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An Emerging Agenda

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Philosophy and Engineering

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Chapter 15
Imagining Worlds: Responsible Engineering Under Conditions of Epistemic Opacity

Mark Coeckelbergh

Abstract How must we understand the demand that engineering be morally responsible? Starting from the epistemic aspect of the problem, I distinguish between two approaches to moral responsibility. One ascribes moral responsibility to the self and to others under epistemic conditions of transparency, the other under conditions of opacity. I argue that the first approach is inadequate in the context of contemporary society, technology, and engineering. Between the actions of an engineer and the eventual consequences of her actions lies a complex world of relationships, people, things, time, and space. How adequate is the concept of individual action under these circumstances? Moreover, in a technological society it is hard to sharply distinguish between her contribution and those of others, and between her action and "accident" or "luck". How, then, can we still act responsibly? I propose that we equip our moral thinking to deal with these new conditions, and argue that imagination can help engineers, researchers, and other stakeholders to reconstruct a world, imagine a history and a future, and imagine consequences for others in distant times and places. I illustrate this by exploring what it means to reconstruct a world of offshore engineering. I conclude that not only engineers but also other stakeholders could benefit from an education of the imagination, and I suggest further transdisciplinary work that contributes to a better understanding of responsible engineering under conditions of epistemic opacity.

15.1 Introduction

How must we understand the demand that engineering be morally responsible? Discussions of responsibility in the context of engineering often focus on the actions and decisions of the *individual*, but engineering takes places in a *social* context that involves many stakeholders. What kind of theory of responsibility can account for this social dimension of engineering? Shall we understand moral responsibility

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as shared or distributed, and what does that mean? Furthermore, in tune with its emphasis on the individual, engineering ethics is often understood as a subdiscipline of *professional* ethics and left unconnected with discussions in philosophy of *technology*. How can we connect both discourses?

In this chapter, I aim to contribute to the discussion about engineering, technology, and responsibility (1) by framing the problem in a particular way and (2) by offering one possible way to tackle the problem.

First, I frame the problem by distinguishing between two approaches to moral responsibility that respond to the epistemic dimension of responsibility. One ascribes responsibility to the self and to others under the epistemic condition which I shall call *transparency*, the other tries to tackle epistemic *opacity* instead. I show that many influential moral theories – traditional ones and others – appear to go for the first approach. I then argue that this approach is inadequate in the context of contemporary society, technology and engineering. But if this is true, then how can we still act responsibly?

In response to these difficulties, I propose that we equip our moral thinking to deal with the challenges poses by contemporary conditions. I argue that imagination can help researchers, engineers, and other stakeholders to reconstruct a world, imagine a history and a future, and imagine consequences for others in distant times and places. I refer to insights from the philosophy of technology (in particular Jonas and Anders), discuss various senses of "world", and offer the example of reconstructing a world of offshore engineering to understand responsibility for a near-disaster. In this way I hope to contribute to a better understanding of responsible engineering under conditions of epistemic opacity.

15.2 Two Approaches to Moral Responsibility

To better understand the demand that engineering or engineers be morally responsible, let us first turn to the contemporary discussion about moral responsibility. I detect at least two reasons for calling that discussion one-sided in the light of concrete, practical problems of responsibility.

First, in the literature responsibility is usually understood as *individual* and undistributed (see for example work of Strawson, Watson, Fischer and Ravizza, Kane, Pereboom, van Inwagen, etc.; an exception is Feinberg, who has described types of collective responsibility, Feinberg 1968). But this focus is highly problematic given that human action is often distributed and co-operative. As Lenk and Martin put it, "As a rule, cases in which an individual alone must take on the entire responsibility are examined in philosophy. Yet are there not also cases of co-operative responsibility, collective/co-operative decisions and collective action in general, that are becoming much more important today, in which someone carries full responsibility by *sharing* responsibility" (Lenk and Maring 2001, p. 100). What does it mean to share responsibility?

Second, following Aristotle's discussion in the *Nicomachean Ethics* (Book III, 1109b30-1111b5) a distinction is often made between two negative conditions for ascribing moral responsibility: (1) one should not be forced to do something and

(2) one must not be ignorant of what one is doing. Contemporary discussions of moral responsibility typically focus on the freedom/control condition (e.g. Fischer and Ravizza 1998, p. 13), not the epistemic condition. (And even Aristotle already emphasised the question whether or not an act is voluntary.) As a result, much of the discussion of moral responsibility merges with the free will/determinism discussion (see again the work of Strawson, van Inwagen, and others). There are only a few exceptions. In his well-known *Harm to Self*, Feinberg discusses ignorance about background facts and mistaken expectations of future occurrences, although these elements are understood to be "failures of consent" and are not as such discussed as epistemic conditions for responsibility (Feinberg 1986, pp. 269–315). And Hadji briefly discusses the epistemic problem in terms of the moral beliefs of the person, defined as the belief that something is right or wrong (Hadji 1998, pp. 172–173). However, the epistemic problem is an important one. For instance, we often have to act with incomplete knowledge and uncertainty about the future. What if we are confronted with unforeseen or unforeseeable consequences (Lenk and Maring 2001, p. 101)? Do we really know what we are doing? Are we still morally responsible under such conditions?

These two problems of responsibility are relevant to all human action, but they seem to get only worse when we consider action in the contemporary, technological world – the world we live in. Perhaps because they are confronted with real, practical problems of responsibility, some authors in engineering ethics have offered more useful discussions that can help us to take seriously the epistemic problem in the light of a technological world. I already mentioned Lenk, who recognises and discusses the problem of distributed responsibility. Furthermore, Harris, Pritchard and Rabins discuss impediments to responsible engineering such as ignorance and microscopic vision (Harris et al. 1995). The term "microscopic vision" has been introduced into engineering ethics by Michael Davis (Davis 1989) and means that engineers – or any other members of a profession – may get a narrow field of moral vision. They become blind to the concerns of the wider society (see also Coeckelbergh 2006a, pp. 252–253). A possible remedy is the development of moral imagination, which can help engineers to know the further consequences of their actions, to put themselves in the places of others outside their profession and to envision more action possibilities (Coeckelbergh 2006a).

In order to further develop these suggestions and to further analyse the epistemological problem in the light of contemporary technological culture and society, let me present my own distinction between two approaches to moral responsibility.

15.2.1 Transparency

The first approach ascribes moral responsibility to the self and to others under the following epistemic conditions, which I shall summarize as *transparency*:

- *Transparency of the relation between action and consequences.* The link between actions and consequences is clear, both from my point of view and from the point of view of others. First, I can, in principle, know and experience the consequences

of my individual actions, since there is only a small time and space gap between my actions and the consequences of my action, and I can oversee the effects of my actions on others. Second, others can, in principle, monitor my action. In this context, individuals receive moral praise or blame from others, and traditional ethical codes such as the ten commandments develop. Corresponding moral systems are build on expectations of reciprocity, which can be tested in small, not too complex communities that are overseeable.

- *Transparency of the relation between my action and what is not under my control.* First, the actions of others are not under my control. But the distribution of action is clear. I can distinguish between what I did and what others did. From a social perspective: if actions are individual, or the contribution of one individual to collective actions are clearly distinguishable from the contribution of other individuals, responsibility is assigned on an individual basis. The distribution of action is clear. Although we may praise or blame several individuals, we know who does what, and we distribute responsibility accordingly. Second, there is transparency of the relation between my action and whatever else is not under my control, described in terms of luck, chance, contingency, natural causes, divine influence, etc. Again the distribution is clear. I know what I did. Either the action is completely mine, in which case my responsibility is absolute, or something happens which I cannot help, in which case no-one (including myself) can praise or blame me for it. (Although many theories of responsibility allow for degrees of responsibility, most of the most influential discussions assume that it is an either/or question.)

Although these conditions are unlikely to apply in circumstances when questions regarding moral responsibility arise (and indeed may appear exotic in many other circumstances of human life), influential moral theories appear to assume them. This is not only regrettable for philosophy; it is a disaster if we want to understand responsibility in engineering practice, which takes place in the context of contemporary technological culture and society. Consider religious ethics: these ethical systems developed in an entirely different historical and cultural context, tailored to small communities or at most a "people" (defined in ethnic and cultural terms), and are struggling to cope with the modern and highly technological world (Consider questions such as: How should Christians respond to nanotechnology? How can a Muslim be a good Muslim in space?). But modern, secular ethics, too, struggles to adapt itself to our contemporary *technological* culture. Let me explain these problems.

15.2.2 Opacity

The transparency assumption, which may have been already unrealistic in the pre-industrial world, becomes even more problematic if we consider the context of technology and engineering in contemporary society. Between the actions of an engineer and the eventual consequences of her actions lies a complex world of relationships,

people, things, time, and space. How adequate is the concept of individual action under these circumstances? Moreover, in a technological society it is hard to sharply distinguish between her contribution and those of others, and between her action and "accident" or "luck". In engineering design, for example, there is an "experiential gap" (Briggle and Mitcham 2007) between the design of a technological installation (e.g. an oil platform), however conform it is to safety regulations, and potential future (disastrous) consequences when something goes wrong. There are simply too many factors, agents, relations that play a role. Moreover, the contribution of the designer is only one part of the process, which also includes other agents and many things (equipment, installations). Consider the difficulties with determining what went wrong in aircraft accidents: blame can neither be ascribed exclusively to human agents, nor to technological artefacts (computers and other systems in the aircraft). Thus, both in time and space there are barriers to complete knowledge of the (causal) relations between action and consequences, there are problems with monitoring, it is hard to know the full distribution of action, and it is difficult to see what, as an individual, the engineer can do about avoiding a disaster. The engineer's moral condition, therefore, is a tragic[1] one, in the sense that incomplete knowledge seems to prevent her from grasping her contribution to what goes on, and, therefore, to assign moral responsibility to herself and to others. How to deal with this problem? The question can be generalised to other activities in a contemporary, technological context. We fail to know the consequences of what we do, if we do not know the distribution of action, and if we cannot clearly distinguish between what we do and what happens outside our control. How, then, can we still act responsibly?

15.3 Imagining Worlds

An alternative approach may assist us to answer this question. My proposal is not that we should try to achieve full transparency (which is impossible), or that we should replace traditional moral theory altogether. We should keep the best moral insights we have. However, we must equip our moral thinking to deal with the challenges poses by contemporary conditions. I recommend imagination as an important

[1] The relation between technology and tragedy is, by itself, an interesting issue that deserves further discussion. For example, Jos de Mul has argued that technology is the locus of tragedy today, since although we create(d) it ourselves, it gets out of control de Mul 2006. My own understanding of the tragic is informed by my reading of Kierkegaard's essay "The Ancient Tragical Motif as Reflected in the Modern" in *Either/Or* (Kierkegaard 1843; Coeckelbergh 2006b). The gist of my view is that tragic action, and therefore tragic responsibility, is situated between absolute control and the absence of control. If we had absolute control, our actions would not be tragic, and we would be fully responsible. If, on the other hand, we lacked *any* control, as is the case with the weather, for example, such external circumstances would not constitute a tragic condition for us either. Engineers (and many of us at many times and in many circumstances, given that we live in a technological culture) find themselves in such a situation: they can do something, but they lack complete control. Under epistemic conditions of opacity, there is insufficient knowledge available for that purpose.

tool for this purpose. It can help researchers, engineers, and other stakeholders to reconstruct a world, imagine a history and a future, and imagine consequences for others in distant times and places. To support this claim, I will refer to insights from the philosophy of technology (Jonas and Anders), and offer the example of reconstructing a world of offshore engineering to understand responsibility for a near-disaster. In this way, my argument moves back and forth between ethics of technology and engineering ethics.

15.3.1 Moral Imagination and Technology: Jonas and Anders

Let me further develop my analysis of the conditions of responsibility as well as my proposed solution (imagination) by using the work of Jonas and Anders.

In *Das Prinzip Verantwortung* (1979), Hans Jonas observes that traditional ethics assumes a narrow scope of human action and responsibility, whereas with technology the nature of human action changes (Jonas 1979, p. 15): we realise that we can wound nature, that we soon will be able to change our own species, and that our actions have consequences for the remote future. He concludes that we need a new ethics to cope with this new situation, and therefore proposes his "heuristic of fear" (*Heuristik der Furcht*). Feeling teaches us that something is at stake. It is easier to see the bad (the *malum*, the danger) than to recognise the good. Therefore, we must consult our fear to find out what we really value. This is not sufficient in our search for the good, but it is a necessary first step. To imagine the *malum*, then, is a duty (64). We should try to imagine what happens to future generations, and let ourselves be affected by it (65). Thus, we must conduct a thought experiment (67) by using feeling and imagination. Jonas also refers to what he calls "the serious side" of science fiction, which can help us in our heuristic exercise (he mentions Huxley's Brave New World) (67). Imagination in this context is not a private fantasy, but a projection of the future, which is a (moral) duty according to Jonas (76). In Chapter 5 he says that the future of humanity is the first duty of human collective action. Since the future of humanity is at stake, we need an emergency ethics (*eine Notstandsethik*) (250). We should mobilise the vision of our imagination and our emotional sensitivity. Fear, then, becomes a preliminary duty of an ethics of historical responsibility (392).

I infer that for engineering, this analysis means that we must take seriously the fears of the general public as a guide to what we value, and that all stakeholders involved must exercise their imagination to assess potential consequences of engineering design for future generations. Science fiction (in literature, film, games, etc.) can help here. Of course we should make sure that such imaginative explorations indeed aid and strengthen, not *replace* a professional practice (and philosophical inquiry) that is responsive to concrete, contemporary problems. Furthermore, we should not forget that scientists and engineers themselves have visions of the future as well. Since both scientific and science-fiction visions are already to some extent part of a shared culture, we can be optimistic about at least one prerequisite for a

constructive dialogue between science and society: we *already* explore future possibility, and often we are aware of ethical danger.

However, we should not underestimate the problem given the limitations to our capacity to imagine and to feel what is at stake. In *Die Antiquiertheit des Menschen* (1956), Günter Anders also proposes imagination and emotion as ways to cope with contemporary technology, but puts more emphasis on the psychological and existential difficulties we have to face. Anders sees a discrepancy between production (*Herstellen*) and imagination (*Vorstellen*). We fail to emotionally and cognitively deal with technology, we are blind in this sense. For Anders, in the stage of industrial mass production there is a gap between, one the one hand, our capacities to imagine and feel, and, on the other hand, our actions. We are unable to imaginatively and emotionally cope with our products and their consequences (Anders 1956, p. 273). Moreover, our existence is torn apart, fragmented. With the Second World War in mind, he suggests that we can have ethically incompatible roles: someone can be at the same time an employee in a death camp and a family father (272). With regard to engineering, and less extreme, we could consider the gap between a professional role as engineer (perhaps developing military technology) and a private role as father/mother, lover, friend etc. We could also think about other public/private gaps typical for modern society. The solution Anders proposes is the development of moral imagination to bridge the gap (273). I guess he means that engineers and designers try to emotionally and imaginatively grasp the consequences of our professional actions– including consequences for the "private" life of others. Perhaps he also means that we should take a more "private" ethics perspective on our "public" responsibility. Anders doubts whether it is possible voluntary to expand our imagination and feeling. If it is not, he thinks that the situation is without hope. But as a moral person we must at least will to try to break through the limits of imagination (273). We should start the experiment: we should try to stretch our imagination, try to transcend our imagination and feeling (274). Anders uses the term "*moralische Streckübungen*" (moral stretch exercises) (274). He contrasts this to human engineering, by which Anders seems to mean changing humans by technological or organisational means. For him, that would entail conformity to the world of appliances. Rather, we want to cope with that world, we want to draw it back into our imagination and feeling. We have to try to take in the world we created (274). Anders thinks it is impossible to provide more concrete instructions for such an exercise (275). When the imagination (*Phantasie*) is unwilling and feeling is lazy – Anders calls this "*[der] inneren Schweinehund*" (275), we should force them to listen, to obey. He compares this to similar techniques to change the self[2] (*Selbstverwandlungs-Techniken*) in mysticism and religion: we try to access regions which cannot yet enter (275). But instead of trying to reach into metaphysical regions, we here must try to grasp artefacts: things we made ourselves. Of course

[2]One may also consider Foucault's notion of 'technologies of the self' at this point, a notion which he developed in his later work (Foucault 1988; compare Foucault 1976 and following works on the history of sexuality).

we can already reach them, but *as imaginative and feeling beings* we are still remote from them (276). Anders refers to the atomic bomb, and prescribes that we should not accept work that directly or indirectly destroys us. In general, he seems to mean that we – as beings who create things – come to fully realise what we are doing. If we try to stretch our imagination and feeling with that purpose, we do not know if our exercise will succeed, but we should try (276).

I conclude from these arguments that engineers and other stakeholders should also engage in such techniques of the self. But what does this "duty" to exercise one's emotional and imaginative capacities imply in the real world? And what about imagining the present and the past (as opposed to the future only)? Looking at Anders's examples, we *can* make Anders's moral stretch exercises more concrete. But perhaps something else is needed first. If we are to imagine the (future) consequences of our actions in a technological and engineering world, and if we are to deal with responsibility questions concerning past disasters in the engineering world, we must start with (re)constructing such a world.

15.3.2 Senses of "World"

What does it mean to say "the world of engineering"? There are various ways to understand "a world" or "worlds": for instance, it can be given a positivist (Wittgenstein 1921), naturalist, phenomenological (Heidegger 1927), or (social) constructivist (Latour 1993, 2005; see also Bijker et al. 1987) meaning. Let me clarify these meanings:

1. From a positivist point of view, "world" means, in Wittgenstein's words, "everything that is the case". "What is the case" (facts) refers to the existence of atomic states of affairs (Wittgenstein 1921). In a naturalist interpretation, it could also refer to the planet earth, or to the (physical) universe. A "world of engineering", then, could mean "everything that is the case in engineering" or perhaps "that part of the universe that concerns engineering".
2. In the positivist or naturalist interpretation, we note the absence of the *human* (observer, participant, . . .). From a phenomenological point of view, one should ask the question: *whose* world(s)? We are involved in the world, we interpret the world. Let me clarify this sense of "world" by using Heidegger's analysis of "world" in *Sein und Zeit* (Heidegger 1927, pp. 64–65) and Dreyfus's useful summary and interpretation of that passage in *Being-In-The-World* (Dreyfus 1991, pp. 89–91). The term world can refer to a universe, that is, a set of particulars. For example, the physical universe is the set of all physical objects. What defines the physical world, then, is what all physical objects have in common. This meaning is similar to the positivist or naturalist definition. But phenomenologists are more interested in a sense of "world" that refers to our involvement in that world. The stress is then on our (Heidegger: *Dasein*'s) living in it – or being thrown in it. For example, the business world is what one is "in" when one is in business (Dreyfus 1991, p. 90). It is what Kuhn calls a "disciplinary matrix": "the entire constellation of beliefs, values, techniques, and so on shared

by the members of a given community" (Kuhn quoted in Dreyfus 1991, p. 90). For example, whereas the physical world is a set of (physical objects), the world of physics is, in Dreyfus's words, "a constellation of equipment, practices, and concerns in which physicists dwell" (Dreyfus 1991, p. 90). Such a world is a shared world by definition. In a similar fashion, we could define the world of engineering as *the entire constellation of beliefs, values, techniques, and so on shared by the community (profession?) of engineers*, or, better, *the constellation of equipment, practices, and concerns in which engineers dwell*. I prefer the latter definition since it includes "equipment".

3. Another way of defining the world of engineering is to say that it is the world constructed by engineering *and* society. It is not given, but constructed, and it is not only the product of engineering (broader: technology). Society cannot be disconnected from these technological activities. The world of engineering, then, is co-constructed. Bijker and others have described how this works (Bijker et al. 1987), although their work has not been focussed on engineering in particular but on technology in general. We could also use Latour's actor-network theory (Latour 1993, 2005): the world is a network of *actants*, including people, things, and relations between them. The advantage of such a definition is that there is more emphasis on *things* and relations. However, I hesitate to buy his symmetrical view that puts humans and things on the same level.

I have now clarified three interpretations of "world of engineering". I have expressed my preference for a definition inspired by Dreyfus's interpretation of Heidegger and for a definition that accounts for the constructive relation between science and society but that does not assume symmetry between humans and things. For an adequate and relevant ethical analysis, however, it is not sufficient to focus on "the world of engineering" at large. We need to delve into empirical detail, we need to look at more specific domains; activities, and *events* within that world. For example, we could discuss "the world of offshore engineering" as related to a specific case or event. Let me clarify this by looking at the Snorre A case. For this purpose, I shall re-interpret earlier work I did with Ger Wackers on the role of imagination in the Snorre A case (Coeckelbergh and Wackers 2007).

15.3.3 Reconstructing a World of Offshore Engineering: The "case" of Snorre A

Snorre A is a technological installation used for the offshore production of oil and gas on the Norwegian continental shelf. In November 2008, gas escaped and clouded the platform, but was not ignited. The platform crew managed to avoid a disaster. How should an ethical analysis of this case proceed?

One could start from an ethical theory and ethical principles, and then apply them to the "facts" of the "case" at hand. In practice, this means that we first have to "get the facts right", to "see what is the case"; then we can judge about responsibility, about right and wrong using our ethical principles. But if I take seriously my

methodological preference expressed above, there is an alternative to the positivist and naturalist perspective on the world assumed by the term "facts" or "case". We can understand the object of ethical inquiry not as a "case", a world of facts, but as a world in which we involved (phenomenological insight) and which we co-shape (social constructivist insight). If we want to do ethics informed by this understanding of "world", we face a different task. Rather than beginning a "passive", uninvolved, and "objective" registration, observation or collection of facts, we must start with an "active" reconstruction of the world of offshore engineering related to this event, an activity which also entails being involved in what happens in the world and – by means of philosophical analysis – co-shaping that world. Furthermore, we must equip our analysis with conceptual tools that do justice to the human-involved and narrative dimension of the world. Just as our world is not merely a collection of atoms, it is not merely a collection of facts. I shall understand the world of offshore engineering as a combination of agents (individual and collective), things, and relations between agents and things. Furthermore, the time dimension is important as well: apart from a world we must also reconstruct a narrative, or rather, narratives (plural) that stretch from the past to the present and the (possible) future(s). Let me explain this twofold task by using the example of the world of the Snorre A and offshore engineering. I will also take this as an opportunity to illustrate and draw together my earlier arguments concerning responsibility and imagination.

First, a world (or worlds) must be reconstructed. Things include the technological installation and its components, the oil and gas, the rescue material, etc. Agents include the oil company (Statoil) and its contractors and subcontractors, such as a drilling company, but also the safety agency (here: the Petroleum Safety Authority), the state, etc. Relations are ethically highly relevant. For example, the Norwegian state is financially involved in Statoil (the oil company) and Norsk Hydro (the company that operated Snorre A).

Second, there is a narrative about how the Snorre A unit changed hands several times, and about contracts which jeopardised safety. The world of offshore engineering cannot be disconnected from the corporate world, and the differences between these worlds are again highly relevant for ethics. Agents in this world include ceo's, bankers, and lawyers. In that world it is important to reduce costs, improve efficiency, and strive for maximisation of shareholder value. The consequences within the world of engineering can be a reduction of safety at platform level (Coeckelbergh and Wackers 2007). Furthermore, since the state was involved here as owner (Statoil until 2002) or half-owner (Norsk Hydro), politicians are also among the relevant agents, and the political world needs to be considered as well when discussing moral responsibility. But people in one world are often unable to imagine the impact of their decisions in a different world. People from both worlds would benefit if they were able to imagine the other world. And given the interlocking of these worlds, not only engineers, but also ceo's, lawyers, politicians, etc. should do an effort to imagine (other) worlds.

Note that someone may well be able to imagine the consequences for another world, but deliberately chooses not to take this into account. However, we must assume good intentions on the part of engineers as a default.

However, in spite of all good intentions, I argued above that in a technological society it is hard to imagine the precise (long-term) consequences of one's actions, and assigning responsibility to one agent is inadequate, since that would require us to imagine the consequences at other levels for other people in different worlds at different times. Furthermore, as a researcher (an outsider position), it is difficult to grasp all relevant events that are going on, the actors involved, etc. The negotiation of a contract at one point in time is only one element in the narrative, and the people involved are only one group of agents involved. (On the one hand, for a better understanding of the "case", therefore, more involvement would be better. On the other hand, when one is too involved, one may be subject to the same imagination problem mentioned before, since one could be so much "in" one world one finds it hard to imagine what happens in other worlds. Moreover, one may start to share part of the responsibility.)

Indications of problems with imagining a complex world can also be found in other worlds. The legal system, for instance, seems to assume epistemic transparency.[3] But legal cases involving technology and corporations become so complex, that it becomes increasingly difficult to prove the accused guilty. If moral responsibility is distributed over many agents, things, and relations between these, and if this distribution is in principle not transparent, our traditional legal and moral procedures fail to the extent that they assume transparency. Of course this argument needs further support, but it is plausible that engineering is not the only practice that struggles with epistemic conditions of opacity.

To tackle the problem, we may resort to imagination, as Jonas and Anders do, but this does not completely solve the problem, since what can be imagined depends on the epistemic input we can get – which is exactly a problem when conditions of opacity apply. Thus, there is not only the psychological problem of our limited capacity to feel and imagine (a "hardware" problem, to use an ICT metaphor), but there is also an information and communication problem, which we can understand in terms of the argument developed in this chapter. Under conditions of opacity, our knowledge of the relevant worlds and narratives is always in principle incomplete. This limits the (re)sources our imagination can draw on. Nevertheless, I propose that we try to stretch our imagination as far as we can, and attempt to gather as much information as we can – for example by enhancing our connections with other people and other worlds. We usually do not reach the limits of our capacity to imagine, since we easily get stuck in our particular roles and perspective, in our particular world or even just a part of that world. For example, in this case the official accident investigation reports of the Norwegian Safety Authority (PSA) and of Statoil limited the scope of their analysis to the Snorre A operations unit. The alternative would be to imagine the complete offshore engineering world connected to Snorre A, as well as the business world and the political world relevant to the problem. The same holds for other cases. The project of epistemic opac-

[3]Consider also criminal justice cases: the legal apparatus has not been adapted to the tragic conditions I referred to. I intend discuss this issue in another publication.

ity reduction – in the service of enhanced responsibility analysis and awareness – needs many hands; it is a task that cannot be accomplished by individuals alone. Pooled intelligence relying on accumulated experience drawn from many perspectives is needed. If this is difficult under contemporary conditions, then researchers, engineers, managers, and politicians need to imagine *structural* changes, new social institutions, which bring together different worlds. Of course, we already have some means to improve the situation. For example, we may think about web-based tools and other ICT tools to bring together people and gather more information. Furthermore, we should also recognise that there are already many imaginative processes going on in existing institutions such as academia and professional bodies, although such institutions must be further adapted to that task. If, being under conditions of opacity, we stick to our old engineering, business, legal, political, and moral institutions models, our attempts to ascribe responsibility remain leaps in the dark.

15.4 Conclusions

In this article, I have drawn attention to the difficulty of analysing engineering responsibility under contemporary conditions of epistemic opacity. To better cope with these conditions, I have suggested imagination as a tool. One way to understand this appeal to imagination is to require that engineers (and those who ethically analyse engineering disasters) stretch their moral imagination and imagine a world (and worlds). I developed this thesis by interpreting Jonas, Anders, and phenomenological and social constructivist views. With regard to engineers, I conclude that imagination must be stimulated. I leave it open how this can best be done. However, I have argued that such a project cannot suffice with educating *engineers* to be more imaginative. Worlds are very much interconnected, there are specific structural links between worlds, such as those between the world of business and the world of engineering. For reform, this implies that changing one world cannot be done in isolation, but must also involve changes in other worlds. It may also require more radical structural social changes. Furthermore, we (engineers and researchers) must also recognise that there are limits to our capacity to stretch our moral imagination and moral sensitivities. But, as Jonas says, we must at least try. And finally, trying to change our cognitive and emotional capacities is only one way of better coping with a world and changing a world, only one way of making moral progress.

The potential of the approach suggested here is not exhausted by the discussion and illustrations I have offered. Both the imagination argument(s) and the proposed "imagining worlds" approach need further elaboration, and more possible gains may show up in the course of that exercise. For this purpose, I recommend that engineering ethics should not be separated from sociology, philosophy of technology, business ethics, political philosophy, and other fields of inquiry relevant to the moral-epistemic problem indicated in this article. Only transdisciplinary work can contribute to a better understanding of responsible engineering under conditions of epistemic opacity.

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