QUESTIONS FOR STS FROM ENGINEERING ETHICS

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In this talk, I identify four questions about engineering I would like answered, questions it seems science and technology studies (STS) should be helping with. All have at least two features in common. First, all arose while teaching Moral Issues in Engineering, advising engineers on ethical questions, or otherwise engaging in "engineering ethics". Second, answering them would serve both practical philosophy and professional practice.

The four questions suggest a paradox. Though STS should already be hard at work on them, in fact STS has from its beginning, and continues today, to focus its effort on science (especially physics, biology, and medicine) and technology (objects and their consumers, processes, and victims). The profession of engineering, central to modern technology, remains peripheral to technology studies.

Of course, STS has done some useful work on engineering (as my examples will show). The trouble is that STS has done far too little (especially when compared to what it could do or what it has done for science), and much of what it has done has not been designed to help with engineering ethics.[1] This talk is a plea for an over-due adjustment in focus.

I proceed in this way. First, I briefly explain what I take engineering ethics to be. Next, I state and discuss my four questions, making clear what each asks, why the answer might be important for engineering ethics, what would constitute an adequate answer, and how STS historians, sociologists, and philosophers might help. Last, I consider what barriers stand in the way of answering the questions. Everything I say is both sketchy and preliminary, an invitation to begin a discussion, not a final judgment.

I. Engineering Ethics

Engineering ethics is a kind of applied philosophy. It is concerned with understanding--and helping to resolve--certain moral problems arising in the practice of engineering. These problems can be approached in at least five ways (what we may call): the philosophical, the casuistic, the technical, the social, and the professional.[2]

The first three approaches--the philosophical, casuistic, and technical--are alike in assuming that engineers are held only to the same moral standards as non-engineers. Professional organization, if it matters at all, matters as a mere "expression" of fundamental moral concerns, as an aid or barrier to doing what should be done anyway--profession or no.

The philosophical and casuistic differ from the technical in relying solely on the facts of a particular situation to transform general standards into specific directives. They differ from each other in the way they determine those general standards. The philosophical appeals to some moral theory (utilitarianism, Kantianism, virtue theory, or the like) to determine (along with the facts) what should be done.[3] The casuistic appeals instead to ordinary moral standards (either explicitly, for example, by citation of a commonly accepted moral rule like "Don't kill" or "Don't take unnecessary risks", or implicitly, by comparison of cases, or--most often--by some combination of these).[4]

The technical approach differs from the philosophical and casuistic insofar as it relies (instead or in addition) on special "principles of [good] engineering" derived from the "nature" of engineering, principles of competence or skill. Those special principles (together with ordinary morality and the specific facts of a situation) determine what should be done in that particular situation. The nature of engineering may be timeless (a Platonic idea) or a product of history (like the English language); but, at any time, it is a given, not something subject to change in the way a law or contract is.[5]

The social approach to engineering ethics resembles the technical in beginning with something special about engineers (or engineering). It differs from the technical in understanding this specialness as (at least in part) a product of social decision (the role society has constructed for engineers). For the social approach, the standards of

engineering ethics derive not from the nature of engineering as such but from a (morally binding) "contract" with society or from society's (morally binding) dictate. For the social approach, standards of engineering ethics are more or less arbitrary, that is, dependent on what society and engineers together happen to agree on or what society happens to decide.[6]

The professional approach, the last on my list, resembles the social insofar as both recognize a certain arbitrariness in what may turn out to be "ethical". The professional approach differs from the social in placing that arbitrariness in the profession of engineering rather than in the decisions of society as such or in an agreement engineers make with society. For the professional approach, society (like morality or the nature of engineering) is (generally) a mere "side constraint", not the primary (or equal) party in determining the content of engineering ethics.[7] I call this approach "professional" to emphasize the distinctive place it assigns the profession. For this approach, and for this approach alone, a (morally binding) code of ethics, typically the work of a professional society, is a central fact.[8]

The term "ethics" is ambiguous enough to deserve comment. "Ethics" has at least three senses. We can use it: a) as a mere synonym for ordinary morality, b) as the name of a specifically philosophical study (the attempt to understand morality, including both the right and the good, as a rational undertaking), or c) as special standards of conduct morally binding on members of a group because they belong to that group ("special" both because the standards do not apply to everyone and because they go beyond what law, market, and ordinary morality require). All five approaches to engineering ethics can use "ethics" in the first two senses (though the technical tends to ignore the second). But only the social and philosophical approaches can use it in the third sense; only they recognize engineering ethics as including special (morally binding) standards of conduct.

I have distinguished those five approaches both because distinguishing them both allows us to see important common ground and reveals some important differences. All five recognize how important understanding what engineers do is to understanding what they should do. None of the approaches supposes that we can do much of interest in engineering ethics without knowing a good deal about engineering, especially about what

moral problems actually arise in practice and what resources are available for resolving them. "Practical philosophy", however approached, requires an understanding of the relevant practice.

The five approaches nonetheless differ somewhat concerning what understanding is necessary. For example, the philosophical approach makes an understanding of the history of professional codes seem beside the point, while the professional approach makes it seem central (since history should provide insight into how to interpret a code).[9] This difference concerning what understanding is necessary may well affect the questions those committed to a particular approach ask about engineering. Here, then, is the place to declare that I am committed to the professional approach.[10]

That commitment should not matter much here. While I do not expect everyone to agree that I have asked just the right questions, I do hope that everyone will agree that I have asked the right sort of question. STS researchers who find another approach more to their liking than the professional can ask somewhat different questions and organize their research accordingly. They will still be serving engineering ethics--in part at least by showing how empirically fruitful the other approaches can be.

II. What is engineering?

My first question is, "What is engineering?" When I attempt to answer it, I find myself in fields of history and sociology all but deserted.[11] Why is this question on my list? That's a fairly long story.

Since I take the professional approach, engineering ethics is, for me, the ethics of engineers, a special group. I therefore need to know who is in the group (and so subject to its special standards) and who is out (and so not subject to them). Determining who is an engineer, and who is not, is not as easy as you may suppose. We can, of course, settle many cases intuitively. For example, someone with a B.S. in mechanical engineering from an ABET-accredited school (say, from IIT in 1975), licensed to practice nuclear engineering, and with twenty years experience designing nuclear power plants, certainly is an engineer (for purposes of engineering ethics). And just as

certainly, the operator of a diesel locomotive or the janitor of an apartment building, though called "engineer", certainly is not. But what about those called "software engineers" or "genetic engineers"? They generally do not have an ABET-accredited degree but (unlike diesel operators or janitors) generally have an education similar to that of engineers and do work similar to engineering. And what about the chemist or physicist who does work engineers also do (and who, unlike "software engineers" or "genetic engineers") may well work beside engineers strictly so called?

Anecdotal evidence makes me think that engineers (strictly so called) are pretty clear about who is an engineer and who is not. Generally, "software engineers" and "genetic engineers" are not; the chemists or physicists may be "adopted" after demonstrating certain skills on the job--but, until then, they are outsiders, whatever title they hold and whatever work they do. Couldn't sociologists tell us as much about this line drawing as they have about the line drawing between science, non-science, and pseudo-science?

The question "Who is an engineer?" soon leads to the question actually on my list, one of interest to all approaches to engineering ethics: "What is engineering?" Even those who do not recognize engineers as having a profession different from science or technology, still need to distinguish, for example, those moral problems properly belonging in a course in engineering ethics from those properly excluded. Not all moral problems engineers face, even in the workplace, are problems of engineering ethics. Some are problems of business ethics or just ordinary moral problems.

Though "What is engineering?" is a philosophical question, historians can help answer it in at least two ways. Walter Vincente's What Engineers Know and How They Know It provides a good example of the first way. By using the techniques of historical study--especially, the gathering and analysis of documents to reconstruct a sequence of events--Vincente was able to help us see engineers at work, to distinguish their work from that of scientists, and so to help us understand some differences between engineering and science. We need more work on the difference between engineering and science.[12] We also need similar work to help us understand the difference between engineering and architecture, between engineering and industrial designing, between

computer engineering and "software engineering", and even between chemical engineering and industrial chemistry (especially when, as sometimes happens, engineers and chemists seem to be doing the same job).

Vincente's work is a series of (what we might call) historical case studies. Sociologists can do something similar using participant observation. The Soul of a Machine is almost an example of what sociologists could do. I say "almost" because Tracy Kidder, while describing the work of engineers in informative detail, never tries to figure out what distinguishes what they do from what the people in Software do (or why the department he studied wanted engineers while Software did not).[13]

Historians can also contribute to our understanding of engineering in a way sociologists cannot. Historians can tell us about the historical process of defining engineering.[14] Layton's Revolt of the Engineers is an important example of what can be done--but, in my view, one that leaves most of the work undone. Layton's focus is on the United States before World War I, that is, at a time when the U.S. was a cultural backwater. The crucial events in professional development may well have occurred in France, England, or Germany. After all, engineering came to America from France, with American engineering schools copying the French at least up to the Civil War; engineering codes of ethics were adopted in England almost a half century before they were adopted in the U.S. We need a trans-Atlantic history of engineering's definition.[15]

What I would expect to learn from such a history is that we cannot usefully define engineering by genus and species, as Artistotleans would, or even by what engineers do or how they do it (their function or method). The useful definitions will define an engineer as a member of a certain historical community, the profession of engineering, and then define that community in terms of certain historically developing criteria including education, experience, and commitment to certain ways of doing certain things.[16] Engineering will be what engineers--at the time in question--typically do that members of other occupational groups don't. Engineering will have ethics built into it insofar as, and only insofar as, the engineering community has in fact adopted special (morally permissible) standards beyond what law, market, and ordinary morality require.

III. What do engineers do?

If we define engineering in some such way as I have suggested, we can distinguish engineers from those doing similar work. Engineers will be those whom the engineering profession recognize as members of their profession (for example, for purposes of membership in engineering societies--"at the professional level"). That way of identifying engineers would allow us to ask what, if anything, engineers--at a certain moment--contribute that others do not (that is, what significance their special standards of conduct have for others). The answer may well interest many in the history, sociology, and philosophy of technology--since it provides a way to study what effect, if any, differences in profession have on the technology members of professions make or use.

While a number of writers have stressed the importance of "engineering" (or, rather, "technology") to science, I don't think anyone has had much to say about the importance of engineers in science (engineers strictly so called). Yet, at most "science" laboratories I have visited, including Argonne, engineers seem to outnumber scientists (although accurate figures were hard to get). The only exception was a Red Cross lab where there were no engineers. There physicians (or, at least, M.D.'s) outnumbered the scientists (Ph.D.'s). What do engineers do in science labs? How much science is the work of engineers? Why?

The relevance of such questions for engineering ethics was brought home to me by a Department of Energy report of a whistleblowing incident at Argonne.[17] The whistleblower was described as a "metallurgist" but--by training, experience, and (it seemed) commitments--he was a metallurgical engineer.[18] The report described an internal investigation which, while siding with the whistleblower on matters of fact, clearly had trouble understanding why he was taking the science issues so seriously. I had less trouble understanding. He was (it seemed to me) doing what a good engineer should (though he might have done it more politicly). He was giving safety more weight than law, market, and morality required, more weight than scientists commonly do; he was giving it the weight engineering required.

Here then is one place where empirical work, historical or sociological, might

help to settle a dispute between philosophers. Both the philosophical and casuistic approaches to engineering ethics assume that engineers are not subject to any special standards, that their local situation or function is decisive in determining what they should do. Studies of cases like that at Argonne might, if they generally turned out as I believe they would, provide substantial empirical evidence favoring those approaches--the technical, social, and especially professional--that identify engineers as subject to special standards (whether of competence or conduct).

IV. How do engineering decisions get made?

Most engineering goes on in large organizations, governmental or commercial. Large organizations exist to do large jobs, doing them by dividing them into manageable parts. If these parts are too small, an engineer assigned one of them could not determine what effect her work would have on the public health, safety, or welfare or even on her employer. Her work would be "bureaucratized" (in one of the uglier senses of that ugly word). If most engineering work is bureaucratized (in this sense), engineering ethics must either be irrelevant to most engineers or consist of matters tangential to engineering as such (for example, treatment of other engineers). Engineering ethics presupposes a world in which engineers generally know what they do.

Here then is a sense of the question, "What do engineers know?" quite different from Vincente's but as worthy of investigation. My own interviewing in ten companies, and much anecdotal evidence as well, has convinced me that engineers generally have a pretty good idea of who will use their work and how; they know what they do. Their work is not, and generally cannot be, bureaucratized (or, at least, cannot without prohibitive waste). Yet, while there is a large literature on business organization, relatively little of it is on technical organization--and very little on engineers in particular. Worse, virtually no work has been done on decision rules in technical decision-making. While most of the organizational literature makes it sound like managers decide and employees, including engineers, either submit, perhaps dragging their feet, exit, or blow the whistle, my own observations suggest something quite

different, a process in which consensus is the rule, engineers generally have the power of veto over management decisions, and engineers are well informed (in part at least) because information is necessary to win their consent.[19]

V. What can engineers do?

Most engineers are employees, subject to termination of employment at the employer's will. Some writers have concluded from this that engineering is a "captive profession", that engineers have little room for professional autonomy, and that therefore there is little room for engineering ethics.[20] I have already suggested one reason to think this view is mistaken--at least in some organizations (those that decide engineering questions by consensus). But what about in an organization where engineers are well-informed but decision is not by consensus? What room for professional autonomy there?

Here we need philosophical work on the concept of "professional autonomy". What is professional autonomy? What conditions are necessary for its exercise? Once we have answers to those questions, social scientists should be able to determine which, if any organizations, actually do eliminate or drastically confine the professional autonomy of engineers (and with what result). We would then have a better idea when talking about the professional responsibility of engineers makes sense.[21]

VI. Conclusion

Last year, Carl Mitcham published an expansive, thoughtful, and informative book, Thinking through Technology. In one small corner, he argues that engineering ethics is part of science and technology studies.[22] While I agree that engineering ethics is properly a part of STS--or, at least, could be--I think that, as a matter of fact, it is not. I have two reasons for so thinking.

First, engineering ethics has so far developed as a field of professional ethics. The professions include many non-technical professions, everything from journalism to

accounting, from lawyering to nursing, fields STS would have trouble absorbing. So, at best, engineering ethics would have to divide its citizenship between two distinct fields. So far, it has not even done that. Even in a field like medical ethics, where empirical research is much more extensive than in engineering ethics and where technology is also a major source of ethical issues, the people doing professional ethics have been different from those doing STS. Whatever can be said about engineering ethics and STS as abstract fields, as living research communities, they have been, and remain, largely separate. So, for example, typical STS journals (Technology and Culture, Science Studies, Science, Technology, and Human Values, and so on) would not appear on most lists of professional ethics journals; nor would typical professional ethics journals (Business and Professional Ethics Journal, International Journal of Applied Philosophy, Philosophy and Public Affairs, and so on) appear on most lists of STS journals.[23]

My second reason for thinking that engineering ethics is not now part of STS is that those working in STS have generally been indifferent to professional ethics. Thinking through Technology bears the subtitle "The Path between Engineering and Philosophy" because Mitcham sees himself as mediating between two ways of doing philosophy of technology, the "engineering" way and the "humanities" way. Neither way has paid much attention to engineering as a profession. The chief concern of both has been "technology" (rather than "engineering"). Rarely does someone on Mitcham's long list of contributors to one way or the other of doing philosophy of technology get closer to engineering ethics than technology assessment or public policy. That is not very close.

Will this change? I don't know. But I hope it will. To understand moral problems we must see them in context. To understand problems of engineering ethics, we must understand the engineering context. Who is better placed than those working in STS to describe, interpret, and otherwise improve our understanding of the context of engineering?

I said "hope", not "expect", because a large barrier seems to stand in the way of STS doing the kind of work I am calling for. STS grew up concerned with knowledge (for science) and things (for technology). Only in the last two decades has science studies come to focus on research communities rather than Science. Technology studies

still seems focused on things, processes, and knowledge, on Technology, rather than on specific technological professions. So, what I am calling for is--to use an overused phrase--a paradigm shift. Paradigm shifts, being rare, are more properly the subject of hope than expectation.

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NOTES

Thanks to Vivian Weil for commenting on an early draft of this paper.

1. What Steve Woolgar hailed as "The Turn to Technology in Social Science Studies", Science, Technology, and Human Values 16 (Winter 1991): 20-50, has so far not reached engineering--except for those who equate technology with engineering. That equation is quite common. Consider, for example, James K. Feibleman's early piece, "Pure Science, Applied Science, Technology, Engineering: An Attempt at Definition", Technology and Culture 2 (1961): 305-317. Engineering actually receives no definition or, indeed, hardly a mention after the title--and the only extended discussion of "engineering" concerns "Roman engineers". The Romans called those guys "builders" ("architects"). "Engineer" is a relatively recent coinage; reference to ancient "engineers" should at least come with a justification (and scare quotes to signal the anachronism). Feibleman's errors have been repeated for more than thirty years.

2. In the context of medical ethics, I have--for obvious reasons--called the technical "the therapeutic". Michael Davis, "The State's Dr. Death: What's Unethical about Physicians Helping at Executions?" Social Theory and Practice 21 (Spring 1995): 31-60.

3. While I cannot think of anyone who explicitly adopts this approach in engineering ethics, John Ladd certainly appears to urge it in, for example, "Collective and Individual Responsibility in Engineering: Some Questions", in Beyond Whistleblowing: Defining Engineers' Responsibilities, ed. Vivian Weil (Center for the Study of Ethics in the Professions, Illinois Institute of Technology: Chicago, 1983), pp. 90-113.

4. For a good example of the casuistic approach, see Ken Alpern, "Moral Responsibility for Engineers", Business and Professional Ethics Journal 2 (Winter 1983): 39-48; or Eugene Schlossberger, The Ethical Engineer (Temple University Press: Philadelphia, 1993).

5. For a good example of the technical approach, see the use Mike W. Martin and Roland Schinzinger make of the concept of engineering as social experimentation in Ethics in Engineering, 2nd ed. (McGraw-Hill Book Company: New York, 1989).

6. I can't think of a clear case of a philosopher using the social approach in engineering ethics. I list it here because it seems to pop up regularly in discussions with engineers. For a philosopher who used it in medical ethics, see Robert M. Veatch, "Medical Ethics and the Grounding of Its Principles", Journal of Medicine and Philosophy 4 (March 1979): 1-19.

7. This is not to deny that there are, now and then, moments resembling direct negotiation between society and engineering; it is merely to acknowledge how rarely society, whether through government or through newspaper editorials or other non-governmental pressures, takes an active part.

8. For a text in engineering ethics that takes this approach, see Charles Harris, Michael Pritchard, and Michael Rabins, Engineering Ethics: Concepts and Cases (Wadsworth Publishing Company: Belmont, 1995).

9. For an example of how hostile to codes a devotee of the philosophical approach can be, see John Ladd, "Collective and Individual Responsibility in Engineering: Some Questions".

10. For my reasons for that devotion, see Michael Davis, "Thinking like an Engineer", Philosophy and Public Affairs 20 (Spring 1991): 150-167.

11. For my own efforts to answer this question, with references to what little useful work there is on the subject, see Michael Davis, "An Historical Preface to Engineering Ethics", Science and Engineering Ethics 1 (January 1995): 33-48.

12. For another good example of what can be done, see Bruce Seeley, "The Scientific Mystique in Engineering: Highway Research at the Bureau of Public roads, 1918-1940", Technology and Culture 25 (October 1984): 798-831.

13. I would offer the same qualified praise for Kathryn Henderson's work, for example, "Flexible Sketches and Inflexible Data Bases: Visual Communication, Conscription Devices, and Boundary Objects in Design Engineering", Science, Technology, and Human Values 16 (Autumn 1991): 448-473.

14. Interestingly, at least some sociologists, noting this advantage of the historians, have simply adopted their methods. See, for example, Peter Meikins, "The 'Revolt of the Engineers' Reconsidered", Technology and Culture 29 (1986):219-246. One of the good features of STS is that disciplinary boundaries remain relatively unimportant. So, "historian" must be read here as "someone functioning as a historian" rather than as "someone of that profession".

15. For a rare example of what such work might look like, see Eva Kranakis, "Social Determinants of Engineering Practice: A Comparative View of France and American in the Nineteenth Century", Social Studies of Science 19 (February 1989): 5-70.

16. For an attempt at such a definition, see Michael Davis, "Defining Engineering: How to Do it and Why it Matters", Journal of Engineering Education, forthcoming.

17. Report of Investigation into Allegations of Retaliation for Raising Safety and Quality of Work Issues Regarding Argonne National laboratory's Integral Fast Reactor Project (Office of Nuclear Safety, U.S. Department of Energy: Washington, DC, December 1991).

18. While he had a Ph.D. in metallurgy, his bachelor's degree was in metallurgical engineering (Colorado School of Mines, 1978) and his job description at Argonne was "associate engineer and experimenter". Report, 19 and 7. The report does not make clear whether his graduate training and other job experience was in engineering or science (though what it does say is at least consistent with his graduate training being in an engineering department).

19. For more detail, see Michael Davis, "Technical Decisions: Time to Rethink the Engineer's Responsibilities?", Business & Professional Ethics Journal 11 (Fall-Winter 1992): 41-56; or, for even more detail, Michael Davis, "Ordinary Technical Decision-Making: An Empirical Investigation", in Communication in High Risk Technologies: Global and Local Concerns, ed. James A. Jaska and Michael S. Pritchard (Hampton Press, 1995), forthcoming.

20. See, for example, Richard DeGeorge, "Ethical Responsibilities of Engineers in Large Organizations", Business and Professional Ethics Journal 1 (1981): 1-14.

21. For some preliminary work on this questions, see Michael Davis, "Professional Autonomy: A Framework for Empirical Research", Business Ethics Quarterly, forthcoming.

22. Carl Mitcham, Thinking through Technology: The Path between Engineering and Philosophy (University of Chicago Press: Chicago, 1994), pp. 103-105.

23. While the editorial boards of many of these journals do mix scholars in professional ethics with those in STS, I take that fact to indicate original hopes. The present separation of the fields is not due to lack of original vision but to failure of daily practice--the choice of editor-and-chief here, the weight of submissions there, and so on.