in assisting him to realise the ethical considerations that came into play as his career progressed.

As we will discuss, providing information and discussion can be other effective ways to encourage filter and lens revision. It may be that there is a limit to what an individual engineer, juggling pressing professional obligations, can do to ensure that they are checking the limitations of their day to day photographic view. In which case it may be necessary to find other ways to encourage engineers to consider their position and what information they are able to appropriately filter out of their decision making. There are pragmatic limitations to this, based on how engineers currently work in the UK. Some suggestions are included in chapter six, when considering the structure of the engineering profession.

5.2 Focussing on narratives or photographic vision

In chapter four I described the link between narratives and photographic vision and I will consider the implications of altering one in relation to the other in section 5.4.3. Since narratives influence our photographic vision we can look to alter either an engineer's professional narratives or elements of their photographic vision directly.

Our narratives and photographic vision include background assumptions about how the world is. The descriptive narratives that Lakoff presents about Anna Nicole Smith each include within them implicit views about the appropriateness of her actions. The American Dream narrative describes a life where adversity is overcome (which is a good thing). Whereas the Gold Digger narrative describes a young woman who takes advantage of an older man (which is a bad thing). Our background beliefs are part of our narratives and influence our photographic view.

If we can demonstrate that there is an error in our background beliefs then this is a challenge to the filters, scales and narratives that incorporate this belief. The response might be that the new information does not change anything significant and we can continue to use the filter, scale or narrative that we have been using. Alternatively, it might that we realise that something we were filtering out, or rendering invisible because of scaling, can no longer be appropriately removed from our vision.

5.3 Approaches to changing photographic vision

The aim behind changing engineers' photographic vision is to encourage them to include particular information in their photographic view, because that information has an ethical bearing on the decision being made. Our photographic view changes in light of recognised experience and alterations in our perceived environment as mentioned in section 5.1.

What follows are some methods for improving an engineer's photographic vision so that they can see ethically pertinent considerations when arise.

5.3.1 Information

We can use information to alter filters and scaling because new information may alter the way that we view things. Information can be presented in lectures, books, websites, advertising etc. We can also alter photographic vision by presenting information that the engineer already has in new ways, ways that make the information more vivid and immediate, so that it becomes a relevant feature rather one that can be appropriately filtered out.

Not all engineering students start their course with a good grasp of the day to day work of an engineer. In determining whether new information is relevant to their current or future professional lives they are influenced by their understanding of the job that they will eventually be doing. If they are mistaken about the nature of the work, then they are likely to include some things in their vision that are not necessary and to leave out other things that are important.

The introduction to the *Engineering in Society ebook*[37] provides information about the mismatch between student expectation and engineering reality.

> For example, students often have misconceptions about a career in engineering. They often underestimate the amount of report writing involved; or they underestimate the importance of communication, and negotiation; or they don't realise the amount of responsibility that they are likely to have, and the extent to which they will have to use their own judgement, and make their own decisions, rather than just doing what they are told…
>
> Essentially, it is important to understand that engineers don't just work with machines, designs or circuit boards, and engineering doesn't only require a good understanding of science and mathematics. Engineering needs to be understood in the context of its role in society, and your role as an engineer has to be understood in the context of your work within a company, and ultimately within society. As an engineer, you may be involved in negotiations; you may become a manager, supervising the work of a team of engineers; you may have special responsibilities to ensure that work is safe, or to ensure it is not damaging the environment. (Lawlor, 2013)

The information in these two paragraphs will be new to some engineering students, and it may be sufficient for some of the students to realise their understanding of engineer was causing them to filter out elements that they will need to consider as engineers.

For other engineering students the information may not be new, but may have been presented in such a way that the information is now more vivid to them, and they would now consider it as important information to see, rather than information that could be appropriately filtered out. The vividness could be a result of the presentation. Students respond very differently to case studies when the case study is provided as video clip rather

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[37] Supported by the Royal Academy of Engineering, Engineering Council, the Institution of Engineering and Technology, the Institution of Mechanical Engineers, Institution of Civil Engineers, Health and Safety Laboratory, the Institute of Materials, Minerals and Mining, Institute of Chemical Engineering and Engineers without Borders UK.

than a written description. This is particularly true of cases like the Ford Pinto and the Bhopal Accident where the visual images make the resultant human suffering more obvious to the student than a written description can. In this case, the information isn't necessarily new, but is presented in a different way that means that it is treated differently.[38] This is particularly effective with cases that we can point towards where the engineer or student can understand and identify with the engineer who made a poor decision that resulted in a disaster. Engineers look to learn from these cases and ensure that they are not repeatable. This approach can cause previously unconsidered information to become highlighted.

Another way that familiar information can become a more significant part of photographic vision is when the information is presented by someone with recognised expertise. Imagine that Fred's friend tells him that he needs to make some lifestyle changes in order to improve his health. Fred later goes to the doctor and receives exactly the same information. Fred's view of the information might well be different in the later case because he treats the information from the doctor as having greater authority than that of a friend.

Additionally, having information (even vivid information) does not automatically mean that the recipient is aware of the implications of that information. Recognising that engineering is a profession, and that they are intending to join that profession does not mean that students will automatically recognise that they have particular duties as professionals (see chapter six for a discussion of professionalism). Giving information with the aim of altering photographic vision may also require that the ethical implications are made clear.

One example of this would be the considering the implications of the argument "if I don't do this someone else will"[39]. On the surface this might seem like a valid justification for doing something that you find to be ethically dubious – your action or inaction does not appear to make any difference to the outcomes, because you don't act someone else will. But the same justification could have been used by slave owners, or drug traffickers. In these cases we still think that it is better not to do something that is wrong, than to do it, even if others will. By considering the implications of the argument we can challenge the ethical view that because someone else would be willing to do it, it is morally permissible for me to do it.

[38] Increasing the vividness of the information is part of what many government and charity campaigns do. Adverts that remind the driver to "think bike" are seeking to alter a driver's photographic view so that motorcycles are something that they look for, rather than something that they filter out.
[39] Thanks to Kevin Macnish for the counterexamples to this argument.

5.3.2 Personal Reflection

Receiving information, however vividly and authoritatively presented, may not be sufficient to alter photographic vision, because the exact nature of the existing photographic view is not necessarily clear to anyone from the outside. (In chapter four I mentioned that we cannot always tell the difference between filtering and focussing from the outside, because the difference is the intent. Since we can approach introducing new ideas differently depending on whether they were filtered out or not focussed on, this not knowing makes the process more challenging).

Our narratives, beliefs and photographic view are a complex web of interrelations. New information might not fit well with our existing beliefs, and personal reflection may be required to determine which views are the most important.

When we internalise ideas they can become part of our narratives, and we can use them to help determine what information I need to keep in view and what can be safely ignored. As was discussed in chapter three, I can also develop an emotional attachment to ideas, and treat them as likely to be useful in the future. Opportunities to engage in personal reflection are often a part of altering photographic vision, because conflicting ideas and narratives can take time to resolve. Nevertheless, although an internal process, personal reflection can be prompted by outside influences.

5.3.3 Need for Engagement

Chapters three and four have highlighted that just because information is available, it does not necessarily follow that particular information will be perceived by a given individual, because we operate with limited perception.

In order for the information, implications and understanding that we wish to share with engineers to actually reach them, we need to ensure that it is perceived. It is possible for me to sit in a room where someone is speaking, and when I leave the room to have no idea what they said. I might have been thinking about something else or been looking at the other people in the room. In order for engineers' photographic vision and narratives to be improved, the engineers must engage sufficiently that the ideas reach them. The ideas, or their presentation, must be sufficiently engaging that an opportunity for photographic vision enhancement can occur.

5.4 Additional Pragmatic Considerations

5.4.1 Attachment to our current position

In chapter three I discussed the distinction between narratives and rules of thumb. An important point to note here from that discussion is that we can become attached to certain narratives and beliefs. When we feel that things, that are highlighted in our narratives, are under attack our response can be to become defensive of our views, even in response to seemingly reasonable arguments.

In Section 5.6.1.6 I will be considering the value of tolerance in professional discussions. The point to be made here is that we can have a strong emotional attachment to particular views. If we want to encourage engineers and students to discuss those views then it needs to be done in a setting that is viewed as safe, and in a manner that takes account that challenging an individual's views is a potentially difficult experience for them. An additional consideration may also be that it can take time to clearly state one's views. This is particularly the case if expressing ethical views is not a familiar task, and the engineer may lack the specialist language to distinguish between two ideas that appear similar but have different implications. I discussed the role of moral theories as a source of language in chapter two, whilst it is not a large focus of this chapter; it is worth noting that part of the process of engaging engineers in discussions about ethics might be supporting them to develop the language to express their views clearly.

5.4.2 Students entering professional education

In section 5.3.1 I explained that students do not always have a good understanding of what they will be doing as professional engineers. In addition, since our photographic vision can develop in response to our environment, students have a photographic vision that develops as a result of being student. Sometimes the photographic view and narratives that they have can make it more challenging to engage in ethical discussion with them. For example, a filter that says "I don't need to attend seminars that are not assessed" might make it more challenging to engage with students using that filter. This is considered in detail in chapter seven.

5.4.3 Distinction between statements and meaning

In section 5.6.1 I will consider a number of different cases where engineers could make very similar statements but have distinct meaning. How engineers explain their ethical views does not always fully encapsulate the ideas that they wish to share. In seeking to respond to these ideas and support the process of improving photographic vision we would do well to bear in mind that the process of clearly communicating ethical ideas is a skill to be developed. Part of supporting that process is seeking to clarify meaning rather than necessarily responding to the statements exactly as they are made.

5.4.4 Coherence

5.4.4.1 Narrative and photographic vision coherence

We often accept or reject ideas that are offered in light of information that we already hold. We consider whether or not the idea fits with what we already know; whether we think that offered idea is from trusted source; and we may also consider the implications of the information or idea as well. Since the information that we already hold includes the narratives and filters that are available to us, it is important to consider that when talking with an engineer what we say will be measured, at least in part, against the information that the engineer already has. Whilst those narratives and filters are not static, and can change in the light of knowledge and experience, in a discussion we should recognise that the new filter or narrative is being considered in light of those the engineer already has.

This introduces an element of the unknown. We do not know what narratives, scales and filters a particular engineer or student has when we start a dialogue with them. Recognising that ideas and arguments will be considered in light of the views that engineers already hold can be an advantage to us as well as a potential challenge. If we can demonstrate that they hold mutually incompatible views then we are not relying on them accepting an outside idea as better, but are encouraging them to consider their own position in greater depth.

When we focus on a narrative (e.g. discussing the role of an engineer in society and suggesting implied narratives) the engineer will be considering the narratives in light of their photographic vision. A significant filter that might impact on their view of the validity of the narrative is "is there anything that I can do about this". If an engineer (rightly or wrongly) believes that there is nothing that they can do to make a difference then they are less likely to continue to engage with the discussion. Another issue that might well impact on discussions of narrative is the scale engineer's use to consider their work. If they are thinking of the detailed technical decisions that they make, questions regarding the role of the public in engineering decision making may not appear to make sense. This is not because they are filtered out, but they may now be outside of the engineer's field of vision.

Equally, if we are focussing on an element of photographic vision (such as considering whether or not "if I don't do it someone else will" is a good response to a challenging situation, and therefore a permissible filter) the implications of changing the filter may also contrast against a narrative, particularly one like the Pure Technician discussed in chapter four.

Not all cases that appear to be incoherent necessarily are. Some cases might be explained by thinking again about scaling as discussed in chapter four. I could be zoomed in on one small part of a photograph, and describe it in great detail. If you talk to me about something that is not visible in my small part of the photograph I might tell you that I can't see what you are talking about, your description of photograph appears inconsistent with my view of it. But by understanding that my photographic view means that I don't see everything I can resolve the apparent incoherence. If I know that I am zoomed in I can appreciate that there are things there that I can't see. If I zoom out I can now see the thing that you were talking about.

5.4.4.2 External coherence: how others influence our filter choice

We have previously recognised that a changing environment can prompt us to develop a new filter, or adjust one that we already have. One of the issues that we have with this is that others do not always display their actions in a manner that appears consistent. Imagine that you start a new job and you are told "fire safety is very important". This message is repeated a number of times during your induction, but as you become familiar with your duties it is never mentioned again; there is nothing that you need to do about it, and you see no one else performing any action in regard to fire safety. This does not mean that you were lied to when you were told that fire safety is important. It is perfectly plausible that, because it is important, everything that needs to be done about fire safety is being done already and you are not required to be involved. However, it is equally possible that no one actually thinks that fire safety is important – there is no obvious reinforcement of this message that you can see, your environment does not support a filter that says that fire safety is important. To do your job well you might well relegate fire safety considerations to the back of your mind and concentrate your focus on the information that you know will make a difference to your decisions.

If fire safety is something that should be considered prominently in your decision making then being told about it wasn't sufficient to make it part of your photographic view. This second form of coherence is one that is important for those who wish to ensure that certain things are included in what the engineer sees. We need to do more than tell someone that something is important, because that is not enough to ensure that it will be highlighted in their views.

5.5 Ethical Considerations and Implications

5.5.1 Demonstrating approaches to ethical considerations

In this process we are not only altering photographic vision and narratives. We are also laying a framework that will influence how engineers engage with and consider ethics into the future. This represents a rich opportunity: not only can we influence how engineers tackle a few key arguments and views of ethical importance, we can influence how they might approach thinking about what needs to be included in their decision making in the future. We can imagine that an engineer might leave the discussion and at some future point think "well, when we had this discussion these were relevant criteria, they might be relevant now" as well.

So we can extend the improvement of ethical decision making beyond direct photographic vision change to enabling engineers to better examine narratives and views (their own and others) in the future.

5.5.2 Engagement not at the expense of good argument

In section 5.3.1 I described the need for engineers to engage in reflection in order for decision improvement to be possible. However, an engaging argument is not necessarily a good argument. Given that discussing ethics not only potentially influences the engineers' views of the discussion topic but also how they think they should approach ethical issues in the future, using engaging arguments could encourage engineers to believe that the correct way to approach ethics is to find engaging arguments, or possibly that all ethics is about is finding engaging arguments.

We have four potential types of arguments if we consider the criteria of engagement and quality.

		Quality of the Argument	
		Good	Bad
Engagement	Engaging	1	3
	Not Engaging	2	4

Table 5-1 Four types of arguments: engagement and quality

1. Engaging for engineers and a good argument
2. Not engaging for engineers but a good argument.
3. Engaging for engineers but a bad argument.
4. Not engaging for engineers and a bad argument.

Good arguments that are engaging for engineers (quadrant 1) are the arguments that we should strive to use when encouraging engineers to improve their photographic vision. The engagement means that we are more likely to succeed in involving the engineer, and the quality of the argument in one that we can use to model what good arguments look like.

Each of the other three quadrants has particular problems. Quadrant 2 (good but not engaging) arguments are not only unlikely to encourage engineers no to engage with the ethical content in front of them, but worse, could lead them to dismiss important ethical considerations because they do not appreciate the relevance. If presented in sufficient number, these arguments could inoculate engineers against becoming interested in the ethics of their professional field. This is not to suggest that such views should never be discussed, because not all good arguments necessarily have an engaging version. Rather, where an argument can be used that is both good and engaging, that is better. Where this is not possible, arguments that are good but not engaging are best left until some experience of discussing ethics has been established, so that engineers can appreciate that ethics is relevant.

Quadrant 3 (engaging but poor) might be accepted as good arguments because they provoke interest amongst engineers, but arguments like this leave the engineer no better equipped to respond to ethical issues, they may even be worse off. Poor arguments do not necessarily highlight elements that should be included in photographic vision, but if they are engaging then we run the risk of skewing the engineers' photographic vision so that it now includes considerations that should have been appropriately left unconsidered.

There is an important point that we must consider: developing arguments that are engaging for engineers might be a pragmatically plausible way of encouraging engineers to engage with the arguments. This is necessary for photographic vision to improve. But it can raise a separate concern: do we want engineers who are swayed by engaging arguments? It may be that by using such arguments we are demonstrating that this is how engineers "should" think about ethics, because there may be no clear distinction to the engineers between arguments that are engaging, and those that are merely engaging.

The potential for engineers to treat all engaging arguments as good arguments seems dangerous in that we want engineers who are capable of making independent moral judgments that are not unduly influenced by those around them. If we train engineers to equate appeal with strength of argument then we are in danger of encouraging engineers to become more easily manipulated by anyone who can make an appealing argument. The purpose of training should be to enable them to better distinguish which views are strong and which are not.

To go to the other extreme though brings us up against a wall of pragmatism. No matter how good my argument, it is reasonable that unless the engineer can see why we should have the discussion, *why this argument should matter to them*, I, and my argument, will appear irrelevant to the engineer. Worse still, I run the risk of tainting my argument and encouraging engineers to view ethics as “an irrelevant talking shop”.

One form of engaging argument is arguments that are intuitively appealing, ones that fit with our current understanding of the world in some way, although it may also bring other views that we hold into question. Sometimes intuitively appealing arguments can be used to create engagement not because they are correct, but because demonstrating how they are mistaken can be interesting in itself.

On a pragmatic level it seems fair enough that appealing arguments are a good place to start. This does not necessarily guarantee that the engineer will be involved since the appealing may look very similar to the obvious. But at least we are not choosing to begin by taking a particularly dull or challenging argument that would create an additional hurdle to overcome before the engineer will become involved. I am not suggesting that appealing arguments are used in the same way that parents introduce children to solid food by feeding them mush which the children eat for a while, but then move past. Appealing arguments often tell us something interesting and useful. They are one way of accessing our own moral intuitions. An interesting case of this is discussed in the consideration of moral relativism, although vulgar relativism described in section 5.6.1 is not a consistent view, moral relativism comes wrapped with a view on toleration that we want to save. The appealing element does contain something of moral value but we can strip it away from the poor argument to which it is attached.

In encouraging engineers to distinguish between engaging and good quality arguments we should also encourage them to recognise that intuitively appealing arguments are also not necessarily good ones. Using appealing arguments could either encourage or discourage engagement. Appealing arguments appear intuitive, and some engineers may appreciate arguments that ‘make sense’ within their existing narratives and photographic vision. But relying on appealing arguments to create engagement may well be flawed, because appealing arguments can also appear ‘obvious’ and statements of the obvious may encourage engineers to believe that if ethical content is obvious then there is no need to give special consideration to ethical issues.

5.6 Roadblocks

There are some ideas that students have that make it challenging to engage with them in ethical discussions. I have included roadblocks here, rather than in chapter seven, because it is plausible that these views are also held by practising engineers. I refer to them as roadblocks because until we respond to them, they prevent us from having a discussion that does not return again to the roadblock idea. Consider the view, “ethics has nothing to do with engineering”. Finding an approach that will engage an engineer will be challenging, because they do not see ethics as being relevant to engineering. In order to have a discussion on ethical issues in engineering, we must first overcome this roadblock.

In attempting to label and tease out roadblocks I am putting words into the mouths of engineers. It is unavoidable that I will, and it is worth reiterating that there are probably many variations of these roadblocks. Also, just because an idea as represented by an engineer sounds similar to a term or idea used in philosophy does not mean that the engineer intends to imply all of the philosophical connotations. For this reason I will sometimes present more than one version of the same roadblock, because the same expression could be used to indicate several slightly different ideas.

As the discussion below will demonstrate, we do not need to wait for roadblocks to arise before we respond, we can sometimes pre-empt the roadblock. For example, if we know that some engineers struggle to see that ethics is relevant to engineering, beginning a discussion with examples of engineering case studies that included significant ethical considerations may remove the need to have a discussion of the relevance of ethics, because this has now been demonstrated.

Overcoming or circumventing these roadblocks is important because road blocks often lead to the end of a thought. If I see an advertisement for a new car I might think “but I don’t drive”. That will probably be my last thought on the matter, if I think about it at all. It is unlikely that I will do anything further with the information on the advertisement. This is how we deal with the enormous amount of information that we have to process all the time. However if the end of the thought is “this isn’t relevant to me” then any other narrative filter, about the role of ethics in engineering, what constitutes a good engineering decision, how to justify ones actions to others if required, is inaccessible because it lies behind a road block

In chapter four I briefly considered the narrative of the Pure Technician, and the influence that this narrative would have on the scales and filters that an engineer would use in their decision making. Not only would the Pure Technician narrative influence photographic vision directly in the way already discussed, but the same vision would make it hard for the engineer to see why there was any value in discussing ethics or ethical issues, because the Pure Technician sees his role as an unpolitical one. The belief that the role of an engineer is an unpolitical one can then be characterised as a road block – a view or belief that prevents the process of discussing ethical considerations from advancing.

This does not mean that someone who views being an engineer as fitting the Pure Technician wouldn't sit through a lecture on engineering ethics. But if they continue to believe that their narrative is an appropriate one they will treat the information that they have received as being unrelated to their work. The belief that their work is unpolitical, and that ethical considerations are not relevant to their work, means that they are not able to see the value in continued discussion of ethical issues. If we want to provide them with further information, or engage them in discussion on ethical issues, then their view that ethics is not relevant to engineer acts as a roadblock that we must overcome before the desired information and discussion can take place.

The nature of the roadblocks considered here is that they are general arguments that seek to undermine the validity in discussing ethical considerations in relation to engineering. Since anything else we might wish to discuss will not be treated as relevant, we must first assist engineers (and engineering students) to find ways past these significant roadblocks.

5.6.1 Moral relativism

Moral relativism is a roadblock to changing photographic vision, rather than a roadblock to ethical discussion in any form. There are a variety of views in the philosophical literature on moral relativism. The version I shall be considering here is that suggested by Bernard Williams. I use this approach because I think that this is the form that is probably closest the views that engineers hold, as Williams says, "the most distinctive and most influential form".

> Let us... look round a special view or assemblage of views which has been built on the site of moral disagreements between societies. This is relativism, the anthropologist's heresy, possibly the most absurd view to have been advanced even in moral philosophy. In its vulgar and unregenerate form (which I shall consider, since it is both the most distinctive and most influential form) it consists of three propositions: that 'right' means (can only be coherently understood as meaning) 'right for a given society'; that 'right for a given society' is to be understood in a functionalist sense; and that (therefore) it is wrong for people in one society to condemn, interfere with, etc., the values of another society. (Williams, 1993, p. 20)

It doesn't prevent an engineer discussing an ethical issue; they might happen to believe that talking about ethics is interesting and happily engage in a discussion. Indeed, an engineer could believe that ethics is relevant to engineering, because an engineer's actions have significant effects on others but still be a moral relativist. In this case, moral relativism is a roadblock to continued discussion because it is a description of what ethics is and how one should respond to others in an ethical discussion that limits the impact that any discussion can have.

5.6.1.1 Inconsistency of view

Williams offers what I will present as the first response to moral relativism (the following sections will present alternative or additional responses). As Williams shows, the view is not, when considered, consistent.

> Whatever its results, the view is clearly inconsistent, since it makes claim in its third proposition, about what is right and wrong in one's dealings with other societies, which uses a nonrelative sense of 'right' not allowed for in the first proposition. (Williams, 1993)

You cannot have it both ways all moral statements can only be made in the context of a particular culture, or you can have universal moral truths – that it is wrong for one society to interfere with another. The moral relativist is denied the ability to claim to ever stand outside their culture and make these universal moral statements.

Whilst William's argument is a response that shows that the view of 'vulgar relativism' is inconsistent, demonstrating this to the engineer may not be enough to change his or her mind, because we have an emotional attachment to our views. This view is best supported by the discussion on tolerance below, because it recognises that proving moral relativism false does not imply that one should not act with tolerance.

5.6.1.2 Reasons

Another way that we could respond to moral relativism is to urge the relativist to consider why it is that a society chooses that some things are right and some things are wrong.

> "So what you say is this: what the people approve of is right and what they disapprove of is wrong."
>
> "Yes. Exactly."
>
> "So torture is wrong because people disapprove of it."
>
> "Yes."
>
> "But why do they disapprove of it?"

Remember, this person cannot say that they disapprove of it because it's wrong, or he'll get stuck in another circular argument, and keep going in circles.

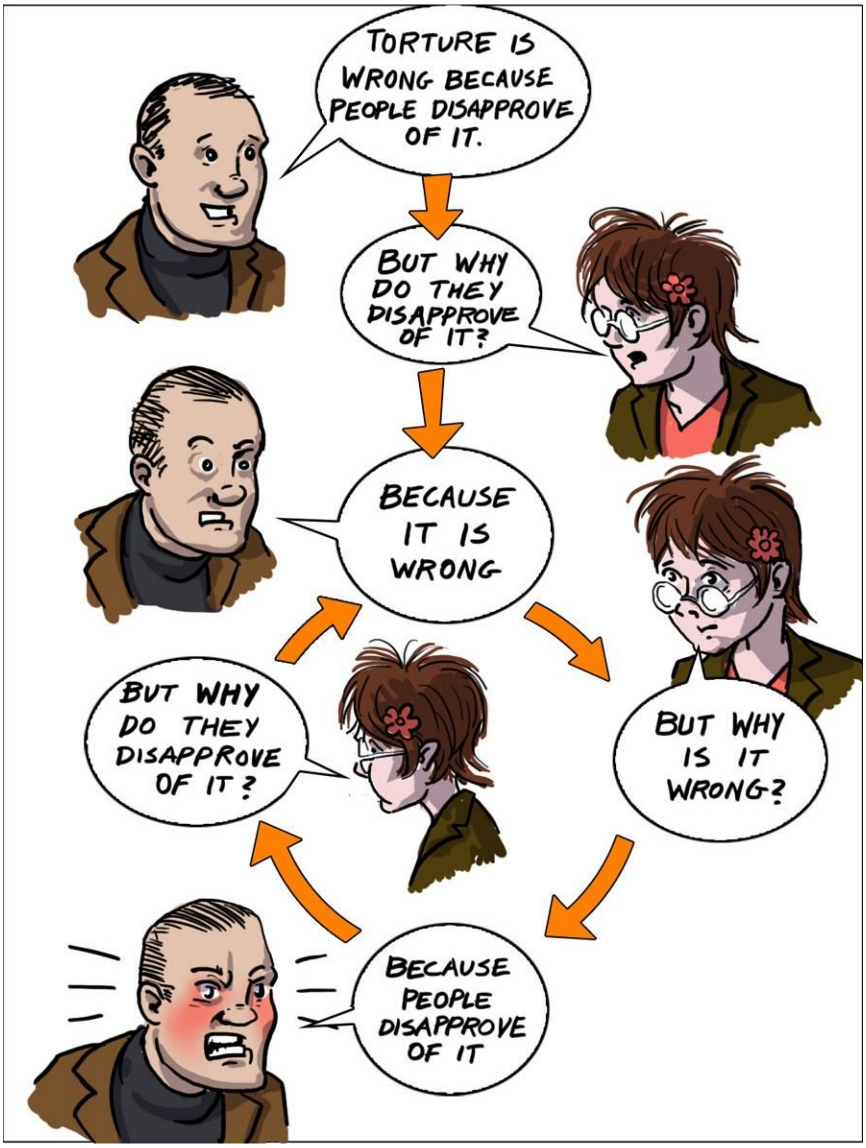

Figure 5-1 Circular Argument

So he needs to say something else when we ask, "Why do they disapprove?" He will have to tell us what reasons they have to disapprove of torture. If torture is wrong, is it wrong whether or not we believe it is or not.(Lawlor and Bristow-Bailey, 2013, no pagination) (Image is included at this point in the original.)

Arguing that an action is wrong because a culture thinks that it is wrong, will take us in circles in the same way. If we appeal to reasons other than "because that's what my culture says" to justify our position then we are making an appeal to something more universal.

5.6.1.3 Ethics is just opinion

This is not the same as the moral relativist claim, because the relativist recognises that morality is shared within a culture but not between them. The view that ethics is just opinion would say that a statement like “slavery is wrong” is comparable to a statement like “beef tastes good”, these are both opinions. The sections below on pragmatic decision making, strong counter-intuitions and tolerance apply both to moral relativism and the view that ethics is just opinion.

5.6.1.4 Appeal to pragmatic decision making

In the quote above, Williams observes that vulgar relativism was popular with some liberal colonialists in areas where “white men held no land”. This is significant to us because the view is more popular in cases where there is no obligation to interact or co-decision make with people from another culture. It is easy to say that one should not interfere with the values of another society when there is no need for you to interact extensively with that society. This is what I take Williams to mean about the prevalence of the attitude in areas where “white men held no land”, that it is prevalent in areas where those expressing the view did not need to interact or co-operate significantly with the society that they recognised themselves as outside of.

This would suggest that another response that we can offer to the roadblock of relativism and “ethics is just opinion” is to ask “how do you make decisions with others from different cultures?”. If the decision that you must make, and must make together, involves ethical considerations you must find a common way to make your ethical decisions, even though you come from different societies.

5.6.1.5 Counter-intuitive implications

In addition to appealing to logical arguments (such as the inconsistency of view and circular arguments discussed above) we have another option, which may be more compelling which is to appeal to other intuitions that the engineer has that run counter to the views of moral relativism or “ethics is just opinion”.

If right action is culturally determined then in that culture anyone who acts contrary to that culture’s moral rules is morally wrong. But this strongly conflicts with our intuition that slavery is wrong. We don’t believe that slavery used to be morally right, and now isn’t. Or that it is now morally right if you belong to a culture that believes that it is. Worse, in those cultures that hold that slavery is morally acceptable, campaigning against slavery may be wrong. Presenting this counter-example to an engineer may cause them to question whether they wish to maintain their view of moral relativism, or their view that ethics is just opinion.

Another strong intuition most people hold is that child abuse is wrong. A moral relativist would be forced to say “if your culture says that abusing toddlers is good, then it is good to abuse toddlers”. This is a very hard position to want to defend and putting it in these terms may encourage some would-be moral relativists to change their views.

Similarly, if ethics is just opinion then I can hold any opinion, and it is a valid view. But in the case of abusing toddlers we have such a strong intuition that it is wrong that it is hard to feel that it is “just an opinion”.

There is a danger with this option, which is that we appear to make the problem “unsolvable” (something that we will discuss further below). Having demonstrated that our previously neat view that morality is culturally determined doesn’t appear to be universally true; we aren’t necessarily offering anything equally neat to replace it with. If it becomes a problem that looks like it has no solution, we may be tempted to give up and walk away leaving ethics as that “never ending discussion that goes nowhere”. In this case our attempt to remove a roadblock may have thrown up another one instead, because now the engineer believes that ethics creates more problems rather than solutions[40]. A counter example to this would be the slavery case. We think that it is better that there is not slavery, and we can view society as having progressed as a result of having banned slavery. The changes may be large scale and long term but we can point to examples that show that ethical problems and challenges can be solved.

In chapter seven I will discuss the idea that students are judging ethics in relation to other subjects they have studied. The claim that ethics is never ending and discussion that goes nowhere may also mean “this doesn’t look like the other subjects I study and I do not know how to determine what the right answer is”. In this case, the response to the student might best be a brief explanation of how ethics is done (by discussion, argument, using examples and counter examples etc.).

A second challenge, certainly prevalent among students, is that the types of examples that have been given above do not seem to touch on their role as engineers. What, they might ask, do my views on child abuse have to do with my work as an engineer? Whilst there may be cases where slavery and child abuse are relevant to engineers, there are plenty to engineers who will never need to consider either. This can be resolved by giving engineering examples that are powerful (e.g. the case of the crematoria designer in Nazi Germany).

[40] Engineers could hold the view that ethics is never ending discussion that goes nowhere without being a moral relativist. In which case, the following counter argument still holds.

5.6.1.6 Tolerance and professional disagreement

Tolerance is not a form of moral relativism. But statements made to demonstrate a desire for tolerance can sound very similar to those made in support of moral relativism. In finding approaches to respond to moral relativism as a roadblock, we should be careful that we do not dismiss a praiseworthy desire to act with tolerance.

In a profession not everyone agrees with each other about everything. Some things are not up for negotiation (such as the view that engineers have a duty to value public safety – although exactly what this means may be a matter for discussion), and other things very definitely are. So, for example, the professional codes of conduct are notably silent on the appropriateness of weapons development[41]. There are a range of ethical issues where holding a variety of views is not incompatible with being a professional and ethical engineer. Having engineers who can interact with others who are expressing different moral opinions is a useful skill, since it is highly unlikely that everyone that they meet throughout their career will agree with them.

So we want to allow for cases in which an engineer wishes to say "we differ on this topic, we will continue to differ and we can still respect each other at the same time". Whilst we might explain it with the line, "My beliefs are a result of my upbringing, if I had had your upbringing I might agree with you" we are not saying that your upbringing means that you are right. Tolerance would allow that we can differ, that your view is understandable and yet still wrong.

This is an important point, because it tells us something about the nature of the conversations that we want to have to alter engineers' narratives. They must take place in a safe environment where engineers believe that it is appropriate to express differing views on topics that may be personally important.

More significantly, and beyond the scope of this work, the same discussions that can lead to changes in photographic vision may also be an opportunity for engineers to develop skills at working with differing opinions in the workplace. There may be many times when our differing ethical views do not cause an issue, but if we need to work together and would naturally make opposite decisions in a particular case as a result of ethical considerations then there is a problem, because we need to make a choice and we disagree on the right course of action. . In these cases tolerance is not going to help make the choice, because the tolerant position is one where I respect your views whilst disagreeing with them.

[41]For an example of a Code of Ethics please see Appendix A.

Encouraging engineers to discuss their ethical views would at least go some way towards enabling them to discuss their ethical views more articulately, even if it does not carry them all of the way towards being able to resolve ethics-based conflicts.

5.6.2 Ethics is too hard; we won't get to solutions only create more problems

We can think of cases where the engineer will struggle to produce a good answer, and may as a result, think that "ethics is too hard".

Imagine an Engineer (let's call him Bob) who works for an engineering company. This company specialise in making a piece of equipment that is used to put very fine layers of metal onto semiconductor devices. Metal deposition is an essential process in making the specialised components that go into so many different electronic devices. Bob's job is to install these machines when required, and then to visit users in situ to assist with problem solving and create ways of improving the machine both now and in the future.

Since metal deposition is used to create many different things with a range of potential end uses, there are a potentially huge number of people that could be affected by Bob's actions. Now let us imagine that something goes wrong for which we hold Bob responsible. (We want to rule out cases like deliberate or non-deliberate operator error or a unique fault that no machine has ever had before and that Bob could not have reasonably predicted). As a result of this fault, faulty electronic devices are produced.

Now let us go one stage further and suggest that this device is deemed safety critical. An easy example would be in a hospital ventilator system. The device develops a fault, the ventilator stops working and someone dies.

Now the question is, to what extent is this Bob's Fault?

If Bob had not made the mistake then the end result could not have occurred. But it also required that a number of other people also failed to notice the problem. If these other individuals had noticed that there was an issue that the death could have been avoided.

Questions like this are challenging to answer. The response I would offer to this roadblock is that there are difficult ethical questions, and not all questions are the responsibility of the individual engineer to answer. In this case, it may be that the question of Bob's responsibility is best resolved through the legal system. In some cases it may be that issue is sufficiently complex that although it is an important issue for engineers, it is best considered at the level of the profession. So we might think that the complex ethical issues around duties to future generations when discussing climate change should not be considered by every engineer individually, but that the engineering profession should be engaged in the discussion of a topic where engineering activity has such a big effect (I will discuss this further in chapter six). None of this is to say that engineers should not think about ethics, but that there are reasonable limits on what they should think about.

The engineer that is testing the quality of a product before shipping and discovers a fault should do something with that information, to ignore the fault would be negligent. To suggest that deciding what to do is too hard is absurd. The response to this roadblock might well be, then, to offer examples of ethical decisions that demonstrate that not all ethics is hard, and that even when it is challenging, the choices an engineer make have an ethical component whether they consider it or not.

5.6.3 Ethics has nothing to do with Engineering

If we do not find a way past this block, any further discussion has a high probability of descending rapidly in to the absurd, because if ethics has nothing to do with engineering then attempting to have a conversation about it is roughly comparable to discussing the effect of oven temperature on the colour purple.

A more plausible version of this view might be that ethics has nothing substantial to do with engineering. Not that it is not possible, if we look hard, to find ethical issues in engineering, but that these are peripheral or non-significant considerations that would not affect any decision made in practise. As will be discussed in chapter seven, this is a view that may be unwittingly enforced by the models of engineering that are presented to students.[42]

It is worth noting, that this view, "ethics has nothing to do with engineering" may be a minority view in the profession and may be more common amongst students that professional engineers. Engineers find, in practice, that they are required to engage with ethical considerations, and are more open to the idea that ethics matter to their work. Also, I hypothesise that branches of engineering that consider "safety-criticality" tend to demonstrate a stronger appreciation of the value of ethics.

5.6.4 Moral neutrality of technological artefacts

In chapter four I briefly introduced the engineer narrative of the Pure Technician. For the Pure Technician narrative to valid (the narrative includes the idea that the engineer's role is an unpolitical one) is must be that "[t]echnology is morally and politically neutral" (Katz,

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[42] It could also be a description of the student's photographic view; they are zoomed in on one small part of engineering so that they do not see that there are lots of other things that need to be considered as well.

2011). Langdon Winner describes this as the “traditional” view of the neutrality of technology, where we must separate a discussion of the right and wrong way of designing and making a product, from the use of the product once it has been made (Winner, 1986).

Eric Katz (Katz, 2011) extending the work of among others Sammons (Sammons, 1993) puts forward an argument that all technological artefacts embody moral value. Briefly, this is because all technological artefacts are created for a purpose and purpose implies a value or values.

> Any technological artefact must have a purpose before it is designed and created. Without such a purpose, there would be no reason to create the technology. But purpose implies a value; there are no neutral purposes. Thus the traditional separation between the making and the use of a technology cannot be the basis of a distinction in the existence of normative value. (Katz, 2011)

5.6.5 Talking about ethics is pointless

Whilst this is not the same as the view that there is no relationship between ethics and engineering it represents a similiar block that we must get past. If the reasons I presented above for suggesting that there is a relationship between ethics and engineering seem compelling, then it seems that having read and engaged with the ideas might change or adapt your ideas of this matter, which shows that talking (or more importantly, thinking) about ethics can change our views.

This then, is a pragmatic block. If an engineer thinks that talking about ethics is pointless, we may well struggle to get him or her to engage with us long enough to change their view. Whilst compulsory ethics lessons may be part of the answer, physical presence is not synonymous with engagement, and this then is one of the challenges to teaching that will be discussed later.

Two variations on this view are “ethics is obvious” or “ethics is just common sense”. These views are easy to counter with examples. Provided that you have a group of engineer together, it is normally relatively easy to find a topic about which they disagree (nuclear power is one example). Either engineers who hold these views are forced to suggest that their colleagues lack common sense or to recognise that ethics might not just be statements of the obvious.

Another response that we can give to the view “ethics is pointless” comes from Katz’s discussion of the implications of technology embodying value. In the previous section I quoted Katz's view that purpose implies value. Engineering is not a process of random generation of artefacts, some of which are then found to be useful. Whilst on a macro scale design failures do occur, the engineering process is one in which an attempt is made to fulfil a purpose.

> We thus arrive at what I called above the most fundamental question for an understanding of engineering ethics: how does an engineer know that the values he embodies through his technological products are good values that will lead to a better world? I cannot answer this question in a satisfactory way. A proper answer would bring us to the fundamental question of all ethical thought: how do I know that my actions lead to the good? (Katz, 2011)

We can read this in two ways. In the first case, we can read it as a sophisticated version of the view that "talking about ethics is pointless", since in order to determine whether or not my values are good ones I need to consider the moral theories discussed in chapter two, and resolve the challenges discussed there. I can respond to this, as I did in chapter two, by demonstrating that there are cases where we can agree that purposes are valuable (or not) without requiring moral theory. In the case of engineering, it is uncontroversial to suggest that designing a wheelchair is good, and that building Nazi death camps is not.

The second way that we can read Katz is to say that since technology embodies moral values it is important to talk about ethics because it is important to take time to consider which moral values are appropriate ones. This is not to say with certainty that the values an individual holds are right, but rather to suggest that since they are embodying values in their engineering work it is better that they have considered whether or not they are appropriate values, than it is to approach the subject blindly.

5.6.6 Ethics is not what engineers do

In chapter six I will discuss some versions of the narrative of what it is to be an engineer. Some narratives of the role of an engineer make it hard to appreciate how ethics fits in to their work as an engineer.

In this respect it may well be as wise to highlight that ethical discussions with engineering students and engineers about their role and work are not intended to mimic the types of ethical decisions that engineers will make in the field. The purpose of the discussion is not to be a role play but to act as a space for engineers to consider implications of their work whilst they are not facing the urgency of outstanding decisions.

5.7 Conclusion

I have argued that we can improve engineers' narratives and photographic vision by providing information and encouraging personal reflection. Reflection can be prompted from the outside, but does require that the engineer is willing to engage in discussion.

I have suggested that we approach such discussions in light of the narratives that we already have, and we have and we can have an emotional attachment to our existing narratives and views.

I have discussed that discussions about ethics can be used as examples of the right way to consider ethical issues and care should be taken that arguments are both engaging and good.

I have presented and discussed a number of roadblock views that make it difficult for engineers to engage and suggested responses that we can use toward each roadblock.

6 Professionalism and the Profession

6.1 Introduction

Thus far I have proposed that we can improve the ethical decisions made by engineers by altering the narratives that they hold, and the view that they see through the camera, to ensure that they include ethically significant considerations in their decision making.

In this chapter I will discuss the implications of engineering being as profession, possible relationships between the individual engineer and their professional role, and consider the implications of characterising engineering as imposing risk on the public. These discussions, and the ideas that they highlight, can contribute to the narrative and photographic vision change that we have already discussed.

6.2 The significance of recognising that engineering is a profession

In chapter three, I introduced Lakoff and Johnson's metaphor using their example of ARGUMENT IS WAR. As was discussed in that chapter, we use metaphor to structure our concepts and actions, so thinking of argument as war encourages people to engage in argument in a warlike manner (as opposed to a dancelike manner). In this chapter I will argue that engineering is a profession and that means that engineers have special duties as a result of being professional. I will characterise engineers as risk imposers, and discuss what duties this characterisation means engineer have. I am not suggesting that "engineering is a profession" is a metaphor, but if engineers (and engineering students) are not familiar with the idea that engineering is a profession (or do not realise the significant implications of this position), realising that it is may restructure an engineer's understanding of their work and their professional actions, altering their narratives about what it is to be an engineer, and influencing what they see looking through their camera.

In the discussion below I introduce several descriptions of a profession. Once we have taken some to consider what a profession is, and how engineering is a profession, we can appreciate that the process of considering engineering as a profession can provide us with a different way of thinking about what engineering is – we open ourselves to new narrative beliefs about the role of the engineer which can in turn alter our photographic vision.

6.2.1 Clarification of 'professional'

When talking about a professional, profession, or professional duty it is necessary to be clear that I do not use the term to mean "anyone who is paid to undertake a particular activity" in the sense that we might talk about a professional footballer, to distinguish them from an amateur in the same field. Nor should ideas about being professional be taken to mean a nebulous set of behaviour that is expected in any number of work environments ("He demonstrates a professional manner by being punctual"). Rather it refers to a set of occupations that we regard as "professions" – law and medicine can be considered as paradigmatic examples. In discussing engineering as a profession, I am distinguishing for engineering as an occupation or engineering as an activity. It is plausible that there are people who do engineering, or are engineers, but are not professionals, as the next section will demonstrate.

6.2.2 Features of a profession

Engineering is generally recognised as being a profession. This section describes three descriptions of what a profession is. These descriptions are offered as representative of the range of views that are used to describe a profession. Although the three accounts are not identical, there are many common features between them.

Simon Robinson, Ross Dixon and Christopher Preece list "the following features [which] can be associated with professionals" adding that "[t]he engineer clearly falls under this definition of profession".

- Specialized knowledge and skills.
- Power - the power of specialized knowledge and the capacity to significantly affect others, be they persons, groups or the environment.
- A monopoly or near monopoly of a particular skill.
- Managers undergo an extensive period of training that includes the development of both skills and the intellect.
- Membership of a professional body that is responsible for maintaining standards, protecting rights and ensuring proper training.
- Autonomy of practice. (Robinson, et al., 2007, p. 17)

The authors go on to demonstrate how each criteria is met by the engineer. Of particular interest to us are (1) power – the implication that professions involve activities that significantly affect others - and (2) membership of a profession body. I shall use these two criteria in the discussion below on the distinction between *potential* professions and *functioning* professions.

Bennion offers a slightly different list of factors. Robinson et al. define their list as "associated" with professionals, whereas Bennion states that "if the following factors are present the activity will be professional in the strictest sense,[43] while acknowledging that the absence of any of them will not necessarily, rule out professionalism, at least in the wider sense"[44]. Listing the factors, Bennion writes:

1. *Intellectual Basis*. An intellectual discipline, capable of formulation on theoretical, if not academic, lines, requiring a good educational background and tested by examination.
2. *Private Practice*. A foundation in private practice, so that the essential expertise and standards of the profession derive from meeting the needs of individual clients on a person-to-person basis, with remuneration by fees from individual clients rather than a salary of stipend from one source.
3. *Advisory Function*. An advisory function, often coupled with an executive function in carrying out what has been advised or doing ancillary work such as supervising, negotiating or managing; in the exercise of both functions full responsibility is taken by the person exercising them.
4. *Tradition of Service*. An outlook which is essentially objective and disinterested, where the motive of making money is subordinated to serving the client in a manner not inconsistent with the public good.
5. *Representative Institute*. One or more societies or institutes representing members of the profession, particularly those in private practice, and having the function of safeguarding and developing the expertise and standards of the profession.
6. *Code of Conduct.* A code of professional ethics, laid down and enforced by the professional institute or institutes. (Bennion, 1969, p. 15)

Factors 1,3,5 and 6 clearly apply to engineering as demonstrated by University degrees accredited by the professional institutions, the example of the Hyatt Regency case in chapter four showing that engineers do take on an executive function, the existence of the professional institutions and their respective codes of conduct. Engineering can meet the second factor if we consider Bennion's comment, "A profession does not cease to be a consultant profession because a proportion of its members enter full-time employment, nor do they thereby cease to belong to the profession." (Bennion, 1969, p. 16) There are engineers in private practice and this is sufficient to meet this criteria as Bennion presents it, although he argues that the implication of this factor is that 'consulting professions' thrive

[43] "[C]haracteristics such that when all or most are present in the case of a particular occupation we can say with the prospect of general acceptance that the occupation falls within a definite category unequivocally labelled "professional"" (Bennion, 1969)

[44] "[W]hich extends these terms to virtually any occupation where some degree of intellectual discipline is required". (Bennion, 1969)

and are best supported when primarily based in private practice. This factor is more controversial than the others, as a requisite for a profession. Medicine is a profession, but certainly in the UK a significant proportion of doctors are employed by the NHS and have no private practice, this does not negate their standing as professionals. It may be that this factor is not required and Bennion's account would be complete without it. Since engineering can be described accurately in this way, we do not need to justify why it is a profession if there is no private practice. At the same time, it may be an unnecessary complication to the definition of a profession.

Bennion's Factor 4 is also covered by statements made by the institutions on their understanding of the profession. The IMechE website demonstrates the tradition of service, "We truly believe we can improve the world through engineering. So the Institution finds and nurtures new talent, helping engineers build their careers and take on the challenges that, when solved, will make a difference to all of us." (Institution of Mechanical Engineers, 2013)

Michael Davis offers our third definition of a profession, which he discusses in detail as applying to engineers;

> While the old expression "liberal profession" referred to any occupation suitable for gentlemen, the modern use of "profession" requires more – organization, with standards of admission, including both training and character, and standards of conduct beyond the mere technical. (Davis, 1998, p. 28)

> [A] profession is a number of individuals sharing an occupation voluntarily organized to earn a living by serving some moral ideal in a morally permissible way beyond what law, market, and ordinary morality require. (Davis, 1998, p. 164)

By these three descriptions of a profession, engineering is a profession. In the next section I will consider the distinction between a *functioning* profession (broadly met by the Davis' first statement above) and a *potential* profession (which broadly corresponds to Davis' second statement). This distinction will emphasise that the nature of professions is that professional activity (the work that one does as a professional) imposes risk upon others.

Another significant point to note about engineering as a profession is that being recognised a professional carries with it a particular narrative. As Geoff Esland notes when critically examining professionalism;

> By marking off the professions in this way from other kinds of occupations we are acknowledging the peculiar status and power which they possess and which they confer on their members. (Esland, 1980, p. 213)

For an individual engineer to recognise that engineering is a profession can be narrative altering because we treat professions as being ‘something special’, occupations that are different and those who belong to them take on a particular role with particular moral duties.

6.2.3 Functioning as a profession

I argue that we can divide the criteria discussed above into two categories, those that describe a *potential* profession and those that describe a *functioning* profession. My argument is that there can be occupations that are *potential* professions that are not functioning in the manner of a profession. Equally, although I will not argue it here, it seems plausible that there are occupations functioning as a profession that do not meet the potential profession criteria. This is philosophically significant because the *potential* criteria can be used to justify the *functioning* criteria (e.g. it may be permissible for a profession to hold a monopoly where that would be generally impermissible because of the nature of the professional undertaking). It is significant for altering engineer’s photographic vision because understanding why engineering is a profession will highlight particular duties that an engineer holds (see chapter four on expertise and understanding).

Table 6-1 Potential and Functioning Profession Criteria from Robinson and Bennion.

		Criteria of a Profession	
		Potential Criteria	*Functioning* Criteria
Author	Robinson	• Specialized knowledge and skills • Power	• A monopoly or near monopoly of a particular skill. • Managers undergo an extensive period of training • Membership of a professional body • Autonomy of practice

	Bennion	• *Intellectual Basis* (capable of formulation on a theoretical basis) • *Advisory Function* (Capacity for) • Addition: *Working for the public good*	• *Intellectual Basis* (tested by examination) • *Private Practice* • *Tradition of Service* • *Representative Institute* • *Code of Conduct*
	Davis	• Serving some moral ideal	• Voluntary Organization • Acting in a morally permissible way beyond what law, market and ordinary morality require • Standards of admission (both training and character) • Standards of conduct beyond the mere technical

Robinson's criteria divide quite neatly into those that describe the nature of the occupation and the organisation of those performing it. We can achieve the same distinction in Bennion's criteria, but in order to do so we must create some additional distinctions. I have included the *Intellectual Basis* is both groups since the basis of an occupation may be able to be formulated theoretically, without it necessarily being tested by examination. The advisory function requires us to recognise that where it in fact occurs it is a description of how professionals organise themselves, but that there needs to be the capacity for them to be organised in this way. The addition of working for the public good is to allow for the idea that some occupations can be understood as public service even when a tradition of service is not present amongst those working in the field.

Robinson's professional body is "responsible for maintain standards, protecting rights and ensuring proper training" and Bennion's representative institute has the function "of safeguarding and developing the expertise and standards of the profession" and enforcing the code of ethics. Although not explicitly stated, the only way that the standards of the profession can be maintained is if the institutions can reach the whole profession. Membership of engineering institutions is not directly comparable with the licence practice required in the UK for either doctors or lawyers. It is possible to work as an engineer without being a member of a professional institution and chartered engineer status, although a protected term, is not a requirement comparable to a bar exam.

Robinson argues that the engineer has a responsibility to the professional body because this is necessary for the public to be able to trust the profession.

> The engineer in turn has a responsibility to the professional body and by extension to other professional engineers to uphold the standards shared by the profession. This is to ensure that trust is maintained and to ensure that the integrity of the engineering profession, with all the associated values of professional autonomy and responsibility, is maintained. In all this anything that the engineer does affects the profession. Equally, the professional's adherence to high standards can ensure trust from the public in spite of any particular problems with particular engineers. (Robinson, et al., 2007, p. 22)

We will return to the relationship between the individual engineer and the profession below.

Davis' description falls mostly into *functioning* category rather than the *potential* category. However, although standards of admission are a *functioning* consideration, that the nature of the tasks involved requires training indicates a requirement of specialist knowledge not clearly discussed by Davis.

I propose that we can understand the basis for a profession (the *potential* criteria) in terms of the risk that the actions of the profession impose on others. I will discuss approaches to engineering risk later in the chapter. If we consider medicine as a paradigm case, the implications of poorly conducted medical interventions are a clear risk to the public – there is the real possibility of death, injury and permanent disability. This fits with Robinson's power criterion. Where there is this significant risk the public has an interest in ensuring that the risk is minimised, which is why doctors are required to undergo long and rigorous training.

In order for us to include professions such as law we must appreciate that harms are not all physical injuries. If we consider the harms that can derive from miscarriages of justice, or from a lack of understanding of the legal system, then lawyers do have the ability to enhance the lives of their clients and also potentially to injure them.

There are many actions that impose risk on others, and by itself this is not a sufficient condition for an occupation to be a profession. Another feature of professions is that they generally involve an imbalance of knowledge and skills. I go to my doctor when I am ill because I do not have the knowledge or skills to diagnose or prescribe.

Engineers have the ability to impose significant risks on to the public, and the public has an interest in ensuring that there is regulation to reduce risks where reasonably possible. The functioning criteria can be understood as means of risk reduction. Ensuring that educational testing, limiting those who can work in the field (monopoly) and an enforced code of ethics all seek to limit the pool of those performing these risky tasks to those appropriately trained to do so. If we think of an element of public risk being a necessary criterion for being a profession, then those occupations that meet this criterion should seek to meet the *functioning* criteria as well.

(Journalism might be a case where the risk element is met – inaccurate journalism can unfairly destroy people's reputations and the media is arguably a necessary part of a democratic society in allowing for the possibility of informed voters. But the recent Levinson enquiry suggests that whilst they may meet the risk requirement they are not yet functioning as a profession.)

6.2.4 Professionalism as a narrative

Our vision is influenced by our narratives about our roles (e.g. parent, teacher, driver, smoker etc) and the roles of the people we interact with. Framing engineering as a profession, and engineers as professionals will alter our view of what engineers do and how they should do it.

Professionalism offers us an alternative to the Pure Technician (which may make it easier to reject the pure technician narrative if we know that there is a viable alternative). The changed vision that comes from understanding what a profession is, and why engineering is a profession, makes it easier to overcome some of the roadblocks discussed in the last chapter. In addition to the responses that were listed there we can now appeal to professional duties. So if we recognise that engineers have power over the lives of others (as Robinson suggests) and there are particular duties that come with that power, then there can be no objection that 'ethics has nothing to do with engineering'. Equally the idea that 'I should just do as I am told to' is no longer plausible if you have already acknowledged that you have duties other than those to your employer or client.

The discussion that follows highlights different ways that we could view what it means to be a professional. The intention of the discussion is that it highlights some concepts that will aid engineers' decision making when present in their photographic vision.

6.3 The individual engineer and the engineering profession

We could use the discussion above to formulate a narrative of the Professional Engineer, which would describe the type of work they would do, their approach to problem solving, their likely career progression etc.

But a discussion of why engineering is a profession still leaves lots of space for a variety of narratives on how individual engineers should act, given that they see themselves as professionals. J.L. Sammons identifies three different approaches that a professional can take in relation to their professional role; the Pure Technician, Rebellious Ethics and Integral Ethics. Eric Katz argues that the first two of these rely on a concept of “doubling” (taken from Robert J Lifton) that does not hold. He argues that when the “doubling” concept collapses so does the plausibility of these two views.

I will add an additional view, taken from the writings of Albert Speer which I call “ends neutrality”. All of these views aim to offer advice on how an engineer should act, and I will argue that these views are not in competition with each other in the way that they initially appear because they are responding to different moral problems.

The purpose of the examples of narrative approaches to a professional role were included in the list of potential narratives of the engineer discussed in section 3.10. Not all of those narratives are included here, because the focus is on professional role, and some narratives is section 3.10 highlight other aspects of the role of the engineer, but are silent about the engineer’s professional role.

Both Sammons and Katz discuss how an engineer should relate to their profession by discussing the case study of Albert Speer, so I shall start with a brief overview of his work.

6.3.1 Albert Speer

Albert Speer was an architect, rather than an engineer, who worked in Nazi Germany before and during the Second World War, and is known as “Hitler’s Architect”. During his incarceration after the war he wrote his memoirs, in which he described elements of his thinking at the time and in retrospect. His description of his thinking is a valuable resource, because it shows us what he did and didn’t see at the time, as well as some of the narratives that he was using. Speer was an enthusiastic supporter of Hitler, and in 1942 became Minister of Armaments and War Production. In this capacity he visited factories that used concentration camp labour.

The arguments that Speer employed as justification for his actions could have been used as justification by any of the technological professionals involved in the creation and maintenance of the concentration camps, gas chambers, crematoria and immediate supporting infrastructure. Like Katz and Sammons, I shall be using Speer as a representative for those technological professionals in the sections that follow.

This case is especially interesting because criticisms of his actions are based on the narrative that Speer was using at the time. Speer was aware that the Nazi regime used brutal and deadly tactics on those who disagreed with them, but he whole heartedly supported the regime;

> Of course I was perfectly aware that [Hitler] sought world domination ... [A]t that time I asked for nothing better. That was the whole point of my buildings. They would have looked grotesque if Hitler had sat still in Germany. All I *wanted* was for this great man to dominate the globe. (Sereny, 1996, p. 186)

So it is not that he lacked the willpower, or that he felt that he was being coerced by circumstances into bad actions. Rather, if coercion occurred, it did so at the level of a narrative, where the narrative of the role of the engineer was manipulated to change the moral content that an engineer could legitimately consider.

A justification of Albert Speer as an appropriate case study for engineers, given that he was an architect, is given in section 6.3.5.

6.3.1.1 Professional View 1: Ends Neutrality

In the words of Speer writing to Hitler in 1944. 'The task I have to fulfil is an unpolitical one. I have felt at ease in my work only so long as my person and my work were evaluated solely by the standard of practical accomplishments'. (Speer, 1970, p. 112)

This is a description of what engineering is where the definition is focussed on the processes an engineer undertakes to the exclusion of the impact of those actions. I discussed view in chapter four, as an example of filtering. If the engineer's task is an unpolitical one then engineers should not think about the results of a project, but only the right way to achieve it. My role as an engineer takes me from one factory door, through the workshop to another door. What my client did before they arrived, and how they use the artefact I create once they leave are outside my role as an engineer.

This is not a view without moral values. It is likely that Speer would have considered failure to meet "the standard of practical accomplishments" as a moral failing. It is questionable, but plausible, to believe that there were approaches that were valid or invalid to use to produce the end result. Not simply those processes that failed to meet the intended specification but ways of working with colleagues, clients or employees that were also morally reprehensible.

For this view to hold true, it is necessary that not only does the engineer have no responsibility to consider the previous and likely future actions of a client, but also that the artefact that is being created is also morally neutral. So that the act of creation is not by itself morally questionable, because the artefact has no moral identity (Winner, 1986). See the previous chapter on the moral neutrality of artefacts as a roadblock, for a response to this argument.

If we consider the criteria for a profession given above, it is possible be a professional engineer and believe that engineers should be neutral on the moral appropriateness of their projects.

6.3.1.2 Professional View 2: The Pure Technician

Sammons suggests that the story of Albert Speer created great discomfit in the professional community. Speer is enough like us for us to want to find a way of separating how we do things from how he does things. As a result an account develops which labels Speer as "the pure technician". "The Pure Technician is the expert who is not accountable beyond his area of expertise. His technique, he claims, is morally neutral and he asks to be judged only by whether his means of the most efficient ones towards whatever ends given him." (Sammons, 1993, p. 125)

This goes one step further than “ends neutrality” in that it says that not only is the artefact morally neutral, but the process by which the artefact is created is also morally neutral. If this is the case the only reasonable criticism that could be levelled at a “pure technician” is that their process has failed to produce the intended ends. This could be viewed as an extreme form of workplace consequentialism, where the value to be promoted is efficiency, and anything that leads to it is viewed as morally good. This would suggest that the narrative is internally incoherent; if the Pure Technician would frame morality as efficiency consequentialism then it is arguable that his technique is not morally neutral.

However, in much the same way that a discussion of moral relativism can rescue tolerance from an otherwise poor argument, the Pure Technician view contains the idea that we have a different way of viewing the world in a professional role, to the one that we have as a layperson. The Professional Engineer narrative says much the same point, but instead of seeking to reduce the moral content of the role, the Professional Engineer recognises that there are enhanced duties as a professional.

For the Pure Technician distinction to appear valid, we must split the personality of the engineer into the “pure technician” and the “normal” person. Doubtless we can criticize an individual for acting harshly to a colleague, we can do so from a moral grounding, but there is no part of that criticism that can be aimed especially at the engineer, aside from their role of a “pure technician” they are morally identical to anyone else and should be praised and blamed accordingly.

6.3.1.3 Professional View 3: Rebellious Ethics

Sammons then suggests that Speer’s moral failure was his lack of detachment from the professional role and corresponding lack of personal reflection on the ethical concepts relevant to the situation. Since the only place that we can stand to criticize the pure technician is from the perspective of a layperson, his moral mistake must have been to act too much as a pure technician and too little as a layperson.

> We will not be like him if we take our professions much less seriously than he did and ourselves much more seriously, but to do this, we must do what Speer did not: We must consciously maintain a personal and psychological detachment from our professional roles. By doing so, we free ourselves for the personal reflection so plainly missing from Speer's life...... If we want to avoid the morally corrupting forces of professional role Speer suffered, we must consciously adopt and steadfastly maintain the personal and psychological stance of the moral rebel against our professions. Thus, the answer professional ethics gives to the challenge presented by Speer's life, and the paradigm in which professional ethics works, is for professional ethics to be rebellious.

Sammons rejects this approach to professional ethics and instead offers an alternative perspective we shall call "integral ethics".

6.3.1.4 Professional View 4: Integral Ethics

Sammons doesn't provide a name for the ethical approach to the profession that he wishes to establish, so I have offered one instead. If rebellious ethics would suggest that Spears failure was that he didn't stand back enough and engage in personal reflection, integral ethics would suggest that his failure was that he didn't identify strongly enough with his role as an architect. So if his role in the rebellious ethics view is that of Pure Technician his role in the integral ethics narrative is the Failed Architect.

Sammons recognises that it was not only professionals who worked within the ideology established by the Nazi state without questioning the regime. To expect that personal reflection would have enabled Speer to realise the moral import of his actions would be to suggest that everyone within Nazi Germany should have done so. But that everyone did not do so, even after the war, appears to be an objection to rebellious ethics. Because it seems to ask for an unrealistic capacity to critically reflect on ones actions from within a culture. Whilst this is not automatically a sign that rebellious ethics is wrong (we can ask a lot of people, that they fail does not mean that we were wrong to ask) neither should we ignore it, since a standard by which most are failing may indicate a flaw in the standard as well as a morally corrupt world.

But more than that, we hold that it is somehow worse that professionals used their professional expertise and judgement in support of the goals promoted by the Nazi ideology. We hold in abhorrence those doctors who conducted and supported medical experiments in eugenics and certainly those who designed and improved methods of murder used in the concentration camps. And we hold more responsible the engineers who designed the gas chambers and crematoria than those labourers who built them. This intuition builds on our understanding that in allowing professionals to undertake work that can impose greater risk we expect them to do so with greater moral judgement.

Sammons argues that in two ways the architectural profession provided Speer with an alternative moral standpoint from which to view the Nazi regime. Firstly, that all professions are so-called because they are ultimately grounded in their contribution towards public good. So in the case of engineering this might be the desire to improve people's well-being through technological artefacts. Coming from an understanding that one’s profession embodies a moral purpose might provide another perspective from which to analyse current events and consider the right course of action. But secondly Sammons suggests that by belonging to a profession you become part of community that has a set of moral standards and when considering the right course of action one can consider how one will actually or could theoretically justify one's actions to that community separate as it is of the political ties that belong to individual countries.

So Sammon’s view is that Speer should have strengthened his professional identity. Should have spent more time as an Architect, and that his moral failing was to reduce himself from a professional to a pure technician and thereby deprive himself of access to the moral values and reasoning that he could access.

6.3.2 Doubling

So far two different dual modes (where an engineer is required to take on two separate roles) have emerged; rebellious ethics which distinguishes between the pure technician and the moral person; and the failed architect which distinguishes between the "normal person" and a professional who belongs to part of community supported by a particular set of ideals.

Eric Katz (Katz, 2011) discusses Robert J Lifton's proposed method of doubling as an explanation for the behaviour of professionals in the Third Reich. Which Lifton describes as "the division of the self into two functioning wholes, so that each part-self acts as an entire self." (Lifton, 1986) Katz extends the idea by considering that this doubling is "the establishment of a moral universe that is radically different from the moral universe of everyday reality." He argues that this view can be undermined by undermining the view that technology is morally neutral. If technological artefacts embody moral values then the idea of a separation between a common and professional moral ontology collapses. (Katz, 2011)

Another form of dual vision is Davis' microscopic vision. This view is not that of pure technician described earlier in that it does not suggest that all it is to be an engineer is the technical microscopic vision that one acquires to education. In this sense it fits well with the initial view of integral ethics in that part of what it is to be an engineer is to consider relevant moral aspects is part of the process of looking at the microscope.

Microscopic vision would support the idea explained above the rebellious ethics is best thought of as rebelling against practice based on moral values or understandings. In that the belief that the vision of an engineer is just the microscopic vision and that they never look up from the microscope would be overly narrow understanding of what an engineer is.

Sammons characterisation of the pure technician within Davis's model is the engineer who never looks up from the microscope. Rather than tell the engineer to look down this microscope not as an engineer but as a person (rebellious ethics) tell them instead that part of what it is to be an engineer is to look up from the microscope (integral ethics).

Whilst Davis does not intend to suggest that there are different moral rules for decision making when looking down the microscope as there are when looking up from it, microscopic vision could become doubling, because the moral rules that govern the microscopic vision can seem so different from those used every day.

I will discuss the different views on the role of the engineer as the professional in the following sections. What we can say here, is that both rebellious ethics and integral ethics are attempts to alter photographic vision by encouraging the engineer to adopt a different narrative of what it is to be an engineer. Speer failed to see and appreciate human suffering and destruction and both these views of professionalism are an attempt to ensure that such blindness does not occur again.

6.3.3 Advice to engineers

Each of these approaches has advice to offer to an individual engineer. Ends neutrality says that the engineer to focus on doing the task in hand the best of their technical ability and not engage in questions about the value of the artefact being produced, because that will produce efficiency.

The pure technician goes further and removes all considerations that do not relate to the success or failure of the immediate task at hand, stripping ends neutrality of any grounds for moral judgement.

Rebellious Ethics tells us that we should seek to separate ourselves from our professional role in order to act morally.

Integral ethics tells us that we should look inside the profession for moral guidance and recognise that engineers have special duties.

It would appear that in any given circumstance these approaches could lead to radically different and quite possibly contradictory advice as to the best way of acting morally.

Aside from the capacity of multiple narratives to confuse (and worse, possibly render the entire moral discussion irrelevant in the minds of some engineers), I suggest that all four narratives are flawed, either by leaving something out, or by a reliance on the moral neutrality of artefacts.

6.3.4 Responses to wrong moral values

We can view rebellious ethics as a response to concern about wrong moral values embodied in the practice of the profession. If the profession believes that the correct way to approach engineering is as the Pure Technician, it would appropriate to rebel against this view. In comparison integral ethics can be seen as growing out of a concern for wrong moral values embodied in the wider community, in the case of Nazi Germany in a society.

As Sammons argued, Speer is blameworthy for his failure to reject the horrors perpetrated by the regime than other non-professional Nazis because he had not only the Nazi values but the values of an international professional community that offered him a place to stand from which to critically evaluate the society in which he lived and worked.

So fundamentally the difference between the description put forward by integral ethics and that put forward by rebellious ethics is that integral ethics suggests that the issue was within societal values and that Speer should of been able to see this from the perspective of professional values whereas rebellious ethics characterises the issue as within the moral values of the profession.

So we can combine these approaches by suggesting that the moral values embodied in practice of society may be wrong and those within the practice of the profession may also be wrong. Because professionals have this additional standpoint they have the ability to switch between them and to query the validity of the moral principles upon which the practice is based. Whilst this is no guarantee that either set of values is correct, the ability to reflect from both positions on a moral problem increases the professional's chances of finding a permissible solution.

There is a distinct possibility that this view of the engineer having dual perspectives could tend towards a schizophrenic account of how engineers should consider ethical issues. We can go some way to remove this obstacle by considering the layperson and professional perspectives as different scales and filters to photographic vision, such that an engineer can appreciate that he now has access to multiple ways of filtering the same information. The need to engage critically with the societal values that one encounters appears to be essential if a professional is to avoid the example set by Albert Speer. Pragmatically perhaps the best way to consider the engagement between societal and professional values is on the level of some sort of social discourse. Not only is viewed in the attempt to encourage the creation of formal professional documents but also possibly through engagement with focus groups (see the section on risk below).

6.3.5 Albert Speer: Architect not Engineer

The case of Albert Speer has been used by Sammons, Katz and myself to consider particular issues in engineering ethics. It is therefore worth considering why it is appropriate to use the case of an architect when considering the ethics of professional engineering.

In a paper that I have already quoted, Eric Katz draws heavily on the work of Albert Speer, as well as the surviving historical record of the design of the crematoria at the Auschwitz Concentration camp. He opens by suggesting that, in training engineers, educators should do what they can to ensure that future engineers do not repeat the tragic mistakes of the past.

> Begin with this fact: engineers, architects, and other technological professionals designed the genocidal death machines of the Third Reich. The death camp operations were highly efficient, so these technological professionals knew what they were doing: they were, so to speak, good engineers. As an educator at a technological university, I need to explain to my students—future engineers and architects—the motivations and ethical reasoning of the technological

> professionals of the Third Reich. I need to educate my students in the ethical practices of this hellish regime so that they can avoid the kind of ethical justifications used by the Nazi engineers. In their own professional lives, my former students should not only be good engineers in a technical sense, but good engineers in a moral sense. (Katz, 2011)

Katz uses Albert Speer as an example of a “technological professional”, a category to which he believes engineers also belong.

> I use the broad term ‘‘technological professionals’’ to refer to those professionals who design, create, and use technologies, technological products, and technological artifacts. Included in this class of professionals are engineers, architects, and specific kinds of industrial managers. These professions are similar to the professions of medicine and law, in that they not only employ specific technical expertise but they also provide a significant social role and purpose. (Katz, 2011)

In chapter four, I suggested that, although there were differences in sub-disciplines that lead to different forms of photographic vision, they were sufficiently similar to be viewed as a single profession. We can also recognise that certain professions, although distinct, have certain similarities that enable us to consider their similarities collectively. Indeed, in suggesting that engineering is a profession, we are stating that there are a group of occupations that have a set of similarities that allow us to think of them as a group. We can say this and not suggest that, because they are both professionals a lawyer and a doctor have the same expertise.

This, however, is not the only justification for using Speer when considering engineering ethics. Albert Speer does not only reflect his own internal views whilst he was working in the Nazi Regime. He reflects on those he worked with, which included engineers. When he speaks of the Pure Technician he is describing a phenomena he observed and exploited in the engineers that he worked with and gave orders to. In his memoires he talks about the engineers who worked for him as “my engineers”.

> I thereupon proposed to Hitler that thirty thousand of the sixty-five thousand German construction workers I was employing be assigned under the direction of *my engineer*s, to repair work on the railroads. (Speer, 1970, p. 185) (Emphasis added)

Remember, at the point that this proposal occurred, Albert Speer was the Minister Armaments and war production. His ministry was responsible for the production of weapons including the tanks and V2 rockets. Work that unavoidably required the involvement of engineers. The justifications that Albert Speer gives for his role were justifications for his role in the production of armaments as well as buildings, in this his work and responsibility aligned with than of engineers. But he does not only reflect on his own views, in labelling those who worked for him as “Pure Technicians” he is describing the views of practising engineers.

As I discussed in chapter five, presenting information clearly can result in changes in photographic vision and narratives, if we do not like the implications of the information on our current beliefs. If we want to be able to say that we are different to Albert Speer then we must be able to differentiate our views from those of Speer. Because he wrote down his views articulately, we know what his views were. They provide a powerful example, and he himself offered them as a lesson to the world, “In writing this book my intention has been not only to describe the past, but to issue warnings for the future.” (Speer, 1970, p. 525)

Speer was technically successful. His work met the required specifications. If we want to challenge him, and if we want engineers to differentiate themselves from him, then they must do so not by being technologically different, but by being morally different.

> Today, a quarter of a century after these events, it is not only specific faults that burden my conscience, great as these may have been. My moral failure is not a matter of this item and that; it resides in my active association with the whole course of events. I had participated in a war which, as we of the intimate circle should never have doubted, was aimed at world dominion. What is more, by my abilities and my energies I had prolonged that war by many months. I had assented to having the globe of the world crown that domed hall which was to be the symbol of a new Berlin. Nor was it only symbolically that Hitler dreamed of possessing the globe. It was part of his dream to subjugate the other nations. France, I had heard him say many times, was to be reduced to the status of a small nation. Belgium, Holland, even Burgundy, were to be incorporated into his Reich. The national life of the Poles and the Soviet Russians was to be extinguished; they were to be made into helot peoples. Nor, for one who wanted to listen, had Hitler ever concealed his intention to exterminate the Jewish people. In his speech of January 30, 1939, he openly stated as much. Although I never actually agreed with Hitler on these questions, I had nevertheless

> designed the buildings and produced the weapons which served his ends. (Speer, 1970, p. 523)

6.4 Risk and the Public

I have offered a partial definition of a profession as being an occupation where the nature of the work undertaken is such that it often imposes significant risks on the public and there is specialist knowledge and skills. We can enrich the understanding of engineering as a profession by giving particular consideration to how engineers impose risk on to the public.

The discussion that follows will talk about engineers as risk imposers. I do not intend to suggest that engineers are only risk imposers. They are also benefit providers. Indeed, part of the reason that engineers can appropriately impose risk is that the imposition of the risk is necessary in order to realise a particular benefit. Earlier in this chapter I have discussed the role of the public good in professions, and have argued that engineers work toward the public good, that is they often significantly benefit society[45]. I propose that there is value in recognising that the types of benefits that engineers can give to individuals and societies often bring with them risks and that cannot be entirely mitigated. Part of this value is that this can be part of the narrative of what it is to be an engineer.

In characterising engineers in this way I will build on the work of Schinzinger and Martin, who suggest that engineering is "an inherently risky activity" (Schinzinger & Martin, 2000, p. 71) and that engineering projects can be viewed experiments, because of partial ignorance in which such projects are carried out. Schinzinger and Martin raise this in order to suggest that engineers should consider the possibility of obtaining some form of consent or proxy consent as part of the engineering design process. In a similar manner, I will characterise engineers as risk imposers to highlight particular issues that can be relevant for engineers to consider, which is compatible with an account of engineering professionals as significantly contributing to the public good.

In characterising engineers as risk imposers I am not saying that all engineers are imposing risk all of the time. This may be because there are cases in which it is possible to obtain informed consent (as discussed below). In other cases, it may be because the level of risk is so low that it seems odd to talk of it as risk imposition. But, I do propose that engineers

[45] I think that it is probable that most of engineering benefits society, I have made the slightly weaker claim here to allow for cases where we do not think that there is a genuine benefits. A few cases, such as gambling machines designed to encourage addiction, seem relatively clear. Weapons and implements of torture are more controversial because they may be morally justified depending on mode of functioning and circumstances of use.

should recognise that they are likely to be risk imposers during their professional careers, and that particular projects, often ones that affect many people, will impose risk on others.

The characterisation of engineers as risk imposers hides and highlights particular aspects of the role of the engineer. It clearly highlights that the actions of an engineer can cause others to be at increased risk, where those others may not be able to consent or may not know that a risk has been imposed. As this chapter progresses, other aspects of the role, such as responsible ways to respond to that risk and ways of engaging with the public will be considered. The questions that I hope engineers will be better able to answer as a result of considering themselves as risk imposers are "given that this project is beneficial, what risks does it involve? Who will be affected by the risk? Can they give consent and what can be done to ensure that the risks are minimised?"

Just as the risk imposer narrative highlights certain elements of an engineer's role, it also diminishes the important point that engineers are creating benefit. This narrative, characterising engineers as risk imposers, is compatible with other narratives, such as the Aspirational Engineer or the Global Problem Solver or the Facilitative Engineer. I am presenting engineers as risk imposers because it provides engineers with a way of viewing their work, which highlights potentially important ethical issues, such as their duty to the public, and the role of public engagement in engineering projects.

In presenting this narrative I am aware that students can particularly struggle in recognising that a particular characterisation is relevant to them. To suggest that engineers can be risk imposers, whilst true, may be easily brushed aside without its relevance and importance being considered.

6.4.1 Engineering as Social Experimentation

Schinzinger and Martin suggest that engineering is "an inherently risky activity" (Schinzinger & Martin, 2000, p. 71) and not only in the testing phases of an engineering project but that "each engineering project taken as a totality may itself be viewed as an experiment".

In support of their view of engineering as experimentation they highlight a number of similarities that engineering has to standard experiments:-

1. Any project is carried out in partial ignorance.

2. The final outcomes of engineering projects, like those of experiments, are generally uncertain.

3. Effective engineering relies on knowledge gained about products both before and after they leave the factor… [t]hat is, ongoing success in engineering depends upon gaining new knowledge, just as does ongoing success in experimentation. (Schinzinger & Martin, 2000, pp. 72-73)

A little later they discuss the importance of learning from past successes and failures in engineering and how this practical knowledge is essential to provide a check system within the engineer when undertaking for example, complex calculation. From this we can draw a fourth point, discussed by them but not listed with the above points.

4. Engineering, just like experimentation, demands practitioners who remain alert and well informed at every stage of a project's history, and who exchange ideas freely with colleagues in related departments. (Schinzinger & Martin, 2000, p. 74)

However, as Schinzinger and Martin acknowledge the nature of engineering does not allow for the degree of control normal in experiment. In particular, it is not normally possible to randomly select participants. In fact this often goes against the nature of the engineering project. No randomly selected parallel control group can be established to study the effects that changes in variables have on two or more parallel groups.

Thus, having said that engineering is experimentation, and that it is important for engineers to learn from the past, we must now accept that the lack of experimental control makes is hard for an engineer to determine exactly which variables produced the desired or undesired effects.

As Schinzinger and Martin observe, the purpose of engineering is not primarily experimental (that engineers rarely make a product "to see what happens", nor primarily to test if what they think will happen does (as is the case with medical trials) but rather with a belief that they are solving a particular problem[46]) does not prevent us from appropriately characterizing engineering as an experiment. I think that characterizing engineering in this way can be helpful, in part because it presents a view that encourages engineers to consider how complete their information is and what degree of unknown outcome is possible.

[46] Solving a particular problem is another way of characterising the concept of 'designed for a purpose' used to demonstrate that technological artefacts are not morally neutral examined in chapter five.

There are cases we can think of where it is possible to gain informed consent (e.g. the use of artificial hip replacements[47]). However, in cases of medical engineering the reasons for gaining informed consent currently come from practices within medicine rather than engineering, so I suggest that they are the exception rather than the rule. Also, whilst there may be cases where gaining informed consent is possible many technological artefacts impose risks on people who had no choice. Whilst the driver may choose the car, and we may consider that they have consented to the risks associated with car travel, the pedestrian who could be hit by the car has not done so, and in these cases the characterisation of engineering as social experimentation may highlight that this risk imposition imposes a duty of proxy consent upon the engineer.

6.4.2 Types of Risky Situations[48]

If the implicit narrative role for the engineer in Martin and Schinzinger's model is the engineer as an experimenter, we can consider several possible narrative roles using the work of Jonathan Wolff (Wolff, 2010). Wolff has examined risky situations by considering risk as the interactions between three roles, those who have the potential risk imposed upon them, those who receive the benefits and those who make the decisions (building on the work of Hélène Hermansson and Sven Ove Hansoon (Hermansson & Hansson, 2007)) . For the purposes of analysis let us consider a case only one individual occupies each of these roles. There are five possible combinations, given in Table 6-2.

Party suffering cost	Party enjoying benefit	Party making decision	Name of Situation
A	A	A	Individualism
A	A	B	Paternalism
A	B	A	Maternalism
A	B	B	Externalities
A	B	C	Adjudication

Table 6-2 Five Types of Risky Situation (Wolff, 2010)

The names listed here are those given by Wolff to each situation. Since the situation names are not always necessarily clear or helpful in explaining their significance, I will refer to each situation by its letter combination – so individualism is AAA. I will briefly summarise the potential implications of each of the five situations, considering cases where each letter represents an individual (rather than a group). Unless otherwise clearly stated, these summaries are drawn from the work of Jonathan Wolff.

[47] Thanks to Rob Lawlor for this example.

[48] The analysis of the situations from Jonathan Wolff has been influenced by the lecture materials which I have co-taught with Rob Lawlor.

6.4.2.1 AAA

In this case I make a decision that affects only me; I receive both the benefits and any costs. Of the five situations presented here this is the least problematic, because I receive both the risks and benefits and no one else is affected by my decision, I am not unduly influenced to choose risky or reduced risk options (unlike some of the cases below). We generally hold that it is a good thing that people are able to make decisions that will affect their lives.

Potential problems may arise if I incorrectly characterise the situation as one where no one else is affected (e.g. the motorcyclist, who having had an injury, imposes costs upon the NHS).[49] There are also cases where society might decide that I should not be allowed to take on certain types of risk even if I am willing to do so (e.g. the choice not to wear a motorcycle helmet).

AAA is the situation that results from informed consent within medicine. Although the medical professional advises the patient, the decision is made by the person who will receive the costs and benefits (when the patient is competent to do so). I will discuss informed consent in relation to engineering as social experimentation in section 0.

6.4.2.2 AAB

B is making decisions for A, A will receive both the costs and the benefits. In the best case this could be a wise parent making decisions for a child who lacks the capacity to make appropriate decisions for themselves (e.g. the decision to be vaccinated). In the worst case it could be a situation of complete indifference, where the lack of impact on the decision maker leaves them with no reason to make a good decision. Where there is no reason for A not to make their own decisions we may see it as disrespectful for them not be allowed to make decisions for themselves.

6.4.2.3 ABA

In this case A is making a decision about a situation in which A will bear the costs and B will receive the benefit.

In cases where A thinks that B's benefit is valuable then A will choose to the take the risk (although arguably in that case A does receive a benefit).

[49] In light of the discussion on photographic vision in Chapter 4, it seems possible that there are likely to be situations where the AAA category is perceived, but does not hold true, because risks are imposed on others that cannot be seen at the particular scale that decision maker is using, or that are filters out so that the decision maker does not realise that they were there.

In cases where A does not receive this hidden benefit, all of A’s incentive is towards becoming risk averse, because A will being bearing costs and there is nothing that A can look to as a reason for doing so.

6.4.2.4 ABB

B makes a decision, B will receive the benefits but A will receive the costs. This is the inverse of the previous situation. This time B may be tempted to choose risky options, because the potential costs will land on A, but B will receive the benefits.

This situation explains much of the response to climate change. If I do not change my behaviour others will suffer, but I might not be around to see it. Since there is benefit to me in maintain my current behaviour I have little incentive to act differently.

6.4.2.5 ABC

This time the decision maker (C) receives neither the costs nor the benefits, A receives the cost and B enjoys the benefit. There are cases where we value this type of decision making e.g. the decision of a judge choosing in favour of one person’s claims over the other. Although this situation has the advantage that the decision maker does not have personal grounds for choosing risk adverse or risky strategies because of the affect that it will have on them personally, this situation could also lead to indifferent decision making.

6.4.3 Conflicts of interest

Describing risky situations in this way, it becomes clear why avoiding conflicts of interest is an important duty for a professional. Professionals are expected to make decisions that are good for those affected by the decisions (e.g. doctors should act the patient’s best interests, engineers should hold public safety as paramount). Where there is a conflict of interest it can change the situation from AAA, AAB or ABC (where there is no personal incentive to the engineer to choose an option that is more or less risky) to either ABA or ABB, where they now have a personal reason for choosing one course over the other.

6.4.4 Engineers as decision makers

I am not suggesting that engineering is a fit for any one of these situations. Not least because engineering involves complex and inter-related groups of people where the benefits, costs and decision making may be spread and split in any number of ways. I suggest that engineers may find themselves in any of these situations. They may act as a consultant for an organisation (AAA) where they provide advice but do not make the decision. They may act as a decision maker for different groups (ABC) e.g. city planning. They may approximate ABB when there is a long delay between their involvement and the imposition of risk on a third party (if it takes five years for a design to be fully implemented, the designing engineer may have been paid and moved to another job before any risks are received, this may represent ABB because of the small likelihood of a cost to themselves).

6.4.5 Implications for Risk Benefit Analysis

When considering whether or not the benefits justify the risks of a project, complex situations are offered considered using Risk Benefit Analysis, which assigns unit values to the benefits and risks in order to facilitate a comparison. But the analysis does not allow for the potential variation in appropriateness that a variation in decision maker could make. There are harms that could arise because the person who is making the decision may be in a situation that inclines them toward a more or less approach.

This highlights the value of Wolff's analysis to engineers. Not that they should abandon use of risk benefit analysis, but rather that they should recognise that there are situations where they or other decision makers may be drawn to a particular course of action. Also, that there may be times when it is right to ask "who should be making this decision".

6.4.6 How should engineering be and how should engineers act?

There are two good questions that we can use the discussion of the roles of decision maker, risk recipient and beneficiary in relation to engineering. The first is, given that engineers can sometimes influence their role, which of these are situations that engineers should strive to achieve. The AAA case, in which those who receive the risks and benefits make the decision is preferable because we think that it is right that where possible people who are affected by the decision should be involved in making it. Below there is a discussion of the idea of informed consent which is based in a desire to approximate the AAA situation. Of particular concern are the ABB and AAB cases because they leave the decision maker vulnerable to the influence of the costs or benefits of their decisions (as is clearly the case in conflicts of interest). This is not say that engineers who find themselves in either of these situations are incapable of making good decisions, but that where the opportunity arises, these are not preferable situations.

The second question is how should engineers act when they recognise themselves to be in these situations? As I have already briefly mentioned, in cases of a conflict of interests it may be that the most appropriate thing for the engineer to do is remove themselves from the situation. In other cases this is not an option, or not an appropriate option. I do not think that there is a single right course of action in these cases, but that being aware that one may have a tendency in a particular direction better allows engineers to ensure that they are making fair and trustworthy decisions.

6.4.7 Informed Consent

If we view engineering as social experimentation this naturally leads us to consider the right way to approach users and consumers of technology if we are viewing them as research participants.

Schinzinger and Martin suggest that as in the case of medical ethics, for it to be appropriate to perform an experiment on an individual it is necessary to gain their informed consent before they participate in medical research. They propose a 'broad notion of informed consent' defined by the following conditions:-

1. The consent was given voluntarily.
2. The consent was based on the information that a rational person would want, together with any other information requested, presented in an understandable form.
3. The consenter was competent (not too young or mentally ill, for instance) to process the information and make a ration decision.

They suggest two additional requirements for situations in which the research subject is not easily identified or limited to an individual.

1. Information that a rational person would need, stated in understandable form, has been widely disseminated.
2. The subject's consent was offered in proxy by a group that collectively represents many subjects of like interests, concerns and exposures to risk. (Schinzinger & Martin, 2000)

Where the first three criteria can be met, the two alternative criteria are not required. But for many engineering projects the scale of impact means that the two alternative criteria are an approximation because informed individual consent cannot be achieved.

The obligation to consult a proxy group does not necessarily have to apply to each individual engineering project. It could be that it is the result of public discussion on particular issues, so that a proxy group can act for many similar cases. Obtaining this type of consent puts engineers between two positions. It may be a necessary part of acting responsibly in light of the unknown risks that are associated with engineering projects. But it is not the same as fully involving all those affected by the risk in the same way that a patient is involved in the decision by consenting to a surgical procedure. Engineers have both the obligation to seek proxy consent and the obligation to be aware that they are imposing risks upon people who have not consented.

One area where we do have this form of proxy consent is in planning applications, where those affected have the opportunity to voice their concerns and views and decisions are made by elected representatives. This model may not apply to all forms of engineering, or be appropriate in all cases, but it represents a metaphor that we can use to consider what might be possible in other areas, where a local government body is empowered to make decisions as to whether or not a particular engineering scheme should go ahead, in light of feedback requested from the public.

This additional obligation to seek proxy group consent does not need to fall to the individual engineer, it can be the focus of the professional bodies. I discuss the role of the professional bodies in ethical duties in the section below.

6.5 Professional Duties and the Professional Body

6.5.1 An issue of scale

One significant issue that engineers then seem to face is that they often spend a significant amount of time focussing on very small details that have a very big impact. We want them to focus on very small details, they are good at it, and we want them to be good at it. It does matter what type of rivets are used in a bridge, some will be strong enough and some will not. But the reason that the rivets matter is because the rivet choice affects real people in real ways. Sometimes the ethical significance of an engineer's work requires them to move a significant distance in scale. We are going further than asking them to look up from the microscope in the manner of a cobbler. Rather we are asking them to switch from a microscope to a bird's eye view and back again, small wonder than some find the transition dizzying.

Some of the burden can be taken off the shoulders of individual engineers by greater engagement on the part of the professional bodies, and this may be a good justification for codes of conduct, that they enable engineers to normally switch between microscopic and normal vision without resorting to macroscopic vision on a regular basis. But the justifications that underpin these views may require us to consider the macroscopic view.

6.6 Complicated and Complex Ethical Issues

The focus of this thesis has been on commonly agreed upon poor outcomes. The cases have been ones where we would agree that a particular ethical consideration was lacking, or given insufficient weighting. This is sufficient to create an improvement in decision making.

However, one of the challenges of ethics is that it is not always clear what the right thing to do is. In this case, recognising that we have photographic vision does not help us, because we are unclear which elements should be included in the field of view. As I mentioned in chapter five, if these are the issues that engineers think of when talking about what ethics is, it is understandable that they think that thinking about ethics should be someone else's responsibility.

One response that we can give engineers, that may be more powerful as a result of the discussion above, is that there are some ethical issues best considered at the level of a profession (facilitated by the professional bodies), rather than at the level of the individual engineer. There is currently an increasing interest in the ethical problems associated with climate change. This is understandable, changes in climate will affect millions of people and if we stand at a point where action now can influence the future wellbeing of so many then considering what we should do is a worthy task. Climate change raises significant complex ethical issues including our obligation to future generations, questions of fairness, how far our duties to assist others extend questions of cooperation and the ethical implications of different forms of climate change intervention. These complex ethical issues may well be best considered not by the individual engineer by the profession as whole, participating in the discussions of climate change already occurring within wider society.

6.7 Conclusion

I have used descriptions of a profession to highlight how engineering is a profession and the narrative that one can form from this of a professional engineer. I have argued that an inherent part of a profession is that the activities that those professional perform impose risk upon the public, and that the formation of functioning professions is one way to safeguard the public from unnecessary risk.

I have discussed engineers as risk imposers, and used Jonathan Wolff's analysis (Wolff, 2010) to highlight that different situations engineers may be in, can tend the decision maker to more or less risky options. I have considered the role informed consent can play in engineering and have argued that some types of ethical consideration, whilst important to discuss, are best discussed at the level of the profession, rather than that of the individual engineer.

7 Implications for Engineering Education

The thesis as a whole can be seen as providing a framework for considering how engineers should be educated. Chapters three and four together provide a detailed discussion of how engineers make decisions (metaphorically looking through a camera, and within the context of their narratives) and from them we can characterise the process of engineering education as one that should prepare students to make these types of decisions well, by ensuring that they will recognise relevant ethical concerns.

Chapters five and six contribute specific arguments and ideas that can be used in discussion with students to assist in the formation of their engineering photographic vision and engineer narratives as part of the development of expertise.

The contribution of chapter two to understanding engineering education is awareness that we can approach discussions of ethical issues without first turning to moral theories, although we might want to consider their place further in to ethics education. Therefore, this short chapter focuses on some additional points that have not yet been discussed in detail because they are more specifically issues that are student and education related rather than relating to improving engineering ethical decisions more generally.

7.1 Understanding what engineering is

Students who study engineering at university have made a conscious decision to do so. They already have a narrative of what it is to be an engineer and what an engineer does. However, most students have not had any experience of being engineer, or of seeing what it is that engineers do. In chapter five, I quoted the *Engineering in Society ebook* as an example of using new information as a way of altering photographic vision. The introduction to the ebook described one of the challenges facing engineering students is their awareness of what engineering is.

> [S]tudents often have misconceptions about a career in engineering. They often underestimate the amount of report writing involved; or they underestimate the importance of communication, and negotiation; or they don't realise the amount of responsibility that they are likely to have, and the extent to which they will have to use their own judgement, and make their own decisions, rather than just doing what they are told. (Lawlor, 2013)

It is helpful to recognise that part of what is happening during the engineering course is that the student is developing and refining their narrative of what it is to be an engineer. We will discuss this in more detail in section 7.3 (teaching by omission). The easy way to begin the process of discussing ethics is to start from case studies. Not only are the case studies useful in demonstrating why ethics is relevant to engineering, but also they can help refine the student's engineer narrative and contribute as vicarious experience to gaining expertise (see the discussion of Klein's work on expertise and recognition primed decision making in chapter).

Not only can students have an incomplete understanding of what engineers do. But they can also have an overly specific narrative that means that they filter too much out. So an electronic engineering student, presented with a mechanical engineering ethics case study may well feel that the information could be filtered because "that isn't the type of engineering that I am going to be doing". The student may not yet have a good understanding of what they will be doing, but none the less they recognise that the activity in the case study is not it. Whilst it might be case, the relevant ethics points might still be true even if the specific application isn't relevant, but the student's engineer narrative may make it more challenging for them to appreciate this.

7.2 Distinction between engineering and science

Many will not have studied engineering as a subject before, and their nearest relevant experience may have been studying maths and science at school. But 'doing engineering' is not the same as 'doing science'. The difference is not just what the engineer will be doing when they are in the field (e.g. how much time is spent report writing etc.) but can also be intuition about what the role and purpose and engineers and scientists is.

Michael Davis argues that engineers are not applied scientists, and should not be thought of as such, or taught in the same way that one should teach applied scientists. He illustrates the distinction by describing the difference in what engineers and scientists value as an outcome of their work.

> I once did a workshop at the research lab of a large petroleum company. The audience was about half chemists and half chemical engineers. I first asked the chemists, "If you had a choice between inventing something useful and discovering new knowledge, which would you prefer?" The chemists thought this a hard question: "After all," they reasoned, "it's hard to imagine an interesting discovery in chemistry that would not have a practical payoff." Eventually, I asked for a show of hands. About half the chemists voted for

> "something useful" and about half for "new knowledge." The engineers, on the other hand, *all* voted for usefulness. For them, new knowledge was just a means of improving human life. (Davis, 1998, p. 15)

I am not proposing that Davis' description provides us with a rule for determining who is and who is not an engineer, or a definitive guide for determining between engineers and scientists (after all, half the chemists voted for "something useful"). But to acknowledge that the narratives that engineers and scientists have about their work is different, and that by the end of their training, those trained as engineers and those trained as scientists tended to have different narrative views on what is valuable in their work.

The distinction between engineering and science is included here, rather than in a discussion on the engineering profession, because the distinction seems to be clear to practising engineers (as demonstrated by Davis) but not necessarily clear to students who do not have first-hand experience of doing engineering. Recognising that engineering is not science, and does not match to their previous experience of learning about science is an important step in navigating past a roadblock that the students must navigate in order to develop an engineer narrative that will better fit their post-educational experience of the profession.

Given that their view of the role of an engineer shapes what they recognise as relevant information, this might appear to be an argument in favour of delaying ethics education until students have a more accurate narrative for what engineers do. I do not think that this is the case and my argument against it is covered in Section 7.3, when discussing teaching by omission.

7.3 Teaching by Omission

It seems that students who study engineering can reasonably expect that their studies are equipping them with the skills, knowledge and understanding necessary for them to work as professional engineers. This is supported by the accreditation system; the professional bodies have assessed that a particular course is one that provides an appropriate foundation for joining the profession.

Becoming an expert is, in part, about developing the filters that allow one to determine which information can be safely excluded from the decision making process, as was discussed in chapter four. This is done, at least in large part, through focussing. Rather than provide the students with long lists of things that they do not need to consider (some of which they may not have recognised, because they lack the understanding that it is possible that there was something there to consider) students are taught about the things that they do need to consider. By focussing on what is important, and by spending time teaching particular information, concepts, skills etc. it is implicitly suggested that if something is important then it will be taught.

For example, so far as I know, students are not generally taught to consider the impact that their engineering work has on potential extra-terrestrial life. They are taught to consider environmental and legal factors. This implies that they are more likely to need to be aware of the laws surrounding their work, and environment considerations, than they are to factor in extra-terrestrial wellbeing. This is a sensible way to order their study and I am not suggesting that it should change. Rather, my point is that students are learning that extra-terrestrial considerations can be safely filtered when making engineering decisions.

Given the wide variety of potential work that engineers do once they have graduated, it is perhaps unreasonable to think that everything that is important will be taught (although it would be interesting to discover how much weight students and early career engineers place on the idea that "if I need it, I would have been taught about it"). But we can say that the more important that something is, the more reasonable it is to expect that it will have been included in the university curriculum in one form or another.

Since the presence or absence of concepts from the curriculum can be used by students to determine the relative importance of the ideas (particularly where the students lack first-hand experience to provide them with an alternative way of judging what they will need to know) omitting ethics from the curriculum would implicitly suggest that it is not significant to the decisions that engineers are making. Not only is this a concern for the immediate, that engineering students are being taught not to consider ethics during their student years. But as Klein observed in chapter three we use our existing experiences as metaphors for novel situations, so by teaching students not to consider ethics now disadvantages them in two ways. Firstly, should they recognise in the future that they need to make a decision with significant ethical components; they will have no bank of ethical decisions to draw on. Secondly, the bank of engineering decisions that they do have available and from which they will seek their metaphors does not include ethical information. Using their existing experience as a metaphor, they are less likely to seek ethical information because they have no experience of its relevance, and could well miss ethically significant information as a result. Also, in chapter four I noted that sometimes background circumstances can change that means that filters are no longer appropriate, but I also suggested that the background changes can be hard to detect (because they are filtered out). In a like manner, if students are taught to filter out ethical considerations, they may also be filtering out the prompts that would suggest that their filters are missing important ethical information.

7.4 Unique opportunity for engagement

Engineers in the UK do not require a licence to operate (e.g there is no direct equivalent to bar examination for lawyers). Engineers can choose to become members of the professional bodies and become charted, but there is no obligation to do so. Also, not everyone that becomes an engineer has an undergraduate degree in engineering. So we can say that some of those who study engineering become engineers, and some of those who are engineers have studied engineering at university.

Given that this is the case, there is no point in an engineer's career where ethics could be placed that would ensure that it would be studied by all engineers. But for those engineers who study engineering at university and become engineers there is no other point in their career path where they will necessarily come in to contact with preparatory ethical discussions other than during their education, and a significant proportion of those who study engineering will go on to become engineers.

We can say this, and stress the unique position of university education as an access point for engineers, and still believe that it is commendable to wish to support engineers at all stages of their career development in improving their ethical decisions.

Although discussing engineering ethics can be challenging for students because they are still learning about their profession and its narrative, it is also an important time for students to consider what they want the impact of their professional activities to be. Many students are not committed to a career when they start university, and their choices about the type of work they undertake when they graduate will be a contributing factor to determining the impact that they have on other people. Making a choice like this for the first time is a different choice from the choice to change jobs or careers, and it would a disservice to the students to delay introducing professional ethical reflection until after these decisions have been made, because they may make different decisions as a result of the changed photographic view that ethical discussion can bring.

7.5 Who should teach ethics to engineers?

Particularly in the early part of an engineering degree, ethics teaching is notably different to the way that most of the rest of the curriculum is taught. It does not look or feel like the mathematics and science that they are familiar with from school, nor is it clearly a practical skill of the kind that you learn in the laboratory. Nor does an ethics lecture sound like a lecture on thermodynamics. In chapter four I discussed the relationship between expertise and photographic vision (that we develop specialised vision as part of becoming an expert), and suggested that this process is occurring whilst students are studying engineering at University.

In chapter six I discussed Wolff's work on different types of risky situation. The purpose of the discussion was not to characterise engineering as belonging exclusively to any one type of situation, but rather to highlight that different circumstances raised potentially different concerns, and that engineers could find themselves in different variations of these situations.

In a similar manner, we can consider whether or not engineering students are best taught ethics by engineers or philosophers, not to suggest that one way is right and the other wrong, but to highlight the different implications of different specialisations. I am aware that these are not mutually exclusive categories and there can be engineer-philosophers. But the discussion still serves to highlight some considerations that will affect how ethics education is approached.

The specialised vision that comes with expertise normally carries with it specialised language to allow the expert to describe differences and distinctions that are not always visible to the lay person. Philosophy uses its own technical terms with distinct and precise meanings. The unfamiliarity of the language and the lack of instant appreciation for the significance of the distinctions discussed can make it challenging for an engineering student to grasp why discussing ethics is relevant. The fact that ethics is taught by someone from outside the engineering faculty might, of itself suggest, that this is in a way not "not engineering".

Conversely, all educators develop specialist areas of competence. I do not think that most engineering lecturers would consider themselves competent to deliver every aspect of an undergraduate engineering programme (leaving aside questions of the practicality of doing so). Possessing the ability to make appropriate ethical decisions as an engineer is not necessarily the same skill as the one that is required to teach ethics to engineers, and as a result it may be that philosophers are best placed to deliver at least some of the ethics content.

Engineers teaching ethics have the advantage that they look and sound more like the students expect their lecturers to look and sound like. Students may find it easier to accept the validity of ethics study when it is presented by engineers who "speak their language". But when presenting ethical considerations in everyday language, it can appear to the student that the ideas presented are just common sense (a roadblock covered in chapter five). Part of developing a student's photographic vision to include ethical considerations is providing them with the language tools to be able to explain clearly their views and which ethical information is important and why. Engineers without a background in ethical study may well feel that this is a very large task to be able to describe and explain the ethical distinctions that mean that the discussion is more than ‘just common sense’.

The above discussions are focussed on formal ethics teaching, lectures, seminars etc. focussed on a discussion of ethical content. As I discussed in section 7.3 when describing teaching by omission, engineering students use their educational experience to determine what information can be safely filtered out from their decision making. The presence of formal ethics teaching is unlikely to significantly alter students’ specialist vision if they do not see ethical considerations used as part of the decision making process throughout their course. The discussion of who should teach ethics is intended to augment the view that demonstration of the relevance of ethical information is a necessary part of the student experience, rather than to replace it.

7.6 Fitting in with existing narratives

Students starting university already have narratives of what it is to be an engineer, and I have already discussed the role that education can have in refining that narrative, both by what we teach (section 7.1) and what we omit (section 7.3). But students also have narratives of what it is to be a student that can be independent of their career choices. Being a university student might imply a certain lifestyle, a certain approach to study, work and recreation. (I do not intend to suggest that there is only one narrative of what it is to be a student, just as I have already suggested there are several narratives of what it is to be an engineer, so there are many potential student narratives.)

This is important because the student narrative will also shape the student’s vision of engineering ethics as it is presented to them. One particular narrative belief that may it is important to consider is the value placed on getting good grades. Of and by itself this is a sensible goal, and certainly more to be commended that the student who is indifferent to their exam results. But this can also lead to a decision making approach that uses grading as a filter for whether or not an activity is valuable. Some students might be interested in ethical issues and enjoy discussing them, but if a student isn’t enjoying discussing ethics and their participation (or lack of it) does not make any difference to their grades, then they might well perceive no reason to engage.

I suggest that there are times when it is a good idea to challenge a narrative belief. If there are good reasons for discussing ethics (as suggested throughout this work) then it is possible to present those reasons to the students directly. However, if the narrative belief isn’t challenged, and it doesn't conform the rule of thumb, "if it's important then it's assessed" then the educator is less likely to achieve the request engagement.

Another potential challenge within the student narrative is the narrative beliefs about the relationship between students and sources of authority (textbooks, research papers, lecturers etc.). Part of the process of personal reflection is to be able to interact critically with different ideas, even when they are expressed by those in authority. This is not the say that this can't be done in an appropriate and respectful way, but some students will find this more challenging than others. I have noticed that philosophy students adopt a more informal attitude towards academic staff than was usual for me as undergraduate engineering student. This is partially, then, within the culture of the discipline as well as within the student narrative. Recognising that it could provide an additional roadblock, we can help avoid it by clearly stating the appropriateness of critical reflection within the context of ethics teaching.

As I observed in chapter three, we can have an emotional attachment to our narratives and our narrative beliefs. In choosing the challenge narratives directly (e.g. by discussion) or indirectly (e.g. altering the assessment criteria to encourage students to engage where they wouldn't) the students may have an emotional response when they feel that something that they value is being challenged.

In chapter five I discussed the need for engineers to reflect on information and concepts to create improved photographic vision. This can be achieved through discussion but students may be reticent to contribute to a discussion. Discussion-style teaching may be new to them, or it may be something that they do not recognise as having a place within engineering education[50]. Reticence of this sort can be hard to distinguish from the roadblock beliefs discussed in chapter five because they can both manifest as reluctance to participate in discussion.

It is worth noting that the photographic vision that the engineering student is forming during their degree is specific to the engineering sub-discipline that they are studying. In order to fit with the narratives that they are developing on what it is to be a particular type of engineer it is necessary that the ethics teaching that they receive match with their sub-discipline and the types of ethical information that will be relevant to their future decision making. Students may struggle to engage with a generic course on engineering ethics if they cannot appreciate the relevance of the discussion to their own sub-discipline. A variety of examples from the sub-discipline (if teaching a single sub-discipline cohort) or from across the sub-disciplines

[50] This is complicated by the number of international students on UK Engineering courses. Individual students may have very different expectations of how to study and learn, and different narratives of what makes a good student.

(if teaching a multi-sub-disciplinary group) may help avoid this. However, there may be times when it is better to prompt the students to explain for themselves the relevance of the particular ethical ideas to their work, rather than to attempt to bridge the gap for them, as this encourages to develop cross-domain mappings that may be useful to their decision making in the future.

7.7 Ethics does not look or feel like engineering

The ability to discuss ethical ideas with increased clarity is a useful skill to engineers, as the practise in developing the ability to disagree with fellow professionals in an appropriate manner. When engaging with students we do well to first remember how different ethical discussion can be to their other experiences of university learning. Not only do they not necessarily have an accurate narrative of what it is to be an engineer, but they may not have a narrative that allows them to clearly see how to express ethical deliberations. In approaching ethical discussions I suggest that there is a greater need to explain the type of undertaking, what participation looks like and why the outcome valuable. From a student's perspective (given their particular lenses and filters at the time) it could be easy to characterise ethics teaching as "we talked, we finished, we left, nothing had changed". As Davis described above, explaining how the process is *useful* can be beneficial in encouraging engineering students to engage.

7.8 Ambition for the future

Engineers have different specialities, and their corresponding expertise means that they have different forms of photographic vision that have developed in line with that expertise. In light of that, the argument that the consideration of certain ethical issues does not necessarily have to fall entirely on the individual engineer, applies variably dependent of the impact of the individual engineer's actions. Engineers, particularly those with responsibility for large-scale engineering projects such as city planning, power generation and distribution systems and transport infrastructure make decisions that rely on considering complex ethical considerations. Making these decisions is part of their work and, much has been argued elsewhere, cannot be decisions that they do not make.

This is interesting, because we can add this as another part of the richness of the narrative that we can give to students. If they want to progress in their careers they are more and more likely to encounter decisions that have a significant ethical component.

7.9 International Engineering

As I have already mentioned, a significant proportion of engineering students in the UK are international students. This means that the countries that they are returning to do not necessarily have a *functioning* engineering profession (although the *potential* criteria discussed in chapter six will still apply). I have already mentioned that international students may have different narratives relating to being a student and to studying. It is also worth noting that they may have different narratives for what it is to be an engineer in their country. It may be that particular ethical issues are more clearly apparent in these narratives. (As an example I found that a discussion about corporate social responsibility in relation to mining was greatly enriched by students from West Africa who presented mining from an imperialist narrative of natural resource pillage, which contrasted with a shoulder-shrugging narrative on the inevitable actions of corporations by other students.) But this variation in narrative means that it highly likely that a given topic or case study is unlikely to be easily perceived as relevant by all of a student group.

7.10 Adapting the learning environment to alter filters

In chapter five I mentioned that we develop new filters in new environments, particularly when our previous filters do not seem to be working well. Students are developing and refining their photographic vision as they progress through the course, not only their photographic vision as engineers but also their photographic vision as students.

We can prompt them to re-evaluate the value that they place on certain information by altering the environment that they are working within. Within the university context this is achievable by altering teaching techniques, assignments (just the move from individual learning to team projects has already altered students' filters) and assessment criteria. Reflecting on chapter six, one way that changing the learning experience might alter the students' engineer narrative would be for them to have a more detailed understanding of the practical functioning of their profession.

7.11 Conclusion

Describing education as a process of specialist vision formation highlights that students are learning how to be engineers during their studies, and are using the cues in their educational environment as a guide to how to do this. Including ethics in their experience allows them to formulate narratives and specialist vision that include ethical considerations in their decision making, and the absence of ethics in the course may encourage them to filter out ethical considerations in the future.

Recognising that students arrive with particular narratives, both of what it is to be a student and what it is to be an engineer, allows educators to respond to these narratives. Responses can be to deliberate challenge or improve them (e.g. by providing accurate descriptions of what engineers do) or to alter their approach so that students' can understand the value of the teaching (e.g. by acknowledging the filter, “I don’t need to go the seminars that are not assessed”). Being conscious that ethics may look and feel unfamiliar to the students may encourage educators to be explicit both in the nature and purpose of ethics teaching.

8 Conclusion

I have argued that we can improve the ethical decisions made by engineers by improving what information they see when making their decisions, because for them to consider something, they must be aware that it is there, and we do not perceive all the information that is potentially available. My argument has used two related descriptions of how we view the world (1) in light of our narratives and (2) metaphorically viewed through a camera. I used these to demonstrate that our view of the world is incomplete and that that view can be altered. I have proposed methods for improvement (information, personal reflection and external engagement) and discussed the removal of roadblocks that make achieving engagement challenging. I have suggested that we can improve narratives of what it is to be an engineer by highlighting what is to be a professional, considering why engineering is a profession. I have also considered the implications of this approach on how engineers should be educated.

I started by arguing that we can approach the thesis question without referring first or primarily to moral theories, but by arguing from case studies and recognised issues of importance rather than with reference to a moral theory. However, we can do this and still recognise that moral theories can contribute to a version of specialist vision by the distinctions contained within, and clearly expressed, by their specialist language.

I have argued that our view of the world and our place in it is shaped by narratives. These narratives include the narratives that describe a life, or a significant portion of it (Lakoff, 2008), those that we use to describe how particular circumstances have arisen and the effect that different courses of action will likely produce (Klein, 1998), and those that we use to forecast the future as a way of considering how we should act (Beach, 2010). There are narratives of what it is to be an engineer, that carry with them different views on what right action consists of, and which have imbedded in them beliefs about the world. I have argued that because these narratives shape our view of the world, we can improve engineers' ethical decisions by influencing the narratives that they have, particularly their narratives of what it is to be an engineer (e.g. the Pure Technician and the Integral Professional Engineer) and narrative beliefs about how engineers should interact with and consider the role of the public.

Michael Davis argues that we can describe how engineers view the world by distinguishing between their specialist view looking down a microscope at a small area in great detail, and the normal vision that they have looking up from the microscope (Davis, 1998). I have incorporated Davis' microscopic vision in to my description of engineers as viewing the world through a camera. This description allows me to introduce distinction lacking in Davis' work. The camera metaphor allows us to appreciate that we do not have only two scales (down the microscope and looking up from it) but an infinite number of potential scales between the microscopic and normal vision. I then expanded our potential view further by zooming out from normal vision to consider the macroscopic view and all the potential scales between normal vision and the macroscopic. I have distinguished between information that is lost by scaling and information that is lost by filtering, and argued that filtering is a constant and unavoidable (although alterable) state. I have also argued that focussing is a form of unintentional filtering and contributes to information loss. I have combined this with a description of specialist vision as the ability to see distinctions and information unavailable to the layperson with no corresponding information sacrifice. I have used these descriptions of engineers' views of the world to suggest that we can improve the ethical decisions made by engineers by altering their view through the camera so that they will see ethically significant information when necessary.

Furthermore, I have argued that there is a link between the narratives that we hold and our photographic view (what we see through the camera). Altering narratives can lead to an altered photographic view, and highlighting particular information within the photographic view can lead to altered narratives. Narratives and photographic vision can be improved as a result of information (both information presented for the first time and information presented in new and different ways), consideration of the implications of the information and personal reflection by the engineer. Personal reflection can be encouraged by others, but it requires engagement from the engineer.

I have claimed that attempts to improve narratives and photographic vision will not be effective unless we work with the awareness that new ideas and concepts are evaluated in light of the existing narratives and views that the engineer has, some of which are exclusively related to the narrative of what it is to be a student. Both inside and outside education, particular views and beliefs can act as roadblocks which prevent the engineer in engaging with ethical discussions. I suggest that we require a response to these roadblocks because they prevent the engineer or student from engaging with other ethical issues whilst they remain in place. I suggest that supporting engineers to develop clearer narratives of the role of the engineer (including the engineer as a professional) will help in avoid some of the most important roadblocks, as do engineering case studies and clearly highlight ethical issues. I have noted that roadblocks can contain important ethical content (such as the value of toleration) and care should be given to ensure that this content is not undervalued in the desire to remove the roadblock.

I have examined accounts of what makes an occupation a profession because the discussion of engineering as a profession highlights elements of engineering practice and professional organisation that clearly demonstrate the role of ethical considerations in engineering, and offers an explanation of the value of professions based on the risk associated with professional action. I have examined different narratives of the role of the engineer, including how engineers should interact with, and respond to, their profession and have argued that the narrative of the Pure Technician is implausible.

In contrast to the Pure Technician narrative, I have proposed that we can characterise engineers as imposing risks on the public, and can use Jonathan Wolff's discussion of risky situations (Wolff, 2010) to highlight that engineers can find themselves in different types of risky situation, with different potential effects on their decision making. I have considered the implications of viewing risk imposition as social experimentation suggested by Martin and Schinzinger (Martin & Schinzinger, 2005) to suggest that engineers should consider whether or not they can obtain a variation of informed consent, where individual informed consent is not practicable.

I have suggested that this type of informed consent consideration belongs to a set of duties that can be better approached at the level of the professional body, rather than that of the individual engineer (another example is public engagement in climate change discussion).

Characterising engineering education as a process of expert photographic vision formation is in itself vision altering, because it can change how educators view their role and task. I have argued that viewing education as photographic vision formation is a characterisation of engineering education as a whole, rather than exclusively a description of teaching ethics to engineering students, and that the absence of ethics from the engineering curriculum could be characterised as teaching by omission.

I have noted that University education has some additional complications because engineering students are not necessarily familiar with the work that they will be doing as practising engineers, and because the narratives that students have of what it is to be a student can make it more challenging for them to engage in ethical discussion. However, I have argued that University education represents a unique opportunity to encourage ethical discussion, and that University educators have an obligation to include ethics in their curriculums as part of providing students with a rounded understanding of what it is to be an engineer. Recognising this allows educators to contextualise their work for students, aware that they may not have a clear knowledge of what engineers do, and to structure courses, teaching and assessment in light of narratives of what it is to be a student.

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Appendix A: The Institution of Mechanical Engineers Code of Conduct (IMechE, 2009)

<u>Extract from the Institution's By-Laws, issued 9 April 2008</u>

CODE OF CONDUCT

28. In order to facilitate the advancement of the science of mechanical engineering by preserving the respect in which the community holds persons who are engaged in the profession of mechanical engineering, every member shall, for as long as he continues to be a member, comply with By-laws 29 to 31 and the Code of Conduct Regulations.
29. All members are ambassadors of the Institution and must therefore conduct themselves in a manner that upholds and enhances the reputations of the Institution, the profession of Mechanical Engineering and the Institution's members.
30. All members shall conduct their professional work and relationships with integrity and objectivity and with due regard for the welfare of the people, the organisations and the environment with which they interact.
31. All members shall take reasonable steps to maintain appropriate professional competencies.

CODE OF CONDUCT REGULATIONS

32. Without prejudice to the generality of By-laws 29 to 31, the Trustee Board may for the purpose of ensuring the fulfilment of the requirements of those By-laws make and from time to time amend or rescind Code of Conduct Regulations to be observed by members with regard to their conduct in any respect which may be relevant to their position or intended position as members and may publish directions as to conduct which is to be regarded as proper or improper (as the case may be).

DEALING WITH ALLEGATIONS OF IMPROPER CONDUCT

33. In these By-laws and the Code of Conduct Regulations "improper conduct" shall mean a failure to comply with By-laws 29 to 31 or the Code of Conduct Regulations or the making of any false representation when applying for election to any class of membership of the Institution or any act or omission

which shall have rendered the member unfit to remain a member of the Institution or shall be injurious to the Institution.

34. The Trustee Board may make and publish and from time to time vary or rescind in such manner as it thinks fit Disciplinary Regulations for the purpose of stating the manner in which allegations of improper conduct that may be brought to the notice of the Institution, properly vouched for and supported by evidence, shall be investigated and dealt with, including the constitution and membership of any committee or committees that the Trustee Board may appoint for the purpose, the procedures to be followed by such committee or committees, the sanctions that may be applied, the orders for the payment of costs that may be made, and the procedures to be followed for the hearing of appeals. No such Disciplinary Regulations shall be in any way repugnant to the Charter, these By-laws or the rules of natural justice.

PENALTY FOR IMPROPER CONDUCT

35. A member found in accordance with the Disciplinary Regulations to have been guilty of improper conduct, will be liable to be penalised in accordance with the Disciplinary Regulations.

Code of Conduct Regulations

Pursuant to By-law 32

Amended and approved by the Trustee Board on 13 July 2009

Members are specifically referred to By-law 30, which sets out the core ethical obligations for all members of the Institution. The following Regulations are founded on the principles contained within this By-law and the Statement of Ethical Principles published by EC(UK) 2007.

Pursuant to By-law 33

Amended and approved by the Trustee Board on 13 July 2009

Members are specifically referred to By-law 30, which sets out the core ethical obligations for all members of the Institution. The following Regulations are founded on the principles contained within this By-law and the Statement of Ethical Principles published by EC(UK) 2007.

CONDUCT OF CORPORATE AND NON-CORPORATE MEMBERS

CR1. Members shall act with care and competence in all matters relating to their duties and shall:

CR1.1. continuously throughout their careers take all reasonable steps to maintain and develop their professional knowledge and skills relevant to their field of professional activity (including new or changed statutory provisions) and their technical and commercial leadership and management skills.

CR1.2. have a duty to take all appropriate measures to assess and limit risk in all aspects of their work for others.

CR2. Members shall maintain up to date knowledge and skills and assist their development in others and shall:

CR2.1. maintain a record of evidence of Continuing Professional Development.

CR2.2. give all reasonable assistance to further the education, training and continuing professional development of other members and prospective members of the engineering profession.

CR3. Members shall perform services only in areas of current competence and shall:

CR3.1. be competent in relation to every project that they undertake. They shall ensure that, having regard to the nature and extent of their involvement in a project, they have the relevant knowledge and expertise, time and authority to perform. Where appropriate, this may include access to the knowledge and experience of others, or access to other relevant sources of knowledge, in addition to the member's own knowledge and experience. In so doing, they shall pay due regard to the laws on copyright and other rights of intellectual property.

CR3.2. if aware or become aware of relevant limitations in, or in any respect unsure of, their competence to undertake professional work they shall disclose that fact to the customer of the work. The member shall only proceed when the customer confirms their agreement to proceeding on that basis.

CR3.3. take all reasonable steps to ensure that persons working under their authority are both suitably equipped and competent to carry out the tasks assigned to them.

CR4. Members shall not knowingly mislead, nor allow others to be misled, in engineering matters and shall:

CR4.1. when called upon to give an opinion in their professional capacity, do so to the best of their ability and ensure that it is objective and based upon the best available knowledge and information.

CR4.2. when their professional advice is not accepted, take all reasonable steps to ensure that the person overruling or neglecting that advice is aware of any danger or loss which may ensue from such over-ruling or neglect and in appropriate cases, to inform that person's employers of the potential risks involved.

CR5. Members shall present and review engineering evidence, theory and interpretation honestly, accurately and without bias and quantify all risks and shall:

CR5.1. when an approach is received from a potential customer, take all reasonable steps to understand and define the brief with the customer. They shall be particularly careful to make the customer aware that they will not be offering a service in matters lying outside their competence. If other professional advice is required, the customer shall be informed.

CR5.2. when acting as independent experts, conciliators, mediators or arbitrators or similar roles do so objectively, with impartiality, uninfluenced by any personal considerations and without undue bias.

CR5.3. be or become aware of the risks of failing to achieve objectives, whether concerning performance, cost or time and take account of the consequences of any such failure and inform their employer or client.

CR5.4. identify and quantify all risks associated with their work and manage them in conformity with accepted engineering and environmental standards and in a manner which does not compromise the welfare, health and safety of society. They shall inform those for whom they work of all matters relating to risk in a full and timely fashion.

CR6. Members shall be alert to the ways in which their duties derive from and affect the work of other people; respect the rights and reputations of others and shall:

CR6.1. use their leadership and management skills responsibly.

CR6.2. not recklessly or maliciously injure or attempt to injure whether directly or indirectly the reputation, practice, employment or livelihood of another person.

CR6.3. accept personal responsibility for all work done by them or under their supervision or direction.

CR6.4. take all reasonable steps to ensure that persons working under their authority are both suitably equipped and competent to carry out the tasks assigned to them.

CR6.5. behave with integrity and objectivity in their relationships with colleagues, clients, employers, employees and with society in general.

CR6.6. ensure, so far as they are able, that other members receive credit for their professional achievements and all rewards to which they are entitled.

CR7. Members shall avoid deceptive acts and take steps to prevent corrupt practices and professional misconduct; declare conflicts of interest and shall:

CR7.1. at all times so order their conduct as to uphold the dignity and reputation of their profession and to safeguard the public interest.

CR7.2. ensure that only legitimate qualifications and demonstrable experience are cited as evidence of professional competence.

CR7.3. not knowingly undertake work on behalf of one client or employer that they may then need to review, authorise or certify on behalf of a second client or employer.

CR7.4. whilst acting for a client or employer, not be at the same time, directors or substantial shareholders in any company with which they may have material dealings on behalf of their client or employer, without divulging the full facts in writing to their client or employer and obtaining their written consent to such action.

CR7.5. not improperly solicit work as an independent adviser or consultant, either directly or by an agent, nor shall they pay any person, by commission or otherwise, for the introduction of such work; provided that, if a member shall be working in a country where there are recognised standards of professional conduct, laid down in that country by a competent authority recognised by ECUK, which are in conflict with the previous provisions of this requirement, they may while continuing to work in that country order their conduct according to such standards.

CR7.6. when acting as independent advisers or consultants, not be the medium of payment made on their employer's behalf unless so requested by their employer; nor shall they place contracts or orders in connection with work on which they are employed, except with the authority of and on behalf of their employer.

CR7.7. when acting as independent experts, conciliators, mediators or arbitrators do so with impartiality, uninfluenced by any personal considerations.

CR7.8. take reasonable and appropriate steps to inform an employer, contractor, or client in writing of any conflict between their personal interest and faithful service to their employer or client that may impair their ability to make objective judgements.

CR7.9. in the event of any conflict between their duties to their superiors and colleagues or their duties to the engineering profession, ensure that their duties to the engineering profession prevail.

CR8. Members shall reject bribery and:

CR8.1. not without their employer’s consent given in writing accept any payment or benefit in money or money’s worth from any person other than their employer in connection with professional services rendered to their employer. Neither shall they without such consent receive directly or indirectly any such payment or benefit in respect of any article or process used in or for the purpose of the work in respect of which they are employed. Gifts of a relatively trivial nature are not considered to be an inducement.

CR8.2. familiarise themselves with, and comply with, the relevant anti-corruption laws of the countries in which they work or of which they are citizens or residents. Members based in the UK or working for UK-based firms shall be mindful of the provisions of UK legislation, under which UK-registered companies and UK nationals can be prosecuted in the UK for an act of bribery committed either in the UK or partially or wholly overseas.

CR8.3. note that those who have senior management positions have a particular obligation to make positive efforts to ensure that, as far as reasonably possible, bribery and corruption does not exist, and cannot occur, in the organisations for which they work. They shall set in place anti-corruption protocols and procedures so that junior employees are not drawn into corrupt practices through intimidation or persuasion by senior colleagues, and whereby they are able to report such practices without fear of reprisals of any kind, in particular, damage to their careers or prospects of advancement.

CR9. Members shall act for each employer or client in a reliable and trustworthy manner and:

CR9.1. not divulge any confidential information regarding the business affairs, technical process or financial standing of their clients, contractors, or employers past or present without their consent.

CR9.2. not use information obtained in confidence for the purpose of making personal profit. Neither shall they use any information obtained in the course of an assignments for the purpose for personal profit, if such action is contrary to the aims of the assignment.

CR9.3. not divulge, without prior permission, any unpublished information obtained by them as members of an investigating commission or advisory board.

CR10. Members shall ensure that all work is lawful and justified and:

CR10.1. when undertaking a professional assignment assess their potential liability for the accuracy and consequences of the work and, where appropriate, hold professional indemnity insurance together with statutory insurances, either personally or through their employers and advise their clients of the position before accepting a commission. (Requirements in relation to professional indemnity may differ in some countries and members shall act accordingly).

CR11. Members shall recognise the importance of socio-economic and environmental factors and shall minimise and justify any adverse effect on wealth creation, the natural environment and social justice by ensuring that all developments, throughout their life, use best practical and economic solutions to meet the needs of the present without compromising the ability of future generations to meet their own needs and:

CR11.1. comply with the obligations for health, safety and environmental protection in relation to both organisational and legislative requirements and must be aware of the purpose of the legislation and be prepared to respond to future legislative demands.

CR11.2. place responsibility for the welfare, health and safety of the workforce and wider community at all times before responsibility to the profession or other sectional interests.

CR11.3. expect to use their influence to the fullest extent and to behave to the best of their ability to maintain a sustainable environment.

CR11.4. ensure that the uses of natural resources are fair, equitable and sustainable and take account of the needs of a diverse environment.

CR11.5. never knowingly or deliberately over-exploit natural resources and promote the actions required in engineering practice to improve, sustain and restore the environment.

CR11.6. promote the wise use of non-renewable sources through waste minimisation, recycling and the development of alternatives where possible.

CR11.7. never knowingly or deliberately cause the environment to be damaged or nuisance to be created by the discharge of unacceptable quantities of any substance or energy in any form.

CR11.8. ensure that the uses of the environment and its associated flora and fauna minimise any adverse effects and wherever possible give positive effects.

CR11.9. embrace the needs of the community and future generations and adopt practices that have minimal adverse effects on social, cultural, archaeological and ethnic heritage, and the broader interests of humanity as a whole.

CR11.10. promote the concepts of integration of the management of the wider environment and foster environmental awareness within the engineering profession and among the public.

CR12. Members shall act honourably, responsibly, and lawfully so as to uphold the reputation, standing and dignity of the profession in general and the Institution in particular and:

CR12.1. if convicted of a criminal or civil offence anywhere in the world inform the Institution promptly, and provide such information concerning the conviction as the Institution may require.

CR12.2. after having been declared bankrupt or having made a composition with creditors or having been disqualified as a Company Director immediately notify the Institution of the same as they may be deemed guilty of improper conduct if they are prevented from undertaking professional duties consistent with the standards of membership of the Institution.

CR12.3. if they become aware or have reasonable grounds for believing, that another member is engaged in conduct or has engaged in conduct which is in breach of the By-laws and Code of Conduct Regulations' inform the Institution in writing of that belief, but in so doing no member shall maliciously or recklessly injure or attempt to injure the reputation of another person.

CR12.4. when entering into any correspondence (verbal or written) shall not implicate the Institution, through direct reference or use of membership status, in any statement that may be construed as defamatory, discriminatory, libellous, offensive, slanderous, subversive or otherwise damaging to the Institution.

CR13. Identify and be aware of the issues that engineering raises for society; listen to the aspirations and concerns of others and:

CR13.1. refrain from issuing public statements unless they do so in an objective and truthful manner. They shall include all relevant and pertinent information in such reports, statements or testimony that they make and ensure that they bear the date indicating when it was current.

CR13.2. not issue statements, criticisms or arguments on technical matters which are inspired or paid for by interested parties, unless they have prefaced their comments explicitly identifying the interested parties on whose behalf they are speaking and by revealing the existence of any interest the members may have in the matters.

CR14. Actively promote public awareness of the impact and benefits of engineering achievements and:

CR14.1. contribute to public discussion on engineering matters in their area of competence if they consider that by so doing they can constructively advance the well-being of the community.

CR14.2. in areas outside their area of competence, but in those in which a member can demonstrate adequate knowledge, comment on details of a project within that area of knowledge. Adequate knowledge generally applies to a narrow aspect of an area of competence. Adequate knowledge may be acquired from working in a related area of competence or through continued professional development. However, adequate knowledge in a narrow area is not generally a sufficient basis for public comment or advice on the overall solution to an engineering task outside of a member‘s area of competence.

CR14.3. in areas outside their area of competence, and in which they are not able to demonstrate adequate knowledge, limit public comment or statements to enquiries which seek to provide deeper understanding. In this respect the member may draw on experience in engineering training and analysis as a basis for asking objective questions which may assist the public to evaluate engineering works without the member implying personal competence or knowledge in the area.

CR14.4. ensure that factual information they issue concerning engineering matters is presented in a clear and unambiguous fashion to the public.

CR15. Issue public statements only in an objective and truthful manner and:

CR15.1. not make any public statement in their professional capacity without ensuring that their qualifications to make such a statement and any association that they may have with any party who may benefit from the statement are known to the person or persons to whom it is directed.

CR16. Members who, on behalf of the Institution, work with children or vulnerable adults must comply with the Institution's 'Working with Children and Vulnerable Adults' Policy.

CR17. Members shall co-operate with any reasonable request made by an Investigating Panel, and or, Disciplinary Board, or an Appeal Hearing for the purposes of their functions.