The Co-ordination of Competencies and Knowledge: A Critical Issue for Regional Automotive Systems

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As the new century dawns, firms are again having to cope with major structural changes which require a reorganisation of current production systems. To deal with these new technological, economic and institutional challenges, the organisational forms that had enabled the industrial development of the past two centuries have to be reconfigured. Like all industries, the automotive sector has to change. In fact, this orientation is particularly poignant in this particular sector, given that the automotive industry has been at the origin of many of the organisational paradigms and productive models that have lead to a transformation of competitive practices and of forms of productive organisation (Chanaron, Lung, 1999) since the early 20th century.

Work that has been conducted by the GERPISA network has made it possible to highlight the fact that the polarisation which exists between mass production and lean production (Womack, Jones, Roos, 1990) does not enable a full understanding of the complexity that characterises these processes. A more detailed analysis, i.e., one that recognises the specific nature of Fordism, Sloanism, Toyota-ism and even Honda-ism (with its innovation and flexibility-related orientations) lends itself to a more precise understanding of the ways in which a profit strategy can enhance the coherency between a productive organisation and an employment relationship (Boyer, Freyssenet, 1995, 2000a, 2000b). During the 20th century, the automotive industry was a matrix for such models, inasmuch as it spawned many of the organisational innovations that would later spread to the other sectors of economic activity (Bardou et al., 1982). Today, with the appearance of the concept of Dell-ism (Sako, 2000b), it would appear that other industries could also be a source of new forms of organisation.

Dell, which entertains a direct relationship with end users, has initiated a type of computer production that revolves around the assembly of a variety of modules in line with the orders that consumers have given over the Internet. At present, this type of organisation constitutes a new paragon of efficiency for the endless reconfigurations that characterise the global complex linking the electronics industry, computer manufacturing and information services. For a long time, such reconfigurations had been epitomised by the rivalries and co-operative alliances involving Intel, IBM and Microsoft. However, since the revolution in microelectronics, organisational forms have changed in a way that reflects the emergence of new activities - an unending reconfiguration that has engendered a certain number of new situations:
The manufacturing sector has been characterised by the rise of electronic component producers (i.e. Intel and the microchip), and by the new role that is now being assumed by the finished product’s architect. This trend has mainly involved computer assemblers (note the decline of IBM and the rise of Dell or Gateway in the personal computer segment), but it also affected those other capital goods industries that increasingly integrate electronic components into their products.

In the intangible sector, note the development of the software industry (Microsoft) and of the ICT service industry, as well as the explosion of the Internet, of multimedia applications and of mobile telephones.

The deep-seated and rapid evolutions that have taken place within this sector highlight the necessity, within a regime of permanent innovation wherein new knowledge must stem from a mobilisation and combination of diversified competencies (Winter, 1987), for responsive forms of productive organisation. These changes are not only limited to the emerging activities in what is sometimes described as the new economy - they also involve an industry that is more than 100 years old, the automotive sector.

To analyse these issues, the present paper is organised as follows. In Section 2, we specify a framework of theoretical analysis, a systemic approach, that analyses the way in which the automotive system’s main actors co-ordinate competencies and knowledge. Section 3 presents the main transformations of the automotive firms’ economic environment. Section 4 focuses on the reorganisation of automotive systems, both through the deformation of their boundaries, and also through the restructuring of the relationships which exist between the various elements comprising such systems. The conclusion, Section 5, specifies principal directions for future research.

A FRAMEWORK FOR ANALYSING CO-ORDINATION PROCESSES

This analytical framework follows a global approach to the automotive system, in that inter-firm relationships are deemed to be a function of the way in which firms’ boundaries have been defined.

A systemic approach to the automotive sector

This approach is an extension of an earlier suggestion (Chanaron, de Banville, 1991) that the automobile industry should be analysed at the level of the automotive system as a whole. This not only means that suppliers (components makers) should be part of the area under study given their involvement in the sector’s sourcing relationships, but also that we need to move beyond a purely manufacturing-oriented perspective, exclusively focused on material production (design-machining-assembly), and integrate all of the immaterial activities that make such a telling contribution to the dynamics of automobile production (starting with new car financing and with the used car market, cf., Froud et al., 1998).

In its broader definition, a productive system can be perceived as a set of activities that interact closely with one another, and which must therefore be co-ordinated. The very definition of this system, and of its organisation (i.e. the division of labour into its smallest units), depends on technological, economic and institutional factors, and on their dynamics. This helps a productive system to evolve via the emergence of new activities, by the disappearance of old ones, and through the restructuring which will ultimately give birth to a new configuration. The intensity of the interactions between the various activities justifies a hypothesis of quasi-decomposability which makes it possible to define the boundaries that characterising this industrial system. New trends in the internationalisation process (globalisation) have lead to a dismantling of the productive coherencies that the automobile countries had developed at a national level during the golden age of Fordism. Today, it is at a macro-regional level (Europe, North-America, South-East
Asia, etc.) that new coherencies are currently emerging in regional automotive systems (Carrillo, Lung, van Tulder, 2001).

A system’s dynamic is essentially determined by the way in which its activities are co-ordinated (Gaffard, 1995) - a co-ordination that can be organised according to three basic economic principles (Richardson, 1972): the market, the firm (hierarchy) and co-operation. In the current environment, co-operation has tended to become a primary method for co-ordinating automotive systems. As such, analysis should no longer be stressing the firms themselves (and particularly on the automakers) – instead, it should be looking at inter-firm relationships for the system as a whole.

Over the past few years, a great deal of economic and business literature has focused on the increased number of strategic alliances between firms, and on the development of reticular forms of organisation. Many authors have scrutinised the concept of firms’ boundaries (Hamel, Prahalad, 1990; Dosi, Teece, Winter, 1990). In so doing, they have tried to identify ‘core businesses’, or ‘core competencies’ that correspond to firms’ specific technological and organisational capabilities (Chandler, 1992). These capabilities are the products of a firm’s history and organisational learning, and they correspond to the tacit - and therefore non-transferable - knowledge that is embedded in the firm’s routines. Firms have had to focus on reinforcing their specific resource-based capabilities, and on developing co-operation mechanisms with complementary competencies. The question of how to best share knowledge throughout a firm – that is, between its various departments – then becomes a strategic issue, as is the sharing of knowledge with external organisations (Nonaka, Takeushi, 1995).

The approach that is being advocated here thus constitutes an attempt to improve the theoretical articulation that exists between evolutionist theory and resource-based approaches (Chandler et al., 1998, Langlois, 1995, Fujimoto, 1999). It seeks to achieve this by situating the analysis at the level of the industrial system.

**The firm’s boundaries**

Even if one subscribes to this point of view, a firm cannot be reduced, even as a theoretical construct, to the management of its internal core competencies, and to its alliances with those companies that can provide complementary capabilities externally. The extent of a firm’s mastery over its specific technological know-how or organisational learning helps to define its core competencies – especially in an industry such as the automotive sector, where the product’s systemic nature makes it difficult to apply the principle of technological separability (Langlois, Robertson, 1995). However, this does not mean that a company is nothing more than the mechanical result of its past experiences, much less a simple product of technological determinism. In fact, firm’s core competencies result from a socio-economic process, and its business’ perimeter is conventional, that is, the product of an institutional compromise. In a changing economic and social environment, firms’ boundaries are never stable. Organisational and technological change is localised (Antonelli, 1995) in proximity to a company’s knowledge base, but it can also occur through the exploration of new horizons, and therefore the creation of a need for new competencies (March, 1991) – some of which are internalised, whilst others are externalised through co-operation.

A company’s profitability will of course be affected by its economic environment. As the competitive climate has worsened, firms have had to tighten their prices, and thus their profit margins from traditional activities. This has lead them to make greater investments in ancillary activities, and even to explore new ones, in the hope of achieving rents in these new areas. Exploring new areas, companies do not possess the competencies that will enable them to evaluate the relevant economic factors with any great degree of precision, and therefore to come to a definitive decision concerning a rational

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6 In the automobile industry, several examples spring to mind: hydraulic suspensions (Citroën), diesel motors (Isuzu), safety (Volvo), off-road vehicles (Rover), Chrysler’s know-how in managing its supplying relationships, etc.

7 For example: in electronics, or in the management of a fleet of motor vehicles.
internalisation or outsourcing strategy. Small events can have a major impact: a success (or a failure) – for purely contextual reasons – can lead to the conclusion that this new line of business has now become part of (or has now been rejected from) its ‘core competencies’.

Finally, *institutional constraints* play a major role in defining a firm’s boundaries:

- The ever changing compromise between the firm’s three components (employees, shareholders, and management) is a key factor: employee resistance to outsourcing, which many managers often share, runs up against the nominal shareholders’ (i.e. the pension fund managers’) insistence that the company return to its core business. As such, this compromise will vary depending on each of the three parties’ bargaining position.

- Another institutional dimension that helps to define a company’s boundaries is the strength of its bargaining position when it negotiates with other firms, either in vertical discussions (supplier/client) or else in horizontal talks (with competitors).

- Finally, a third institutional dimension to be considered turns on the role of the macro-economic environment, especially with respect to economic policy.

In this light, the definition of a firm’s boundaries – in other words, the identification of its core competencies and of the ways in which it seeks to optimise them – cannot be accomplished through the use of a static and one-sided approach which considers that an optimal configuration exists for all companies. Changes in the social and economic environment imply an analysis that focuses on the processes of dynamic reconfiguration that shape the system, as well as on the ways in which the different activities are to be co-ordinated.

**THE TRANSFORMATION OF THE ECONOMIC ENVIRONMENT**

The reorganisation of the automotive industry’s economic and social environment is the product of three main factors: technological changes, a competitive process that has been marked by the effects of globalisation, and finally, an institutional context that is related to the relationships which exist between the various actors of the system.

**Mobilising new types of knowledge**

Advances in the field of microelectronics have paved the road for a new information revolution. The new technology can be applied in a number of different ways. Some lay a foundation for new types of activities; others require the redefinition of traditional ones. In the automotive industry, electronics now play a crucial role in the vehicle itself (representing 25% of its value according to certain professional sources - who estimate that this figure could reach 40% by the year 2010). This deeply modifies the product's architecture, in that it encourages the appearance of new functions. Mastering these technologies thus becomes a key issue. It helps bring about a redefinition of the relationships that exist within the automotive system, in that firms position themselves vis-à-vis those specialist companies, both insiders and new entrants, that are already active in these “new” activities (in terms of their complementarity, competition, etc.). Moreover, the co-ordination of electronic competencies, whether incorporated into the product itself (vehicle components), or into its functionality (navigation system), has been a particularly fraught question ever since firms began to abandon their previous affinity for internalisation (vertical integration, etc.) in favour of outsourcing – this being part of a productive process in which inter-firm relationships are based on a co-operative approach.

This is a complex situation – one that requires firms, especially carmakers, to come up with a variety of responses, each of which has to focus on the set of diversified competencies and knowledge that firms already have at their disposal (and/or on whatever new skills emerge). However, the system’s traditional actors are at best capable of developing by themselves a limited portion of the total skills that they will require. Such categories of knowledge and competencies can be scientific and technological in nature (electronics, materials, recycling), or else managerial and organisational. Their development
implies that actors need to rethink existing production systems – reorganising design and R&D functions in such a way as to strengthen co-development practices based upon stable partnerships (Lecler, Perrin, Villeval, 1999; Jürgens, 2000).

The current restructuring of the automotive industry’s knowledge base, and the emergence of new types of knowledge and competencies, will probably be accompanied by a reshuffling of tasks and functions throughout the entire industrial value chain. This will cause a change in the sector’s balance of power, both between the actors who participate in the industrial process, and also inside of each and every firm (Weil, 1999). The risk that automobile manufacturers will be weakened (given the co-ordinator’s role that they fulfil within the automotive system) has to be more fully analysed (Chanaron, 1995). The delegation of competencies towards first tier suppliers (systems integrators), certainly of those competencies that involve the design and production of a vehicle’s more important subsystems and modules strengthens these latter firms’ overall negotiating position within the branch. Given the strategic role the new types of knowledge (i.e., microelectronics) fulfil in areas other than in actual motor vehicle manufacturing, it is very possible that new players will soon be making their presence known within the sector. Moreover, if modular production catches on, an “Intel Inside” syndrome could also make its appearance.

To a certain extent, this is what is happening with the automotive industry reorganisations that have been caused by the so-called net economy. The market relationships that exist between firms, and between firms and households, are now being relayed by new support systems (i.e., e-commerce) that imply the advent of new competencies at a technological and organisational level. The rapid introduction of these information and communication technologies provides an opportunity for observing actors’ strategic behaviours.

The trend towards globalisation

Since the early 1990s, the automobile industry has been greatly affected by the process of globalisation. Yet the example of the automobile demonstrates the limitations of this process: both in the way in which many participants who had invested such high hopes in the emerging markets have been disappointed (Humphrey, Lecler, Salerno, 2000), and also in the repeated failures of global car or global platform strategies (Boyer, Freyssenet, 2000a).

The globalisation process has tended to exacerbate competitive pressures. It is one of the prime sources of the accelerated concentration that has occurred over the past few months. This included the merger between Daimler and Chrysler (followed by the alliance with Mitsubishi), Volvo's takeover by Ford, Renault's assumption of control over Nissan, and a mutual exchange of capital stakes between Fiat and GM. Moreover, in terms of mergers and acquisitions, parts makers have been just as active as automobile manufacturers. Above and beyond the advantages that are supposedly derived from operations of this nature (the achievement of economies of scale through the sharing of mechanical systems and platforms, rationalisation of the purchasing function, etc.), it is in no way certain that such alliances and mergers are going to succeed, given the likelihood of conflicts that will be born either out of situations in which duplicated competencies are being placed in competition with one another, or else out of the adjustments that are going to have to be made in order to integrate different backgrounds are to be brought together on joint projects. In fact, it is not at all out of the question that certain new groupings may end up by failing altogether (Boyer, Freyssenet, 2000c).
Strategic transregional alliances in the automobile industry

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The trans-regional nature of these alliances undoubtedly constitutes the new and specific trait of the 1990s – a trend that was facilitated by the opening of the Japanese market (for car manufacturers as well as for parts makers) to foreign companies. However, it would be wrong to conclude from this that a homogenisation trend which relies on an integration of the world automobile market is making greater progress than the drive towards regionalisation (Freyssenet, Lung, 2000). On one hand, certain carmakers have not got involved in these trans-regional alliance strategies, and have in fact been striving to maintain their local embeddedness (Honda, PSA, even VW). On the other hand, these trans-regional alliances are related to the fact up until now, product strategies have only been implemented on a global scale for the very top of the range or niche cars. High-volume models have been more or less the reality at a regional level (see the failure of Ford's CDW27/Mondeo/Contour global platform). When seen in this light, what firms have actually done is to set up a spatial division of labour within their regional systems, in Europe and in North America, or else in South America and in Southeast Asia (Freyssenet, Shimizu, Volpato, 2001).

The regionalisation process - when understood as (1) an integration of markets (Product strategies), (2) a space for structuring productive systems and (3) a level at which an articulation can be set up between supply and demand (Carrillo, Lung, van Tulder, 2001) - tends to redefine the automobile industry's geography via the redistribution of activities that it provokes. There has both been an opening towards other peripheral spaces (Eastern Europe, Mexico and Southeast Asia) and a reconstitution of localised automobile complexes, such as "Smartville" near the Micro Compact Car facilities at Hambach in France. Does the diffusion of modular production denote an unmitigated return to a configuration based upon the existence of agglomerations situated within "industrial districts" (Bianchi, Enrietti, 1998; Frigant, Lung, 2000)?

The redefinition of social compromises

The current trend towards globalisation reflects an increasingly competitive international business environment. The pressures created by this situation have lead to an outbreak of rationalisation, and to a search for new sources of competitiveness through the development and the implementation of specific competencies.

Globalisation and outsourcing have first and foremost had a very strong effect on employees’ status. The exacerbation of competitive rivalries has lead to rationalisation measures which have had a direct effect on work and on employment. This has been true first of all in quantitative terms, inasmuch as the search for productivity gains at a manufacturing level infers a reduction in industrial employment, according to modalities and at a rhythm that depend specifically upon the relationships that exist within that particular branch. However, the drop in employment levels in assembly activities has been partially offset by the greater number of employees in the components sector (Sturgeon, Florida, 1999). Moreover, it is important to carry out a more exhaustive analysis by also taking those service sector jobs that are tied into the automotive industry into account. The aforementioned transformations...
can also be qualitative in nature: the qualifications structure has been modified, and there have been transformations in the work organisation which, even though it has increased the value of employee activities at certain points along the value chain, has also introduced negative adjustments and new tensions into workshops and offices (Durand, Stewart, Castillo, 1998; Hatzfeld, Durand, 2000).

The labour unions' role has also been directly affected by this reconfiguration of the automotive system, even if new forms of solidarity and collective action (Stephenson, Stewart, 2000) are being developed both within companies and outside of them (regarding environmental issues, for example). The return to a more favourable economic environment (notably in Europe after the so-called years of "Euro-sclerosis") could nevertheless reverse these trends. The success of the strikes organised in the United States in 1998 highlighted the fragility of the just in time production system, and the power of the UAW union seems to have been reinforced (Babson, 1999) - even though the overall environment is characterised by the strengthening of the shareholders' position.

Internationalisation and financialisation (Williams, 2000) have not only modified the competitive rules that govern firms' behaviour - they have also changed the structures of corporate governance. Shareholders' increased power (notably since the General Motors shareholder “revolt” of 1992) encourages firms to situate the creation of shareholder value (Lazonick, O'Sullivan, 2000) at the very heart of the evaluation criteria that weigh so heavily upon their strategic decisions. This reflects the financial markets’ domination of the automobile industry’s funding (Froud, et al., 1999). Weaker managerial power, and greater shareholder power, are the specific features of the recent trend in the United States, and in other countries practising its particular variant of “Anglo-Saxon” capitalism (or Liberal Market Economy for Hall and Soskice, 1999). In fact, this trend has also been widely diffused throughout Europe, including in countries where more institutionalised forms of capitalism prevail (Organized Market Economy): Germany, France or Italy (Hollingsworth, Boyer, 1997). Its advent has been slower in Japan, at least with those firms that have attempted to remain independent, notably Honda and Toyota. The financial investors’ (especially the pension funds’) increased power has on a number of occasions led to a redefinition of firms' corporate governance structures (O'Sullivan, 2000a).

This process has added a new dimension to the trend towards globalisation. It strengthens those firms that are trying to refocus on their core business, outsourcing more and more of their activities (selling entire business lines that had once been integrated into their perimeter of operations). One example is the spin-off of component making subsidiaries, including GM's sale of Delphi and Ford’s sale of Visteon (Bordenave, Lung, 2000). Such spin-offs are intended as a way of creating value immediately (through the financial operations that are associated with them). However, they are also part of a more long-term orientation: with outsourcing, firms reinforce their flexibility in a highly uncertain economic environment.

Increased market uncertainty has been accompanied by a greater variability in the volumes and structures of demand. The volumes in the so-called emerging markets have fluctuated significantly. Moreover, due to renewed cyclicality, volatility has also tended to rise in the industrialised countries. In this latter group, the main source of uncertainty has been the increase in market segmentation, a situation that the carmakers themselves created through their competitive behaviours. Forced to broaden their product ranges, firms have been continuously adding new vehicle models to their product portfolios. To manage this variety, they have been looking for efficient and responsive flexible production systems that will enable them to adapt their production mix to market demand in real time (Lung, Chanaron, Fujimoto and Raff, 1999). The ideal technical solution, from the engineers’ point of view, operates according to the principles of modularity, inasmuch as this helps firms to cap scope-related costs by using elements shared amongst their various products (Baldwin, 1999). This modular recombination theoretically allows for unlimited variety.
From a financial perspective, there is also a widely accepted theoretical solution for this ambient uncertainty – liquid assets (money serving as the liquid asset par excellence in financial theory). In the productive sphere, this translates into a "liquidity of activities", with firms being able to withdraw rapidly from an activity whenever profit expectations are not satisfied, and then to reposition themselves in more profitable sectors. This responsiveness – the excesses of which equate, in the financial sphere, to market volatility - presupposes an avoidance of sunk costs (Gaffard, 1995; Lazonick, 1991). These are the commitments that can lead to exorbitant exit costs if it becomes necessary to withdraw from an activity. The trend towards outsourcing can therefore be interpreted as one manifestation of the search for a certain form of liquid activities.

However, the productive sphere is, almost by definition, an area in which economic performance can only be achieved through a series of sunk costs. Such outlays do not necessarily only consist of the material investments that manufacturing activities require (construction of buildings and plants, machine and equipment purchases): contractual systems such as renting or leasing can reduce the sunken nature of these costs.

One example of an innovative contractual relationship is Ford’s recent proposal, for the 2001 European launch of its new Fiesta, that it pay its suppliers in capital goods, with the price being a function of the new model’s sale volumes. In any event, it is impossible to avoid the intangible investments that are linked to the development, through individual and collective learning, of design-, manufacturing-, organisation- and distribution-related competencies. These competencies are a precondition for the implementation of an appropriate profit strategy, in that they help to build a "corporate government compromise" between a firm’s various stakeholders (O’Sullivan, 2000b) – and notably its suppliers and distributors, when the firm is being defined as the extended enterprise system that it has become in a changing automotive world.

THE REORGANISATION OF AUTOMOTIVE SYSTEMS

An automobile firm’s performance should be analysed at the level of the regional automotive system within which it operates. However, this analysis should not be limited to the representation of manufacturing activities (new car production and assembly). This dimension is the most visible of all, but it tends to underestimate the importance of the immaterial activities that are related to the product’s distribution, usage and life cycle.

Changes in the productive organisation

At a material (physical) level, there has been an extension, both upstream (value chain management) and downstream (the end of the product’s life cycle) of the areas that the automotive industry, and carmakers in particular, have been responsible for, and getting involved in. Witness the development of modular design and production upstream from final assembly operations, and the financial responsibility carmakers now assume for the ultimate dismantling and recycling of the end-of-life product.

In the past, the automakers were responsible for almost all of the branch’s manufacturing activities – the internalisation trend having reached its pinnacle with Ford’s Rouge River plant (Bardou, et al., 1982). In recent years, however, they have tended to delegate this material aspect of automobile production to specialist firms (components makers, parts suppliers, engineering companies, etc.) who assume responsibility for an ever-greater proportion of industrial design and production functions. Car manufacturers seem to have decided that their involvement should be more upstream, that is, in the overall coordination of the activities and actors that participate in the design of an automobile product (Ciavaldini, 1997; Weil, 1999). As such, they will mainly tend to become the co-ordinators of those manufacturing activities that are realised by tier 0.5 suppliers (the latter group being in charge of the managing the productive chain’s lower tiers), entertaining close relationships with the various distribution channels (and thus the final market) in
what becomes an *extended enterprise* (Helper et. al., 1999).

Components makers, particularly from Europe and North America, have become heavily involved in the march towards modular production (Sako, Murray, 1999), offering automakers new solutions that will help them to consolidate their commercial and strategic positions. Nevertheless, automakers diverge greatly with respect to the extent to which they have taken these principles on board. Such disparities reflect firms’ regional dimensions as well as their differentiated orientations. Toyota, for example, seems to be very hesitant in this field. This is coherent with the Toyotist model itself, which does not presume a Ford-like vertical integration, but instead stresses the control of upstream and downstream relationships within the framework of an industrial *keiretsu* (Aoki, 1988; Lecler, 1998). Of course, a module-based logic has long been in effect in Japan’s automobile industry – but this has been achieved internally, as part of sub-assembly preparations. The outsourcing of a module’s preparation constitutes a major change from an internalisation-based logic, inasmuch as it impacts the incentive to develop modular production: the suppliers actually tend to develop a modularisation dynamic that benefits them more in terms of their share of value creation. This may be why Japanese carmakers are so prudent as regards the externalisation of module preparations (Takeishi, 1999).

The American carmakers Ford and GM have had to restrict their ambitions in their domestic market. This is due to their relationships with their parts suppliers, and with their employees (McAlinden, Smith, Swiecki, 1999). The UAW labour union has been strongly opposed to an ambitious GM plan involving the construction of a plant that would produce small cars according to the principles of modularity: the Yellowstone project has been abandoned. Ford and GM have not definitively turned their back on the idea of introducing certain elements of modular production in the US, where BMW’s and Mercedes’ greenfield plants have gone the furthest with these methods (Pries, 1999). However, US carmakers have already widely applied these methods in their overseas plants, in Europe, but above all in Brazil, a country that, with GM’s Blue Macaw project and Ford’s Amazon project, remains a promised land for wide-scale experiments with this type of productive organisation (Lung, Salerno, et al., 1999). In fact, it is at its Resende truck plant in Brazil that VW first introduced the concept of modular consortium, whereby operators working for components makers assemble their module directly on the assembly line, under the supervision of a VW staff member. From consortium to condominium, every automaker has gained a wealth of experience each and every time that it has built a new plant intended to satisfy the dynamic North American market (Salerno, Dias, 2000). Mexico has tended to become a major player in the North American arena (Juarez, 2000), given the United States’ resistance to modular production. In Europe, Ford and GM have been closely tracking the steps that have been taken in this direction by VW (notably in the Czech Republic), DaimlerChrysler (with the Smart car and the Mercedes Class A), and by Fiat, which has sometimes been depicted as the *first mover* in this field (Camuffo, Volpato, 1999).

Yet the issue of modularity remains a topic of debate within many automotive companies, inasmuch as modular policy is being decided in an environment in which there is a large uncertainty as to the long-term effects that such an orientation could have on actors’ innovation capabilities. Many observers have criticised the analogy that has often been drawn with the computer industry (Sako, 2000a; MacDuffie, 2000), given the complex nature of the automobile product, an item that people use in an extremely varied and unpredictable range of situations, yet which must always guarantee a maximum of safety. Moreover, vehicles’ industrial production has to be achieved at a reasonable price. The deeply systemic nature of the motor vehicle contradicts the basic principles of modular architecture, inasmuch as any modification, however minor, has an immediate knock-on effect on the product’s overall quality (product integrity). The frequent postponement of new model launches in recent months translates this inability to master the technological problems that are associated with the various subsystems’ final
integration – difficulties that crop up relatively late in the product’s design cycle, i.e., at the end of the development phase. This argument remains valid despite the systematic implementation of shared platform strategies since the mid-1990’s (this having been a reversal of previous policy in this area) – a trend that would appear to indicate the feasibility of a modicum of modular logic, albeit of a limited nature. In addition, there is the special case of the particular modular reasoning that can be associated with outsourcing issues, wherein subsystems design, module preparation and supply management are delegated to 0.5 tier suppliers.

In the long run, outsourcing casts a doubt on the preservation of internal innovation capabilities. By delegating major functions and subsystems to their suppliers, carmakers may be running the risk of losing control over the innovation process, in that they are losing part of a business that would otherwise have allowed them to capitalise on whatever essential technical and organisational knowledge they could have learned. How can firms absorb external knowledge when they do not develop such competencies internally (Cohen, Levinthal, 1989)? The seemingly straightforward matter of conducting a technological and economic evaluation of the solutions components makers propose may actually create a number of problems in the long run. Indeed, this is another example of one of the many trade-offs that characterise the innovation process – a dilemma that infers a whole range of open-ended and necessarily contextualised responses.

Borders between different firms’ internal and external operations are far from being identical and universal. They vary for each carmaker, for each geographic region, primarily revolving around firms' history, the competencies and capabilities that they have developed, and their location. One contradictory example of the aforementioned trend towards outsourcing is provided by Toyota, which would like to avoid getting rid of its Denso subsidiary. Then there is the French carmaker PSA, which affirmed in October 2000 that its objective was to consolidate its presence in the components sector, using Faurecia as a focal point (this firm having taken over Sommer-Allibert’s automotive businesses). Such strategic decisions are being made even as the US carmakers Ford and GM have been seeking to disengage from this sector, or whilst Fiat has been expressing doubts as to whether it should maintain control over its subsidiary, Magneti-Marelli. For certain automakers, their function as a motorist has been thrown into question, particularly wherever product innovation (i.e., new driving systems) have lead to the disappearance of the decisive advantage that automakers had been able to accumulate as a result of their having learnt to master the workings of the internal combustion engine. Given their alliances with other car manufacturers or components makers, certain firms seem to be withdrawing from areas that had long been deemed to be their core business: engine and transmission production (i.e., Ford’s transmission agreements with ZF or Getrag, and Ford and PSA alliance for diesel engine in Europe).

Modular production seems to have opened the door to new entrants, firms that are interested in building niche automobiles - whether component makers, design and engineering specialists, the low-volume assemblers who have become involved in projects of this sort (Magna International, Matra), or else the entrepreneurs who had first started out as automotive industry executives (i.e., Lopez de Arriortua's project in Brazil, or the supercar that Robert Lutz has launched in the United States). As regards the production of high-volume models, there are no guarantees that a modular path is going to be followed, even if certain elements of modularity may start to become more widespread, particularly in the small car market.

Another factor has contributed to this restructuring of productive organisations, and to this co-ordination of competencies: environmental regulation. Given the general preoccupation with environmental issues, government authorities have strengthened legislation to reduce pollution levels. This has had the effect of making the innovation process (which includes development of engines with lower emissions, utilisation of lighter materials to reduce energy consumption, etc.) – changes that have become part and parcel of the ongoing reorganisation of development activities, of the competencies that are now beginning to emerge,
and of their integration within organisations (Aggeri, Hatchuel, 1997; Aggeri, 1999), and in inter-firm cooperation. The recycling of end-of-life vehicles has become a prime objective for governments (see the measures announced by the European Parliament spring 2000) - many of whom have been setting themselves ambitious recycling targets. These changes are likely to lead to the appearance of new actors in the automotive system. In the immediate future, carmakers will be trying to organise this recycling with the help of specialist entities who possess competencies in this area (den Hond, 1996). These constraints are likely to spill over upstream, and changes in the automobile product’s design (electronic contents, new materials, electrical propulsion systems, fuel-cell) may create a new strategic role for actors who up until now had been marginalized, even absent, from the automotive system (i.e., if electrical vehicles become successful, electro-chemical firms will become altogether more important in this sector, cf. Larrue, 1999).

As such, it is important to study how firms have been positioning themselves within this system by focusing, above and beyond the direct relationship that exists between assemblers and "system integrators" or module suppliers, on the effect that their positioning will have on the whole of the supply chain. Changes could take place upstream from those first tier (0.5) suppliers who currently entertain a direct relationship with carmakers – changes that could affect entities who are currently second or third tier suppliers (Le Masson et al., 2000; Camacho, 2000).

With their ever-increasing delegation of subsystem design and module production and assembly functions to suppliers, carmakers seem to progressively organising their withdrawal from the manufacturing function. They appear to be limiting themselves to a role as an architect and global manager, getting involved in the overall product design and in the production chain’s management. With this upstream disengagement (outsourcing), carmakers appear to have been trying to position themselves increasingly as service providers, and this has had implications for their complementarities, competencies and knowledge bases.

**The increasingly immaterial dimension of automobile production**

The dynamics that have been at work in the world’s automotive systems are not only limited to the constraints that linked to the manufacturing phase. They also encompass all of the activities that are associated with a vehicle’s utilisation, particularly its material (upkeep, maintenance, spare parts) and fundamentally immaterial services. Services are one of the older constituents of the automotive system (finance, insurance, rentals, resale of used vehicles) and automobile firms have long been active in these areas, above all through their financing of new car sales. In fact, financial activities make a major contribution to firms’ profitability (the Ford Financial Division contributed more than 40% the Group’s total operating revenues between 1988 and 1998, cf. Froud et al., 2000b).

However, the global competition pressures have lead to an erosion of profit margins on new car sales at the same time as pressure from shareholders has forced companies to try to reach ROI profitability targets of 15% per annum. Yet new car purchases only represent a small portion of total motoring expenditures, that is, of all the payments that are linked to the acquisition and utilisation of vehicles (Froud, et al., 2000a). In France for example, this percentage has actually been decreasing, representing 22.5% of households’ motoring expenditures in 1999 versus 28.7% in 1990. This drop can be explained by the productivity gains that have characterised automobile production in recent years - gains that have lead to a drop in real prices. As a result, automotive firms (vehicle manufacturers and component makers) and new actors in this branch have renewed their interest in services, especially since it is now paramount to gain an advantageous

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8 Note that neither the increase in tertiary sector, nor the debate over the transformations of work organisation, detract from the fact that the productive system remains the only real basis for economic growth and international economic performance. The United States’ renewed interest for issues of this sort during the 1980’s (Made in America, by Dertouzous, Lester and Solow, 1989) definitely contributed to the revival of a North American economy that had been previously prone to bouts of lethargy.
position in their new variants (navigation systems and the other developments that are tied to the new information and communications technologies).

While waiting for these new services to become profitable, something that can only occur once the new technologies have been widely diffused, firms have been tending to increase their investments in traditional services in an effort to find hitherto untapped sources of profit. This is exemplified by the flurry of deals that manufacturers have been making in the car rental market (acquisition of Hertz by Ford, of Europcar by VW), in the maintenance and rapid repair business (purchase of Kwick Fit by Ford, of Midas by Fiat, Renault's European launch of the Carlife network), with their commercialisation of spare parts, and resale and recycling of used parts (as Ford has been doing in the United States), in the insurance market, and through the development of innovative financing solutions. Ford wants to be "the world's leading consumer company for automotive products and services", and GM "the clear innovation leader in product and services".

As regards services, automotive distribution channels represent a major challenge in the sense that, according to many observers, existing sales networks are relatively inefficient. This is the case in Europe, characterised by the block exemption regime that is to remain in place until the year 2002, wherein dealers can still be locked into an exclusive and selective distribution system; in North America, where new entrants like CarMax or AutoNation have been trying to compete with established dealers; and above all in Japan. There would appear to be major productivity reserves in the distribution function, and automakers have been undertaking rationalisation operations that sometimes provoke strong opposition and virulent reactions from their networks of dealers (Jullien, 1998, 2000). These reorganisations create links between the various dimensions of the automotive system, notably an articulation between new car sales and the used-car market. Nowadays, the sale of new vehicle is often predicated on the repurchase of an old vehicle (even as new leasing or availability systems have increased the difficulty of making new car sales in the first place).

Automobile manufacturers have been modifying their approach. They are no longer simply seeking to sell a new vehicle (profits are rare in this area, and usually stem from the financing that is associated with the sale). Instead, they are now trying to track the vehicle over the course of its life cycle. This means that they are following the car through a number of phases (and thus profit opportunities): sale of the new car, repurchase and resale (on several occasions) as a used-car, structuring a type of financing that is adapted to each transaction (leasing, credit, etc.), insurance offers, warranty work (particularly as part of the ever more frequent recall operations), upkeep and maintenance during the vehicle's entire life cycle, provision of spare parts (protected by intellectual property rights), destruction at the car's end-of-life and recycling.

A new element has started to affect this already changing world: electronic commerce. The potential offered by the rapid diffusion of the Internet and of e-business seems considerable in the area of new or used-car sales, both for Business to Business (sourcing relationship) and for Business to Consumer (end-user relationship) transactions. There is still a great deal of uncertainty in this domain, and firms have been exploring various solutions, depending on firms' reactions (Chanaron, 2000; Volpato, Stochetti, 2000). New entrants have been trying to emerge in the e-business sector (such as autobytel.com) at the same time that insiders have been attempting to consolidate their bargaining position.

At first, each car manufacturer tried to set up its own system, but the development of Covisint, a platform that a number of carmakers (Ford, GM, DaimlerChrysler, Renault, Nissan) can share for their supply bidding processes, represents an attempt by these parties to consolidate their power over components makers. In return, this latter group has been free to organise an e-commerce system in the spare parts market, a sector that is much more lucrative than the OEM (original equipment manufacturing) market in terms of the profit margins that can be achieved there. These changing methods

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9 This issue is the core of the new IMVP (International Motor Vehicle Programme) project that was launched in the year 2000 (Fines, 2000; MacDuffie, 2000).
of new car sales, based on the Web, also translate a relational environment in which distribution networks are being rationalised. As such, after first having attempted to exert direct control in this new area, Ford and GM have decided to establish this new tool in the United States through the joint venture arrangements that they are trying to set up with their own dealer networks.

Just like the automobile product, whose systemic nature necessitates an understanding of the many complex implications that are associated with any element’s modification, it is also important to conduct a systemic analysis of the changes that have been affecting the automotive industry as a whole, notably through the articulations that have created links between service-oriented and manufacturing activities.

**CONCLUSION**

The core of the new GERPISA international research programme is this analysis of the co-ordination of competencies and knowledge within regional automotive systems. The networks’ members will compile information, analyse it, confront their results and interpretations, and debate about the structural changes that are occurring in the world’s automotive systems. This approach revolves around a comparative analysis that will from the very outset be refuting the notion that there has been any convergence towards some optimal solution purporting to be a “one best way” for all firms concerned (Freyssenet et al., 1998). It will on the other hand incorporate hybridisation processes that are at the origin of organisational and institutional innovations which could emerge (Boyer et al., 1998). All in all, the aim of this approach is to identify and to explain the diverse nature of the strategies and reactions of the actors who make up today’s automotive systems.

An initial batch of work will attempt to specify changes in productive organisations, more specifically in the vertical inter-firm relationships and in the co-ordination of the industrial competencies and other types of knowledge that crop up during design operations (co-development) and production stages (modular assembly). A second research series will be focusing on immaterial activities, delving into the automotive system’s financial dimension and exploring the automobile’s social uses – this having becoming a new source of profits for car firms (and thus a new area for developing competencies or for pursuing competitive strategies). Finally, a third project will look into the geographic aspects of the aforementioned structural changes, studying the effects of spillovers and/or enlargements towards peripheral spaces, the revival of agglomerated production activities, and the specific nature of the various types of regional automotive systems. The focus here will be on a determination of the role of institutional arrangements. If co-operation becomes the main form of competencies and knowledge co-ordination, its various manifestations could, depending on the given institutional environment (Amable, Barré, Boyer, 1997), diverge substantially.

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