Are carmakers on the wrong track? Too much outsourcing in an imperfect-modular industry can be harmful

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Abstract: Over the past few years, research into modular production – also known as modularity – has largely portrayed this approach as one way of increasing outsourcing. At the same time, empirical studies have often focused on industries that are associated with a pure form of modularity. This paper considers the case of the automobile industry, where modularity has demonstrably developed an imperfect form. Based on a literature review covering the automobile industry and modularity, we will show that a strategy of excessive outsourcing can be criticised because of the risks associated with opportunistic behaviour or the loss of absorptive capacities, and due to problems surrounding the long term fall in production costs. The conclusion looks at the suitability of the choices made by Western carmakers, which seem to differ from those made by Toyota.

Keywords: modular production; imperfect modularity; automobile industry; outsourcing; carmakers; suppliers.

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1 Introduction

Since a decade, the carmakers, particularly in Europe and North America, are increasing outsourcing. Nowadays, suppliers assume 75 to 80% of automobiles’ production cost. A supplier like Magna builds cars for Chrysler and BMW and soon a sports car for Porsche. This massive outsourcing can be explained by three reasons. First, carmakers are moving toward business strategies based on core competencies (Prahalad and Hamel, 1990), in particular because they are under pressure of financial investors (Froud et al., 2002): focusing on core competencies is a mean to restore profit margin and support price competition. It is also a way to improve innovation process (quality and time-to-market). The idea is to focus on the fundamental core business of a carmaker: design cars and sell a mobility solution. Second, the producers of parts and components have been considerably restructured. The main suppliers are now worldwide firms possessing a large scope of skills which allow them to offer technical solutions on shelves to the carmakers (Frigant, 2009). Third, the intrinsic nature of the outsourced components has changed. Necessary condition to both previous phenomena, the development of modularity in auto industry allowed a new step in the sourcing strategy: development of more complexes but less numerous components realised by key suppliers (the First Tier Suppliers, FTS) who design, develop and produce them (Camuffo, 2001; Volpato, 2004; Cauchik Miguel and Pires, 2006).

Even if vertical disintegration is the common strategy of the carmakers, we can discuss its relevance starting from the last point: the modularity issue. Indeed, the car is a complex system (Clark and Fujimoto, 1991). In the literature on modularity, we say that the automobile is a complex product system (CoPS) (Sako, 2003). The carmakers must be systems integrators (Brusoni and Prencipe, 2001; Brusoni et al., 2002). So, if we follow the analyses of these authors the modularisation of more complex products fits in poorly with extensive outsourcing and necessitates, at the very least, some tight coordination of suppliers managed according to relational principles (Prencipe et al., 2003). The advent of virtual firms – veritable LegoLands as Pavitt (2003) has described them – is empirically and theoretically debatable.

From this point of view, the aim of this paper is to provide a review of the literature on modularity in the automobile industry in order to discuss the risks of outsourcing. More precisely, we wish to investigate a key question: are the (occidental) carmakers going too far in their outsourcing strategy?

For studying this question, we will study a hypothesis, and then we will defend three propositions.

Hypothesis 1: Is the automobile always a CoPS? Or, is it nowadays a pure modular product in the sense of Ulrich’s (1995) definition? Indeed, in this case, we could consider that a virtual organisation is an efficient strategy as it has been demonstrated by works on computer industry (Baldwin and Clark, 2000), electronics (Langlois and Robertson, 1992) or bicycle industry (Galvin and Morkell, 2001). The reject of this hypothesis will lead to formulate three propositions.

Proposition 1: In a situation of imperfect modularity, the carmakers take the risk to reduce dramatically their (future) absorptive capacities. Too much outsourcing induces a risk for the integrity of the carmakers from a knowledge point of view.
Proposition 2: From Hypothesis 1 and Proposition 1, too much outsourcing allows the development of strategic behaviours from others firms, in particular First Tier Suppliers. Here again, it is a risky strategy for the disintegrated carmakers.

Proposition 3: A disappointment could appear concerning the reduction of total production costs along the value chain thanks to outsourcing.

In conclusion we will summarise our results and open the discussion to another outsourcing strategy.

2 The irreducible imperfection of modularity

Before all, we need to study the nature of the modularity in the auto industry. Is the automobile always a CoPS or a pure modular product? To answer, we first explain how auto industry ‘translates’ the concept of modularity. We show it’s an imperfect modularity, and we will defend the hypothesis it will remain imperfect in the future.

2.1 Variants of modularity in the automobile industry

According to Ulrich (1995) products can be distinguished by their architectural properties. This refers to the way in which a product’s function materialises via its physical components and based on the interactions between the various components comprising the final product. It is a conception that opposes modular and integral architectures. The architecture of a product is described as modular when:

1. the overall product results from the assembly of different sub-assemblies (modules) characterised by their autonomous and independent nature
2. these sub-assemblies are interlinked by previously defined interfaces.

Inversely, an integral architecture is one where the product results from the assembly of physically interdependent or multi-functional sub-assemblies, and/or whose interfaces have been decoupled.

This definition has the merit of determining what constitutes a modular product. However, it is also weakened by its fundamental dichotomy. We can imagine different degrees of modularity and that a continuum exists between two extremes. Situations that we describe as imperfect modularity can be thought of in two ways. Horizontally, we can imagine that some products contain stabilised and decoupled elements whereas others need to be redesigned for each product generation insofar as they are structurally dependent on other technological choices. Vertically, we can consider that sub-assemblies are themselves sub-architectures that can be either integral or modular.

These ‘imperfect’ configurations – categorised by the purity of their modularity – reflect to varying degrees the economic advantages of a kind of modular architecture that has long been of interest to analysts, through topics like shorter design delays; lower R&D costs; product diversification or the postponement of technological irreversibility (Garud and Kamaraswany, 1995; Ulrich, 1995; Baldwin and Clark, 2000; Sanchez, 2000; Schilling, 2000; Jacobs et al., 2007). The key to our analysis is that modularity carries the seeds of a deeper division of labour since building a modular product can be apprehended as a series of tasks undertaken separately and synchronically, in both production terms...
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The notion of interface is crucial in the analysis of modularity since it encapsulates all the information needed for a detailed module design. This cognitive property enables a dramatic reduction in the intensity of the interactions between the agents in charge of development, be this at a quantitative level (number of iterations required) or a qualitative one (mode of coordination used) (Sanchez and Mahoney, 1996). All of this argues in favour of adopting modular product architecture and seems to justify the idea that outsourcing can be the organisational vector of its implementation. Empirical research demonstrates that in the wake of pioneering computer industry (Baldwin and Clark, 2000; Sturgeon, 2002), the modularisation/outourcing tandem has been adopted by many assembly industries, like electronics (Langlois and Robertson, 1992) or bicycle manufacturing (Galvin and Morkell, 2001).

The automobile, a complex product par excellence, is also subject to the temptation of modular reasoning (Takeishi and Fujimoto, 2003). At the same time, give the sector’s imperfect configuration, industrialists working in this field have chosen a singular way of breaking down modularity’s principles. Two points are crucial here. Firstly, modules are defined above all by their physical dimensions. Faced with the constraint of product integrity (Clark and Fujimoto, 1991), industrialists have defined modules as sub-assemblies corresponding to vehicle parts (front module, rear module, doors, etc.). Very few are mono-functional (notable exceptions being seats and engines, and to a certain extent exhaust systems). Quite the contrary, most are multi-functional, and therefore diverge from the principle of ‘one-to-one mapping’, which holds that one sub-assembly should fulfil one function. Modules defined thusly, are more like macro-components (Volpato, 2004) than modules in the pure meaning of the term. This is especially true when interfaces remain decoupled. After all, most macro-components are specific to one vehicle. Their mode of integration into a vehicle must be redefined from one model to the next (Sako, 2003), although there are a few exceptions, like engines that can be shared amongst several models.

![Figure 1 Examples of macro-components](image)

Of course, as the move toward modularity is a process, we do not forget that all the components bought by carmakers are not macro-components. In the current supply chains, we have a set of components more or less modular, more (cockpit, front/rear end module...) or less (batteries...) idiosyncratic. But these macro-components are the key issue for carmakers. They determine the economic performance of the supply chain because they are costly; they define the differentiation and quality of the final product; and they are at the centre of innovative strategies. In brief, the macro-components are crucial for the future of carmakers and First Tier Suppliers and we will focus our questioning of ‘too much outsourcing’ on this kind of ‘modules’.
The notion of modules in the automobile sector is therefore relatively different from the pure definition formulated by Ulrich. It remains, however, that many industrialists implement a pragmatic solution aimed at reproducing certain properties of modularity. Concepts revolving around the separated and synchonic production of physical elements are part of this singular category. More, if we shift vertically from global product architecture to detailed module architecture, we discover that suppliers have a relatively modular way of designing some modules, i.e., they seek to de-specify the structure underlying the modules they deliver (one example being seats’ metallic frames). For these reasons, we do not believe that it is possible to describe automobiles as possessing integral architecture, since theirs is more of an imperfect and intermediary kind of architecture. In addition, industrialists, carmakers and suppliers, have been trying to develop increasingly modular architectures (Cauchik Miguel and Pires, 2006). This objective convergence justifies asking whether the current period constitutes a transitory phase.

2.2 A transitory or a perpetually renewed stage?

In a seminal reflection on modularity, Simon (1962) explained that the modular breakdown of a complex system is necessarily contingent on the advance of knowledge. With this in mind, it is possible that, in time, firms driven by modularity’s economic advantages will engage sufficient resources to improve the automobile’s degree of modularity. The idea already makes sense if we consider that the ‘translation’ of modularity in this one industry offers proof – which would have been difficult to find just a few years ago – that it is possible to break vehicles down physically into blocs of macro-components. In this way, certain innovations, relating for instance to electronics or computerised design, should enable further advances down the road towards modularity. Veloso and Fixson (2001) have shown how airbag systems became more modular thanks to progress achieved in electronics and miniaturisation, at the behest of airbag producers whose economic future depended on their ability to make this functionality more compact and reliable so that manufacturers would want to integrate it into all of their models.

The point here is not to deny that progress can be made. At an analytical level, however, two sets of arguments advocate replacing the transition hypothesis with one predicated on irreducibility.

The first series of arguments can be more or less broken down into two technological levels. Firstly, product definition is influenced by changes in regulation. The most sensitive topics today are environment and security. There are more constraints now in terms of recycling, effluents (CO2 notably), passenger and pedestrian protection or production standards (e.g., the REACH Regulation in Europe). These are all elements that require the exploration of new technological paths (materials, production and assembly processes, parts design). For each generation, the engineers in charge of general architecture (of the car) and detailed architecture (of the modules) are forced to introduce innovations. Secondly, whereas a few years ago the automobile was mainly a question of mechanics and hydraulics, nowadays it mobilises a vast field of technologies based on dissimilar competencies. The development of electronics but also glass technology, for example, has turned the automobile into a technologically composite product. Seen in a static light, this diversity is no real problem since modularisation is in fact a modality for managing such complexity. But when we adopt a dynamic perspective, modularity’s
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Intrinsic limitations come to light. Technologies are associated with varying innovation rates, forcing developers to constantly reconsider the physical interactions amongst components as well as the new functional products born out the progress achieved in one domain or the other (Brusoni and Prencipe, 2001). In short, either the architecture remains frozen and the quality of the final product deteriorates (materially due to incompatibilities, or as a result of missed opportunities), or else the global and detailed architectures are redefined by actors’ progress. Because the second choice is usually preferred, not are only interfaces unstable but also macro-components themselves.

The second series of arguments is more explicitly organisational because it refers back to the strategic behaviour of the firms involved. Empirical studies show that far from constituting a ‘dominant design’ in Utterback and Abernathy’s sense of the term, different automakers achieve modular breakdown in different ways (Gadde and Jellbo, 2002). One clear divergence is between Western and Japanese carmakers, with the latter taking much greater care to develop modules and break their branch down along modular lines (Chanaron, 2001). Some might view this diversity as a reflection of the novelty of the general shift towards modularity – given that new models are usually born after a period of experimentation – but this would be a dubious interpretation. Sako (2003) and Batchelor (2006) have shown that the type of modular breakdown adopted by a carmaker depends on the strategic objective that it attributes to modularity: design, production or utilisation. Highlighting one or the other form of modularity leads to divergent choices being made regarding the vehicle’s modular breakdown, in the sense that modules do differ from one carmaker to the next. Batchelor (2006) has added that part of this choice reflects a firm’s history. Since over the long run automakers constitute differentiated firms that each pursue their own trajectory (Boyer and Freyssenet, 2002), there are few reasons to believe that uniform choices will be made across the whole of the industry, hence that just one kind of modular breakdown exists. In actual fact, the opposing hypothesis of renewed diversity seems a better bet.

The argument encounters its limits when we consider that design models can be imposed by certain prescribers – this being a role that some module suppliers would like to inherit. Conceptually, however, this causes a problem since, by definition, suppliers have knowledge of detailed (module) architecture but not of the overall architecture. Thus, they necessarily find themselves in a situation of dependency within the design chain, despite their efforts to offer manufacturers readymade solutions. Note that such solutions, despite their sophistication, derive more from module suppliers’ attempts to differentiate themselves than from any real efforts to restructure their product offer. For this to occur, suppliers would have to collude on each and every module. This could happen if there were some kind of standardisation body to impose professional norms, but three elements prevent this:

1. the different ways in which supplies chains are organised by carmakers, some of whom continue to run powerful supply subsidiaries
2. carmakers use multi-sourcing practices for the different models comprising their product range to force suppliers to compete with one another
3. with a pyramid of module suppliers that (still) remains relatively open, there is always a possibility of new entrants.
The pragmatic definition of modularity adopted by the automobile industry is therefore likely to last. The ‘persistent integrality’ will stay the norm (Zirpoli and Camuffo, 2009). Far from being a transitory phase, we should expect the automobile to remain an imperfectly modular product insofar as technological and organisational dynamics drive it towards a continuous renewal of architectural definitions. This hypothesis raises two theoretical questions. On one hand, we cannot expect interfaces to encapsulate all of the information required for inter-firm coordination. On the other, demand characteristics are unstable: the product demanded (the module) will differ substantially from one carmaker to the next, and usually from one model to the other. The combination of these two elements limits the possibility of externalisation. More specifically, three interlinked but distinct problems arise at this level: risks associated with opportunistic behaviour and the loss of absorptive capacities; and problems surrounding the long-term fall in production costs. These three elements are limitations on outsourcing given that, as per the arbitrage logic that has been developed in transaction cost economics, outsourcing constitutes an efficient solution when it does not harm a firm’s current and future integrity or market power, and when it saves supply costs. Three elements are often debated in situations of imperfect modularity.

3 Lesser absorptive capacities

Much of the debate about modularity focuses on questions relating to firms’ knowledge boundaries. The shift to modularity has led to a transfer of the ‘loci’ where production occurs and where research is exploited. This is because modularity should make it possible - in an organisational solution where outsourcing has been chosen – to delegate design functions to module suppliers, possibly on a cooperative basis. In the automobile industry, this is generally the path chosen due to the fast rising R&D costs that manufacturers must otherwise face. Two main mechanisms are at work here. On one hand, the accelerated speed of cars’ replacement reduces the sizes of the series over which carmakers can spread their development costs. On the other hand, absolute spending has risen, with the combination of new technologies and more stringent regulatory constraints leading to higher spending on new model development. At a more contextual level, the objective or subjective rise in financialisation constraints has heightened firms’ desire to outsource their design functions since, by so doing, they can transform into variable costs what used to be fixed costs weighing upon their financial ratios (Froud et al., 2002). To carmakers, the modularity/outsourcing tandem therefore constitutes an opportunity to manage these constraints by transferring R&D costs to module suppliers. In other words, they can cut their R&D departments and focus on developing architectures (a key point in inter-firm competition) whilst taking advantage of permanent innovations that have a strong chance of market success but are developed by suppliers seeking to achieve monopolistic positions in the innovation arena.

Delegating development to suppliers should trigger four cumulative mechanisms:

1 Competition between suppliers should accelerate the innovation rate. At an initial level, it is expected that suppliers’ specialisation will allow them to improve the functionalities integrated into the modules they manufacture, hence the characteristics (in Lancaster’s sense of the term) of the final products (Sanchez and Mahoney, 1996). At a second level, in a period of uncertainty about modules’
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2 Delegating design to module suppliers helps improve ‘design-for-manufacturing’. Suppliers’ module products gain in reliability and manufacturing costs when their production process is designed at the same time as development, a key point in a mass industry (Clark and Fujimoto, 1991).

3 Suppliers enjoy economies of substitution derived from their ability to reuse components that have already been developed and tested during the course of preceding developments (Garud and Kamaraswany, 1995).

4 Development delays should shorten, enhancing carmakers’ flexibility by generalising parallel development and concurrent engineering practices (Clark and Fujimoto, 1991; Baldwin and Clark, 2000).

These mechanisms are cumulative since as suppliers specialise in the design/production of a specific module, they ascend the learning curve and reinforce their abilities in these different aspects of the innovation process.

In short, outsourcing can in fact be an effective solution, in static terms, due to lower R&D costs throughout supply chain, but also dynamically, thanks to the learning effects. It remains that this argument tends to neglect the situation of buyers, who in this instance are the automakers. The decision to reduce internal R&D capabilities can have negative side effects over the medium or long term.

Where interfaces are unstable, designing the product’s global architecture means controlling the attributes of the physical interactions between the different modules comprising the whole (Prencipe, 2003). By externalising the module design, carmakers necessarily lose some of their technological prowess in this area. There are at least two reasons for this: because they diminish or even lose research capabilities relevant to these modules; and because they deprive themselves of user/producer interactions (Lundvall, 1988) to become simple consumers of technologies. Clearly, organisational solutions can be implemented to offset apparent shortcomings, like platform teams coordinated by a so-called ‘heavy manager’ (Clark and Fujimoto, 1991). It remains that if these teams are capable of close inter-firm collaboration between carmakers and suppliers, the former can only hope to capture some of the knowledge about modules’ detailed characteristics, and even less about their production process. These arguments, which have been advanced in Complex Product Systems literature (Prencipe et al., 2003), are well and truly embodied in the automobile sector where manufacturers have lost the ability to develop autonomously certain functions like dynamic braking systems (Autobusiness, 2004). According to Morris and Donnelly (2006, p.270), carmakers may maintain a good enough functional knowledge of modules (knowledge about functions, applications and uses) but they only have an approximate knowledge of many modules’ production and design processes, described as ‘grey box modules’.

Analytically, the complete delegation of modules’ R&D diminishes carmakers’ absorptive capacities (Cohen and Levinthal, 1990), with firms losing their ability to evolve their product and to innovate. Prencipe (2003) specified this by noting that the
outsourcing of R&D can hinder the introduction of new architectures. If the architect of a
global product no longer controls inter-module interactions and no longer understands the
technological and functional opportunities offered by module-related innovations, s/he
will be unable to design radically new architectures. The product will freeze in its current
state, and this will weaken the manufacturer who has taken the outsourcing decision,
affecting its ability to make radical innovations, especially in comparison to more
integrated competitors. From a more short-term perspective, Chesbrough and Kusunoki
(2001) have shown that buyers run the risk of falling into a modularity trap, construed as
their inability to exploit all of the technological opportunities derived from the
fragmentation of knowledge amongst different value chain actors. In an industry that is
modularised and functions on the back of externalised complementary competencies,
each firm only has a fragmented vision of the whole.

A more detailed study of the innovation process reveals that this fragmentation of
knowledge also constitutes a qualitative problem. Takeishi (2002) has shown that the
quality of suppliers’ developments depends strongly on the degree of carmakers’
technological prowess, notably in regards to architectural knowledge. The same study
confirms that carmakers that have substantially reduced the scope of their ancillary
(non-core) competencies are less successful in innovation terms than carmakers who have
maintained and continue to achieve significant learning regarding detailed module
architecture. In a case study, Zirpoli and Becker (2009) obtain similar results and,
interesting thing, FIAT managers seem to understand the problem: “It is naïve to believe
you can integrate a system without holding an in-depth and detailed knowledge of the
components that are going to affect the performance of the whole car. Managing each
system performance does not, in fact, automatically result in effective system integration.
The performance is the ultimate objective, not systems... We realised you cannot
integrate the performance of components you know very little about... if you have never
designed a component or a system it will be very difficult to understand the subtle
interactions with the rest of vehicle” [FIAT Director of Vehicle Concept and Integration,
2006, quoted in Zirpoli and Becker, (2009), p.14]. But, in the same time, FIAT seems to
be prisoner of past choices: “We should have reversed our strategy by integrated back
competences that we had lost. We had two problems, however, no money and no time”
[FIAT Manager in charge of System and Vehicle Integration, 2006, quoted in Zirpoli and
Becker, (2009), p.17].

De facto, the two studies demonstrate that carmakers should maintain internally an
extended range of competencies. This dovetails with Brusoni and. Prencipe’s (2001)
conclusions about the chemical and airplane motor industries. This solution intimates a
reconsideration of organisational choice since it indicates a need to renounce any and all
outsourcing of detailed design so as to benefit from suppliers’ various aforementioned
advantages. It also corresponds to an internal duplication of research, since in this
instance firms decide to maintain R&D departments that do ‘more than firms do’, to
paraphrase the title of an article by Brusoni et al. (2001). Such organisational choice
should enable a partial abatement of the loss in absorptive capacity (only partial because
the carmaker can’t benefit from user/producer interactions) whilst at the same time
partially offsetting the risk of suppliers behaving opportunistically.
4 Risks resulting from suppliers’ strategic behaviour

The above discussion was mainly cognitive in nature. It is possible, however, to extend its scope by considering the strategic behaviours pursued by the firms in question. In modularity literature, the implicit assumption is that buyers can be ‘virtualised’ due to suppliers’ ongoing dominant position. For Langlois (2003), for instance, the ‘vanishing hand’ refers basically to a market logic where suppliers are forced to compete and replace one another in bidding wars, depending on their ability to offer the lowest price. This view is, however, questionable. Intel and Microsoft, microprocessor module and software system suppliers, have shown that an industry’s endogenous dynamic can reverse market power – even in a branch reputed to be purely modular. A recent study by Howard and Squire (2007) has confirmed that the shift to modularity leads to a rise in firms’ mutual dependency.

So, it is not a surprise that the consequence of modularity on inter-firm relationships is one of the more studied issues in the academic literature. Recently, we have a lot of evidences that, contrary to some initial predictions, the carmakers keep their power. By example, Rutherford and Holmes (2008, p.540) show that “The financial advantages enjoyed by OEMs [carmakers], combined with their strategic position within GPNs [Global Production Networks] and their ability to access low cost suppliers globally, is eroding the cluster-based advantages of suppliers, and in particular, SMEs”. They explain notably that carmakers can diffuse proprietary information of a given supplier to another which can produce components more cheaply. This picture is singularly true for US carmakers which maintain their historical “predatory purchasing practices” (Sturgeon et al., 2008), in particular thanks to the overcapacity affecting the part sectors (Helper and McDuffie, 2006). But when we observe the economic results of First Tier Suppliers at a global level (of course, before the current crisis), their weak economic performances suggest that the predatory purchasing practices are not an US specificity (Frigant, 2009; for a European case study see Fourcade and Midler, 2004).

If many observers sustain that carmakers have still the market-power and maintain competitive pressure on the suppliers, we need to address this issue with a prospective vision. Indeed, the current crisis could change some parameters for two main reasons:

1. the many failures of auto-parts firms reduce sharply the industrial capacities
2. the crisis could induce a more aggressive behaviour from certain suppliers which in the past have not used their structural power advantage (as Gulati and Sytch, 2007 shown).

We can also expect a growing pressure from state and local authorities. By example, in France, the association of suppliers (FIEV) has obtained from the French Government an agreement (signed by suppliers, carmakers and minister) in which the carmakers promise to adopt a more fairly procurement policy (banning of a presence in a low cost country as a precondition to be considered for a new part, improvement of the payment of RD expenditures, reduction of the payment times. (http://www.etatsgenerauxdelautomobile.com/). We will consider two specific problems due to imperfect modularity.
4.1 Assessing product offers

The loss of competency regarding detailed architecture raises questions about how to assess module suppliers’ product offers. How can we hope to ascertain the suitability of an offer if the carmaker has imperfect knowledge of the design and production process? How should ‘grey box modules’ be categorised? Manufacturers sometimes lose the ability to estimate their choices’ technological applicability and market value. Suppliers do adopt opportunistic behaviour, for example, when they offer overly customised modules and/or apply unjustifiable cost criteria. This risk of over-performance has been highlighted on many occasions in the defence industry, where prime contractors’ expertise is singularly below producers’ innovation capabilities and innovation justification (Moura, 2007). There are no reasons to assume that carmakers can escape this predicament in the long run, despite the (technical and financial) audit and expertise programmes that they have set up to overcome it.

Alongside of this, carmakers face problems relating to the confidentiality and diffusion of technology. The first risk they face is that a module supplier working with several carmakers may diffuse information to one manufacturer about the models that another is developing. This can be avoided by contract clauses giving carmakers ownership rights over the module. Such a procedure, called ‘design entrusted’, is one of the contractual forms used to complement traditional ‘design supply’, where carmakers build a component to their own specs, or ‘design approved’, where the whole of the design is delegated along with ownership rights (Asanuma, 1989; Clark and Fujimoto, 1991). Due to contractual incompleteness, however, this sort of solution cannot satisfy all contingencies. Moreover, Fujimoto and Ge (2006) have noted that ‘design approved’ procedures seem dominant with the more complex and more modular macro-components, even though greater challenges are faced here. More concretely, a carmaker will demand a dedicated workforce amongst its suppliers’ development staff (Brandes et al., 2007). From a confidentiality perspective, there is a clear argument to make here, but questions remain about the efficiency of this kind of solution, measured in cost terms. How much will be saved in development costs if the supplier is unable to enjoy the same economies of scale as it would achieve by getting employees to work on several design projects at once? How significant will the learning mechanisms be if developers are dedicated to a single type of project? Lastly, what kind of internal governance costs will be incurred by suppliers running a number of dedicated teams?

To limit the financial impact of having dedicated teams, suppliers try to duplicate their R&D processes. The current trend is to organise R&D into two strata. The first level brings the modules’ integration modalities into a global architecture, along with the definitions of the detailed specifications of the modules that the dedicated teams have built in close collaboration with manufacturers. The second level accommodates the general design of modules along with their constituent (hidden) components, in the words of Baldwin and Clark (2000). Activities of this nature are concentrated in large research centres that are often specialised by module types, and where teams undertake transversal research on behalf of several carmakers. Clearly, the challenge in these specialised centres is to achieve economies of scale, scope and substitution.

It remains that this kind of organisational solution creates a new problem relating to R&D costs. When a supplier establishes its sales price – and depending on the contractual schema applied - it will pass on to the carmakers some or all of the R&D sums that have been spent on developing the module. There is a moral hazard here that the supplier will
invoice several carmakers several times for the same development phases or upstream research. Such behaviour may enable suppliers to rebuild their margins but it also leads – in contradiction with the initial goal – to higher overall R&D costs throughout the value chain (all things being equal). A solution implemented by a number of carmakers has been to introduce exclusivity clauses guaranteeing that, after a waiting period, the supplier will not be able to propose the technological innovation to another competitor. Clearly this solution is partial at best, since it does not keep suppliers from funding transversal research. And even if this does not happen, it would still run counter to the initial outsourcing aim of reducing overall R&D costs up and down the value chain since the supplier could no longer spread costs amongst carmakers.

4.2 Entry strategies

In a modular industry, there is a risk that a module supplier will contest the buyer’s status. Stabilising product architecture reduces entry barriers dramatically. Establishing oneself as a product architect is a possibility that is mainly open to those who can draw from a catalogue of suppliers offering complementary modules. On the face of things, this property makes it easier to contest markets, even if we can demonstrate that intangible advantages (brand image, knowledge of consumers, familiarity with suppliers’ quality, etc.) can sharply diminish the degree of a market’s contestability.

In imperfectly modular industries, the risk of horizontal competition is much weaker. Outsourcing can be a safer bet with such a strategy. In the automobile industry, despite module suppliers having achieved considerable size over the past decade (sometimes matching small carmakers), few actors can hope to get into the auto-making business. De facto, only the Canadian firm Magna possesses sufficient architectural competencies to try and compete with automakers. But even Magna do not believe that it can become a carmaker without an ally inside the market. This was its plan in spring 2007 when it positioned itself to acquire Chrysler, which Daimler was putting up for sale. In other words, it was in fact through the acquisition of an established and reputed carmaker that this supplier intended to penetrate the market. This is also its plan in spring 2009 when it proposes (with success when we write this paper) to acquire Opel from GM Europe with the financial help of the Russian bank Sberbank and the industrial cooperation of the Russian carmaker GAZ. But, if Magna carry out its acquisition successfully, how will the established carmakers react? We may suppose that they would adopt retaliatory measures and reduce their orders to the Canadian supplier? It is not at all clear that the gains from a strategy based on entering the manufacturing business exceed the losses a supplier would suffer in its original business.

Horizontal risk may be relatively weak but there is also the risk that module suppliers may favour a pre-existing firm. Chesbrough and Teece (1996) evoked this possibility using the example of Intel when it tried to favour Compact in order to reduce IBM’s market power. In the automobile sector, this kind of behaviour can be seen with automakers in emerging countries (China and India). There is a lesser degree of modularity in the automobile business, although it is possible to use reverse engineering to detect a given vehicle’s global architecture. By delegating the modules’ manufacturing to international suppliers who make the modules used on the original model, it is relatively easy to match such equipment’s international quality standards. Variations do subsist where manufacturing is internalised, notably with final assembly operations, but
firms that enjoy an absolute advantage in cost terms can always position themselves in the low-cost vehicle niche. It is in module suppliers’ interest to adopt this approach for two reasons: they can spread their development costs across new series; and they can increase the production scale of the units that they have had to move to these countries at the behest of Western carmakers who require their suppliers to follow them abroad (follow sourcing).

5 Does outsourcing really cut production costs?

Simplistically speaking, the first reason why production costs fall is because of labour costs. Wage differentials are favourable to suppliers in a given country, translating the historical weight of the trade unions there as well as the higher average seniority of employees working for manufacturers (ILO, 2005). Insofar as production tasks are more labour-intensive upstream, transferring production costs to suppliers cuts the total wage bill for the whole of the value chain. This is not a new argument (Helper and McDuffie, 2006), p.419 and p.422), however, nor does it explain how the shift to modularity has become such a clear cost-cutter.

Williamson (1985) asserts that the differential in production costs is generally favourable to outsourcing due to the fact that suppliers are able to aggregate individual demands, thereby increasing their scale of production. This argument is reproduced in modularity literature, to which we can add a more explicit argument framed in terms of economies of scope, one where modules are conceptually construed as being the equivalent of macro-components. The argument here is that co-production by one and the same company of components X and Y should be inferior to a separate production of X and Y in which different companies are able to optimise the two elements’ design and production processes. Of course, the question is whether these classic arguments apply in the case of imperfectly modular production.

We can start by asking about the magnitude of these economies of scale. Modular variations in the automobile sector have led to a number of idiosyncrasies, especially where each main module is associated with a particular vehicle model. This clearly does not apply 100% to engines, although having said that, in general engine production has not been outsourced and remains (for the moment) one of the few activities that carmakers view as a core competency (note that in the aircraft industry this is not the case, and the carmakers are quite willing to sell one another certain types of engines). Aside from this one case, modules are designed and produced for specific models. By definition, this reduces opportunities for economies of scale. The problem is worsened by the fact that the value chain operates according to synchronous flows principles: modules that are voluminous and fragile must be delivered to carmakers’ assembly chains in real-time and according to very tight schedules. This logistical constraint has been overcome through the construction of supplier parks, i.e. final module assembly workshops that suppliers build immediately adjoining carmakers’ plants (Larsson, 2002) and even inside them in the case of modular consortiums (Pires, 1998). This sort of solution raises two problems, however: it leads to a duplication of production capabilities on many smaller sites; and it causes a site specificity problem that augments bilateral risks of opportunism (Frigant and Lung, 2002). A spatial organisational schema of this nature increases production and transaction costs.
To cope with the aforementioned problems, suppliers try to build shared modular platforms that we can call meso-components, to distinguish them from the final modules that we call macro-components (Frigant and Layan, 2009). The purpose of these meso-components is to generate economies of scale, in the sense that such elements are supposed to be shared by several carmakers, even if they are mostly used on different models made by one and the same carmaker. This is also how economies of scope are generated, be it in the production or design area. The challenge is how to design platforms that reuse a maximum of components that have already been developed (economies of substitution) whilst integrating product components coming from specialised plants. The aim here is to maximise economies of scope.

At the same time, we need to consider the organisational aspects, as well as the different ways in which suppliers have structured themselves organisationally. Automobile suppliers are firms that existed before the shift to modularity. This is unlike computer industry for instance, where modularity preceded the founding of most if not all supply companies – whose birth constituted in actual fact an expression of market opportunities (Baldwin and Clark, 2000). In the automobile sector, we need to account for the trajectory of an industry that was already structured by the time the shift to modularity occurred, i.e., where the firms that slid towards modularity were already up and running. Usually, these were large and highly internationalised and structured organisations, run by functional divisions that were not thought of in modular terms but defined by the components they were offering. Empirical analyses have shown how difficult it is to transform an organisation and set up a new organisational matrix - one geared towards a modular approach to the market – whilst continuing to manufacture components for non-modular carmakers and the spare parts market (Doran, 2003; Fourcade and Midler, 2004, 2005; Belzowski et al, 2006). Furthermore, the architecture of the modules in question differed from one carmaker to the next. De facto, uncertainty, governance costs and reorganisation/restructuring costs were high, limiting expected cost savings.

We could assume that this was a transitory phase, following which suppliers would have had an efficient organisational structure allowing them to respond to the explicit demand. Yet this interpretation runs afoul of the aforementioned hypothesis of a lasting redefinition of the modules’ design (Section 2). Instability in the modules’ detailed architecture implies that suppliers’ internal reorganisation process will be a long-term if not permanent one. This is what has happened, not only at a purely organisational level but also at a productive apparatus level.

One of the advantages of outsourcing in the computer and electronic industries is that it helped to increase the international fragmentation of production. The cognitive properties of modularity, bigger components markets and lower logistics costs have helped module suppliers to fragment their production process and establish production units that exploit locational advantages (Berger, 2005; Sturgeon, 2003; Ernst, 2002; Lüthje, 2002). We know that some carmakers demand to their suppliers a quota of production in low cost countries. It's a kind of precondition to obtain a market. But despite the increasing international division of labour, it remains that in the automobile sector, logistical and cognitive constraints make it hard to exploit this fragmentation (Domanski and Lung, 2009), especially since the modules’ instability makes it impossible to establish an efficient spatial organisational schema.
Automobile suppliers have been trying to build up a global fabric of production and R&D sites that can respond as efficiently as possible to customers’ centrifugal and centripetal constraints yet allow suppliers to benefit from locational advantages. If we observe the geography of suppliers' production sites, we see they try to combine proximity and internationalisation, insertion in global production networks and clusters, in order to respect low cost production and efficiency in coordination (transport, exchange of knowledge...) (Frigant and Layan, 2009; Sturgeon et al., 2008). The pursuit of this objective has translated over the past few years into a proliferation of industrial restructuring operations: site closures.sales and openings/acquisitions; production specialisation; and production transfers. All of these operations hamper overall production costs, at least in the short run, but are undertaken in the hope that other savings will be generated in the medium term. The problem with this hypothesis is that it requires the assumption that, simultaneously:

1. site specialisations will in fact correspond to future module sales
2. automakers’ production locations will themselves be stable
3. customer portfolios will remain identical
4. new entrants will not come in and destabilise the industrial structure.

These four conditions, necessary for the construction of an optimal spatial-organisational schema, might be difficult to validate over time.

6 Conclusions

Automakers – like other assembly industries (e.g., aircraft) – have singularly increased outsourcing in recent years. These refocusing strategies are often legitimised by notions like (responsive and proactive) flexibility, improved quality or lower overall design and production costs. In part, they would appear to be grounded in the rise of modularity. Despite the difficulty of transferring this notion to a product as complex as this one is, carmakers and suppliers have converged strategically around the automobile’s modularisation.

The point of this article was to take a critical look at the outsourcing strategies adopted by a large number of carmakers, particularly in Europe and North America. Even if modularity literature demonstrates the economic potential of the modular architecture/outsourcing tandem, the sectors considered in previous empirical analyses were mainly based on pure modularity such as Ulrich has defined this. The automobile will operate for years to come within a framework of impure modularity. In this context, this summation of empirical literature on how inter-firm relationships function in the automobile sector has shown that cognitive and strategic limitations are endangering the future integrity of carmakers engaged in an organisational model based on massive outsourcing and an exacerbated refocusing of firms’ boundaries. Moreover, it is not sure that we can expect a huge reduction of overall production costs thanks to outsourcing.

In our analysis of outsourcing, we have tried to demonstrate that internal tensions and contradictions do exist. The main sources of tension derive from the fact that most of the problems identified will only produce their effect in the medium and long run, with some of the more immediate effects being masked. For example, discussions about the reality
or extent of the drop in production costs have been partially obscured by the behaviour of suppliers, most of whom have cut their margins dramatically. This strategy may be possible in the short term but it has caused a significant fall in these firms’ average profitability, with some facing serious financial difficulties – even before the current crisis (Frigant, 2009). Can such behaviour be considered viable? Is there any hope that suppliers can maintain a high level of R&D spending and participate in a modular strategy logic that requires increasing material and immaterial investments?

Clearly, carmakers see some of these problems but their levels of perceptiveness differ singularly. Fujimoto (1999) and Takeishi and Fujimoto (2003) have shown, for example, that a carmaker like Toyota relies on a growth model in which the shift to modularity occurs very progressively on both the technological and organisational levels. The Japanese carmaker tries to internalise most knowledge about modules’ global and detailed architecture. Outsourcing can often be understood as the act of delegating part of the design function to a firm’s own supplier subsidiaries, which in many cases still remain the primary partners for manufacturers. De facto, Toyota embodies a strategy of quasi-vertical integration that has proven itself in the past and could be formidable again in the future if the limitations discussed in these pages concretise and if they are not sufficiently integrated into Western auto manufacturers’ strategies.

References


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Notes
1 Another way to envisage a continuum is to change the level of analysis. Clark and Baldwin (2000) distinguish between modularity in design, production and use depending on whether they are looking at the upstream or downstream side of a product’s production. Thus, a product can be modular at certain stages but not at others.

2 Several research teams have been working to find measurements of a product’s degree of modularity. Probably the most advanced is the group led by Fujimoto (MMRC, University of Tokyo). See Fujimoto and Ge (2006).
3 An example from the French supplier Faurecia: “Faurecia is stepping up its ‘component platform policy’, targeting maximum standardization for non-visible vehicle part […] One example of this approach is a seat frame for the worldwide General Motors platform, and a common cockpit structure across different Ford Group models” [Faurecia Annual Report, (2006), p.20].