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

Caroline Lanciano-Morandat, Hiroatsu Nohara

January 2008

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

Caroline Lanciano-Morandat and Hiroatsu Nohara

Chercheurs au Lest-CNRS
Aix-Marseille University, LEST-CNRS
36 Avenue Jules Ferry, 13626 Aix-en-Provence, France
Email : hiroatsu.nohara@univ-amu.fr

This article has been published:

LANCIANO-MORANDAT Caroline, NOHARA Hiroatsu, (2009), "Professionals, Production Systems and Innovation Capacities in The Software Industry: A comparison between France and Japan", Journal of Social Science 社會科學研究 (ISSN 2189-4256), 60(1), pp.43-66 (2009-01-27)

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 extensions 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 present 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.
JEL Classification Code : J24 (human capital and skill), L8 (Software), M5 (HR management)

Introduction

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 new 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-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, but 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 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 the 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 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

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

abstract and intangible product? All these questions call into question the traditional 'business models' that Japan and France have constructed until now.

I - Method of investigation: societal approach

To bring some analytical and interpretative elements to 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).

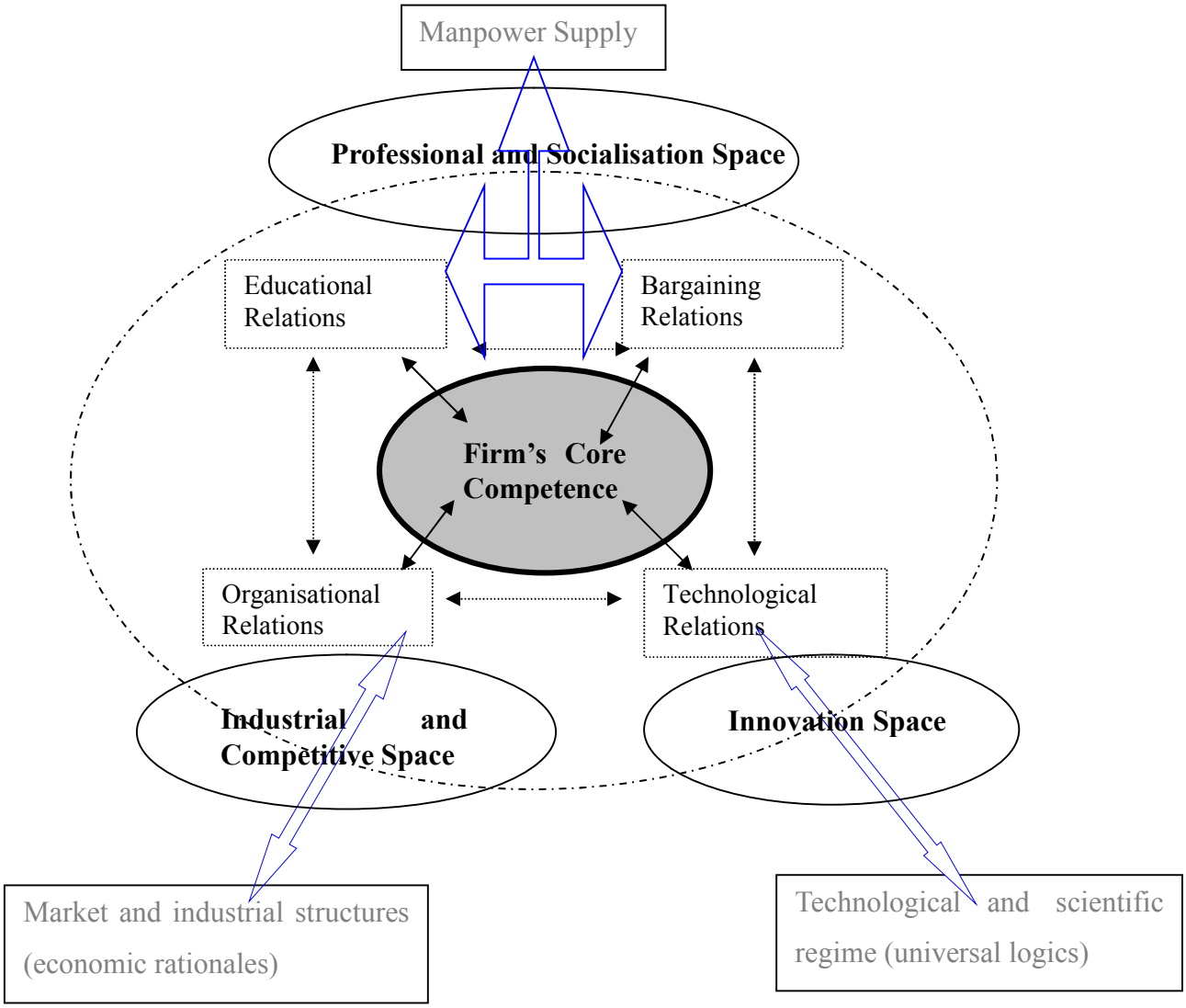
From the methodological point of view, the societal approach was constructed fundamentally, in order to examine the firm (or a whole of firms in the group/sector/geographical zone) in relation to the society of which it is a part, although its analytical subjects are not necessarily limited to this one[3]. 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 firms 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 the 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 vocational training, 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 spaces which seems 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 practice – 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 the executive/engineer 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 integration of outside resources and partial exteriorisation of the innovative process. In Japan, innovation occurs within a firm's internal dynamic, being based on close contacts with the workshop, 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. They had in common that they all work (not necessarily exclusively) for the banking and insurance sectors. Managers, executives, engineers or technicians from these firms were interviewed regarding production organisation, the software development process (including customer or market relations) and human resource management practices (training, assessment, involvement, etc.). The construction of occupational skills, training or individual career projects were 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 articulation 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 and also to organise '**collective creativity'** (Lanciano-Morandat and alii 1998).

II - 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 industrial environmental quality and how 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 dynamic, 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. Not only has growth slowed dramatically since the mid of the Nineties, but there has been a fall in business and a reduction in the work force, likely to produce significant sectoral reorganisation and changes in human resources management after the beginning of 2000s. The 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 dynamic 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 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 computerisation of the economy began, it has successfully occupied a strategic position, partly as a result of certain historical factors surrounding its emergence, the first of these being a certain weakness of French computer manufacturers. At the time the 'Plan Calcul' was launched, American manufacturers dominated the computer market. Since it was inconceivable that computer-engineering tasks in space, defence or banking should be entrusted to American multinationals, a national solution had to be found, and 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 technical expertise. The second factor is linked to the foresight behind the creation of the first independent SSIIs. Sometimes developed from strategic consultancy firms or else created from scratch, they intervened upstream of computer projects (guiding plan, computer strategy, etc.) and gradually developed a supervisory capacity for the whole range of computer engineering (Nohara 2000). In particular, the civil service and nationalised companies awarded them the first major computer contracts in which they served their apprenticeship. Handling key functions in the computerisation process (guiding plan, basic structure, integration), ensured the SSIIs good professional standing and a sectoral identity, despite the existence of many companies described as 'temporary'. The strength of the French software industry is one of the reasons for its foreign expansion (nearly 12 % of turnover in export sales, compared to less than 3 % for Japan).

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

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

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 many direct links with important customers or the state, and they are confined downstream from 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 sectoral field. The majority of them took over the most elementary tasks, such as computer custom work (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 computer services industry can broadly be categorised **as a series of sub-contracts** (Imano, Sato 1991).

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

At the beginning of 2000s, the French computer services industry represented 28,1 milliards of euros and was ranked fifth 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 in Japan employing more than 10 persons, and a total workforce of 567,000.

Although 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 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 shows the French computer services market to be more open or externalised than in Japan, where the captive market apparently plays an important role. Similarly, 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 computer products seems to be moving in the same direction in both countries, with greater attention to cost-cutting, quality and commitment to results. This involves a reduced share of custom computer work, reflecting large productivity rises and the development of 'fixed-cost service' to the detriment of 'the supply of means', increased business in software packages, etc. All these movements are converging towards a certain 'rationalisation' of computer 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. However, to progress beyond this 'artisan' stage would involve creating economies of scale and consolidating financial resources, corresponding to the current capital reorganisation strategy (M&A, regrouping, etc).

The strategic positioning of the companies studied is largely dictated 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- retains links to its origin in service management, but 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, it is a consecutive participant in a new industrial space.

In other words, the first adapts to the domination of the large groups, occupying a 'complementary' position in the industrial space, while the second participates in the creation of a

[5] Syntec is a main trade (and employer) organisation that groups the SSIIs in France.
[6] JISA is a main SSII trade organisation in Japan.
[7] The 'statistic service' department belonging to the French Ministry of Industry.

specific space. In France, the SSIIs form a true sector with its own institutions, whereas in Japan they are a collection 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 dynamic in each country.

Although a fair comparison of the computer engineers' qualifications is very difficult, the French computer services 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 executives. In addition, three-quarters of students in 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 between two categories: 'system engineer' and 'programmer', representing respectively two third and one third of the total. A comparison of 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 represent only 19% at this level. A concentration of highly qualified staff, the majority of whom possess advanced qualifications in computer science. 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, with computer studies qualifications from specialised training schools. The reputation of these private schools is not high; they direct the students into programming, 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 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 fragment tasks, less for reasons of rationalisation and 'taylorist' organisation than because of the need for a gradual learning process.

The third one relates to the small number of software 'professionals' in both countries with research training (bac+8 or PhD level), although it is more common in France than Japan. 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 organisation will affect production 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 powerful external restrictions. Despite real progress, this type of development, and the professional space defined, have not yet raised all the SSIIs to a standard equivalent to the new importance of software production.

---

[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 collapsed. It is not clear if this fall was due to purely economic causes or for structural reasons.

III - Innovation space at the micro or firm level

We now attempt to articulate, 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.

III-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 partially explains the type of market segment where they operate and their professional orientation.

The two large companies originated outside the software sector. FLg was formed from a business consultancy firm and today still favours a methodology, which combines customised company counselling with computer engineering. The software engineer is directly responsible for customer relations. JLg originally specialised in data exploitation and production and still attaches special significance 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. From their creation (FLg in 1951, JLg in 1964) both companies grew continuously and fast (around 30% per year since 1985, 20% for JLg) 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 but since then, like other French SSIIs, it has developed by taking over other companies. These takeovers have enabled it to expand its markets, either thanks to the expertise of recently acquired subsidiaries in segments of activity new to FLg (e.g. scientific computers) or by opening additional branches abroad (e.g. in Germany and the USA).

In accordance with their policies and tradition, the two companies also invested in different **trades** (métiers). For a long time JLg specialised in contracting out or custom work, dividing its activity between supplying the client with qualified personnel for a given period (obligation of means) and taking complete responsibility for a specific task (e.g. company pay). Since the end of the Seventies, it has turned towards system integration and software development and thus to 'fixed price contracts', preferring to reduce risk with many small contracts rather than commit to a large operation. Recently it has taken an interest in software packages, for direct production within specialised departments (e.g. the banking sector). FLg had always focused its activities on consultancy and management engineering, software 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 would seem 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 present 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, each individual's skills going into the common pot, 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, gradually working up to increasingly complex services generating surplus profit, demonstrating an enrichment of skills over time. JLp began in custom work, gradually moving on to delegation of computer staff (contract with obligation of results). It should be noted that this working-up 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 small and medium-sized companies are integrated into the subcontracting networks. Nourished technically by the subcontracting relationship, JLp nevertheless adopted a strategy aimed at enlarging 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

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

example, on a single principal contractor, a computer manufacturer, for as much as half its turnover. From an organisational point of view, despite its relatively modest size (200 employees), JLp is already showing signs of bureaucratisation, visible in functional 'divisionalisation', the importance of the 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 principal, 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 identity seems to become diluted into a 'vagueness' with no visible limits. 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 his position with the large groups in the division of labour. 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 management hierarchy or subcontracting relationship. The independence of the French SSII enables it to construct a specific 'métier'.

III-2 Construction of professional capacity

These different relationships between the market and 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. They are also different from those noted 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 atypical of Japan[11]. In France, the computer services sector can draw on a human potential with good computer training. FLg, like other French SSIIs, prefers 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' 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 gives them the capacity to act individually as the link between organisational consultancy and computer techniques, and mobility within the company. This is a fundamental difference compared to Japan.

Despite its small size, FLp attracts some of the best graduates from 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 professional autonomy. As a counterpart to recognising their executive status (cadre), FLp benefits from their capacity for autonomy, which is the very source of its creativity.

[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.

Supply of computer scientists in Japan are in short run, since the higher educational system, with the exception of the technical college to the level Bac + 2, does not produce a great deal of graduates in computer sciences. Moreover, they have practically no chance of recruiting engineers from the scientific or engineering faculties, since these are largely absorbed by manufacturing industry. Most of the time, they make do with 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 suit the customer's operation, it recruits engineers with non-technical skills and a general training, particularly in economy, law and management, similar to those of its customer (80% of company employees have this type of background).

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

The non-technical nature of education in Japan means that on-the-job training in computer techniques is very important and continues 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 appropriate to their area of application. Both parties commit themselves to a long-term relationship of mutual obligations. The firm agrees to invest in training, gambling on the recruits' potential. Young graduates agree to learn the profession and to await 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 qualified by the educational system and are expected to be operational more quickly. Contrary to 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. The young French engineer has a certain autonomy and responsibility in relation to the project head, within the pre-defined limits of his job. The young Japanese comes under the collective responsibility of the project group. Considered to be virtually incapable of functioning independently, he will begin with simple tasks so that the more experienced employees can help him gradually to acquire technical skills.

In both countries, at all recruitment levels, the new employee starts as a programmer and gradually advances to more complex tasks. Progress is much more rapid in France and more variable in relation to the engineer's diploma than is the practice in Japan.

In Japan **collective labour agreements** exist only at company level. For example, JLg fixes its own personnel management rules and negotiates them with the company union. Like all Japanese firms, there is no corporate objection to the existence of a union in this SSII, since the white-collar workers are traditionally union members in the same way as the manual workers. The union presence is however less 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 that has been negotiated with the trade unions. This chart is widely used by all the SSIIs, each adjusting the details individually. FLg negotiated an adaptation of this system with its own works' council. The unions are not represented on 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 development for each employee. A performance assessment is made yearly by the immediate superiors and helps to ensure individual employee wage development and promotion in the long term. Career management is closely articulated with in-service training. Alternate periods of on- and off-the-job training are programmed in advance, in accordance with the

[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.

important stages of professional life. This extreme formalisation of management tools suggests strong company control of employees, with little leeway for individual freedom of action.

At FLg personnel management is much less systematised, allowing 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 used as required for immediate project needs. FLg does have a system that makes it possible to control project advancement and profitability in real time. Although this system is not linked to individual assessment, it enables the management to monitor individual employee efficiency. This system is probably more restrictive than a traditional assessment and the computer engineers consider this individual management of their time as a professional limitation and a specific factor in their position as software engineers. These controls partially counterbalance the engineers' strategic autonomy.

Another particularity of the software sector in both countries, in comparison with the other manufacturing sectors, is a blurring of the usual professional categories. 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 are taken into account, daily company management ignores the gap between executives and non-executives that is so significant in the French workshop reality. The 'managerial staffs' are close to the Anglo-Saxon concept of management, i.e. possessed of a real hierarchical responsibility.

The Japanese companies mostly use the American double-ladder management system, adapting it to their needs. After a period of career development common to all engineers and regulated by seniority, two channels for advancement are proposed: management and expertise. There is a correspondence between levels and ranks in each channel. Experienced engineers with no managerial responsibility can attain the same levels of classification and recognition 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, and the engineers in both countries are assigned in turn to different projects, type of mobility differs. 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 quit the department (for example, banking), which constitutes its **area of specialisation**. In France, the engineer's task is individualised: he is assigned to contracts according to his own competence. When he changes departments, it is more likely to be in response to a need for organisational flexibility than for training or from a personal desire to expand his career. His mobility is in any case an individual movement to any part of the company.

Inserted in the specific societal contexts of France and Japan, generally speaking 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 computer professional enters the labour market of the large industrial groups. In France an occupational space for computer engineers is emerging. Engineers and executives (cadres) start their career in a SSII; some later move on to client companies, so that the movements of the labour market increase coordination between the computer services industry and its customers.

Two observations linked to the sectoral specificity of these SSIIs moderate this model. The first concerns the necessary overlapping of tasks between the SSII and the client company, which produces different relationships in each country. These relationships, new in the context of the usual division of labour system, influence the nature of employee 'professionalism'. The second observation concerns the blurring of the category of engineer, particularly in France. Thus the novice engineer carries out the same programming and analysis tasks as the technicians, contrary to his traditional function of technical supervisor: he is an 'operative' engineer and a 'directly productive' engineer. He is placed in 'manufacturing' conditions, and the checks on the time spent on each task and on the

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

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 scientists, or at least those who work in the software sector, do not entirely correspond to the traditional category of 'engineer'.

III-3 Production organisation

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

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 customised production of a product specifically designed for an individual client. To compete with American software, and cut production costs, French and Japanese companies are starting to **standardise** their products. Increasingly, the software product is no longer an 'original' item but has become a complex and specific assembly of a variety of elementary software 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 applied software and edited package, but these small and medium-sized runs for a large market are not produced in the same conditions as a unique product/service, designed for a specific company, and each 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 forms a specific team to satisfy the customer's demands. Vertical hierarchical relations and horizontal relations are intermingled within the team, which breaks up when the contract ends. This type of unstable, shifting organisation places the employee in a situation of permanent mobility-adaption, but does not necessarily cause him to change departments within the company. Employee adjustment to customer demands is all the more necessary since in both countries, the engineer is often seconded to the customer's location 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 company as in the Japanese.

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, one 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 control of the overall organisation, the adjustment of the various parts of the system and customer relations according to a logic of assembly. Relations within this cluster 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 only participates in this process as a principal or 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 and production, 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 over 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 head 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 design work is directed by the FLg engineers. In many cases, the coordination between the teams of the two firms can cause tension, 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 and remodelling 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 a future in the product system, while those of the SSII, despite their involvement, are attached to the software company. 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 requiring further study.

In France, unlike Japan, division of labour within the SSII is blurred and variable between the SSII and the customer. The software engineer appears as guarantor of the system's coherence. His autonomy is counterbalanced by strict controls of his work, which is organised on the basis of a contract of obligation of results and a permanent gap-assessment from a theoretical target budget. Although there is a 'taylorist' aspect to his work, he is responsible for a group of successive tasks, consistent with each other in time, and he is very closely supervised. Skills production within the company is left to individual good will.

In general, for software production, French and Japanese companies are positioned differently both in the market and in relation 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 that observed in manufacturing industry: design, industrialisation and commercialisation, even though the various phases are very interwoven, with frequent feedback between design and commercialisation.

In this context, Japanese company 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 his 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 adapts to product development. The strength of the sales department in particular, although it distances the designer from the client in customised production, makes it possible systematically to unload a large production run on to the market and also to tailor a software package to the customer's requirements.

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

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

- an autonomous organisation, linked to capitalisation of expertise acquired from software production and cooperation with the customer, and based on the industrialisation of an 'artisanally-produced' product (Veltz 1986).

If these two methods of organisation could be successfully combined and made interactive, 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 computer engineer in order to accumulate knowledge and expertise. Despite much effort towards rationalisation (computer engineering, development of automatic

[14] This activity combines research, development, technological supervision, improvement of tools and product lines. It is situated upstream from the software standardisation that constitutes the software package.

programming tools - CASE - etc.) the design aspect of computer work remains extremely personalised and continues to generate knowledge, which is difficult to formalise, or tacit expertise. This makes communication, collective learning and the accumulation of the knowledge thus produced extremely problematic. Companies are attempting to formalise this process of creation, explanation and transmission of knowledge, via the development of memorisation tools.

JLp has developed a computer engineering system via the simple assembly of pre-programmed subroutines. Even though its validity so far seems to be limited to storage of certain existing programmes for more effective re-utilisation, this type of tool is undeniably useful in standardising programming techniques, facilitating knowledge transmission and accelerating the computer scientists' training. This company also makes use of the job note, in which each computer engineer is invited to note the incidents, the faults and their solutions, which occur during the day's work. French companies have this same concern. Although FLp is less well-equipped, it devotes an important part of its energy to implementing a knowledge codification system. For example, publishing a reference document that condenses 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 knowledge formalisation and accumulation. In any case, the systematisation of these tools, even if it does not always function as the companies would wish, signifies their intention to format tacit knowledge and ensure its durability (Foray 2002).

IV - 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 firm is capable of creating collectively new knowledge on the job while producing software. It is also apt to coordinate the technical type of knowledge incorporated in computer engineers and the specific and professional know-how obtained from customers. The French firm can rely on very professional engineers, who naturally collaborate with the customer and are individually creative and innovative. It still has 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 extensions 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. 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 present 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 découverte.

Gadrey J., 1994. "La modernisation des services professionnels. Rationalisation industrielle ou rationalisation professionnelle ?". *Revue Française 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. and Nohara H., 2003. "Les essaimages académiques dans le secteur de l'informatique en France: effets institutionnels, effets de territoire ou construction des acteurs locaux? Revue dEconomie Regionale Urbaine, 2, 235-265

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*.