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# "I Became an Engineer by Accident!": Engineering, Vocation and Professional Values

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## Abstract

Contrary to many other countries, in France, engineering education remains attractive. Paradoxically, French students do not seem to be motivated by the engineering profession and many graduates seem to have become engineers "by accident". The outcome of our research is that engineering students are "pushed" by an invisible parental and social pressure. The most successful ones end up in a very few prestigious schools, which are supposed to open the doors of the higher management positions in big private companies and public administration, the great majority in a school they have hardly heard about before the "concours", with little motivation for applied science, hardly any vocation for engineering. This work is at the crossroad of two developing approaches within the fields of educational sciences and sociology: the choice to study successful students belonging to the upper or upper middle class which are less investigated than lower classes, and the choice to adopt a qualitative approach, while most researches about orientation are based on wide quantitative surveys. Our aim is to contribute to a better understanding of the construction of the engineers' culture and ethos, through an analysis of the socialization process from the engineering students' point of view.

## Introduction

Contrary to many other Western countries, in France engineering education remains quite attractive. But paradoxically, French students do not seem to be motivated to enter the profession, to work as engineers. In 2009, in a survey about the students' motivation to enroll in their studies, 19% of French male engineering students (and 10% of female) declared that they did not want to become an engineer, versus 4% of European students. More than 25% of French engineering students declared they believed they would not be working in the field of engineering 7 years after their graduation, versus – to take a contrasting case – 0% of German male and 6 % of German female students (Cdefi 2009).

In order to explain the gap we observe between a high appeal for engineering education in France and the surprisingly low interest for the profession itself, we have developed an original research program with the goal of understanding the reason why French engineering students have chosen this educational track. This question has implications for engineering ethics. Actually, the deeper question behind this is: "how can we expect engineers to take up the major challenges of development and sustainable development that face their profession, if the students are not interested in engineering?"

## Context of the Study

One of our hypotheses is linked to the French system of higher education, highly structured by the distinction between the Universities and the Grandes Ecoles (schools of higher education), which we will first say a few word about. Higher education in France is historically divided between Universities and Grandes Écoles. Some curricula are given in both types of institutions, mainly Sciences and Technology and Business and Management; some curricula are given only in Universities, like Medicine, Law and Humanities. When a curriculum is given in both spheres, the Grandes Ecoles are usually said to provide a better (even the best) quality, because of the general level of the students (as a consequence of a stronger selection at the entrance), and because of the smaller size of the classes and of the institutions. In short, Grandes Ecoles appear to give more chances to their students to enter the 'elite' of the nation (Bouffartigue and Gadea 1997).

Someone wanting to study Engineering must enter one of the 240 Engineering Grandes Ecoles, among which 10 are considered as the greatest, the "top ten" (Baron 2010). More than two centuries ago, the first French engineering curricula were given outside of the university and until the end of the nineteenth century, only a handful of institutions had been training engineers in France. When their number increased, the profession organized. In 1934 a law was enacted to protect the title and to establish an accreditation body (Grelon 1984). During the twentieth century, many new schools were created. In addition, accredited curricula were started within the Universities' Faculty of sciences. Being the only programmes needing an accreditation from outside gives them a peculiar status. Although organized within the public university system, they are considered and called Grandes Ecoles. They belong to various networks dedicated to all Grandes Ecoles, or to engineering only Grandes Ecoles. In France, in most people's minds, the expression "engineering education" evokes the mythical world of the "Grandes Ecoles".

The "canonical (traditional, historical) model" of engineering education in France follows a "2 plus 3" years scheme organized in two separate types of institutions. Two years of selective 'Preparatory Classes' conclude with a selective competitive entrance exam. The more famous the schools, the more selective are the exams. Those 2 years are followed by 3 years in the engineering school, to earn the Engineer's degree, which is equivalent to a Master of Science in Engineering in the European System. Despite the Bologna process, the dominant model follows the "2 plus 3" scheme, instead of a 3- year Bachelor's degree plus a 2-year Master' degree.

The main alternative model to the 3-year program consists of 5-year continuous curricula, which is followed by one out of three students. Many private catholic engineering schools propose a program split into two periods: 2 years of "integrated preparatory class" which follow national programs, and 3 years which follow the school's program proper. Other types of 5-year continuous curricula have been proposed since the 1950s in the public-owned Institutes for Applied Science, which follow a German model, and since the 1970s a few Technological Universities follow the North American model. Finally, a dozen institutions gathered in the Polytech' network proposes engineering programs within the Faculties of Science of multidisciplinary Universities (Chatzis 2009).

## Methodology

Our research project consists of a qualitative study based on one-to-one in-depth, semi-structured interviews. Our goal was to find out the reasons why students decided to enroll in an engineering school. The type of methodology we chose (a qualitative one based on a small sample) is often considered as appropriate, when the initial question of a research program begins with “Why?” or “How?”. Here, our aim was to find out subtle relationships between the individuals’ social and cultural context and the concrete choice they made. Qualitative approaches with interviews have been very rarely used in social science in France until recently to deal with educational choices, especially to deal with the choices of those who can choose (Blanchard and Cayouette-Remblière 2011).

We selected five engineering schools located in the north Region of France, which we found to be rather representative of the diversity of French engineering education. One was a 4-year curriculum with a very “atypical” model, at the mining school of Douai which is a publicly-owned school created in 1878. (There are four “minor” Mining schools, not to be confused with the prestigious Mining school of Paris. They recruit after 1 year of preparatory class for a 4-year curriculum. Their competitive exam is considered by many French students as just a training session at the end of their first year.) We also selected three catholic private 5-year curricula: HEI, created in 1885, which proposed various majors; ISEN, an electronic school created in 1956; and ISA, an agricultural engineering school created in 1963. The last school is a public school following the historical ‘canonical model’. The Ecole Centrale de Lille, created in 1872, is considered as one of the best schools in the country, and the best in the northern part of the country.

The sample of students, selected by the academic dean of each school, is composed of volunteer ‘average’ students (not the brightest ones, but with a good probability to achieve their studies). There were a total of 17 students, 9 male and 8 female. Four were from the agricultural school, three from the electronics school, and two from HEI. These entered the project just after secondary High School. Four students joined the project after their first year of preparatory class when they entered the Mining School of Douai. The last four students joined the sample when they entered their 3-year program at the Ecole Centrale.

## Analysis

We have distinguished two ideal types among the students.

(a) First type: the determined and eager to become an engineer (5 students, plus 3)

The “determined engineering students” are strongly committed to becoming engineers and want to practice this profession as soon as they can. They choose to enter an engineering school out of a true interest for the profession. Most of them joined a 5- year engineering school just after High school, and most of them come from middle class families. Camille, whose pharmacist father died when she was young, wants to work as an engineer in the food industry in order to design healthy food. Matthieu, whose father owns a farm, wants to work as a sales engineer in the field of agricultural business. Both of them chose the agricultural engineering school. Guillaume, also from a middle class family, has always been fond of nanotechnology and wants to manage technical projects in the field of electronics. He is not so much interested in the engineering title he will receive from ISEN, but rather the type of job engineering education leads to. Aurélie’s case is singular. She followed a very

unusual track before entering Centrale Lille. Interested in civil engineering since High School, she was discouraged by her family to enter a prepa because of her older sister's bad experience. She decided to study to become an engineer after 2 years of work experience under the responsibility of engineers as a Technical college student apprentice. She enrolled at university where she earned a Bachelors' degree, took the national competitive exam dedicated to bachelor students, and she succeeded very well; she occupies one of the four desks opened to such students at Centrale.

Two Mining school students also belong to this group, although they entered a preparatory class without any desire to become engineers. For them, shortening the prepa after 1 year only to end up in "minor" mining school meant renouncing the chance not only to reach a top ten school, but also to enter one of the 200 other engineering schools reachable at the end of the second year of prepa. The decision not to continue in the second year may be a personal choice. Marine was eager to get out of prepa where she was pushed by the social pressure that weighs on all the good French pupils, especially when in an elitist high school. Having developed a true interest for civil engineering, she chose the mining school of Douai because of its majors.

Talented Chinese Moxi was pushed to go to prepa by her teachers, although her dream before arriving in France as a teenager was to become a novelist. Relieved to be out of the prepa system, she is now determined to work in the luxury goods industry. Marion was a very good pupil in high school. Daughter of an electrician and a social worker, she has always been very interested in maths and biology, but she thought university would only lead to teaching. Scared by the prepa, she chose a 5-year agricultural engineering school eager to earn her living and work in the field of science. Like Moxi, she doesn't know very well what she could do as an engineer. Mohammed, whose parents are both doctors, considered doing medicine, but preferred not to. For him, engineering education is "a good start in life" but it is not really his goal. He wants to create his own business, in the field of information technology, perhaps in Algeria where his parents come from. He really wants to do something useful and thought that a 5- year school would prepare him earlier for a profession than the prepa system.

(b) Second type: the "dithering" students (nine students)

The dithering students are undecided students whose main reason for being in an engineering Grande Ecole seems to be to delay decisions about their professional orientation. Although rather good at, or at least interested by, sciences, they are not particularly attracted by any engineering topics. Their presence in an engineering school is often the result of an absence of choice, of many decisions taken more or less consciously for them, rather than by them.

Mathilde's parents are both graduate engineers. They knew very well the educational system and encouraged their daughter, together with her teachers, to enter a very good prépa. She succeeded in entering the Ecole Centrale of Lille, a good engineering school, although not in the top ten, but she doesn't manifest any interest for engineering or technical matters. Icham, from Morocco, is the grandson of a graduate engineer from the prestigious mining school of Paris. He entered the mining school of Douai, although accepted in a very good second year class, because the school's rank in a magazine was good enough, and because he believed it was a generalist school. He discovered the schools' majors only when entering it. Nicolas failed to enter a Grande Ecole in political sciences and joined a

scientific prepa to please his father, a high school teacher, who dislikes university and values the prepa system. He entered the school in Douai because his teachers told him he would not be able to get a better school the next year and he believes it is a “generalist” school. Lucie is in a 5 year curriculum at HEI. She is a rather good student brought up in an engineers’ environment, but for her being an “engineer is not a job, but a diploma that will allow you to do many jobs”.

Amaury, at the Ecole Centrale, comes from an upper class Parisian family and was a low-average high school student in a top ranked institution. Before entering prépa, he believed that an engineer was a kind of industrial worker and the word “engineer” didn’t appeal much to him. His parents, who are both very successful business people, considered that engineering was the good type of education for him. He wanted to study biology but followed their advice. Celeste was a low-average student in a very selective school. Coming also from an upper class family, her career will depend more on her parents’ overdeveloped business networks than on her own determination to do something with her life. She was discouraged by her counsellor to go to a Business Grande Ecole and says “engineering doesn’t mean much to me (...) Once graduate, in general, no one ends up working in an engineering field”. Thomas is the son of a very successful self-taught business manager. A low-average student at high school, he failed twice on the second year entrance exam but identified a major in medical engineering at HEI. His goal is “not to become an engineer” and will pursue an MBA. Jérémy, a low-average student was very interested in environmental issues and was pushed by his father, a medical doctor, to enter an engineer school because it is better than university; ISA was the only engineering school in the field of Life Science to admit him.

Damien’s case is very different. Neither a son of an engineer or a teacher, nor coming from an upper class family, his parents are both self-educated and were not introduced at all in the higher education system. Being an excellent high school student, he was strongly pushed by his teachers to go to a preparatory class and ended up in the very best preparatory class of the country. There his goal became to be admitted in the best- ranked school in the country. He admitted during the interview that it was a strange way to choose for one’s education and career. None of the students who entered the Ecole Centrale of Lille after completing prestigious prepa like Damien had decided to study in this particular school. When answering the very first question, “why are you here?” Damien answered quickly, “because I didn’t manage to enter the Ecole Centrale of Paris”. Having failed to join the “top ten”, they did not feel like trying their chance a second (and last) time, mostly as the result of a profound boredom with the preparatory class. Aurélie, the “outsider” who ended up at Centrale after an unusual track, comments about her classmates: “there are two main groups of students: those who are disappointed because they got “only” Centrale Lille, and those, like me, who had never dreamt it would be possible.”

## Conclusion

The analysis of the interviews allowed us to highlight two main dimensions worth taking into account when trying to understand the engineering students’ choice. The first relates to temporality, because choosing engineering is perceived by some students as a means to delay their professional choice, or even not to decide. A second dimension relates to their level of interest for engineering topics. The analysis also showed how much what should be

a personal decision for one's future is shaped by more or less subtle scholar and family pressure, as well as a series of myths. Finally it showed how the choice to enter a scientific preparatory class is not conceived as a means to become an engineer in many people's minds other than the students', although the preparatory classes prepare only for the competitive exam to enter engineering schools. So why did they choose engineering education?

(a) Because Grandes Ecoles' degrees are better than Universities'

The choice of those students often appears as a negative choice: they (or their families, their teachers) discard the possibility of studying at University. One of the reasons is that French society is still very hierarchical, even in the companies, where strong importance is given to diplomas, hindering the recognition of experience and non-formal training. Within this strong weight given to the diplomas, there exists a subtle but rigid ranking between the diplomas. Since there is no selection process in order to be accepted into University, the University degrees are believed to be of poor quality.

Conversely, a "Grande Ecole" will be considered as awarding a diploma of high quality. Moreover, in upper class families, studying in a small "Grande Ecole" will quite often be considered a wiser choice than studying in an excellent University; the curriculum in the former will be (really) much easier, while the corresponding diploma is believed to be much better socially recognized.

(b) Because it opens doors and enable to decide later on

Another strong and widely held social belief in France is that engineering education is a "generalist" education, giving the possibility to do anything once acquiring the Engineer's diploma. This undiscussed belief is relayed by high school teachers and/or parents: "if you are good at sciences, you should go to engineering ... you will be able to do whatever you want afterwards!" In fact, even the engineering schools themselves engage this kind of rhetoric; even the most specialized ones tend to present themselves as "generalist schools", because a diploma from a top ten school does in fact lead to a great variety of jobs, sometimes far from typical engineering jobs, and the students religiously recite it. Actually, for those who go through the prepa system, the 2 years of delay before the real choice does not help; the students are just intensively prepared to a competition based on very scholarly individual capacities. They neither learn to know themselves better, nor do they learn the various activities one can practice upon graduation. Instead they learn to respect the very rigid and very French, hierarchical organisation of academic grades.

(c) Because they did not know what to do in their life

Many students said that they went to engineering because they did not know what to do. Actually, in an educational system where selection means "to keep the best and to reject the others", they have no need to ask themselves about what they could do in the future; this kind of question is only for the losers. But this kind of secondary education encourages self-formatting and "fitting into the mold". It develops an early learning of social and scholarly segregation, but totally fails in terms of decision-making pedagogy. A more situational factor that also contributes to this would be the current environment of economic downturn and chronic unemployment. In such a context, to question oneself on one's vocation or the social usefulness of a profession may appear to be an unaffordable luxury when the main issue is how to survive in a jungle? The students' social background, often privileged, paradoxically

does not help because the social pressure is no less in this social environment than in less comfortable backgrounds. Privileged environments will pressure their daughters and sons to reproduce the social model, to have a good standard of living and to reach the highest possible position.

What is the point of such a sterilizing system for the students as individuals, but also for the society as a whole, which is more and more in need of engineers? Obviously some questions need to be asked of secondary education, but also to the lower secondary and to elementary education, since the selective pyramidal model described above, starts at the youngest age. Questions may also be asked of the French system of preparatory class, which does not at all prepare the students to become engineers. One must conclude that this highly selective system ultimately works on erroneous criteria, that is if one intends to assess it in terms of the students' professional commitment, as well as in terms of ethical concerns about technologies and environment. Finally, questions should be asked of the engineering schools themselves, who cultivate ambiguity, and, as they begin to lack recruitment, try to mimic Business Schools, which tend to become the last trendy curriculum for a successful professional life. In the meantime, engineers are so much needed not only to contribute to the nation's economic growth, but also to take up the great challenges of development and sustainable development (UNESCO 2010).

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