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Why, and how, do they choose to become engineers?

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ABSTRACT

This paper presents the first results of a still on-going longitudinal and qualitative study with typical students in French 'Engineering Schools'. It tends to prove that a good half of these students, at the beginning of their studies, do not really know what kind of profession they would like to carry on. And nearly a third part of the others choose this course of study because they believe that it is a quite good training, which will allow them to take up the career they are longing for... this latter not being an engineer career! In order to throw some light on these results, we try to give some interpretations, taking into account the specificity of the French Higher Education.

Keywords

France; Higher Education; Engineering Schools; Vocation; Choice; Self-determination; Social determination.

1. INTRODUCTION

Many research programs of the last years have been dealing with the question: "why are young people so reluctant to study engineering?"¹. In France, scientific education is traditionally considered the "high way" for a good career, and engineering education remains a rather attractive perspective. As a consequence, an important proportion of these students may end up in engineering studies with scarce motivation. At the same time, one can see a growing importance of themes such as Sustainable Development and Corporate Responsibility in the various Engineering curricula.

For the authors, senior lecturers in Engineering Ethics, these topics are not just technical questions, but global concerns, and we believe that our society is in need of engineers who are deeply concerned by these issues, beyond the reigning fashion or the mere use of recipes "just not to come under the law".

It is therefore essential that the Engineering students take this concern upon themselves, as persons, in order to give it an embodying status of their studies. But, if we want this conviction to be more than a mere wishful thinking, it is essential to understand how our students can involve more of themselves in their studies.



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¹ e.g., Johnson & al. (2006); Prieto & al. [12].

Therefore, our still ongoing study follows some engineering students during their whole curriculum, to understand how they make their choices: first, when they are 18 years old and fresh from High School, and then, during their curriculum. We wonder to figure out how they end up, after five years, as graduates in Engineering, comprehending themselves as true "engineers". Our study begins with the initial choice at the beginning of Higher Education, just after High School. In the upcoming steps of this study, we will progressively shift our attention to the ways, for these young persons, of adapting themselves to their future engineer identity.

First, we will have to draw the implicit landscape which allows our readers understanding our results. The matter is the specificity of the French Higher Education system, consisting of a partition and a kind of rivalry between the University and the so-called 'Grandes Écoles', the 'Engineering Schools' belonging to the second pole. Secondly, we will begin with the first working hypothesis which guided us, in order to build the methodology of our study. Given the reduced space available for this paper, we will quickly present our methodology². Then, we will expose and discuss the first findings of this exploratory study. This will allow us to revisit our first working hypothesis, in order to confirm, to refine, to supplement or to improve them.

2. HIGHER EDUCATION IN FRANCE

2.1 'Grandes Écoles'

Higher education in France is divided between University and 'Grandes Écoles' (from now on, abbreviated *GEs*), which are often seen as two enemy sisters³. *GEs* may be public or private⁴. Some curricula are given in both *GEs* and Universities (mainly, on the one hand: Sciences and Technology, on the other hand: Business and Management); other are given only in Universities (like Medicine, Law and Humanities). When a curriculum is given in both spheres, the *GEs* 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, and of the better educational environment for the students. In short, *GEs* appear to be more elitist, or to give more chances to their students to enter the 'elite' of the Nation.

Things become a bit more complicated, when one discovers that "GE" is not granted with an official definition. The Ministry of

² A wider presentation of this methodology will constitute the material of a bigger paper in the future.

³ Bonnard & al. [2], 603.

⁴ The only difference is the fee one must pay for his studies. A public *GE* is quite affordable: very often, some hundreds of Euros a year. In some of the most prestigious ones only, the students are even paid during their studies! But studying in a private *GE* happens to be rather expensive: several thousands of Euros a year, the most expensive ones being the Business and Management Schools.

Schools). However, it belongs to the daily language, and even the very *écoles supérieures* use it on purpose. Why? Originally, that is to say until 30 years ago, the label “GE” was reserved to a very reduced number of Superior Schools, the most famous ones, which were mostly Schools preparing senior civil servants like *École Polytechnique*, *École des Mines de Paris*, *École des Ponts et Chaussées*. Thus, nowadays, because of the original elitist connotation, and because of the lack of an official definition, every *école supérieure* tends to apply this expression to itself, for some quite understandable reasons... The final result is that “GE” just sounds like “not the mere University”. But a strong hierarchy still prevails among the various GEs, be they Business and Management Schools or Engineering Schools. As an example, every year, several great newspapers and magazines publish their “hit parade” of the French GEs⁵. One could say that, being the University the ‘common birth’ people, there are, among the GEs, the nobility and the gentry⁶.

2.2 Engineering ‘Grandes Écoles’

In France, someone wanting to study Engineering after High School, must (with very few exceptions) enter a *Grande École d’Ingénieurs*⁷. There are more than 200 GEIs in France⁸, among which, only 10 to 15 are considered as the greatest.

The ‘canonical model’, for Engineering GEIs, consists of :

- 2 years of ‘Preparatory Classes’⁹, not yet in a GEI, concluding with highly selective competitive entrance examinations (‘concours’); the most famous the GEIs, the most selective the ‘concours’.
- followed by 3 years in the very GEI, to get finally the Engineer diploma.

This model is the unique path to the most prestigious GEIs. It is still the most common among the 700 000 French graduated engineers, but it is tending to disappear; the proportion from CPGE is slowly but regularly falling: 52% in 2009, against 53.4% in 2008¹⁰.

A small number of GEIs recruit their students after only one year of CPGE, for a 4 years curriculum. The other main model consists of a 5 years continuous curriculum in the GEI, including the 2 first years having a status of CPGE, but without a selective ‘concours’ at the end.

Some schools are rather generalist, other begin with a generalist formation and afterwards offer various specializations, whilst some are very specialized from the beginning of the curriculum. But, in all cases, we must add that, since about 20 years, a growing importance of the Human and Social Education (in French: “Formation Humaine”) has been progressively noticed in nearly all the GEIs. At the beginning, this kind of complementary education was strictly limited to the greatest GEIs and the Catholic ones. But this pattern is nowadays spread among the majority of GEIs¹¹.

As a conclusion we may say that, because of the (more or less) ‘aristocratic’ status of GEs in France, an *engineer* diploma

certainly gives the awarded a real social acknowledgement, beside the professional one.

3. WORKING HYPOTHESES

1st hypothesis: Given the French elitist context of the GEs, choosing to study in a GEI could be a kind of negative choice; since getting an engineer diploma grants a social acknowledgement, it is conceivable that students who are not already self-determined about their future when they get out of the secondary school, but showing some gift for sciences, might choose this solution more as a non-choice, as a way to delay their real choice. This will be the first hypothesis we will have to test.

2nd hypothesis: This hypothesis has to be considered as a possible consequence of the previous one. The negative choice could be strongly based on the socially rooted belief that an engineer diploma can open a great variety of doors, that is to say, on the attractiveness of the diploma, not so much for the quality of the received formation, as just as a visiting card.

3rd hypothesis: This hypothesis is split into two parts. If the first hypothesis is validated, we will have to check if this kind of ‘non-choice’ behavior is:

(A) more pronounced for the ‘canonical model’ GEIs, than for a 5 years curriculum GEI. This hypothesis is based on the fact that, in the ‘canonical model’, the results of the ‘concours’ at the end of the 2 years of CPGE are rather risky, and that the majority of the students don’t have any idea of which GEI they will enter next year. Conversely, since the selection is less fierce for the other kind of GEIs, we might infer that the students have more possibilities to choose the kind of curriculum they want to study. However, this hypothesis could be toned down, because of the lesser maturity of these students at the moment of their choice;

(B) more pronounced, within the sub-category of the 5 years curriculum GEIs, for a generalist school than for a more specialized school.

4th hypothesis: This is the last explanation key that we will test in the future. We suppose – and we hope – that, in the case of students with weak self-determination, these will gradually enter the engineer’s shoes throughout their curriculum. The final confirmation of this hypothesis will come at the end of the study, but we may find some partial confirmations at the various stages of the study.

4. METHODOLOGY

4.1 An Exploratory Qualitative Study

We chose to conduct at first an exploratory study, in order to check if our hypothesis could have some validity. And it appeared to us that the best way to achieve it was a qualitative study. But this kind of study must first be replaced in a broader perspective. It follows a quantitative Ph.D. study¹², and is parallel to another research on ‘a-typical engineers’: graduate engineers who engage their skills and knowledge in the socio-political field¹³.

As such, an exploratory study is aimed to open some tracks of interpretation which will be, later, tested in a quantitative and statistical way. Social scientists often distinguish four features in an exploratory study: small size of the sample, interaction between observer and object, observer as an instrument for the

⁵ e.g. *L’Express* [9] and [10].

⁶ Bourdieu [3].

⁷ From now on, abbreviated *GEI*.

⁸ For a good synthesis, see: Baron [2] and *Le Monde* [11].

⁹ From now on, abbreviated *CPGE*

¹⁰ *Le Monde* [11].

¹¹ Didier [4].

¹² Didier [5] and [6].

¹³ Didier [7], to be published.

cases analysis, in which the role of interpretation is fundamental and gathering of qualitative data.

A qualitative study is often considered as appropriate, when the initial question of the research begins with “Why?” or “How?”¹⁴, when the study deals with an emerging topic. It may thus be considered as a kind of craftwork, before the ‘industrial’ stage.

4.2 Practically

The fundamental idea of the study is to follow a group of ‘average’ students proceeding from various GEIs, during their whole curriculum, in order to find out firstly, why they decided to study in a GEI and secondly, how they evolve during their curriculum.

4.2.1 Choice of the GEIs and of the Students

For the whole study, which is still ongoing, we selected six GEIs, which we found to be rather representative of the diversity of GEIs: five years curriculum (HEI, ISA, ISEN), ‘canonical model’ (Centrale Lille and Centrale Paris), and intermediate model - four years curriculum (Mines de Douai).

Tables 1a & 1b. Characteristics of the selected GEIs

	HEI Lille	ISA Lille	ISEN Lille
Curriculum	5 years continuous		
Status	Private (Catholic University of Lille)		
Orientation	Various majors after 3rd year	Agriculture, Agrofood, Environment	Computing, Electronics, HighTech
Ranking ¹⁵	33 of 64	55 of 64	16 of 64
Graduates	276	134	113
Webpage	www.hei.fr	www.isa-lille.fr	www.isen.fr

	Mines de Douai	Centrale Lille	Centrale Paris
Curriculum	4 years	3 years (‘canonical model’)	
Status	Public	Public	
Orientation	Generalist Various majors	Generalist	Generalist
Ranking	29 of 99	13 of 99	2 of 99
Graduates	236	250	431
Webpage	www.ensm-douai.fr	www.ec-lille.fr	www.ecp.fr

In order to select our students, we contacted the academic dean of each selected GEI, we explained him our project, and asked him to choose himself some ‘average’ students (not the brightest ones, but with a good probability to achieve their studies), to take part in our research.

4.2.2 Interviews

During their GEI curricula, we meet each of these students once a year, for an hour semi-directive interview. These interviews are recorded and integrally transcribed for further analysis.

¹⁴ e.g. Wacheux (13).

¹⁵ Ranking according to *L’Express* [10].

All these students (except if one had to repeat a year) got out of the secondary school in June 2008, and should normally be graduated in June 2013. But, because of the variety of GEI models, we begin to follow them at different stages of their curricula.

Table 2. Calendar of the interviews

	HEI ISA ISEN	Mines de Douai	Centrale Lille Centrale Paris
2008-2009	Eng. School Year 1	CPGE Concours	CPGE
Int. N°	1		
2009-2010	Eng. School Year 2	Eng. School Year 1	CPGE Concours
Int. N°	2	1	
2010-2011	Eng. School Year 3	Eng. School Year 2	Eng. School Year 1
Int. N°	3	2	1
2011-2012	Eng. School Year 4	Eng. School Year 3	Eng. School Year 2
Int. N°	4	3	2
2012-2013	Eng. School Year 5	Eng. School Year 4	Eng. School Year 3
Int. N°	5	4	3

5. THE FIRST STAGE OF OUR STUDY

As a logical consequence of the upper calendar, at the date of the redaction of this paper, we did not already carry out the first interviews with the students from Centrale Lille and Centrale Paris.

5.1 Some Data about the Interviewed Students

They will be designated by their initials. At the moment, we have a 13 students sample, gender balanced (7 M / 6 F). They are 2 from HEI, 4 from ISA, 3 from ISEN and 4 from Mines de Douai. We present some of their characteristics hereafter.

MP (F, HEI): His father is a graduated engineer from ISA, now settled in the south of France. Most of her friends and cousins study in a GE, she is attracted by science. Therefore, studying in an GEI sounds “normal” to her, but she is still floating about her future.

MB (M, HEI): Son of a self-taught engineer. He has a passion for medicine, but he did not succeed in it, and turned to HEI where he identified a major in medical engineering. He is interested in starting his own business.

CM (F, ISA): Many members of her family are pharmacists. She wanted to study pharmacy too, but they discouraged her from taking this way, because of the toughness of the sector. Since she is fond of biology, she decided to study at ISA, in order to work in the food process sector, and possibly to design new healthy aliments.

JB (M, ISA): Son of a physician. He was a low-average high schoolboy, and ISA was the only GEI he could enter (it was his last choice). He would like to work in the field of “environment”, not knowing what to do. He is looking for a good 5 years higher education.

MH (M, ISA): He comes from a rural low middle class family, studied previously in a rural catholic high school. His father, a

widower, is a farmer. He wants his studies to enable him to remain in his milieu, would like to be a commercial or start his own business.

MD (F, ISA): She too comes from a rural low middle class family. Her father is an electrician. Very interested by mathematics and biology, a very good high school student, she might like to work in the field of research, but her project is still not clear.

CD (F, ISEN): She comes from an upper class Parisian family. She was a rather low-average high school girl, even being grand-daughter of a *Polytechnicien*. She does not know what she wants to do later, and she chose a GEI following her parent's, teachers' and tutor's (himself *Polytechnicien*) advice. She would have preferred to study business and management but failed at the "concours".

GH (F, ISEN): He comes from an upper middle class family and was not a very good student. Fond of nanotechnologies since long, he clearly wanted to study at ISEN, because this GEI is in the field of electronics, whilst giving a broader education than University.

MH (F, ISEN): Both of his parents are Algerian physicians, practicing in France. He hesitated to undertake medical studies, but finally chose a high quality technical education, because "it's a good start in life". He insists on the social utility of the job and may want to start his own business.

MM. (F, Mines Douai): After one tough and stressful year of CPGE in a very selective one, she tried the 'concours' of this GEI as training session. But having passed, not willing to spend another year in CPGE, and being already fond of construction (one of the majors in his GEI) she decided to enter this Ecole.

MI. (M, Mines Douai): He came from Morocco to study in France. His parents are both working in the field of IT (graduated from the French University). His grandfather graduated from the very famous GEI *Ecole des Mines de Paris*. Mohamed I. took this "concours" as a training session, and passed it. He was also admitted in the second year of CPGE, in a very good class, and could have pretended to pass a much better "concours" the year after. Not knowing very much about this GEI, he thought that, because of its rank, it was good enough and chose to enter this Ecole.

MZ. (F, Mines Douai): Chinese, her parents live in France (storekeepers in Paris' China Town) She arrived in France at about 14 years old, not speaking a mere word of French. In China, she dreamed of being a writer. But her coming to France meant a new language, a new culture, and she had more facilities in mathematics and physics. She would like to work in the field of luxury.

NB (M, Mines Douai): Son of a teacher and a librarian, he was a good high school pupil, but his level was rather low in CPGE. At the end of the first year of CPGE, he took the 'concours' as a training session, and passed it. Being admitted in this GEI, he was advised to enter it, because he could not be sure to get a GEI of better level the year after. He likes math and is interested in quality management, but is rather floating about his future.

5.2 First Results

5.2.1 Three Ideal Types

Our first interviews allowed us to highlight 3 main ideal types, i.e., according to Max Weber, "a construction, a utopia, won by one-sided exaggeration of certain aspects of reality"¹⁶.

- **1 - Floating:** Socially determined and/or personally undetermined students.
- **2 - Pragmatic:** Choosing to study in a GEI is for these students a compromise. GEIs are supposed to offer a high quality higher education, with a very good scientific and technical underpinning, but broader than a mere Master in Technics and Sciences at the University (Management, Economics, Communication, etc.). They believe that this kind of higher education is the best one to go in for a career in superior management for example.
- **3 - Determined:** These students are strongly decided to become engineers and willing to exercise this profession. There is evidently a clear-cut frontier between the first ideal type and the two others: on the one hand, the students are uncertain about their future, on the other hand, they are not. However, the first and the second ideal types are close together with relation to the 'utilitarian' attitude towards the fact of studying in a GEI. The only difference is the subjective attitude towards the future.

5.2.2 Distribution between the Ideal Types

Table 3. Distribution between the 3 ideal types

Name	GEI	Group		
		1	2	3
MP	HEI	1		
MB	HEI		¼	¾
CL	ISA			1
JB	ISA		1	
MH	ISA		1	
MD	ISA	½	½	
CD	ISEN	1		
GH	ISEN	½		½
MH	ISEN		1	
MM ¹⁷	Mines D.	1		(1)
MI	Mines D.	1		
MZ	Mines D.	½	½	
NB	Mines D.	1		
Sub-totals		6.5	4.25	2.25 (3.25)

Since these groups are defined as Weber's ideal types, one may predict that some students will necessarily fall between two categories. In this case, we count his belonging to each group for ½, or for a ¼ and ¾.

5.2.3 First Findings

The first striking observation is that half of our students belong to the first ideal type, and that only a quarter of them are 'determined'. Even taking into account the small size of our sample, we may think that a good part of the engineering

¹⁶ Weber [14].

¹⁷ The case of MM. is peculiar: she does not belong to two groups simultaneously but she transits from type 1 to type 3 during her studies. We already might say that she incarnates the first example for our fourth hypothesis.

students in French GEIs choose this kind of studies because, though being rather good at math, they do not already know what they want to be when they get out of the secondary school. Most of them believe that studying in a GEI will grant them with a reliable and socially acknowledged education, which will allow them to make up their mind later on.

Even more striking is the fact that all the students of Mines de Douai belong (at least partially) to the first ideal type. We may interpret that finding from the idea that the ‘concours’ for this GEI takes place after only a year of CPGE. When a young student enters the CPGEs, he usually dreams of the greatest GEIs (Polytechnique, Mines de Paris, Centrale Paris, etc.). But the toughness of the reality soon drives the great majority to admit that they never will enter these most famous GEIs. The choice of Mines de Douai could therefore be a squared choice ‘by default’: first, because shortening the CPGE tastes in itself like a semi-failure, and second, because this GEI is the only choice one has got when deciding – or when being obliged – to stop the CPGE.

A third interesting observation is that a third part of the students who study in a GEI is not willing to have a job of engineer. This is likely due to the somewhat ‘aristocratic’ status of the GEs in France, in comparison with the ‘mere’ University.

5.3 Comparison between our Working Hypotheses and our First Findings

From the simple fact that a half of the interviewed students belong to the first ideal type, we already are able to declare that our first hypothesis is clearly confirmed.

Our second hypothesis is partly confirmed. The attractiveness of an engineer diploma, seen as universal ‘sesame’, does exist, but our research discloses another strong reason to study in a GEI: that is, the belief that the best asset to begin a professional career is a robust polyvalent education with scientific and technical underpinning, broader than at the University. This finding surprisingly appears to be more frequent for the 5 years curriculum GEIs, which are usually considered as not quite as good as the schools belonging to the ‘canonical model’, and even for the most specialized one (ISEN). This finding is even confirmed by the sayings of the most ‘convinced’ students (ideal type N° 3): although they began engineering studies because of their scientific passion, they usually happily discover that the education in a GEI is broader than what they had thought at the beginning.

Our third hypothesis, split into two parts, sees its first part fully confirmed by the fact that a half part of our students belongs to the first ideal type, and that all students of École des Mines de Douai belong to this group. The second part of this hypothesis is difficult to confirm, because of the small size of our sample. This could be a question for a more quantitative subsequent study.

6. CONCLUSION

The first part of our study has been fruitful. Our first hypotheses were not out in left field, and we are thus able to continue our study, according to the steps we had defined. We will have to take into account the nuance introduced in the third hypothesis: that should open new avenues for our research. Overall, the specific French context of ‘Grandes Écoles’ seems to be strongly determining, and might give rise to an interesting comparative study with various countries.

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