Chapter 4
Engineering as Profession: Some Methodological Problems in Its Study

Michael Davis

Gather round me, boys, and you will hear
The story of a brave engineer:
Casey Jones was that roller's name –
On a 68 wheeler, he won his fame.

– folk song

Abstract Engineering is a function, discipline, occupation, and profession to which the term "engineering" is only a rough guide. Some activities not called "engineering" – applied physics and naval architecture, for example – are plainly engineering in the sense relevant to this volume. Other activities called "engineering", such as driving a railway locomotive or overseeing the operation of a ship's boiler, are just as plainly not engineering in the relevant sense (despite the participation of "engineers" such as Casey Jones or a sailor rated "marine engineer"). (These examples are all from English, my own language but not one known for its logic. It is therefore worth noting that other languages seem to have similar difficulties – or, at least, so I have heard from their native speakers – Italians, Japanese, Greeks, and so on. I'll give one example here: The Dutch give the title "Ingenieur" to anyone who receives a bachelor's degree from a technological university, even if the degree is in political science or philosophy. Anyone with that title is free to use it, much as anyone in the United States with a Ph.D. is free to call herself "doctor". The Netherlands do not license or register engineers, yet everyone there seems to understand the difference between "engineers" who are just philosophers and "engineers" who are engineers strictly speaking.) The status of other activities is more controversial. Is "software engineering", "social engineering", "genetic engineering", "re-engineering", or "financial engineering" engineering in the relevant sense? What about architecture (strictly so called), computer science, industrial design, or synthetic chemistry? What separates those technological activities from engineering (in the sense relevant here)? The answer to such questions will (or, at least,

M. Davis (✉)
Humanities Department, Center for the Study of Ethics in the Professions,
Illinois Institute of Technology, Chicago, IL 60616, USA
e-mail: davism@iit.edu

S.H. Christensen et al. (eds.), *Engineering Identities, Epistemologies and Values*, Philosophy of Engineering and Technology 21,
DOI 10.1007/978-3-319-16172-3_4

should) determine what gets studied as "engineering" and therefore what conclusions we, those who study engineering, draw concerning our subject. What I propose to do here is summarize the answers I have elsewhere given these questions and then dispose of prominent objections to those answers. (See especially Davis M, Thinking like an engineer: essays in the ethics of a profession. Oxford University Press, New York, 1998; Davis M, Profession, code, and ethics. Ashgate, Aldershot, 2002; Davis M (Philosophia 37(2):211–225, 2009a); Davis M (The Monist 92(3):325–339, 2009b); Davis M, Distinguishing architects from engineers: a pilot study in differences between engineers and other technologists. In: van de Poel I, Goldberg D (eds) Philosophy and engineering: an emerging agenda. Springer, Dordrecht, 2010.) Most of the objections, it turns out, arise from disagreement about how to study engineering (method) rather than about ordinary facts concerning engineering (how certain people are trained, what they do, and so on).

Keywords Function • Discipline • Occupation • Profession • Ethics • Engineering

Function

Once, while unsuccessfully seeking a position at a certain large technological university, I briefly met with its president. To make conversation, I remarked how unusual it was for a university to have, as his did, both a School of Engineering and a School of Applied Science and Technology. How, I asked, did he decide which programs went to which school? His answer was: "The School of Applied Science and Technology consists of all those programs which look like engineering to me but not to the Dean of Engineering." I thought that answer showed considerable theoretical insight. I hope the insight will be clear by the end of this section. In any case, I propose to use the terms "technology" (and "technologist") in the same spirit – as a catchall that includes not only what I think is engineering (or an engineer) but also what others think is engineering but I do not.

By "technology", I simply mean any useful artifact embedded in a social network that designs, builds, distributes, maintains, uses, and disposes of such things. So, for example, while a hammer lost in space is only an artifact, a hammer at work in a factory is technology (part of a technological system). A technologist is anyone with a *significant* role in technology. A young child who lifts a hammer is not a technologist, but a carpenter doing the same is.

Like other technologists, engineers design, "build" (or, at least, manage the building), or otherwise contribute to the life (and death) of certain technologies. Indeed, designing, building, or so on is (some might say) "the function" of engineers, what engineers, and only engineers, exist to do. It is what defines engineering.

This way of defining engineering is, I think, a mistake because it has at least two undesirable consequences. First, equating designing, building, or the like with engineering makes distinguishing engineers from other technologists impossible – by a

definition that clearly goes against usage. Architects, computer scientists, industrial chemists, and other technologists also design, build, and so on. Indeed, so may any inventor, however untrained, undisciplined, and isolated. Even beaver and corral are engineers in this sense. Any definition of engineering that counts such animals as engineers is, I think, plainly in deep trouble.

The second, and equally important, undesirable consequence of equating engineering with designing, building, or the like is that is gives a misleading picture of what engineers in fact do. Some engineers simply inspect; some write regulations; some evaluate patents; some attempt to reconstruct equipment failures; some sell complex equipment; some teach engineering; and so on. Whether all of these activities are properly engineering, indeed, whether any of them is, is a question that should not be settled by a mere definition. My point now is not only that inspecting, writing regulations, evaluating patents, and so on are what engineers frequently do (a mere statistical fact) but as well that such activities are what some engineers are supposed to do as engineers (a fact about how they are expected to function). So, for example, employers sometimes advertise for engineers rather than other technologists to do one or another of these things. I agree that design (or, rather, engineering design) is central to understanding engineering, but I do not see how designing can be the (defining) function of engineering or even one major element of an engineer's function – because, as I see it, there is no function that engineers, and only engineers, seem to have (except, of course, engineering itself, which is what we are trying to define).

If not defined by its function, what can define engineering? I have elsewhere given two answers to that question, one negative and one positive. (See, especially, Davis 1998.) The negative answer is that, if "define" means giving an abstract definition (for example, by genus and species), there are only practical definitions, useful for a particular purpose. There can be no philosophical definition, that is, one that captures the "essence", "nature", or "Platonic form" of engineering – because engineering no more has an essence, nature, or Platonic form than you or I do. Like you and me, engineering is a mere individual, a work of history rather than of logic or a priori reason. Therefore, all attempts at philosophical definition will either be too abstract to be informative, or circular (that is, define "engineering" using "engineering" or an equally troublesome term such as "technical"), or open to serious counter-examples (because they exclude from engineering activities clearly belonging or because they include activities clearly not belonging), or suffer a combination of these errors.

The positive answer helps to explain this negative one: Like other professions, engineering is self-defining (in something other than the classical sense of definition). There is a core, more or less fixed by history at any given time, which decides what is engineering and what is not. This historical core is not a concept but an organization of living practitioners who – by discipline, occupation, and profession – are undoubtedly engineers. They constitute the profession, that is, they admit or reject candidates for membership, using criteria such as similarity in education, method of work, and product. Often these criteria work like algorithms. So, for example, the ordinary physician or philosopher clearly is not an engineer (that is,

competent to engineer), while the typical graduate of an ABET-accredited engineering program with a few years experience successfully working as an engineer just as clearly is.[1] But perhaps as often these criteria cannot be applied without exercise of judgment. Does someone with a degree in chemistry who, say, has successfully managed a large refinery for 5 years, count as an engineer because what she has been doing is, in effect, "chemical engineering"? (Davis 1998, Chap. 3; Davis 2010)

We can now understand what was going on at that unnamed technological university. The president, not himself an engineer, was applying a functional definition of engineering, one that could not distinguish between engineering and closely related technologies. The Dean of Engineering then applied engineering standards (especially, ABET's list of engineering disciplines), which did precisely that. These standards recognized naval architecture and applied physics as engineering but excluded "engineering technology" and "packaging science", as well as software engineering, social engineering, genetic engineering, re-engineering, financial engineering, architecture, computer science, industrial design, synthetic chemistry, and so on.

But, it will be objected, surely the theoretical question of what is and what is not engineering cannot be settled in such a practical way. There are good reasons for, say, excluding architecture and synthetic chemistry from engineering while including naval architecture or applied physics.

I agree. But those reasons are themselves a consequence of history, that is, a consequence of decisions that, over several centuries, made the discipline of engineering what it is today. The discipline might have been different, indeed, so different that it would not count as engineering at all.

Discipline

By "discipline", I mean any set of standardized ways of carrying on a specific activity, developed over time and taught in some structured way. Breathing is not a discipline but the breathing required for meditation is. Building is not a discipline but building according to the standards of the Guild of Masons was. Inventing is not a discipline, but engineering is.

The history of engineering is in large part the history of its discipline. The way I tell that story, the discipline began to take shape after the French created the *corps du génie* in 1676. Had the French given a different name to that organization (say, *corps de l'artifice* or *corps du mécanisme*), we might well have a different word for engineering (say, "artifice" or "machining"). Before 1676, the term "engineering" (or its equivalent) referred to a function (primarily, the management of sieges, whether defense or assault, and whatever skills were necessary for that function).

[1] ABET, Inc. (formerly the Accreditation Board of Engineering and Technology) is the nongovernmental organization that accredits engineering programs in the United States. It also accredits some other technology programs, including computer science and applied science.

An engineer was simply someone who managed sieges (catapults, artillery, trenching, sapping, and so on). Within a few decades after 1676, the term engineering (or, rather, *le génie*) referred to the French way of doing such things. By then, engineering was a discipline.

To say that engineering (in the sense relevant here) did not exist before 1676 is not to say there were no technological achievements before then that might now count as engineering. There were, of course, for example: the invention of the ax, sling, and spear; the building of the Passage Tomb at Newgrange (3,200 BC), the Egyptian pyramids (2,575–2,150 BC), and the Beijing-Hangzhou Grand Canal (581–618 AD). To say that engineering did not exist before 1676 is to say instead both that no one called "engineer" did any of these things and that those who did do them did not work as engineers typically do but according to another discipline – or no discipline at all. The history of engineering is only a small part of the history of technology.

During the 1700s, the French slowly developed a curriculum – a sequence of formal courses – to teach the new discipline to those who were to be engineers in (roughly) our sense, *officieurs du génie* (not enlisted men with shovel or saw, an older sense of "engineer"). There was much curricular experimentation, some of which – from our perspective – may seem ridiculous, such as (for a time) including riding, dancing, and fencing in the curriculum. But, by the late 1700s, the curriculum was recognizably what it is today: calculus, physics, chemistry, mechanical drawing, statics, dynamics, and so on. There was a common core lasting 3 years; then, in the last year, the engineers specialized, choosing artillery, military engineering (fortification and sieges), mining, bridges and roads, cartography, or shipbuilding. Though the engineering curriculum has changed much since then (for example, adding electricity and computing), today's engineering curriculum resembles that of 1800 more than it resembles any other discipline's curriculum then or now.

Generally, it is this curriculum, or rather the distinctive discipline resulting from it, that distinguishes engineers at any time from the non-engineers around them, whether they have "engineer" in their job title or in the name of their discipline. So, for example, Benjamin Wright (2013), the Chief Engineer of the Erie Canal (2013) (1817–1828), was a self-taught surveyor with only a primary school education. Though he certainly functioned as an engineer (so much so that civil engineers like to claim him as the "father of American civil engineering"), he is in fact proof that one could still be a great builder without being an engineer. The nineteenth century had many other such builders, such as the gardener, Joseph Paxton who, though without any formal education, designed and oversaw construction of the Crystal Palace to house Britain's Great Exposition (1851). Indeed, it was only late in the nineteenth century that engineers (strictly so called) came to dominate large building projects. Today, the Crystal Palace could not be built without engineers involved at every stage after the initial sketch.

Have I not (it might be objected) put too much emphasis on the curriculum as the means of distinguishing the engineering discipline from other technological disciplines? The first year or two of the engineering curriculum today differs little from the corresponding curriculum in math, physics, or chemistry. In the last 2

years, it does differ from these, but the curricula of the major fields of engineering differ considerably too. Does that not make it hard to see engineering as a single discipline – without falling back on generalities that make it hard to distinguish engineering from the physical sciences? Indeed, the problem of line-drawing may be getting worse. One field of engineering, electrical and computer (ECE), seems to be abandoning courses that have helped to define the engineering curriculum since the eighteenth century, especially statics, dynamics, and thermodynamics. Surely, such changes do not individually, or even collectively, mean that ECE has ceased to be an engineering discipline. But, if they do not, then what does make engineering a single discipline – if it is.

This objection points to two unusual features of the way I have understood engineering. The first is that I have described the engineering profession as making decisions concerning the "similarity" (or difference) between the candidates for admission to the profession and those disciplines already in. Similarity is always a matter of degree. Matters of degree are often matters of judgment. Matters of judgment are subject to reasoned disagreement even among those competent to decide. There is no simple "fact of the matter". I therefore have no reason to be concerned if some people, even some whose judgment on matters of engineering I respect, have doubts about the engineering status of some discipline when I do not. What I have said about engineering stands as long as there is a historical core about which there is no dispute. That core can then make decisions about the others – decisions anyone, even a philosopher, can approve or criticize (just as judges make legal decisions which anyone may approve or criticize). But, just as with judges, so with the engineering professions: their judgments concerning membership matter in a way mine do not.

The other unusual feature of the way I have understood engineering is that inclusion of a discipline in engineering is (in part) a matter of history. That means, among other things, that what has already been included matters to what will be included. Consider ECE again. It might be that, if ECE were invented today, it would – like software engineering – not be recognized as engineering (strictly speaking). On the other hand, because of past decisions, ECE, already an engineering discipline, is likely to remain so in part at least because it is itself part of the comparison group. The departure of what was formerly an engineering discipline is unlikely to occur until the difference between that discipline and the rest of engineering has become so great that working as a single discipline seems too inconvenient. The inconvenience will consist in part of differences in curriculum (what engineers are supposed to know) but in part too in what happens after members of the discipline enter practice. Right now, the various disciplines of engineering do not seem to have trouble working together as engineers. Indeed, engineers not infrequently migrate from one field of engineering to another during their career. If, as a result of changes in curriculum, a certain engineering discipline can no longer work with other engineering disciplines without standing out as alien, then either the changes in curriculum will be abandoned or the former engineering discipline will eventually be accounted something other than engineering (strictly so called) – as happened, for example,

with "scientific management" (which began within mechanical engineering and ended up as operations management and research, a business discipline).

So, I agree that recent changes in the ECE curriculum do not "mean" that ECE is no longer an engineering discipline. Of course, "mean" suggests that there is a sharp line between engineering and everything else, one making judgment unnecessary. Either recent reforms in the ECE curriculum have obviously passed that line or they have not. As I have defined engineering, though, not only is there no sharp line between engineering and everything else (except what engineers happen to draw) but also that there is a process of deciding a discipline's status as engineering that may take years to reach a conclusion. The objection thus seems to miss the point of my historical definition. Ultimately, it is history that decides – with abstract reasons (similarities and differences) constituting only some of the relevant considerations.

Occupation and Profession

Though the curriculum of engineering is recognizable by the late 1700s, engineering did not become an occupation until many decades later. This will seem a strange claim to anyone who does not appreciate how much is built into the term "occupation". By "occupation", I mean any fulltime activity defined (in part at least) by a certain body of knowledge, skill, and judgment (a discipline) by which one can (and a significant number of people do) earn a living. Not all disciplines are occupations. So, for example, fencing, though certainly a discipline, is (in the US at least) not a way to earn a living (though teaching fencing may be).

Engineering could not become an occupation until it ceased to be an exclusively military activity and became something more or less independent. Until then, engineers were a certain kind of military officer. They did not have a "calling" of their own. Engineering (strictly speaking) did not separate from military engineering much before the 1830s when railroads became the first important civilian employer of engineers. It was about then that the earlier distinctions between kinds of military engineering, including "civil engineering" (roads and bridges), became a distinction between military engineers (of all kinds) and civil engineering (in the modern sense), that is, the building of great works for civilian purposes, and mechanical engineering (that is, the building of boilers, pumps, and other machines).

But even after civilian engineering separated from military engineering, engineering still could not be an occupation. Engineers were still gentlemen. And, until well after 1830, a gentleman could not earn a living. To earn one's living meant "going into trade" or becoming "a hired man" (or, worse, a servant). For a gentleman to go into trade or become a hired man was to cease to be a gentleman. Gentlemen were supposed to have enough inherited wealth to live decently (or, at least, were supposed to act as if they did). Any money a gentleman received for what he did when following a "calling" was not earned (the way wages, pay, or salary is earned) but given as an honor (much like the modern "tip" but without its demeaning suggestion of subordination). What to us would clearly be payment for services

rendered was a "pecuniary acknowledgement" (as physicians called it). Even today, professionals tend to refer to the price of their services as "my fee" – a word recalling "the knight's fee", that is, the land given to a knight so that he could afford weapons, armor, horse, and the time to fight for his lord. Gentlemen did not work to live but, if they worked at all, lived for their work, whether reimbursed or not. Engineering could not become an occupation until that conception of "gentleman" lost its force (or until engineers became tradesmen or manual laborers).

The term "gentleman" did not die – as, for example, its opposites, "villain" and "churl", did (more or less). Instead, gentlemanliness was reconceived as one or more of its former implications, especially, good manners, good character, and good education (college or its equivalent). In the rough markets of the late nineteenth and early twentieth century, being a gentleman in this sense (polite, decent, and well-educated) was not necessarily an advantage. Eventually certain occupations, those that tended to attract gentlemen, began to organize to help gentlemen earn their living as gentlemen (in something like the new sense of "gentlemen"). Each of these occupations was, or at least was intended to be, "a profession, not a mere trade or money-making calling".

The term "profession" has several senses today. In one, it is just a synonym for "occupation". A professional in this sense is the opposite of an amateur. In another sense, a profession is an honest occupation (one it is safe to profess, that is, to declare openly). In a third, a profession is a "learned art" (one requiring a knowledge of Latin and, hence, a university education). The opposite of a professional in this sense is a "mere artisan" or "mere mechanic". All three of these senses are quite old. During the late nineteenth and early twentieth century, "profession" came to have a new sense, one that provides an interpretation of the slogan, "a profession, not a mere trade or money-making calling". I have argued elsewhere that the following definition best catches this new sense: A profession is a number of individuals in the same occupation voluntarily organized to earn their living by openly serving a moral ideal in a morally-permissible way beyond what law, market, morality, and public opinion would otherwise require (Davis 2009a).

While each profession (in this sense) is a historical individual, profession as such is an ordinary concept (or conception), one developed by considering what the individuals apparently collected under the term are. Formal statements of the concept, that is, attempted definitions of it, might change over time both because the concept itself is changing or because our understanding of the concept has changed (or for both reasons). So, for example, the definition of "water" is different now from what it was, say, 300 years ago. That is in part because the concept no longer includes all clear, colorless, odorless, and tasteless liquids, but also in part because we have learned that water is H_2O (that is, that most of what was once called water consists of this chemical compound while some liquids once counted as water, such as aqua vitae, do not). Those who seek the meaning of profession in the origin of the term misunderstand how language works. Though the origin of the term can be suggestive, it can never be more than that. The concept a term names stands at the other end of its history.

Professions have been mocked as "gentlemen's clubs". Those so mocking them generally do not explain what is wrong with gentlemen's clubs. They should. After all, there is much to be said for a gentlemen's club if the alternative is, say, a criminal gang or illiterate clique. My guess is that what is supposed wrong is the criteria of membership. If, as with an ordinary gentlemen's club, membership in a profession were determined by sex, race, family, religion, and the like, then there would be something objectionable about professions. A gentlemen's club in which the membership is determined merely by sex, race, family, or the like marks of companionability would still be a gentlemen's club. Indeed, it might even be a good one. The purpose of a gentlemen's club is, after all, to please its members in a certain way (providing a home away from home, good company, and so on). A gentlemen's club makes no pretence of doing anything more exalted. Gentlemen's clubs differ in this respect from other similar voluntary associations, such as the Kiwanis or Lions Club, which have a higher purpose (charity). Professions also differ from a gentlemen's club in this respect. To be a profession, a voluntary association must – as the definition given above says – seek to serve a moral ideal (in a morally permissible way beyond what law, market, morality, and public opinion would otherwise require).

A moral ideal is a state of affairs every rational person (at his rational best) recognizes as a significant public good, that is, as something desirable enough that he wants everyone else to aid in achieving it, whether by positive support or merely by not interfering, even if their doing so would mean having to do the same. Among moral ideals are: justice, public health, knowledge, and beauty. The moral ideal of engineering is (roughly) improving the material condition of society. To serve that ideal as engineers, engineers must be competent in their discipline, honest in its practice, and so on. The sex, race, family, religion, class, or the like of an engineer is (more or less) irrelevant. Indeed, taking those factors into account in the selection of engineers is likely to exclude some candidates who would be good engineers or include some candidates who would not be (depending on which criteria are used and whether they are used positively or negatively). Hence, insofar as engineering seeks to serve its moral ideal, it should not select its members in the way a gentlemen's club properly selects its members. Selecting members by sex, race, family, and so on would tend to impede serving engineering's moral ideal.

Profession and Codes of Engineering Ethics

Like other professions, engineering seeks to serve its moral ideal by setting (morally permissible) standards that require more of engineers than law, market, morality, and public opinion otherwise would. These are the "higher standards" that are supposed to distinguish a profession from a mere trade or money-making calling. They are "higher" in the sense that they require (morally permissible) conduct that law, market, morality, and public opinion do not require (or at least, do not require

until the profession has established the standards in question). These standards are "special" insofar as they apply to the profession in particular, not to all moral agents as such or even to all professions as such.

A profession's special standards are correctly identified as the profession's "ethics" and incorrectly identified with the profession's "code of ethics". I have argued elsewhere that professional ethics is best understood as those morally permissible standards of conduct that every member of a group (the profession in question) wants (at her rational best) every other member of that group to follow even if their doing so would mean having to do the same. See, especially, Davis (2002). Given this definition of professional ethics, it is, I think, obvious that the ethics of engineers includes a good deal more than what is called "the code of engineering ethics". Among the standards that are ethics in this sense are technical standards of safety, quality, and documentation. Or, to put the point another way, the entire discipline of engineering – apart from those few standards in dispute at any time – constitute the ethics of engineering. What engineers call "a code of ethics" is simply the most general statement of the discipline.

To say of some statement (or command) that it is an (actual) "standard of conduct" is to make two implicit claims. The first is that the statement generally guides conduct, that is, that its instructions are followed, that those it governs generally use it to evaluate their own conduct or that of others in the relevant group, and that members of the group generally use it to criticize publicly their own conduct or that of others in that group. If the standard does not generally guide conduct, it is an ideal (or model) standard, but not an actual standard – that is, not "really" a standard at all. An actual standard resembles a scientific law insofar as it allows us to predict (with reasonable success) what those it supposedly governs will do.

The other claim implicit in saying that some statement is a standard of conduct is that, though it generally guides conduct, the standard does not always. Statements that always "guide" conduct are not standards but scientific laws (strictly speaking). So, pointing to a few violations of a code of ethics does not refute the claim that it is an actual standard of conduct. A few violations may be explained away as, for example, the result of differences of opinion (rather than as indifference to ethics), as the result of factual mistakes, or simply as anomalies. To refute the claim that a code of ethics is a living practice requires showing that there are so many violations that the code tells us little, if anything, about what those whom the code supposedly governs will do.

I am therefore inclined to dismiss those critics of ethics codes who move from a few obvious violations of a code to the conclusion that the code in question is "mere window dressing". Certainly, codes are (or, at least, may be) "window dressing", that is, something put on display to potential customers in order to attract them into the store that lies behind the window. There is nothing wrong with window dressing as long as the store actually provides what it displays in the window. The problem is with *mere* window dressing, that is, with displays that mislead concerning the stock inside. On the evidence I have, codes of ethics in general, and codes of engineering ethics in particular, are not mere window dressing. I have myself interviewed several dozen engineers and found them to be serious about engineering

ethics. I have also been assigning students in Engineering Ethics a paper requiring them to interview an engineer of their own choosing. Generally, they have found those they interviewed not only serious about engineering ethics but knowledgeable enough to give reasonably good answers to an engineering ethics case the interviewer posed to them. We definitely need empirical work on the question of how much engineers actually follow their ethics, including their technical standards, but absent such a study showing the opposite, I think the evidence points to the conclusion that engineering ethics is a living practice.

Indeed, it could hardly be otherwise – or, at least, otherwise for long. The public, including sophisticated businesses and governments, employ engineers for certain jobs when they could employ other technologists – and, in the past, did. Apparently, they do so because they suppose engineers to have certain ways of doing certain tasks different from their technological competitors. They suppose that because engineers have proved that they routinely do a better job than their technological competitors at those tasks (constructing large bridges, boilers, chemical plants, computer chips, and so on). Like a trademark, the term "engineer" is valuable only so long as individual engineers generally confirm the expectation that that term invites. Once engineering's special standards became mere window dressing, not much time would pass before only a fool would employ an engineer.

I have not claimed, please note, that most engineers have ever read their code of ethics, much less that they regularly consult it. The interviews that led me to the conclusion that engineers generally act as their codes of ethics require have taught me that most engineers cannot even recall seeing a code of engineering ethics. The engineering code seems to be "hardwired" into engineers. Of course, "hardwired" is a metaphor for a process we do not understand very well. Yet, we can be pretty sure that the process is not the self-selection by which students choose engineering. Those of us who teach engineering students in their first-year as well as in advanced courses can see that many of the attitudes we take for granted in fourth-year engineering students are not present in first-years. The hardwiring seems to occur during the 4 years of engineering school. Since few engineering courses (at least until recently) explicitly discussed engineering ethics, my best guess is that most engineers learn ethics through instruction in technical standards (which goes on almost everywhere in the engineering curriculum). The students learn engineering ethics much as native speakers learn their own language, that is, while doing something else.

Like many other professions, engineering seems confused about the moral status of its code of ethics (but not, I think, its technical standards). There are at least four reasons for that confusion. First, there is the question of how many codes there are. On the one hand, there seem to be dozens because so many engineering associations have their own code. The American Society of Mechanical Engineers has one; the American Institute of Chemical Engineers has another; ABET has another; and so on. Yet, these codes differ in language more than substance and even many differences that seem substantive at first disappear upon inquiry. (For example, engineers whose code of ethics does not yet include a provision on sustainable development seem to interpret the environmental or public welfare provision to

include sustainable development.) I have therefore come to think of the many formal codes as much like the many dictionaries of (American) English. Though they differ, they are reporting the same underlying reality. One code simply omits what another includes because of a different purpose, style, or the like. One includes an interpretation that might be helpful in a certain context or fails to take account of recent change (because of editorial standards or date of publication). And so on. This variety in formal statement is consistent with (more or less total) agreement on the "unwritten code".

The second reason engineers have to be confused about the moral status of their code of ethics concerns the source of a code's moral authority. There are in fact at least two possible sources.[2] Some codes of ethics are supposed to be morally binding because those governed have taken an oath, made a promise or commitment, or otherwise given the code an "external sanction". (The IEEE's code of ethics is a good example of this sort: IEEE members "commit" themselves to it when they join the IEEE.) The other source of a code's moral authority is "internal" to the practice, much as the moral obligation to follow the rules of a morally permissible game arises from one's voluntary participation in the game. (A good sign that we have such a code before us is that it applies to "engineers" as such, rather than members of some formal association.) The idea is that, when a person voluntarily claims the benefits of a code of ethics – for example, the special trust others place in those whom the code binds – by claiming to be a member of the relevant group ("I am an engineer"), that person thereby takes on a moral obligation, an obligation of fairness, to do what the code says. Because a code of ethics applies only to voluntary participants in a special practice, not to everyone, a code, if it is generally followed, can create trust beyond what ordinary moral conduct can. It can create a special moral environment. So, for example, if engineers generally "issue public statements only in an objective and truthful manner [including] all relevant and pertinent information" (as the NSPE Code of Ethics, like most others, requires), public statements of engineers will generally (and justifiably) be trusted in a way those of politicians, lobbyists, and even ordinary private citizens would not be. Engineers will therefore have a moral obligation to do as required to preserve that trust. They will have a special moral obligation to provide all relevant and pertinent information even when others do not have such an obligation.

The third reason engineers have to be confused about the moral status of their code of ethics is controversy concerning whether – to be more than "mere window

[2] I ignore a third possibility here, that the code has moral authority because the code's content consists of rules derived (either by deduction or determination) from general moral rules (a kind of natural law approach rather than the two variations of social contract offered here). I ignore that possibility here because no modern code claims moral authority in this way. That was, however, not always so. The AMA code of 1847 presented itself as a work of "deontology" (Davis 2003). I also ignore other possibilities that will immediately come to a philosopher's mind, such as a grant from (or contract with) society, because they also do not seem to have anything do with present confusion among engineers about the moral status of their profession's code of ethics.

dressing" – the code must be enforced in the way laws are enforced, that is, by formal penalties (such as reprimand, fines, suspension, or expulsion). The legal (or "compliance") model of ethics often leads to calls for mandatory licensing of engineers, enactment of the code as "professional regulation", and an official body with the power to bar an engineer from practice for serious violation of the code of ethics. While there may well be good reason for legal enforcement of some aspects of the code of ethics, understanding ethics as primarily about law-like enforcement, that is, formal means of holding engineers accountable (such as expulsion from a professional association), simply confuses ethics with law. Law, custom, and other external guides to conduct do not claim to be standards everyone in the group (even at their rational best) wants everyone else to follow. Law, custom, and the like must, then, depend heavily on external enforcement. Ethics, on the other hand, need not. Insofar as individual engineers can see how everyone following the standards in question serves their interest, they have reason to do their share to maintain the trademark's value, that is, they have reason to act as engineers should. If they are dishonest, or simply indifferent to long-term consequences, they may (even at their rational best) find that reason unconvincing. They will therefore be incapable in principle of joining the profession (whatever their education and experience). In practice, they are likely to be driven from engineering by peer-pressure, employer avoidance, civil damages, or even criminal punishment. Most engineers, however, may be counted on to do their fair share (insofar as they understand it) because they are relatively rational and morally decent and understand that doing anything else would, all else equal, be morally wrong.

The fourth reason engineers have to be confused about the moral status of their profession's code of ethics is that different codes formally apply to different engineers. Some codes apply only to members of an association, some apply only to a class of engineers not defined by organization, and some apply to "engineers" generally. The IEEE's Code of Ethics is a good example of the first; the (Asian) Declaration on Engineering Ethics, of the second; and the code of ethics of the National Society of Professional Engineers (NSPE) (2007), of the third. The first sentence of the IEEE code says that IEEE members "do hereby commit ourselves to the highest ethical and professional conduct and agree" to the ten rules constituting the body of the code (IEEE 2013).[3] The suggestion is that, but for IEEE membership, the engineers in question would not have those obligations. The Declaration (adopted by the national engineering societies of China, Korea, and Japan in 2004) speaks instead of "Asian engineers". Interestingly, the only significant difference between the standards of the Declaration and the IEEE or NSPE code seems to be the last: "Asian engineers shall … Promote mutual understanding and solidarity among Asian engineers and contribute to the amicable relationships among Asian countries." (Asian Code 2004) The NSPE Code (2007), in contrast, speaks only of

[3] The IEEE is the organization formerly known as "The Institute for Electrical and Electronics Engineers".

"engineers". There is no distinction between ordinary engineers and (licensed) Professional Engineers, American engineers and others, or NSPE members and non-members. The suggestion is that the obligations arise from being an engineer, that is, from membership in the profession of engineering, not from membership in any technical, scientific, or professional association.[4] Only codes of ethics that apply to the profession as a whole are properly codes of professional ethics; the others are organizational codes (such as the IEEE's) or sub-professional codes (such as the Asian Declaration).

Conclusion

I have, I hope, now explained the importance of the distinction between function, discipline, occupation, and profession for the study of engineering ethics. While doing that, I tried to dispose of several objections commonly raised to this way of understanding engineering. Some of the objections seem to make the error of trying to refute a general claim with a few counter-examples, forgetting that general claims (which claim to be true "for the most part") cannot be refuted with a counter-example or two in the way that universal claims can be. The other objections seem to rely on empirical claims that, if true at all, remain to be proved. The error of these objections is putting the burden of proof on the wrong party.

References

Benjamin Wright (2013). *Wikipedia.* http://en.wikipedia.org/wiki/Benjamin_Wright. Accessed 14 Jan 2013.

Chinese Academy of Engineering. (2004). *Declaration on engineering ethics*. http://ethics.iit.edu/ecodes/node/5076. Accessed 14 Jan 2013.

Davis, M. (1998). *Thinking like an engineer: Essays in the ethics of a profession*. New York: Oxford University Press.

Davis, M. (2002). *Profession, code, and ethics*. Aldershot: Ashgate.

Davis, M. (2003). What can we learn by looking for the first code of professional ethics? *Theoretical Medicine and Bioethics, 24*, 433–454.

Davis, M. (2009a). Is engineering a profession everywhere? *Philosophia, 37*(2), 211–225.

Davis, M. (2009b). Defining engineering – From Chicago to Shantou. *The Monist, 92*(3), 325–339.

Davis, M. (2010). Distinguishing architects from engineers: A pilot study in differences between engineers and other technologists. In I. van de Poel & D. Goldberg (Eds.), *Philosophy and engineering: An emerging agenda*. Dordrecht: Springer.

Erie Canal Construction (2013). *Wikipedia.* http://en.wikipedia.org/wiki/Erie_Canal#Construction. Accessed 14 Jan 2013.

[4] Some professional societies, such as the American Medical Association (AMA), have actually gone back and forth between the first and third kind of code. For details, see Davis (2003).

Institute of Electronics and Electrical Engineers (IEEE). (2013). *IEEE code of ethics*. http://www.ieee.org/about/corporate/governance/p7-8.html. Accessed 14 Jan 2013.
National Society of Professional Engineers (NSPE). (2007). *Code of Ethics for Engineers.* http://www.nspe.org/Ethics/CodeofEthics/index.html. Accessed 14 Jan 2013.

Michael Davis Ph.D. in Philosophy, University of Michigan. Senior Fellow at the Center for the Study of Ethics in the Professions and Professor of Philosophy, Illinois Institute of Technology, Chicago. Before coming to IIT in 1986, he taught at Case-Western Reserve, Illinois State, and the University of Illinois at Chicago. Since 1991, he has held – among other grants – four from the National Science Foundation to integrate ethics into technical courses. Davis has published more than 200 articles (and chapters) and authored seven books, including: *Thinking Like an Engineer* (Oxford, 1998); *Ethics and the University* (Routledge, 1999); and *Profession, Code, and Ethics* (Ashgate, 2002). He has also edited or co-edited other books: *Ethics and the Legal Professions* (Prometheus, 1986); *AIDS: Crisis in Professional Ethics* (Temple, 1994); *Conflict of Interest in the Professions* (Oxford, 2001); *Engineering Ethics* (Ashgate, 2005); and *Ethics and the Legal Profession, 2nd ed.* (2009).