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Engineering ethics at the Catholic University of Lille (France).

Research and teaching in a European context.

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Abstract :

The first chapter relates to the development of non-technical education (and ethics within them) in engineering curricula in Europe and in France. Two projects of the Centre de recherche en éthique de l'ingénieur (CREI) of the Catholic University of Lille (France) are developed and discussed : the first is an engineering ethics course which has been running for 6 years in an State engineering school, with a strong emphasis on analysing the ethical issues of the students' first work experience. The second is the writing of a European hand-book in engineering ethics which gives us a good insight into how engineering ethics as a discipline is shaped by the cultural background of those who develop it (philosophical dominant tradition, religious background, professional organisation of the engineers and education). Two main approaches seems to be present in Europe today : the first relates to professional ethics as discussed in the USA since the 50', the second relates to a new discipline that is developing in Europe : ethics of technology

Résumé :

La première partie de l'article décrit le développement des disciplines non-techniques (dont l'éthique) dans la formation des ingénieurs en Europe, et plus particulièrement en France. Deux projets du centre de recherche en Éthique de l'Ingénieur (CREI) de l'université catholique de Lille sont esuite développés et commentés : le premier, un cours d'éthique donné depuis 6 ans dans une école publique sous tutelle du Ministère de l'Industrie (l'Ecole des Mines de Douai) dans lequel une place centrale est accordé à l'analyse de cas d'éthique présentés par les étudiants à partir de leur expérience de stage en entreprise. Le second projet développé, un manuel européen d'Engineering Ethics en cours d'élaboration, donne l'occasion de repérer de quelle manière cette discipline est façonnée par les enracinement culturel de ceux qui la développe (tradition philosophique et religieuse dominante, mode d'organisation professionnelle des ingénieurs et modalité de formation). Deux approches semblent se dégager en Europe : la première dans la lignée de l'éthique professionnelle telle qu'elle s'est développée aux Etats-Unis depuis les années 50, la seconde davantage en lien avec une autre discipline qui est apparue plus récemment, notamment en Allemagne et au Pays-Bas : l'éthique de la technologie.

A. ETHICS IN ENGINEERING CURRICULA : THE EUROPEAN AND FRENCH CONTEXT

1.1. Humanities in engineering education in France

André Cherval reminds us that "the importance of teaching of literature to the students of the *Ecole Polytechnique* has always been recognised since the beginning of its history"¹ at the end of the XVIIIth. If the objectives, the status and methods of this teaching were in the heart of many debates, the existence of a Chair of Literature and/or one of History has never been questioned since the very first years of the most famous French institution. The influence of the *Polytechnique* model on the whole high-level scientific educational programs in France gives some weight to this two century-old choice.

Another influence to mention is the "social role of the engineer", a concept created by Catholic engineers, that became the keyword of the "professionalisation" movement. It first appeared in 1894 in the title of an unsigned paper that summarised the ideal of the whole profession at the dawn of the XXth century. The author cited the engineers' vocation, just like Officers', to be "spiritual guides for their men" and wrote that the "engineers [had] to apply themselves to understand them [their men] in order to be genuine leaders"². These ideas were taken up again later in many articles and books: in 1932, *Le rôle social de l'ingénieur* of Lamirand described engineers as the bearers of the "ideology of the third way" between capitalism and socialism³. The « industrial sociology » of Frederic Le Play⁴ laid an intellectual foundation for the "social engineers" and the social teaching of Pope Léon XIII gave to the Catholics among them a theological justification⁵.

This historical background explains partly the importance given to humanities within engineering curricula in France under two influences : a secular one, with its "meritocratic" ideal and the figure of the *Polytechnician*, which vocation is to serve the State with the highest degree of excellence and loyalty ; the Catholic one, with its ideal of the « social engineer » and its vocation to be a mediator between the ruling and the working classes.

1.2 Humanities in today's engineering curriculum in France

Today the teaching of literature is required in the first years of engineering education in France : it is part of the compulsory subjects of the competitive exams taken to enter one of the 232 French "engineering school"* . However, teaching humanities is not simply teaching literature or preparing for a literature standardised exam. That is why some schools offer

* In France most engineers are educated in one of the 232 (in 1998) "engineering schools" which are outside the university system These institutions are open to good or very good students only, who managed to pass highly competitive examinations, prepared in a two year specific course (While there is no selection to enter university

courses in philosophy or art, with different kinds of academic status. On the other hand catholic school have long proposed vocational courses on the social teaching of the Church, or more generally on social issues. Moreover, in these last ten years, some have gone further and created genuine multi-disciplinary research departments : the Research Centre for Applied Epistemology (CREA) at *Polytechnique*, the Centre for Sociology of Innovation at the *Ecole des Mines de Paris* and the Centre for Humanities at the *Institut National Supérieur des Sciences Appliquées* (INSA) of Lyon⁶.

In 1996, the theme of the Annual Congress of the *Conférence des Grandes Ecoles* (CGE)^{**} was "The Humanities and the *Grandes Ecoles*". The proceedings give an idea of the importance given to the teaching of humanities apart from the few pioneers. More than 250 people (school directors and/or professors) listened to 30 contributions (chosen from among 90) describing teaching experiences. The President of CGE welcomed the participants with these words : « Learning to be a man among men, among all men is a question to which religions give an answer (not necessarily the same !). In our secular and Republican country, if the public institutions cannot neglect this question, they must find their place with diplomacy ». How can we not see in this introduction the old French dispute on education between Catholics and secularists ? This background may help understand the way French engineering education has dealt with ethics until now.

The best place to observe transformations within the engineering curricula, in France, is the *Commission des titres d'ingénieurs* (CTI, Engineering Title Committee). This Committee, composed of representatives of engineering schools, various Ministries (Industry, Education,...) and members of the profession, was created in 1934 in order to protect the title of "graduate engineer"^{***}. It advises and controls the quality of the curricula by conducting periodic enquiries, and makes recommendations for accreditation of engineering schools to the Ministry. In 1995, CTI made public its criteria : these made clear that in addition to scientific and technical knowledge, engineering schools were expected to give a "general

in France). A good explanation (in English) of the French educational system can be found on the official Education Ministry website at <http://www.cri.ensmp.fr/mesr/>

^{**} *La Conférence des Grandes Ecoles* is a non-profit association created in 1969 with 180 members (135 « engineering schools » and 30 business schools.

^{***} "The exercise of an engineering profession is neither controlled nor regulated by French law. Only the title of "graduate engineer" is, the usual naming of "engineer" is not (...) An engineering school may only deliver an engineering degree if it has been allowed to do so by the Engineering Title Committee, created by the law of July 10, 1934(...) CTI appears to be the main basis of French engineering education system", cited from <http://cri.ensmp.fr/cefi/plaquet.html>, 03/09/1998.

education composed of foreign languages, economical social and human sciences, a concrete approach to communication problems as well as an opening to an ethical reflection on engineering profession". What can be the content of such an expectation in a country where the concept of professional ethics for engineers is so vague, almost absent ?⁷ Why does it seem important to have an ethical reflection on the engineering profession ? To whom ? To what extent did this concern come from the influence of the president of CTI, who at that time, was a graduate from a Catholic engineering school ? There are no clear answer, but in any case, an interest for ethical education seems to emerge.

1.3 Non-technical subject in engineering curricula in Europe

The question of what engineers should know, and what place to give to non-technical subjects in their education or selection, has been debated since long in most industrial countries. As stated before, the *Ecole Polytechnique* has always had a Chair of Literature, and sometimes of History as well. How was it in other countries ? In France, the development of the engineering profession has often been associated with a government corps of engineers, and the establishment of engineering schools. These were absent in the United Kingdom, for instance, where apprenticeship and experience have long been preferred to degrees. The Institution of Civil Engineer (ICE) founded in 1818 is an alternative model to the continental one that has proved successful in many ways. Still today, holding an engineering degree is not enough to be considered as a "chartered engineer" : it has not even been necessary at all for very long. Nevertheless a "professional examination" was created in 1898 in order to increase the qualification of the members of the Profession. It is interesting to note that this examination included since its creation not only sciences but subjects as language and humanities as well⁸. These examples show within two very different models for the engineering profession, emphasising a high level of scientific education as in France or rather experience and acceptance by peers, like in the UK, that humanities have had a place since the early times of modern time engineers.

More recently, in 1940 et 1944, Hammond Report suggested a general introduction of social and human sciences in engineering education in the USA⁹. From 1964 to 1966 an enquiry was held by UNESCO on the teaching of social sciences in engineering education. In 1974, UNESCO published the proceedings of a Congress on the teaching of social and human sciences in engineering education, with contributions from Chile, Romania, USA and Japan¹⁰. In 1995, the European Society for Engineering Education (SEFI) organised a Seminar in

Poland on the role of non-technical subjects in engineering, with contributions from Poland, United Kingdom, Germany, the Netherlands, Romania, Switzerland, Russia, Turkey, Lithuania and Czech Republic. Obviously, even if the academic status and objectives are not always clear, non-technical education in engineering curriculum is a subject of interest for educators.

1.4 Ethics in today's Engineering curricula in Europe

Recently, some institutional decisions have made more concrete the growing concern for the teaching of ethics as part of the engineering curriculum in Europe. In France, the Engineering Title Committee explicitly suggested, in 1995, introducing ethics into the engineering curricula. In the Netherlands, an initiative came from the Dutch Minister of Education and Sciences who sent a memorandum to Parliament in 1991 indicating how the ethical aspect of scientific research could be approached.¹¹ In Portugal, the *Ordem dos Engenheiros*, which control the legal use of the professional title, and the accreditation for engineering degrees, stated in its guide-line that they should look for "awareness of social and ethical problems of the engineering profession ; ... the engineer's sense of responsibility as regards problems of safety, health and environment".¹² These are only a few examples of the emergence of an interest for ethics among educators, institutions and professional associations. Obviously there is a need for an extensive and systematic survey at the European level that would give an idea on the different kind of institutional regulations and on the engineering curriculum standards.

In any case, neither the discussions, Congresses and Seminars on humanities, ethics or human and social sciences in engineering nor the institutional decision should cause us to ignore the concrete difficulties met in many places to find the right balance between scientific and technical teaching in engineering training. Things are obviously changing but in the face of the new initiatives there is still resistance from students, scientific educators, school directors and from the profession or sometimes employers. Günter Heitman, one of the editors of the 1995 SEFI Seminar stated that the Association of German Engineers (VDI), which is the largest association of engineers in Germany and one of the most influential in the world, recently recommended 20 % of non-technical subjects, comprising 10 % profession related subjects and another 10 % for electives in humanities and social sciences. "Despite this urgent demand, Heitman writes, in general, engineering science and engineering educators have shown, up to now, a remarkable resistance to the type of change proposed"¹³.

B. TEACHING EXPERIENCE : An Engineering Ethics Course at *l'Ecole des Mines de Douai*

L'Ecole des mines de Douai is a State school, founded in 1878, which is under the supervision of the Ministry of industry. The curriculum's originality lies in the long training periods. During their four years, the students have to spend three months between the first and the second year working in a company, a further three months between the second and third year, and finally five months at the end of the fourth year. In 1994, the director asked to the new-born CREI to set up a course in the third year. This engineering ethics course is the more significant teaching experience of our team.

There were three major objectives for the course : making engineering students aware of their future responsibilities, helping them realise to what extent they could find some degree of freedom within the institutions in which they will work, enabling them to strengthen their moral convictions by means of discussion. These objectives show the clear inclination towards an ethical reflection focusing on the individual level, more rooted on the Catholic humanism than the encyclopaedian ideal. In 1999, the programme, 14 hours long, contained two lectures (in big groups of 70-80 students), three seminars (in medium size group of 30-35) and two tutorials (in small groups of 15 to 18), focusing on the main themes of social ethics : the engineers and how they deal with their power as technicians, the problem of decision-making in the market system (security versus money, quality versus money, and so on...), the objectivity of the sciences and aestheticism as a strong motivation and a danger inherent to any technical activity. In each course a case-study was followed by the presentation of theoretical and methodological approaches to give the students some analysis skills and help them develop rational argumentation.

1.1. An inductive pedagogical approach

Cases are at the centre of the methods, but not in the same way as in the USA where the first case-study courses to be used were found. Maybe it would be better to talk about stories (and/or history) than cases, because "case study" often supposes a particular approach and a search for the "right solution". Stories, real stories, appear a good means to analyse the concrete situation of engineers at work, their power and autonomy in their institutions, their constraints and their motivations as well.

The story of Metrotelephone was written after Shoshana Zuboff, *In the Age of the Smart Machine*¹⁴. It is based on the true story of the choice of a new computer-based management system and is sometimes used as a role game. Students are invited to play the role of the different people (workers, engineers and managers) concerned by the technological change and by the problems that soon appeared. Representatives of each group have to confront the other points of view and decide together what to do with the new system. This story leads to questions such as : are technological tools value-free or not ? is it only a question of proper use ? to what extent do engineers abuse their position of being the only one to know what was inside the black box ? The pedagogical problem is that engineering students are more interested in solving problems (which are "only a question of time") than in understanding what happens and why.

The "DC-10 case"¹⁵ analyses the plane accident that occurred in Ermenonville in 1974 and, sadly, has become a classic in engineering ethics literature in the USA. This story offers different levels of analysis : macro-social with the problem of collusion between the Government and Federal Aviation Agency (FAA)¹⁶, mezzo with the direct and indirect moral responsibilities of McDonnell-Douglas¹⁷, micro-social level focusing on the famous "Applegate dilemma" (he was the only engineer to protest and he wrote a memorandum to express his disagreement)¹⁸. It is a very rich case, nevertheless its complexity may scare the students sometimes. Some of them do not dare to express their judgement arguing a lack of information, others are focused too much on the legal, rather than the moral dimension of the case.

There are two original stories as well : the first deals with "passion for technique" or "technique for its own sake". "Aerotrain or Bertin's Tragedy"¹⁹ is the story of an engineer who invented in the '60s' a fast train that was abandoned but indirectly enabled the success of TGV. Bertin was so sure of his technical project that he became deaf to the social demands and never understood why his marvellous "toy", visited by so many influential personalities of the time, was suddenly abandoned. This story leads to discussion on the virtue of prudence, the irrational relationship that can exist between engineers and their creation and with the interaction between social demands and technical innovation. The second original case deals with "Superphénix nuclear plan"²⁰ and questions technocracy.

1.2. Assessment of the students

Since 1995, the assessment of the student has been based on a personal ethics case study. Students were asked to select situations they have experienced during their training, which could form the basis of a case-study. The discussion groups were intended to describe the situation and demonstrate why this situation has something to do with ethics. Some methodological supports were given in order to help the student analyse their own case. It was suggested that the final project (about 6-8 pages) should contain :

- an introduction to justify the choice of the topic : why do you think this story deals with ethics ? Which values and principles are dealt with ? for what reasons did you chose this topic ?
- a description of the individual and collective agents that are involved in the cases and an analysis of their interests at stake : what is the topic of the decision ? who acts ? who undergoes the consequences of the discussed decisions ? In which way were the decisions taken ? were all groups represented ? what were the prevailing norms and laws ? what is the main dilemma ? and who has to cope with it ?
- a study of all possible alternatives and a motivated choice of a decision : are there alternatives ? are they realistic ? who could have suggested them ? who could have made them effective ? what would you have done if you had to decide ? why ?

After six years at the engineering school of Douai, it seems that this kind of assessment is fruitful and well understood by the students. Most of them appreciate it, even if some find it difficult to choose a situation. Still, after listening to other students, many realise that they do have a case to analyse. Some realised that the case didn't come earlier to their mind because they had forgotten what had been disturbing (or even morally shocking) during their training (which was their first time in a company sometimes). Others realised that they had become used to what was considered normal by their colleagues or supervisor, even if the situation was still morally disturbing for them.

Talking about their personal experience seems to help students keep in touch with their ethical insights and clarify what they would call an ethical problem, why they call it so, and why they think it is worth talking about it. That is the first step of any ethical reflection. Many students did not go much further in 14 hours. With yet others, the interest of the course was not so much to discern what was an ethical problem, but to think about how to deal with it. It was very interesting to see how students could make their imagination work when they were invited to think about what could be done, what they would have done... Ethical sensitivity

and ethical imagination are certainly main capacities to develop, especially with engineering students who are more eager to find quickly the most rational (efficient) solutions, than talk about their moral intuitions and doubts, and to find the proper words to make them clear to others.

The main lessons from this experience can be seen in the evolution of the organisation of the course (smaller groups, more discussions) and the assessment (a personal case study). The experience showed the difficulties for engineering students to recognise ethical issues due to a confusion between moral and legal dimension in the complex cases or an ability to forget or get used to what may be a morally disturbing situation in their own cases. The objectives changed too. It seemed less important to help the students be able to analyse the external constraint on engineering practice that limits their freedom, than to be aware of their own inner limitations due to their representation - and conditioning - shaped partly by their education. Developing analytical skills remained an important objective through logical thinking and arguing both sides of a position and considering alternatives (role game and personal cases). The mastering of theories and principles of ethics had to be more developed along the course to help the students increase the quality of their arguments for moral views and identify better moral issues.

C EUROPEAN HAND-BOOK ON ENGINEERING ETHICS

The Ethics Centre of Lille in conjunction with the Catholic University of Leuven (Belgium) has started up a network called the European Ethic Network (EEN), recognised in 1996 as a thematic *Socrates* network by the European Commission and granted to realise four handbooks of professional ethics, medical ethics, of business ethics, and one of engineering ethics. CREI was asked to assume the responsibility of the fourth one. 35 papers from 10 countries were chosen by an editorial comity made up of members from 6 European countries²¹ The handbook intended to give engineers and their trainers and advisors the means to reflect on the engineers' contribution to the development of technologies and to find out the moments and possibilities, of their social and moral responsibility. But since, this project was also an opportunity to know better at a European level what engineering ethics meant to the pioneers of this subject. "It wishes to bring its contribution to the building of the discipline of engineering ethics, still immature in Europe." ²²

The papers were chosen by a European committee composed of engineering ethics teachers, philosophers and engineers. Conscious that there were different definitions of the

subject, their aim was to give a picture of the diversity of the movement. The idea was to give voice to as many disciplines and countries as possible. Moreover the handbook separated methodologically three levels of analysis: the micro level developing the ethical problems met by engineers in their institutions; the mezzo level where technical systems and institutions are in competition; the macro level representing technical developments as societal problems. Each part has been designed with the same structure: specialists of the human sciences, mostly history and social sciences, were asked to give a description of technical praxis; engineers, sustained by some social scientists and philosophers, to show problematic examples; philosophers to reflect on these materials.

What appears clearly now is that there is a need of working on common concepts for a better mutual understanding. Currently, some key-words of the emerging engineering ethics have different meanings not only in the different countries or languages but also in the different disciplines, such as moral philosophy, sociology of the professions, professional ethics. The concept of Profession - and consequently, Professional ethics - has a specific meaning opposed to occupation in some countries (like the UK) while in others, a professional is a person who does a job for which he has the competence and receives a remuneration (in France, for instance). In moral philosophy, the concept of deontology relates to some specific kind of ethical justification of moral choice, but it can also relate to the sets of norms and values within a certain group (*déontologie professionnelle*, in French). Even the definition of ethics (and moral) and techniques (and/or technology) differed from one author to another. But it appears also that according to the academic and professional tradition of the contributors, engineering ethics relates rather to professional ethics or to the ethics of technology.

C.1 Engineering ethics understood as specific part of professional ethics

Engineering ethics is clearly considered by some authors as a part of professional ethics in the way it has been developed in the USA. Professional ethics applied to the engineering profession, focuses on engineers as professionals, as members of a profession. Not only does this suppose a certain understanding of what is a profession and if engineers belong to a profession, but it also supposes that the concept itself is relevant, which is not the case in all European countries²³. In the USA, engineering ethics is clearly in this line. It developed first in the professional organisation who have been writing codes of ethics since the beginning of the XXth century. Then thanks to sponsoring from the National Science

Foundation in the '80s, multidisciplinary research teams came into being composed of moral philosophers and engineers. This led to the publication of many text-books and handbooks in engineering ethics, which always give a large place to case studies and codes, and also to the description of moral theories.

Some European teaching experiences, like that of CREI, have started with using American case such as Challenger or DC-10. Some papers of the European text-book are obviously in this line. One limit of this approach is that it focuses on one particular agent of the technological process as if forgetting the social complexity of the making of engineering. Of course, there are good reasons to focus on engineers because, even in their diversity, they play a unique and crucial part in it. But this is not enough because today's technology is shaped by so many other agents : consumers, business persons, politicians, citizens, voters, members of special interest groups like that for labour, environment, peace, development...

Another limit is that the dialogue between moral philosopher and engineers does not take into account many other disciplines that could interact in the reflection such as the philosophy of technology, the sociology of technology, the sociology of organisation... In Europe, the German philosophers Lenk and Ropohl have tried to develop a kind of professional ethics for engineers with wider interaction with other disciplines²⁴. In the USA, Carl Mitcham opened the dialogue between the philosophy of technology and professional ethics.²⁵ In his last book, Michael Davies addressed "four questions for the social sciences", stating that it would "serve both practical philosophy and professional practice"²⁶.

C.2. Engineering ethics as part of an ethics of technology

Engineering ethics can be related to professional ethics, but also to "ethics of technology", considered as moral philosophy applied to technology (rather than to engineers). This approach of engineering ethics finds its basis first in the philosophy of technology. The philosophy of technology is a discipline with some history. But although ethical questions are raised in some works, a real ethics of technology does not exist. Most of the early studies tried to understand what characterises technology as part of reality and only some of the critical approaches have an explicitly moral point of view, like Hans Jonas' for instance²⁷.

The "constructivistic " approach to technology studied the way specific technologies developed out of competing influences within the society. It is closely connected to the Technology Assessment movement which started in the '70s in the USA. The constructivistic

approach contributed to the insight that technologies are complex and intricate networks of products, processes, institutions, organisational patterns, people with different social roles, cultural values etc, but the moral point of view was absent in the first works. The first author to take this approach, Thomas Hughes²⁸, was followed by European authors like Callon and Latour in France and Bijker in the Netherlands. Some authors of the European text-book seems to follow this approach of ethics of technology, inspired by philosophy and sociology. Engineering ethics, for them, is a special focus on engineering within technological development, and on engineers as agents among others.

CONCLUSION

Although all European countries have to confront the same kind of technical and social issues, each of them has its own way to deal with engineering ethics practically and theoretically : this is partly due to the different kind of organisation of the profession and education, partly due to the intellectual traditions in ethics. Whatever the prevailing model there has always been some kind of interest for humanities in engineering, but ethics as the last subject to appear within the increasing development of non-technical subjects in engineering education faces its own practical and theoretical questions.

The first part of this paper described how historically the concern for engineering ethics appeared Europe and in France and tries to show in this process the convergence of pedagogical and ideological motivations. The historical investigation revealed two different origins in France : a secular and knowledge-oriented one and a Catholic and more socially-orientated approach. Recent times have been characterised by an increasing interest for humanities (and somehow of ethics as part of them) but what to teach and how to teach are questions that should not make us forget the main one which is why teach humanities, for what purpose ? The teaching experience at the *Ecole des Mines de Douai* illustrates the first steps taken by the CREI of Lille to answer the question of how and what to teach based on the American experience but rooted in the social Catholicism The European project made obvious the absence of consensus on what was "engineering ethics" as a discipline and revealed two main different academic approaches. While professional ethics intends to teach some guideline for professional conduct and to contribute to the building of a professional group, the ethics of technology intends to enable a better insight into what engineering is and what effects it has on our societies.

The professional tendency may have some common points with the old French Catholic ideology on the social role of engineers, because both are looking for justifications and guidelines for personal conduct to deserve the professional qualification or to maintain a specific position in a time when to be an engineer is not special anymore. But while the professional movement is still active in the USA for cultural reasons, the French Catholic engineers' movement has become very marginal in France²⁹. The ethics of technology tendency may have some common points with the French and secular encyclopaedic ideal but with a search for a pragmatic interaction between different spheres of knowledge and experience. For its defenders, the question of the direct influence of the teaching on the individual conduct is secondary. The most important seems to understand better not only ethical issues at an individual level (or professional level) but also with a wider perspective in interaction with the rest of the society. The next step of our common reflection after the European Project, and its aim to strengthen the dialogue between disciplines for the building of a "European" engineering ethics, may benefit, from such a socio-historical perspective.

NOTES

¹ André Chervel "Les études littéraires dans la formation polytechnicienne", in B. Belhoste, A Dahan Dalmedico et A. Picon, *La formation polytechnicienne, 1794-1994*, Dunod, Paris, 1994,

² A.B. , « Le rôle social de l'ingénieur », *Etudes*, 1894. The author was Father Pupey-Girard, whose mission was to spread the « social teaching of the Church » (following the encyclical *Rerum Novarum* published by Pope Léon XIII in 1891)

³ Georges Lamirand, *Le rôle social de l'ingénieur*, Plon, Paris, 1932.

⁴ Frédéric Le Play (1806-1882) a *polytechnician* and *ingénieur des mines* studied workers families and created his own sociological methodology. He was a social reformer and was followed by many engineers who joined the "social unions" (*les unions de la paix sociale*) he created in 1872. Bernard Kalaora and Antoine Savoye, "Frederic le Play et les figures de l'ingénieur", *Culture technique*, n°26, dec 1992, pp. 128-133.

⁵ André Grelon, « L'ingénieur catholique et son rôle social », in Yves Cohen et Rémi Badouï, *Les chantiers de la paix sociale (1900-1940)*, ENS Edition, Fontenay/St Cloud, 1995, pp. 167-184.

⁶ INSA, Institut national des sciences appliquées, was created in 1957 with its Humanities Department.

⁷ Christelle Didier, "Engineering ethics in France : a historical perspective", in *Technology in Society*, 21, 1999, pp. 471-486.

⁸ Michael M. Chrimes (head library), February 1996, "History of the Institution of Civil Engineers", <http://www.ice.org.uk>, 24/02/99 (7 pages)

⁹ *Journal of Engineering Education*, march 1940 and May 1944.

¹⁰ *Les sciences sociales et humaines dans la formation des ingénieurs*, Les presses de l'UNESCO, Etudes sur la formation des ingénieurs, n°2, Paris, 1974, p.1.

¹¹ I.R. Van de Poel, M. Brumsen, P.A. Kroesen, H. Zandvort, "Teaching ethics and engineering at Delft University of Technology", SEFI Working Group on Ethics and Engineering Education, April 29-30 1999, Rzeszow, Poland.

¹² Paulo M.S. Tavares de Castro, "Engineering Ethics in Engineering Education : a Portuguese Experience", conference on Ethics in Engineering and Computer Sciences, Western Reserve University, Cleveland, Ohio, march 1999.

¹³ Günter Heitmann, "Concepts of General Studies in German Education at Universities and Fachhochschulen", in G. Heitmann, V. John, H.J., van Oort and Z. Waszczyszyn, *Educating the Whole Engineer. The Role of Non-Technical Subjects in Engineering Curricula*, SEFI Curriculum Development Group, Cracow University of Technology, may 1995, SEFI Document n°15, p. 135.

¹⁴ Christelle Didier, "le cas de *Metrotelephone*", in *Ethique industrielle*, op. cit., pp. 113-124.

¹⁵ Fay Sawyer, "Le cas du DC-10 : chronologie et commentaires", in *Ethique industrielle*, op. cit., pp. 175-186.

¹⁶ Patrick Lagadec, *La civilisation du risque. Catastrophe technologique et responsabilité sociale*, Seuil, Paris, 1981, p. 155-158.

¹⁷ Peter French, "What is Hamlet to McDonnell-Dougllass or McDonnell-Douglas to Hamlet : DC-10", in Joan Callahan, *Ethical Issues in Professional Life*, Oxford university Press, New-York, 1988, pp. 274-281.

¹⁸ Stephan Unger, "The DC-10 Disaster - Result of Swallowing the Whistle", in *Controlling Technology*, John Wiley and Sons, New-York 1994 (1st ed. 1982), pp. 16-20.

¹⁹ Christelle Didier, "L'Aérotrain ou la tragédie de Jean Bertin", in *Ethique industrielle*, op. cit., pp. 323-337.

²⁰ Bertrand Hériard Dubreuil, "Les dimensions de la décision technique : l'exemple de *Superphénix*", *Alliage*, n° 27, été 1996, pp. 23-32.

²¹ Jose-Angel Ceballos (Madrid), Göran Collste (Linköping), Gérard Fourez (Namur), Philippe Goujon (Lille), Bertrand Hériard (Lille), Christian Hogenhuis (Driebergen), Martin Meganck (Gent) and Sally Wyatt (London).

²² Christelle Didier, Philippe Goujon, Bertrand Hériard, Christiaan Hogenhuis, "introduction", in *A European Quest for Socially Responsible Engineers*, to be published.

²³ Even in the USA there are different sociological approaches of the professions in conflict : while professional ethics may be considered has a natural attribute of the genuine profession to the functionalists, it is considered by the interactionists as a construction created in order to defend some privilege.

²⁴ The best illustration of this is Lenk, H.& G. Rophol, "Toward an interdisciplinary and pragmatic Philosophy of technology", in P. Durbin (ed.) *Research in Philosophy and Technology*, vol 2, Greenwich Conn, 1979.

²⁵ Carl Mitcham, *Thinking Through Technology : the Path Between Engineering and Philosophy*, University Press of Chicago, 1994.

²⁶ Michael Davies, "Epilogue. Four questions to the social sciences", *Thinking like an Engineer. Study in the Ethics of a Profession*, Oxford University Press, 1998, p.172.

²⁷ Hans Jonas, *Das Prinzip Verantwortung. Versucht einer Ethik für die Technologische Zivilisation*, Insel, Frankfurt, 1979.

²⁸ Thomas Hughes, *Networks of Power. Electrification in Western Society, 1880-1930*, John Hopkins University Press, Baltimore, 1983.

²⁹ see Christelle Didier, "Engineering ethics in France", op.cit. The Catholic Union of engineer transformed in 1902 into a trade-union called the Social Union of Catholic Engineers (USIC) was a very active group at the centre of the professionalism movement until the end of WWII. In 1964 USIC became a mere spiritual movement.

Bibliographical note

Christelle Didier studied mechanical engineering, then turned to sociology. She has been working in the Ethics Research Centre of the Catholic University of Lille (France) and has been teaching ethics, sociology and history of technology to engineering students for seven years. She is co-author of the first French text-book on engineering ethics, *Ethique industrielle* (1998) and author of *Pour un questionnement éthique des choix techniques : une ouverture dans la formation des ingénieurs* (1999). She published case-studies and papers on engineering ethics in France and in Europe : "Le cas de *Metrotelephone*", in *Ethique industrielle* et "L'Aérotrain ou la tragédie de Jean Bertin", in *Ethique industrielle*, "Engineering ethics in France : a historical perspective", in *Technology in Society*, 21, 1999. She is also co-author of the introduction of *A European Quest for Socially Responsible Engineers*, (to be published). Christelle Didier is completing her doctoral dissertation in sociology on French engineers and their vision of the ethical issues of technology.