Regulation or Responsibility?

Autonomy, Moral Imagination, and Engineering

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A prima facie analysis suggests that there are essentially two, mutually exclusive, ways in which risk arising from engineering design can be managed: by imposing external constraints on engineers or by engendering their feelings of responsibility and respect their autonomy. The author discusses the advantages and disadvantages of both approaches. However, he then shows that this opposition is a false one and that there is no simple relation between regulation and autonomy. Furthermore, the author argues that the most pressing need is not more or less regulation but the further development of moral imagination. The enhancement of moral imagination can help engineers to discern the moral relevance of design problems, to create new design options, and to envisage the possible outcomes of their designs. The author suggests a dual program of developing regulatory frameworks that support engineers' autonomy and responsibility simultaneously with efforts to promote their moral imagination. He describes how some existing institutional changes have started off in this direction and proposes empirical research to take this further.

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There are at least two conflicting public expectations related to the problem of how the wider society can ensure that engineering risks are acceptable. On one hand, publics (rightly) demand action on the part of politicians and engineers to increase the safety of sociotechnological systems such as the British railway system, an important part of the demanded action being better and more regulation and control. On the other hand, there are voices that question the effectiveness and desirability of an ever-growing culture of accountability and control (e.g., O'Neill 2002).

Of course, it would be wrong to portray the engineering profession and the remainder of society as separable, and just who belongs in the "profession" category and who belongs in the "rest of society" category is a matter of context. But there seems to be little question that in the aftermath of technological disasters, there are some who identify a distinct group—typically managers and engineers, often in a particular organization—as being culpable. And it also seems to be true that professional individuals often assume that there is a "public" advocating controls on professionals but without fully understanding what they are asking for.

Let me further specify who claims what. This may simplify the positions, but it will help to disentangle both apparently conflicting expectations. Although useful as a label to stress the societal aspect of engineering technology, *the public* is too vague a term and needs further specification. The first claim for more rather than less control is typically made by victims of accidents,[1] potential victims of accidents (all users of the technology), and other people concerned with safety and in particular with the loss of and damage to human lives in accidents (also the professionally concerned of course, for example, the regulators). More control and regulation is meant to prevent (more) accidents. The second claim is made by engineers and other professionals and expresses a concern for professional autonomy. In the case of engineering, a collective activity, this concept means the independence not of the lone professional but of a group that has some degree of self-containment and self-determination. Less control and more trust are meant to increase professional autonomy and, therefore, so it is argued, the quality of the services provided by professionals, including more safe and ethical outcomes.[2]

Given these conflicting claims, it is desirable, from a theoretical point of view, to develop and consider arguments for and against external control, and its possible alternative(s).

Note that it is not my purpose to deal with this issue as a primarily empirical question. My question is not how does the wider society manage risk (by external regulation or internalized responsibility), and how do engineers act, but rather how should the wider society and engineers deal with risk? This does not mean, however, that a better understanding of how risk is managed cannot inform thinking about these normative aspects. Moreover, I make suggestions for empirical research in the conclusion of this article.

First, I discuss arguments for and against external control and stress the importance of giving engineers responsibility and autonomy. Then I redefine the problem and argue that the problem is not one of more or less control or of regulation versus responsibility but of offering engineers a regulatory framework and other devices that stimulate their autonomy and moral imagination.

External Control

Arguments for External Control

General

External control in the form of legal regulation has certain advantages, both for engineers and wider society. It provides a floor to performance: everybody has to reach a certain level. Furthermore, society at large knows what to expect; it's a way of making things predictable. It is also a way of encapsulating design experience (though not the only one). Finally, it produces a certain amount of certainty for engineers in so far as that what they need to do is meet the regulations; they do not need to think more broadly about the risks themselves and how society perceives them.

Consider recent problems with the U.K. railway system. Following a long sequence of rather serious train accidents during the past decades (Paddington[3] etc.), it has been widely accepted that public action is required to turn the tide. A call for more rather than less regulation, therefore, may meet with greater public acceptance. In this situation, it seems, external intervention is an entirely appropriate means to ensure a lower level of risk.

We should not forget that regulation is not the only external constraint on engineers. There are external pressures of many kinds that might influence engineering design. In the first place, of course, there are the wishes of the client. It seems likely that designers often do what clients tell them to do. Moreover, there are managerial requirements,[4] sometimes resulting in conflicts between engineers and managers. Conflicts may even arise across the dividing line between industry and regulator. But the fact that managers play a major part in the decision process does not mean that engineers are not responsible. In practice, the idea that managers formulate the goals and engineers find only the best solutions to meet them is not realistic (Van de Poel 2001).

Another form of external control is legislation. Of course, legislation may sometimes help to increase safety. For example, the corporate manslaughter law in the United Kingdom[5] may make companies more aware of safety issues and more inclined to increase safety to avoid having to be taken to court. So some forms of external control can sometimes result in safer outcomes.

Thus, there are different kinds of external control. Regulation is one. There are different kinds of regulation. I here consider prescription and goal setting and show that within regulation, there is a definite stratification; both prescription and goal setting have advantages and disadvantages. Moreover, any thinking about regulation in the United Kingdom has to acknowledge changes in the nature of regulation, in particular, the change from prescription to goal setting.

Prescription

Arguments for prescription. A prescriptive form of regulation requires engineers to show that they have followed relevant codes and standards. For the regulator, the advantage of such codes and standards is that (1) they embody accumulated historical knowledge and (2) they guarantee some uniformity. The general advantages are consistency and high levels of predictability of technical decisions and solutions.

There are also advantages specific to certain sectors. In the maritime industry, for example, prescription has the following advantages. Shipping is a very diverse activity, and from the point of view of the regulator, it is easier to prescribe certain standards across the board. Moreover, prescription is suitable to deal with some technical problems. It is often possible to specify requirements (in the case of fire protection, this means, for example, that one is required to put x number of sprinklers per x meters). Furthermore, from the point of view of inspection (the other side of the regulation coin, often neglected in theory), it is easier to check whether the rule is followed the more specified it is.

Arguments against prescription. The drawbacks, however, are that there is no guarantee that the future will resemble the past, that prescribed rules often fail to account for all the differences between unique situations and projects, and that prescription may lead to the goal of risk minimization being displaced by adherence to codes.

Moreover, a major disadvantage relevant to the question of autonomy is that engineers tend to see prescription as a paper-making exercise without "buying in" to the philosophy, that means, without internalizing the goal of risk reduction and safety enhancement. It is plausible that if people are told what to do, they tend to concentrate on following the specific rules and commands, rather than thinking for themselves about the aim and how to realize it.

Goal Setting

Arguments for goal setting. The general argument is that goal setting offers freedom over technical decisions and encourages designers to think about risk.

Regulatory agencies in many countries are well aware of the limitations of prescriptive regulation. The U.K. main regulator, the U.K. Health and Safety Executive (HSE), further developed its thinking about this issue as a result of learning from specific accidents, such as the lessons from the Piper Alpha disaster[6] for the offshore industry. In general, the HSE has shifted the emphasis of its regulatory regimes from prescription to goal setting. The HSE (2001, 8) document *Reducing Risks, Protecting People,* setting out HSE's policy on the regulation of risk, defined this approach to regulation as follows: "to set out the objectives to be achieved and to give considerable choice to duty holders as to the measures they should put in place to meet these objectives." In the case of the offshore industry, this boils down to the requirement for duty holders (offshore oil companies in this case) to demonstrate that risks are as low as reasonably practicable (ALARP). This means that duty holders have to prepare safety cases in which safety critical elements are identified, performance standards are laid down, and arguments are advanced to demonstrate that risks are ALARP. Although this goal-setting regime is not applied universally (there may be circumstances in which specific measures are more appropriate), it means a major change for duty holders.

Goal setting is still a form of external control but of a different kind, giving, so it seems, more autonomy to engineers. Instead of being told what to do, they are told which process to follow to justify their own decisions and actions.

Thus, goal setting tries to accommodate the disadvantage mentioned that engineers may be less inclined to think for themselves when presented with prescriptions by giving engineers more autonomy. To come back to the fire protection example, instead of being told they have to install a certain firewall at a certain point, engineers are free to choose where to put it, but they have to show that it's safe, they have to justify themselves. The idea is that as long as the outcome is better, that is, safer, they have some discretion as to how to achieve this goal. It is up to them which means they use.

A concept used in the context of maritime regulation that is related to (or rather an application of) goal setting, since it allows for more discretion on the part of the regulated, is equivalence. The idea is that engineers are allowed to substitute something as long as it is equivalent, whereby equivalent seems to refer to "serving the same purpose." This requires proof on the part of the regulated.

Note that it is possible for the regulator to combine prescription and goal setting. Applied to the example from the maritime industry, this means that engineers have the choice between following prescribed rules (say, a firewall every six meters), on one hand, and proposing different means to achieve the goal of fire safety, on the other hand. If the second option is chosen, however, the engineers have to justify the particular means proposed.

Arguments against goal setting. A major difficulty recognized by the HSE is that duty holders must have a clear understanding of what is required of them: by giving more freedom, more uncertainty arises as well. For example, in a goal-setting regime, the duty holder cannot be certain that the regulator will accept his or her arguments, whereas in a prescriptive regime, he or she could be certain. With regard to the shipping industry example, this means that, perhaps unsurprisingly, the industry has found it hard to know how to demonstrate that risk is ALARP. The criterion is imprecise and allows for various interpretations.

In general, goal setting means increased uncertainty and difficulty of interpretation. Both duty holders/operators and inspectors have to make a responsible decision about what measures are fit to achieve the goal. This requires trust, from the regulator toward the regulated, of course, but also from the regulated toward the regulator.

Freedom might be misused, or it might not be welcomed by the engineers involved. Since goal setting requires innovation by the regulated, they may be reluctant to invest time and money in it. Inspectors too may be resistant to change. In general, goal setting changes the role and the required competences of the parties involved, something that tends to meet resistance. And again, this change is a question of trust. Instead of a culture of blame and punishment, a culture of trust and responsibility is presupposed. To realize this may be very difficult, especially if people may not want responsibility.

It seems to me that although goal-setting regimes value the engineer's freedom and professionalism more than prescriptive regimes, they fail to recognize the moral importance of the individual's own intentions and capacity to make autonomous decisions. Let me consider this point in relation to arguments against external control.

Arguments against External Control and Problems

Individual engineers with a sense of responsibility may see and signal certain problems, but often external political, economic, or bureaucratic structures inhibit rather than facilitate remediating action. Moreover, such structures may prevent feelings of responsibility from arising in the first place. If engineers are told what to do, if they are not given responsibility, the chance is small that they will assume it.

The danger with external control is that it tends to project to all members of society the image of engineers who do not possess the ability for autonomous and responsible action. Giving autonomy to engineers is therefore a structural consolidation of trust in their abilities to make responsible decisions.

It seems highly likely that many professionals want less external control, and this is recognized by academics, who are of course also professionals themselves and often experience forms of auditing and regulation as burdening and inhibiting their core activity (research and teaching). In the BBC Reith Lectures of 2002,[7] philosopher Onora O'Neill argued that what she calls "the accountability revolution" has eroded trust in the professions, and she related this to the term *risk society* (Beck 1986) popular with some sociologists. According to her, there is no such thing as a risk society if this is meant to express that we are exposed to more risk today than before. Rather, our perceptions of and attitudes to risk have changed. Applied to technological risk, this could mean that people trust less in technology and the professions designing and producing technology. But even this is questionable. First, in terms of behavior, we see that people do (still) use technology. Do we have evidence that points univocally in the direction of a general and increasing mistrust? Second, as O'Neill rightly remarked, "hankering for a world in which safety and compliance are total" is simply "unrealistic" (lecture 1). Rather, O'Neill suggested that "perhaps the culture of accountability that we are relentlessly building for ourselves actually damages trust rather than supporting it" (lecture 1). In her third lecture, this idea is elaborated. She related that as a response to, for example, the bovine spongiform encephalopathy crisis or the many problems with the British railway system, a regime of regulation, inspection, target setting, and audit "has penetrated the entire public sector and parts of the private sector too" (lecture 3). However, many people find that these forms of accountability undermine professional independence. O'Neill argued that these instruments for control, regulation, and monitoring have not produced the required trust. The only result is a culture of suspicion. Rather than fantasies about total control, she says, we need the provision of "substantive and knowledgeable independent judgement" for individuals and a "margin for self-governance" for institutions (lecture 3).

Various criticisms may be offered as an answer to O'Neill's thesis. For example, even if we agree with the way she states the problem, it is not clear from her lectures which answer she has. To say that individuals and institutions need a margin for autonomy and self-governance, for example, is rather vague. If we agree with part of what she says, we will need to spell out a more specific, less vague solution. From the reactions to her lecture, on the other hand, it is clear that her diagnosis of the situation rings a bell with many professionals. For example, if you have one system to control people, you may need another system to look after the controlling system. The result is an infinite regress of control mechanisms. Furthermore, many people feel that there is a limit to what politics and bureaucracy can and should do. In general, it is perceived that accountability is not by itself a problem; rather, the question is what kind of accountability we want.

What does this discussion mean for engineers? In the first place, it bears out very well the problem of external control versus responsibility. I do not think that there is necessarily an opposition between the two, but if certain forms of external control reduce feelings of responsibility, other ways need to be found to meet the demands that lie at the heart of the public expectations concerning safety. If not too unrealistic (not asking for absolute safety, for example), expectations of increased safety are justified in themselves; the question is how to meet them without imposing a regime of regulation and inspection that (unwontedly) reduces feelings of responsibility engineers as professionals have. This does not mean that there cannot be any form of institutionalized support and even regulation, but the challenge is to think about ways of doing that without taking away the responsibility and autonomy of engineers, or, preferably, by increasing the responsibility and autonomy of engineers. Rather than the establishment of a potentially endless hierarchy of control (the controller is controlled by a controller, etc.), we need to think about tools to support engineers.

Finally, a significant drawback of legal regulation is that it assumes responsibility to be exclusive. But given the many actors related to the design of technology, is such a model of responsibility adequate? I suggest that engineers share responsibility in society's dealings with technology.

Responsibility can be construed as both shared and individual. Shared, since responsibility for technology cannot be assigned to engineers only; whatever the responsibility of various social actors may be, part of that responsibility is at least to support engineers in making decisions. If there are certain ethical expectations toward engineers, they need to be shaped in a format that actually helps engineers, and the institutional conditions need to be created to enhance ethical decision making, for example, through education. So institutions and social actors such as politics and media should not take away the engineers' responsibility by (encouraging) overregulation but rather stimulate it. The engineers remain responsible, both as design teams and as individuals.

This idea that shared responsibility does not mean less responsibility may be difficult to accept but appears to me as the only workable notion. Furthermore, the need for and the problems with a notion of shared responsibility have since long been recognized in the literature (see, e.g., Lenk and Ropohl 1993). As part of the German discussion on the ethics of technology, for example, Hans Lenk has used the term *Mitverantwortung* and stressed that, although recognizing problems with distribution of responsibility, still every single individual is to be held responsible (Lenk 1993, 123-25). And Walther Zimmerli too has expressed the view that the subject of responsibility remains the single individual, even though engineering design is not an individual activity. Similar to the notion of internalized responsibility argued for in this article, Zimmerli (1993, 108) defined responsibility as consciousness of mutual dependency, meaning that persons are responsible for everything and everybody they related to in action. This flags the question as to where the limits of the scope of responsibility lie, but in any case, his claim that it is the task of the individual to transform the objective relation of liability into a subjective relation of felt responsibility (Zimmerli 1993, 108) strikes chords with the desired shift of attention considered earlier in this article: away from regulation, control, and liability as legal and imposed responsibility and toward responsibility as a feeling within the individual as an autonomous professional. Different from most forms of legal responsibility, moral responsibility is nonexclusive (see also Ladd 1991) and at the same time individual. In other words, the fact that you share responsibility does not mean that you are less responsible. This view does not mean that institutional support and the wider social, political, economical, legal, and ideological context should be neglected but is meant as a plea to encourage personal responsibility of professionals, within their social context, as one of the tasks of society in general and of institutions in particular.

Internalized Responsibility and Autonomy

Arguments for Autonomy

Giving people autonomy affirms their better qualities, whereas external regulation appears to assume that people will not do the right thing until they are told what to do.

Autonomy is not necessarily less constraining than external control is. On the contrary, to self-impose a moral principle may be much more constraining. It certainly does not mean absolute freedom. Indeed, professional autonomy is often understood as meaning that professionals do what they want. This may falsely suggest that engineers should be given absolute freedom and be able to do "what they feel like." Instead, professional autonomy for engineers may rather refer to the capacity and condition of being able to make their own decisions on the basis of principles with which they identify. This is different from complete freedom since they are constrained by (ethical) principles. Furthermore, this form of autonomy is compatible with a framework that supports decision making by providing principles and ways of thinking about them. Arguably, it is even compatible with some form of monitoring because if engineers act on principles that they can call their own, they are also able to justify themselves toward others, such as managers, stakeholders, media, and so forth. But what this understanding of professional autonomy is not compatible with is a strict all-encompassing system of audit and regulation that tells engineers what to do and therefore encourages them to waive any responsibility for their actions. If they are told what to do by the controller, then why should they feel and be responsible? They can feel and be responsible only if they make certain principles and criteria truly their own, if they genuinely identify with them. Then ethics is not something that is alien to the professional but part of what it is to be this professional, part of what it is to be an engineer, for example. Furthermore, since people tend to value autonomy as a good in itself, they will feel recognized in one of their most basic needs as humans.

If autonomy is chosen or preferred, then professionals need to be encouraged to act in a responsible way. Note that this is possible only if they are first given that responsibility and autonomy. This can be done, for example, by introducing ethics and social sciences as part of the professional education. This facilitates the feeling that responsible decision making in a social context is not something alien to what they are doing but is an integral part of what it is to be, for example, an engineer. Furthermore, the professional organizations have the task of encouraging responsibility by providing the professional with the necessary institutional support.[8] Finally, since institutions are generally more inclined to see things from a macro point of view, that is, from the profession as a whole, they are better suited to provide the right information that may help professionals make the right decisions. For example, they can make the engineer aware of the outcomes of certain designs.

Arguments against Autonomy and Its Problems

Giving engineers autonomy plainly means they will not always meet people's expectations, and their actions could undermine people's trust in them. For example, airbags in cars require people to sit at a minimum distance from them, as injury can result otherwise. Very short people often have to sit closer than this minimal distance. The technology, therefore, in effect discriminates against short people, and some people find it morally objectionable that a protective technology should be discriminatory in this way. The designer, however, might have reasoned in a utilitarian, consequentialist way[9]: if the overall consequence of the airbags is that it increases road safety, it is well designed, even if it discriminates against short people.

This case highlights the general point that trust is fragile and sometimes difficult to maintain in the face of specific problems. We might expect engineers to be guided by ethical constraints, but this expectation is not necessarily met. Therefore, a case such as this may call for some form of external control if design practice does not change. However, it does not follow that the case for trusting engineers and giving them (more) autonomy is fundamentally problematic because of the possibility of expectations not being met. In the long run, of course, if unanswered expectations continue, trust may disappear. Is there a reason why the features of the relation between public and engineers ought to be fundamentally different from those of personal relationships? Trust need not be blind. However, since the relationship between public and engineers is mediated by products, it is an anonymous rather than a personal relationship. This does render the issue of trust in relation to engineers problematic. Whereas health care professionals, for example, have a direct and personal relationship with their patients, engineers do not generally have to face the people who benefit or suffer from their design. The people an engineer might deal with are managers or at most people representing "the client," who generally do not personally experience the benefits or harms arising from the design. Even if legal action is taken, (1) it may not be action against individual engineers, and (2) even then, they may be confronted with a lawyer rather than with the victim.

Redefining the Problem

Is This a Problem of More or Less Control? What Is Autonomy?

It appears from the previous sections that the problem is how to choose between external control and autonomy. But was the above discussion an adequate presentation of the problem? It was worth considering the various advantages and disadvantages; they help to enhance our understanding of issues related to external control, on one hand, and the call for more professional autonomy, on the other hand. However, more work needs to be done. In particular, we need to consider that

1. the issue of external constraint is more complex,
2. the issue of autonomy is more complex, and
3. the relationship between these two is more complex.

On this basis, I revise my argument. First, I enrich the view of regulation that has emerged from my discussion so far and consider other forms of external constraint. Second, I discuss autonomy and its relation to external constraints.

Regulation is more complex in at least the following ways.

1. So far, I have written about regulation as if it were something given. In fact, regulation in that sense is only the outcome, the last stage of a process. To the extent that this process involves communication and public debate, regulation can serve to reflect communication of public expectations to the engineer and a rational public discourse[10] about risk and engineering ethics.
2. Regulation as a process does not end with having a body of written rules. The implementation of regulation is at least as important. Implementation requires engineers to span what Asa Kasher (2002) called an "ethics-society interface." Such an interface is meant to resolve the tension between, on one hand, a professional community lacking the expertise needed for an accurate social and ethical interpretation and assessment of technology and, on the other hand, people outside the profession lacking the professional knowledge for setting particular standards and imposing particular regulation. Adequate implementation of regulation requires engineers who resolve this tension within themselves. Endorsing the social and ethical dimension of their design, engineers confirm regulation as the legitimate interface between them and their society and therefore implement it wholeheartedly. Regulation is also a conduit to inject wider societal expectations into the practice of the profession.

Table 1
Example of a Framework for Thinking about Moral Development

Level	Name	Stage
1	Preprofessional	Actions motivated by gain for oneself
		Same, but aware that my actions will affect others
2	Professional	Actions motivated by loyalty to the firm
		Same, but also loyalty to the profession
3	Principled professional	Service to the rules of society
		Following rules of universal justice and fairness

3. Are some engineers more morally mature than others are? Regulation is needed as a precautionary measure if there is anything like a concept of moral development. If there are different levels of moral maturity, the risk of having no regulation is not a risk a society finds acceptable. McCuen (1979) has proposed the following stratification of professional engineering morality (Vesilind and Gunn 1998). It is based on Kohlberg (1984) and Piaget (1965). There are alternative ways of defining the various stages, and the highest stage in particular. Kohlberg's model, has been heavily criticized.[11] I present it here merely as an example of a framework for thinking about moral development (see Table 1). Empirically, we do not know how many engineers operate at what level. But if we cannot be sure, it seems reasonable to me that society chooses to regulate rather than rely on the assumption that all engineers are morally mature in the highest degree.

The issue of external constraint is also more complex since legal regulation is not the only form of external constraint engineers experience. Legal regulation is a visible form of external constraint, but there are other forms too that may be thought of as constraining the engineer's autonomy. Engineers are not atomistic individuals, isolated agents working in a social vacuum. Rather, they are part of the following:

- a peer group that may exert pressure on them, but this does not necessarily prevent them from being ethical; it may encourage responsible behavior.
- an organization. This includes managerial pressure but also an organizational culture. Again, this does not necessarily impede ethical action. There are different cultures of dealing with risk (Westrum 1991). Some organizations encourage individuals to act when they see that something needs correcting (Westrum 1991, 408) or actively encourage them to inquire into potential problems, using their imagination. Westrum called these "cultures of openness." On the basis of various case studies, he concluded

that "the cultivation of imaginative inquiry into potential problems often avoids the occurrence of these problems in real life. Organisations with a culture of openness work effectively to verify and validate systems under development because they empower their people. Members of the organisation are given a licence to think, and use it to probe into things that might go wrong" (p. 414). This is an important part of what I will discuss below under the name of "moral imagination."

- a commercial system. Engineers design for clients and are highly constrained by what their clients tell them to do.
- a profession. Professional organizations can also constrain engineers, but this also means they can constrain them in a way that encourages them to think about ethics.
- a wider society with certain values, a certain culture, a (governmental) policy, political decision making, ideology, a socioeconomic system, and so forth. For example, individual autonomy itself (as life, freedom, etc.) is valued in our society. This also constrains engineers in that they need to take these values into account when designing.

The issue of autonomy is also more complex. Given the constraints just considered, it could be argued that these factors are effectively impeding the engineer's autonomy. On this view, external constraint and autonomy are incompatible. However, this would be to assume that autonomy means doing what you want. If this is taken to be the definition of autonomy, then certainly engineers are not autonomous. As part of a peer group and an organization, a profession, and a society, they are often directly or indirectly heavily constrained. But is this the right definition of autonomy, or even of freedom? Autonomy is not absolute freedom. Rather, persons need constraints to be able to exercise autonomy. Innovative and creative engineering requires demanding constraints, and regulation can provide these. Rather than being "in the way," regulation can help engineers in a variety of ways. For example, legal requirements may help engineers to resist managerial pressure and in this way support ethical behavior. If the engineer's claims for safety have to survive in a context dominated by competition for money and power, regulation with an ethical content may be the engineer's ethical life jacket.

Without external structure, freedom of choice cannot be exercised.[12] For example, if a regulator would tell engineers to prepare a safety case, without specifying what the engineers have to show, the engineers cannot use their judgment with regard to how to make sure their design is safe. Furthermore, without structure, the engineers' creativity and imagination cannot find a grip. If engineers are told to design a safe car, without being given any constraints, the task becomes completely undemanding. Only when constraints are introduced are skill and judgment required.

Engineers are faced with two types of constraints. There are practical or technical constraints, such as the maximum costs of a design. But there are also moral constraints, for example, the requirement to not harm people (unnecessarily). Autonomy is exercised within this context. On one hand, without any of these constraints, it would be impossible to design and to make a moral judgment in relation to design. On the other hand, being overconstrained would eliminate the possibility of choice. The practice of autonomy is situated somewhere in between these extremes. This allows scope for engineers to make a professional judgment about what the best design is given the technical and moral constraints they face.

To conclude, professional autonomy is not the absence of external constraint but rather needs a certain context in which professional judgment can be exercised. Therefore, rather than seeing autonomy as absolute freedom, I believe it is a more realistic approach to view autonomy and dependence as (potentially) compatible. If external control and autonomy are seen as opposites, we overlook the possibility that contextual factors may enhance professional autonomy rather than impede it. This means that in the previous discussion of external control versus autonomy, the problem was not correctly defined.

If we view professional autonomy as the capacity to make a professional judgment in a certain context, the engineer's autonomy can be married with dependence in the following ways.

1. Regulation may enable engineers to justify their actions toward society and empower them to stand up against managerial pressure. However, there is still a problem when the regulation is considered by engineers to be unethical. When are they justified to not act according to the rule? And when are they justified not to follow the decision of the manager?
2. Engineers can take the values of the society in which they live into account. But when two values conflict, how do they decide between them? Furthermore, as I mentioned already, certain organizations may be better to deal with risk and motivate engineers to consider various options and their ethical consequences. But how to assess whether an outcome is ethical?
3. Since the engineers' clients are equally autonomous in the sense of having the capacity to judge whether their wishes are ethical, engineers have to respect their client's wishes. However, it may be that engineers judge the wish to be unethical. On what grounds can they (and their clients, for that matter) make this judgment?

The questions that emerge when we try to relate autonomy to dependence

If autonomy involves making a judgment, then, insofar as this judgment has ethical aspects, we need an account of what is ethically right. Such an account should enable engineers (1) to decide whether there is an ethical aspect involved in their decisions at all; (2) to make their judgment, that is, to decide whether their design is inadequate on ethical grounds and needs changing or abandonment; and (3) to decide what alternative design or what changes are appropriate and justified ethically.

A common approach to these questions is that of presenting the engineer with a code of ethics, a list of moral principles, or the most relevant moral theories to draw on in making his or her decision. However, I wonder whether this will do. Even if engineers can be made interested in such codes, principles, and theories, it is still quite another matter whether this enables them to apply those principles and theories in a given situation. First, to say that we need to simply "apply" principles is misleading: real problems are often too complex. Second, to deal adequately with a moral problem (a dilemma, for example, but it need not be in that form), engineers have to be able to recognize it as an ethical problem in the first place. Therefore, I point to the need of moral imagination. What do I mean by this term? The argument is that if morality is not just about following and applying principles in a certain situation, moral reasoning involves more than knowing some principles. Johnson (1993) argued that moral reasoning is basically an imaginative activity. It requires imagination

- to discern what is morally relevant in situations,
- to understand empathetically how others (patients) experience things, and
- to envision the full range of possibilities open to us in a particular case.

Morality is often not a question of choice as such—it is often not a multiple-choice problem of ticking off boxes[13]—but, rather, requires the creation of an option or route of action that can properly be regarded as a option at all, which can be chosen. Imagination is needed, then, to create such a morally acceptable option.

For engineers, this could mean that in certain circumstances, it may be appropriate to use their imagination to create other design options rather than consider existing ones and choosing between them. Furthermore, if it happens that the possible consequences of the engineer's action are not immediately given, moral reasoning seems to require engineers to try to imagine all potential harms to people and the environment and therefore all possible outcomes.

The concept of moral imagination chimes with Davis's (1989) critique of what he called the engineer's "microscopic" vision. Davis argued that wrongdoers are not necessarily weak willed or evil willed but rather have a too narrow field of vision. Although every profession and skill involves microscopic vision, in certain circumstances this may result in disaster. Engineers may be members of a design team, a corporation, and a profession, but they may still be blind to the concerns of the wider society of which they are part. Moral imagination is required to widen their perspective.

Furthermore, moral imagination can be seen as a quality of the morally mature person. It could be argued that being morally mature includes being able to imagine how your actions influence others, being able to empathically understand others, and being able to envisage alternative courses of action if necessary.

Perhaps the most compelling argument for supporting the development of moral imagination is that it provides us with a solution to what we could call the problem of the subjective character of risk bearers' experience. The philosophical problem of whether we can get access to the subjective experience of others (Nagel 1974; Atkins 2000) is relevant to the engineer faced with ethical decisions. How can the engineer know how the victim experiences the consequences of a (possible) engineering failure? Is there not always something of the victim's experiences that resists communication? Although these questions point to real difficulties, it seems to me that as humans, we not only have, in principle, the capacity to communicate (to a large extent) what we experience, but we also use this capacity. Whether or not mediated by the mass media, victims do communicate what they feel. Now if engineers want to use these opportunities to improve the ethical dimension of their design, they need moral imagination (1) to empathetically understand the victim's experience and (2) to make an ethical decision based on their understanding and other information available to them.

Moral imagination is not trivial. For example, our lives tend to be compartmentalized. We have different roles (user, designer, parent, friend, etc.), and often we are not able to transcend our role. Engineers may be constrained by the microscopic vision of a certain role and not be able to imagine what it is to be in a different position. Furthermore, it may be that moral imagination is not enough to act ethically and autonomously. For example, in following a process of moral reasoning, we need concepts. And acting ethically and autonomously may require engineers to act against their (immediate) personal interests and/or those of others, demanding much moral strength. But if the above arguments for moral imagination are right, the cultivation of moral imagination enhances the engineer's professional autonomy, and supporting it should accompany regulation.

Communication and the Self-Image of Engineers

Part of the problem engineers in particular may have with feeling and being aware of ethical expectations is that ethics and social considerations are perhaps not naturally part of their self-image as a professional. By saying this, I do not mean that engineers generally are not virtuous persons, but rather (1) that thinking about the ethical and social dimension of their work is not generally encouraged both during their education and during their professional career and (2) that the way they see themselves is generally less expressed in terms of their relationship with people than with (material) artifacts (see also Hubig 1993). If this is true, then both internalized responsibility and external control are problematic in the following way. If engineers cannot articulate or even recognize the ethical dimension of their design activities, they cannot reason about ethics and communicate these reasons to society. In turn, this influences society's image of engineers, confirming again the engineer's self-image. And it seems that external control alone is not going to enhance the ethical and social sensitivities of engineers. Rather, it could be argued that through bureaucratical control and regulation, the view engineers get of social reality and of themselves will tend to be instrumental and alienated: society as an instrument of control and the individual as an object of this control. This does not give engineers the feeling that they are, as professionals, autonomous and independent individuals with considerable responsibilities for others. It also prevents willingness to share information, expertise, and arguments with stakeholders in more productive ways than organized by the regulation and accountability system.[14] Communication works well only if both parties have a genuine interest in it, and this is impossible if engineers (rightly) feel alienated from the wider society that presents its expectations in the form of an impersonal system of control rather than other forms proposed in this article and elsewhere. Therefore, that wider society cannot rely on external control alone to communicate its moral expectations; moral education and development need to accompany it to convey the message that society views, respects, and trusts engineers as autonomous and responsible individuals.

To summarize, if we want to enhance a feeling of responsibility, we can

1. not constrain engineers but inform them about what the public expects and give them the necessary autonomy to make decisions for themselves. If engineers are faced with a social/ethical claim, they can always produce counterarguments and argue why they think it necessary not to meet

the expectations in this or that particular context. So there is two-way communication, and neither of the parties can get their view accepted without a good justification.

2. constrain engineers but in a way that effectively communicates society's ethical concerns and supports the engineer's ethical concerns, while at the same time leaving room for debate about the constraints. If the space for dialogue is closed or even nonexistent, external control excludes autonomy, since autonomy has to do with the engineers' capacity to exercise their capacity for independent reasonable judgment. If society decides to constrain engineers by external control, it also at the same time needs to recognize this capacity for independent judgment and further dialogue.

Given this conclusion, the task of institutions is the encouragement of responsibility through the right kind of regulation. My answer to the question of whether external control is empowering or limiting is that this depends on the kind of regulation and on the circumstances. If institutions create the right kind of regulation that supports the engineer's autonomy to stand up against managerial pressure, for example, then in certain circumstances, institutional constraints are enabling rather than (merely) constraining. They can be also enabling if they provide a structure that fills gaps in the engineer's knowledge and, by limiting choice, encourage creative design. As I have argued in the previous section, creativity is particularly required when the design problem is very constrained. And if institutions, by enforcing regulation, create a framework that helps engineers to define their responsibility, then this is a way institutions can contribute to their autonomy.

Conclusion

External control imposed by regulators on engineers has its advantages and disadvantages. But it is wrong to see external control and autonomy as incompatible. Often, external control does indeed impede autonomy, but if we obtain a better understanding of the concept of autonomy, it can be shown that not all forms of external control are a threat to engineers' professional autonomy. I have discussed some ways external control can even support and enable the engineer's autonomous judgment, and I suggested moral development and moral imagination as (other) tools that can facilitate such a judgment and the recognition of the moral dimensions of that judgment.

My discussion shows that there is a range of instruments and concepts available to a society to deal with engineers and their profession in a way that encourages and supports engineers to recognize the moral dimension of their work and that helps them to deal with ethical questions. Regulation should embody respect for engineers as autonomous agents and stimulate responsibility, thereby facilitating their duty to go beyond a narrow understanding of what is professionally required. But there is no reason why engineering should be seen in that way. Engineers generally see themselves as having a social task. If the engineering profession is understood as the improvement of people's lives and environment through the imaginative design and application of technology, ethics and ethical reasoning is an integral part of what it is to be an engineer.

In the light of such an understanding of the engineering profession, feelings of responsibility cannot be separated from the professional practice of engineering. Furthermore, given the collective nature of this practice, responsibility should not be understood as belonging to individuals alone. In some places above, I may have wrongly given that impression. We have perhaps oversimplified with a model of engineers who first acquire technical skills and then have to learn taking responsibility. In fact, of course, responsibility is acquired in general processes of socialization and then subsequently in early work experience among other professional engineers (in processes Lave and Wenger [1991] refer to as "legitimate peripheral participation") and to some degree in their professional bodies' codified schemes of personal development.

The adequate exercise of this learned responsibility, however, is possible only if the professional autonomy of engineers is respected. Furthermore, the socialization and personal development processes referred to above need to be changed, and supplemented, with training that stimulates moral imagination. Imagination can help engineers to discern the moral relevance of design problems, to create new design options, and to envisage the possible outcomes of their designs. The latter includes using their imagination to understand (potential) victims of engineering failure. My conclusion is that the capacity for taking responsibility is further enhanced by a dual program of, first, designing regulations that support autonomy and, second, designing schemes that equip engineers with moral imagination. Moreover, this proposal sees social and institutional settings as being central to this improvement.

What would such a dual program look like? In some respects, it would resemble what is happening at the moment: regulation is increasingly becoming goal setting rather than prescriptive, thus allowing engineers and managers on specific occasions to be innovative in the way in which they meet demands for safety. This requires education in the management of risk. For example, the U.K. principal safety regulator has a program of understanding and communicating societal risk perception. There is also an interesting report on lessons learned from risk governance that focuses on differences in risk perception between the public and experts (Dubreuil et al. 2002). Note that lessons can be learned from disasters as well as from cases that ended well (Pritchard 1998). More broadly than regulatory developments, ethics has been a concern for professional bodies for a long time, and there is an extensive literature on the extent and nature of this concern (see, e.g., articles in *Science and Engineering Ethics*).

I think ultimately, however, that these changes are not sufficient. Further efforts need to go toward finding not the right regulation but the right kind of regulation that stimulates moral imagination. And programs should be developed that target the development and stimulation of moral imagination explicitly. To say more on the content of such programs is not within the scope of this article. On the basis of my discussion, I advocate that there should be such programs, but clearly more research is needed. In particular, I suggest empirical research to determine how moral imagination is stimulated or destimulated in the apprenticing and practice of engineering professionals. The ideas put forward in this article can help define the precise aims of such a project.

Notes

1. In the aftermath of specific events, such as an accident, claims for more external control are made by victims of the accident or people related to them. This raises a methodological issue for the study of engineering ethics. On one hand, it seems a good idea to look at engineering ethics from the victim's point of view. On the other hand, it could be argued that a more neutral or objective standpoint is preferable. The problem with the latter argument, however, is (1) that it is not clear what such neutrality or objectivity is supposed to mean and (2) that on an empirical level, we usually get evidence only in relation to engineering ethics questions from victims. Someone who has not been affected in any way by incidents/accidents related to technology will not necessarily have much to say on the topic.

2. What a safe and ethically acceptable outcome is, is of course a huge ethical and practical question. In the field of (regulation of) engineering, for example, there is a discussion about the precise meaning of the as low as reasonably practicable (ALARP) criterion. For more information on ALARP, see, for example, the Health and Safety Executive document *Principles and Guidelines to Assist HSE in Its Judgements That Duty-Holders Have Reduced Risk as Low as Reasonably Practicable* (www.hse.gov.uk/dst/alarp1.htm).

3. This is a well-known U.K. railway disaster. Note that the Paddington case has recently been reopened: an engineer knew that the signal in question was unsafe and told the people in charge, but they did not do something about it. This shows that external control sometimes

works entirely counterproductive, in this case by producing more unsafety by ignoring the warnings of an engineer acting responsibly. It calls for giving engineers more autonomy and responsibility, as well as a culture of listening rather than command.

4. There is a view of engineering that sees engineers as being "captive" to corporate value judgments (Goldman 1991).

5. Note that questions concerning corporate manslaughter differ from questions of liability and negligence in that the former deals with a criminal offence, causing the death of people.

6. In July 1988, fire and explosions on the Piper Alpha drilling platform (120 miles off the northeast coast of Scotland) killed 167 people. In November 1990, Lord Cullen's report on the disaster severely criticized safety procedures. As a result, the safety regime was changed.

7. Transcripts of these lectures can be found on the BBC Web site (www.bbc.co.uk/radio4/). They are also published as a book (O'Neill 2002).

8. I have been thinking of a variety of tools that institutions can use to support engineers. Existing ones include a professional code of ethics, providing the engineer with a list of professional duties, and guidelines by regulating bodies. But I could imagine other tools as well, such as an ethics help line or a first aid kit for ethical design. I intend to further develop these ideas.

9. Perhaps most engineers use utilitarian and consequentialist reasoning, as Loui (1998) argued. But this does not mean that focusing on such consequentialist theories is the only way to approach engineering ethics. For example, Robinson and Dixon (1997) proposed focusing on the virtues engineers need to fulfill their responsibilities. My proposal to look at moral imagination later in this article can be understood as a similar approach: the focus is not so much on the kind of moral reasoning engineers use as such but more on the kind of capacities engineers need to exercise their moral responsibility.

10. I think about applying Habermas's (1981) theory of communicative action to the societal risk decision-making process. However, such a project is not within the scope of this article.

11. For a well-known feminist critique of the Kohlberg model, see, for example, Gilligan (1982).

12. The criticism of autonomy as absolute freedom of choice in this section is informed by my research on the relationship between freedom and dependence (Coeckelbergh 2002) and the relationship between autonomy and constraint (Coeckelbergh 2004).

12. See also Caroline Whitbeck's (2002) article at the conference "Research in Ethics and Engineering."

13. For example, the legal system tends to understand responsibility (and therefore blame and punishment) generally as exclusive rather than shared. There may be good reasons why this is so, but it can hardly be a desirable principle for the regulation of technology as a whole.

14. For example, the legal system tends to understand responsibility (and therefore blame and punishment) generally as exclusive rather than shared. There may be good reasons why this is so, but it can hardly be a desirable principle for the regulation of technology as a whole.

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