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“I Became an Engineer by Accident!”

Engineering, Vocation and Professional Values

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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% French male engineering students (and 10% female) declared that they did not want to become an engineer *versus* 4% European students. More than 25% French engineering students declared they believed they would not be working in the field of engineering seven years after their graduation *versus* –to take a contrasted case - 0% German male and 6% female. (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 very profession, we have developed an original research which goal is to understand the reason why French engineering students have chosen this educational track. You may wonder how this question relates to ethics. Actually, the 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?”

1. Context of the study

One of our hypothesis being linked to the French system of higher education, highly structured by the distinction between the University and the *Grandes Ecoles* (school of higher education), we will first say a few word about it. Higher education in France is historically divided between University 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), 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.

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"¹. More than two centuries ago, the first French engineering curricula were given outside of the university and until the end of the XIXth century, only a handful of institutions had been training engineers in France. When their number increased, the profession organized. In 1934 a law was voted to protect the title and to establish an accreditation body (Grelon 1984). During the XXth century, many new schools were created. Beside, accredited curricula were started within the Universities's Faculty of sciences. Being the only programmes needing an accreditation from outside give 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* ... Anyway, in France, in most head, 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 most famous the schools, the most selective the exams. Those two years are followed by three years in the very engineering school, to get finally the Engineer's degree which is equivalent to a Master of Science or in Engineering in the European System. Despite the Bologna process, the dominant model follows a "2 plus 3" scheme, instead of a 3 years-Bachelor's degree plus a 2 years-Master' degree.

The main alternative model to the three years-programme consists of a five years-continuous curricula which concerns one students out of three. Many private catholic engineering schools propose a program split into two periods: two years of "integrated preparatory class" which follow national programmes and three years which follow the school's proper program. Other types of five years-continuous curriculum have been

¹ For a synthesis about engineering education in France, see Baron 2010

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 of institutions gathered in the *Polytech*' network proposes engineering programmes within the Faculties of Science of multidisciplinary Universities².

2. 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 enrol 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 begins with "Why?" or "How?", here because our aim was to find out subtle relationships between the individuals' social and cultural context and the concrete choice they made. Qualitative approaches with interview 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 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: a four years curriculum very "atypical" model, the mining school of Douai which is a public 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 one year of preparatory class for a four years curriculum. Actually their competitive exam is considered by many French students just as a training session at the end of their first year. We also selected three catholic private five years-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 school of the country, and the best of the region³.

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

² For an explanation of the fragmentation of engineering education in France see Chatzis 2009.

³ There has been one *Ecole Centrale* in Beijing since 2005. Richard Marion, PhD student at Lausanne University in Switzerland is writing his dissertation about this "Sino-French Engineering Curriculums".

their studies), 17 students, 9 male and 8 female. Four from the agricultural school, 3 from the electronics one and 2 from HEI 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 four last students joined the sample when they entered their three years-programme at the *Ecole centrale*.

3. Analysis

We have distinguished two ideal types among the students.

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

The “determined engineering students” are strongly decided to become engineers and willing to exercise 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 five year engineering school just after High school, most of them come from middle class families. **Camille**, whose father a pharmacist died when she was young, wants to work as an engineer in the field of 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 project in the field of electronics. He is not so much interested by the engineering title he will receive from ISEN that 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 her two years of work experience under the responsibility of engineers as a Technical college student apprentice. She pursued 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 one year only to end up in “minor” mining school meant renouncing to try one's chance not only to reach the top ten schools but also to enter on of the 200 others engineering schools

reachable at the end of the second year of *prepa*. The decision not to continue in the second year may be a first personal choice. **Marine** was eager to get out of *prepa* where she was pushed by a subtle social pressure which weigh 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 one its majors. Talented Chinese **Moxi** was pushed to go to *prepa* by her teachers although her dream before arriving to 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 at 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 five year agriculture 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 hesitated to do 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 is own business, in the field of information technology, maybe in Algeria where his parents come from. He really wants to do something useful and thought that a five year school would prepare him earlier for a profession than the *prepa* sytem.

b) Second type: the "dithering" students (9 students)

The dithering students are undetermined students whose main reason for being in an engineering *Grande Ecole* seems to delay the decisions about their professional orientation. Although rather good 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 to enter the *Ecole Centrale of Lille* a good engineering school although not in the top ten, but doesn't manifest any interested for engineering or technical matters. **Icham** from Morocco is the grand son 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 the 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 five years curriculum at HEI. A rather good school girl brought up in an engineers' environment, her orientation sounds like an undisputable evidence but for her "*engineer is not a job, but a diploma that will allow you to do many jobs*".

Amaury today 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 of 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. Low average student at high school, he failed twice 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 with a MBA. **Jérémy**, a low average student was very interest in environmental issues 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, ended up in the very best preparatory class of the country. There his goal became to be admitted in the best ranked school of the country: he admitted during the interview that it was a strange way to chose for one's education and career. None of the students who entered the *Ecole Centrale of Lille* after *prepa* like him had

decided to study in this particular school. When answering the very first question: “why are you here?”, **Damien** answered quickly as an evidence, “*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 you 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 personnel decision for one’s future is shaped by a more or less subtle scholar and family pressure and a series of myths also. Finally it showed how the choice to enter a scientific preparatory class is not conceived as a means to become an engineer in many heads else than the students’, although the preparatory classes prepare only to the competitive exam to enter engineering schools. So why did they choose engineering education?

a) Because Grandes Ecoles’ degree are better than University’s

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 the 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 small “*Grande Ecole*” will quite often be considered a wiser choice than studying in an excellent University: the curriculum in the former one 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 wide social evidence in France is that engineering education is a “generalist” education, giving the possibility to do anything once acquired the Engineer’s diploma. This undiscussed evidence 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!”. The fact is that even the engineering schools themselves engage this kind of rhetoric: even the most specialized ones tend to present themselves as “generalist schools”, because the top ten indeed lead to a great variety of jobs sometimes far from typical engineering jobs and the students religiously recite it. Actually, for those you go through the *prepa* system, the two years of delay before the real choice do not help: the students are just intensively prepared to a competition based on very scholarly individual capacities. Neither do they learn to know better themselves nor the various activities one can practice once graduate. 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 eject 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 scholar segregation, but totally fails in terms of decision-making pedagogy. A more situational factor would be the current environment of economic downturn and chronic unemployment. In such 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 than 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 life 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 to secondary education, but already to the lower secondary and to the

elementary education, since the selective pyramidal model described above, starts at the youngest age. Questions are also to be asked to the French system of preparatory class, which do not prepare at all the students to become engineers. One must conclude that this highly selective system ultimately works on erroneous criteria, when one intends to assess them against their results in terms of professional commitment, moreover in terms of ethical concerns about technologies and environment. Finally, questions are to be asked to 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, while engineers are so much needed not only to contribute to the nation's economical growth, but also to take up the great challenges of development and sustainable development. (Unesco 2019)

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