

[Resumed after Breakout Session]

REPORT BACK SESSION AND PANEL DISCUSSION

Group 1

Natasha McCarthy: The vast majority of our discussion centred on the issue of risk, so that was clearly something people had a great interest in. I will just go through the topics that we covered.

We started by talking about 'what is engineering', which was one of the topics of the presentations, because it became apparent that many people had different ideas of what engineering was and what engineering is. It was felt that, if we were going to address philosophy of engineering, then we should know what our subject matter is.

Relevant to that was the issue of when did engineering start, and what is the etymology of the term – apparently there are different etymologies for the term 'engineer' as well. Is it that engineering goes right back to medieval times, or are we thinking of the modern engineer that really got going in the industrial revolution? There is a topic there about when engineering did actually start and hence where did this term 'engineering' come from.

We then talked about engineering ethics, and we questioned whether there was actually a minimal ethical principle for engineers to abide by. For example, medical ethics starts with the principle of 'do no harm' but obviously, from what we talked earlier, with the example of the rail issue, engineers cannot actually just adhere to 'do no harm', because they have to do some harm in order to do some good. The question was whether there is a minimal principle of ethics for engineer and, if not, can we do engineering ethics without that?

We had a long discussion about risk. The main part of that discussion was about whether the non-engineering view of risk was irrational. Are 'rationality' and 'irrationality' the right way to cast this discussion about actual engineering risk, as opposed to perception? Should we be thinking that public perception is irrational, or should we have another look at the perception to see where it comes from? I thought there was an interesting topic to do with rationality itself, and how we judge rationality in engineering and how we judge rationality outside of engineering.

Another topic was the engineering attitude to the precautionary principle, and whether that was an appropriate principle to use in engineering, especially in policy issues around engineering. Related to that, was the use of models and simulations in engineering, because these are often used to work out whether something is a big risk, and what precautions are necessary. There is an issue about whether those models and simulations are actually viable and whether they are usable. How we can know that the model simulation actually works, until what it is meant to simulate actually happens?

So those were the main issues. The over-arching topic was risk, and ethical issues around risk, but we also looked at what is an engineer, what is the right way to look at rationality with regard to risk, and the precautionary principle and how to employ it.

Robert Hawley: Did anyone ask, what is a philosopher?

Natasha McCarthy: No!

Group 2

Ibo van de Poel: The main issue we began with was to wonder whether there was such diversity in engineering that philosophy of engineering would not make any sense at all. Perhaps there are so many different branches of engineering and so many different ways of doing engineering, that you cannot talk about a philosophy of engineering. Happily, however, we decided that this was not really a problem, and we came up with two solutions. The first is that we said that there are a number of topics that are relevant across all engineering disciplines, or at least most of them are – and I will mention a number of those that we came across.

Secondly, we said it would be important to work in a bottom-up way, in a kind of case study approach, or whatever you would like to call it. We should look at what engineers actually encounter as problems, and where philosophy might be helpful.

We came across a number of topics which are quite similar to those on Natasha's list.

1. The first is risk, and I will not say much about that. One important ethical issue there is how to trade-off net welfare against the distribution of welfare.
2. The second issue we came up with is ignorance and uncertainty. We did not mention the precautionary principle, though it certainly relates to this issue. Is a precautionary principle a good way of dealing with ignorance and uncertainty? There is a good deal of debate going on around that, and also at the political level. There is the whole

issue about free trade between Europe and the United States, which is partly about whether it is allowable to use the precautionary principle.

3. A third issue that we came up with is value sensitive design. This is the idea of building values into the design of products, to make them better, from a moral point of view. It is not only a question of avoiding what is bad with technology but also to do good with technology.
4. Fourth, there is social decision making about technology, and especially the issue about what the role of experts versus the role of the public should be. That is a very difficult topic.
5. Next, causation – the cause-effect relationships which are very important in engineering and design, but also if an accident happens. This is a topic on which philosophy has something to say. This would also be a fruitful topic.
6. Finally, we talked a little about how to promote philosophy of engineering, and we came up with two concrete proposals. The first is to have a chair in Philosophy of Engineering somewhere, and the second is that we should really work on drawing the attention of philosophers to this subject, and making this into good philosophy. In my experience, if we look at the history of philosophy of technology in Europe, on the continent, what has happened is that many philosophers of technology have split away from the rest of philosophy and are no longer being taken seriously. There is a warning there: if you want to do the philosophy of engineering, you should be sure to do good philosophy, to maintain links with other philosophers.

There are at least two activities that I have mentioned that we could do. One is to have a conference on the philosophy of engineering, and the other is to look for journals in which we could publish papers on engineering – for example, a special issue of *Monist* was mentioned.

Group 3

Igor Alexander: I had some excellent colleagues and so I am just a reporter here.

The main point we identified was that there is something missing in the education of engineers. We could say that that something was a grounding in philosophy, which would not necessarily be cured by putting on a 10-hour course in philosophy in every year of an engineering course. However, this is something that, for example, in other parts of Europe, is taken as being natural – perhaps because people study philosophy at school. What could

the Royal Academy do, to promote an improved culture in the design of engineering courses and the education of engineers?

We need some saints in this business. One that was mentioned was Ove Arup – and I believe that there is due to be a very interesting biography coming out fairly soon about Ove Arup. He was not only well-grounded in philosophy, but he was a multi-math, multi-linguist and so on. He was one of the leading engineers on an international level.

The question is, how does one promote that kind of breadth that is needed to be that kind of person in an undergraduate course where everything goes exactly the other way? There is pressure to be very focused on solving problems, and on solving a very *narrow range* of problems. We recognised that this was a very difficult problem and that it would not be solved by five people sitting around at table for 20 minutes. However, something might be done if one got a group of people together who were known to have a broad cultural background both in philosophy and in engineering. They could perhaps make some sensible recommendations about how one might move towards the future.

Other points that were made included the idea that it should be recognised that engineering is a brutally empirical activity and that, as such, there is the opportunity to make mistakes. ‘Justified scepticism’ is the term that came out there and, again, anyone learning about engineering may hear about risk and about ethics, but they do not necessarily live with a sense of justified scepticism.

There is a great deal of work to be done and the Royal Academy could be quite active in that.

Group 4

David Jenkins: We considered the topic in the general rather than in the specific sense. We have four questions.

1. Should a philosophy of engineering change engineers?
2. How could philosophy enable engineers to take a broader approach?
3. What values are intrinsic to engineering?
4. What is the role of engineering, and what is a philosophical approach to the subsets of that role? That is where you get ethics, safety, environmental impact and all the rest of it. To think about the role of engineering, what is the philosophical approach to the subsets of that role?

Keith Guy: That was very succinct, thank you. Obviously – and fortunately – everybody has discussed something different and we probably have time for some general thoughts.

Jo Wolff: Having been part of the blue team [Group 4], I will expand a little on the first point about whether a philosophy of engineering should change engineering, as that itself is a philosophical question.

Clearly, much of the interest in philosophy, from the point of view of engineers, would be how can we make engineering better? How can we be better engineers? There is the question about whether that is a realistic expectation.

If one looks at the philosophy of art, there is a question whether that makes any artists better artists. If you look at the philosophy of history, there is a question about whether any historian would be better for knowing the philosophy of history. It does not make it useless, but it makes it a different type of thing.

The first fundamental question is, what sort of practical importance does one want to have? That would then probably steer the next level of questions. If you felt that the philosophy of engineering was a philosophical reflection upon engineering, then you might be reflecting about the nature of the creative process in engineering, for example, rather than thinking you would be able to design better buildings, or build better bridges for having done this, or even be better people. In a way, that is the first question of all: what does one hope to get out of the philosophy of engineering? Is it better engineering practice, or is it simply more reflective engineers?

Robert Hawley: Engineers are practical people. They like an outcome and they like to reach conclusions. I just wonder how an exposure to engineers might make better philosophers. I am confused because – with tongue in cheek – I really do not understand what philosophers do, other than pontificate, and what is the use of their outcome, because they have not explained that to us. I will just leave that thought hanging there.

Jo Wolff: There two quite different projects that we could be engaged on. One is thinking about how you can get a co-operation between philosophers and engineers, to make some sort of better outcome. Both Peter and I have been engaged on that type of project. It is a type of philosophy *in* engineering, where philosophers are consultants to consultant engineers – a sort of ‘meta-consultant’. It may be that in those very practically-focused issues on particular projects that we can be of some help. It may also be that there are some areas in philosophy where an engineering approach would help. However, that is interdisciplinary research, or interdisciplinary action, rather than philosophy of engineering. It

is vital to work out what sort of collaboration is envisaged because philosophy of engineering may give you nothing like the type of practical output you are really seeking.

As I said, there is philosophy of art and philosophy of history – there is philosophical enterprise where certain questions arise. The question that comes up in the philosophy of art is ‘what is an artwork?’ Is a piece of music the score, the performance, both or neither? A similar question in engineering would be ‘what is a building?’ Is a building the blueprint, or the occupied bit – although that may be an easy question to answer in that case!

You may think that there questions on that level – a metaphysical level or a epistemological level. However, what I have not heard is anyone identifying any specific philosophical questions that arise in the context of engineering, in the way in which they come up in history or art. So that would be the challenge. Why should engineering be a topic of interesting reflection?

Greg Hunt, Warwick: One of the things we talked about in the Green group concerned ways of bringing about some kind of rapprochement or some connection between philosophy and engineering. One of the suggestions was that the design process is something where philosophical issues arise fairly naturally. For example, in a large engineering project involving one or more firms, what provides the continuity? Is it the customer, whose core needs go through, or is it the traditions of the firm? A historical case would be when there are both trends, and these seem to be methodological questions with huge importance to philosophy. What steers projects? Because philosophers do projects as well. How are we guaranteed consistent decision-making at sub-levels and so on. This is all part of the methodology of engineering and indeed it is part of the methodology of big science projects as well.

It seems to me that there are – when one thinks about it – deep and interesting philosophical questions in engineering as well as in many other things. It seems to me that, by focusing on design, you actually naturally build in almost all of the issues, including risk and including ethics and so on. This is something which, were we to have some fairly analytical case studies, might actually interest practising engineers, or at least academic engineers who are teaching the subject, as a way of illustrating points and getting into the realms of conceptual and philosophical issues which naturally arise when you take a broader view of the management and the carrying out of large projects.

John Uff: Could I ask a question that arises out of the exchanges from before? Would philosophy have anything to contribute to the investigation of a disaster, where there was a lot of debate about how engineers should approach it and how things should be investigated, how lessons should be learned and how blame should be apportioned and, if so, on what basis? There are plenty of disasters to choose from but would philosophers have anything to say about rail disasters, for example?

Peter Simons: Certainly potentially. It would depend on how well the disaster inquiry was going. If it was going well – if the disaster inquiry was not itself a disaster of the second order – then the answer is that the philosopher would do best to leave well enough alone. However, where disaster inquiries might go wrong because people are asking the wrong questions or focusing on the wrong issues, then philosophers, who are used to seeing things in the large scale and trying to balance all the different considerations from different areas, might at least have a corrective function. They might raise awkward questions at just the right point.

John Uff: Perhaps you should, because disaster inquiries are politically directed and motivated. They are often so set up that only certain answers are open to being –

Peter Simons: That is a good thing, and let me choose one parallel. The one place where philosophers have proved themselves useful to the community over the last decade is in chairing Royal Commissions. These are typically concerned with rather large-scale ethical issues such as cloning, surrogate motherhood, pornography and so on. Philosophers have been good at that because they have been able to sit in amongst all the different specialised disciplines and keep some kind of balance going, and also critical reflection on the process. It seems to me that it would not necessarily be a bad thing to have philosophers in a similar sort of chairman role in disaster inquiry conditions.

Jo Wolff: Could I just add, aligned to that, that Peter has made a distinction that I make. It is philosophers, and not the *philosophy* that is useful in these cases. You do not want someone who is coming in with a philosophical theory to apply in these cases. You need the type of virtue that one has as a result of philosophical training and a philosophical mind.

John Uff: That was not what I had in mind. I was asking the opposite question: does *philosophy* have anything to contribute to the way that engineering operates in this very difficult area?

Igor Aleksander: Could I make myself very unpopular? There is a danger of us making some mistakes – things that philosophers sometimes called ‘category mistakes’ –

and that is to ask questions just like the one that has been asked. What is the use of philosophy? I am not getting at you there! It is the sort of thing that Francis Crick became very disappointed about. The question one should ask is, what is it to be philosophical? Then, one might have an attitude to certain types of engineers, or a certain type of engineer, who might produce something very useful in the engineering community.

The other thing that brings a curtain down in front of my eyes is the phrase, 'philosophy of engineering', I think it should be 'philosophy *in* engineering'.

Jo Wolff: To go back on that issue, I was trying to think about what are the types of philosophical questions which would generate a philosophy of engineering? Typically, in other areas of philosophy, the philosophical question or issue arises because you have some sort of division in commonsense. There is a mind/body problem because, on the one hand, it looks like the mind is separate from the body but, on the other hand, how can it be? There is therefore a natural way of stating a problem which we do not know how to think about.

Similarly, in other areas of philosophy, commonsense pushes you in two different directions, and that is what generates a philosophical problem. This is thinking of philosophy in terms of problems, rather than questions or concepts. What I was struggling for earlier perhaps could be put this way: I do not see philosophical questions arising in that way from engineering, because I just do not know what the problems are. This is in support of philosophy *in* engineering, rather than philosophy *of* engineering. Perhaps I need to know more about engineering, but I do not know what those issues are.

Igor Aleksander: If I could give a very quick answer to that, there are very few good examples. However, one or two are very interesting. Someone mentioned Wittgenstein as not being their favourite philosopher. Having been an engineer, he was in aeronautical engineering at a time when engineers started using abstract language that came from mathematics, but he started using it in a conversational sense. This features a little in the *Tractatus*. This was never followed up, but I think it is a brilliant idea. Is there anyone who would like to look at the impact of discussions in state spaces, for example, as a philosophical issue?

Peter Lipton, Cambridge: Responding to the question, what good is this for the philosopher, one clear benefit you could have is that, when philosophers who – in my neck of the woods – work on trying to understand how knowledge works and how it grows, we tend to have a very narrow view. In the philosophy of science, there is a great deal of

focus on physics, as if that were the only model of knowledge acquisition. Widening our menu, and having a look at the way engineers do it, would be very good for us.

Another point I wanted to make is to agree with Jo – and perhaps I am disagreeing – in that you should ask the benefit question, which was the other question you asked. One should give a differentiated answer. If we look at ethical issues that arise in engineering, there is actually a chance for fairly direct, identifiable benefit to the engineer, that will help in making intensely practical decisions. If we look more broadly at philosophical questions about how engineering works, there is also a benefit, but it will be more diffuse.

At my university – I am in the department of the history and philosophy of science – almost all of our undergraduates are natural scientists. By teaching them the history and philosophy of science, I do not think I will be giving them any recipes for doing better lab work, but I will make them a little more reflective about what they do. That has a real, although more diffuse, benefit. Both kinds of benefits are genuine.

On the question of identifying a problem, I agree with Jo that this is not a mind/body problem, or something analogous to that, that immediately jumps to one's attention in the case of engineering. However, in everything we do, there is such a gulf between what we can do and what we can describe – between being good at solving problems and being good at some kind of account of how we solve them. Much of philosophy consists in working that gap. It is not necessarily about telling people how to do it better, because they are already very good at doing it, but it is trying to come up with a slightly better articulated account of how it is that they actually do it. Of course, that is inter-disciplinary and it is not just philosophy – it is sociology, psychology and history as well.

Robert Hawley: You have started to answer one of the questions I raised, which is where does experience fit into all of this? You have started to answer that. Of course, you can get young undergraduates to think laterally, more broadly and so on. In the end, however, the next vital ingredient is experience – *real life* experience. I am sitting here today with scars all over my back, as an engineer, because of problems that we have had and work we have had to do, and I am a better engineer as a result. If there was some application and thought in terms of where experience fits into rounding these people off, that would also be very good.

Shepley Orr: I just have one comment to follow up on the question of what is philosophy, and what might philosophers bring. I think Jo's very modest answer, which is that there may not be a philosophy of engineering and often what you want is philosophers

and not philosophy – or, even worse, a philosophy, such as X’s philosophy of Y, is quite right.

So far, what has been said about what it is to be a philosopher has been that it just the opposite of being an idiot. By that, I mean that it involves good, clear thinking. Just as a suggestion, and not to put down philosophers, you might get good, clear thinking just as easily from, say, a legal theorist or, very often, an economist, or somebody doing robotics. That leads to two points that I wanted to make.

First, engineers are very often using models, and that is why I mentioned economics in particular because, very often, economists will use models to try to figure things out. Philosophers can be helpful in this, in looking at a model and thinking through it slowly, asking whether this or that has been taken into account. More importantly, what good, clear thinking from any discipline might offer is a way of thinking of alternatives.

Just as an example, I work in an engineering department although I do not really know much about it. However, my boss, who is head of the department, is always telling me that engineering students are very good at doing what you tell them, but they do not tend to think about the problem and whether there is another way of solving it. They just say, ‘Oh, we need to get from A to B: let us build a bridge’, as opposed to thinking about whether you actually need to get to B, or whether you could build B on this side instead of building a bridge, and so on. That is just to say what kinds of thinking engineers might be looking for. You could say, please, by all means, keep philosophers on your payroll, but you might find similar good thinking elsewhere.

Ibo van de Poel: I would like to come back to this question about what is philosophically interesting about engineering. This is a very important question, and I would like to try out two answers.

The first is the notion of artefact. In Delft, we have a programme to do with the nature of artefacts, based on the idea that artefacts come with two descriptions – one is in physical terms and can be understood in terms of science, and one is in intentional terms. The idea was, in that project, that engineers somehow make a translation from the intentional realm to the physical realm. And that is a type of philosophical problem that is typical to engineering, at least in our minds, and, in a sense, comparable to the mind/body problem. That might be one answer to what, in engineering, really raises a philosophical problem.

The other answer I would like to try out is more in my own realm, is the ethics of technology, and perhaps engineering is not completely distinguishable from other things –

although there are a number of characteristics of engineering which make it quite special. One is the notion of uncertainty and ignorance – this is typical of engineering. The second is the collective character – so that it is not individuals doing this, but there are collectives working on it. Thirdly, there is the role of materials – so the role of the physical. All these three aspects are not really well covered in traditional ethics. So I think that there is a chance for philosophical ethics to deal with all of them, within the sense led by engineering. You could of course say that there are other topics that also raise this challenge for ethics, but engineering is especially interesting because it brings this challenge to philosophical ethics.

These are two topics which might be quite interesting for philosophers and which might also enhance philosophy here.

Peter Simons: I agree – certainly with the first one, and I was listening carefully – that what engineers are required to do is to take a bunch of requirements put on them by somebody or other and to translate those into some kind of physical architecture. How they do that might appear like a process of extended magic but of course it is not – it is blood, toil, tears and cash overflows. That happens typically in the most complex cases of realising – and the only other area of human activity in which intents are realised with such complexity is war. In both of those cases, it is important, for all sorts of reasons, to understand more clearly what goes on, and what the different steps and criteria of success and failure are.

I certainly think we are getting clearer about what goes on when intents are realised, and how well they are realised, and that is very important. That is one area where a philosopher could certainly gain from looking at the concrete problem *in situ*.

Another area which is very closely connected with this is understanding the whole notion of process involving multifarious agents on the way from intent formalisation, or requirement formalisation, through design to manufacture and into maintenance, use and so on. One of the things that joins both Hegel and Whitehead from Professor Aleksander's pantheon there was that they were both philosophers who laid great stress on the notion of process. Typical philosophers, both in the English tradition and in the old Greek tradition did not, however, but they laid stress on matter, substance and things. It is very important to see how things and processes interact in the complexity with which engineers confront us.

Just simply becoming clear about that – I cannot imagine that would not have some kind of knock-on benefits for engineers as well as for philosophers.

Keith Guy: It is time for me to sum up now.

I came to this whole subject through Natasha. I was concerned about the epistemic view of engineers and scientists and thought that perhaps, through philosophy, we could achieve two ends. I have heard both of them today.

One, I have called 'what is good engineering?', which I think somebody called philosophy *in* engineering, and the other one is 'what good is engineering', which I call philosophers *for* engineering. That is what I want – I want philosophers to go out and tell people that engineering is worthwhile and that people can benefit from the knowledge of it.

What was also interesting was that, when we started this, we were concerned that it would end up with just a discussion of ethics. However, what has been encouraging to me is that this has ranged well beyond ethics. It has ranged into areas of risk, which are not just ethical but they are truly philosophical, because they are about meaning and acceptability of risk, which will always be a philosophical issue, and of causation, which is also very important.

As I grew up, every project I did had something called 'design philosophy' written at the beginning. I spent hours writing design philosophy and in fact it was probably the most difficult document to write for a project because every single engineer who looked at it, and every single economist or accountant, thought it meant something totally different. However, the philosophy of design and the philosophy of process is actually very important.

In universities, we do not teach people how to think but we teach them how to mimic. The philosopher could really help in understanding the difference between good design, and the way in which people do good design, and the way that people produce rubbish. There is a whole field of study there, and it is different, with respect, from the philosophy of science – it may not be different from the philosophy of live science but it is a different process. That is what has come out of this.

Then we have come out with a whole group of ideas, which everyone has said are very interesting. Therefore, my take from the meeting is that there are issues that are worth pursuing. The difficulty will be in keeping philosophers engaged. There is also Bob's point about what they are really going to do, and your colleague's point about whether they will be so corrupted that nobody will take any notice of them anyway.

We have a challenge but my general feeling is that people will think that this is a worthwhile subject to continue to pursue. We will therefore work with you to call some follow-

up, probably in the form of some further seminars and perhaps with some tighter subjects, where we can have some more specialised discussion.

Thank you all very much. Particular thanks to our panel for being so open in the discussion. Thank you all for participating so freely. [*Applause*]

- *Close of Meeting* -