Chapter 1
Introduction

Every art and every enquiry, and similarly every action and choice, is thought to aim at some good; and for this reason, the good has rightly been declared to be that at which all things aim. But a certain difference is found among ends; some are activities, others are products apart from the activities that produce them. Where there are ends apart from the actions, it is the nature of the products to be better than the activities. Now, as there are many actions, arts, and sciences, their ends are also many; the end of medical art is health, that of shipbuilding a vessel, that of strategy victory, and that of economics wealth.

Aristotle 350 BC/1998: 1094^{a}1-10

1.1 A Beginning

Above are the opening sentences of Aristotle's foundational *Nichomachean Ethics*, which more than 2350 years later than its origins remains essential reading in the serious study of ethics. These sentences stimulate two thoughts in the present context. Firstly, it is remarkable that Aristotle uses an engineering example – shipbuilding, a leading-edge technology of his time – in seeking to explain the nature of ethics. Indeed, such an example is especially relevant, for Aristotle regarded the knowledge gained by the pursuit of ethics as being "practical knowledge", a questioning and reflection that leads to action. Secondly, if we were to generalise and update the example, what would we define as being the objectives of modern engineering? In particular we might ask how we could benefit from modern ethical analysis in defining these objectives.

The present book is a response to an assessment that, despite the demonstrable achievements of modern engineering, engineers have to a significant extent forgotten that their primary objective is the promotion of human wellbeing. A crucial factor in this amnesia is that engineers have not engaged sufficiently in ethical analysis of their activities. Further, when they have so engaged they have considered only a narrow and inadequate range of the types of such analysis available. In these considerations, the activities of modern engineers do not compare favourably with the modern equivalents of the other professions referred to by Aristotle in the opening of *Nichomachean Ethics*, medicine and business. *The primary thesis of the present book is that the greatest present challenge for engineering is the development of a genuinely aspirational ethical ethos for the profession, and an outline of such an ethical ethos will be presented.*

An important purpose of the present book is to provide a conceptual framework that encourages engineers to reflect on how they can best realise the benefits of the application of their skills. In order to do so they need to allow time and effort to assess their immediate professional tasks in a broader human context. One of the reasons for the previous and current lack of such engagement is undoubtedly that the technical core of engineering is intellectually a very demanding activity. This leads to a specific danger, which has been succinctly formulated, "When one's head and hands are busy day in and day out with technology, one's heart will soon be filled with the same as well" (Schuurman 2002/2005: 17). The engineer becomes lost in "the labyrinth of technology". It is not only engineers who are dazzled by technology. The poet R.S. Thomas (1952/2000: 30) has written of a poor hill-farmer acquiring a tractor:

> Ah, you should see Cynddylan on a tractor.
> Gone the old look that yoked him to the soil;
> He's a new man now, part of the machine,
> His nerves of metal and his blood oil.

If such dazzling is experienced even on the periphery of modern society, then the engineer at the centre of technological development needs to be especially aware of his or her prioritisation and responsibilities.

1.2 What is Engineering?

The outcomes of engineering are practical. Such outcomes are most usually considered to be the design, manufacture and operation of useful devices, products and processes, often on a notably large scale. Here scale may refer to both the actual size of an individual outcome and to the number of such outcomes. To realise these outcomes, engineers use their knowledge of science and mathematics combined with imagination, reasoning, judgement and experience. The overall scope of engineering may be reviewed by considering the familiar names of some of its subdivisions, such as chemical engineering, civil engineering, electrical engineering and mechanical engineering. Each has made enormous contributions to the material wellbeing of individuals around the world. Each also creates potential risks. For example, benefits include clean water production, large-scale pharmaceutical manufacture, hygienic food processing, energy generation, buildings, transport infrastructure, mechanical devices, medical diagnostic equipment, instrumentation, computing and telecommunications. Risks include weapons manufacture and proliferation, damage to the natural environment and possible adverse effects on human health.

The practical emphasis of engineering distinguishes it from science. Simply expressed, the primary goal of science is a better understanding of the nature of the universe, and especially of the physical and biological phenomena of the world. However, the distinction is not sharp and precisely defining the boundary is not a productive activity. Thus, improved scientific understanding may often have significant practical outcomes and scientists may be motivated in their work by very practical concerns. Correspondingly, the most challenging engineering often seeks to exploit recent scientific discoveries. Indeed, engineers may themselves advance scientific understanding in their quest for better engineering solutions. It may be suggested that engineering is to science as ethics is to philosophy – both engineering and ethics are driven by a need for action, with philosophy and science being driven by a love of knowledge.

The designation “technology” hovers somewhat uncertainly between science and engineering. Technology does not primarily involve the same quest for fundamental knowledge that drives science, though technologists may contribute to basic understanding. Technology may have clear practical objectives, but these do not appear to be essential to the technologist. We are all familiar with technically ingenious gizmos that do not have a significant practical advantage or that are designed to carry out tasks that may be otherwise accomplished with greater simplicity and at lower cost. The dangers of giving priority to technical wizardry will be an important theme of the present book.

1.3 What is Ethics?

Ethics has sometimes been viewed by engineers as a somewhat arcane theoretical aspect of philosophy having little relevance to their practical activities in the world. Actually, philosophers have expressed such scepticism earlier and with intense irony, “Should philosophy, among its other conceits, imagine that someone might actually want to follow its precepts in practice, a curious comedy would emerge” (Kierkegaard 1843/1985: 124). Ethics certainly involves philosophical activities such as careful conceptual analysis and contemplation. However, ethics is in essence practical, for the way in which we choose to act and live is the primary objective of such analysis and contemplation. Ethical decisions, like engineering decisions, may have significant consequences for human wellbeing.

The outcome of ethical analysis might be considered to be a decision on how “everything ought to happen, while taking into account the conditions under which it very often does not happen” (Kant 1785/1998: 1). Ethics at its core is about how we relate to others. In such relationships, problems may arise for several reasons, including: limited resources and limited sympathy generating competition and conflict rather than mutually beneficial cooperation; limited agreement on goals and different conceptions of “good”; inadequate rationality, insufficient information and limited understanding; poor communication. Life is complex. Ethics and engineering are complex. Ethics is also, unlike much of engineering, “uncodifiable”. It cannot be reduced to a “calculus of consequences” (Ratzinger 1969/2004: 27).

In conventional English usage, the designation "ethics" is to a large extent used interchangeably with the designation "morality". The origin of the word "ethics" lies in the Greek *ethikos* referring to ethos, that is, distinctive character, spirit or attitude. "Morality" comes from the Latin *moralis*, especially as used in Cicero's translations and commentaries on Aristotle, and is more concerned with which actions are right or wrong. The present book will adopt the convention of Ricoeur (1990/1992: 170) in regarding the designation "ethics" as referring to the *aims* of a life that could be described as good and regarding the designation "morality" as referring to the *rules* or *norms* that provide specific articulations of these aims. This implies the primacy of ethics over morality, but also the necessity of morality for expression of the ethical aim, though with the provision that recourse may be made to the ethical aim if the rules or norms existing at any time prove inadequate for a specific purpose. On this basis, morality expressed as norms or rules constitutes only a limited actualisation of the ethical aims. On the basis of this convention, most previous books dealing with "engineering ethics", which have largely been concerned with specific dilemmas arising in the practice of engineering, may be regarded as primarily treatments of engineering morality. Further, the several "ethical codes of conduct" for professional engineers have by their very nature tended to be prescriptions of engineering morality. A great benefit of Ricoeur's distinction in the present context is that it encourages the formulation of a genuinely *aspirational* engineering ethical ethos.

1.4 What is the Issue?

At its best, engineering changes the world for the benefit of humanity. However, there are at present significant imbalances in the application of engineering knowledge. *These imbalances reflect a tendency for engineering, as presently taught and practised, to prioritise technical ingenuity over helping people.*

In some instances, appropriate technology is available but is not being applied. A prominent example is water treatment. The provision of drinkable supplies through more effective management and treatment of freshwater resources and through desalination of sea and ground water is one of the most significant challenges that the world faces. Appropriate water management and treatment processes, both simple and advanced, are available. It might, therefore, be expected that the design, installation and operation of such processes would be accepted as being unequivocally good and would be given the highest priority. However, this is not the case. As a result, 2 billion people are affected by water shortages in over forty countries, 1.1 billion people do not have safe drinking water and 2.4 billion have no provision for sanitation. The consequences are enormous. It is estimated that 25,000 people die *every day* from water-related hunger (some specifically from thirst) and that 6,000 people, mostly children under the age of five, die *every day* from water-related diseases (UNESCO 2003).

In other instances, complex and inappropriate technology is being developed and applied. For example, the design and manufacture of military equipment and weapons would be impossible without the extensive use of advanced engineering techniques, both theoretical and practical, across the range of the engineering disciplines. World annual military expenditure is estimated to have reached $ 1339 billion in 2007 (SIPRI 2008). Almost a third of engineers in the US are reported to be employed in military related activities (Gansler 2003). Weapons are often designed to cause indiscriminate injury and death, in contravention of international conventions and treaties. For example, cluster munitions, which are a means of delivering and scattering a large number of explosive sub-munitions that due to their high failure rate remain hazardous over wide areas in large numbers for long periods of time. Children are again most often put at risk.

Peaceful and military uses of engineering compete for the same skilled personnel. Moreover, as recent conflicts show, war is often related to competition for limited resources, such as energy and water. In the case of energy, it is especially ironic that many of the engineering skills needed for civilian nuclear power are closely related to those that are essential for nuclear weapons programmes. As the availability of such skills is limited, maintenance of such weapons programmes may very significantly diminish a country's capability for achieving greater energy self-sufficiency and hence increase the likelihood of later engagement in military action to ensure future supplies.

A theme of the present book is that engineers need to think creatively and become smarter in using engineering to avert conflicts in non-military ways. An alternative to the use of engineering in preparation for military deterrence and pre-emptive war is to use the same basic skill resources in preparation for genuine peace. Thus, in the case of water, a focus on using engineering to resolve some of the intense competition for limited resources would not only resolve the immediate human need but also remove a significant likely cause of future military conflict.

In a short book it will only be possible to consider a few specific practical issues. Thus, the issues of weapons and water will be used throughout as key exemplars. Engineers among readers will be able to identify other such issues in their own fields of expertise. Present in all of the specific issues will be aspects of the changed scale of modern engineering activity compared to actions in previous human history. Whereas traditional ethics reckoned only with local and non-cumulative behaviour, our modern engineering has unprecedented and cumulative influences on multitudes of people and vast areas of the natural environment, lasting for extended periods of time. One of the first works to analyse the additional responsibility that this scale brings included the formulation of a new imperative, "Act so that the effects of your action are compatible with the permanence of genuine human life" (Jonas 1979/1984: 11), an outlook which requires special consideration in the development of an aspirational engineering ethical ethos.

1.5 Traditional Ethical Viewpoints

The documented quest for a basis for ethics has occupied philosophers for about 2500 years, though some have denied the possibility of such a basis. The present book will not provide a survey of the entire scope of this quest, for several excellent texts are available[1]. However, those approaches that have been most widely adopted by engineers will be discussed. In this discussion, the overall attitude adopted will be that which has been termed "soft objectivism", which holds that for any ethical question there *may* be a right answer (Graham 2004: 14). At the very least, this allows a rational enquiry to proceed. Of the many ways of categorising possible approaches to ethics, Graham's recent and cogent discussion identified egoism, hedonism, virtue theory, existentialism, Kantianism (duty), consequentialism, contractualism and religion. Of these approaches, those most usually adopted by engineers have been consequentialism, contractualism and duty, with some consideration of virtue based views.

There is a tendency for engineers to adopt as a default position in the consideration of ethical problems a calculation of consequences and risks, a calculus of consequences, essentially a form of utilitarianism. The most enduring account of this viewpoint is that of Mill, who defined the standard for action as "not the agent's own greatest happiness, but the greatest amount of happiness altogether" (Mill 1861/2001: 11). The approach has since been considerably sophisticated and variants of this methodology are also termed consequentialism and proportionalism. Though such assessment of consequences is important and remains a standard against which other approaches need to be compared, there appears to be insufficient awareness amongst engineers of its fundamental difficulties as identified by philosophers of very diverse viewpoints. Some of these difficulties and their possible resolution will be analysed.

Contractualism regards the motivation for acting ethically as being social agreement backed by a regulative framework. A celebrated early version of such a contract is developed by Socrates in Plato's dialogue *Crito*, where it is said to be established between the laws of the city and each citizen (Plato c.395 BC/1997). The approach has been refined in many ways since, with the most significant modern work being that of Rawls, who claimed to provide, "an alternative systematic account of justice that is superior … to the dominant utilitarianism of the tradition" (Rawls 1971/1999: xviii), and where the emphasis is on the development of a contract between individuals. Professional ethical codes of conduct are by their very origin and nature likely to have a strong contractual aspect. The present book will analyse some of the benefits of a contractual approach to engineering ethics and also some of the limitations, many of which are related to the international and multicultural nature of the profession. It will be proposed that

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[1] For example, Graham (2004), Vardy and Grosch (1999).

a crucial limitation in the present context is that contractualism provides more of a basis for securing the present arrangements, even of justifying ethical mediocrity, rather than providing an opportunity for promoting an ethos of high ethical aspirations. In addition, international agreements are frequently not adhered to.

An important aspect of the aspirational engineering ethos to be outlined in the present book is an emphasis on our responsibility for others. A foundational formulation of the priority of respect for others in Western philosophical ethics has been given by Kant. Kant was especially concerned with actions undertaken from duty, that is because they are the right things to do rather than because they are an immediate inclination or because they further some end. He is famous for the statement of the "categorical imperative", "act only in accordance with that maxim through which you can at the same time will that it become a universal law" (Kant 1785/1998: 31). However, he emphasised that this fundamental law required a respect for persons and hence reformulated it as, "So act that you use humanity, whether in your own person or in the person of any other, always at the same time as an end, never merely as a means" (Kant 1785/1998: 38). The respect for persons inherent in a duty approach has much to offer engineering ethics, but the often dense associated argumentation in its modern expression is a barrier to its more widespread adoption by engineers as an underlying basis for their actions.

As previously mentioned, Aristotle considered ethics to be a practical pursuit and his work remains very relevant to the practice of engineering. He was greatly concerned to identify the factors that can promote human flourishing. His approach to ethics is termed "virtue theory", as the qualities of mind and character that promote such flourishing are central to his thinking. For Aristotle, friendship was the greatest aim of the ethical life. He noted that "friendship asks a man to do what he can, not what is proportional to the merits of the case" (Aristotle 350 BC/1998: 1163^{b}15), which certainly provides a succinct possible formulation of an aspirational ethos appropriate for engineers. In the present book, an important modern analysis and development of virtue theory by MacIntyre will provide essential features of the aspirational engineering ethos to be developed.

1.6 Other Professions: Medicine and Business

In the opening section of the *Nichomachean Ethics*, Aristotle referred not only to engineering, shipbuilding, but also to medicine and business. A consideration of ethical practices in the modern professions of medicine and business can be very beneficial in the preparation of an aspirational engineering ethos.

Modern medicine uses very advanced science and engineering. Indeed, without engineering medicine would be a very restricted activity – there would be no advanced building design, sophisticated diagnostic equipment or pharmaceuticals.

Yet, in contrast to engineering, medicine is seen as the paradigm of a caring profession. This difference appears to be the consequence of two main factors:

(i) Medicine is seen as relating more directly to people. In some ways this is a curious perception, for most people generally only come into contact with a doctor if they are ill whereas virtually every aspect of our lives is affected by engineered artefacts or processes. However, the engineer often does not come into direct contact with the people affected by his or her work and, due to the complex nature of engineering projects, there may be a significant time lapse between his or her initial work and the final outcome of his or her activities. It will be proposed that redressing this lack of physical and temporal proximity is an important aspect of promoting an ethical approach to engineering.
(ii) Medicine has a vigorous and public ethical debate about its activities whereas this has been lacking for engineering. This lack of debate, among both engineers and philosophers, is surprising considering the great impact that the practice of engineering has on our lives. The present book aims to stimulate such ethical debate among both engineers and philosophers, and also more widely in society.

Two features of modern medical ethics hold special lessons for the development of an aspirational engineering ethical ethos. Firstly, there is a great emphasis on the *individual*, the patient affected by the doctor's actions. Secondly, the doctor is emphatically *personally* accountable for decisions.

Business ethics is prominent both within business and in public awareness. Engineering and business have a symbiotic relationship, for engineers need to work with those who have business skills in order to exploit their technical skills, and business needs the skills of engineers for the design and manufacture of saleable products. One of the important ways in which business ethics can help the formulation of an aspirational engineering ethical ethos is though its analysis of the situation of individuals employed in large enterprises. Two related aspects are important. First, there is a lack of freedom for many staff in large organisations. They are employed for the way in which their know-how promotes the achievement of certain specified ends so that their discretion, where it exists, often lies only in the choice of means. This can lead to a suppression of ethical responsibility, a bracketing of personal ethical values. Second, there is a tendency for individuals to be less ethically alert in their role as employees than they are as private persons. Social science studies suggest that employees often function at a level of minimally acceptable ethical behaviour rather than aspiring to the highest achievable levels. In response to this first aspect it will be appropriate to consider how possible changes to working practices and career structures can give engineering employees a greater awareness of ends. Redressing the second aspect will require a consideration of how an engineer's professional and private concerns can be integrated in a more coherent way.

1.7 Outline of an Aspirational Engineering Ethics

An aspirational engineering ethical ethos needs to overcome the limitations of the traditional ethical views and to learn from the more advanced analysis of ethics in other professions. The present book builds on two philosophical sources. Firstly, on writings that lie somewhat outside what is conventionally regarded as the mainstream of ethics, but which contain profound ethical insights that can provide an important balance to prevailing views. Secondly, on recent writings that build on the philosophical mainstream in especially imaginative and practical ways.

Foremost among writings in the first category is Buber's *I and Thou* (1923/2004), which is concerned with the way in which relation arises. Buber introduced a seminal vocabulary for describing our existence by using the "primary words" *I-Thou* and *I-It*. The world of *I-It* is the world of *experiencing* and *using* where a man or woman "works, negotiates, bears influence, undertakes, concurs, organises, conducts business, officiates …" (Buber 1923/2004: 39). Engineers will recognise the *I-It* world as a description of the conditions under which they usually carry out their professional activities. In contrast, the world of *I-Thou* is the world of *meeting* nature and people, with the possibility of a relationship engendering care. This is an aspect lacking in most analyses of modern engineering. Indeed, Buber warned that vigilance is necessary in highly technological societies, for he had observed that the development of experiencing and using leads to a decrease in the ability to enter into relation. For the formulation of an aspirational ethical ethos for engineering, Buber's insight has the unique advantages of encompassing both person/person and person/natural world (environmental) relations and of recognising the importance of technical knowledge. It also vitally balances the priority presently given to rule and outcome approaches in engineering ethics. However, the nature of engineering requires an extension of *I-Thou* interactions in terms of *I-You* interactions, based on care but lacking personal proximity.

Levinas provided an even stronger statement of the priority of the demands that others make on us, which he designated by the strikingly visual notion of *the face*. He describes an ethical act as, "a response to the being who in a face speaks to the subject and tolerates only a personal response" (Levinas 1961/1969: 219). In simple terms, and changing the metaphor, we need to hear the voice of others saying, "It's me here, please help me!". The directness of the approaches of both Buber and Levinas make them very appropriate starting points for the development of an aspirational engineering ethos. It is worth noting that Korsgaard (1996) has reached a similar conclusion about the ethical priority of others through a sophisticated Kantian-duty based analysis of a type that only the most ethically committed of engineers are likely to follow.

Of works in the second category, MacIntyre's *After Virtue* (1981/1985) provides further key concepts for the development of an aspirational engineering ethical ethos. Like Buber and Levinas, he argues that traditional approaches have placed too little emphasis on persons, and additionally that such approaches also placed too little emphasis on the contexts of their lives. In his view, the ability to give ethical priority to people is facilitated by cultivation of personal virtues, which may depend on context. This approach is promoted by consideration of the appropriate virtues in terms of a *practice* supported by *institutions*. Though he does not mention engineering, MacIntyre's virtue based description of practices and institutions can provide the starting point for a coherent description of engineering that may be readily recognised by professional engineers. The virtues (or principles) particularly appropriate to engineering may be categorised, for example, as: accuracy and rigour; honesty and integrity; respect for life, law and the public good; responsible leadership, listening and informing (RAE 2007). MacIntyre's terminology also provides a very appropriate description of the outcomes of engineering activity. These are *internal goods*, including standards of technical excellence and the satisfaction arising from personal accomplishment, and *external goods*, including engineered artefacts and wealth. The description of engineered artefacts as *goods* allows such physical technological accomplishments to be distinguished from the *end* or *goal* of engineering activity, which may be described as the promotion of human flourishing through contribution to material wellbeing. *Such an analysis leads to the important conclusion that the present imbalanced prioritisation in engineering of technical ingenuity over helping people may be considered as arising from mistaking the external goods of the practice for the real end of the practice.*

The development of an aspirational ethical ethos for engineering requires an antidote to the tendency of individuals to adopt lower ethical aspirations in professional contexts than in private contexts. It will be proposed that this may best be achieved through encouraging the consideration of life as a *narrative unity*, including the aim of coherence in ethical standards in all activities. Such an approach further promotes ethical aspirations through generating an awareness of the desire of others to achieve a narrative unity in their lives. This leads to the need to consider how a balance may be achieved in *I*, *I-Thou* and *I-You* prioritisation, or alternatively expressed, in self care, proximate care and care beyond proximity. Achieving a balance when prioritising such commitments is especially challenging for engineers as their professional activities may have substantial influence far beyond proximity in both place and time. Two factors are especially significant in such a balance. Firstly, an acknowledgement that there is a limit to the extent that any individual can prioritise ethical behaviour. Very few people are saints, and indeed sainthood may indicate a lack of a full range of human values and activities. Secondly, the need for compassion and generosity in professional as well as in private life. Such a balance requires sensitivity, including sensitivity to consequences. However, a *calculation* is never possible, a *decision* has to be made.

1.8 Practical Outcomes

The outcomes of both engineering and ethics are practical. Hence, any analysis of engineering ethics should be doubly expected to have practical outcomes. Therefore, the final task of the present book will be to consider some of the practical outcomes of the analysis presented. These outcomes relate to ways in which an aspirational ethical ethos for the profession may be promoted, rather than to the solution of specific moral quandaries. Important outcomes to be discussed include:

In education Recruitment of students and the overall tone of engineering courses should give greater emphasis to the goal of benefits in terms of the quality of life. Personal responsibility for the results of professional activities should be emphasised.

Engineering institutions The professional codes of national engineering institutions should progressively incorporate increased degrees of compassion and generosity. The development of an effective international engineering initiative to promote aspirational practice should be supported.

Industry and work practices The more widespread adoption of aspirational codes of conduct in industry should be promoted. Career development plans that bring employees into closer proximity with end-users for at least part of their working life should be encouraged.

Positioning engineering in the public and intellectual mainstreams The public should be engaged in positive debate about engineering priorities, as already occurs for medicine and business.

An aspirational role for engineering in international initiatives Alignment of engineering aspirations with international initiatives such as the United Nations *Declaration and Programme of Action on a Culture of Peace* may be an especially effective way forward. There is also a need to prioritise a culture of peace *within* engineering.

The personal ethical responsibility of every engineer All engineers need to take a more active role in considering the ethical implications of their work. Our aspiration should be summarised: *"Here I am, how can I help you?"*.

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