Engineering Ethics

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1. The birth of a discipline

Engineering ethics is an academic research field which can be first traced back to the United States at the end of the 1970s. In this specific context, this discipline has taken its roots in a former ethical reflection developed by professional organizations. Following the model of the British *Institute of Civil Engineers*, the American associations drafted numerous "codes of ethics" at the beginning of the XXth century (AICE in 1911, AiChE and AIEE in 1912, ASME and ASCE in 1914). They also attempted, unsuccessfully, to reach an agreement on a common text. In the middle of the 1970s, most of them converged on the code put forward by the Engineers' Council for Professional Development, (now the Accreditation Board for Engineering and Technology, ABET).

The end of the 1970s marked a turning point for engineering ethics, thanks to the financial support of the National Science Foundation (NSF), which allowed the creation of teams made up of philosophers and engineers. These teams achieved the first specialized conférences (CSEP of the Illinois Institute of Technology in 1982: Weil 1983) published manuals (Baum and Flores 1978, Schaub and Pavlovic 1983, Martin and Schinzinger 1983-1995, Harris et al. 1995, Whitbeck 1998) and essays (Unger 1994 2nd ed., Davis 1998). They put on line many codes of ethics (CSEP) as well as case studies for pedagogical use (Murdough Center of Texas A&M University 1992, CSES Western Michigan University 1995). The NSF also contributed to the creation of a Website which has become a reference in the domain (onlineethics.org).

This discipline also developed outside the United States. In Canada, where professional ethics has the force of law, several works were published with the support of the professional associations: the Engineers' Order of Quebec (Racine et al. 1991) and the provincial Association of Ontario (Andrews and Kemper 1999). In France, (and in Europe more generally) the publications are more recent than in North America: *Ethique industrielle* (Didier et al. 1998) is a collection of classic and original texts and case studies selected by a fellowship of teachers and engineers. It prolongs the reflection conducted in the form of an essay by an engineer and philosopher who had discovered the field of engineering ethics in the USA (Hériard Dubreuil 1997). Books are also published in other European such as Spain and the Netherland.

Several projects supported by the European Commission (SOCRATES program) have led to the organization of conferences (European Ethics Network since 1996), the publication of works (Goujon and Hériard Dubreuil 2001). One of the chapters of *Philosophy in Engineering* (Christensen and al. 2007), also an outcome of a SOCRATES program, explicitly concerns engineering ethics.

With regard to research, the presence of active teams, particularly in the Netherlands at the 3TU Ethics and Technology Center (www.ethicsandtechnology.eu) can be noted. In France, the major work of the CETS researchers of the "Institut Catholique d'Arts et Métiers"

(www.cets.groupe-icam.fr) bears upon technical democracy. Those of the ethics department of the Université Catholique de Lille (www.univ-catholille.fr) also take an interest in the articulation between engineers' ethics, sustainable development and corporate social responsibility. In Japan, one can find evidence of the emergence of the discipline in view of the participation of Jun Fudano and others scholars in international conference such as the one organized in 1999 in Cleveland by Caroline Whitbeck, and more recently the WPE, (Workshop on philosophy and engineering) organized by the Delft Technology University, Netherlands. The works of Martin and Schinzinger, Harris et al. and also Whitbeck were translated in Japan. Several works were also published by Japanese authors (Saito and Sakashita 2001, Ohnuki et al. 2002, Nakamura 2003).

Concerning publications, we can quote the presence of articles on engineering ethics in professional journals of engineers (*IEEE Technology and Society magazine*) or related to engineers' training (ASEE's *Journal of Engineering Education*, SEFI's *European Journal of Engineering Education*, The journal of the *Japanese Society of Engineering Education*), in journals on general ethics (*Journal of Business Ethics*, EEN's *Ethical Perspective*). Since 1995, many articles have been published in *Science and enginering ethics*.

If the existence of a more and more visible active scientific community can be pointed out, engineering ethics as an academic discipline remains underestimated, criticized or even disputed. Technologies can raise moral problems to the society (this is not much questioned), without posing any to the engineers who contribute to their development.

2. Status and stakes of engineering ethics?

2.1 Professional, applied ethics or something else

In the United States, *engineering ethics* is often classified among "professional ethics". The great majority of North American *engineering ethics* manuals explain why students should rank engineers among the "professionals". In fact, this insistence on re-demonstration shows the difficulty to define the status of engineers. In order to understand this discussion, it is necessary to place it in its legal context: the Taft-Hartley law (1947). This law distinguishes, in the United States, the attributes and the prerogatives of the "professions" by opposing them to mere "occupations". Nevertheless the existence of ethical stakes bound to the practice of the engineering profession has perhaps no link with the fact that engineering is or is not a *"profession*". It was already the opinion of Karl Pavlovic (1983) who considered it a "parasitic" question.

In Canada (at least in some region), Spain, Portugal and Italy were engineers need to be registered there is no doubt that engineers are "true professionals". In France and Germany, the question does not arise because it is not relevant: there is neither a legal status, nor a specific social recognition, for the so-called "professionals". The stake of engineers' deontology differs according to the cultural and legal contexts: in Québec the code of ethics as a legal status, but not in the USA, the Netherlands or France; there is no code of ethics in Spain and Italy. Ethical stakes, on the other hand, are very often similar.

To classify *engineering ethics* among the "applied ethics" has other drawbacks (which are not specific to this field). This option implies that it would be possible to define beforehand "the" moral theory or the code article which is advisable to use. It also supposes that the work of ethics consists in solving problems. This is the position of certain authors: according to Harris et al. (1995) it is a question of applying codes; according to Martin and Schinzinger (1983), it is a matter of applying moral theories. As for Mitcham (1997), he considers that the role of *engineering ethics* is neither to promote respect for a professional ethics and behavioral righteousness, nor to apply theories. It is a reflective work concerning a specific context of

“human actions”: engineering. The focal point of *engineering ethics* is neither a status (a "profession"), nor a knowledge ("techno/logy", “engineering sciences"), but a "practice", a form of action.

2.2 What are the specific traits of this practice?

Engineering presents the characteristic of being both scientific *and* economic: the test of the engineers’ work does not take place in the laboratory, but on the market (Layton 1986). It is also a combination between the work and the capital (Downey and Lucena 1995). It is finally a "situated practice", both technical and non-technical, which contributes to building up a "conceptual and political network". (Bijker and Law 1992). Engineering must be understood as a hybrid (social and technical) form of action developing in a complex context (and not merely complicated) where political, social and economic stakes are intermingled.

Although having something to do with the sciences, the engineer’s work is not that of the scientific researcher: engineering is a "social experimentation" (Martin and Schinzinger 1983). The product of engineering is not knowledge, but an object which transforms the world: “when science takes the world into its laboratory, engineering takes the world for a laboratory (Mitcham 1997, 138). Engineering generates all kinds of risks: social, sanitary, political, environmental, economical. It is characterized by potential power and its uncertain impacts on its natural and human environment, today as well as in the future.

Finally, engineering is not a simple resolution of problems: it is an art which requires imagination and creativity (Davis 1998). The activity of industrial design is considered by most researchers as the central and most specific engineering act. The activity of design is the process by which ideas, objectives or functions, take shape in the plans for implementing an object, a system or a service, aiming at attaining the objective or performing this function.

2.3 Each of these characteristics raises ethical questions

Complexity: where are the spaces for freedom in these intermingled decisions? What are the spaces where ethical acts remain possible? How to assume a responsibility that is diluted in the mass? How to define the limits of human responsibilities in action?

Impact and irreversibility: on what grounds should we accept the existence of risks resulting from the multiple "social experimentations" which surround us? Who can and who must decide on it? What is a socially and morally acceptable risk?

Design: how to estimate the “ethicality” of the creative acts which are at the heart of engineering and consist in transforming ideas into forms, objects, programs, processes? How are values and standards embodied in these objects, programs and processes?

3. The moral responsibility of engineers

Engineering designates a type of action which takes place in a complex social and technical network, jeopardising multiple animate and inanimate beings and consisting fundamentally in transforming ideas into concrete forms. The designing act entails a specific responsibility of its authors because society is dependent on engineers in this domain. The intensity of this responsibility is proportional to the number of beings whose existence, health, quality of life - even life expectation - are at stake.

Certainly, the engineers’ obligation is difficult to apprehend owing to the engineering context. Dennis Thompson (1980) gave the name of “problem of *many hands”* to the phenomenon of dilution of the individual responsibility in large organizations where it is difficult to identify who is morally responsible, because many different persons in various manners contribute to the decisions. Nevertheless engineers, due to their training, their mission and their position in

the social space, contribute collectively to the creation of phenomena whose effects on the social and natural environment are important, and sometimes irreversible.

To draw the boarders of the engineers' moral responsibility amounts to raising three questions: what is their specific knowledge? What are their concrete "degrees of freedom"? What is their moral legitimacy to take into account the engineering ethical stakes within the framework of their professional activities?

3.1 The knowledge of engineers

One cannot be held responsible for what one does not know, but some gaps in knowledge are more morally acceptable than others.

The impacts of technologies are partially uncertain. Many manufacturers are worried about the extravagant plea for a "precautionary principle" which would consist in restraining any innovation for fear of possible undesirable consequences. Engineers have no vocation to be transformed into experts in ethics. On the other hand, they probably have the moral obligation not to be not ignorant of the debates upon the controversies aroused by the projects in which they take part. They probably have the obligation to be among the best informed of their fellow citizens. More generally, they can be expected to have an opinion on the goals of the company employing them.

Finally, given the intrinsically risky nature of engineering, they can also be expected to have an opinion on the important issues raised by our "risk society": are the parties exposed volunteering and properly informed? What are social profits worth in view of the resulting social costs? Is the distribution of risks fair?

3.2 The engineers' power

Another reason for claiming that there is no place for ethics in engineering practice rests upon the fact that the engineers' status as employees would not give them enough freedom. This old-time argument is evoked, either to state that, on principle, the position of employee is incompatible with the practice of a professional ethics, for lack of autonomy, or to say that it is often true in practice. (Nader 1967, Noble 1979).

The working context of engineers is nearly always a large company or an organization working for one or several big companies. The problem of "many hands" can lead to the development of a feeling of impunity. The responsibility dilution is all the more likely as there is not always a continuity in the projects. The decisions are sometimes passed on from one individual to another occupying the same post successively.

Engineers are not always there to witness and assume the consequences of the decisions in which they took part … Moreover, certain choices have repercussions in new time scales. Nevertheless engineers can be expected to feel accountable for their activities, to feel concerned even if they are not liable, and not to benefit from the difficult traceability of the decisions to lose interest in the (short and long term) consequences of their professional work.

The space of freedom within organizations employing engineers may not be so narrow. The real power of engineers, which binds their moral responsibility, is to be looked for beyond its most visible aspects, i.e. the set of authority relations. Wiebe Bijker and John Law compare engineers to "social activists" because they design the societies and organizations so that they adapt to machines. Langdon Winner (1989) observed that the conception of nuclear power stations had implications on the very structure of societies, on social roles and their distribution.

3.3 The legitimacy of engineers

The American engineer and essayist Samuel Florman is very skeptical about the obligation imposed on engineers, through the most recent American codes of ethics, to protect the public from the harmful effects of technical developments, particularly in the domains of hygiene, health, safety and damage to the environment. According to him, engineers are no more qualified than novelists, dentists or philosophers to determine what it is advisable to do (Florman 1987, 30). "A feast is to be appreciated by the guest, not by the cook" already said Aristotle (Politics, Book 3).

If all the actors - technical, economic, political or even social - have a role to play in technical development, engineers stand in a position which generates quite specific obligations.

At the beginning of the development of any new device, there is a wide palette of possible technological choices, each responding to the interests of one or several groups concerned (the contractors, their customers, the engineers, the political leaders). The definition of the option which will be retained is the object of a negotiation between these groups. In the end, the technology chosen becomes a "black box". Engineers have no legitimacy to decide for the others but stand in this technical dead angle. They do not know everything, but sometimes know things that they are the only ones to know.

One of their obligations perhaps will be in extreme cases to be *whistleblowers.* In a more trivial way, society is entitled to expect them to take an active part in the debates on technical choices in the diverse scales where they take place, inside as well as outside the companies which employ them. There are numerous places where the engineers' words are absent, though quite justifiable, beside those of other "stakeholders" of technical development.

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ASCE American Society of Civil Engineers
ASEE American Society for Engineering Education
ASME American Society of Mechanical Engineers
CSEP Center for the Study of Ethics in the Professions
CSES Center for the Study of Ethics in Society
EEN European Ethics Network
IEEE Institute of Electrical and Electronics Engineers
JSEE Japanese Society for Engineering Education
NSF National Science Foundation
SEFI Société Européenne pour la Formation des Ingénieurs