Professionals, Production Systems and Innovation Capacities in The Software Industry: A comparison between France and Japan

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Abstract

Our analysis shows that the two French and Japanese software production systems form a coherent whole and that the strengths and weaknesses of each system are logical extension of the societal characteristics already observed in industrial manufacturing. In Japan, the software industry tends to imitate manufacturing logics with its proper efficiency in producing standardised and material goods, but it doesn't always succeed in doing the same with regard to intangible goods. The software production needs in a sense an unorganised and more control-free invention system. In France, the software companies represent a high quality and 'artisan-type' production system. French engineers can perform a far-reached technical prowess but fail to co-operate in order to accumulate a collective and shared knowledge and finally to forge a 'neo-industrialisation' logic of service. As a result, the reconfiguration of organisational and institutional arrangements in software sector is essential, for the two countries, to readjust their production systems to a new technological environment.

Key Words: software industry, French-Japanese comparison, societal approach, innovation space, professionalism, production systems, human resource management, core competence, absorptive capacity.
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This paper aims at comparing the French and Japanese production systems and professionals in the software industry. The software industry constitutes an empirical subject of particular interest. It produces intangible, strategically important goods and symbolises the economy's transition towards what might be called 'knowledge-based society', a phenomenon which presages a new set of organisation, professional capacity, training methods and different uses of skills.

One of our **central problematic** is to know whether the software sector should be considered as an extension of the industrial sector or as a new innovative production organisation[1]. This question leads us to wonder if a set of pre-existing and manufacture-

1) For example, Cusumano (1990) conceptualised the notion of 'software factory', in arguing that the

centred systems and practices in the domains of strategic decision, production method and human resource management can be still effective or not.

Both countries have considerable stakes in the short and medium-term competitive edge of this software sector, while it is very poorly understood, not only because of a lack of in-depth studies, but also because it occupies **an ambiguous position between industry and service**. This comparative analysis then leads to the study of the new 'transversal sector'[2] in the economy, which poses many questions about continuity and discontinuity of innovation capacity at the macro/national level as well as the micro level (Kodama 1991).

The software sector, part of an extremely competitive industry, has a high added value and is exposed to international competition and more recently off-shoring risk. With a highly qualified and professional work force, labour mobility is particularly difficult to monitor and human resource management reveals all the strengths and weaknesses of a certain type of functioning of the labour market.

In Japan, where 'professional' is not a traditional concept, the questions concern the way new graduates become a specialist/expert and the opportunity of their external mobility beyond a single company. These questions are essential to understanding the emergence of the new 'professionalism' and the new labour market segment, alongside the traditional internal labour market. In France, where the career strategies of highly qualified workers may be exacerbated in an external labour market, the question is how the companies that aim to be the most effective can control these individual strategies and organise collective creativity.

The great interest of this sector results also from the constant and rapid evolution that software firms experiment since 80s so far. Does this permanent reorganisation affect all firms or are there areas of greater stability? This question refers back to the development of the software product, which evolves very quickly technically, requires perfect reliability (like an industrial product) and needs constant adjustment to meet customer demands (like a service).

It must therefore be taken into consideration the very complexity of the software

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Japanese software industry could create the factory system in which large number of workers are engaged in developing software in the manufacturing and 'taylorist' manner - i.e., individual programs are not developed in isolation but rather use standardised methods and automatic tools as well as parts of other programs. This vision of software industry reflects one side of current trends in the world, but seems to be too simplistic: software industry will continue to keep more or less the service/tertiary rationales (Gadray 1994). Moreover, this mixing between industrial and service characteristics might largely depend on the national institutional arrangements in which the software industry is embedded.

2) In the sense that the software production takes place everywhere in the economy, since characterised by the co-production between the users, the application services companies and the software products providers. In particular, the users - software engineers working for the IT users - play an important role in the software production.

product in comparison with a manufactured product or a service. Defects in software quality can cost the customer very dear. The same customer frequently requires assistance to define his problem. To launch software products into the market requires very specific industrialisation and commercialisation (Berry 1991). Software production cannot be managed in the same way as in industry or in the tertiary sector (Borum 1987). What is the meaning of quality control for such an abstract and intangible product? All these questions call into question the traditional 'business models' that Japan and France have constructed until now.

1. Method of investigation: societal approach

To bring some analytical and interpretative elements into the initial problematic, we shall conduct two series of analysis:

The first one is at the macro and sectoral level. Here our analytical tools such as professional space, industrial space and innovation space will be mobilised. This kind of analysis, based on the 'societal approach', allows us to characterise some sectoral specificity in each country, by focusing on the interaction effects between different spaces (Maurice, Sellier, Silvestre 1986).

From the methodological point of view, the societal approach was constructed fundamentally, in order to examine the firm (or a whole of firms in the group/sector/geographical zone) in relation to the society of which it is a part, although its analytical subjects are not necessarily limited to this one[3]. In this academic context, it is essential to take into account the interdependence between the firm and society, a process that helps to produce the firm's core competence through the interaction between the actors and the spaces.

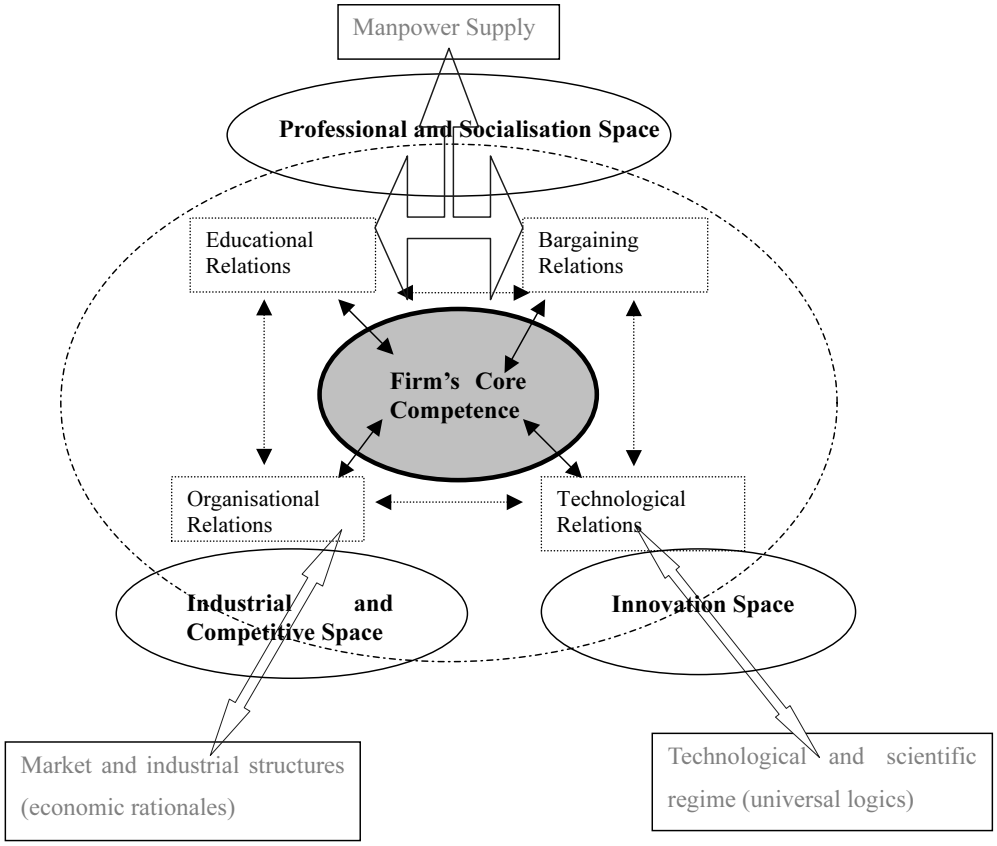
There are of course many mediating factors intervening between these various institutions, organizations and categories of actor specific to each country and firms. Each firm has its own autonomy that enables it to manage its relations with its 'environment' or its societal 'context'; each firm makes its own choices and defines its own strategies with respect to the product/market matching, the formation of skill, the subcontracting, the form of organisation or innovation.

However, it seems possible to highlight some basic relationships of interdependence by means of which firms, operating within a given society, construct their specific resources, actors (different category of workers) and competence.

3) From our point of view, it is very possible to realise an international comparative study on any organization, social category, practice or process (for example, family, political party, health system, voluntary movement, belief etc) in the perspective of societal analysis.

Figure I

Societal effect and interactions between professional space, industrial space and innovative space



In the figure I, the largest circle represents the society of which the firm is a constituent part. A given society includes numerous systems or relations which are built up by the different institutions or organizations: the state plays an important role through the policy-making in various domains of 'industrial policy', 'educational and scientific policy', 'manpower policy', 'innovation policy', 'competition regulation policy' etc. But also there exist many semi-public and private organisations, at the national or regional level, which make a contribution to the vocational training, the patent and commercial regulation or to the development of scientific and technical research. Thus these institutions or organizations contribute together to constitute what it might be termed the 'spaces' in which they interact to create an environment for the firms. We are led to privilege three space which seem to be the most relevant for our current study:

For instance, the industrial group cohesion, the strong identity of the firm in Japan, and the significance of the sector and trade (or métier) logics in France produce a different **industrial (and competitive) space** in each country and it shapes a particular form of the

company. In the first case, legitimacy of the company entity is based on certain 'impermeability' to its environment, whereas in the second the company tends to become 'diluted' within the sector, itself legitimised by broader codification systems (State, third parties such as trade-union, national occupational classification system).

Also, the Japanese system of mass university education supplies generic, relatively homogenous human resources with a stock of academic knowledge that is not immediately operational (Shapira 1995). The engineers' competence is built up progressively through professional practices — on-the-job training — and in technical proximity with the manual workers. In consequence, apart from the vertical management hierarchy, design capacity and operational capacity tend to overlap. In France, the existence of the 'Grandes Ecoles' and the title of engineer confer an aura of scientific excellence on the engineers' training and give to the graduates a professional autonomy (Nohara, Verdier 2002). Newly qualified engineers benefit immediately from cadre (executive) status, entering an existing hierarchy that distinguishes them from other employees and bestows on them the capacity to innovate. These different methods of skill formation produce different **professional (and socialisation) spaces** in France and Japan.

Likewise, job division methods in France tend to favour not only technical design function but also formalised knowledge and at the same time to neglect operational function i.e. empirical know-how. Firms encourage the integration of outside resources and exteriorisation of the innovative process. In Japan, innovation occurs within a firm's internal dynamic, being based on close contacts between the workshop, and the design team, and on reactivity to the market. The boundary and the form of **innovation space** differ therefore in each country.

The second one is at the firm level. Relationships of interdependence exist between these three spaces and between each one of them and firms. In other words, all these relationships contribute, in each country, to the constitution of what might be called the core competence/capability of firms in which the organisational and cognitive resources and professional skills of manpower are developed and from which each society's dynamic and potential for technical and industrial creativity flows.

Then the inner circle represents the firm, with the four relations (educational, bargaining, organisational and technological relations), which mediate the articulation between the firm and the society (societal contexts or national environment). By 'endogenising' such external contexts, each firm defines its own R/D or industrial strategies and its relationships to the market, as well as its strategy for human resource management and the division of labour between different categories of actors. It is thus at the heart of these multiple relationships that the firms are embedded in the society and at the same time they create the society (Lanciano-Morandat and alii 1998).

At this micro level, we can observe the interaction between company strategy, management practices and various types of actors. For this purpose, two large companies, (FLg and JLg) and two small ones (FLp and JLp) have been pair-matched, one of each from France and Japan. These all firms work (not necessarily exclusively) for the banking and insurance sectors. Managers, executives, engineers or technicians from these firms were interviewed regarding the production organisation, the software development process (including customer or market relations) and the human resource management practices (training, job assessment, involvement, wage etc.). The construction of occupational skills, training or individual career plan was also discussed. From a detailed analysis of these interviews, we forged a typology of relations between professionalism, learning and organisational structure (project management, hierarchical organisation, human resource policy etc.).

The methodology based on 'societal approach' makes sense, only if these distinct levels of analysis (country, sector, firm and individual actor) can be recomposed according to a certain type of coherence and dynamic. Thus it is essential to examine the linkage between macro and micro in each country, by observing the 'endogenisation' of institutional logics into individual and collective actions through the socialisation process of actors.

In the following sections, we will firstly analyse the different sectoral configurations in each country, focusing on the differences in the firms' openness or 'impermeability' to their environment in France and Japan. Then we attempt to investigate, at the micro level, the interactions between actors (managers and software workers) and to characterise the software firms' innovation space: the main focus is here on the methods of developing 'professionalism' in order not only to improve productive efficiency but also to organise **'collective creativity'** (Lanciano-Morandat and alii 1998).

2. Sectoral environment and configuration of the software firms

Since the construction of each sector and each firm takes place in interdependence with and between the various effects of productive structure, industrial policy and public agency etc., it can only be understood in terms of the **industrial space**. The organisation of firms or the sector, their relations with suppliers, customers, subcontractors and market, and their scope for innovation, will depend in large part on the quality of interaction and on the way they appropriate these external resources. Cohen and Levinthal (1990) in their innovation literature named this type of competence 'absorptive capacity'. The software sector, the firms that compose it and the industrial space they form, can be described via this specific dynamics, their history and their strategic

orientation.

In both Japan and France, the computer services industry grew rapidly. Up to the mid-90s, the number of companies multiplied, due to the development of Personal Computers (PCs), and then Internet technologies. But its growth slowed down dramatically since the mid of the Nineties; there has been a fall in business and a reduction in the work force, which introduced significant sectoral reorganisation. After the beginning of 2000s, software firms have suffered from the general economic sluggishness affecting both countries, which has led to internal reorganisation and changes of practice, in relation both to their environments and to their previous strategies. Carried by the particular dynamics of computer and communication technology, both countries have simultaneously followed similar economic and industrial paths. Nevertheless, the similarity of development and type of industrial evolution cannot conceal the deep-seated differences, which were apparent from the start and which continue to condition to define the industrial space in each country.

The history of this industry thus leads to different structuration of this space.

A) In France, the computer services industry is a **centre of excellence** and assembles **high-level intellectual skills closely related to abstract logic**. Since the beginning of computerisation of the French economy, it has successfully occupied a strategic position, partly as a result of certain historical factors surrounding its emergence. The first factor was a weakness of French computer manufacturers. When the 'Plan Calcul' -national project- was launched, American manufacturers dominated the French computer market. Since it was inconceivable that the main computer-engineering tasks in Space, Defence or banking should be entrusted to American multinationals, a national solution had to be found, and then the first SSIIs[4] seized their opportunity (Nohara, Verdier 2002). This was the main source of their initial turnover and enabled them to build up their technical expertise. The second factor was linked to the strategy orientation behind the creation of the first independent SSIIs. Often originated from consultancy firms, they opted for intervening in the upstream process of computer projects (architecture planning, computerisation strategy plan etc.) and gradually developed a supervisory capacity for the whole range of computer engineering (Nohara 2000). In particular, the civil service and nationalised companies provided them with the first major computer contracts in which they have done their apprenticeship. Handling key functions in the computerisation process (guiding plan, basic structure, integration), gave these SSIIs a good professional standing and a sectoral identity, despite the existence of many companies described as 'temporary work office'. The strength of the French software industry resulted in its foreign expansion (nearly 12% of turnover in export sales, compared to less than 3% for

4) SSII (Société de service en ingénierie informatique) means 'Computer Services and Consultancy Firm' in French.

Japan, at the beginning of 2000).

B) The Japanese computer services industry has not the prestige of its French counterpart and has difficulty in affirming its identity, although some SMEs show their real competences. It continues to struggle with two problems:

- the software product was for a long time considered without 'intrinsic' value, simply an accessory service to help improve sales of computers.
- in Japan, the computer market is characterised by competition between several major national computer manufacturers under the aegis of METI, which operates a protectionist policy against American manufacturers. Each manufacturer tends to use its own subsidiaries to control the 'prestigious' part of computer project design. This particularly strong control prevents the 'independent' SSIIs from forging direct links with important customers or the state, and they are confined to a downstream process in the computer operations that generate little profit. This explains why the independent Japanese SSIIs have made a modest start and have not so far played a major role in this field. The majority of them took over the most elementary tasks, such as computer custom works (data entry, calculations, etc.). Later, they were limited to programming tasks under the supervision of the manufacturers or subsidiaries of the major users (banks, insurance companies). Despite the recent emergence of a few independent SSIIs, which have attained the status of prime contractor (integrating system), the **hierarchical division of labour** in the software industry can broadly be categorised **as a system of sub-contracting firms** (Imano, Sato 1991).

C) Such historical differences continue to define the SSIIs' sectoral structure and strategies as well as the management of human resources in each country.

At the beginning of 2000s, the French software industry represented 28,1 milliards of euros and was ranked in the fifth position in the world -- and third in Europe slightly behind Germany and UK--, compared to Japan: 102 milliards of dollars, ranked second just behind the United States. This corresponded to 2.6% and 2.1% of GNP in France and Japan respectively. According to the Syntec[5], the French industry comprised 1,500 companies employing more than 10 persons, and a workforce of 285,000 (210,000 of them in France itself). METI estimated that there were 7,600 companies employing more than 10 persons, and a total workforce of 567,000.

Even though relatively equal in terms of economic importance and number of employees compared to the total population, the configuration (extent and composition) of the sectoral industrial space is different in each country. Although France has some of the leading SSIIs in Europe, it is distinguished by a large number of small, independent

5) Syntec is a main trade (and employer) organisation that groups the SSIIs in France.

companies. The concentration is greater in Japan, due to the many large SSIIs, which are 'subsidiaries' of manufacturers or users.

It is estimated that the 'independent' SSIIs produce 68% of sectoral turnover in France (PAC-Consultancy Company) compared to only 54% in Japan (JISA[6]). This means that the French computer services market is more open or externalised than in Japan, where the captive market apparently plays an important role. Similarly, the use of subcontracting appears exceptional or less well-developed in France (less than 5% of sectoral turnover (SESSI[7]) whereas in Japan the subcontracting system accounts for 15% of the computer services market (JISA).

The evolution of software market seems to be moving in the same direction in both countries, with greater attention to cost-cutting, quality and commitment to results. These trends involve a reduction of share of customised computer works, large productivity rises and a development of 'fixed-cost service' to the detriment of 'the supply of means', increasing business in software packages, etc. All these movements are converging towards a certain 'rationalisation' of software services production. However, France remains somewhat ahead of Japan. The software package business represents 26% of all professional services in France, compared to 15% in Japan (PAC, JISA, 2002). French SSIIs have clearly shown a real innovative capacity in this field. However, to progress beyond this 'artisan' stage, they need to create economies of scale and to consolidate financial resources, which seems to correspond to the current capital reorganisation strategy (M&A, regrouping, etc).

The strategic positioning of the four companies studied below is largely determined by the macro definition of industrial space in each country. For instance, JLg -Japanese big company surveyed- belongs to a large group as one of affiliates. It is obliged to adapt to this situation, to submit to their supervision and to participate in a division of labour decided outside its control. FLg -French big company surveyed- owes its autonomy to its origin in service management, Its autonomous construction enables it to build its space in an original fashion, in co-production with its customer. Instead of adapting itself to a pre-defined industrial space, this firm is a consecutive participant in a new industrial space.

In other words, the first adapts itself to the domination of the large groups, occupying a 'complementary' position in the industrial space, while the second participates to the creation of a specific space. In France, the SSIIs form an authentic sector with its own institutions, whereas in Japan they are a heterogeneous set of dependent companies.

D) The educational space, like the configuration of industrial space and the human resource management of the SSIIs, all contribute to the sectoral innovation space

6) JISA is a main SSII trade organisation in Japan.

7) The 'statistic service' department belonging to the French Ministry of Industry.

dynamics in each country.

Although a fair comparison of the computer engineers' qualifications is very difficult, the French software industry seems to be better able to attract highly qualified graduates than is the case in Japan. In France, 63% of the industry workforce are 'cadres' and professional workers. In addition, three-quarters of graduates from computer science are classified a cadres at the very beginning of their career, whether or not they have the required educational qualification (Bac + 4 or 5[8]). In Japan, the MITI statistics distinguish software workers into two categories: 'system engineer' and 'programmer', representing respectively two third and one third of the total. The computer engineers' recruitment flow in 2001 was significantly different in each country. The French SSIIs hired 12,000 computer engineers, of whom only 4,200 were new graduates, compared to 14,500 new graduates out of some 19,000 computer engineers hired in Japan. This simple comparison leads us to some observations:

The first observation concerns the French computer engineers' high degree of external mobility[9] contrasting with the pre-eminence of young newly graduates in Japanese SSIIs. The degree of autonomy enjoyed by computer engineers differs considerably between the two countries.

The second one concerns the novice engineers' training, which reveals how the SSIIs aim to develop the computer engineers' professionalism.

The French SSIIs attract a great part of new graduates (10-15% of the qualified computer engineers who graduate each year are absorbed by the SSIIs). 2,400 out of 4,200 (57%) possess Bac + 5 diploma. Those with Bac + 2 or less certificates represent only 19% at this level. A concentration of highly qualified staff, the majority of whom possess advanced qualifications in computer science, is a main characteristic of the French software industry. In Japan, the new graduates are divided between Bac + 4 (34%) and Bac + 2 (48%). Unlike other sectors, the Japanese software industry benefits from the students at Bac + 2 level, with computer-related qualifications from specialised training schools. The reputation of these private schools is not high; they confine the students into programming operations, where they tend to remain captive. Of the new graduates with Bac + 4 or more, 60% have read arts or social sciences, 36% have a scientific or technical education and only 4% a computer science qualification. With few exceptions, the Japanese SSIIs cannot compete with the industry, in particular with the computer manufacturers, in attracting the best scientific graduates. Given the low technical qualifications of these new graduates, the Japanese SSIIs tend to finely divide tasks, less for the reasons of rationalisation and 'taylorist' organisation than because of the need for a gradual

8) Bac + 4 (or 5) corresponds to 'baccalaureate level + 4 (or 5) additional years spent in higher education' in French academic credential system.

9) This external mobility fell sharply in 2000-2002 period where the E-economy faced a severe collapse. It is not clear if this fall was due to purely economic causes or for structural reasons.

learning process.

The third one is relative to the small number of software 'professionals' with research training (bac+8 or PhD level) in both countries, although it is more common in France (250) than in Japan (150). This is evident, when compared with the USA that produces nearly 2000 PhDs in computer sciences a year.

The strategic positioning of French SSIIs, and the high quality human resources at their disposal, create a high level of professionalism, to which the concept of autonomy is central (Lanciano-Morandat 1996). This professionalism is linked to traditional expectations of the role of the French cadre/professional executive. This professional autonomy, well-adapted to the 'artisan-type' organisation of the software industry, may encounter difficulties in a new stage of rationalisation, when standardisation, economies of scale and new organisation will affect the production process of software and software packages.

The construction of 'professionalism' in the Japanese SSIIs is conditioned by the social division of labour and the poorly adapted labour offer. There is residual 'taylorist' logic. The desire for autonomy and training are subject to some powerful external restrictions. Despite a real progress, this type of development with the professional space weakly defined has not yet raised all the SSIIs to a high standard level equivalent to the international standard of software production.

3. Innovation space at the micro or firm level

We now attempt to link, at the micro level, the company strategy, the professionalism of the actors and the organisation of innovative creativity within the firm, in order to describe a full significance of **innovation space** and the construction of core competence.

3.1. Company strategy and historical path dependency

The independent software firms are a relatively recent phenomenon in both Japan and France. For this reason, the four companies[10] examined in this paper are of very diverse origins. This partly explains the type of market segment where they operate and their strategic orientation.

The two large companies originated from the outside of the software sector. FLg is spinned off from a business consultancy firm and today still favours a methodology

10) We have for the first time investigated these firms in the mid-1990 and revisited them ten years later.

which combines customised consultancy with computer engineering. The software engineer is directly responsible for customer relations. JLg originally specialised in data processing and still attaches special importance to its sales department, which is responsible for customer relations. They do not operate in the same market segment, nor have they chosen the same type of development. Since their creation (FLg in 1951, JLg in 1964) both companies grew continuously and fast (around 30% per year since 1985) until 2000. JLg's growth was internal, but during this period it developed subsidiaries specialising in certain types of operation (data entry for example). FLg's growth remained internal until 1984. Since then, like other French SSIIs, it has developed by taking over other companies. These takeovers have enabled it to expand its markets, thanks to the expertise of recently acquired subsidiaries in new activities for FLg (e.g. scientific computers) and to the opening of foreign branches (e.g. in Germany and the USA).

In accordance with their policies and traditions, the two companies also invested in different **trades** (métiers). For a long time JLg specialised in sub-contracting the customised works by two ways: supplying the client with qualified personnel for a given period (obligation of means); taking a complete responsibility for a specific task (e.g. company pay). Since the end of the Seventies, it has turned towards the 'system integration' and 'internal' software development and thus to 'fixed price contracts', The company preferred to reduce risk with many small contracts rather than to engage in a large operation. Recently it has taken a first action in software package production within specialised departments (e.g. the banking sector). FLg had always focused its activities on management consultancy, software engineering and 'fixed rate contracts' (obligation of results). But it was one of the first French SSIIs to move into software packages (30% of its activity in 2003) and most recently, sectoral software packages. It seems that JLg is presently consolidating its new skills while FLg is expanding its traditional field of activity.

The two small companies are more difficult to compare, since they represent profound historical, strategic and organisational contrasts. JLp was founded by twelve associates who together left their employer - a computer company - and staked their future on the development of computer services. This creation was a collective adventure, although the personality of the present Director (and his entrepreneurial spirit) played a decisive role. Its history over the last twenty years is typical of the evolution of many Japanese SSIIs: they gradually caught up complex software services generating more profit, which demonstrated a trajectory of skill-up over time. JLp began with customised works, gradually moving on to the delegation of computer staff (contract with obligation of results). It should be noted that this up-grading through the industry, involving a new relationship with the market and a change of trade (métier), took place within a fairly constricting relational space, the hierarchical space of subcontracting. In the computer services sector, where computer manufacturers - or their direct subsidiaries - often act as

prime contractor for computer projects, most of small and medium-sized companies are integrated into the subcontracting networks. Nourished technically by the subcontracting relationship, JLp nevertheless adopted a strategy aiming to enlarge its autonomous field of action, by developing its own sales operation or creating a network of regional subsidiaries. But it remains dependent, in the banking sector for example, on a single principal contractor, a computer manufacturer, for as much as half of its turnover. From an organisational point of view, despite its relatively modest size (200 employees), JLp is already showing several signs of bureaucratisation; the functional 'divisionalisation', the importance of central administration or the formalisation of management tools (job classification, management control system, assessment system, etc.). This organisational bureaucratisation is not due to societal factors but rather to contingent factors such as company size (JLp has 200 employees compared to 26 for FLp), age or stage of development, etc. Another organisational characteristic is the dense interpenetration between the company's internal organisation and its immediate external environment, which is structured by a complex configuration of the actors: the joint venture partners, the company's own subsidiaries or customers, etc. JLp appears to be both subject to, and creator of its environment. Its frontiers seems to become blurred. This organic embedding means that its internal functioning is only really intelligible when its interactions with the outside are fully understood.

The French company, FLp, despite its legal form, remains an individual company, which fundamentally embodies the entrepreneurial initiative of its founder, the present Chairman. It was founded to transform a personal idea into a product or to industrialise an original, individual invention. Moreover, its creation was totally dependent on the founder's personal capacity to mobilise the necessary resources (goodwill, financing, etc.). Thus, right from the start, it asserted a strong identity inseparable from its creativity. This self-affirmation is also derived from the strategic autonomy, which has enabled it to use a dynamic form of learning to forge a new professional concept (publishing property management software), and skills adapted to new markets. Unlike its Japanese counterpart, it remains organisationally relatively mobile and unformalised, or 'artisan-type', that is, coexistence in the decision-making process of the founder's great personal authority and non-explicit procedures of mutual adjustment. FLp is now clearly in a transition period towards a stage of industrial organisation requiring organisational codification and formalisation of management tools.

The Japanese companies are characterised by a mediated relationship with the customer, induced by their position in the division of labour with the large groups. The French companies are free to pursue a more original development in the market. Their trades (or métier) are also different: in Japan, trade (métier) is both dependent on that of the client and restricted by the subcontracting relationship; with its independence, the French SSII are able to construct a specific 'métier'.

3.2. Construction of professional capacity

These different relationships between the market and the firms' trades (métiers) are interdependent with the software engineers' professionalism. Different methods in the fields of personnel management and building-up of professionalism are used in France and Japan. The management tools are also different from those utilised for industry in both countries (Lanciano-Morandat, Nohara 2000).

The employees of the companies studied are particularly young, their length of service is short and in general they are recruited at a high level (Bac + 4), which is relatively typical in Japan[11]. In France, the computer services sector can attract a human resource with good computer skill training. FLg, like other French SSIIs, prefers a high-level recruitment, particularly engineers from the 'Grandes Ecoles', followed by university science graduates (possibly computer scientists). The importance attached to the 'Grandes Ecoles' is partly explained by a sort of informal 'sponsoring' exercised by the founders of the SSIIs, themselves graduates of these schools. These engineers are chosen for their general technical competence and their organisational and relational ability. This overall competence gives them the capacity to act individually to bridge the linkage between organisational consultancy and computer techniques, and enables them a large mobility within the company. This is a fundamental difference compared to Japan.

Despite its small size, FLp attracts some of the best graduates from the French higher education (engineering school, professional postgraduate degree, etc.). Most of the new graduates are trained in computer science and possess the solid basic computer skills, which confer them a professional autonomy. By recognising a professional status (cadre) to them FLp benefits from their full capacity for autonomy, the very source of its creativity.

Supply of computer scientists in Japan is in short run, since the higher educational system, with the exception of the technical college at the Bac + 2 level, does not produce a great deal of graduates in computer sciences. Moreover, software companies have practically no chance of recruiting engineers from the scientific or engineering faculties, since they are largely absorbed by manufacturing industry. Most of the time, they recruit university graduates (Bac + 4) with non-scientific degrees (commerce, liberal arts, law, etc.) or students with Bac + 2 or Bac. Specialisation in ready-to-use software products has led JLg to become involved in its customer's profession. To follow the customer's operation, JLg recruits students with non-technical skills and a general training,

11) Almost 90% of JL workforce is of undergraduate to postgraduate level, and 81% of its recent recruitments were at Bac + 4 level. 90% of FL workforce is Bac or over and 60% at level Bac + 5 or over.

particularly in economy, law and management, similar to those of its customers (80% of company employees have this type of background).

In both countries, the socialisation of the new employees is a slow process. Both French and Japanese employees in software sector receive an introductive company training (3 months in Japan, 2½ months in France). This type of training has a double purpose: teaching them specific computer techniques and familiarising them with company management practices.

The non-technical nature of education in Japan means that the 'on-the-job training' in computer techniques is very important and it lasts for a long time. JLp is obliged to train its employees both in the computer business (1 to 2 years) and in the sectoral knowledge specific to their area of application. Both parties (employer and employees) commit themselves to a long-term relationship of mutual obligations. The firm agrees to invest in training, gambling on the young employees' potential. They agree in return to learn the profession and to await a future recognition. This type of learning, which reinforce the conformity of mind, is adapted to the innovation based on an 'incremental change' in manufacturing industry, but is not at all suitable for a 'radical change' necessary in software sector[12].

In France, new graduates are considered to be already trained by the educational system and are expected to be operational more quickly. Contrary to the industrial practice, after the trainee period, the employees are not assigned to a precise post or function but to a department (for example Banking or Insurance) and temporarily, to a team or to a task. From the start, the young French engineer has a certain autonomy and individual responsibility in relation to the project, within the pre-defined limits of his job. The young Japanese engineer comes always under the collective responsibility of the project group. Considered to be virtually incapable of functioning independently, he begins with simple tasks so that the more experienced employees can help him in order to acquire gradually technical skills.

In both countries, the new employees at all recruitment levels start as a programmer and gradually advance to more complex tasks. Progress is however much more quick in France and more variable with regard to the engineer's diploma than is the practice in Japan.

In Japan **collective labour agreements** exist only at company level. For example, JLg sets its own personnel management rules and negotiates these rules with the company union. Like almost all Japanese firms, there is no corporate objection against the existence of a union in the SSIIs, since the white-collar workers are traditionally union members in the same way as the manual workers. The union presence is however less

12) Archordoguy (2000) argues that this is one of the reasons why the Japanese software industry has never met a success, while its manufacturing sectors have competitive edges in the world market.

visible and more discreet than in the industrial sector.

Unlike the usual situation in France, in the metallurgical industry for example, the software sector has no specific, nationally valid system of job classification. Syntec, one of the French trade organisations, provides its members with a classification chart (a quasi-collective agreement) that has been negotiated with the trade unions. This chart is widely used by all the SSIIs, each one adjusting the details to its individual situation. FLg negotiated an adaptation of this system with its own works council. The unions are not represented in this council and the management encourages the employees to stand as staff representatives. For this reason, corporate participation is very low.

With regard to the **career management** and the **chain of command**, the software firms are representative of the societal features. Within JLg promotion is based on two criteria, length of service and assessment of individual merit. The length of service criterion is intended to guarantee a minimum of professional advancement and wage progression for each employee. A performance assessment is made yearly by the immediate superiors and helps to ensure individual employee wage progression and promotion in the long term. Career management is closely linked with in-service training. Alternate periods of on- and off-the-job training are programmed in advance, in accordance with some important stages of professional life. This extreme formalisation of management tools suggests strong company control of employees, with little scope for individual freedom of action.

At FLg personnel management is much less systematised, which allows the French engineers relative autonomy in constructing their individual career strategy. The firm has no open and formal assessment system and no employee training plan. Specific and complementary training programmes are to be applied, when required for immediate project needs. FLg does maintain a system that makes it possible to control the project advancement and its profitability in real time. Although this system is not linked to individual assessment, it enables in fact the management to monitor the individual efficiency of each employee. This system is probably more restrictive than a traditional assessment one. The engineers consider this individual time management as a professional constraint and a specific factor to software engineers. These controls partially counterbalance the engineers' strategic autonomy.

Another particularity of the software sector, in comparison with the other manufacturing sectors, is a blurring of the usual professional categories in both countries. In France, software company employees are divided solely into two categories: operational and management personnel. Operational staffs comprise both non-cadre employees (programmers, technicians) and engineers and cadres. Although the special advantages traditionally attached to 'cadre' - status in France (bonus, time management etc.) are taken into account, daily company management ignores the splits between cadres and non-cadres that are so significant in the French workshop reality. The 'managerial staffs' are close to the Anglo-Saxon concept of management, i.e. hold a real hierarchical

responsibility.

The Japanese companies mostly use the American double-ladder management system, by adapting it to their needs. After a first period of career development which is common to all engineers and regulated by seniority, two channels for advancement are proposed: management ladder and expert ladder. There is a correspondence between levels and ranks in each ladder. Experienced engineers with no managerial responsibility can attain the same levels of classification and recognition (wage etc.) as management staff.

External mobility of engineers has always been of minor importance in the companies studied[13]. Extremely rapid company growth has made it possible to increase the number of functions with responsibility, create internal hierarchical mobility and consequently, a strong internal labour market structure. Although companies are organised around projects in both countries, and the engineers are assigned to different projects, types of internal mobility seem to differ. In Japan, the working group acquires a certain technical expertise; it remains relatively cohesive and is **collectively mobile** from one project to the other. On the other hand, it is rare for this group to leave a department (for example, banking), which constitutes its **area of specialisation**, for other departments. In France, the engineer's task is individualised: he is assigned to contracts according to his own competence. When he changes the department, it is more likely to be in response to a need for organisational flexibility than for training or to be based on a personal desire to expand his career. His mobility is in any case an individual movement to any part of the company.

Put in the specific societal contexts of France and Japan, the firms reproduce the same type of methods of human resource management and the same type of engineering 'professionalism' as in the other sectors. In Japan, the major parts of software engineers enter the labour market of the large industrial groups and they move between associated companies. In France an occupational space for softwere engineers is emerging. Engineers and 'cadres' start their career in a SSII; some later move on to client companies, so that such movements in the labour market reinforce the coordination between the computer services industry and its customers.

Two observations linked to the sectoral specificity of these SSIIs modify this model. The first concerns the necessary overlapping of tasks between the SSII and the client company, which produces different relationships between producer and user. These relationships, new with regard to the usual division of labour, influence the nature of employee's 'professionalism'. The second observation concerns the blurring of the category of engineer, particularly in France. Thus the novice engineer carries out the same programming tasks as the technicians, contrary to his traditional function of technical supervisor: he is an 'operative' engineer and a 'directly productive' engineer. He is

13) This could probably be a specific characteristic of the large French company studied.

bounded to the 'manufacturing' conditions, and the controls on the time spent on each task and on the quality of his work are identical to those for industrial workers. This proximity between the categories of 'designer' and 'operative' is exceptional in France. In Japan, on the other hand, the massive presence of non-scientific and non-technical graduates radically transforms the very concept of 'engineer'. The computer related workers, or at least those who work in the software sector, do not entirely correspond to the traditional category of 'engineer'.

3.3. Production organisation

Interdependent and parallel movement helps to develop the actors' 'professionalism' and to organise their creativity. This creativity depends on several factors: job organisation, the degree of actors' autonomy or submission to control, and the way in which knowledge is accumulated.

A) The parallel evolution - hard and soft - of products and markets is accompanied by a rationalisation of software production. French and Japanese software companies have developed via the customised production of a product specifically designed for an individual client. To compete with American software, and to cut down production costs, French and Japanese companies are starting to **standardise** their products. Increasingly, the software product is no longer an 'original' piece but has become a complex and specific assembly of a variety of elementary software parts produced in small quantities. The software package must satisfy general market requirements. It is designed to be sold in medium-sized runs. It is then adapted, *a posteriori*, to the individual customer's specific demand. There is certainly a tendency to blur the difference between customised software and edited package. But these series of edited software for a large market are not produced in the same conditions as a unique product/service, designed for a specific company: each product requires a different type of organisation.

i) Software application services

In software production units in both countries, hierarchical and project organisations are settled as a 'matrix form' and coherent within a department. For each contract, the department organises a specific team to satisfy the customer's demands. Hierarchical and horizontal relations are intermingled within the team, which breaks up when the contract ends. This type of unstable, shifting organisation places the employees in a situation of permanent mobility-adaption, but does not necessarily conduct them to change their departments within the company. Employee's flexibility to the customer demands is all the more necessary things, as the engineer is often located in the customer's site to carry out part of his tasks. The forms of coordination between the two partners -customer and software supplier - in the production process and their division of labour are not the same in the French Japanese companies.

The Japanese company has an 'extended' boundary with a network of subsidiaries and subcontractors. Each of these subgroups specialises in a phase of software production: one in coding, others in programming, etc. Each employs specific staff. This division of labour within the group is accompanied by a division of labour between the sexes: women are specialised in production tasks, data entry, for example, and the men in design tasks. The mother company, JLg, designs the software and has a control of the overall organisation, the adjustment of the various parts of the system and customer relations, according to logic of assembly. Relations within this group of production units are both legal and financial (subcontracting, sub-delegation, loan of labour) and derived from a true complementarity between the employees. But the client also participates in this process as a main actor to specify his own requirements.

The Japanese system seems paradoxically to be organised according to the 'taylorist' principle of division of tasks. However, as this strict allocation of labour is related to the lengthy on-the-job training of the employees, it enables skills acquisition for them, at the same time creating a link between the customer's profession and that of the SSII.

The large French company is organised in departments or subsidiaries, which are not situated at different stages of the same production process, as is the case in Japan. These units are autonomous companies, specialised in particular market segments, (facilities management, scientific information proceeding, networking). Each department or subsidiary of FLg has a direct, exclusive relationship with each client providing a given contract. The direct relationship of each unit with its customer is not intermediated by a sales department. The contract is usually precise and on a forfeiter basis. It establishes a certain division of tasks between the two partners. The project team may be composed of employees of both the SSII and the client company, managed by a project leader from FLg. Or some of these tasks (generally data entry, programming etc.), may be left to the customer, or possibly to another SSII, while the conceptual work is directed by the FLg engineers. In many cases, the coordination between the teams of the two firms can create tensions, but there is also obvious emulation. This cooperation between different competences goes beyond the exchange of information and knowledge. It might be suggested that the product is **co-designed** by the customer and the SSII, as attested by the **co-ownership of the software** (included in the contract).

Thus, a project for maintaining the programmes for the computer department of a large insurance company has created a durable organisation - two years old at the time of our study - that is a complete mix between the SSII and the customer. Each employee is positioned on the common organisation chart according to his personal skills and his parent company. The insurance company employees have their future posts in this information system, while those of the SSII, despite their involvement, are attached to the software company and could move out at any time. The situation whereby employees of the same organisation, at the same work location, follow different timetables and benefit

from different assessment and wage systems, creates complex behavioural patterns.

In France, unlike Japan, division of labour within the SSII is blurred and unstable between the SSII and the customer. The software engineer appears as a promoter of the system's coherence. His professional autonomy is counterbalanced by strict controls of his work exercised by management on the basis of a permanent measurement on the delay in the target time/budget schedule. Although there is a 'taylorist' aspect in his work, he is responsible for a set of successive tasks, consistent with each other in time. Skills production within the company is left to the individual good will.

In general, for software applicasion services, French and Japanese companies are positioned differently in the relationship to their customers. The French company develops its own technical skills, thanks to the 'professionalism' of individual engineers, and cooperates with the customer, going as far as to **co-design and co-produce software** with him, while the Japanese company becomes involved in the customer's profession and delivers a ready-to-use product.

ii) Software package production

In software package units, the production process tends to be similar to the process observed in the manufacturing industry: design, industrialisation and commercialisation, even though the various phases are interwoven, with frequent feedback between design and commercialisation.

In this context, Japanese companies' assets are principally derived from their coherent industrial space and the relative 'taylorisation' of their production process. Often supported by a manufacturer, they benefit from its assistance and the collaboration with it in the software engineering development phase[14]. They thus take advantage of the group's size and organisation and the existing division of labour with subsidiaries and subcontractors. This organisation is relatively stable and suitable for a rapid product development. The strength of the sales department in particular, although it separates the designer from the client in customised production, enables to bring quickly a large lot of semi-tailored software package into the market.

In France, the production of software packages has a dual and alternative model:

- a pure industrial organisation: the process is strictly divided between employees with different skills; the client is absent; and the introduction of the product on the market "is not our job...," according to a technico-commercial agent interviewed.

- a semi-autonomous organisation: this model combines the capitalisation of collective expertise among the software engineers and the cooperation with the customer, to launch the industrialisation of an 'artisanally-produced' product (Veltz 1986).

14) This activity combines research, development, technological supervision, improvement of tools and product lines. It is situated upstream in the software standardisation process for the software package.

If these two methods of organisation could be successfully combined, some of French SSIIs would gain a significant competitiveness.

B) A concern of both French and Japanese companies is how to coordinate the relatively autonomous activity of each software engineer in order to accumulate knowledge and expertise. Despite many efforts of rationalisation (computer engineering, development of automatic programming tools - CASE - etc.) the design aspect of computer work remains extremely personalised and continues to generate tacit knowledge and know-how, which makes the collective learning and the accumulation of the knowledge extremely problematic. Companies are attempting to formalise this process of creation, clarification and transmission of knowledge, via the development of 'memorisation' tools.

JLp has developed a genuine computer engineering system via the simple assembly of pre-programmed subroutines. Even though its validity so far seems to be limited to the storage of certain existing programmes for more effective re-utilisation, this type of tool is undeniably useful in standardising the programming techniques, facilitating the knowledge transmission and accelerating the computer scientists' training. This company also makes use of the 'job note', in which each software engineer is invited to note down the incidents, the faults and their solutions, which occur during the daily work. French companies have the same concern. Although FLp is less well-equipped, it devotes an important part of its energy to implementing a knowledge codification system, for example, by editing a reference document with the essentials of knowledge on property management, which is its core competence. It is also trying to reorganise the work process by separating development and programming, in order to improve the knowledge formalisation and its accumulation. In any case, the systematisation of these tools, even if it does not always function as the companies would wish, indicate their intention to codify tacit knowledge and to ensure its durability (Foray 2002).

4. Conclusion

Each country retains distinct and proper assets or resources, which could contribute to make expertise/knowledge more productive and organisation more efficient (Lundvall 1992, Nelson 1993, Edquist 1997, Lam 1997). The Japanese firms are capable of creating collectively new knowledge on the job. These firms are also apt to combine the technical type of knowledge incorporated in software engineers and the specific and professional know-how obtained from customers. The French firms can rely on very professional engineers, who naturally collaborate with the customer and are individually creative and innovative. They still have to learn how to collectivise and organise such an individual performance.

Our analysis shows that the two French and Japanese software production systems form a coherent whole and that the strengths and weaknesses of each system are logical extension of the societal characteristics already observed in the industrial manufacturing. In Japan, the software industry tends to imitate manufacturing logics with its proper efficiency in producing standardised and material goods, but it doesn't always succeed in doing the same with regard to intangible goods. This could be interpreted in terms of 'paradox' - and failure - due to the 'institutional isomorphism' (Di maggio and Powell 1983). The software production needs in a sense an unorganised and more control-free invention system (Nakamura and alii, 1990). If not, software engineers tend to lack in imagination, which represents a source of radical innovation. In France, the SSIIs represent a high quality and **'artisan-type'** production system. French engineers can perform a far-reached technical prowess but fail to co-operate in order to accumulate a collective and shared knowledge and finally to forge a **'neo-industrialisation'** logic of service. Such a rationale seems to necessitate the renewal of management methods and a new type of 'professionalism'.

As a result, the reconfiguration of organisational and institutional arrangements in software sector is essential, for the two countries, to readjust their production systems to a new environment symbolised by the development of 'open source software' and Web.2.0. However, such a reconfiguration may probably be done along with the national path specific to each country.

From the point of view of sectoral dynamics, we would like to stress again on the fact that the innovation space in the software industry appears to be subject to a dual tension that exists in both countries:

The first one is an internal tension, which is due to the coexistence of a strong pressure on industrialisation logic of software production and an increasing demand on creativity of individual engineer, and the second is an organisation that implies a 'professional' service logic (Gadrey 2003). The way that the cross-fertilisation of two logics is being done seems very different in France and Japan: it corresponds to two distinct sectoral rationales based on each historical path, to various 'professionalisms', and to different stages in the same process. The sectoral future of software services in each country depends probably on how these two types of rationale could be overlapped or hybridised (Sorge 1991).

References

Archordoguy M., 2000. "Japan's software industry: a failure of institution? ", *Research Policy 29*.

Berry G.,1991. "La révolution du logiciel". *Réalités industrielles 21-1*, Paris.

Borum F., 1987. *Computer specialist communities: a paradigmative analysis of the structuring of the Danish computing field*, Working-paper, Institute of Organization and Industrial Sociology, Copenhagen.

CEFI 2002. Rapport de synthèse: *étude sur les besoins d'ingénieurs EEI, électrotechnique, électronique, informatique*. Paris : CEFI.

Cohen WD. and Levinthal DA, 1990. "Absorptive Capacity: A New Perspective on Learning and Innovation". *Administrative Science Quarterly 35 (1)*.

Cusumano MA., 1991. *Japan's software factories: a challenge to US management*. Oxford: Oxford University Press.

DFP 2003. *Etudes prospectives sur les emplois et formations des informaticiens en France*. Report.

Di maggio P.and Powell W., 1983. "The iron case revisited: Institutional isomorphism and collective rationality in organizational field". *American Journal of Sociology*. Vol.48.

Edquist Ch., 1997. "Systems of Innovation Approaches-Their Emergence and Characteristics". In *Systems of Innovation, Technologies, Institutions and Organizations*, ed. Edquist Ch. London and Washington: Pinter Publishers.

Foray D., 2000. *L'économie de la connaissance*. Paris: La decouverte.

Gadrey J., 1994. "La modernisation des services professionnels. Rationalisation industrielle ou rationalisation professionnelle ?". *Revue Francaise de Sociologie*, XXXV-2.

Gadrey J., 2003. *L'économie des services*. Paris : La découverte.

Imano K. and Sato H., 1990. *Sofutowea Sangyo to keiei (Management and software services sectors)*. Tokyo: Toyokeizaishinposha.

Kodama F., 1991. *Analysis Japanese high technologies: the technolo-paradigm shift*. London: Pinter Publishers.

Lam A., 1997. "Embedded Firms, embedded Knowledge: Problems of Collaboration and Knowledge Transfer in Global Cooperative Ventures". *Organisation Studies 18/6*.

Lanciano-Morandat C. 1996. "Les ingénieurs des sociétés de services et d'ingénierie informatique", *Formation et emploi N°55*. Marseille: Cereq.

Lanciano-Morandat C. and Nohara H., 2000. "A Comparative Study On R/D Staff in France and Japan; skill-formation, career pattern and organisational creation of knowledge", European socio-economic research to the benchmarking of RTD policies in Europe, Colloquium organised by the European Commission, March, 20 pages.

Lanciano-Morandat C., Maurice M., Nohara H., Silvestre J.J. eds. 1998. *Les Acteurs de l'Innovation et l'entreprise: France-Europe-Japon*. Paris: Edition l'Harmattan.

Lundvall B.A., 1992. *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.

Maurice M., Sellier F., Silvestre J.J., 1986. *The Social Foundations of Industrial Power: a Comparison of France and Germany*. Cambridge Mass.: The MIT Press.

Nakamura K., Umezawa T., Totsuka S., 1990. *Nihon no Sofutowea Sangyo: Keiei to Gijutsusha (The Software Services Industry in Japan: management and engineers)*. Tokyo: Tokyo University Press.

Nelson R. ed. 1993. *National Systems of Innovation: A Comparative Study*. Oxford: Oxford University Press.

Nohara H., 2000. "National system of innovation in France: the case of information technology". *Keio Studies on Organizational Behavior and Human Performance N°30*. Tokyo: Keio University.

Nohara H. and Verdier E., 2002. "Sources of resilience in the computer and software industries in France". *Industry and Innovation, Vol. 8*.

Shapira P. ed. 1995. *The R/D workers: Managing Innovation in Britain, Germany, Japan and United States*. Westport, Connecticut: Quorum Books.

Sorge A., 1991. "Strategic fit and the societal effect: interpreting cross-national comparisons of technology, organisation and human resources". *Organisation Studies 12/2*.

Veltz P., 1986. "Informatisation des industries manufacturières et intellectualisation de la production".

Sociologie du Travail 1/86.