The Royal Academy of Engineering

Inter-Disciplinary Ethics Applied
A Centre for Excellence in Teaching and Learning

Engineering ethics in practice:
a guide for engineers

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ISBN 1-903496-73-X

August 2011
Published by
The Royal Academy of Engineering
3 Carlton House Terrace
London SW1Y 5DG

Tel: 020 7766 0600
www.raeng.org.uk
Registered Charity Number: 293074

This is an abridged version of a full guide available online at:
www.raeng.org.uk/ethicsinpractice

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1 Foreword and introduction

> ***"Engineers invent the future and their work affects the lives of millions of people, for better or worse. That raises enormous ethical issues in every branch of engineering, from computing through biotechnology and energy to civil and aeronautical."***
>
> *Engineering ethics in practice survey*

This guide is addressed to the professional engineering community. The United Kingdom Standard for Professional Engineering Competence[1], published by the Engineering Council, defines three types of engineering professional – Chartered Engineer (CEng), Incorporated Engineer (IEng) and Engineering Technician (EngTech). While their roles and responsibilities differ, each has to demonstrate a commitment to professional and ethical standards. This guide aims to support members of this community in addressing the ethical issues they face in their daily professional lives, helping them to identify, analyse and respond effectively to the challenges these issues raise.

The Royal Academy of Engineering and Engineering Council's Statement of Ethical Principles (SEP) was developed to identify the common ethical standards which all engineers are committed to – and is included as appendix 1 in this document. This guide is designed to complement the SEP by illustrating these principles with concrete cases and helping readers to explore their widespread application. The publication of both of these documents is part of the ongoing process of providing support to professional engineers in the development of their ethical skills, such as their ability to recognise the ethical aspects of engineering decisions, and to fulfil the ethical expectations of the general public. The primary elements in these skills are the abilities:

- to ***identify*** the different, and sometimes competing ethical concerns they face
- to ***analyse*** the issues that might underlie those concerns and
- to ***respond*** effectively to those concerns.

These are key elements of good professional judgement, which complement other technical skills that form an engineer's professional competency. In describing the key principles that bear on an engineer's ethical responsibilities, the SEP has provided the initial stage in the process. This guide constitutes the next step.

The case studies and discussions below are intended as a resource for engineers who are working in demanding roles, and making important decisions based on a very wide range of different kinds of information. The intention is not to present ethics as an additional demand that also needs to be taken into account, adding to what is already a very complex and demanding working environment. Instead, the aim of the guide is to show that ethical considerations are already built into the decisions made by engineers, yet that these issues can be navigated with confidence, clarity, and above all with the same high standards of rigour, evidence and rationality that engineers already apply to other aspects of their roles. Indeed, engineering can be enriched by paying more attention to ethics.

This guide uses cases drawn from real engineering situations, in order to allow engineers to practice ethical reasoning as it applies to these situations. However, in terms of developing better ethical awareness and reasoning skills, there is no substitute for dealing with the dilemmas and decisions that each of us faces daily. The first step is recognising these when they arise. Analysing them and responding effectively goes to the heart of personal and professional identity.

This guide is available as an abridged published document, and as a full set of case studies available online, including an in-depth discussion of the place of ethics in engineering. It is our intention to update and add to the case studies over time, reflecting the changes in technology and society that affect engineering ethics. Ethics, like engineering, is a practical subject, and its exercise is in debate and discussion. We hope that these case studies are used to stimulate discussion between engineers, to help individuals, and the profession as a whole, to advance their understanding of the ethical issues in engineering.

How to use this guide

The purpose of this guide is to supplement the SEP with discussions, clarifications and illustrative personal experiences that will bring the ethical issues in engineering to life. The guide is also intended to encourage reflection on the complex nature of the ethical demands described in the SEP. For instance, the SEP describes the requirement for professional engineers to act with "integrity", but this is a difficult concept to pin down. By highlighting subtleties in some of the words and concepts, and challenges and obstacles that might get in the way of adhering to the SEP in a simple and straightforward manner, the descriptions and discussions contained in this guide will illuminate the SEP and provide the tools to make concrete ethical judgements in an effective way. The chapters will also describe the principles in more detail, and provide examples of ways in which they might become relevant in different areas of engineering.

Chapters two to five are devoted to the four fundamental principles from the SEP as described above. Each chapter begins with a short discussion of the principle and how it applies to engineers. These introductions also include some very short descriptions of cases where the principle might come into play in different areas of professional engineering. After the introduction, each chapter gives an example case study relating to one aspect of the principle. It then gives details of other case studies relating to the principle, which are available in full in the online version of this guide.

Each of these case studies have been drawn from real life situations, though details have been changed in some, either to maintain confidentiality or to make the case clearer in the way it highlights a particular issue (individual and company names have been changed in all cases). Following a detailed description of the case, the central dilemma is stated simply and clearly, followed by a number of possible courses of action. Some of these might be ruled out altogether, either because they are against the law, or because they clearly contravene one or more of the fundamental principles as set out in the SEP. However, they are included because circumstances may arise where there would be pressure to take these unacceptable options. Other possible courses of action may be more difficult to choose between, and it may be necessary to exercise fine judgment in deciding what to do. The discussion section in each sub-section shows how this can be done, and progress made on the ethical issues involved. The last two parts of each section summarise the discussion, and then show how different principles referred to in other parts of the guide may have a bearing on the case in question.

Although the guide discusses cases based on real life the actual choices made in the original situations are not set out here. This is partly because those choices may sometimes have been mistaken, or might even be illegal. But it is also because the primary aim of this guide is not to present supposedly authoritative answers to specific cases but to stimulate reflection.

The final chapter of the guide provides advice on how to take an interest in engineering ethics further, including useful resources and places to go for further

information. It also lists some further sources of practical guidance, for example, websites, ethical helplines, and specialist advisory organisations.

Ethics and the law

This guide seeks to provide engineers with guidance in identifying ethical issues in their professional lives and responding to them. It does not provide legal advice and should not be taken to do so. While there is clearly a close relation between ethics and the law – many laws are implemented to enforce the ethical judgments of our society – the two are not identical. A course of action might be legal, but it may still strike the engineer as unethical. Equally, it is clear that thinking through the ethical contours of a situation tells you nothing directly about the laws that apply to that situation in a particular jurisdiction.

The issues raised in some of the case studies presented in the guide touch very closely on particular legal issues, and in some cases detail of these legal issues has been noted. However, it is important to reiterate that nothing in this guide will provide you with the knowledge necessary to incorporate legal considerations into the decisions you make as an engineer. Some further thoughts on this relation between ethics and the law are presented in Appendix 2 of this guide.

Engineering ethics in practice

This guide was influenced in part by the results of a survey on the ethical issues that engineers face in the course of their work, and the support that they receive (or not) from their employers in dealing with them. The small survey was carried out in 2009 and 77 engineers responded. Although this was too limited a sample to draw broad conclusions, some insightful responses were given. A selection of anonymous comments are quoted or paraphrased in section introductions.

2 Accuracy and rigour

Accuracy and rigour is the first principle listed in the Statement of Ethical Principles. This states that "professional engineers have a duty to ensure that they acquire and use wisely and faithfully the knowledge that is relevant to the engineering skills needed in their work in the service of others".

Probably the most obvious reason why accuracy and rigour is important to professional engineers is that accuracy and attention to detail ensures better engineering solutions, just as inaccuracies and carelessness in engineering can mean failure of engineering projects, which can in many cases mean financial failures, accidents, injuries and deaths.

Professionalism also involves being honest about level and areas of competence, and never agreeing to work in areas in which you are not competent or not able to easily achieve competency. The temptation to do this can be generated by commercial considerations, for example a company bidding for a lucrative contract despite not having the correct skills and technical knowledge within its teams. The risk here is that engineers working on the project will make mistakes, as they may not be aware of the key mistakes to avoid, and mistakes in engineering projects have the potential to be catastrophic. Conversely an engineer employing their specialist skills within their area of expertise can make a significant and positive contribution to society. However, it is important to note that many engineering projects are novel, and will require previously untested skills and methods. In these cases it is an engineer's duty to ensure that risks are managed and steps taken to allow teams to acquire the appropriate skills – but above all to be honest about unknowns and skills gaps.

"Q: Are there different pressures in your company which make it hard to always work in a way that you feel is ethical? A: Inability of management to get to grips with the idea that everyone can't do everything, and that available competency is a constraint in some cases which needs to be considered."

"Safety in construction requires continuous training and emphasising."

Engineering ethics in practice survey

Engineers also have a specific duty to maintain up to date knowledge in their fields of expertise because of they have the trust of their clients and the wider public. Engineers should be aware of the value that is given to their 'professional opinion', and never give it lightly or on the basis of insufficient evidence. If an engineer's opinion turns out to be mistaken, they may be held accountable for any negative consequences of actions taken on the basis of it. Although they may have used inaccurate information unwittingly, given their position as a supposed expert they will still be responsible for those actions.

Conflicts of interest can influence the accuracy of an engineer's opinion. Engineers should consider whether the opinion they have given is objective, correct to the best of their (up-to-date) knowledge, and based on the available evidence; or whether there might there be other considerations influencing their judgment. These might include, for example, commercial considerations, or loyalty to an employer.

The boxes below give some brief engineering examples relating to accuracy and rigour:

Anne is an engineer working for a company that has an opportunity to tender for some work on the construction of a new building. However, neither Anne nor anyone else at the company is familiar with one of the materials that the client wants to use in the project. Anne's boss suggests that they submit a tender for the work without saying anything about their lack of experience with the material, and in the meantime Anne can take the opportunity to learn what she can. Should Anne go along with this?

Bill is a software engineer who is asked to give an opinion in court as to the level of security offered by a company's data protection procedures. Bill suspects that the system may not be completely secure, though he has not had the opportunity to inspect it as thoroughly as he would like. Should Bill accept the request to appear as an expert witness? If so, how should he phrase his testimony?

Claire is a mechanical engineer working on the design of a new make of car. The car has passed all of the legally required safety checks, nevertheless Claire believes that there may be a problem with the transmission, that will only manifest itself after a few years' use. Claire has informed her manager, who has informed her that he does not believe the issue is severe enough to delay production until it is fixed. What should Claire do?

2.1 Case Study: Ensuring others are not misled

Professional engineers should "not knowingly mislead or allow others to be misled about engineering matters"

Scenario
Bradlet Structural, a firm that provides consultancy services regarding structural integrity and subsidence evaluation for heritage sites, has been hired by STZ, a contracting company that has been building a complex of luxury flats in the centre of a market town. Work has been halted as concerns have been raised about the effect of the building work on some nearby historic buildings, including a Medieval church and a street of Grade 1 listed buildings.

The development was controversial from the outset, being situated so centrally, but the Local Authority was persuaded that the design would be in keeping with the surrounding buildings, and would regenerate the centre of the town.

In an effort to satisfy the planning officers as well as the local media and the community of the town, STZ engages Bradlet Structural to undertake an evaluation to demonstrate that their building work is not having a negative effect on the structural integrity of the church. Specifically, Bradlet Structural has been charged with investigating the possibility that construction of the foundations of the development is causing ground settlement and subsidence underneath the church building. STZ is hoping to use Bradlet's report to allay local worries, and to allow building work to continue. A team is sent to perform the evaluation.

In the course of the team's investigation, it discovers evidence that points to significant recent subsidence in the vicinity of the church. The foundation work on the flat development is the clear cause of this subsidence, which is likely to exacerbate the increasing natural problems with the structural integrity of the medieval church.

Before compiling a report, the team leader verbally advises STZ of the team's findings, and their conclusion that there is a high risk of further development causing structural damage to the church building if the working methods are not changed.

On receipt of this information, STZ informs Bradlet Structural that the consultancy contract will be terminated, with full outstanding fees paid. Bradlet Structural is no longer required to compile a written report.

Some weeks later, when the controversial issue of the development work is being covered in an influential local paper, a member of the Bradlet Structural team notices that representatives from STZ have claimed that the development work is having no effect on local subsidence, and that the church is under no threat from the building work. The representative further claims that STZ have evidence (by implication from Bradlet Structural) to support that view.

Dilemma

Imagine you are the team leader from Bradlet Structural. It is your responsibility as a consultant to give advice on whether you think a building project is a threat to the structural integrity of a local church. By ignoring your advice and claiming that the church is under no threat, the company who engaged your services, STZ, has given information to the public that you feel to be false, about a topic that has the potential to cause harm to people and property. Furthermore, you have substantial evidence that this is the case, gathered by your team in a professional capacity. How should your team act?

What should you do?

1. You could decide to say nothing, given that the information in your possession was gathered whilst your company was employed by STZ, and there is an obligation to be loyal to those who pay for your services.
2. You could inform STZ that you do not agree with their public statements on the matter of the subsidence around the church, and that they should reconsider their position in the light of the information that your team gathered whilst in their employment.

Discussion

The information at your disposal was gathered during consultancy work for STZ; they have therefore paid for that information. Their ownership of the information is not absolute, but you may feel that its future use is their prerogative, and not that of Bradlet Structural or the consultancy team. In which case, STZ should have a role in the decision as to whether to publicly release the information.

There are also commercial reasons for Bradlet Structural to withhold the information. It may damage the reputation of the company if potential clients receive the impression that they may unilaterally release findings generated through client work. Any organisation in a situation with a risk of negative publicity from Bradlet's investigations will be reluctant to engage their services.

However, the consultancy team do have information that strongly indicates that the public statements of STZ are false. Moreover, those misleading statements concern development work that has the potential to lead to serious structural damage to a local heritage site, and possible injury or death to visitors and residents. Given that STZ are misleading the public on such a serious matter, and probably acting illegally given their duty of care to the public, it is clear that the company, the team, and the Team Leader as an individual have a responsibility to counter their claims. Not to do so would be a particularly serious case of allowing "others to be misled about engineering matters" and would therefore be contrary to the Statement of Ethical Principles. Moreover, people may hold Bradlet Structural responsible if serious structural damage did occur. The first option above, doing nothing, is therefore not an ethically acceptable option in this case.

These considerations may persuade you that the best course of action is to urge STZ to disseminate the information themselves, or at least to modify their public statements. This course of action has the advantage of giving STZ the opportunity to do the right thing. However, the position of STZ is such that they are probably unlikely to accede to the demand. Their actions have clearly demonstrated that the accuracy of their pronouncements is not their primary concern. To urge them to reconsider their position may be a collaborative solution to the problem, or it may just be a way of assuaging your conscience.

If you decide to go public with the information, Bradlet Structural will probably be brought into direct conflict with STZ, perhaps damaging their reputation with other engineering firms. You may feel that your duty to the public overrides these concerns, but going through the official channels looks like a way of discharging this duty more discreetly, without damaging Bradlet Structural's reputation by appearing unprofessional.

Summary

In this case, advising the Building Regulations department of the Local Authority looks like the best option. This department has the powers to stop any work that they deem to be dangerous and ask for modifications to ensure public safety. Going through the official channels means that, as Team Leader for Bradlet Structural, you can discharge your duty of care to the public, while staying mindful of your responsibilities to your employers.

However, if you take this route you may have to decide whether your responsibility ends there. What if the Local Authority does not act on the information? Should you then go public?

Other ethical considerations involved in this case

As well as ***honesty***, this case also highlights issues of ***accuracy and rigour***. The company in the case were disseminating inaccurate information, but when does 'mere' inaccuracy become outright dishonesty? It also involved considerations of ***respect for life, law and the public good***, and particularly the injunction to ***'hold paramount the health and safety of others'***, particularly the members of the public who would potentially be affected by the new development. Finally, as a Team Leader, the protagonist in this case was asked to show ***responsible leadership***.

2.2 Further case studies

The following case studies are available in full in the electronic version of this guide.

Acting with care and competence: ***Professional engineers should "always act with care and competence"***

Dilemma

You have reason to believe that a colleague, and friend, is not taking sufficient care in the execution of his role of examining engineer, and that this breach of duty may be impacting the safety of rail bridges. You know that you and he both have a duty to ensure that work is conducted with care and competence, but you must decide firstly what such a duty requires in this case, and secondly whether any breach is the fault of your colleague or the system in which you are both working. On top of this, you must also contend with conflicts that might arise between your professional duties and your loyalty to your friend. Should you give your friend the benefit of the doubt, report him to superiors, or raise the more general issue of how the system works with your managers?

Staying within your limits: ***Professional engineers should "perform services only in areas of current competence"***

Dilemma

You are an environmental engineer completing an Environmental Impact Assessment (EIA) for a paper manufacturing company, you have been urged to include your judgement that the increase in traffic caused by the development will not have a negative effect. However, you do not feel sufficiently competent in this area to be confident in your judgement and think that the company should engage a specialist consultant, which they are reluctant to do. Should you insist an expert is used, produce an incomplete assessment omitting traffic, or give your view on the impact on traffic, despite your inexperience in this area?

Keeping up to date: ***Professional engineers should "keep their knowledge and skills up to date and assist the development of engineering knowledge and skills in others"***

Dilemma

You are the managing director of an aeronautics compnay. You have a responsibility to assist the development of engineering knowledge in others, particularly those who work for you. You are requested by a team leader to send her team on training to update their specialist skills, but you will have to take them off the project that is sustaining the company and spend money that will generate no immediate return. If you allow the training you would certainly be unable to fund similar requests from other teams, but if your company loses all it specialist skills, it will be harder to acquire new work and complete it competently. Should you allow this team to undertake the requested training?

Being objective: *Professional engineers should "present and review engineering evidence, theory and interpretation honestly, accurately and without bias"*

Dilemma

You have been hired by the CEO of a financial company to develop an internal communications system for non-confidential information. You feel that it is important to include substantial safety features, but the CEO is confident – over-confident, in your opinion – in her ability to ensure that staff members restrict their communications to non-sensitive information. Should you suggest that advice is given by a security consultant; push your opinion that extra security is essential, or proceed as your client requests?

Evaluating risks: *Professional engineers should "identify and evaluate and, where possible, quantify risks"*

Dilemma

You are project manager for a power company, carrying out work on a sub-station, which serves an area with a large hospital. The work is likely to take longer than the 12 hours for which the hospital has back-up generating capacity. You feel that there is a powerful reason to perform intensive working on the overhaul of the substation (meaning overtime payments to workers), to protect the hospital from the risk of a damaging powercut. However, this decision is not motivated from a financial point of view, as there is no specific penalty from the regulators for disrupting power to a hospital as opposed to any other energy customer. How are you going to communicate your judgement to your manager? Should you argue it for in terms of responsibilities to the community; argue that it is in the commercial interests of the company to protect the hospital; or pass the decision on to a senior manager?

3 Honesty and integrity

Honesty and integrity is the second principle listed in the Engineering Profession's Statement of Ethical Principles. This states that "Professional Engineers should adopt the highest standards of professional conduct, openness, fairness and honesty".

"If I know that a competitor is bidding unethically, but will win the business, should I a) match his unethical behaviour in order to win the business which was rightly ours, or b) expose the unethical nature of the rival bid, therefore jeopardising the confidentiality of the unattributable source, or c) walk away from the business and retain the moral high ground?"

"Competitors are often less ethical... How does one compete with people that lie?"

Engineering ethics in practice survey

Honesty and integrity are in fact two separate but closely related concepts. While they have different meanings, it is hard to imagine anyone exhibiting one without the other. At least, someone who is dishonest is unlikely to be described as having integrity.

Engineers are likely to work for the benefit of a number of different groups of people, and in many cases will have a duty to keep these people informed of relevant facts. The public trusts professionals to provide information that is as complete and accurate as possible. Honesty is not simply a matter of not lying: an engineer may at times need to disclose information which has not been requested directly, and which in some cases people may not want to hear. In other cases, such as where there is a duty to maintain confidentiality, for example to a client, it may be unethical to disclose information which would jeopardise that confidentiality. In these cases, failure to disclose would not necessarily be dishonest.

Integrity is a more difficult concept to define. It has to do with acting ethically, even when there is no personal advantage to doing so. A person of integrity will resist pressure to compromise their ethical values and principles, whether that pressure comes from employers, clients, or anywhere else. They will take steps to avoid conflicts of interest or, where this is not possible, declare these conflicts clearly and do their utmost to avoid improper influence. People with integrity are consistent and reliable, and their actions match up to their words.

For some, integrity may also mean 'standing for something', trying to change practices and attitudes that seem less than ethical; it might mean trying to influence for the better the practices of an employer, the engineering profession, or even society at large. According to the Statement of Ethical Principles, an engineer should "take steps to prevent corrupt practices or professional misconduct" in others, and not simply avoid falling into such practices individually.

The boxes below give some brief engineering examples relating to honesty and integrity:

Dave is employed by a radio broadcast equipment manufacturer as a sales representative. In addition, Dave works as an independent consultant for organisations in the radio broadcast field. This work can include analysing their technical problems and, when required, recommending any radio broadcast equipment that they might need. In some cases, Dave recommends the use of broadcast equipment manufactured by his employer. Is it enough for Dave to declare his conflict of interest, or should he resign one of his positions?

Esther works on military contracts for a company manufacturing sensors which can detect and warn of the presence of chemical and biological agents. Esther is proud that her work contributes to equipment that saves lives. One day, she is asked to begin working on a new lightweight radar which can sense and display the movement and location of soldiers and vehicles on the battlefield. With this information soldiers can quickly call in mortars and artillery fire to destroy enemy positions. Can Esther work on the new project and keep her integrity?

Faisal is a technician working on the central heating system for a building which is occupied by a large financial services company. One day, while carrying out maintenance work in one of the building's corridors, he overhears two executives talking about a debt crisis at the company, something which has not yet been communicated to the public. Later, Faisal's friend, who owns shares in the company, asks him if he knows anything about the company's financial health. Should Faisal warn his friend about what he has heard?

In the following chapters, more detailed cases, based on real scenarios, are used to illustrate different aspects of honesty and integrity. These cases are designed to be challenging, and to allow reflection on what the principle means in practice.

3.1 Case study: Preventing corruption

Professional engineers should "avoid deceptive acts, take steps to prevent corrupt practices or professional misconduct, and declare conflicts of interest"

Scenario

Sudobuild is an international civil engineering consultancy that undertakes work all over the world. They have been assigned to direct a project in a developing country involving the development of a large hydroelectric installation that will in due course provide power for a town of several hundred thousand inhabitants. In conjunction with a business manager, the project manager negotiates the terms of the deal with the client, who is the construction company that will be building the facility.

The client agrees the contract with Sudobuild, and they inform the project manager that the funding for the consultancy work will be coming from a donor-backed central government fund dedicated to the development of energy production facilities. A small team from Sudobuild, including the project manager, flies out to provide guidance on the plans that have been developed, to give specific direction on ensuring that the facility can cope with a wide range of flow variation.

After the work is complete and the project manager is submitting an invoice, the client asks the project manager to invoice for twice the original amount. The client explains how this specific government fund operates; the fund is supposed to pay for 50% of the fee, and the client company is supposed to pay the other 50%. However, key individuals involved in the administration of the fund have developed a practice whereby consultants bill for double the amount, thus ensuring that the government covers the whole cost of the work.

The fee for Sudobuild's services in this situation is £370,000, of which only £185,000 was supposed to come from the government fund. The client is proposing that Sudobuild invoices for £740,000, and Sudobuild will then receive the full £370,000 that the government pays. The client points out the benefit of this from Sudobuild's perspective: they are paid in full, and on time. This is rare in consultancy work of this kind, and will save both time and money for the accounts department. The benefit for the client company is clear, as they receive the services without having to pay for anything. The government is none the wiser, as the administrators of the fund conceal the procedure from senior government officials.

On being informed of this unilateral change of procedure by the client, the project manager expresses surprise, and some anger. The project manager does not wish to participate in the theft of state funds however "normal" it is, and the manager explains Sudobuild's position to the client company. The client company then breaks some disappointing news; they say that they do not have the money to pay the consultancy fee. They claim to have available only a quarter of the 50% that they were scheduled to pay Sudobuild, and they urge the company once more to follow the process they have outlined so that Sudobuild can receive their full payment.

Dilemma

You have undertaken some consultancy work with a foreign company, under a scheme whereby half of your fee comes from the central government. However, the client company informs you after the work has been done that they are in financial difficulties, and that the only way you will be paid in full is if you falsify the invoice document so that the government pays 100% of your fee. You are also told that this is standard practice, and happens with the cooperation of the administrators of the government fund.

What should you do?

1. You could agree to the process as described by the client company. It is important that Sudobuild get fair remittance for the work they have undertaken, and administrators of the government fund have approved the practice of doubling the invoice.
2. You could refuse to participate in the practice, and accept whatever funds that the client company have available. You do not want to engage in corruption, but you do not want to sever your relationship with this company and others in the region.
3. You could refuse to double your invoice, and take the client company to court to recover your fee. It is important to take a stand against corruption, and to ensure that companies face up to their financial obligations.

Discussion

This situation places you in a scenario where perhaps the simplest course of action, refusing to get involved in the situation at all, is not possible. You are already embroiled in the situation, and you have been placed in an uncomfortable position. Your job in this case would be to manage the problems as best as possible for everyone concerned.

Perhaps the main point to consider is that doubling your invoice is likely to constitute fraud. It is clearly against the explicit rules of the fund, and also against the spirit in which the fund was established. Doubling your invoice is equally clearly an act of falsification of an official document. The consequences of this type of fraud are very serious. Both the company and responsible managers could be liable both for a criminal conviction, and for damages. In addition, you may be committing consequent accounting, tax and money laundering offences. The fact that it is standard practice, and that it has been endorsed by the administrators of the fund, does not provide a defence.

Sensitivity to differing working practices and business procedures is a key part of undertaking work in foreign countries. This sensitivity entails not rushing to ethical judgements about the way things are done, but it equally does not mean giving blanket acceptance either. Just because something is normal, does not make it acceptable from your point of view as an employee of a company with its own values and standards. Nor does it make it legal; you must never issue a false invoice.

You must avoid endorsing and participating in that process. If short-term benefits are the main issue, then taking the company to court may be the most attractive option. This may constitute the best way of getting your money, but may have a negative impact on your reputation in the area. Not only have you refused to play by the normal rules, you have also launched legal proceedings against a local company. Accepting a smaller amount of money in return for maintaining positive relationships with the local companies could be the better long-term option, but not if they are likely to repeat this conduct.

Summary

Several issues need to be balanced in this situation: the reputation of your company, the need to be paid for your work and how to deal with corrupt practices. Going along with the practice may appear to be the easiest option, but it is illegal and would constitute "a deceptive act" and a "corrupt practice", both of which are explicitly prohibited by the code of conduct.

Agreeing to take a smaller amount of money, on the other hand, may result in your company being seen as lacking business acumen, and you may risk other clients trying to do the same with you, resulting in your company not being paid for their work. Equally, while court proceedings may expose the corrupt practice of your client and offer a way of recovering your money, you run the risk of alienating many potential clients in the area.

Other ethical considerations involved in this case

This case raises questions of ***accuracy and rigour*** since it touches on an engineer's duty not to mislead about engineering matters. It is also particularly relevant to issues of ***respect for life, law and the public good***: work must be undertaken lawfully, and the reputation of the profession must be upheld. This reputational element is important since, even in cases where you think the suggestion of your client does not constitute corruption, you must also consider whether it will *look* as though you have acted corruptly. Finally, you also have a duty to be truthful and not to take advantage of the trust placed in you by society. These considerations are part of your obligation to show ***responsible leadership***.

Wider applications

Imagine you find out that senior local government managers in your civil engineering section are giving preferential treatment to their friends, equivalent to significant overpayments in consultancy payments.

One issue that can arise regarding corrupt practices is what to do when you discover that they are happening. If this involves senior members of your organisation then the problem becomes acute, as there are fewer options to report the activities within the normal channels. You will have to consider disclosing information either to regulators or to other relevant parties. The effect on your own career and reputation, at least in the short term, may be severe and you will have to consider the effects on your family and personal situation before deciding how to balance your professional responsibilities.

Imagine you are an experienced engineer moving into a new industry sector in which corruption in procurement and contracting procedures is rife. You want to put measures in place to prevent the prevalence of corrupt practices.

You may have advance knowledge that a role may involve dealing with corrupt practices. There are certain engineering sectors, and certain areas in the world, where corruption is a significant issue. In this kind of situation, you will be faced with putting systems in place, at an individual and organisational level, to deal with those pressures. These measures may include rigorous oversight of financial decisions and increased disclosure both inside and outside the organisation. A crucial step may also be to inform new and experienced staff about the legal, ethical and social situation regarding corruption and bribery.

You come to realise that a public procurement official, who happens to be a good friend of yours, has overpaid you for some stock. You did not realise this at the time, and you are uncomfortable that you received preferential treatment.

If you find yourself in the position of having received unwarranted benefits, on the basis of friendship, family ties or other factors, you will be faced with a difficult decision about disclosure. It may be tempting to remain silent on the grounds that there was no corrupt intention on your part, but you will have to be aware of how things may appear. It may be necessary to be open about the situation, although the effect of this on the friend (family member, etc.) that was involved will have to be considered. In particular, once you have discovered that there has been an overpayment, you should immediately repay the overpayment, otherwise you could be committing a criminal offence.

3.2 Further case studies

The following case studies are available in full in the electronic version of this guide.

Affecting others: ***Professional engineers should "be alert to the ways in which their work might affect others and duly respect the rights and reputations of other parties"***

Dilemma

You have started consultancy work on a project to develop a sophisticated monitoring system for residential buildings, and you learn that the proposed use is as a surveillance system for elderly and infirm individuals. There is a concern that as some of those individuals will not have the mental capacity to understand the system, and so will not be able to fully consent to the system, your work might lead to an invasion of individuals' privacy. Should you refuse to work on the project; continue to work on the basis that simple measures could be included to protect privacy; or insist that the system specification is changed to allow those people being monitored have the means to turn the system off?

Rejecting bribery: ***Professional engineers should: "reject bribery and improper influence"***

Dilemma

You work for a mining company setting up gold mining projects overseas. To get a license to mine in a particular area, you have to deal with the local Mayor who suggests that a license would be made available if you were to build a hospital for the local community. You are presented with what looks like an excellent opportunity to set up a prosperous mining operation and also to provide some benefit to a local population. However, in order to get this operation off the ground, it looks like you may have to bypass certain legal channels, and to perform this quid pro quo service for the Mayor which could be interpreted as a bribe. Should you go along with the mayors suggestion; abandon the attempt to acquire a license; or persist in trying to apply for a license following the normal legal channels?

Gaining trust: ***Professional engineers should "act for each employer or client in a reliable and trustworthy manner"***

Dilemma

As a team leader presenting a bid for R&D funding, you naturally want to present the best possible case for the project that you wish to work on. However, this may mean omitting details about the risk of further funding being needed, should initial research not prove fruitful. Should you disclose this possibility in your presentation, or express confidence that the project will be completed on budget?

4 Respect for life, law and public good

"The debate concerning the use of ATP [advanced train protection] on Britain's railways is an ethical dilemma - the system saves lives but the cost is disproportionate compared to using the funds for health or road safety."
Engineering ethics in practice survey

This set of principles is probably the broadest of the four that make up the Statement of Ethical Principles, and arguably the one that encompasses the ethical issues most commonly associated with engineering ethics. Obviously, all of us have general responsibilities for the life, law and the public good, but the engineer also has particular professional responsibilities to protect and uphold these. Many discussions of engineering ethics focus on major accidents where people were killed and injured, and particularly cases in which there seems to have been some level of negligence involved; for example, the Bhopal chemical leak, the Challenger space shuttle disaster and the Piper Alpha offshore rig fire.

Indeed, when Michael Davis, a leading ethicist,[2] considers the question "What does it mean to think like an engineer?" his conclusion is that the principle of ensuring the safety of others is so central to engineering that following it constitutes a large part of what is involved in thinking like an engineer. His analysis was based on an investigation of the Challenger disaster, in the course of which the head engineer was apparently asked to think like a manager, and not like an engineer.

This set of principles is not limited to health and safety, but also covers respect for the law, respect for (and the protection of) the natural environment, and the reputation and dignity of the engineering profession. It encompasses all aspects of engineers' responsibilities for the people affected by their work and the social and environmental context in which they function. This aspect of an engineer's responsibility is very sensitive to changing social and political standards and expectations, and the steps engineers are expected to take to protect others have changed over time, and vary across the world. The risk that labourers on Victorian engineering projects would have been exposed to, such as the building of Brunel's Great Western Railway, where 100 people died blasting one tunnel alone, would not be tolerated now. Similarly, there is increasing awareness of the impact of engineering projects on the local landscape and the global environment, and the need to mitigate any negative impacts.

These principles overlap significantly with the previous principles because, for example, failures of accuracy and rigour can put the public at risk, and failures of honesty and integrity can damage the reputation of the profession. Furthermore, as the example below illustrates, this principle doesn't only apply to the most senior engineers making decisions at the highest level, but on all engineers, from technicians to managers.

James is replacing the window of a commercial passenger aircraft, but realises that he doesn't quite have enough new bolts with the screen – he has just over half of the number he needs. The standard practice is usually to throw away old bolts and to refit windows with new bolts provided with the screen. However, time is short, he's due to finish for the day, and he suspects that if he goes to find more bolts there will be delays and he won't be able to finish on time. In addition he'll be late for his date, and he wants to make a good impression. He knows that other members of staff sometimes re-use old bolts when they're short of parts. Is using the old bolts compatible with showing due respect to life, law and the public good?

In the following sections, more detailed cases, based on real scenarios, are used to illustrate different aspects of the respect for life, law and the public good. These cases are designed to be challenging, and to allow reflection on what the principle means in practice.

4.1 Case study: Health and safety

Professional engineers should "hold paramount the health and safety of others"

Scenario
Kudochem is a multinational chemical company producing chemicals for the agricultural industry. Responsibility for engineering issues at the 11 Kudochem chemical plants in Europe, primarily in the UK, Germany and the Czech Republic lies with Kudochem's European Regional Engineering Director, Sally Proctor.

In the early hours of one morning, Sally receives a telephone call informing her that there has been a serious explosion at one of the plants. There have been some injuries, and damage has been done to property several hundred metres from the plant, but there have been no fatalities. The scale of the damage is huge, and the main site of the chemical plant is almost completely destroyed.

In accordance with company policy, an inquiry team is set up, involving company employees as well as independent consultants. After several weeks, the team discovers two possible causes, both relating to a new ammonia production technique for fertiliser, which has recently been introduced in all of Kudochem's plants. They are unable to determine which of these two possible causes are responsible. Given the presence of the flawed procedure in all of Kudochem's plants, it is imperative that the ultimate cause of the explosion is identified, so that urgent steps can be taken to safeguard against similar accidents at other sites.

The inquiry team is very concerned at their inability to determine the cause of the accident. Without this knowledge, it will be impossible to satisfactorily modify the plants in order to prevent future explosions of this kind. They make a radical recommendation: to call a meeting with several competitor companies who are also using the new procedure in their fertilizer plants, in order to share experiences and research findings.

This would be a significant departure from standard practice, and some senior colleagues with commercial responsibilities have reservations. To call the meeting would entail releasing information about the safety lapse, as well as discussing sensitive commercial information with business rivals. However, it may be the case that other engineers in other companies have encountered problems with the new method for producing ammonia, and could offer help in isolating the problem. Whilst such a course of action may be unusual in this case there are industries where safety critical information is routinely shared amongst competitors.

Dilemma

You are the European Regional Engineering Director for a multinational chemical company. After an explosion at a chemical plant, you have responsibility for preventing similar accidents at 10 other sites. The inquiry team has been unable to identify the cause with complete accuracy, and they have recommended that you initiate discussions with competitor companies to pool knowledge. This would be unconventional, and would entail significant commercial risk.

What should you do?

1. You could take the advice of the inquiry team, and invite engineers from other chemical companies who are using a similar process to produce ammonia, to come and discuss the accident.
2. You could persevere with the safety inquiry in-house, hire more consultants and attempt to ascertain the precise cause of the accident without involving other companies.
3. You could consider the entire process as too risky, and reconfigure your chemical plants to utilise a different method of ammonia production, perhaps reverting to the older established method.

Discussion

In this scenario, the situation could be seen as one in which there is a conflict of interests and duties, such that you are required to balance these conflicting concerns. On the one hand you need to ensure the safety of employees and local residents, and on the other hand you need to maintain the security of commercially sensitive material. In addition, you need to balance the risks with the financial costs of possible remedies, and you need to judge what is appropriate in an abnormal situation.

The Statement of Ethical Principles states that you must "hold paramount the health and safety of others." At the same time, though, you need to take into consideration any other obligations you may have – including the duty to keep sensitive material secure, and to protect people's jobs by protecting the commercial interests of the company.

Of course, if a company is acting illegally or irresponsibly, you may have a duty to 'blow the whistle', and this may defeat any obligation to keep sensitive information secret. However, in this case, there is no indication that the company was acting irresponsibly. As a result, while it may be the case that you have an obligation to protect the safety of others, you have other duties too.

As such, you could consider the commercial risks of sharing information with your competitors to be too significant. Even if this is not your first response, you could be persuaded by commercial managers of the company that this is true. However, it is not clear that these considerations can outweigh the safety concerns. The principle states that you should hold paramount the health and safety of others. The same procedures are being used in all of Kudochem's plants and, given that the cause hasn't been identified, you need to take seriously the possibility that there could be another explosion.

Therefore, whichever option you choose, you will need to ensure that you take steps to ensure that there isn't a similar accident in one of the other plants. Therefore, if you decide to keep the enquiry in house and just hire more consultants, whether or not this is acceptable may depend on what other steps you take to prevent accidents at the other plants. If no steps are taken, this option would appear to be ruled out by the principle we are considering.

Alternatively, you may decide that a remedy will not be found in-house, and that it is not suitable to share information with competitors, and that it is preferable to take the drastic step of replacing the entire process rather than run the risks associated with the other options. This solution at least has the benefit of being associated with predictable costs, timescales and safety levels.

Finally, it may seem like pooling safety information with other companies is the best way of ensuring the safety of the chemical plants, and of holding "paramount the health and safety of others". Not only will you be able to ascertain the cause of the accident and modify your own plants, but your competitors may be able to avoid similar accidents.

This last point should not be understated. The principle is not just to avoid being the direct cause of harm, but to hold paramount the health and safety of others. As such, if you are able to act in a way that helps other companies to make their plants safer, you should do so. Of course, it is not your main responsibility, and of course your competitors have the primary responsibility of ensuring that their plants are safe. But if there might be problems with their plants, of which they are not aware and about which you could warn them, this does seem to be a further reason in favour of sharing information.

Furthermore, the practice of sharing information in this manner has precedents in other commercial areas. For example, following the Piper Alpha disaster in the North Sea, offshore oil and gas companies now routinely share safety related information. This may be true, but it is important that in extreme situations such as this you make a thoughtful decision, and reflect on a range of considerations. The safety of employees and residents should take priority, but how this is achieved and how other considerations are compromised will require reflection and careful consideration.

Summary

In this case, there does seem to be good reason to share safety information, if at all possible. Of course, where possible this should be done in a way that gives appropriate weight to one's other duties, regarding sensitive information, for example. Ultimately, however, it should be recognised that holding health and safety paramount doesn't just mean ensuring that you are not *directly* responsible for harms to the public, but that you also have some responsibility to help others improve their health and safety, for example by warning them of dangers they may not be aware of.

Other ethical considerations involved in this case

Another consideration that is central to this case is the principle of ***upholding the reputation of engineering***. If engineers were perceived to be taking unacceptable risks because they were putting economic considerations and competition before health and safety, this could be very damaging to the engineering profession. On the contrary, the sort of co-operation considered in this case might well enhance the profession's reputation.

Wider applications

One of the characteristics of engineering decisions is that they can affect the health and safety of very large number of people. This means that the general public expects engineers to consider the ways in which their activities might put people in danger, and to remove or mitigate those dangers.

It is easy to say that the health and safety of employees and the public should take priority, but issues arise in identifying an appropriate level of safety. Engineering activities are rarely 100% safe, and what matters is whether an activity is "safe enough", where this is down to the judgement of individuals, society, politicians, scientists or lawyers.

This issue crops up most often in engineering in the form of managing a balance between safety and financial cost. How much should you spend in order to avoid death or injury to a member of the public? This decision can depend on many factors, and different answers are given in different areas; rail transport and car transport, for instance. Many aspects of this kind of question are settled by legislation and industry standards, but engineers can easily find themselves having to make decisions at the boundaries. In these situations it is important to be able to think about health, safety and risk in a rational manner, without either feeling totally constrained by financial pressures, or disregarding the practical implications of implementing safety measures.

4.2 Further case studies

The following case studies are available in full in the electronic version of this guide.

Justifying the work: ***"Ensure that all work is lawful and justified"***

Dilemma

You are the managing director of a software company providing e-learning tools. You are planning to tender for some work from a public sector agency – an e-learning course aimed at job-seekers. The work as specified in the Invitation to Tender is, in your opinion, unnecessarily complex. On the one hand, your business needs to take on work, and if you do not bid for the work as described it may be less likely that you will win this contract. Moreover, even if you do win it, a less complex project will bring in less revenue. Should you bid for the work as described; submit a bid for a more simple system; or ignore the work altogether?

Minimising and justifying adverse effects: ***Professional engineers should "minimise and justify any adverse effect on society or on the natural environment for their own and succeeding generations"***

Dilemma

You are a self-employed engineering consultant. You have been employed to produce an environmental impact statement for a new road tunnel on behalf of the construction company proposing the tunnel. It has been made clear to you that the expectation of your client is that the statement will not find significant environmental problems with the project. However, you are concerned that if you produce a report that meets these expectations, it will not fully represent the adverse effects of the project and could lead to the project proceeding even though its benefits do not outweigh the environmental damage it will cause. How should you go about completing the environmental impact statement? Should you aim to meet their expectations, adapting the methodology to get the desired results; warn them that the report may highlight problems; or simply produce the most honest, accurate report that you can?

Respecting limited resources: *Professional engineers should "take due account of the limited availability of natural and human resources"*

Dilemma

You work for a company contracted to restore a listed building, which is a children's home. You need to source wood that is of the same type used originally, but which comes from a sustainable supplier. You need to decide whether to go with the supplier who is able to provide wood from the same country as the original wood to reasonable sustainability standards, or a supplier who is able to provide wood that is from a different country to the original source, but which meets higher sustainability criteria. You need to decide between two important considerations: taking account of limited natural resources and carefully preserving our collective heritage.

The reputation of engineering: *"Act honourably, responsibly and lawfully and uphold the reputation, standing and dignity of the profession"*

Dilemma

Imagine you are an engineer working for an overseas airline, given orders to replace the studs attaching the pump casings on all the jets under your control, but you believe the replacement studs to be of poor quality. As a relatively junior member of staff you are expected to follow orders and you are worried that raising your concerns in this case could be detrimental to your career. However, as an engineer your primary responsibility is to ensure the safety of the jets under your control, their pilots, crew and passengers. You believe that if you simply follow the orders that you have been given to replace the studs, you will not be acting responsibly and the safety of the jets will be compromised. What course of action should you take given your competing responsibilities to obey orders and to maintain the safety of the jets, and considering your concerns for your career? Should you follow orders; go against those orders; recommend to your superiors that work does not proceed; or pass your concerns to the media?

5 Responsible leadership: listening and informing

"Give ethics a prominent place in all that the institutions do. Communicate this widely and frequently through the media. Work closely with other professional groups e.g. medicine to learn from their approach. Hold discussions with others from non engineering/scientific backgrounds e.g. philosophers to gain a broader insight into how they view and handle ethical issues."

Engineering ethics in practice survey, in response to the question: Do you feel that the engineering profession could be doing more to promote engineering ethics and to support engineers?

Under the heading, 'Responsible leadership: listening and informing', the Statement of Ethical Principles states that professional engineers "should aspire to high standards of leadership in the exploitation and management of technology. They hold a privileged and trusted position in society, and are expected to demonstrate that they are seeking to serve wider society and to be sensitive to public concerns." This guide focuses largely on cases in which an engineer has to make a decision, often at a particular time. In presenting a report, for example, the engineer is required to be honest and objective. Or, if offered a bribe, an engineer is required to reject the bribe. We can think of these as requirements for an individual engineer, at a particular time. If the engineer fails to be honest, or if he accepts a bribe, the engineer does something wrong.

Not all ethical considerations are like this. If we think about the engineering profession as a whole, there might be responsibilities that apply to the profession, without being the responsibility of any specific individual professional. Professional bodies can engage with politics, campaigning for changes in the law and so on. For example, the medical profession gets involved with debates on the safety of sports such as boxing, or on public health policies relating to issues such as childhood obesity. It is plausible to think that this is a part of the profession's responsibilities but, typically, we would not claim that any particular doctor had done something wrong if they were not involved in any particular campaign. It may be perfectly permissible for any given individual not to be involved in any of these wider activities but something would be lost if the medical profession as a whole was not involved in public debate and had no part to play in forming public policy. Indeed it may be thought that the medical profession fails if it does not engage in this way.

Similarly, while it may be acceptable for any individual engineer to choose not to be involved in political debate, there may be an obligation for the engineering profession as a whole to engage in these wider activities. Issues such as climate change, energy security, the protection of personal data and so on are high profile policy issues to which the engineering profession can make an important contribution.

Hence, there is a specific interpretation of 'leadership' in this guide. This principle above could refer to the duty that engineers have to be responsible leaders when managing other engineers. As such, "listening and informing" would be a reference to the duty of a senior engineer to listen to the other engineers he is working with, and to keep them informed. Although this is important, this principle refers to the responsibility not of individual engineers, but of the engineering profession as a whole, to provide responsible leadership, to listen to society and to engage with the public. However, it is individual engineers who must make the decision to follow this principle. If there are no engineers who engage with the wider debates in society, then the profession as a whole cannot fulfil this responsibility. How these

responsibilities of the profession translate into individual responsibilities will depend on how (and how well) the profession organises itself.

The boxes below give some brief engineering examples relating to responsible leadership.

Some have argued that a number of major engineering disasters – such as the Hatfield rail crash – occurred not because engineers made mistakes or made the wrong decisions, but because engineers were not sufficiently involved in the decision making. In a number of large companies, there has been a move towards reducing the number of engineers involved at the higher levels of management, so that engineers have less direct involvement in a number of crucial decisions.

This is a trend that the engineering profession could try to address, for example by inviting and promoting dialogue on measures to promote health and safety.

One concern that some people have about carbon capture technologies as a response to global warming is that the prospect of a technical solution to the problem may discourage people from using energy more responsibly. One way in which the engineering profession could respond to this concern would be to be active in explaining all the different implications of implementing the new technology, encouraging a wide and balanced debate that captures both the positive and negative aspects.

Frequently, whistleblowers suffer as a result of their effort to expose corrupt, fraudulent or unsafe practices. Arguably, professional bodies could do more to protect the engineers who risk their own careers to help protect others, and similarly engineers could do more to encourage their professional bodies to do more.

In the following sections, more detailed cases are used to illustrate different aspects of responsible leadership. These cases are designed to be challenging, and to allow reflection on what the principle means in practice.

5.1 Case Study: Promoting public awareness

Professional engineers should "actively promote public awareness and understanding of the impact and benefits of engineering achievements."

Scenario
SudoWatch specialise in surveillance technologies, and in CCTV and cameras in particular. Shanil is a senior engineer leading one of the main projects, which involves trying to develop a system that monitors live CCTV footage in order to detect unusual or suspicious activity, so that a human operator is not required to monitor each individual camera.

The system is designed primarily for train stations and airports, and the challenge is to develop a system that will detect people leaving bags unattended, or acting suspiciously, while limiting the number of people involved in innocent activities (such as trainspotting) being harassed.

Shanil is committed to his work, believing that it makes an important contribution, both because he believes that this technology will help to keep people safe, protecting them from terrorist attack, and also because he believes

that it protects people's privacy interests – because the CCTV will not be watched by a human operator.

However, he also has concerns about the lack of regulations governing CCTV and other surveillance technology, and is concerned about the amount of CCTV, particularly owned by private individuals.

In addition, SudoWatch have recently started producing cheap hidden camera products, such as hidden cameras made to look like smoke alarms, clocks, mp3 players, pens and watches. These products typically sell for under £200 and can be bought by anyone who wants one.

Shanil doesn't believe that these products have a legitimate purpose, and is worried by the lack of regulation regarding the sale and use of such products. In particular, Shanil believes that the public are not aware of how easily these products are available, and of their potential impact. Shanil doesn't have any involvement with the production of these products, but is not happy that the company he works for has decided to go in this direction.

Dilemma

You work for a surveillance technology company, developing behaviour recognition systems to protect people from the threat of terrorism – a project that you believe in. However, you have misgivings about the company's new venture into developing hidden cameras for individual use, although you recognise that your company are legally entitled to develop these monitoring products. What do you do?

What should you do?

1. You could tell yourself that you are working on a worthwhile job, and it is not your responsibility to address concerns about public policy and the misuse of products.
2. You could leave your job, stating that you have concerns about the work the company is doing.
3. You could continue working on the project, but at the same time speak out publicly about your concerns about the lack of regulation.
4. You could try to persuade your company to work with you to consider the ethical issues, to work with people in the community and with ethics committees. You could encourage them to work towards campaigning for better regulations while, at the same time, developing the new technologies.
5. You could work with professional bodies to explore the ethical issues, and to campaign for better regulations, informing politicians and the public of the technology that is already available and/or is likely to become available in the near future.

Discussion

In favour of the first option, it could be tempting for you to think of this in terms of a simple division of labour, with scientists and engineers developing the valuable technologies, and politicians dealing with the social policies to avoid the possible undesirable consequences of the technology. However, this option could be seen as an abdication of your responsibilities; at the very least, it is your responsibility to think about whether this is worthwhile work which ought to be done. If it isn't, perhaps you should refuse to work on something that isn't worthwhile, and could be harmful.

In this case, you do consider your own work to be worthwhile. Beyond this, however, there is another reason not to assume a sharp division of labour.

Arguably, you as the engineer could concentrate on the possible benefits of a new technology, and downplay any potential problems, especially when these could (potentially) be dealt with by a change in the law, or some other social change. This is especially true if you think about the issue in the way described above, with a clear division of labour, and if you assume that society will address the problems that need addressing in order to get the benefits without the harms.

Unfortunately, we live in an imperfect world, and you cannot assume that the appropriate laws will be passed or social changes will happen. You must consider what impact the technology will have, given that we live in an imperfect world, where there are many drivers governing what legislation gets passed. You should not focus only on the impact the technology would have *if only* we could eradicate various social problems and human vices.

In general, ignoring the complex social context in which decisions are made can lead to unrealistic calculations about the value of new technologies: if evaluating a technology involves weighing up the pros and the cons, this evaluation will be distorted if the cons are not given the appropriate weight.

This also illustrates why engineers have a duty to engage with society. A society cannot make the necessary changes if they are not made aware of the relevant developments by those with the right technical knowledge and expertise. If, as you fear in this situation, society isn't ready for the new technology, then the engineering profession has a responsibility to work to inform the public of the technologies that are being developed, and to offer advice about what changes are required, and to start a public debate.

You as an engineer – and the engineering profession as a whole - needn't accept the world as it is, and can legitimately encourage society to consider the possible consequences of new technologies and to take the steps that will be necessary to limit the unwanted side effects of a particular technology. The medical profession, for example, has been involved in debates about the ethics of abortion, or of stem cell research. This has typically gone beyond just giving medical advice, and has included ethical analysis, arguing for or against particular views. Engineers can involve themselves in similar ways in decisions relevant to their profession.

If you dismiss option one, and acknowledge that you have some responsibility to consider the social impact of your work, the question of what is a suitable option remains. Option two, leaving your job, doesn't seem appropriate in this case, but could be in other cases if you felt strongly enough about the issue. As a clarification of the third option, it should be noted that the suggestion is not that you speak out against your company (though, of course, whistleblowing is legitimate in some cases, especially in cases of serious wrongdoing). Rather, the suggestion is that you speak out publicly about the need for changes in the law, to stress the need for regulation. This could be done in a way that remains supportive of your company and your company's aims. The claim could be that these new regulations are required so that companies (like the one you work for) are able to continue to do valuable work without worrying that their products can be very easily used for less legitimate purposes.

Nevertheless, it would, of course, be preferable if you were able to persuade your company to work with you in this. Similarly, it will also be beneficial if you have the support of professional bodies.

Summary

In this case, you have a conflict between believing in the value of the project that you are working on and concerns about other products manufactured by the company. It may not be appropriate to quit your job over the issue in the first instance, as you could work towards the sorts of social changes that would be necessary to protect people from the misuse of surveillance technologies. Where possible, it would be best if you could work with the company and/or professional bodies in trying to achieve these aims.

Other ethical considerations involved in this case

As well as ***responsible leadership*** this case raises important questions regarding what an appropriate ***respect for life, law and the public good*** requires.

Wider applications

There will be many situations in which public awareness of an issue is important. Respecting the requirement to promote public awareness may just require publicising a new issue: to demonstrate, for example, that driverless vehicles are now a real possibility, and to consider the implications of this new technology.

In other cases, the promotion of public awareness may be important because the public have misconceptions about a particular technology – possibly due to lack of information. For example, individuals might have concerns about nanotechnology. Some of these concerns may be legitimate, and may be real issues that society needs to address. Other concerns, however, may be based on misconceptions, and the promotion of awareness and understanding may be sufficient to create informed opinion of important new technologies.

5.2 Further case studies

The following case studies are available in full in the electronic version of this guide.

Listening to society: ***Professional engineers should "be aware of the issues that engineering and technology raise for society, and listen to the aspirations and concerns of others."***

Dilemma

You passionately believe that nuclear power is the only real solution to the problem of global warming, but you are frustrated by the public's opposition to it. You want to work to promote a proper understanding of the benefits of nuclear power, and to highlight the dangers of not using it, but you don't know how to deal with the public's opposition. You want to write an article giving your views, but how should you approach the article? Do you argue that the public concerns should be ignored, or recognise their importance?

Truth and objectivity: ***"Be objective and truthful in any statement made in their professional capacity"***

Dilemma

You work as both an independent consultant and as a sales rep for Spectrup, a radio broadcast equipment manufacturer. Given that you are called upon to recommend appropriate equipment to clients in your role as a consultant, you recognise that you are faced with a conflict of interests between your two jobs. As a consultant you should be impartial, but as an employee of Spectrup you should promote their products where possible. Is it possible to separate your roles to avoid the conflict? And if it is, how do you convince people that you can maintain this separation?

6 Conclusion

One of the intentions of this guide was to give some impression of the range and complexity of ethical issues faced by engineers. The eighteen cases in the full version of this guide attempt to reflect this range of issues, though there are countless other cases that could have been used, from all areas of engineering work. Another intention was to demonstrate the need for engineers to engage with ethical issues in their work, and to show that that by untangling these issues it is possible to see clear paths ahead, and not just a thicket of conflicting opinions. This brief concluding section will suggest some general ways in which to take an interest in ethics further.

Firstly, there is a good deal of further information available relating to ethics, including more case studies, analysis of news events, and other resources connected to ethics in the engineering profession. The following resources section points to sources of such information.

Secondly, the insights from the cases in this guide can be applied to ethical issues faced in everyday practice. The following questions might help in applying the cases:

- Having thought about some ethical issues in engineering, can you now identify any issues from your own work of which you were previously unaware?
- Are any of the cases in the guide closely related to issues you or your colleagues have faced or are facing?
- If so, what were the important similarities and differences between your case and the case in this guide?
- Has the way the case was discussed in the guide changed the way you thought about your own case?
- Would you act differently, or do you feel you should have acted differently, in the light of the considerations outlined here?

Closely related to this last point, it is important to engage with the way that ethical questions are tackled at organisational as well as individual levels. One way of doing this would be to seek out and reflect upon material such as company codes of conduct and guides to ethics. As well as these explicit statements of ethical commitments, it is also important to reflect upon implicit ethical guidance – what kinds of behaviours are rewarded and praised by employers? What kinds are censured? In taking a reflective view of how an organisation approaches and deals with ethical issues it will be interesting, and important, to determine the extent to which explicit and implicit forms of guidance cohere or conflict with each other.

Engineering is a broad discipline and the case studies here cannot encompass all of the ethical issues that an engineer might face. However, ethical dilemmas quite different from those included in this guide can benefit from being approached in a similar way. This involves asking the following questions regarding as situation:

- What are the empirical facts relating to the case?
- What are the ethical values?
- How do these depend on and inform each other?

- How can the reasons for taking a particular course of action be articulated and defended? Is the proposed course consistent with the Statement of Ethical Principles, and with the values, principles or rules of conduct of the relevant professional organisation or company?

Finally, engineers are invited to take a more active role in the ethical life of the profession. Traditionally, there has not been a clear demand for engineers to take a view on the ethical issues affecting their profession. In this respect, engineering is different from, for example, medicine. It would perhaps be surprising for a doctor not to have at least thought about the ethical issues surrounding, say, abortion, or euthanasia. Yet, as we have seen, the ethical issues in engineering are just as real, and they too can have very grave consequences. Moreover, it is no more possible for engineers to avoid ethical issues than it is for doctors to do so.

A good place to start engaging with professional ethics is through professional bodies. Some of these run training events or workshops in professional ethics, or provide web forums or other means of communicating with other members about these issues. The Royal Academy of Engineering has a series of publications on engineering ethics issues, links to which can be found in the 'resources' section at the end of this guide. Individual professional bodies can be encouraged to communicate the importance of ethics, and this can be stimulated by groups of engineers organising themselves to discuss ethical issues.

Regarding specific ethical issues, some engineers are concerned that decisions are increasingly taken out of the hands of engineers. One concern that people have about rail safety, for example, is that it seems to be the case that fewer engineers are being employed at the higher levels of management resulting in important decisions being made without appropriate input from engineers. If this concern is right, this is a trend that engineers should be active in trying to reverse.

Similarly, when engineers are involved in decisions regarding public safety there is a concern that they are often put under pressure to agree with the decisions that the managers want to make. The Challenger disaster is typically cited as an example of where this sort of pressure affected the decision of the engineers. In these cases, it can be very difficult for engineers to stick to what they consider to be the right decision. Likewise, where engineers are aware of unsafe or illegal practices, and feel that they ought to blow the whistle, it may still be very difficult for them to actually do what they feel they ought to because they may (legitimately, given past history) worry about the effect that being a whistleblower will have on their career.

However, industries are increasingly using confidential reporting techniques as a way of allowing engineers to report problems and enabling lessons learned by others to be passed on. Such systems are used in medicine, aviation, and structural engineering. These systems could be used across the engineering profession, and individual engineers will have a significant role in encouraging professional bodies to put them in place.

Ethics is not a set of rules that can be learned and taken for granted. Nor is it a simple 'framework' that can be applied to problems to make them disappear. Engaging with ethical questions is a difficult ongoing process that requires awareness, reasoning skills, imagination, and the ability to scrutinise and evaluate your opinions as well as those of others. In short, it is a set of skills, abilities and character traits that can only be developed with practice. This development is not only necessary, however; it is rewarding, enlightening and confidence-building. We hope that this guide will inspire engineers to take this approach in their working lives.

7 Resources

The Royal Academy of Engineering and the Engineering Council

The Academy and the Engineering Council jointly produced their Statement of Ethical Principles (http://www.raeng.org.uk/societygov/engineeringethics/principles.htm) in October 2005, and revised and updated it in June 2007. This guide is based on the principles in that statement. More information on the Academy's activities with regard to engineering ethics and practice and teaching engineering ethics can be found on their website.

The Academy also produces events and publications related to engineering ethics. These include a discussion document on the social, legal and ethical issues surrounding the development and use of autonomous systems, and some tips for teaching engineering ethics, as well as reports from a workshop on engineering ethics and accreditation, a conference on engineering ethics and practice and an earlier engineering ethics conference.

The Engineering Council provides guidelines for institutions' codes of conduct, and maintains the UK Standard for Professional Engineering Competence (UK-SPEC), which sets standards for levels of professional registration for engineers, including ethical and professional standards.

Professional engineering bodies

Approaches to ethics differ among the UK engineering professional bodies. The following are links to the sections of the public area of a selection of engineering institutions' websites that are relevant to ethics. Often, though not always, this is a code of conduct, royal charter or set of ethical principles or values. Usually, there are several areas on the site that are worth exploring, and in some cases, some information may be restricted to members.

Institute of Materials, Minerals and Mining
http://www.iom3.org/content/code-conduct

Institution of Chemical Engineers
http://www.icheme.org/about_us/ethics.aspx

Institution of Civil Engineering Surveyors
http://www.cices.org/bylaw.html

Institution of Engineering Designers

Institution of Engineering and Technology
http://www.theiet.org/about/ethics/index.cfm

Institution of Mechanical Engineers
http://www.imeche.org/membership/ethics

Institution of Structural Engineers
http://www.istructe.org/knowledge/topic_areas/Pages/default.aspx

Other professional bodies

The following links are to the relevant public web pages of organisations from professions outside engineering. Some of these will relate to activity that is directly relevant to the work of many engineers – most obviously those that discuss ethics in the conduct of business activity. Others will not be directly relevant, but instead provide an interesting point of contrast, illustrating the extent to which common ethical considerations apply across various professional activities.

Chartered Institute of Building
http://www.ciob.org.uk/about/royalcharter

International Federation of Accountants
http://www.ifac.org/Ethics/

British Medical Association
http://www.bma.org.uk/ethics/index.jsp

Faculty and Institute of Actuaries
http://www.actuaries.org.uk/regulation/pages/actuaries-code

The Bar Standards Board
http://www.barstandardsboard.org.uk/standardsandguidance/codeofconduct/tableofcontents/

Royal Institution of Chartered Surveyors
http://www.rics.org/ethics

Support, advice and guidances

Many professional bodies will provide support, advice and guidance for engineers facing ethical issues. Often, employing organisations, whether public or private sector, will have their own ethics guides, statements of values, or codes of conduct to help staff tackle ethical issues in their professional lives. In addition, many offer helplines which offer advice and support to staff. There are also specialist organisations that provide support and advice for some specific kinds of ethical issues that arise for engineers.

Transparency International is an organisation that focuses on issues of corruption.

The Global Infrastructure Anti-Corruption Centre (GIACC) publishes extensive free information, advice and tools on preventing corruption in the infrastructure sector.

Public Concern at Work (PCAW) deals with issues of whistleblowing.

You may also be able to get legal and other relevant advice from Citizens' Advice.

Institute of Business Ethics is an organisation promoting best ethical practice in business.

Academic centres

Centres of expertise based at UK academic institutions.

Inter-Disciplinary Ethics Applied CETL
Producers of this guide. Based at the University of Leeds, the centre aims to help students and professionals to recognise, analyse and respond effectively to ethical issues as they arise. The IDEA CETL does extensive work in engineering ethics, both inside and outside HE.

Engineering CETL
Another Centre for Excellence in Teaching and Learning, the EngCETL seeks to impact on students and to develop and produce graduates who are employable, entrepreneurial, productive and innovative, through links with industry. It is located in the Faculty of Engineering at Loughborough University.

Higher Education Academy, Engineering Subject Centre
Also based at Loughborough University, the Engineering Subject Centre seeks to work in partnership with the UK engineering community to provide the best possible higher education learning experience for all students and contribute to the long term health of the engineering profession.

Blogs

Blogs are an excellent way of keeping up-to-speed with the ethical aspects of current events. The blogs below were active at the time of publication of this guide.

Engineering Ethics Blog
Mixes general reflections on ethical issues in engineering with in-depth discussion of news events.
Ethics in Public and Professional Life
By the Inter-Disciplinary Ethics Applied CETL. Analysis of public and professional ethics issues.
Crane and Matten Blog
Analysis of business ethics issues and news events.

Journals and magazines

Journals and magazines with engineering ethics content.

Science and Engineering Ethics
A multi-disciplinary academic journal that explores ethical issues of concern to scientists and engineers.

The Engineer

Engineering Magazine

Professional Engineering Magazine

Ingenia

General engineering publications covering all aspects of engineering, including ethical aspects. (Magazines in specific engineering disciplines will also often cover the ethical aspects of engineering stories).

Books

These are intended to be accessible to engineers with a general interest in ethics.

Benn, P., *Ethics* (Routledge, 1998).
A short, clear introduction to some central questions and ideas in ethics.

Bowen, W. R., *Engineering Ethics:* Outline of an aspirational approach (2009, Springer-Verlag, London)
Challenging analysis which takes a view of the overall ethical direction of the engineering profession rather than focusing on specific issues.

Davis, M., *Thinking Like an Engineer: Studies in the ethics of a profession* (1998, Oxford University Press).
A good place to start if you want to explore further the ethical dimension of engineering as a profession. Davis offers an analysis of what is distinctive about the profession of engineering, drawing on real-life case studies to illustrate his points.

Kitcher, P., *Science, Truth and Democracy* (2003, Oxford University Press).
An academic study of science as it is practised, including the ethical aspects of its relation to society. Also relevant to engineers.

Martin, M. & Schinzinger, R., *Ethics in Engineering*, 4th edition, (2005, McGraw-Hill).
A text book which is aimed at academics and professionals alike. A comprehensive and far-reaching guide to ethical issues in engineering.

McCarthy, N., *Engineering: A beginner's guide* (2009, Oneworld Publications)
An introduction to the technical, philosophical and cultural history aspects of engineering, including ethics.

Training

Training courses are offered by some engineering professional bodies, see individual websites for details.

The Inter-Disciplinary Ethics Applied CETL offers training courses through its programme of activities, Professional Ethics for Professional Engineers. This project was initially supported by an Ingenious grant from the Royal Academy of Engineering. Often these training courses are provided in conjunction with Professional Bodies, but the Centre also offers bespoke courses tailored to the specific needs of individual organisations.

In addition, the Inter-Disciplinary Ethics Applied CETL offers an Online MA in Applied and Professional Ethics – a distance learning course in applied and professional ethics appropriate for engineers as well as other professionals.

Appendix 1: The Statement of Ethical Principles

The Royal Academy of Engineering, in collaboration with Engineering Council (UK) and a number of the leading professional engineering institutions, has created a Statement of Ethical Principles to which it believes all professional engineers and related bodies should subscribe.

Professional Engineers work to enhance the welfare, health and safety of all whilst paying due regard to the environment and the sustainability of resources. They have made personal and professional commitments to enhance the wellbeing of society through the exploitation of knowledge and the management of creative teams.

This Statement of Ethical Principles sets a standard to which members of the engineering profession should aspire in their working habits and relationships. The Statement is fully compatible with the principles in the UK Government Chief Scientific Adviser's Universal Ethical Code for Scientists, with an emphasis on matters of particular relevance to engineers. The values on which it is based should apply in every situation in which professional engineers exercise their judgement.

There are four fundamental principles that should guide an engineer in achieving the high ideals of professional life. These express the beliefs and values of the profession and are amplified below.

Accuracy and rigour

Professional engineers have a duty to ensure that they acquire and use wisely and faithfully the knowledge that is relevant to the engineering skills needed in their work in the service of others. They should:

- always act with care and competence
- perform services only in areas of current competence
- keep their knowledge and skills up to date and assist the development of engineering knowledge and skills in others
- not knowingly mislead or allow others to be misled about engineering matters
- present and review engineering evidence, theory and interpretation honestly, accurately and without bias
- identify and evaluate and, where possible, quantify risks.

Honesty and integrity

Professional engineers should adopt the highest standards of professional conduct, openness, fairness and honesty. They should:

- be alert to the ways in which their work might affect others and duly respect the rights and reputations of other parties
- avoid deceptive acts, take steps to prevent corrupt practices or professional misconduct, and declare conflicts of interest
- reject bribery or improper influence
- act for each employer or client in a reliable and trustworthy manner.

Respect for life, law and the public good

Professional engineers should give due weight to all relevant law, facts and published guidance, and the wider public interest. They should:

- ensure that all work is lawful and justified
- minimise and justify any adverse effect on society or on the natural environment for their own and succeeding generations
- take due account of the limited availability of natural and human resources;
- hold paramount the health and safety of others
- act honourably, responsibly and lawfully and uphold the reputation, standing and dignity of the profession.

Responsible leadership: listening and informing

Professional engineers should aspire to high standards of leadership in the exploitation and management of technology. They hold a privileged and trusted position in society, and are expected to demonstrate that they are seeking to serve wider society and to be sensitive to public concerns. They should:

- be aware of the issues that engineering and technology raise for society, and listen to the aspirations and concerns of others
- actively promote public awareness and understanding of the impact and benefits of engineering achievements
- be objective and truthful in any statement made in their professional capacity.

Appendix 2: A legal perspective

Rules of ethics set by professional bodies are intended to guide members of the professional body as to what to do in difficult situations, particularly where there are conflicting pressures or considerations which need to be reconciled. The rules of ethics of some professional bodies are enforceable by disciplinary action by the professional body, but the principles discussed in this guide are more in the nature of precepts, providing authoritative guidance to engineers who are members of a range of professional bodies.

Law is also seen as a set of rules about what people ought to do. Legal duties and ethical duties may overlap, but ethical rules do not have the force of law; that is, their breach does not give rise directly to criminal sanctions or civil liability enforceable by the courts.

On the other hand, many of the situations addressed by the Ethical Principles involve concerns about risk to life or property or the environment and, in some cases concerns about confidentiality or accusations of wrongful conduct. Since the law tends to become involved if and when there is actual injury or damage to life or property or the environment, or where there is an alleged breach of confidentiality or unjustified accusation of wrongful conduct, the question may arise in legal proceedings as to the effect on legal liability of both efforts to follow the engineering ethics guidelines and of failure to do so.

Following ethical guidelines can increase exposure to the risk of involvement in legal proceedings, as illustrated by the example of doctors who fear to respond to calls for medical assistance when they are not on duty because it could lead to them being sued if the treatment goes wrong. It is important to appreciate that actions taken in response to ethical guidance are likely to be judged on the basis of professional standards of due skill and care, and ethical guidance is only an element of such standards. Ethical guidance does not grant exemption from professional standards of due skill and care.

Probably the most important practical point is to appreciate that if legal proceedings occur, the outcome depends primarily on evidence (for example to prove that one has exercised due skill and care, or given an adequate warning), and that the most cogent form of evidence recognised by the courts or any other tribunal is that provided by contemporaneous written records, preferably communicated at the time to those likely to be affected to allow them to challenge if they disagree. Engineers need to understand the importance of establishing such contemporaneous written records, and how best to do this. Diaries are a valuable means of providing a contemporaneous written record, but the most effective means is usually a letter. There is a maxim that an engineer needs to recognise when "the time has come to write a letter". If and when such a time comes, the engineer needs to appreciate what to put in such a letter and who to send it to. Guidance on the contents of such a letter is straightforward:

- Be clear and complete.
- Strip out all excess and emotion.
- Recognise the purpose of the letter.

The question of who to send the letter to may be more complex, since the problem may be that the person to whom the letter should be sent as a matter of protocol is perceived as a person who will not act in response to the letter. Some specific guidance on the effect of the Public Interest Disclosure Act is given below and this may be relevant.

Another major legal point is that where an engineer comes under a duty to warn, the approach of the courts in recent cases has been that for the warning to be sufficient, it must be persisted with, almost to the point that if no action is taken in response to the attempt to warn, the warning was not sufficient.

The Public Interest Disclosure Act 1998

Situations arise where no injury to life, property or the environment has yet occurred, but an engineer, in the course of his employment, has concerns that there is a substantial risk which is not being addressed by others. Action by the engineer in making such concerns public in response to ethical guidance may upset his employer and lead to threats to his employment.

The law in this area has developed in the UK with the Public Interest Disclosure Act 1998. Workers who disclose information relating to health and safety matters now have statutory protection of employment rights in defined situations under the Employment Rights Act 1996 Part IVA, as inserted by the Public Interest Disclosure Act 1998. 'Workers' are defined to include individuals working on an agency basis as well as employees working under a contract of employment. For the protection rights to apply, the disclosure must be a 'qualifying disclosure' as regards content, the person to whom it is made, and the motivation for making it.

As regards content the information disclosed must, in the reasonable belief of the worker making the disclosure, tend to show that a person has failed, or is failing or likely to fail to comply with any legal obligation to which he is subject, or that the health or safety of any individual has been, is being or is likely to be endangered.

The legislation contemplates three classes of persons to whom disclosure might be made, and imposes different rules on motivation in each case. In all cases, the disclosure must be made in good faith to be a qualifying disclosure. The first class of persons to whom disclosure might be made is the worker's employer or, where the worker believes the failure relates solely or mainly to either the conduct of a person other than his employer or a matter for which a person other than his employer has legal responsibility, to such other person. A disclosure to a person under a procedure authorised by the employer is treated as a disclosure to the employer. Disclosures to this class of persons are subject only to the requirement of good faith to qualify.

A second class of persons to whom disclosure might be made comprises persons prescribed by order of the Secretary of State. The Public Interest Disclosure (Prescribed Persons) Order 1999 names the Health and Safety Executive as a prescribed person in regard to matters which may affect the health and safety of any individual at work, or of any member of the public in connection with the activities of persons at work. The professional engineering Institutions are not prescribed persons under the Order, nor is SCOSS. To qualify, disclosures to HSE as a prescribed person are subject to a requirement not only of good faith, but also of reasonable belief that the matters fall within the area for which HSE is a prescribed person and that the information disclosed, and any allegation contained in it, are substantially true.

The third and final class of persons to whom disclosures might be made comprises all other persons. Such disclosures are subject to more stringent requirements to qualify. Either the worker must believe that the employer will react adversely if the disclosure was made to him (either by subjecting the worker to a detriment or by concealing or destroying evidence) or the failure must be an exceptionally serious matter. In either case, the disclosure must not only be made in good faith, but the worker must also believe that the information disclosed, or

any allegation contained in it, are substantially true, the disclosure must not be made for the purpose of personal gain and, in all the circumstances of the case, it must be reasonable for the worker to make the disclosure. There are factors listed as relevant to whether it is reasonable for the worker to make the disclosure, including the identity of the person to whom the disclosure is made, the seriousness of the relevant failure, and whether the relevant failure is continuing or is likely to occur in the future.

References

1 Engineering Council: *United Kingdom Standard for Professional Engineering Competence* 2003, updated 2008 and 2010

2 Davis, M., *Thinking Like an Engineer: Studies in the ethics of a profession* (1998, Oxford University Press)

The Royal Academy of Engineering

As the UK's national academy for engineering, we bring together the most successful and talented engineers from across the engineering sectors for a shared purpose: to advance and promote excellence in engineering. We provide analysis and policy support to promote the UK's role as a great place from which to do business. We take a lead on engineering education and we invest in the UK's world class research base to underpin innovation. We work to improve public awareness and understanding of engineering. We are a national academy with a global outlook and use our international partnerships to ensure that the UK benefits from international networks, expertise and investment.

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Drive faster and more balanced economic growth

The strategic challenge is to improve the capacity of UK entrepreneurs and enterprises to create innovative products and services, increase wealth and employment and rebalance the economy in favour of productive industry.

Lead the profession

The strategic challenge is to harness the collective expertise, energy and capacity of the engineering profession to enhance the UK's economic and social development.

Foster better education and skills

The strategic challenge is to create a system of engineering education and training that satisfies the aspirations of young people while delivering the high calibre engineers and technicians that businesses need.

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The strategic challenge is to improve public understanding of engineering, increase awareness of how engineering impacts on lives and increase public recognition for our most talented engineers.

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