

Engineers' Ecoscepticism as a Challenge for Engineering Education

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INTRODUCTION

Since the 1970s, environmental issues have become a central concern throughout the world, thanks in part to a better understanding of the interconnection between environment, economy, and quality of life. Moreover, major technological disasters have generated public awareness of the dangers posed by human activity on the natural environment. In the late 1970s, the first green parties were founded, as well as environmental department ministries in many countries. This period also saw the birth of a new field of enquiry in the social sciences: environmental sociology. If the business world should be concerned about its environmental impact, the industrial world should be even more concerned, because technical development is at the root of many environmental problems.

Although the definition of who is regarded as an engineer may vary from one country to another, this profession is generally considered to be -- owing to their particular knowledge and activity -- as highly aware of environmental issues. They are not necessarily personally sensitive but, as members of their professional group, they have to carry their share of collective responsibility. Obviously, engineers are aware of this unique position as evidenced by the presence of environmental topics in major engineering conferences as well as in most training for over thirty years.

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The first code of ethics of the European Federation of National Engineering Associations included, already in 1992, an article dealing with the environment. The version adopted shortly after by the French Engineers Association (CNISF, today IESF) was more cautious. The “*Charte d’éthique*” [7], which replaced in 2001 the “*code de déontologie*” [6], more explicitly evokes environmental issues in several articles. (Both French expressions translate as “code of ethics” in English, but the expression “*code de déontologie*” is particular to France and describes a professional code that is legally binding.)

While some surveys have been made to determine what engineering students know about sustainable development [2], there is a lack of information about engineers’ attitudes once they have left university. Therefore, our research question is: To what extent have French engineers (not just their official spokesperson) adopted the view of the ISF Charter? It is based on an extensive survey conducted online, in 2011, by the CNISF.

1 HYPOTHESES AND METHODOLOGY

1.1 Engineers versus French people

Firstly, engineers have a specific position in the social and the economic world, as well as in their relationship between society and the natural environment. This professional group is responsible for many environmental problems, sometimes also for solutions: in one case as in the other, they might know and be able to do what laymen might not know or be able to do, or to a lesser extent. Secondly, previous research suggests that engineers are more optimistic than their fellow citizens about the social impacts of technology. A survey conducted by C. Didier in 1999 to 3901 graduates showed that only 2 % French engineers considered that technical progress brought more harm than good to humanity [10]. Thirdly, the analysis of the code of ethics in various countries shows an emergence, among the engineering profession, of an awareness of environmental issues, although it remains conservative and came rather lately in comparison with the rest of society. Those three observations lead us to formulate our first hypothesis, which is that the engineers’ environmental attitude differs from those of the French and is marked by a greater optimism *vis-a-vis* the environmental impact of technical development

1.2 Demographic changes in the profession

The engineering profession has undergone profound changes over the last twenty years in France. Firstly, although largely masculine (only 17 % women), the number of women in this profession is growing: in 2011, 26 % graduate engineers under 30 years old are women [8]. Secondly, the influx of graduates has increased a lot and the profession is becoming younger. There are more and more young engineers (under 30). Thirdly, the way to gain access to the engineering degree has evolved, especially over the past thirty years. In 2010, 85 % of graduates obtained their grade through initial training, with an increase in parallel admissions enabling university students to enter higher education engineering schools (In France gaining an engineering education from a “*Grande Ecole*” confers a higher status than via university education); 11 % of students became engineers through continuing education and 5 % as apprentices, proposed since the 1990s. Our second hypothesis is that the engineering profession’s new demographical makeup -- more young people who will have been sensitized to environmental issues since their youth, and more women, more sensitive, one might suppose, to environmental issues -- might lead to some changes in the profession’s ethos towards attitudes that are more pro-environmental.

1.3 Environmental attitudes and other values

The survey conducted in 1999 by C. Didier, with French graduate engineers, highlighted strong links between the political and religious attitudes of respondents and their professional ethics. Engineers who are Practising Catholics (22 % of respondents) appeared to be more sensitive to social issues, but less sensitive to environmental issues, than their colleagues. Left-wing engineers (26 % of respondents) seemed to be more concerned about the potential negative impacts of technology on the environment and they agree more often than their colleagues with the environmental and anti-nuclear movements; they seemed to have more confidence in the capacity of democratic debate to guide the country's technical choices. Those observations coming out of previous research led us to formulate a third hypothesis, which is that the values that engineers hold in the areas of morality, religion and politics might have an influence on their environmental attitudes.

1.4 Methodology

To test our research hypotheses we have developed a series of questions that were included in the annual CNISF survey conducted in April 2011. More than 39,000 graduate engineers responded to the survey and more than 27,000 to the optional module, on values, that we designed. This module consisted of fifty variables dealing with opinions and behaviours on ethics, morals, religion and politics. Ten variables related specifically to environmental attitudes, including six of the fifteen statements from the "revised New Ecological Paradigm" [12]. To make comparisons with the attitudes of French in general, we relied on the European Values Study (EVS) conducted in France in 2008 [4]

3. OUTCOMES

3.1 The specificities of the engineers' environmental attitudes

Most investigations dealing with the French and their attitudes to the environment show very little change in attitudes over the past fifteen years. They also show that a high social status, education and income appear to be linked with keen environmental awareness. Do these findings hold true also for French engineers (who are all graduates of higher education, benefit from rather high social status and come for many of them from well-off families)?

The outcome of our research is that graduate engineers' attitudes towards environment differ from those of the rest of the French population and that these variations we observed are highly significant. Moreover, engineers share the same social characteristics of people with deep sensitivity to environmental issues, but they do not hold the same opinion. They appear much more confident in "the ability of the ingenuity of mankind to ensure the sustainability of the planet for future generations", a stance which reflects their training and profession. More surprisingly, they are more numerous in rejecting the idea that "the destiny of mankind is to dominate nature" although they play an active role in making this domination possible. Regarding the fragility of nature, the attitude of the engineers is specific to them. Whereas an overwhelming majority of French people (95 %) are concerned about the consequences of human activities on the planet, only a small minority of them (16 %) believing that nature is able to cope with the damage, the engineers' opinion is divided on both issues (51 % agree with the two statements which are negatively correlated). Finally, the engineers' answers also differ from those of the rest of the French population about the statements concerning the future: they are much less concerned about the occurrence of an environmental catastrophe "if changes are

made to current developments” (14 % versus 89 %). However, they are much more worried than their fellow citizens about the impacts of population growth (67 % versus 48 %).

The attitudes of the engineers are characterized by trust in and optimism towards technical development. Millenarian discourse on the end of the world due to environmental catastrophes, blaming disastrous consequences on human intervention, has little effect on them. It should also be noted that not only do their opinions differ greatly from those of their fellow citizens, but the very structure of their environmental attitudes differs: two statements that are the most commonly linked among engineers are among those that French people surveyed disagreed with the most strongly: “The balance of nature is strong enough to cope with the impact of modern industrial nations” and “If things continue on their present course, we will soon experience a major ecological catastrophe”.

Table 1: Agreement of the French and engineers with the six statements from the NEP

	French 2008	Engineers 2011
We are approaching the limit of the number of people that the earth can support (Overpopulation)	48	67
When humans interfere with nature it often produces disastrous consequences (Disaster)	95	51
Human ingenuity will insure that we do not make the earth unlivable (Ingenuity)	51	87
The balance of nature is strong enough to cope with the impact of modern industrial nations (Strong)	16	51
Human beings were meant to rule over the rest of nature (Domination)	23	8
If things continue on their present course, we will soon experience a major ecological catastrophe (Catastrophe)	89	14

3.2. Low correlation with demographic variables

We have formulated the hypothesis that the demographic diversification of the profession might impact on their environmental attitudes. Our analysis of the impact of gender provided some surprising findings. Contrary to our expectations, we found no difference of opinion regarding the statements from the NPE between men and women. Of course, the causes of this are multiple. However, we are inclined to believe that the influence of the workplace and the predispositions towards the sciences that led students (and perhaps more so in the case of women than men) to undertake engineering studies are two important explanatory factors of the women engineers’ professional identity and ethos.

If gender generates little difference among engineers with respect to environmental attitudes, age proves to be a slightly higher determinant. Younger engineers appear slightly more sensitive to environmental issues. They are more sceptical about the balance of nature. They agree less than their elders with the statement that the destiny of humankind is to be to dominate nature. However, they are less worried about the possibility of a major disaster. Overall, even if the amplitude of the variations is low, engineers under 30 appear more concerned about environment than engineers who are over 60. We can suppose that because they were born at the same time as the concept of sustainable energy and its widespread distribution, they were

sensitized early to the environmental issues, which have been debated a great deal in the public arena.

Thus, neither the gender of the respondent, nor their age, appears to be strong explanatory factors in the engineers' responses. Despite a few variations related to the type of educational route, we can consider that the second hypothesis is not confirmed and consider that the demographic evolution of the profession might not lead to major changes in the collective ethos

3.3. The engineers' environmental attitudes and their other values

Does an individual's concept of good and evil correlate with their environmental attitudes? In our survey, a question was asked about moral attitude. Within the population of engineers, 15 % believe that where moral matters are concerned there are clear lines that may be held in all situations ("intangibles"), 62 % believe it always depends on the circumstances ("conditional") and 23 % disagree with both proposals ("moderate"). The "intangibles" are less alarmist against the risk of overcrowding (63 % versus 68 % of all engineers and 48 % French) and more likely to agree with the idea that the destiny of Mankind is to dominate nature (13 % versus 8 % engineers and 23 % French). Their view is close to that of French people in general about these two statements from the "revised New Environmental Paradigm". However, they have different opinions about the of nature's ability to compensate for industrial damage (60 % think it is strong enough to compensate for the industrial damage *versus* 51 % engineers and 16 % French).

The engineers' religious attitudes generate differences in environmental attitudes. Engineers who define themselves as being religious are less concerned than other engineers about the risk of overcrowding. They are also less concerned about the environmental risks that may result from human actions than "non-religious" engineers and even less so than "atheist" engineers. They are more likely to believe that nature is strong enough to compensate for the damage caused by the industrialized countries than "non-religious" and even more so than "atheists" (59 % *versus* 50 % "non-religious" and 44 % "atheists"). They are, however, more sensitive to the risks of a major ecological disaster (21 %) than "non-religious" and "atheist" engineers (11 %). It should be noted that these four environmental variables, the correlation with the subjective religious feeling is greater than the previous the one with moral attitude and far higher than the correlation between the attitudes towards with the demographic criteria.

In general, the choice between freedom and equality is highly linked to people's symbolic universe. Engineers who prefer "equality" (and represent 45 % of the population) are much more sensitive to the risk of overcrowding than those who place higher value on "freedom" (76 % show concern *versus* 61 % of the "pro-freedom"). They give slightly more credence to the ingenuity of man to solve environmental problems and have less confidence in Nature's robustness (45 % "pro-equity" *versus* 57 % "pro-freedom"). Rejecting the idea that mankind's destiny is to dominate nature, they are also less pessimistic than the general population about the risk of ecological disasters. They promote an "ecological discourse" based on greater solidarity and human intervention in the process of evolution of the planet. They seem both more concerned about the current situation and future but also more confident in the ability of man to deal with the situation

The most politicized engineers (i.e. those who declare a high level of interest in politics) are less often than the average engineer concerned about the risks of natural disasters caused by human activity. Less confident in the ingenuity of

humankind to protect the environment, they have more belief in Nature's ability to compensate for the errors caused by the industrialized countries. They are also much more likely to believe in the possibility of a major ecological disaster (17 % of the engineers who say they are very much interested in politics *versus* 11 % of those who reported "little" or "no interest at all" in politics

On a number of points, one could highlight the influence of religious attitude on environmental attitude. Variations also exist when considering the criteria of political interest. The engineers who are more interested in politics - and those who advocate greater involvement of the profession in the *res publica* - have a conception of the relationship of men to the environment that differs from other engineers. They believe that the balance of nature is strong enough to withstand industrial damage while worrying about the possibility of a major ecological catastrophe "if things continue on their present course". Overall, subjective criteria seem far more relevant in explaining the different environmental attitudes within the engineering profession than demographics. These criteria show a correlation two to three times higher than the demographic one. From this fact, we can conclude that the ethical stance, the preference of the respondents for liberalism or egalitarianism, as well as their religious and political attitudes, are important variables to take into account in understanding the environmental attitudes of French engineers. Hence, hypothesis 3 is confirmed.

4. CONCLUSION

In conclusion, our research finds the following: Environmental dynamics occur at different levels. On the one hand, engineers, differ in their attitudes regarding environmental issues from French people in general. On the other hand, engineers are driven by values. The different dynamics at work, which are not mutually exclusive, have their genesis in a series of factors - more endogenous than exogenous - probably uniting them in a complex manner to form a symbolic system capable of structuring the universe of representations, beliefs and behaviours relating to the environment. We have helped to reveal a not insignificant some pluralism in a profession dominated by the scientific paradigm and often seen as monolithic.

Regarding the explanation of the attitudes of engineers, the analyses presented here have eliminated assumptions rather than offered full explanations. The lack of gender variation leads us to conclude that attitudes specific to engineers cannot be explained by the strong masculinity of socio-professional group composed of 83 % men. Feminization of the profession is unlikely to produce a transformation in the environmental attitudes of engineers, because the attitudes of women do not seem to differ from those of their male colleagues on this topic. The strong correlations between moral, religious, and political attitudes of engineers and their environmental attitudes promote recognition of pluralism within the profession. They do not allow us to advance causal explanations regarding environmental attitudes. Finally, a draft analysis of the respondents' attitude according to their type of engineering education - although not at the heart of this work, and therefore not presented here - has opened up new avenues of research. But the first outcomes showed minor variations.

5. SUMMARY AND ACKNOWLEDGMENTS

What are the attitudes of French professional engineers towards environmental issues? Research based on an extensive survey conducted in 2011 by the French association of graduate engineers with 39 000 professionals, among whom 27 000 responded to an optional section dealing with social, ethical, and professional values,

enables us to provide some answers. In the current presentation, we analyse responses given by the engineers to questions relating to environmental issues, and particularly regarding the statements from the “revised New Ecological Paradigm” of Callon, Dunlap, and Van Liere. Comparisons with the engineers’ fellow citizens were made thanks to the European Values Survey conducted in 2008.

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