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INEQUALITIES CONCERNING ACCESS TO ENGINEERING SCHOOLS SOME WAYS TO IMPROVE EQUAL OPPORTUNITIES

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Abstract

We would like to show how inequalities at school in terms of success rate may entail significant social injustices concerning the access to a career in engineering. We have carried out research in two major engineering schools, in the Rhône-Alpes region in France, that each recruit more than a thousand students per year. These are the National Institute of Applied Sciences in Lyon (INSA) and the various schools composing the Grenoble National Polytechnic Institute (GINP).

Through these data we can see how success at engineering school is linked to the parents' occupation. We have developed indicators to measure social representation in these schools so as to take into account the national occupational structure of the population. We have also studied some of the developments since the 1950s, when data are available. Today, the relative representation ratio between children of executives and higher intellectual professions and children of workers has increased to more than 20.

We have especially referred to the theory of reproduction and to the theory of justice to highlight the social drawbacks which this entailed. We wanted to know where injustice lies: in the reproduction phenomenon or in the lack of equal opportunity. How to select excellent students with different and representative origins ?

We have tried to find explanations for this phenomenon, engineering schools can focus on creating policy in order to reform such a trend, thanks to: tutoring in secondary education, special recruiting, individual support, awards, and incentive information toward the less advantaged students ...

Note on classification

We refer below to the French national Institute of Statistics and Economic Studies (INSEE) socio-occupational categories that have been used in France since the 1950s to study social groups and describe their professional occupations. (Table 1) This system combines three distinct criteria to separate categories: status, occupation, and skill, so as to offer a good description of many behaviour patterns, among which are cultural or educational practices. Initially, these categories were seen as representing the different social classes. Nowadays "socio-occupational categories are a form of accumulated history, as a product of decades of transformation of society's self images"². The main categories are the following:

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² A. Desrosières, *Courrier des statistiques*. English series, n°15, 2009

<i>Table 1. Main socio-occupational categories of the INSEE and subcategories</i>	
Farmers	Self employed farmers
Craftsmen, retailers and entrepreneurs	Craft workers Retailers and related professions Head of a company with 10 or more employees
High level managerial workers	Self employed professionals Managerial occupations in Government Secondary- and higher-education teachers, scientists Professions of information, arts and entertainment Administrative and sales / marketing managers in the business sector Engineers and technical managers in the business sector
Intermediate level professions	Primary-school teachers and related professions Intermediate professions in the healthcare and social work sector Clergy and religious professions Intermediate administrative professions in government Intermediate administrative and sales/ marketing professions in the business sector Technicians Foremen / women and supervisors
Lower service professions	Civilian employees and service workers in Government Police and armed forces Administrative employees in the business sector Sales / marketing employees Workers providing direct domestic services
Manual workers	Skilled industrial workers Skilled craft workers Drivers Skilled workers in the handling, warehouse and transportation sectors Unskilled industrial workers Unskilled craft workers Farm labourers

Introduction

A study of the National Centre of the French Engineers and Scientists (CNISF) in 2001 noted that at the beginning of their engineering studies 48% of the students in engineering schools had a father who was high level managerial worker, and 12, 2% had a mother who was high level managerial worker. 50% had a mother who did not have a work. In 2001, 44% of engineers over the age of 50, 49% of those aged 30-39 years, and 52% of those under 30, had a father who was high level managerial worker came from this socio-economic origin. The diversity in the social background of engineers is decreasing from generation to generation³. The 2008 CNISF study, covering nearly 7% of engineering graduates under 65, estimated that: only 7% of the engineers had a manual worker father, 2% a manual worker mother, 8% had a father with a lower service profession, 18% a mother lower service profession; 51 % had a father who was a manager, an engineer, an employer or was self employed professional and 42% had a mother who did not have a work. These observations legitimate the emerging concerns on the students recruiting policy in engineering school.

WHY WONDER ABOUT THE ORIGIN OF THE STUDENTS?

Since the beginning of this century the most famous “grandes écoles”-prestigious French engineering and business schools- pay close attention to the issues of diversity in their student population. This desire stems from the will to implement greater equal opportunities, the search for efficiency by discovering all talents and the desire to ensure greater social cohesion. This issue is particularly significant for engineering schools that, in 2006-07, only accepted 6% of students whose father was a manual worker. Are these schools, that recruit and train the people who will one day participate in technological discoveries and decisions which may prone for mankind, able to select future scientific and technical managers who are representative of the

diversity of society? These students came from a population which was selected throughout the secondary education system. Nevertheless, some schools propose affirmative action combining the use of several tools for both promoting the diversity of the applications, selections and the struggle against the failure of certain groups within the engineering schools itself.

The goal of French engineering schools is to select the young people who will one day become the engineering professionals that society needs.

Selectivity as opposed to equality of opportunities

In order to train competent engineers, the candidates' scientific pre-requisites, as well as their ease and speed of acquisition are crucial. Schools then recruit the candidates who have already proved that they have a high level of technical knowledge, methodology and capacity to work. These characteristics are expected to be present among students who have already acquired a good level in science and have taken the scientific baccalaureate. All of these features can more easily be acquired in a socially favourable family environment characterized by high economic, educational and professional status. Should higher education establishments implement a compensation for the social, economic or cultural disadvantages students may suffer from? This principle is in theory applied during the 15 years of school attendance that precede the French baccalaureate, which is equal to British A-level or Scottish Highers. How does the non-compliance with equal opportunities concerning success in obtaining a scientific baccalaureate, affects the recruitment and the academic policies of the schools? Which candidate selection policy should be implemented?

If the role of the engineer is like that of a general technician, his or her scientific expertise is essential. However in this case, it is about ensuring a level of competence when students leave the school and not necessarily an excellent level when they enter. Thus one could consider recruiting more socially representative students, even if engineering schools would have to compensate for these students' shortcomings, by offering more suitable or longer academic curricula.

If the engineer is to be a researcher or an innovator, one should recruit according to criteria, such as experience, imagination, and creativity, qualities that may not be present among the purely academic students. P.Veltz (2007) explains that our major engineering schools form few innovators or entrepreneurs, notably because most of their recruits candidate in view of minimizing risk in term of employment opportunities.

If the engineering is a social function, it would be necessary according to Rawls (1987/1971) that everyone could access to it thanks to an effective equality of opportunity (notably through education). There may be fair inequalities, he said, if they operate to the benefit of disadvantaged people (those with the fewest primary resources). French engineering schools reveals a lack of equal opportunities in French society. But Rawls' argument is ambiguous: promoting "the brightest" can also be seen as a way to work to the benefit of the most disadvantaged when the most talented will, by their work, improve growth, innovations...

The Rawlsian approach also assumes that a fair society must attract people to positions where they are most useful from a social sight. It is one signification of the difference principle. So scientists should rather use their scientific talents instead of being converted to managers or executives, trades for which they were neither selected nor trained. If the engineering profession is to lead teams, highly competent scientists are not necessarily required for such tasks. We can then question the choice of scientific baccalaureate as a breeding ground for recruitments.

How ensuring general interest if citizens responsible for the tomorrow's challenges come from closed social origins? May altruism be an object for training? In keeping with the liberal logic as thought by A. Smith (1991/1776), the interest of society is served by the pursuit of individual interest. However, for A. Smith (1999/1759), the implementation of methodological individualism in the construction of the natural harmony is also based on the principle of sympathy. Everyone acts while being sensitive to the sympathy its behaviour arouses in others, referring to a criterion of good and evil he considers universal. Thus respect for the others' interests is ensured thanks to the concern that everyone has for the others' opinion. However, we believe this can be applied only in a society in where people live in the real dependence of the others' look and not in a partitioned off society that builds homogeneous and quite separated groups Altruism is probably more difficult to teach in this second case. With a weak diverse recruitment the risk is increased that technical choices are made in the absence of debate on societal issues.

Two ways seem then possible to secure the service of general interest: identify and teach an ethic of social interdependence, or create a representation of the diversity of interests through the application of a kind of quotas.

Main obstacles to a significant opening to social diversity occur during secondary education

In engineering schools, the overrepresentation of children of higher executive category and underrepresentation of manual workers' children is an extension of the selection based on scientific disciplines in preparation for the baccalaureate. (Table 2).

Table 2. To compare socio-occupational origins of pupils and students

2008-09							
According to the socio-occupational category of the head of the household							
% of each column	First cycle of secondary education (ages from 11 to 14)	Second cycle of secondary education (ages from 15 to 18)	All students (after baccalaureate)	Universities	External preparatory classes « Grandes écoles »	Technological universities and Polytechnic National Institutes	Other engineering schools
Farmers	2.5	2.3	12.6	10.9	11.7	10.6	14.4
Craftsmen, retailers and entrepreneurs	11.3	11.4					
High level managerial workers	18.8*	26.8*	39.0	40.3	56.4	54.7	56.1
Teachers	3.5	5.1	0.0	0.0	0.0	0.0	0.0
Intermediate level professions	14.5**	17.1**	17.6	18.4	14.9	17.6	15.7
Lower service professions	18.2	16.8	16.9	17.2	10.5	9.6	8.5
Manual workers	31.2	20.5	13.9	13.1	6.5	7.5	5.3
2007 Employment inquiry Insee							
% of each column	Employed population over the age of 15	Employed population aged 30-49 years	Employed population over the age of 50	Male employed population over the age of 15			
Farmers	2.1	1.8	3.7	2.3			
Craftsmen, retailers and entrepreneurs	6.2	6.3	9.4	8.0			
High level managerial workers	15.5	16.6	18.3	18.2			
Intermediate level professions	23.6	24.6	21.4	22.1	Source : Insee		
Lower service professions	29.8	28.4	28.9	13.3	Repères et références statistiques. MEN, 2009		
Manual workers	22.8	22.3	18.3	36.1	* except secondary- and higher-education teachers ; ** except primary-school teachers		

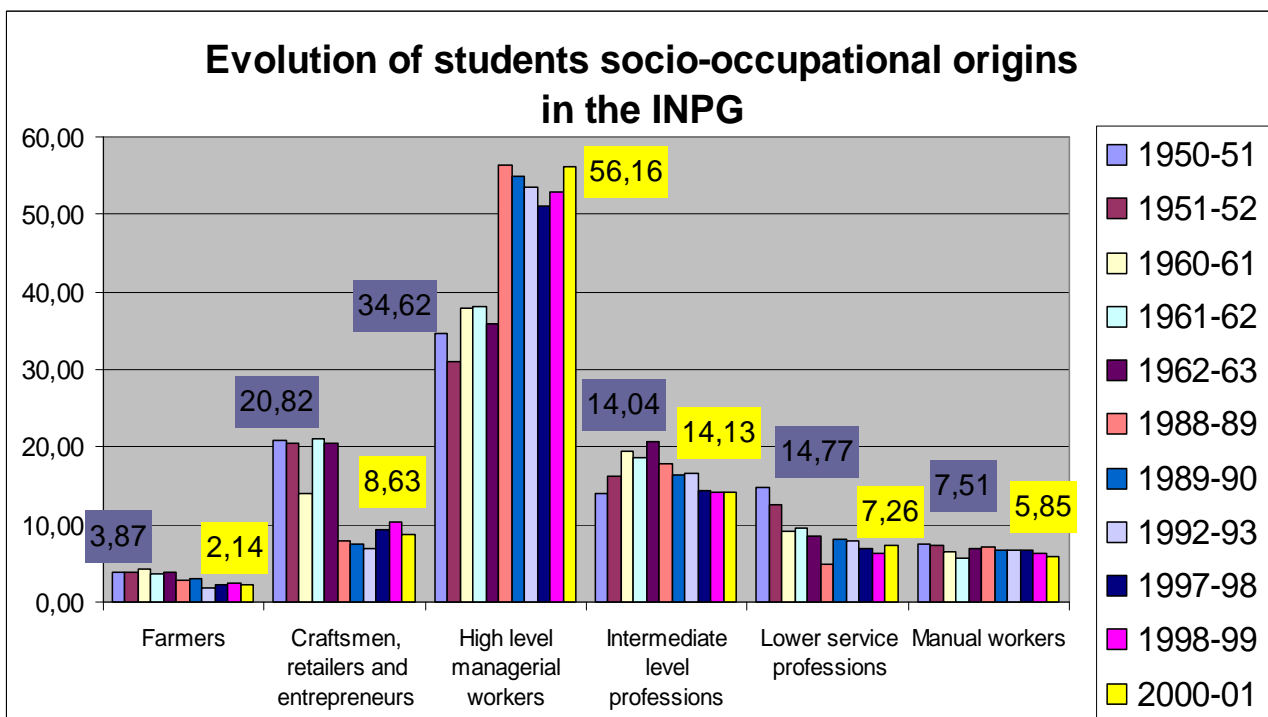
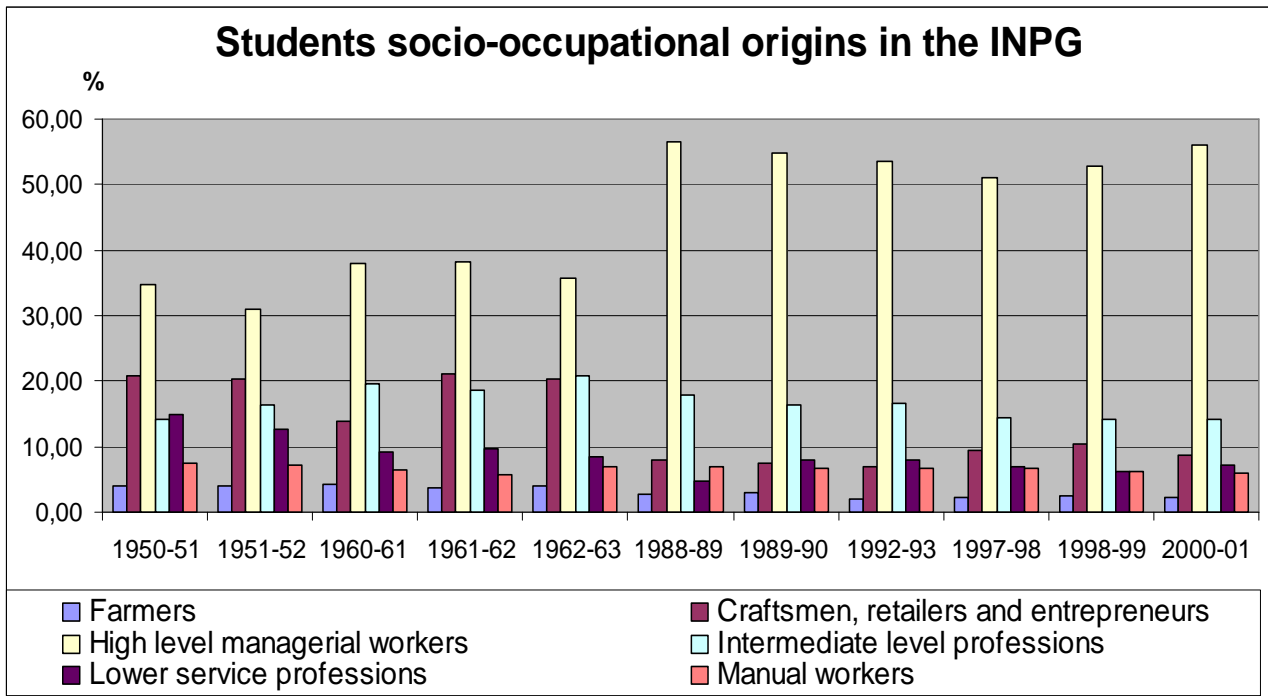
We look at the socio-occupational representation from the first cycle of secondary education to higher education. Overall, higher the development of studies is, the more the proportion of children of high level managerial workers increases (from about 20% to over 56%) and the one of children of manual workers declines (from 31% to 7%).

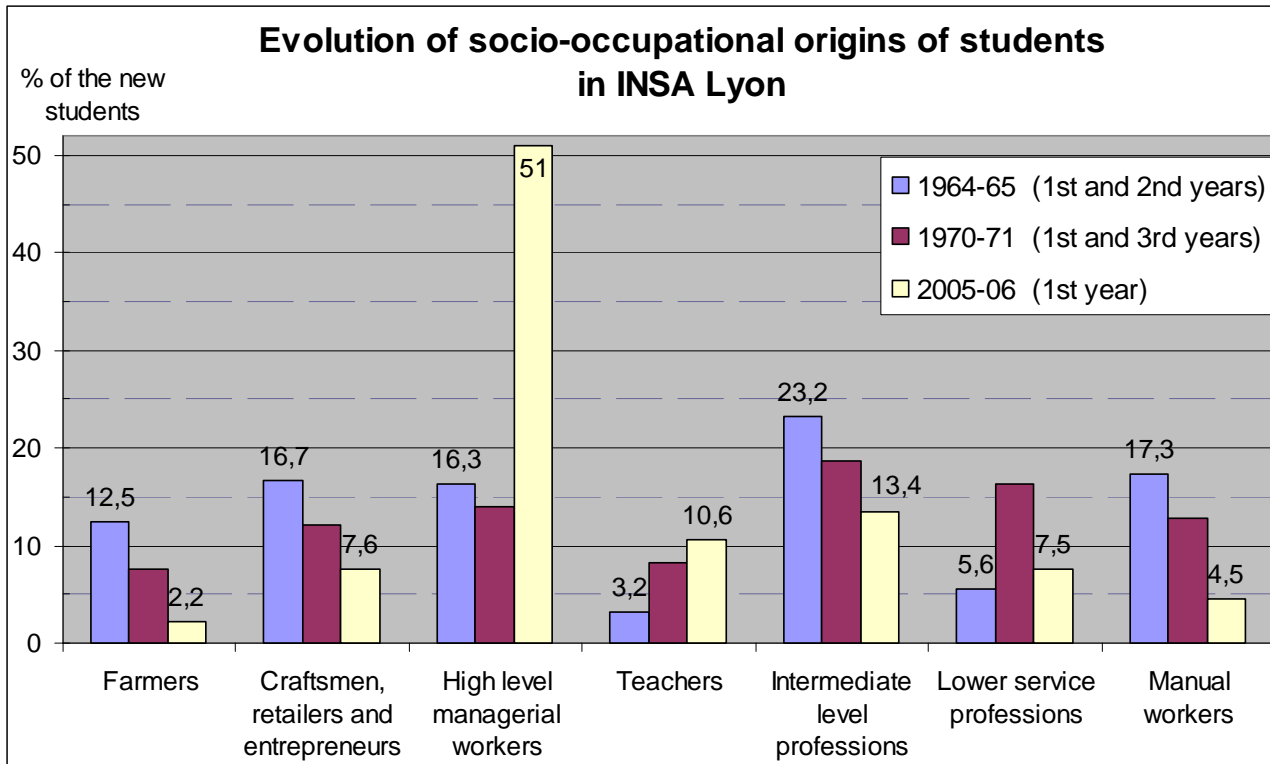
Compared to the active population, there are, in the first cycle of the secondary education, more children of farmers (ratio of 1.2 compared to the overall workforce, and 1.1 compared to the male workforce) craftsmen, retailers and entrepreneurs (1.8 respectively 1.4), high level managerial workers (1.3, respectively 1.1), but significantly fewer children of intermediate level occupations (1.4 time less). For lower service professions or manual workers, it depends on the reference population (1.7 times less and 1.4 for the former, 1.4 and 0.9 for the latter).

STUDENTS OF THE NATIONAL POLYTECHNIC INSTITUTE OF GRENOBLE (INPG) AND OF NATIONAL INSTITUTE OF APPLIED SCIENCES OF LYON (INSA LYON)

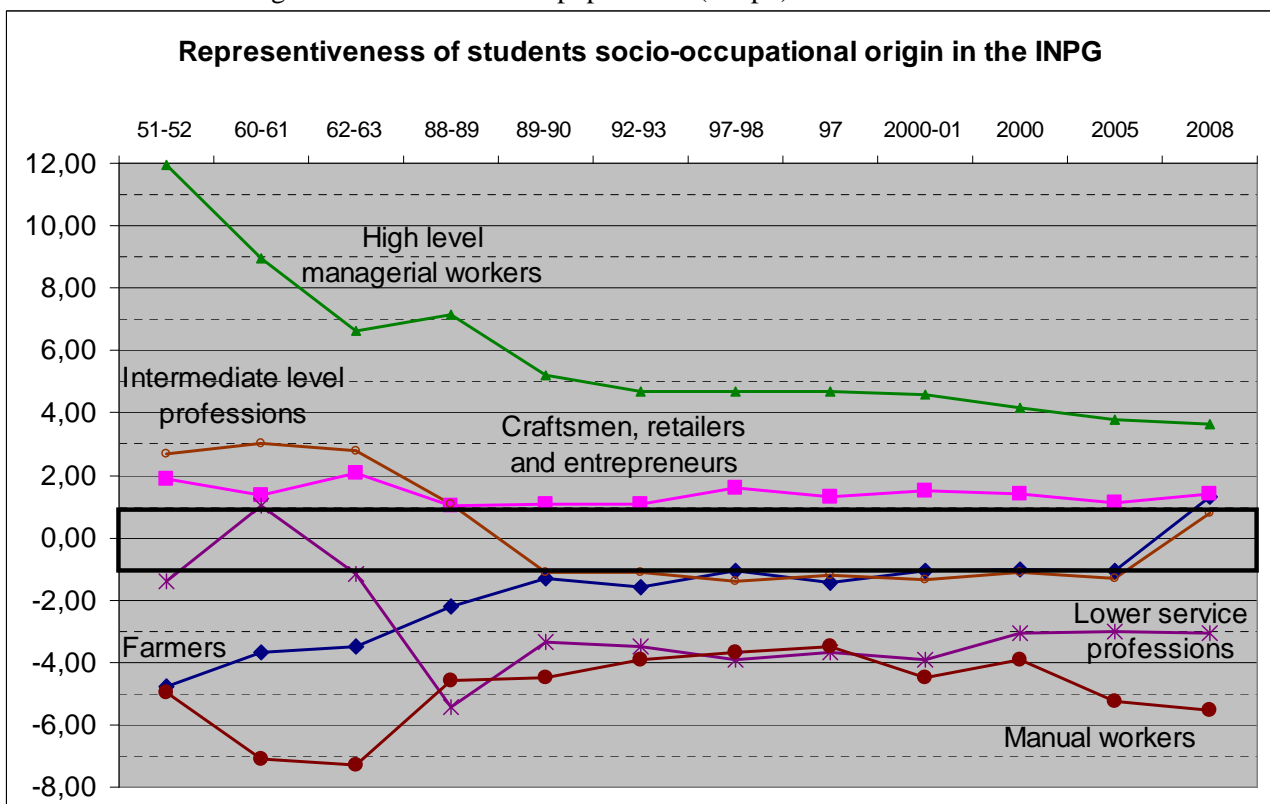
These schools are among the biggest engineering school in France: they recruit each more than thousand students per year. The raw data here are from the archives of schools, and from their statistical files.

As concerns INPG, from 1950 to 2008 the share of some socio-occupational categories has decreased: there is a decrease of 65% for craftsmen, retailers and entrepreneurs, of 52% for farmers, of 50% for manual workers and of 43% for lower service workers. Meanwhile there is a growing share of parents high level managerial workers (+44%) and intermediate level professions (+16%). Other significant developments: the growth of the share for retirees. Nonexistent in 1950, this category is rising steadily to over 7.5% from 2005. (Graph). We notice a similar evolution for INSA (Graph).



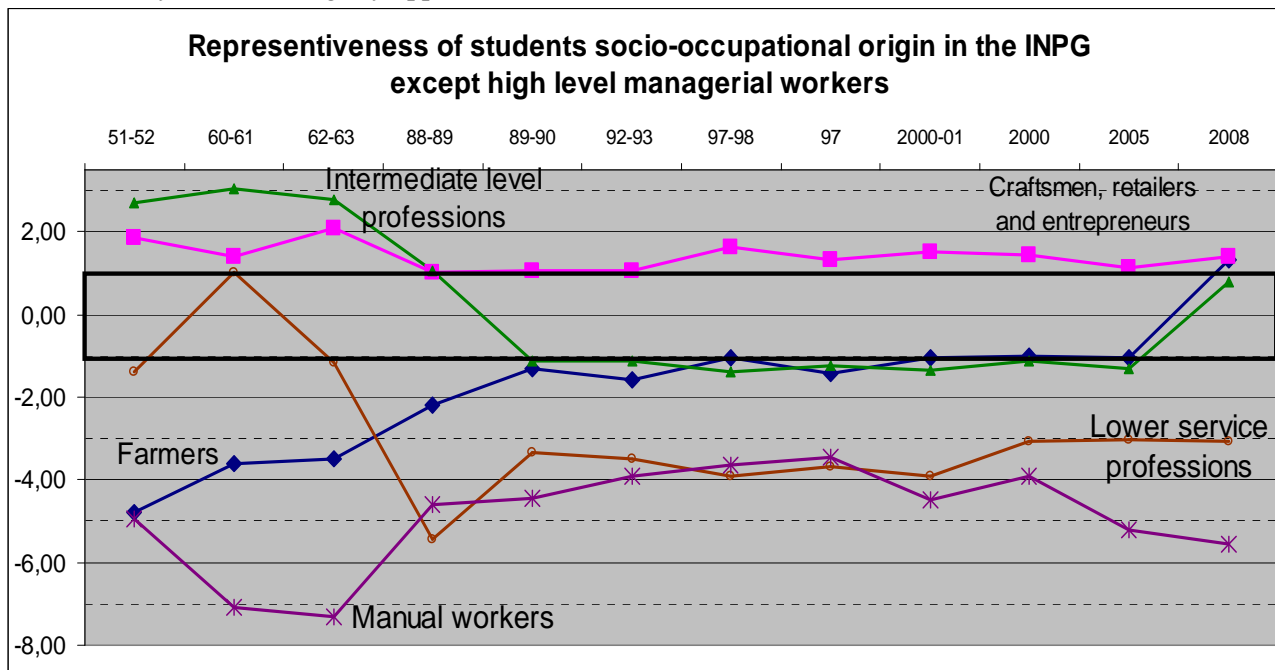


We wanted to compare the recruitment of engineering schools to the French active population. We built a measure of representiveness for occupational and social categories. It allows comparisons taking into account structural changes in the active French population. (Graph).



In INPG, leading the categories overrepresented are the high level managerial workers, about 4 times more represented than in the workforce, even though one observes a light recent decrease of this yield. Then one finds the craftsmen, retailers and entrepreneurs 1.4 times more represented. The intermediate level professions are lightly underrepresented since the years 90. Among the under-represented categories, are the manual workers, from 3.5 to 5 times less represented than in the active population, without notable evolution. The lower service workers are also under represented (4

to 3 times less represented than in the active population); a slight recovery appears to have taken place since the first turn of the years 2000. The farmers, broadly under represented in the years 50 and 60 (5 to 3.3 times less represented than in the active population) have progressively come to a normal representiveness among the students (yield of 1 or lightly upper).



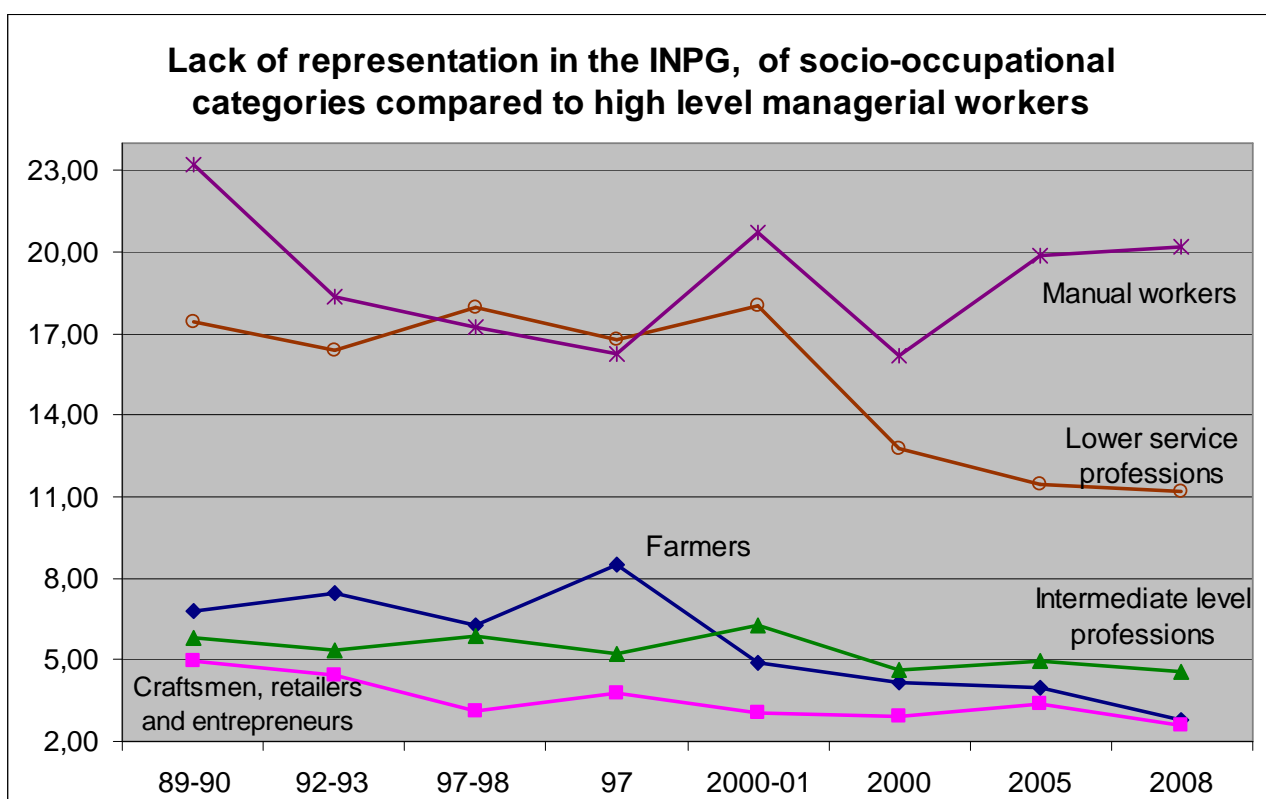
In INSA of Lyon, children of high level managerial workers are 3.7 times more represented than their parents in the active French population, while the children of manual workers are 7.7 times less represented than their parents (Table 3).

% of the column or ratio	INSA Lyon 2005-06 Fathers' occupations	Male French population over the age of 15 2005 with 1,61% of retirees	Ratio	INSA Lyon 2004-2005 Mothers' occupations	Female French population over the age of 15 2004 With 2,54 % of retirees	Ratio
Farmers	2.15	2.98	1.39	1.00	1.39	1.39
Craftsmen, retailers and entrepreneurs	7.63	7.21	1.06	2.90	3.13	1.08
High level managerial workers	59.06	15.98	3.70	32.37	8.86	3.66
<i>Included secondary and higher-education teachers and scientists</i>	12.08	2.19	5.51	13.06	2.60	5.01
<i>Included engineers and technical managers in the business sector</i>	21.05	5.64	3.73	3.90	1.04	3.74
Intermediate level professions	15.91	20.52	1.28	23.21	19.79	1.17
<i>Included primary-school teachers and related professions</i>	2.49	1.88	1.33	6.44	3.82	1.69
Lower service professions	7.48	12.38	1.67	12.60	40.98	3.22
Manual workers	4.52	35.88	7.70	1.63	9.55	5.88
Retires	1.61	1.61	1.00	2.54	2.54	1.00
Other people without employment	0.83	3.43	4.17	19.31	13.89	1.39
Unknown	0.81	0.00		4.44	0.00	

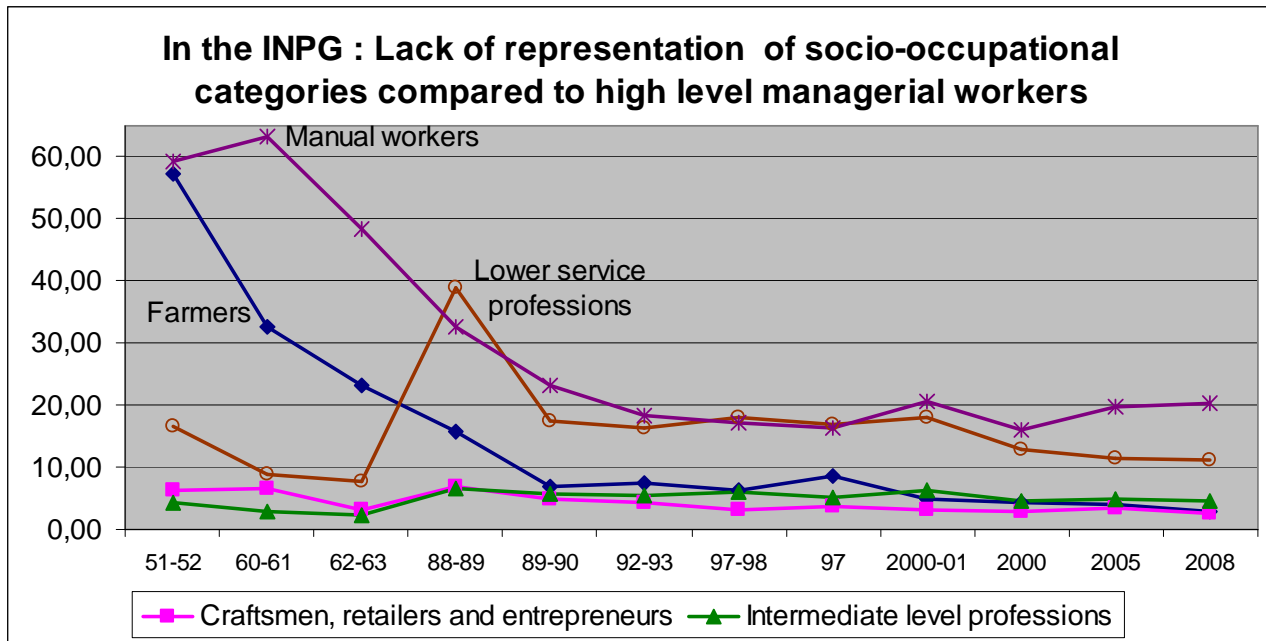
We notice that the representiveness of the students' social background is the same as it focuses on fathers' socio-occupations or on mothers'. The socio-occupational categories represented in proportion to the corrected active French population are: craftsmen, retailers and entrepreneurs. The under-represented are: intermediate level professions, farmers, lower service workers and, more importantly, other people without work and manual workers. The overrepresented categories are primary-school teachers but also high level managerial workers including engineers and technical managers and, more significantly, Professors and scientific professions.

Measure of the relative representation deficit

The chances of joining the engineering schools are unequal from one socio-professional origin to another. We compare here the lack of representation of categories in relation to high level managerial workers' children. In the INPG child whose father is a manual worker is 20.19 times less likely to enter than a child whose father is a high level managerial worker. This yield seems to grow in the 2000s. It is 11.19 for lower service workers and 4.58 for intermediate professions (Graph).



The long term trend shows nevertheless a significant improvement over the years 50 and 60 for manual workers and Farmers (Graph).



Inequalities in access to engineering schools are strongly present. They occur mostly against the children of manual workers and lower service workers, but also against the children of intermediate level professions. In contrast, high level managerial workers are showing great ease of access.

The chances of joining the INSA Lyon are similar. They are very uneven from one socio-professional origin to another (Table 4). A child whose father is a high level managerial worker is 29.3 times more likely to enter than a child whose father is a manual worker. This ratio is 21.4 between a child whose mother is a high level managerial worker and a child whose mother is manual worker. The largest differences are observed among children, whose father is a secondary and higher education teachers or scientists and those, whose father is a manual worker, the odds ratio is 42.

Table 4. Relative representation of children of high level managerial workers compared to other categories in the Insa of Lyon

	2005 Fathers' occupations	1999 Fathers' occupations	2004 Mothers' occupations
Farmers	5.1	3.5	5.1
Craftsmen, retailers and entrepreneurs	3.5	4.3	3.9
High level managerial workers	1.0	1.0	1.0
<i>Included secondary-and higher-education teachers and scientists</i>	<i>0.7</i>	<i>0.6</i>	<i>0.7</i>
<i>Included engineers and technical managers in the business sector</i>	<i>1.0</i>	<i>1.0</i>	<i>1.0</i>
Intermediate level professions	4.8	3.6	3.1
<i>Included primary-school teachers and related professions)</i>	<i>2.8</i>	<i>1.9</i>	<i>2.2</i>
Lower service professions	6.1	5.2	11.9
Manual workers	29.3	22.8	21.4
Retires	3.7		3.7
Other people without employment	15.3		2.6

Does this mean that the engineering schools are condemned to a lack of diversity? Is there discrimination in access to school? The tracks of reflections that follow invite us to think about the actors' motivations and their regular practices to explain these inequalities.

What about the recruitment?

Usually engineering schools recruit students through competitive examination after they have done two years of external preparation after the baccalaureate (A level). In the INSA every student is recruited directly after the baccalaureate, the preparatory classes are integrated for all. In INPG only ten to fifteen percents of students enter in integrated preparatory classes. Failures in first year of integrated preparation are around 20%.

These schools have created internal preparatory school in order to: - train by themselves students who have not only a good scientific level but also critically and analytically capabilities, - familiarize students with their earlier future environment in a more diversified way than the traditional external preparatory classes. The data suggest the failure of this diversification goal.

In INPG, the recruitment is based on the review of school records of the two last years then on an interview. Are auditioned students whose average is consistently above 12, regardless the college from they come. The interview is based on a summary of a scientific article, then on discussion to test motivation.

The integrated preparatory classes are more socially selective. People least well represented at INPG are even less in CPP without notable change over time. This lower representation in the integrated preparatory classes comparing to the schools incites to question the finality of these classes. The recruitment of these classes is not more diverse in terms of parents' socio-professional origins than traditional preparatory classes.

Since 2004, in response to evidence of a narrowing of diversity in all five INSA (Lyon, Rennes, Rouen, Strasbourg, Toulouse) new recruitment methods try to use multiple criteria. Were introduced three waves of recruitment for each one third of the recruits. The wave A is based on academic performance in the two last years of college regardless of the college or its reputation. This joins here a little experience advocated by Roemer (1993) to assess students within their equivalence class. Wave B is based on a selection of candidates with good school reports, but that are received in interview for enabling them to put forward personal qualities. Phase C occurs after the results of baccalaureate (A level) it takes into account. It is therefore a multifaceted recruitment. Its detailed analysis shows that it is not necessarily conducive to diversity. Recruitment through wave A, based on the regular work of the students, is a little more supportive of diversity. Curiously this type of recruitment has disappeared in 2009.

To promote the diversity of profiles, recruitment procedures in the INSA try to take into account not merely academic experiences but also sports, arts, cultural, social or humanitarian experiences, elements of personality and motivation, personal projects, looking more for skills in the profession of engineer. Experience of recruiting students from technologic baccalaureate (industrial sciences and technologies) has shown that a specific pedagogical approach based on active training more deductive and less conceptual was needed during the first two years of integrated preparation to ensure an equivalent success rate to general scientific baccalaureate.

INSA Lyon and Grenoble INP have put in place a kind of "Convention diversity" with some secondary school in the suburbs, including schools of priority education zones. This is to ensure positive discrimination towards disadvantaged pupils and give them a passport to the recruitment interview.

Lack of socio-occupational diversity is so important that this could be an argument for introducing quotas in anticipation, and perhaps as an incentive for improving openness of natural recruitment.

QUERYING EXCELLENCE

Human excellence is in the mouth of Protagoras of Plato (1950 b, p. 94)), this association of justice, practical wisdom, and morality that gives value to someone and designates him/her as capable and worthy of living among other (wo)men. It results of a teaching in all practices and of a long application in childhood. It does not depend on any single specialty and its equal distribution allows the sustainability of cities. But the excellence that the today education system is trying to distinguish is only a part of this virtue that is manifested by the hard work and knowledge. Ignorance is seen as the source of behaviour unjust or harmful. Socrates tries at the end of that text, to show that the five parts of virtue (that are prudence, wise moderation, courage, justice, piety) are not based on anything other than knowledge that enable to distinguish good from evil beyond pleasures and pains.

Nature of academic excellence

Proven excellence in school becomes the student awards. P. Perrenoud (1995 p.17) explains that in the field covered by the standards of excellence, the school claims to assign to each its true level of excellence and based on that assessment decisions without appeal The perfect match to a school standard then becomes an entry in better higher schools, a road to high social functions.

The notion of excellence is a priori far from the notion of justice and equal access to prestigious studies and upper social functions. On the one hand, it is because it owes part of its existence to factors outside the responsibility of the pupils. On the other hand, it is because competition between pupils and the limited number of places in the engineering schools, may ultimately show a large difference in achievement between very similar levels pupils.

If one compares students of the Grenoble National polytechnic institute and the National institute of applied sciences of Lyon with the youth of 17 to 24 years as photographed by the national census of 1999, we can calculate an index of representiveness for socio-occupational categories (Tables). Then we observe that children of high level managerial workers are represented 4.49 times more at INPG (4.29 times more INSA), than in the young population of same age. Conversely, children of manual workers are 6.67 times (respectively 3.57 times) less-represented and the children of lower service professions are 2.22 times (resp. 3.7 times) less represented than in the population of the same age.

The probability of being recognized as excellent is obviously strongly linked to the socio professional origin; and historical data show a gradual shift towards less social diversity in these schools (Table).

Excellence and the use of time

Diversity is rooted in consideration for the others, in the absence of absolute standard. Opening large diversity in engineering schools is basically asking the extent of compatibility of the two concepts of diversity and excellence.

The sociological work on the reproduction has drawn a causal link between large capital endowment of parents and school success. Certainly this relation is not exclusive but it brings to question the essential issue of the excellence's origin. There appears to be a combination of individual and environmental determinants in which the second factor seems predominant, leading to inequality of opportunities for academic success. P. Bourdieu insisted on the existence of a domestic transmission of cultural capital based on exposure over time to specific knowledge and reasoning. "The "ability" or "gift" is also the product of an investment in time and cultural capital" (Bourdieu, 1979, p.3). Spontaneous or strategic investments, the transmission of cultural capital takes time and proximity with school work. Among the three states of cultural capital distinguished by P. Bourdieu (1979) cultural capital in incorporated state in particular may shed light on the mechanism of inheritance showing through in academic excellence. "The accumulation of cultural capital requires an incorporation which, as it involves a work of inculcation and assimilation, costs time and time to be personally invested by the investor" (p. 3).

The use of time appears here as a predominant factor to excellence.

Academic excellence: and if it was just practice?

To the mechanisms of conversion of different kinds of capitals between them, in P. Bourdieu adds a struggle between social worlds for determining the value of different capitals (economic, social, cultural) among them education and qualifications. It gradually appears differentiated fields with their own laws, and that are unique and autonomous. Each field is dominated by a kind of capital. There are two distinct levels in which the mechanisms of conversion are taking place (Fernex & Compeyron, 2007). In the first level, capitals would be efficient in all fields, but their relative value would vary depending on the field. In the second level (the field of power) occur the struggles between holders of different capitals to conserve or transform the balance of forces so as to gain dominant position. The issue of conflict is determining the value and relative strength of different capitals that may occur in different fields.

We can then consider as regards our subject that the value of diplomas reflects the importance of investments that have realised there the people better equipped with dominant capital. Then diploma value is far from an objective criterion but rather the result of struggles for power. It is exercising its capacity to distinction thanks to the possession of capital which can influence the dominance. Then diploma legitimate dominant positions. In essence it is not accessible to everyone. This is a mechanism of reproduction; fortunately some capitals as the cultural capital can be acquired without prior capital through work and time and especially since the educational system contributes.

As an instance, when INSA Lyon gradually rose to the rank of first fifteen French engineering schools, it showed a decrease in the diversity of its students. Therefore is diversity ordered to exist only marginally in the spheres of excellence, otherwise cause a devaluation of the diploma?

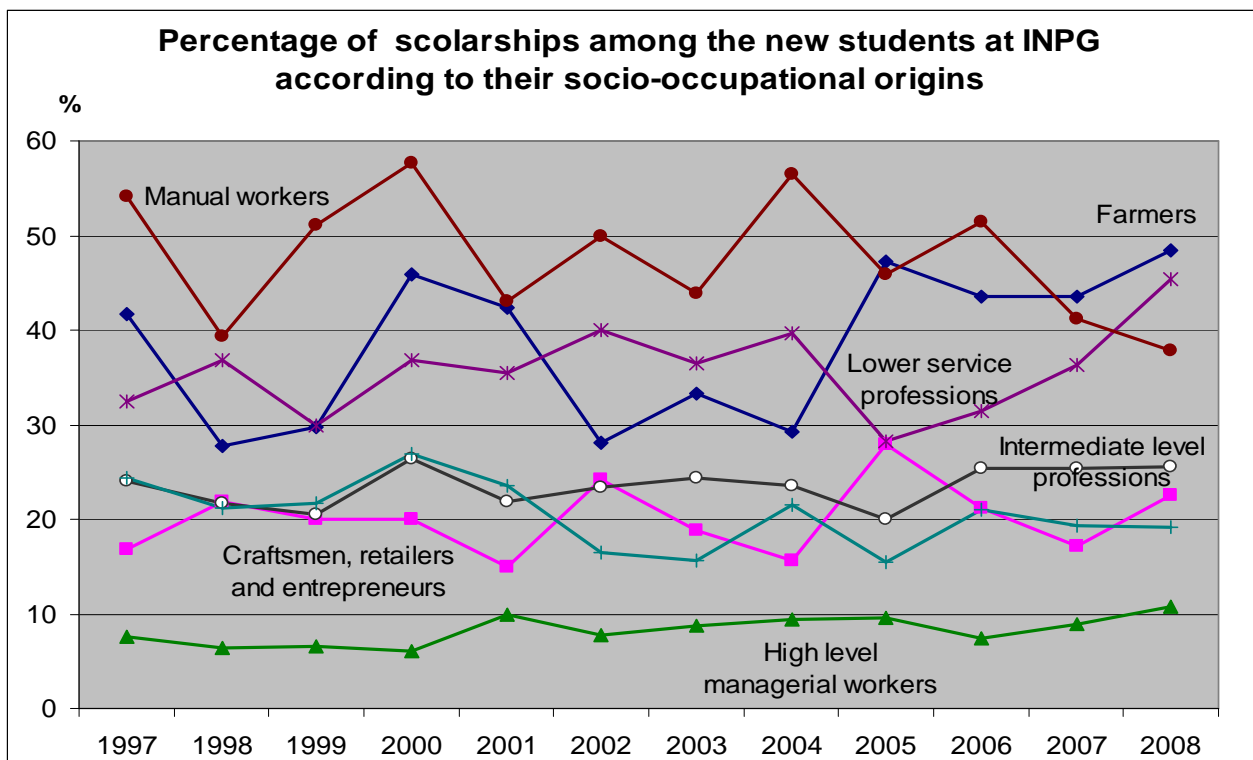
IMPROVING EQUAL OPPORTUNITY

The rate of scholarships to measure the impact of economic barriers

We refer here to scholarship offered by French government to students according to their weak income family.

Despite the closure on the social diversity, the rate of scholarship students in the engineering school is regularly increasing (graph). In INPG, from 13.3% in 1994, he grew steadily to 19.9% in 2008. It is around 25% in the INSA of Lyon.

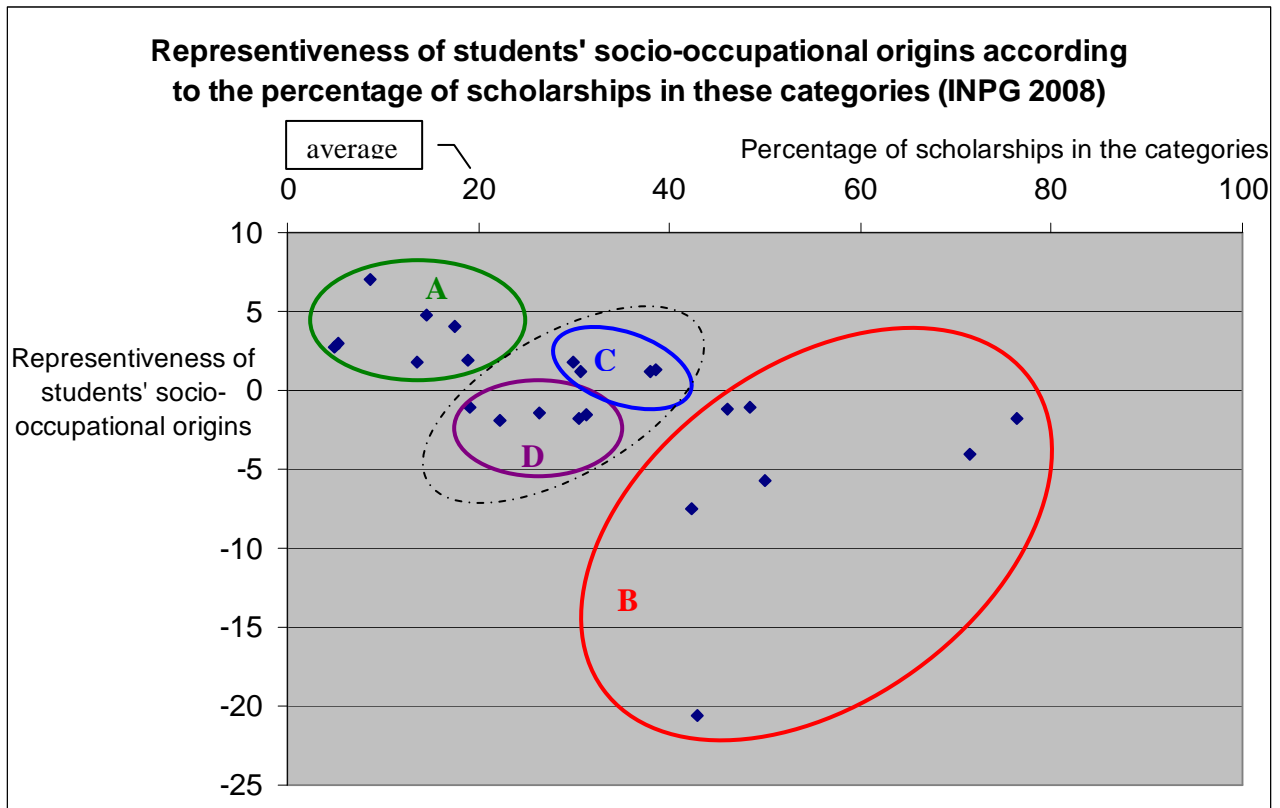
Nevertheless the rate of scholarships varies strongly according to the social occupational category of the person of reference within the family (graph). An observance in the INPG on the twelve years from 1997 to 2008 allows drawing a strong link between these two variables. On average over that period there was 17, 8% of scholarships in the engineering schools, with an upward trend. Highest for the children of manual workers (overall between 40 and 58% with an average of 48%), this rate appears to decline over 2007 and 2008 to reach 38%. This decline, coupled with the fall in working-class students could suggest that the financial in higher education is strengthened to eliminate manual workers' children who have the least financial resources. Besides, the decrease rates of scholarships affects the category of the unskilled manual workers not that of skilled workers. The manual worker category is the only one for which the rate of scholarship sometimes exceeds 50%. Children of farmers are between 28% and 48% (average 38%) to have scholarship with an upward trend that marks a maximum rate of 48% in 2008. For children of lower service professions this rate is between 30 and 40% (average 36%), it increases to 45% in 2008. There is nevertheless great disparity in this category.



We then go to categories for which the rate of scholarship is regularly below 30%. Children of intermediate level occupations with an average of 24% are between 20 and 26% of scholarships. Within this category of children technicians and primary-school teachers have the lowest rates (respectively 20% and 21% of average). The children of retirees with an average of 21% ranged between 16 and 22%. Children of craftsmen, retailers and entrepreneurs show an average rate of 20% with limits between 15% and 28%. Within this category entrepreneurs' children are distinguished because their average rate over the period is only 6% and rarely exceeds 10%. In the most extreme situation, children of high level managerial and intellectual professions have scholarship to 8% on average, with rates between 6% and 11%, a trend low but steadily upward.

We try to observe what relation may exist between the representiveness of categories within the engineering school and the percentage of holders of a scholarship within the categories. We use for this a division into 25 subcategories from which we remove those who are too few among students (children of clergy and

agricultural workers). The representation of the data shows the existence of a decreasing linear relation between the two variables (Graph and table 4). The low representation of some socio-professional categories in Grenoble INP comes with their high rates of scholarship, while those most represented are those for which the rate of scholarship is lower.



Group A	Group C	Group D	Group B
Scholarship rate < 20%	Scholarship rate between 29% and 39%	Scholarship rate between 19% and 32%	Scholarship rate > 42%
8,7> representiveness >1,8	Representiveness between 1,75 and 1,16	Representiveness between 1,23 and -1,75	-1,8> representiveness >-21
<ul style="list-style-type: none"> - Head of a company with 10 or more employees - self-employed professionals - Managerial occupations in government - Secondary and higher education teachers, scientists - Administrative and sales / marketing manager in the business sector - Engineers and technical managers in the business - Intermediate professions in the healthcare and social work sector 	<ul style="list-style-type: none"> - Retailers and related professions - Primary school teachers and related professions - Intermediate administrative professions in government - Administrative employees in the business sector 	<ul style="list-style-type: none"> - Craftsmen - those working in the fields of information, art and entertainment - Technicians - Foremen / women and supervisors - Police and armed forces 	<ul style="list-style-type: none"> - Farmers (self-employed) - Intermediate administrative and sales / marketing professions - civilian employees and service workers in government - Sales / marketing employees - Workers providing direct domestic services - Skilled manual workers - Unskilled manual workers

We try to model the relationship between the share of the scholarships in categories and the representiveness of these categories; we found that more than one quarter of the variance of the representiveness is explained by the share of the scholarships. Therefore, there is a significant non-negligible relationship between economic resources and access to training in engineering.

Which priorities to increase socio-occupational diversity?

Our data are images of the difficulty for working class children to access areas of excellence. Although explanations of the mechanisms of transmission inside the family are consistent, this is hardly acceptable in a society that claims to democracy. Several arguments are raised for affirmative action to promote diversity in recruitment to come.

The first type of argument appeals to notions of democracy and its corollary: the sense of social justice. Even if one can believe that we are no longer in a class society, interests and lifestyles of different socio-professional categories are far from homogeneous. It is disturbing to note that complex technologic choices sometimes irreversible escape increasingly to the most economically and culturally deprived of the French population. This first point is a claim for democratic recruitment.

The second type of argument is the belief that diversity must broadcast its reality also in engineering schools. It is a principle of social reality. For most recruiters in engineering schools, recruitment should be a reflection of diversity of society. It is what we can call a principle of osmotic recruitment.

We can refer to the R. Bourdon's work on the reasons for choice and apply it to the engineering schools issue to see that we could act on 3 types of reasons that can engage children from disadvantaged families in such studies: reducing costs (thanks to scholarships, students housing), reducing risks (to replace the failure in preparatory class, to allow for shifts to other trainings), and increasing the perception of scientific professions (by promoting the attractiveness of trades, revealing fashions and lifestyles which are attached).

According to our previous observations, we can then draw three lines of work which are complementary and reinforcing each other, in order to make the situation fairer:

- Promote the proximity with the practice of working, the acquisition of methods, and favour choice between alternative activities to the benefit of study. This entails acting on the time devoted to education outside of school time and on a long period. (It is the practical axis). So, it may be the most difficult to enforce

- The mobilization of young people, their awareness of the interests of the school with a view to career opportunities. The spring here is the investment of young people and their families that will make interests converge to high scientific studies prospects (it is the strategic axis). There are already some experiences such as coaching pupils of comprehensive school, building partnerships for science lessons, tutoring by engineering students, especially in disadvantaged areas.

- Reduce economic barriers to enable students and their families to venture into studies seen nowadays as costly and risky in case of failure (It is the economic axis). It means for instance to offer boarding places, to open apprenticeship training.

The actions and projects of INP Grenoble and INSA Lyon for equal opportunities, are mobilizing the two first points, in cooperation with secondary schools and with local associations. Acting on the third axis requires sustainable mobilization of consistent financial resources the engineering schools have not searched yet.

Conclusion: diversity as a source of wealth and general interest

We could try to describe the desire for diversity among engineers as a precautionary principle as concerned knowledge, initiative and social cohesion. Just like the words of J. S. Mill (1990/1859) when he said that it steals the humanity not to allow everyone to speak, we can think that to fail in the attempt to diversify the engineering profession might deprive ourselves of discovery, innovation and service to general interest.

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