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The Socialisation of Engineers and the Development of their Skills:
A Comparison of France and Japan

TODAY, *the competitiveness of economies is mainly linked to their ability to produce technical innovations. Engineers naturally find themselves right in the centre of such action. It is therefore vital to analyse the* ***interdependency*** *between the way engineers produce, and the form* ***their*** *technical creativity takes. A comparison of France and Japan shows a clear difference in the way engineers in both these countries develop the capacity for innovation. In France, creativity is revealed through the engineer acquiring both social and professional autonomy, whereas in* ***Japan,*** *it is produced on the basis of the preeminence of the organisation* ***controlling*** *the mobility and learning processes of each individual engineer.*

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ENGINEERS: A ***CATEGORY WIDELY*** *DISSIMILAR FROM ONE COUNTRY TO* ***ANOTHER !***

IN France, the category of **"engineer" is** ambiguous and heterogeneous, since **this** title **is** used both for an educational **qualification** and a post. Thus, not all qualified engineers hold engineering Jobs, and likewise, not all those who are **in** engineering have an engineer's qualification. In **Japan,** the category of **"gulJutsusha" is** even wider-embracing than that of **"engineer" in** France. It **is** neither associated **with** a specific type of qualification nor a professional status. The national census defines this category, as "those who have

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received scientific or technical training, generally in higher education establishments such as universities, or those having an equivalent level with respect to capabilities and professional experience...". Such a definition corresponds more closely to the French definition of "engineers and technical company staff". If, then, we compare the stocks and flows of both categories, we obtain a similar proportion in both countries: the percentage of "engineers" in the working population currently in employment is 2.1 % in France and 2.3 % in Japan. In terms of the annual flow of young qualified graduates having spent at least 3 years in higher education, they represent 1.26 per thousand of the working population in France and 1.43 in Japan.

Nevertheless, this overall similarity cannot hide a profound difference between the two countries. France emphasises the production of engineers with a long initial training period (more than 5 years after the baccalauréat and subsequent entry into higher education), whereas in Japan a four-year period is predominant Similarly, there is a considerable difference between the number of scientific theses produced annually - 0.20 per thousand of the working population in France for 1989, but only 0.04 in Japan.

• *Educational training* systems

In France, various routes to qualification may be taken within higher education. There exist both engineering schools and university science faculties. Each is designed to "grade" and train a particular category of student. Thus, university graduates traditionally enter either the public or private sector as research workers, whereas engineers from the most famous engineering schools (*"grands corps"*) tend to quickly embark on careers in higher management The rationale behind training and qualification possibilities corresponds to a way of management characterised by a marked distinction and hierarchical order of statuses. A distinction will be made between an engineer from an "*Ecole Polytechnique*", another from a small engineering school, or yet another having graduated from university after 5 years in higher education. Those graduates with only 3 or 4 years in higher education will not automatically be given the title of engineer at the beginning of their career. The logic behind these distinctions is based on the strength of the educational referent and leads to distinct professional identities. The latter themselves serve to legitimise various hierarchically ordered territories within the company - professional areas between which mobility is extremely difficult.

In Japan, the educational system is characterised by a continuum from one university level to another, without any radical breaks between them. Three quarters of graduates spend four years in higher education. Their qualification therefore constitutes a clear reference point for the whole "gijutsusha" category. Company seniority depends on the length of time spent in higher education with reference to this dominant period (a six-year training period, for example, represents an extra two years as far as seniority is concerned). Such an assimilation means that the management of all university qualifications by year of entrance into the company is both homogeneous and compatible with competitive progress. Nonetheless, whilst the qualifications are accepted as equivalent in Japan, the effects of the various universities' hierarchy remain. They are revealed only slowly during the graduate's career, in contrast with the almost Immediate effect of the hierarchy of French *"Grandes Ecoles"*.

• The engineer's status

In France, an engineer's status is clearly defined by his title and the fact of belonging to the category of *"cadre"*.(1) French legislation makes a clear distinction between engineers who graduated from accredited engineering schools and others who are given the title of engineer within a single company (Grelon, 1992). Such a title attests both to general and technical knowledge. Due to collective agreements, it automatically grants access to the status of "*cadre*". The status thus defined confers the engineer with both social legitimicy and professional autonomy; at the same time, he appears as an external given imposed on the companies.

In Japan, there is no formal recognition of the "title of engineer" as a prerequisite to entering a company. Such recognition is built up gradually from the time that the young university graduate is recruited. Both parties commit themselves to a strict relationship involving mutual obligations. The company must invest in training, taking its chance on the long-term graduate's potential. As for the graduate, he consents to learn the art of engineering and wait for this deferred recognition.

THE *ACQUISITION OF "PROFESSIONALITY"* BY *ENGINEERS IN A COMPANY*

THE "professionality" of engineers in both countries is built up in a way that depends on the way the company organises their recruitment, how competent they have become and the way their career has been, and is being, managed.

• Recruitment

In France, companies recruit an engineer according to their particular needs. Even if the latter is not obliged to remain tied to a particular job, his recruitment corresponds to the time he was taken on for a given post The engineer is himself a "specific" product i.e. he is chosen primarily in relation to the school from which he graduated and that school's rank within the national hierarchy, but also because of his specialisation or individual performance (final grade and rank etc.). This young engineer can then negotiate the" conditions of his contract and professional commitment with the company on an individual basis.

In Japan, companies systematically recruit a certain number of engineers each year, regardless of their specific or immediate needs. The young graduates are thus selected and recruited "by group" depending on their age when leaving universities. They are all subject to the same procedure and enter employment at the same date. They automatically accept this collective commitment without negotiating individual conditions. They are not recruited because of their particular skills but because of the university level they have reached. Furthermore, there is no direct relationship between the

(1) The French concept of "*cadre*" Includes not only management but also highly qualified professionals.

Initial training received and the first job. Companies consider that the engineer's practical training only begins after recruitment (Imano, 1994), which is why the transitional period is so important.

• Entry into *working life*

The French engineering graduate enters a company with recognised skills and a title of engineer. In this way, he may be considered a "finished product". He integrates a pre-established division of skills; the engineer's task is conceptual in nature as opposed to the technician's, which consists in resolving empirical problems. Whilst there is undoubtedly a technical dimension to it, hierarchy and management also come into play. The engineer thus fulfils control functions which make him take initiatives and identify himself as a manager.

In Japan, for each graduate the initial period of work is used to become an engineer through on-the-job training. During this period, his "professionality" is built up in proximity to manual workers and technicians. This proximity is firstly reflected in the salary: the difference between the average salary of a young manual worker and that of an engineer at the beginning of his career is minimal (less than 10 % in Japan, compared with 100 % in France). It is also technical in nature, as the young graduate will be assigned to concrete technical tasks. These tasks become more complex, nevertheless, in line with his professional advancement. This kind of company-controlled learning puts the young employees in a situation of dependence and long-term competition with colleagues in the same entrance group. Such a slow rate of progression does not encourage initiative and may sap the creativity of individuals, but this kind of "apprenticeship", just like in Germany, forces employees to learn how to work together and to keep up the idea of overall performance.

• *Career progression* and mobility

The external labour market is of little importance to Japanese engineers. Most of them follow their career within the same industrial group. Their internal mobility is strictly controlled by the company. The former, qualified as "technical proximity", facilitates the accumulation and spreading of both individual and collective knowledge. It is therefore a two-edged tool for management, developing engineers' "professionality" and forming part of production dynamics. Up to now, career advancement has been related to the employee's length of service. The majority of Japanese engineers keep more or less abreast of each other up to the 35-40 age range, whereas their French counterparts are rapidly put to the test and channelled into different careers. During this first half of their career, Japanese engineers are constantly placed into a learning position where they contribute to the collective development of knowledge. Thus, they gradually acquire the professional competence required to take increasingly greater responsibility. This long-term competition nonetheless ends in a hierarchical structure. At around the age of 40, it leads to a rational differentiation between engineers who are, and those who are not, managers. However, this classic procedure is now being subjected to change: the large increase in the recruitment of engineers during the 1980s is forcing Japanese companies to back away from career uniformity and instead to diversify the professional routes open to engineers.

Compared with the Japanese situation, individual strategies play a major role in the career advancement of French engineers. Up to now, human resource managers have had to take into account the "career profile" drawn up ideally by every person in order to avoid his departure, which represents a loss of professional knowledge. The employment crisis affecting engineers is reducing this tendency, however. Whilst the career of a Japanese engineer is pursued within the same company, that of a French engineering graduate is not. The latter reenters the national market for engineers (either really or virtually) at each stage in his career. Notwithstanding, engineers having acquired their title through professional training or promotion within the company tend, just like their Japanese colleagues, to follow their career within the internal labour market. The mobility of such engineers within a company corresponds to a progression between functions which are organised according to a notion of territory. This territorial rationale leads to a trade rationale, with each territory determining a certain trade - the laboratory contains researchers, whereas production engineers are to be found on the shop floor. Moving from one to another is a sign of the engineer's ability to fulfil different functions, master them and adapt to them. In France, therefore, the career paths followed by engineers appear discontinuous, with breaks between different types of technical or managerial responsibilities.

ORGANISATIONAL *COMPETENCE AND SKILLS*

AROUND his territory, the French engineer develops scientific and managerial skills. Such a building-up of the competency solidly and autonomously encourages inventiveness. It bears a potential of originality, the possibility of a breakthrough innovation. It can lead to occasional scientific successes or even a far-reaching "prowess" (particularly when the State acts as challenge coordinator). This phenomenon is particularly noticeable in certain sectors such as the chemical, pharmaceutical and nuclear industries, where the scientific performance of research upstream of the production process determines its overall competitiveness. An engineer's confinement within his own territory, however, leads to a certain difficulty in communication, cooperation and collective learning. Likewise, having a markedly different status from that of technicians or manual workers tends to make the collectivisation of knowledge and/or know-how highly sensitive, and to make the collective risk random. In France, original creativity appears to show itself at certain "times" or in exceptional circumstances, with its spin-offs being poorly capitalised upon or consolidated. The new path to the title of engineer in France (a recent opening through apprenticeship in accordance with the Descomps circular), together with the debate on the training of "technologists" (3 or 4 years in higher education) undoubtedly reflect the French preoccupation with remedying such a flaw.

In the case of Japan, an engineer does not occupy his own territory right from the start. His skills and recognition as an engineer are built up over time. In the position of a learner, he trains himself by slowly exploring an area of competence collectively covered by a work group to which he belongs. His contribution to the group consists in gradually pushing back the limits of current knowledge. Creativity and the technical risk are seen less as strategic "coups" as the prolongation of a certain collective continuity. Japanese engineers

therefore develop a "contextualised" competence which incorporates two industrial realities. The first concerns the need to combine theoretical knowledge with empirical know-how in order to build up "production intelligence". The second refers to the necessity of creating a complementarity with other categories of employee (such as technicians and manual workers) which goes so far as the overlapping of skills. Somehow, both realities are found in the way German industry ensures the continuity of the qualification process, through its professional training system, ranging from the skilled worker to the "Meister" and then again to the "graduate engineer" (Sorge, 1994). It is doubtless not by chance that both these countries have built up their Industrial power around mechanical sectors which require this productive intelligence from the shop floor. A Japanese engineer is competent enough to efficiently ensure the move from prototype to industrialisation and to consolidate expertise over time. Nonetheless, such competence has rarely demonstrated its ability to go beyond the known. Closely supervised by management and faced with a slow ascent, the Japanese engineer tends to retreat into a certain conformity which does not favour original creativity. This shortcoming is nonetheless being taken more and more seriously at a time when a move back to basic science is becoming a major challenge in industry. A series of reforms being set up will no doubt Influence the destiny of engineers in Japan, whether the former are dealing with the recent creation of "Doctoral Universities", whose aim is to increase the number of doctorates awarded, or with the increasingly differentiated management of "gijutsusha" within companies.

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