

FRENCH ENGINEERING EDUCATION: A SHORT LOOK ON THREE WAYS OF EVOLUTION

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I would like to point out in this communication some of the main lines in the evolution of French engineering education. They concern in particular the role of the universities in professional training, the politics of transformation launched at the beginning of the 90's with the creation of the Nouvelles Filières d'Ingénieur (NFI), and the relative feminisation of the pupils of engineering schools. Before developing these points, I will situate what appears to me to constitute the prominent points of engineers' professional space in France.

The scholar engineer, a dominant figure but in a minority

French engineers are the heirs of a long history who continues marking their position in the educational and professional universe. In spite of multiple consecutive attempts at reform over two centuries (Shinn, 1978; Grelon, 1989), education remains dominated by the pattern of the 'grandes écoles' distinctly separate from the university, recruiting their pupils in a elitist manner and distributing some prestigious titles. To this educational pattern corresponds a pattern of career which consists in leaving the technical functions quickly in order to evolve towards positions of direction. Although this pattern has been undermined (Bouffartigue, 1994), it keeps a strong influence. Put together, the educational and the career dominant patterns are actively involved in one of the poles of the engineers' professional space, the pole of the scholar engineer, very typical of the French case. However, we must recall that in reality, the individuals corresponding to this pattern are not the majority of engineers, at least if one refers to the workforce of the 38th category in the national nomenclature of INSEE which is called: "engineers and technical executives of the enterprises". Actually, the Malthusian politics of the schools and the taste of the graduates for management jobs rather than for production functions have urged companies to call upon some engineers without diploma ("house engineer", "self-educated"). Even today, less than half of the engineers have an equal or superior diploma to bac+3.

Facing the pole of the scholar engineer, in which it would be necessary to distinguish some very precise hierarchical levels, in particular concerning pay (Demailly, 1994), is therefore the production engineer, the self-educated engineer. He can claim historic roots dating back

as far as those of engineering schools: the Conservatoire National des Arts et Métiers were created in 1794, the same year as the Ecole polytechnique. It provided a superior technical teaching all the way through the 19th century and remained until recently the main and nearly unique way of adult continuing education leading to the title of engineer.

In order to be more complete, it would be necessary to introduce two other poles. The first is the one of the researcher engineer. He follows a specific training (often prolonging his diploma by a doctorate) and his pattern of career is also different to the scholar engineer's one. The desire to leave the engineering profession in order to evolve towards management is not as important, at least in some specific surroundings like the small innovative enterprises with an informal organisation. The last pole is the one of the technician. It concerns either some engineer graduates, and some holders of short technical superior diplomas (bac+2) without the title of engineer (protected by the law of 1934), but who have been promoted by their employer to a position of engineer. In France, the law protects the title given by the school, but doesn't prevent an employer from recruiting anybody he wants as an engineer. The self-educated engineer and the technician are often confused in the representations, but it seems to me necessary to distinguish them clearly in order to understand some recent evolution.

The rising role of university diplomas

In most countries in world, engineering schools are a part of the university. In France, they constitute a different world to that of the university, recruiting through its own competitive entrance examinations, often after specific preparatory classes, of a much selective manner than that of the university which accepts every holder of the baccalauréat. The length of engineering studies became standardise to bac+5, so a lot of graduates of scientific universities at the level of bac+3 to bac+5 could justify a superior education very close to that of engineers, but they don't have the title solely delivered by the authorised schools. For fifteen or twenty years, the French state wanted to lead a politics of professionalization of the universities, which led to the creation of many diplomas such as MST, DESS, and more recently the diploma of engineer-master of the IUP (Bouffartigue & Gadea, 1997). The Instituts

Universitaires Professionnalisés is an academic way which leads to a bac+4 level diploma. All the ambiguity is due to the fact that it is not a title of engineer, but the word "engineer" is in the name of the diploma, and of course it exasperates the engineering professional organisations.

The statistical relations between the important fluxes of the university and those more limited of engineering schools are creating a new situation where one finds more and more university graduates beside the beginners recruited as engineers (Martinelli, 1996). At the present time, half of the beginner engineers are university graduates and not of engineering schools. They often have an applied vocational training, with a consequent theoretical level and they are satisfied with a slightly lower salary than that of engineers. The pole of the engineer technician, who could be an engineer of a little "école", or a technician without an engineering diploma, tends to be occupied by graduates with the same level than scholar engineers but without an engineering diploma. The question arising for the future is whether careers of the university graduates will become similar to those of scholar engineers or if they are going to constitute a lower stratum in the engineers professional universe. The question is also as to whether or not engineering schools are going to become a minority within the educational ways followed by the graduate recruited as engineers, in the near future.

The impact of the NFI

Some important changes were introduced also in the pole of the self-educated engineer. A voluntary attempt to alter this pole was launched at the beginning of the 90s, but it did not have the desired effects. However, this policy did introduce considerable modifications concerning the engineers education as a whole.

Indeed, when B. Decomps presented his report to the Minister of Education in 1989, he recommended the creation of new channels of engineering education (NFI) which would enable engineers to be trained on a more technical aspect, with less abstract knowledge and a stronger taste for production tasks. One of the ways to achieve this goal was, in his opinion, to make sure that most of the graduates (80%) were formed by continuous education.

The new channels (sometimes in new schools) were therefore intended preferably for technicians of level bac+2 having some professional experience and ready to follow a one or two year training in order to become engineers. The aim of the creator of the NFI was also to increase the number of graduates among promoted technicians. The category of engineers is renewed by pretty much equal fluxes of young graduates (15 000 at the end of the 80's) and of promoted technicians without diplomas. B. Decomps

is in favour of the promotion of the technicians who have proved their worth, but he fears that many of them don't have the technical and scientific knowledge which is necessary to master the technical innovations (Grelon and Marry, 1996).

The recourse to the continuous education is at the same time a means of breaking out the deadlock in the technicians careers and of inflecting the profile of engineers as a whole. In fact, for some rather complex reasons, this goal was not reached regarding the quantitative point of view : there were less than 40% and not 80% of graduates coming from continuous education. Furthermore, one observes for the last two or three years a decline in the number of candidates in education, which still remains much lower than that plan. Many commentators have underlined the drifts in regard to the initial objectives.

Nonetheless, the NFI can not be considered as a failure. Firstly, for the continuous education graduated engineers, they really open up the way for engineering functions (which was often the case before the entrance into formation) and they keep open an important way of professional mobility both at the personal and social level (Rey, 1996). They give rise to strong salary increases and of responsibilities indicating that the diploma is fully acknowledged by the employers (CEFI, 1998). From a point of view of initial education, most of the graduates find a job quickly, either immediately at the end of their studies, or after a short job research (less than two months long). But above all, the historical role of NFI was to introduce a radical innovation with the principle of the alternation between periods of training in an enterprise and periods of studying at school. This was an obvious break with the principle of the separation of functions between school and enterprise which lie at the very heart of the dominant pattern. Furthermore, they gave birth to a new variety of engineers: the apprenticed engineers, formed by a narrow partnership between teachers and the enterprise tutors, considered as real members of the teaching staff (Malglaive, 1992). Many issues are raised about the kind of professional produced by this new pedagogy : a true engineer quickly operational and efficient in production tasks, or a second-rate one, not very different from a technician? Moreover, one can wonder if the will of making the promoted technicians by continuous education won't appear once again in the future and if, in this hypothesis, the figure of the self-educated educated engineer is not going to become more and more statistically marginal.

The feminisation of the schools

For a long time, women were excluded from engineering schools, on one hand because of the military statute of some of these schools, but also, more extensively, because of the few places open to them in the higher educational system, and more particularly in sciences. The presence of women in engineering schools was almost non-existent before the seventies. It's only in 1972 that the first woman was admitted to Polytechnique, but it was done in style and splendour: Anne Chopinet was major of her promotion. The exclusion from professional world came to reinforce the exclusion from schools. Very often, graduate women didn't exercise their profession in the industry, turning rather towards the professions of teaching or research.

It would be naive to believe that all this is now in the past and that the equality between men and women engineers is on the way. On the contrary, this way of education remains one of the most masculine, but some clear evolution in this domain have to be noted. For about 25 years now, all schools have been open to women by law. However change is slow to come: 1.9% in 1954; 4% in 1964; 3.7% in 1972, but it did not stop growing and reaches today close to one pupil out of 4 (22,6% in 1996). One should say that the rise in women's education is one of the major features of 20th century. Since the 1970's, the number of women in the higher education system has been comparable to that of men, and has now surpassed it. The women breakthrough is remarkable in law, economics, and in the domains of health and sciences of the life (biology, medicine, pharmacy, agronomy) where they are currently a majority.

On the other hand, the masculine hegemony is just as remarkable in the "hard" sciences like mathematics and physics and, to a lesser extent, in chemistry, either in the abstract and theoretical shape of these sciences (academic doctorates, schools of engineer) and in their industrial applications (mechanical, electricity, Instituts Universitaires de Technologie). The same inequality towards women can be found again when one compares the engineering schools depending on their speciality. In some domains, as agronomy and chemistry, we tend to find a higher representation of women, (30 to 50% of women), but their representation is very low in aeronautics or mechanics (less than 10%). In most specialities, the proportion of women is between 10 and 20%. Both the most compliant schools to the elitist pattern, and those nearer the pole of the technician engineer, are particularly closed to women. In spite of signs of scholastic excellence as strong and sometimes higher than that of men (Ferrand, Imbert, Marry, 1996), in 1996, only 13% of the pupils of Polytechnique, 14% of the Ecole des Mines and 12% of Supélec were women.

One also notes that almost the totality of women, who get an engineering diploma work, even when they are mother of three or more, and that their job is less frequently

than in the past confined to activities of teaching or research. But there are also inequalities in the couple linked to the distribution of domestic tasks and child care perceptible in the sphere of work and career. When men have children, they work more hours, earn more money and have better chances of reaching high managerial positions than men without children. Women's careers evolve in the opposite way: when they have children, they more often get a part-time job, and their salaries and career perspectives are lower than those of women without children (Marry and Gadea, 1998). We are therefore a long way from abolishing inequality between men and women engineers, but there is certainly no doubt that a slow-moving, discreet, but continuous evolution is going on.

Conclusion

Maybe this changing figure of the engineer is the most important transformation in the engineering education. The engineer in France and in many other countries combines the picture of a man who succeeded his studies and who got a respected and remunerative job. We have to get use to the idea that it may be a woman and not a man. Some other changes have also to be taken into consideration. For example, the differences between graduates and promoted are becoming less obvious, insofar as an increasing number of promoted receive a bac+2 level education and often follow a continuous adult education. The engineering schools are no longer what they were, since they are often a university which can't deliver an engineer's diploma. And an engineer, like a baker or a plumber could have learned his profession through an apprenticeship (but of course it's another kind of apprenticeship). There are therefore some serious alterations, to bring to the traditional picture, however the background has not been deeply transformed.

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